DISSERTATION

AN INTEGRATED LANDSCAPE CONSERVATION APPROACH FOR THE AGROLANDSCAPES OF SOUTHERN BRAZIL: THE CASE OF CAMPOS GERAIS, PARANÁ

(VOLUME 1 - CHAPTERS 1 - 4)

Submitted by

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WE HEREBY RECOMMEND THAT THE DISSERTATION PREPARED UNDER OUR SUPERVISION BY CARLOS HUGO ROCHA ENTITLED *AN INTEGRATED LANDSCAPE CONSERVATION APPROACH FOR THE AGROLANDSCAPES OF SOUTHERN BRAZIL: THE CASE OF CAMPOS GERAIS, PARANÁ* BE ACCEPTED AS FULFILLING IN PART REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY.

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ABSTRACT OF DISSERTATION

AN INTEGRATED LANDSCAPE CONSERVATION APPROACH FOR THE AGROLANDSCAPES OF SOUTHERN BRAZIL: THE CASE OF CAMPOS GERAIS, PARANÁ

This study utilizes mixed methods to develop a strategy for conserving a network of natural and restored parcels of varying sizes in an intensively managed yet biologically diverse agricultural region of Southern Brazil. As these lands are essentially privately owned, a dialogic-dialectical conservation approach based on understanding landowner perspectives, assigned meanings, and collectively constructed knowledge, was used along with spatial information to develop a landscape-based conservation praxis.

Spatial information was used to develop a broad understanding of the Campos Gerais ecoregion, the biophysical and human context on which conservation planning and management should be developed, and to select and prioritize remnant habitat patches and connecting lands. Brazil's legal framework was then analyzed in order to identify current and potential incentives for private land conservation. A purposive sample of farms and ranches were selected and using farm-level spatial information, these landowners were interviewed in depth, using a mutual learning approach in order to establish their predisposition to conserve and which conservation incentives are seen by them as most appropriate.

Using this information it was possible to predict the "conservation likelihood", preferred conservation techniques and whether the techniques could be agreed upon or

would have to be negotiated for different types of landowners. Conservation likelihood can then be expressed spatially allowing us to model or anticipate the effects of conservation – or the changes that might otherwise occur. These models can in turn, be used dialectically with landowners to implement a landscape level conservation strategy.

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DEDICATION

to my family

to Helenna - our angel.

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Chapter 1: Setting the Landscape Research Framework

1.1 Description of the Topic

Destruction and degradation of natural habitats are widespread and profound and their implications for the conservation of biological diversity and the sustainability of natural resources are of global significance. Such transformations are not a new phenomenon, but it is the rapidity and the global scale at which change is now taking place that causes alarm. Worldwide, protected areas, the traditional form of conserving biological diversity, are becoming islands of natural systems, isolated and surrounded by human shaped landscapes; the increasing demand on the natural resources is putting the very existence of such reserves at risk (Milano 1991, McNelly 1994, Hunter 1996, Noss, 1996, di Castri 1997, Terborgh 1999, Langholz et al 2000, Foley 2005).

Closely coupled with the issue of broad scale loss of natural habitats is the challenge of maintaining and conserving biodiversity in landscapes dominated by human land use. In these landscapes, large natural tracts are becoming scarce or no longer exist. Such changes in the landscape imply modifications in the mechanisms of conservation and transference of genetic information. As the final stochastic force pushing populations toward extinction, the fragmentation of natural landscapes is one of the main causes of the extinction of species (Begon et al 1990, Hunter 1996, Noss 1996, Bennett 1999, Terborgh 1999).

As continuous expansion of the capitalist system has pushed environmental degradation to global level, remnants of the natural environment increasingly occur as a mosaic of large and small patches, survivors of environments that have developed into new forms of productive land use for humans. Together they provide the habitats upon which the conservation of much of the flora and fauna in developed landscapes ultimately depends. Understanding the consequences of habitat change and developing effective strategies to maintain biodiversity in developed and disturbed landscapes, is a major challenge to both scientists and land managers (Forman 1995, Bennett 1999).

The integration of strategies for biological conservation in landscapes managed for agriculture, forestry, ranching, and recreation, have been proposed as complementary approach. The challenge is to design and implement land-use strategies that will ensure the conservation of natural resources in the face of competing demands for land use. A key element to address biological conservation within such landscapes is the integration of scientific skills with applied management and policy in order to achieve practical outcomes that have long-term benefits for species and biological communities. (IUCN/UNEP/WWF 1991, Forman 1995, Ahern 1999). Hence, the need to integrate human dimensions into conservation policies and programs is widely accepted (Mascia et al 2003), although not often addressed.

Bawa et al (2004) have pointed out that the conservation science community has put much more effort in generating knowledge to address the question of "what to conserve" rather than "how to conserve". As argued by them: "the models based on conservation science seek unifying principle reflecting science's quest for general and widely applicable concepts. They tend to view the world through relatively coarse filter and may fail to encourage the emergence and spread of fine-grained models adapted to local conditions. Under conditions of rapid change, long-term conservation goals may best be achieved by a strong focus of building resilience within ecological and social systems. Most models, however, are directed toward the achievement of particular outcomes, rather than the support of systemic resilience".

As pointed out by Bawa et al (2004): "with the question of how to conserve, we are confronted with the complexity and heterogeneity of ecosystems, and superimposed on this heterogeneity we find a myriad of social, economic, and institutional factors that determine the prospects for conservation". Thus, the literature on the means for achieving conservation results, within given social and economic contexts (e.g., Hagmann 2002, Ericson 2006, Sheil et al 2006) are exceptions. Kiss (2002) has observed that the conservation community worldwide has focused too much on carrying out project activities and too little on creating incentives for conservation.

Accordingly, conservation science and landscape planning theories must be further expanded to include social theories of action and change (Habermas 1987, Stringer 1999) to become capable of producing ecologically improved differences on real landscapes (Bosshard 1997, Bawa 2004). As pointed by Williams & Paterson (1999) "to advance landscape planning and conservation, we must advance the state-of-the-art of landscape management to a well-functioning citizenry employing their own skills for making public or moral judgments". Furthermore, conservation strategies must be conceptually defined and integrated at multiples scales to be effective.

Addressing multi-scale "how to conserve" questions is especially important for public agencies responsible for the management of large areas, but it is also relevant to community groups and individuals managing small parcels of land in fragmented landscapes. It is also a relevant research question to address biodiversity conservation matters on the intensively managed agricultural landscapes of southern Brazil. On such biodiversity rich agrolandscapes there is a clear demand for strategies to enhance habitat conservation in the management of natural resources at farm level, the scale where land management decisions are made by managers and landowners.

Therefore, the conservation of unique remnant ecosystems in the agricultural landscapes of southern Brazil needs an epistemological and landscape multi-scale planning approach that includes both a biological and a human dimension. This will require non-conventional research approaches. Hence, to explore a conceptual framework for answering the research question of "how nature conservation practices can be tackled on the agrolandscapes of study?" was the academic pursuit adopted for this dissertation research.

With this broad perspective in mind a Case Study was designed on the agrolandscapes of the Campos Gerais ecoregion located in the State of Paraná (Figure 1.1). The selected study area, defined as the Regional Matrix for this research, was included in the list of "Priority Areas for Biodiversity Conservation in Brazil" (MMA 2002, 2004, 2006). Comprised predominantly of privately owned land, the region's grasslands ecosystems have been converted into intensive farming lands in the last 30 years. Protection of the few remnants of natural ecosystems is the only feasible option for the conservation of the rare habitat types associated to this ecoregion.

Conservation biology and landscape ecology can provide a comprehensive theoretical foundation for tackling conservation issues in the Campos Gerais. While conservation practices must be based on scientific knowledge, they must incorporate the biological, social, economic and cultural context of the landscapes whereupon conservation actions must be integrated. Tress et al (2004) have argued that "we need

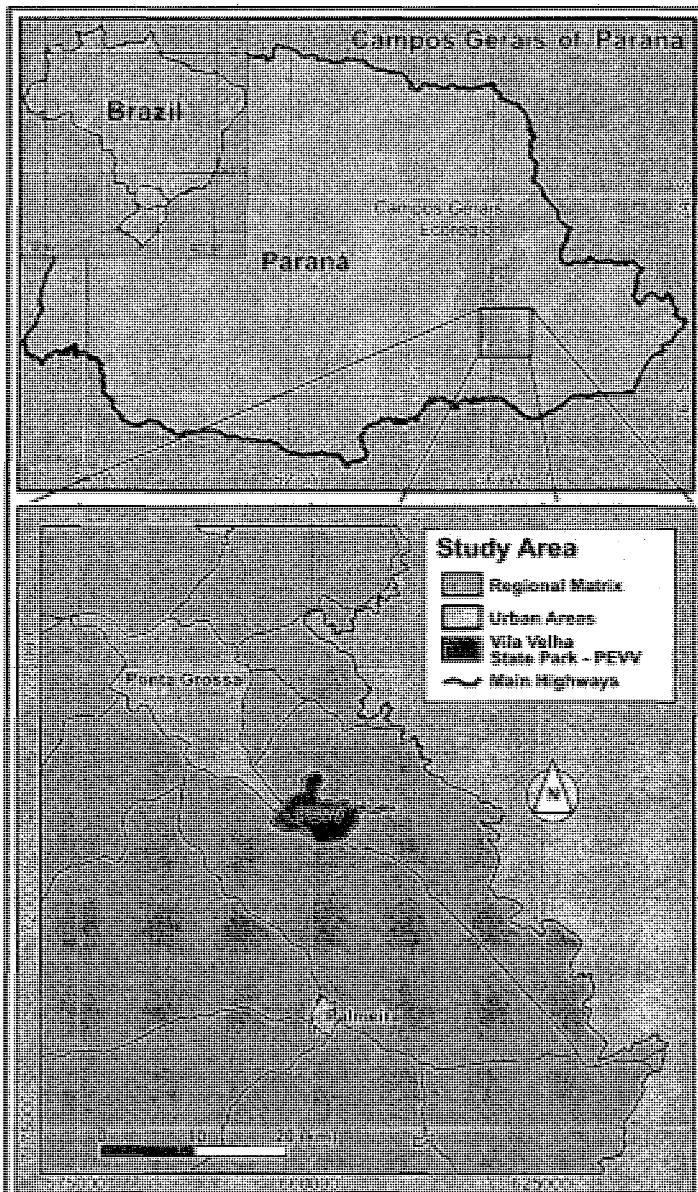


Figure 1: Situation map of Campos Gerais in the State of Paraná (Adapted from Maack, 1968) and Study Area

different approaches for different research questions”. The challenge is to understand how to choose the most appropriate approach for a specific landscape-related problem. Accordingly, the construction of a landscape-based research framework was pursued throughout the development of this dissertation to address conservation biology and associated human dimensions issues in the study area.

The theoretical perspective of the research framework is centered on the comprehension of landscapes as the synthesis of interacting ecological and cultural systems. Results of these coexisting subsystems are expressed on the agrolandscapes of the regional matrix, formed by distinct patterns of land use systems interspersed by remnant fragments of natural vegetation. Drawing on this landscape concept, the ecological and social components of the research were carried out. Although the discussion that follows is presented in a linear way, in practice the landscape research was a continual iterative process alongside analysis.

1.2 Aim, Research Questions, and Purpose of Study

This dissertation research aimed to explore the development of a landscape-based conservation framework for designing networks of nature reserves as conservation strategy for the typical agrolandscapes of southern Brazil. As the land is essentially privately owned, we are also looking for the development of a dialogic-dialectical conservation approach, i.e. based on understanding the views and meanings of stakeholders and collective constructed knowledge as the theoretical perspective for the development of a landscape-based conservation praxis.

Research Questions

Conservation research, planning, and management should be developed based on broad ecological and human premises in order to address relevant research questions and the appropriate ontological and epistemological issues. The topics bellow, derived from the conservation arguments presented by Miller (1997), Dourojeanni (1997), Rocha & Milano (1997), Sá & Ferreira (1999), Silva & Dinouti (1999), Conservation International (2000), MMA (2002, 2004), Wallace 2004, Tabarelli et al (2005), Silva (2005), Rambaldi & Oliveira (2005), and Rocha & Weirich Neto (2005), are considered basic premises for planning and developing policies for biodiversity conservation in the fragmented landscapes of southern Brazil:

a. The incomplete knowledge about the country's biodiversity and ecosystems' ecology;
b. The inadequate representation of the country's biomes within the national system of protected areas;
c. The existence of few small and scattered reserves, ineffective for long-term conservation objectives;
d. The lack of human and financial resources for the adequate management of protected areas and the limited capacity for public and private investments in conservation and research;
e. The increasing isolation of protected areas within intensive human-managed, fragmented and degraded natural landscapes;
f. The vulnerability of protected areas to exotic invasions and to direct and indirect human actions, including global warming;
g. The private system of land tenure.

Based on these assertions, the following Research Questions were formulated:

1. How can habitat conservation practices be developed and implemented on the agrolandscapes of study?
2. How to plan and carry out management on privately owned, multipurpose lands in order to minimize loss, maintain, and even enhance biodiversity?
3. How can we encourage those who make the land use decisions in these areas to forego the benefits associated with habitat destructive activities in favor of conserving biodiversity?

The conceptual framework explored in this research was designed to develop a participatory strategy which allows these questions to be answered, as far as possible, by the stakeholders themselves. Therefore the main purpose of this research is to construct landscape-based conservation alternatives with stakeholders that would be feasible for implementation on the scale of the land units that they manage – in agreement to the values that they hold, their views, interests, and the future plans that they may have for their lands – and that could be networked throughout the landscapes of the regional mosaic.

The characteristics of multiple uses of resources, the increasing pressure towards fragmentation, and the conservation of unique remnant patches are the references upon which this dissertation project was built. While the emphasis of the research is placed on the development of farm and local scale strategies, they must be conceptually developed upon broader scale analyses of ecological systems and tuned into human perspectives concerning environmental legislation and public policies for conservation and socio-economic development. Therefore a multi-scale transdisciplinary analysis was carried out to answer the proposed research questions.

Specifically to the regional mosaic this dissertation project was designed to explore methodological procedures to:

1. Identify the ecological and human context in which landscape conservation goals and practices must be developed;
2. Identify, map, and classify remnant patches of the Campos Gerais ecoregion;
3. Design a conservation priority model and map remnant patches accordingly;
4. Design a network of protected areas.

Specifically to the Landscape/Watershed and Farm/Local scale this dissertation project was designed to explore methodological procedures to:

5. Identify a range of legal tools and other feasible tangible benefits as potential incentives for regional conservation;
6. Develop a dialogic-dialectical approach with landowners to collectively construct landscape conservation strategies.

1.3 Research Design: An integrated Landscape Approach to Conservation

Landscapes are the result of complex processes and interactions between landforms, ecosystems and humans and, as such, a difficult thing to plan and manage. As put by Antrop (2000) "the perceivable landscape consists of numerous pieces of land owned by many people, all of whom have peculiar interests, which seldom correspond. Land is private property and it's very difficult to accept that someone else tells the owner what to do with his property. Hence, landscape can transgress these boundaries into a larger concept, as a common value of the whole society".

There exists an extensive volume of literature on evaluating landscapes based on distinct ontological and epistemological approaches. The idea of creating a standard method of landscape evaluation, which dominated publications over a long period, is less and less considered an aim in recent literature (Bosshard 1997). Recent experiences in landscape planning confirm epistemological considerations that a model for evaluation cannot be objective, in the sense of being generally valid. Rather, every validation is individually dependent on the landscape context and to the particular researcher's perspective. To develop a landscape conservation theory is not a purpose as such, but a means; the knowledge has to be achieved on the object itself (Bosshard 1997, van Lier 1998, Oreszczyn 2000, Tress & Tress 2001).

The underlying premise of an integrated landscape approach to conservation is that the focus of planning and management must extend beyond the boundaries of nature reserves to encompass the whole landscape. We must find creative ways to develop networks of habitats across reserves and off reserve lands, which together can serve as integrated systems for conservation of biodiversity. This approach is relevant where conservation reserves are few, sparsely distributed or inadequate for effective long-term conservation. It is also relevant in countries with an increasing human population, where land use is dominated by agricultural or urban development and there is intense pressure on dwindling natural environments (Bennett 1999, Forman 1995).

The concept of an integrated landscape approach can be applied at a range of scales, from local conservation plans to regional or national conservation strategies. The scale of the landscape is necessary to ensure that the planning framework is large enough for the units of land being managed. A broad regional perspective is necessary so that the planning process takes into account the wider ecological and social processes that shape and modify the natural environment in a particular study area (Forman 1995, Dramsdat et al 1996, Noss 1996, Hobbs 1998, Bennett 1999). As farmers have the final decision on land use change on privately owned lands, each individual farm has a key position in the process.

To advance landscape planning we must advance the state-of the-art of landscape management. "Too often it has been thought as a technical art employed by experts rather than a well-functioning citizenry, employing their own skill for making public or moral judgments" (Williams & Paterson 1999). Accordingly, good landscape planning and management will require a comprehensive map of landscape meanings within an ecological context, as landscapes represent socially constructed systems of meaning (Greider & Garkovich 1994). Of particular importance is the identification of the meanings individuals, groups or cultures assign to specific parts of the land and understand the extent to which people and social groups agree or disagree on these meanings.

Recognizing that conservation is about people as much as it is about species or ecosystems, suggests a significant shift in the nature and use of science in conservation. Every landscape/region is shaped by a specific combination of natural and cultural factors (subsystems) and, consequently, knowledge derived from every subsystem will have specific contributions towards the perception and the comprehension of the whole. A pragmatically conceived landscape conservation approach, therefore, needs a creative framework in order to define the most relevant research questions and the epistemological approach to address them.

Conservation practices (praxis) ought to be the main focus to direct data collection and should be based on information derived from a conceptual framework that includes data from the bio-physical and socio-economical subsystems. It must be framed in agreement with the scientific knowledge, but also incorporating human, economical and locally available technological resources. The relevance of an integrated landscape conservation approach relies on its holistic perspective, potentially combining different research areas in a complementary framework to address relevant conservation issues.

1.4 Designing a Landscape-Based Research Framework

Generally, an inductive approach to research is used for generating theory, and the hypothetic-deductive approach is taken when a theory has been formulated and needs verification. The research process used on this Case Study has not taken the hypothetic-deductive or empirical approach most often used in methods of inquiry. Rather it has taken a holistic approach to researching landscapes at multiple scales within which landscapes were considered as a whole; that is, as an integral part of a total human ecosystem (Naveh & Lieberman 1994, Bosshard 1997, Oreszczyn 2000, Naveh 2001).

Such a systemic approach, investigating the situation in terms of the connectedness and relationships between parts set in a particular context, as opposed to looking at parts in isolation, can shape the landscape research theoretical framework, the methodology, the fieldwork, the analysis and the conclusions (Oreszczyn & Lane 2000). The emphasis lies on theory as a process, and the approach is iterative rather than linear, involving an open form of inquiry. This approach calls for contextual knowledge and case studies to address conservation issues on real landscapes.

Given the complex nature of the systems in which conservation operates, the urgent need for action and the current lack of information as how to best proceed, effective conservation ultimately requires an adaptive knowledge and management approach. Adaptive management combines research and action and, thus, it is both a learning technique and a guide for landscape-based conservation praxis. The lessons learned through adaptive management are documented and advanced through case studies of specific projects and places (Margules & Pressey 2000, Robertson & Hull 2001, Holling 2001, Salafsky et al 2002, Berkes 2004).

A key tenet of adaptive knowledge is that when dealing with complex systems, practitioners must first describe it in a relatively simple conceptual model to be able to both understand and efficiently change the system. Such a framework should record current understanding and provide a common language through which people with different perspectives can address the state of affairs (Salafsky et al 2002). Case studies also demand a conceptual framework of hierarchically arranged logical types, which covers its main features and their presumed relationships (Robson 1996).

Successful conservation studies must rely on appropriate scales and their linkages in the design of a landscape study. Ecological and social phenomena at each level of the scale tend to have their own emergent properties and, consequently, the landscapes systems must be analyzed simultaneously at different scales (Malk et al 1999, Levin 2000, Antrop 2000, Wiens 2002, Blaschke 2006). Hence, three main complementary hierarchical scales were considered for the development of this research: a) the Regional Matrix (area = 3,422 km^2) and its immediate Mosaic Context (defined by setting a 3 km buffer and area = 4,296 km^2); b) the Landscape/Watershed scale (sampled landscapes and areas of sub-basins < 300 km^2); and c) at Farm/Local level (areas < 10 km^2).

Following these precepts, a Landscape-Based Research Framework was iteratively developed, reviewed and refined throughout the development of this Case Study to address the research goals. The research framework is integrative in nature and multiscalar in focus; it is broad and exploratory and uses multiple lines of converging evidence from several different related disciplines and methodologies to address conservation issues in the agrolandscapes of study. Accordingly, in the next chapters we will explore this framework in the development of a coherent systematic approach to address critical conservation issues in the study area.

The Case Study will be presented in this report through four main topics: a) Designing a Landscape-Based Research Framework; b) Mapping the Regional Conservation Landscape; c) Mapping Landowners' Views of Conservation Alternatives; d) Between Consensus & Compromises - Conclusions & Recommendations. These topics are written as eight separate chapters, yet inextricably intertwined and cross-referenced with each other throughout. The Figure 1.2 presents the final version of the Conceptual Framework as it was employed to guide the development of the research and that directed the discussions presented in this report.

The research framework is further described in detail on chapters 3, 4, and 5 to address methodological procedures for answering research questions as they apply to the different scales of analysis and to specific landscape research goals. The discussion to follow will address why each of these chapters and methods were chosen, and how they fit into the research philosophy, conceptual framework, and the multiple scale strategy for landscape and social data collection and analysis.

1.4.1 An Integrative Transdisciplinary Case Study

As it will be demonstrated along the following chapters, this dissertation is a transdisciplinary study of the Campos Gerais ecoregion, drawing on disciplines such as: geology, geomorphology, hydrography, soil science, natural history, ecology, regional and environmental history, rural and environmental sociology, rural extension, rural economy, land use and landscape planning, environmental law, GIS and remote sensing, landscape ecology and conservation biology. The disciplinary bounds are transcended to give way to a transdisciplinary approach to conservation biology in which the landscape and its human dimensions have been placed at the center.

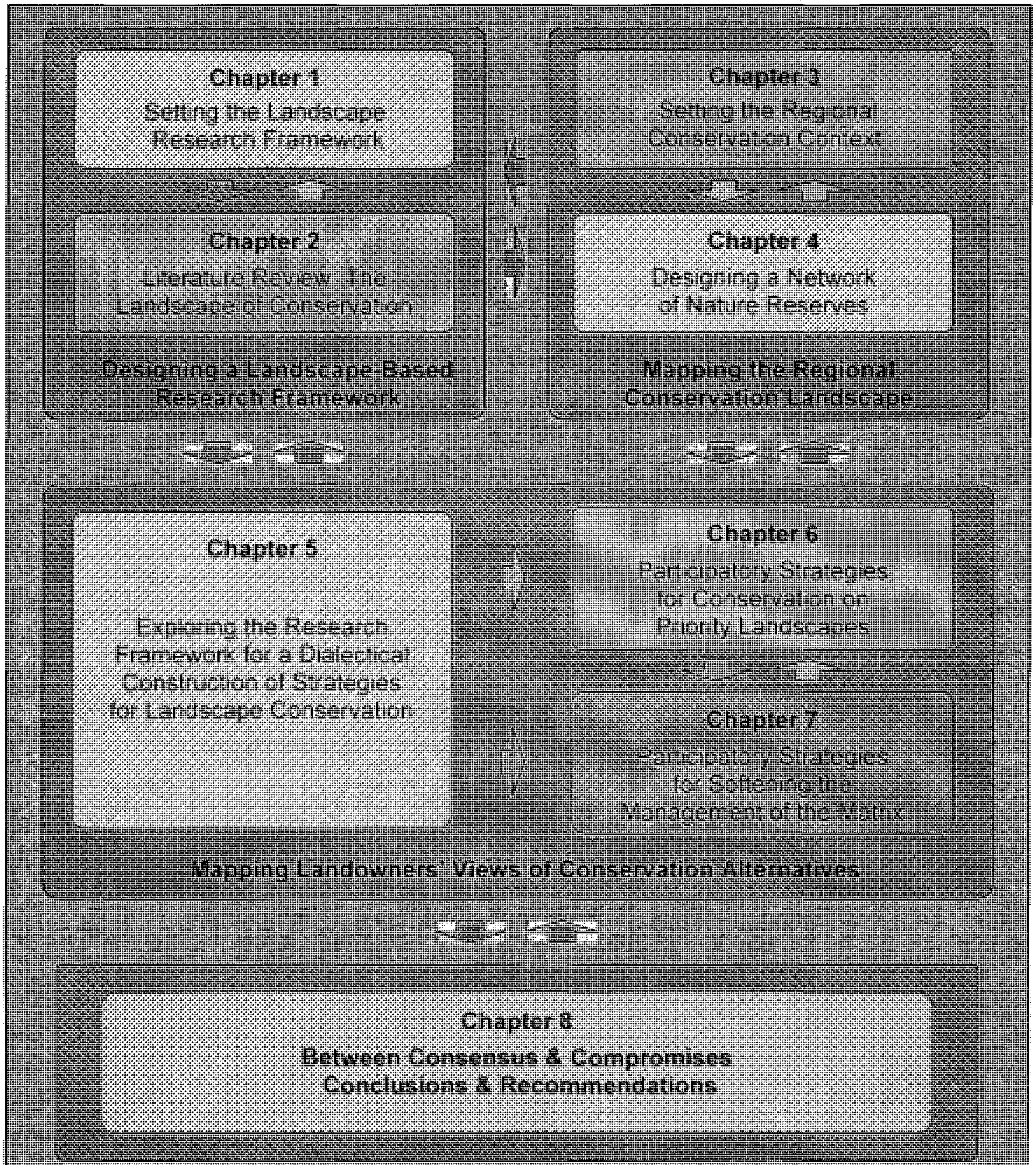


Figure 1.2. Landscape Based Research Framework. Although the discussion in the text is presented in a linear way, in practice the landscape research was a continual iterative process alongside analysis. Arrows' directions stress the iterative nature of the research process.

Integrative studies have the advantage of stepping out of "normal science", in the Funtowicz & Ravetz (1995, 1997) sense, and allow science to progress through paradigm shifts (Kuhn 1962). The deductive analytical hypothesis-testing approach does not address the larger, more complicated issues operating within the social and ecological realm, it is very vulnerable to larger scale effects, resulting in deductions that are biased by them (Özesmi 1999). The integrative approach employed in this work is informed by previous analytical and integrative approaches and should be complemented by further studies in the future.

By adopting an integrative research strategy and advocating transdisciplinary science, the point is not to dismiss disciplinary and analytical approaches to conservation. Both the disciplinary analytical science of parts and the transdisciplinary science of the integration of parts complement each other and are essential for understanding landscapes and developing coherent conservation action (Özesmi 1999, Robertson & Hull 2001). The complementarity of these approaches has long been recognized (Odum 1969). As stated by Holling (1998) "those more comfortable in exercising only one of these cultures of ecology have the responsibility to understand the other" to advance conservation science and conservation action.

1.4.2 Mapping the Landscape of Conservation

The epistemological and theoretical perspective, upon which the landscape conservation framework and the dialogic-dialectical component of the research were developed, will be addressed in Chapter 2 - Literature Review. In the review, we first developed the concept of landscape as the synthesis of ecological and cultural phenomena and outlined a systemic framework to analyze the regional landscape mosaic. Working with the literature in the human dimensions of natural resources and on the main paradigms of social science, we set a theoretical perspective upon which we developed our dialogic-dialectical approach to address conservation issues on the landscapes of study.

As a "post-normal", in the Funtowicz & Ravetz (1995, 1997) sense, rather than a positivist approach to knowledge, a landscape conservation science requires that the knowledge constructed for conservation decision making reflect the pluralist and pragmatic context of decision making, while striving for the rigor and accountability that earns scientific knowledge its privileged place in the sociopolitical arena where conservation decisions are made (Robertson & Hull 2001). Although scientists and managers have traditionally had a strong advisory role, innovative processes will necessarily disrupt such relationships by relocating decision-making power to represent different viewpoints and types of knowledge systems (Song & M'Gonigle 2000, Ludwig 2001).

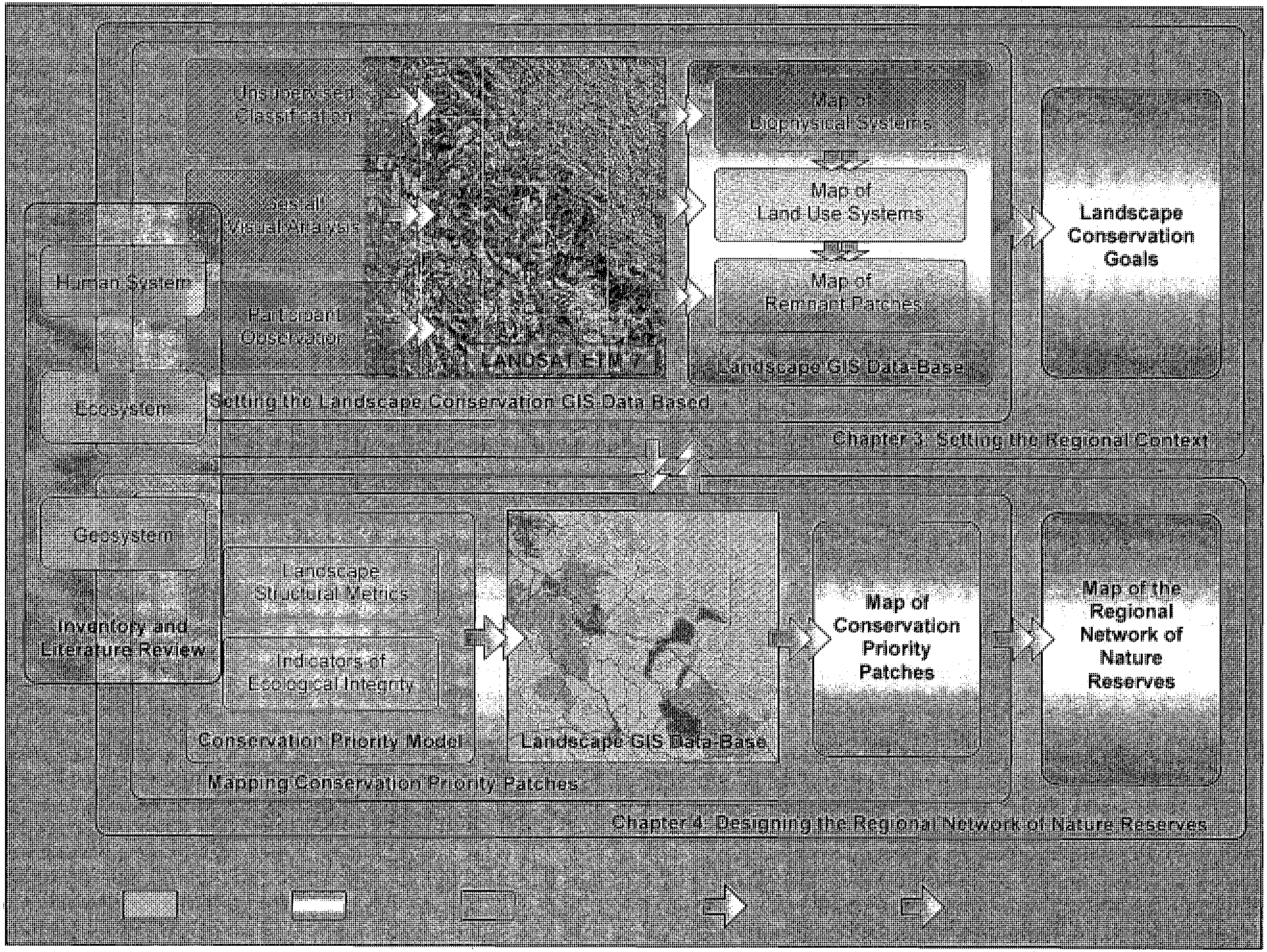
In the postmodern thinking there is openness to qualitative diversity, to the multiplicity of meanings in local contexts; knowledge is a perspectival, dependent of the viewpoint and values of the investigator. Human reality is understood as conversation and action, where knowledge becomes the ability to perform effective actions (Kvale 1996). In this light, the key to "good science" is a participatory process with open dialogue and paradigmatic debate (Song & M'Gonigle 2000). As put by Kvale (1996) "today the legitimation question of whether a study is scientific tends to be replaced by the pragmatic question of whether it provides useful knowledge".

1.4.3 Mapping the Regional Conservation Landscape

Chapter 3 - Setting the Regional Conservation Context, builds upon the understanding of the Campos Gerais ecoregion, drawing on the landscapes of the Regional Matrix and Mosaic Context, to outline the biophysical and human context in which conservation planning and landscape management must be developed. Figure 1.3 shows the detailed version of the Conceptual Framework for landscape analysis in the context of the regional mosaic. Initially, secondary data from the geosphere and biosphere systems' components (Inventory) were processed together with the Literature Review to identify broad structural features that had shaped the regional landscape before human occupation and the main habitat types existing at the community level.

Thereafter, we combined this information with landscape science through techniques of GIS and remote sensing to identify, map and classify relevant landscape bio-physical properties in order to enrich our understanding of the natural processes and patterns in the Campos Gerais ecosystems. Following, we combined this "natural" landscape model with the analysis of how historical social systems interacted with nature, how nature influenced social conditions, and how natural processes were transformed by social interactions (Clark & York 2005) throughout the regional history. We analyzed how land use changed and how the recent phenomenon of intensive habitat loss and fragmentation was produced by the introduction of "green revolution" farming techniques and was accelerated by the global demand for farming commodities.

Current Land Use Systems (LUS) were then mapped, as indicators of the environmental impact on remnant habitats produced by the human activities, as well as spatial indicators of social and cultural differentiation in the matrix. LUS are regarded as


Unsupervised Classification
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Participant Observation
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the main landscape types within a large regional context and are the product of the interaction among ecological and socio-cultural systems that generate landscapes and regions. Participant observation techniques were employed to draw a broad understanding of the human dimensions associated with the main land use types in the region. Remnant patches of natural vegetation within broad patterns of land use systems were then identified, mapped and classified.

From the consistencies found in the evidence from these multiple sources, an inductive[1] landscape system understanding was outlined where human dimensions are integrated into landscape ecology and conservation planning. We looked at biophysical and human interactions at multiple scales, from farm/local to a broad regional extent, to the global trends in crop commodities, and identified multiple and only partially separable causes to habitat destruction and landscape fragmentation. We analyzed multiple competing alternatives to frame main causes and consequences, in order to search for alternatives to halt and reverse such processes. Building upon this broad landscape understanding, landscape conservation goals were then defined to guide the next steps of the research framework.

Critical information necessary for the development of a conservation strategy was lacking, including biological components such as an adequate base about species, populations and distribution, as well as cultural components such as the lacking of systemized land tenure maps and other socio-economic data. These gaps were filled by the use of a variety of techniques; a combination of remotely sensed and aerial imagery, a reconnaissance overflight executed in 2002, consultation of existing biological

[1] See discussion on abductive reasoning on Section 1.5

inventories, and visual display of information on GIS to cost-effectively gather landscape ecological as well as social information about the area.

Chapter 4 - Designing a Network of Nature Reserves, was developed focusing on the methodological procedures for selecting conservation priority areas. Since we cannot protect every place, we must choose which places to protect. As written by Johns (2000) "what places will best ensure functioning ecosystems and healthy populations of all native species in perpetuity? What places will allow the recovery of top predators, essential to ecosystems regulation, and allows disturbance regimes and succession to operate unfettered? What habitats and connections are necessary to recover and re-wild places? What sorts of human uses are compatible in multiple-use or transition zones lying between human settlements and protected areas"?

This broad set of questions guided a review of the methods for selecting priority areas existing in the literature, followed by selecting operational surrogates of Ecological Integrity and Landscape Metrics, which could provide tangible information about the conservation state of remnant patches and their relative conservation importance in the context of the regional mosaic. The resulting GIS-based Conservation Priority Model was then employed to select Conservation Priority Patches in the Matrix. The final step in the research at regional scale was to design a network of protected areas and corridors to minimize impacts from surrounding land use, increase the amount of linear habitat, and to provide structural and functional connections throughout the matrix.

1.4.4 Mapping Landowners' Views of Conservation Alternatives

Chapter 5 – Exploring the Research Framework for a Dialectical Construction of Strategies for Landscape Conservation, was written aiming to provide a methodological link between the broader regional landscape analysis and the landscape research developed on the scale and context of the individual farm units. Built on the results gathered in the previous chapters, this chapter will focus on the theoretical foundations for structuring the conceptual framework and the methodological procedures as it was employed for sampling places and individuals and developing a dialectic landscape conservation approach with stakeholders.

As the land is basically privately owned, the conservation of priority remnant patches demands the establishment of partnerships with landowners; the collective construction of conservation alternatives is regarded as the primary approach for planning and implementing a system of nature reserves. As private lands, conservation plans need to be in tune with production activities. The basic question, therefore, is how to plan and carry out management on such privately owned, multipurpose lands to minimize loss, maintain, and even enhance biodiversity?

To accomplish the normative research goal of landscape conservation, is necessary to go beyond one-time elicitations of the preferences of individuals and to engage community members in a process of further clarification and integration of landscape values as a part of the search for democratically accepted conservation management goals. Our research strategy was designed to develop a participatory strategy which allows the central research question to be answered, as far as possible, by the stakeholders. Rather than just collecting data from, we are looking for establishing partnerships with stakeholders for the construction of the new conservation landscapes of the future (Selman 2000).

The aim of such conservation approach should be the development of landscape-based conservation alternatives – based on the land values landowners may hold, their views, interests, and the future plans they have for their lands – which would be feasible for implementation on the scale of the land they manage and that could be expanded to broader landscapes as well as to the regional mosaic. While the emphasis of the research is placed on the development of farm and local scale strategies, alternatives must be in tune with broader socio-economic perspectives concerning legislation, development policies, and the present and potential markets for regionally produced commodities.

The landscape research was then followed by qualitative social science procedures to identify relevant human dimensions associated with the region's landscapes and how such understanding can be applied in the development of conservation strategies with stakeholders. For this purpose, priority landscapes and watersheds were defined and sampled for the development of strategies on the scale and context of the farm units they manage. To guide interviews, a previous effort was taken by the researcher to map existing legal tools and incentives for conservation and, based on such alternatives, dialogues with stakeholders were performed to explore new conservation possibilities.

Chapter 6 - Participatory Strategies for Conservation on Priority Landscapes, draws on the results of the participatory approach of inquiry employed to construct strategies for the conservation of remnant patches and to improve connectivity within the matrix. Similarly, Chapter 7 - Participatory Strategies for Softening the Management of the Matrix, addresses the participatory process employed to construct strategies for minimizing impacts and developing potentially eco-friendly land use alternatives for the Matrix.

The dissertation report is then concluded in Chapter 8, in which we summarize the results of the research and reframe the Landscape Conservation Approach. Land units were defined by mapping ecologically homogenous tracts of land at the farmland scale as a tangible and recognizable unit upon which future desirable management can be dialectically discussed and constructed with landowners. Drawing on the Habermas' (1987) communicative rationality of creating conditions that approximate the "ideal speech situation", we conclude by outlining a landscape conservation praxis, an action research process, based on the land units and on the search "for consensus on landscape conservation issues that are unproblematic and negotiating compromises on issues that are potentially conflictive".

1.5 A Qualitative Approach for Constructing a Landscape Conservation Praxis

Qualitative research attempts to capture people's meaning, definitions, and descriptions of events, in contrast with quantitative research, which counts and measures things. While statistical analysis and hypothesis testing are the methods used in quantitative research, qualitative research seeks to provide explanations for attitudes and behavior rather than to quantify the extent of their existence in the population. The purpose of qualitative research is to map the relevant themes and characteristics emerging from qualitative data (words), and the results are reported referring to the expressions and opinions of informants (Acharya 2004).

The mode of understanding implied by qualitative research involves alternative conceptions of social knowledge, of meaning, reality, and truth in social science research. The basic subject matter is no longer objective data to be quantified, but meaningful relations to be interpreted. The subjects not only answer questions prepared by an expert, but themselves formulate in a dialogue their own conceptions of their lived world. "There is a move away from obtaining knowledge primarily through external observation and experimental manipulation of human subjects, toward an understanding by means of conversations with the human beings to be understood" (Kvale 1996).

Qualitative research focuses on multiple methods involving an interpretive, naturalistic approach to the subject matter. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them. Qualitative research involves the studied use and collection of a variety of empirical materials - case study, personal experience, introspective, life story, interview, observational, historical, interactional, and visual texts - that describe routine and problematic moments and meanings in individuals' lives (Denzin & Lincoln 1998).

Denzin & Lincoln's (1998) description of the qualitative researcher as *bricoleur* suggest that qualitative researchers employ a variety of strategies and interconnected methods to collect and analyze a variety of empirical materials, hoping always to get a better fix on the subject matter at hand. "The *bricoleur* produces a bricolage, that is, a pieced-together, close-knit set of practices that provide solutions to a problem in a concrete situation. The solution (bricolage) which is the result of the *bricoleur* method is an emergent construction that changes and takes new forms as different tools, methods, and techniques are added to the puzzle" (ibid). The choice of research practices depends upon the questions that are asked, and the questions depend on their context (Coffey & Atkinson 1996).

The research questions in the landscape study are not hypotheses; rather they are intended as a guide to an inductive research process (Strauss & Corbin 1998). This inductive approach differs from deductive approaches; it is not limited to data collection to verify a pre-determined hypothesis but involves simultaneous gathering of data, data analysis and theory emergence. Instead of testing a hypothesis, this research explored people's understanding about "what was going on" in the natural setting in which participants were living. An inductive approach allows the researcher to begin with only some vague concepts, which may later be developed into a theory (Acharya 2004).

The *bricoleur* understands that research is an interactive process shaped by his or her personal history, biography, gender, social class, race, and ethnicity, and those of the people in the setting. The *bricoleur* knows that science is power, for all research findings have political implications. There is no value-free science. As expressed by Denzin & Lincoln (1998), "the *bricoleur* also knows that researchers all tell histories about the worlds they have studied. Thus the narratives or stories scientists tell are accounts couched and framed within specific storytelling traditions, often defined as paradigms" (e.g., positivism, postpositivism, critical theory, and constructivism).

Qualitative data occur in a variety of forms. Data can take the form of field notes, interview transcripts, transcribed recordings of naturally occurring interaction, documents, pictures, and other graphic representations. There is no single way of approaching those materials (Coffey & Atkinson 1996). This implies that a variety of perspectives is inherent to the qualitative approach in general. As Strauss & Corbin (1998) argue, "qualitative researchers have quite different investigatory styles, let alone different talents and gifts, so that a standardization of methods would only constrain and stifle social researcher's best efforts".

Variety stems not only from the range of researchers' commitments and talents; the diversity of social settings and attendant contingencies also have an impact on the collection of qualitative data, as does the aim of the research. The types of data that can be collected in various field settings also affect the possibilities for data analysis, as do the analytical aims of the researcher. This diversity associated with data lead us to a wide variety of analytic strategies for qualitative data collection and analysis. In dealing with qualitative materials, analysts make problems, grounding them in the everyday realities and meanings of social worlds and social actors rather than taking problems from policymakers, general theorists, or others (Coffey & Atkinson 1996).

Hence, our choice of qualitative methods lies in the nature of the landscape research topic, aim, research objectives and questions; that is, constructing conservation strategies by enriching our understanding of the ecoregion through a systemic analysis of landscape components and stakeholders' perspectives. We did not test existing theories, rather, in applying qualitative procedures for collecting and analyzing data, we used multiple theory information as data to enrich our understandings of the conservation issues at stake.

Accordingly, the product of our qualitative landscape research is intended to be a "bricolage", as "a complex, dense, reflexive, collage-like creation that represents the researcher's images, understandings and interpretations of the world or phenomenon under analysis" – the search for a landscape conservation approach. This bricolage will connect the parts to the whole, stressing the meaningful relationships that operate in the situations and social worlds studied (Denzin & Lincoln 1998). This kind of landscape research requires place-based models; "understanding the dynamic interaction between nature and society requires case studies situated in particular places" (Berkes 2004).

Another useful concept is the notion of "thick description", often used to characterize the goal of qualitative, ethnographic research and the task of representing multiple layers of meaning (Argyris et al 1985, Denzin & Lincoln 1998). Thick descriptions, that will make thick interpretations possible, go beyond to produce thorough descriptions of the phenomenon being studied and includes the context of the action, the intentions of the social actors, and the processes through which social action and interaction are sustained and/or changed; it also provides an understanding and possibly an explanation (Blaikie 2000).

One fruitful way of thinking about the production of "thick" analysis is to recognize the value of multiple analysis strategies (Coffey & Atkinson 1996). In examining our data we thought not only in terms of the thematic content of our interviews but also in terms of their narrative forms. We also examined aspects of their semantic and metaphorical content. We pondered how we could write about and represent our ideas and we stressed the generation of ideas in order to draw attention to the fact that the analysis must always go well beyond any specific analytic procedures and techniques (Coffey & Atkinson 1996).

1.5.1 Case Study

Case study is a strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context and using multiple sources of evidence (Robson 1996). The case study has been used extensively in social anthropology, political science, sociology, management and organizational study, and in urban and regional planning. A large number of theses in social science have used case studies for various purposes: exploratory, descriptive and explanatory research. These uses will depend on the research question asked and the extent to which the researcher has control over the events being studied (Robson 1996, Blaikie 2000).

For that reason the case study, is not one or a number of specific techniques. It's a way of organizing social data so as to preserve the unitary character of the social object being studied. Case studies are neither research design nor methods of data acquisition. They constitute a method of data selection, and as such, require particular procedures for generalizing from the results produced. This means in practice that the case study attempts to keep together, as a unit, those characteristics which are relevant to the scientific problem being investigated (Blaikie 2000). This contrasts to survey research that deals with individuals, but only as a collection of traits or variables, in a often one-time elicitation of the preferences of individuals.

All cases necessarily occur in a specific context; the common and unique features of that context need to be acknowledged, and researchers need to give readers a sufficient account of the context to enable them to evaluate the conclusions drawn. However, detailed knowledge of the context is also an important element in the researchers' capacity to draw conclusions from a case study. Case study research for Yin (2003) is "an empirical inquiry" and for Acharya (2004), "a case is considered to be a case when it has working parts, it is purposive, and has a self".

In many situations, researchers intentionally select case study as a method because they are interested in covering the contextual conditions, i.e. they believe that the case will help them to understand the phenomena under study (Yin 2003). The need for a case study arises when there is a desire to understand complex social phenomena. A case can be anything that interests the researcher, such as an individual, a program, project, decisions, or a process. The case study allows the researcher to attempt to preserve the unity and wholeness of a case by using multiple methods of data collection and analysis in a naturalistic setting (Acharya 2004). There can be single or multiple cases and they can be simple or complex, but not general (Stake 2000).

There is a great deal of confusion and many misconceptions about what case studies are, and what they can be used for (Blaikie 2000). Criticism of the case study is often based on grounds that it does not offer the possibility of generalization of findings. Stake (2000) claims that these critiques under-value the importance of an intrinsic case, by emphasizing the need to generalize the findings. It is further argued that such criticisms come from people who presume that research should contribute to science, whereas case studies are often carried out by people who have more intrinsic interest, rather than in the generalization of scientific findings alone. Different issues to be studied in a case are determined by the researcher depending on the questions they are putting forth (Stake 2000, Acharya 2004).

Yin (2003) argued that the question of generalizability raised against case study is unclear, and require deeper consideration. To him, the four commonly mentioned properties of social science research are also applicable for case study: a) construct validity, which is about having correct operational measures for the concept being studied; b) internal validity, which is established by showing certain conditions to lead other conditions; c) external validity, by establishing the domain wherein findings can be generalized; and d) reliability, which requires that the operations of a study, such as a data collection procedure, can be replicated. Case studies are not generalizable to a population, as they do not represent a sample. However, "the goal of a case study researcher is to expand and generalize the theories arising from it, with no concern about frequencies" (Acharya 2004).

Selection of a case and a unit of analysis within the case are equally important in a research project. In our research, the conservation of the biodiversity associated with the grasslands of the Campos Gerais ecoregion is considered as the case, as it will involve different stakeholders in a naturalistic setting and the use of multiple methods of data collection. The unit of analysis for addressing the landscape research goals is the land unit, which was mapped in this research on different scales of analysis (e.g. vegetation types, remnant patches, land use systems, farmlands, and land units). Since our study aimed to understand the view points of the main stakeholders to be involved for biological conservation, the dialogical component of the case was centered primarily on the landowners.

1.5.2 Grounding in Data

There are many ways of analyzing qualitative data, and what links all the approaches is a central concern with transforming and interpreting qualitative data - in a rigorous and scholarly way - in order to capture the complexities of the landscapes and the social worlds we seek to understand. There is a variety of techniques because there are different questions to be addressed and different versions of social reality that can be elaborated. There are good reasons, in other words, for the existence of complementary or contrasting analytic strategies. Equally, it is essential to find ways of using the data to formulate ideas and to find productive ways to organize and inspect our materials (Coffey & Atkinson 1996).

This research has been based on the exploration of a variety of theoretical approaches but has sought to use methods that acknowledge that the researcher is also part of the system under investigation. Systems thinking, i.e., thinking of wholes in terms of connectedness, relationships and context (Oreszczyn 2000) underpins the research. As a systemic approach, grounded theory premises (sensu Strauss & Corbin 1998) were chosen as the research methodology, because they fitted in well within the landscape approach adopted and were a method of enquiry which would allow the central research question "how can nature conservation practices be tackled on the agrolandscapes of study?", to be answered as much as possible by the stakeholders themselves.

The grounded theory was first formulated in 1967 by Glaser and Strauss in "The discovery of grounded theory" (Glaser & Strauss 1967), and emerged out of attempts to close a perceived gap between theory and research. This methodology is now among the most influential and widely used ways of carrying out qualitative research on many fields

(Coffey & Atkinson 1996, Olson & Raffanti 2004). It is not necessary to endorse grounded theory as formulated by the most influential authors and textbooks (e.g. Glaser & Strauss 1967, Strauss & Corbin 1998, 2004, Charmaz 2000, and Glaser 2001) and other interpretations, in order to appreciate its relevance as a methodological approach in qualitative studies (Coffey & Atkinson 1996).

Grounded theory has since been adapted and used across a range of disciplines and there is a growing interest in its use in natural resources and conservation-related disciplines in many countries (e.g., Tuler & Webler 1999, Fischer & Bliss 2004 and Carolan 2006 in the US; Özesmi 1999 in Turkey; Stoll-Kleemann 2000 in Germany; Oreszczyn 2000 and Oreszczyn & Lane 2000 in the UK; Oettlé & Arendse 2003 and Koelle et al. 2003 in South Africa; Acharya 2004 in Nepal; Milestad & Hadatsch 2003 in Austria; Farmar-Bowers 2004 and Fazey 2005 in Australia).

Grounded theory is explicitly emergent and, therefore, it does not test a hypothesis. The focus is on theories firmly grounded in the data collected, rather than on verifying pre-existing theories found in the academic literature. It is an iterative process, where data collection is guided by the findings of the research process and theory is generated from the data as the research proceeds, i.e. within a bottom up - inductive approach (Strauss & Corbin 1998, Oreszczyn 2000, Stoll-Kleemann 2000). Grounded theory offers analytical explanation of real situations, actual problems and basic processes in the research setting, allowing the ordering of data within an analytical framework, and which are grounded in respondents' own accounts.

Grounded theory methods do not dictate details of data collection techniques, but advance each step of the analytical process towards the development, refinement and interrelations of concepts (Charmaz 2000, Acharya 2004). Its strategies usually include simultaneous collection and analysis of data, coding them and performing constant comparisons. The basic procedure associated with the grounded theory approach is to read (and re-read) a textual database (such as a corpus of field notes or transcripts of tape-recording devices) and "discover" or label variables (i.e. concepts, categories and properties) and their interrelationships.

As put by Glaser (2001), in grounded theory "all is data"; the grounded theorist can include all kinds of data: quantitative, qualitative, interviews, studies, and literature without preconception or manipulation. With great care and constant comparison, the researcher uses the data to generate concepts, categories, and their variations. The data's usefulness earns its way into the emergent theory because of its relevance (Olson & Raffanti 2004).

The basic unit of the analysis is "concept", as the theory is developed from conceptualizing the data, not from the data itself. The process of conceptualization starts with data collection and ends when all data are "coded" and "categorized". These data are labeled conceptually, and then grouped into concepts to reduce the number of units. During this process, the concepts that are similar and fall under the same phenomenon are called categories. Categorization pulls together other concepts or sub-categories to form major categories, under which others may be grouped (Strauss & Corbin 1998, Acharya 2004).

The ability to perceive variables and relationships is termed "theoretical sensitivity" which "refers to the attribute of having insight, the ability to give meaning to data, the capacity to understand, and capability to separate the pertinent from that which isn't" (Strauss & Corbin 1998). It is affected by a number of things including one's reading of the literature and one's use of techniques designed to enhance sensitivity.

Within many research approaches there has been a trend among researchers of using higher formal theories which may be inaccessible, or of little use to the practitioners, i.e. those actually dealing with practical advice to people on the topic of environmental management. One of the key concerns of grounded theory is that the findings should be both accessible and useful to those who may make use of it (Oreszczyn & Lane 2000). The research question in grounded theory study is a statement that identifies the phenomenon to be studied. It tells the readers what the researcher specifically wants to know about this subject (Strauss & Corbin 1998).

It is claimed that grounded theory allows researchers to develop deep analytical questions by studying the data, and for that reason it was considered appropriate for this landscape research. Hence, we acted as a strategist, developing and adapting the landscape-based research framework to particular landscapes and farm/local conditions. The methods were based on the ecological properties of the Campos Gerais ecoregion and on the cultural roots of its rural inhabitants using principles of qualitative research and grounded theory.

While taking a participatory and emic approach, we were nevertheless aware that informants can give deceitful information (Özesmi 1999). This threat was kept in check with cross checking information from several sources, and asking other informants. The grounded theory approach permits looking not only at what people say, but also how they express their views, examining repeated use of words, expressions, etc., to understand underlying factors responsible for shaping human behavior. In deed we tried to learn the motivations of informants and tried to understand how their motivations shape the information.

Since we were analyzing how individuals could add conservation measures to their normal practices of land management, it was particularly important to contrast information found at one farmstead, with that provided by its neighbors or by other landowners within the same group of Land Use Systems (LUS) and also to contrast with information gathered at other LUS. Triangulation then implied collecting the information from different sources and using this to cross check its veracity (Bacon et al 2005).

However, unlike grounded theory, the main focus of our research was not to develop a theory per se, but to determine how to promote changes in real landscapes. We had set basic premises as normative goals to direct our research: the need for conserving the last remaining landscapes of the Campos Gerais ecosystems and the need for creating conditions for changing the way land has been managed, based on a narrow economic focus and limited to intensive production of farm commodities. So we are dealing with "what" and "how" research questions (Blaikie 2000): what to conserve, and how to conserve?

As theory development was not the main purpose of this research, the process of iterative gathering and evaluating data was directed by the question: "what empirical data will be suitable to advance the development of participatory landscape-based conservation strategies"? Grounded theory as methodological approach was employed in order to generate unexpected insights of underlying motivations based on interview evidence and associated data, and helped to understand, and to explain "what is going on" in people's minds in the sphere of landscape conservation. The intention was to explore such meanings, so the emphasis lay on conceptualization rather than on descriptions or measurements.

The data collected was constantly compared within and between the field notes in order to arrive at some main landscape conservation themes (concepts) and core categories that were cross-referenced with literature and further elaborated as discussions in Chapters 6, 7 and 8, where we draw final recommendations and the conclusions of this study. As previously noted, to develop a landscape conservation theory is not a purpose as such, but a means; the knowledge has to be achieved on the object itself (Bosshard 1997, van Lier 1998, Oreszczyn 2000, Tress & Tress 2001).

1.5.3 Beyond the Data

The strategies for analysis that we have outlined thus far enabled us to think about our data, which we then used throughout the research to generate ideas and theories. Based on the analytic techniques outlined by Coffey & Atkinson (1996) we direct the discussion on the qualitative approach to reveal the extent to which the full implications of "analysis" led our landscape research beyond the manipulation of data to "think with the data". That means "going beyond" the data to develop ideas and to generalize and theorize from the many types of data we dealt with. The goal is to generate potentially useful ideas, concepts and theories that may concern to the normative conservation goals of the landscape research.

We have chosen a methodological pragmatist position focusing on processes that yield most meaningful information (Özesmi 1999) to address conservation issues on the regional landscapes. This pragmatist position enabled us to look beyond one particular method and use several procedures interactively: in-depth interviews, key informants, participant observation strategies, published literature, maps, aerial and satellite imagery, documents, and archives. We also have exercised our ability to listen, observe, participate, and make sense of these multiple experiences by linking their meanings and relating them to the underlying structures that produced the ecological or social phenomena under analysis. While conducting the interviews or on participant observation (P.O.) instances, I remained aware of the limitations of selective attention in my own perception and tried to be a "good active listener" (Kvale 1996).

As commonly practiced in grounded theory, we have taken seriously that "all is data" (Glaser 2002). Hence, we considered the information gathered from the literature as secondary source of data (Strauss & Corbin 1998), to elaborate, support or contradict evidences of the reasoning and of the ideas elaborated along the landscape analysis process. The integration of theory with relevant literature, iteratively with field work, can help to show the relevance of the new concepts generated by the research (Acharya 2004). The data was segmented and divided into meaningful units, but a connection to the whole was maintained; and the data was organized according to a system derived from the data itself. On the whole analysis was an inductive, data-led activity (Coffey & Atkinson 1996).

Accordingly, the process of analysis was not seen as a distinct stage of the research; rather, it was a reflexive activity that influenced data collection, writing, further data collection, and so forth. Therefore, the analysis was not the last phase of the research process, and it should be seen as part of the research design and of the data collection. "The research process, of which analysis is one aspect, is a cyclical one and a reflexive activity; the analytic process should be comprehensive and systematic but not rigid" (Coffey & Atkinson 1996). Hence, research problems and questions, research design, data collection techniques, and the analytic approaches we employed were not thought of as different stages in the research process; what is referred to as analysis throughout this text, was a pervasive activity throughout the life of the landscape research.

As put by Coffey & Atkinson (1996), "we can use different analytic strategies in order to explore different facets of our data, explore different kinds of order in them, and construct different version of the social world. That kind of variety does not imply that one simply can take the results from data from different sources, or derived from different methods, and aggregated in some way in order to produce a fully rounded, more authentic, portrayal of the social world. Qualitative data analysis requires methodological knowledge and intellectual competence. Analysis is not about adhering to any correct approach or set of right techniques; it is imaginative, artful, flexible, and reflexive. It should also be methodological, scholarly, and intellectually rigorous".

The emphasis on exploration that is characteristic of much qualitative research calls for ways of generating new ideas. One useful way to think about the process of generating ideas is in the notion of abductive reasoning. Abduction is defined as a method of constructing knowledge from consistencies in the evidence from multiple perspectives reasoning (Coffey & Atkinson 1996, Tognetti 1999, Blaikie 2000). It is not necessary to go into the philosophical issues in detail and it is not even necessary to agree with the pragmatist philosophy in order to use the idea productively and heuristically. Abductive reasoning and logic were used to contrast with the polar opposites of inductive and deductive logic (Coffey & Atkinson 1996, Blaikie 2000).

Inductivism is based on the presumption that laws or generalizations can be developed from the accumulation of observations and cases, and that the close inspection of ever more data can be made to reveal regularities. A hypothetic-deductive approach to inquiry confines the role of research to the context of testing existing ideas. Neither of the polar types is satisfactory in informing the actual generation of ideas. Practical researchers need guidance on the generation and organization of ideas (Coffey & Atkinson 1996, Blaikie 2000).

The abductive reasoning allows for a more central role for empirical research in the generation of ideas as well as a more dynamic interaction between data and theory. "Abductive reasoning or inference implies that we start from the particular – we identify a particular phenomenon and then try to account for that by relating it to broader concepts. We do so by inspecting our own experience, our stock of knowledge of similar, comparable phenomena, and the equivalent stock of ideas that can be included from within disciplines, or from other theories and frameworks from many other complementary fields" (Coffey & Atkinson 1996).

In other words, "abductive inferences seek to go beyond the data itself to locate it in explanatory or interpretive frameworks". The researcher is not content to try to slot them into existing ideas, for the search includes new, surprising, or anomalous observations. On the other hand, such phenomena are not used only to disconfirm existing theories: they are also used to understanding social phenomena and coming up with new configurations of ideas (Coffey & Atkinson 1996, Blaikie 2000). Thus, there is a repeated interaction among existing ideas, former findings and observations, and new ideas. Abductive inference is thus especially appropriate for qualitative work in which an open-minded intellectual approach is normally advocated (Coffey & Atkinson 1996).

In our landscape conservation research, we relied heavily on the conceptual framework (Figure 1.2 and its detailed versions such as presented in the Figure 1.3 and as it is presented in the chapters to follow) of hierarchically arranged logical types, from members to classes, to classes of classes, as a structure of inquiry and as a way to make epistemology explicit. What is considered important are the differences and the resemblances between such differences, which in turn reveal "the pattern, which connects", and provide the basis for abduction - a fundamental process in human thought. The perception and understanding of differences is also key to a later concern with recursive patterns (Tognetti 1999).

Hierarchical structures of inquiry are fundamental in ecosystem approaches to the study of complex systems. Hierarchical levels of organization are distinguished, which allows expansion of the problem domain to include the observer as well as a system of interpretation from which meaning can emerge and which provides context. The context of discovery must be a major preoccupation for all researchers. From this perspective "we can view the relationship between ecological and social systems as an interplay between context and process - ecological systems provide the context or constraints for societal systems at different scales, which can in turn alter the structures of ecological systems as well as the context for self-organizing processes of ecosystems, which can in turn alter the context for societal systems" (Tognetti 1999).

Heuristic ideas and theoretical frameworks will often have their origins in the published literature of the disciplines. Hence, we used concepts, theories, and ideas constructively and creatively. We explored and deployed them whatever their origins, whether they come from the published literature or from elsewhere. As put by Coffey & Atkinson (1996), "we can engage with ideas of the others, however, in an active sense. Our task as qualitative researchers is to use ideas in order to develop interpretations that go beyond the limits of our own data and that go beyond how previous scholars have used those ideas".

"It is in that synthesis that the new interpretations and new ideas emerge. The point is not to follow previous scholarships slavishly, but to adapt and transform it in the interpretations of one's data. An active engagement with the published literature means that the ideas are available for use in research. The work of others is inspected not only for its empirical findings but also for how its ideas can inform the interpretation of one's own research setting. Theories are not added only as a final gloss or justification, but they are drawn on repeatedly as ideas are formulated, tried out, modified, rejected, or polished" (Coffey & Atkinson 1996).

Chapter 2: Literature Review – The Landscape of Conservation

In this Chapter we will take a look at the fields of landscape science and conservation from a broad theoretic, ecological and social perspective, attempting to bring out the field of landscape conservation into context. Hence, we will first draw on the concept of landscape as synthesis of ecological and cultural phenomena and, based on this understanding, we will outline a systemic framework to analyze the regional landscape mosaic. Working on the main paradigms of social science and the human dimensions of natural resources literature we, thereafter, will discuss the theoretical perspective upon which we developed a coherent systemic landscape research framework and its dialogic-dialectical component to address conservation issues, the normative goal of this dissertation, on the agrolandscapes of study.

2.1 Landscape: an evolving and versatile concept

Landscape is an evolving and versatile concept, used in many different ways by different people and, as such, a complex phenomenon that can be analyzed in many different ways (Antrop 2000a, Brandt 2000, Wiens 1999a). Standard English dictionaries identify several meanings for also the suggestion of landscape planning. Because it is also a vernacular word and a seemingly familiar term in research and practice, as well as in everyday language, it should, therefore, be clear defined before use in any scientific work, publication or transfer into practice. Clear theoretical concepts are the preconditions for a scientific work (Zonneveld 1995, Tress & Tress 2001, Brandt 2000, Wiens 1999a).

Many recent works had reviewed the historical roots and origins of the various landscape concepts (e.g., Tress & Tress 2001, Bastian 2002, Makhzoumi 2002, Blaschke 2006). The word "landscape" in the Germanic languages, comes from the term "land", meaning country, indicating place, region or territorial sector; from that radical came the expressions *landschaft* (German), *landscape*, (English) and *landschap* (Dutch). The Latin term "*pagus*", origin of the words *paisaje* (Spanish), *paysage* (French), *paesaggio* (italian) and *paisagem* (Portuguese) express similar meaning. From the renascence the realistic depiction of nature idealizing classical scenes and visionary panoramas, established a genre of painting that continues as contemporary common sense of the word. Hence, the artistic and aesthetic sense is rooted on the origins of the term and should also be considered presently by scientists, land managers, and professionals from distinct fields working upon landscapes (Forman & Godron 1986, Capdevila 1992).

In the transition from the 17th to the 18th century, Alexander von Humboldt, Johan Wolfgang von Goethe, Carl Ritter and others introduced the term landscape into science. Humboldt glossed the term as the physical reality of a landscape. To him, landscape was the sum total characteristics of a region (Zonneveld 1989, Bastian 2002). The rich descriptions of the Campos Gerais in 1820, by Saint-Hilaire (1978), contain information on geophysical, biotic, and human components of the regions' landscapes, and are typical of this time. In the second half of the 19th century, such complex holistic meaning of landscape begun to disappear in the division of science into single disciplines and an increasingly analytical way of thinking, giving rise to disciplines as geology, geomorphology, soil science and the human geography disciplines (Zonneveld 1989).

Further in the 20^{th} century, the complex meaning of landscape and holistic inquiry into it disappeared due to the organization of science into disciplines and led to specialization of scientists. The existing meanings of landscape were analyzed separately and so were the parts of landscapes. A range of landscape concepts came into existence, each of which served the specific purposes of a specific discipline vary depending on whether they were developed within the natural, the social science, the humanities or the arts (Forman & Godron 1986, Zonneveld 1995, Tress & Tress 2001).

The availability of aerial photography in the 1930s has revolutionized the perception of landscapes and stimulated a "holistic" approach to landscape research. The concept of Landscape Ecology, introduced in the end of the 30's, by the German bio-geographer Carl Troll, was formulated from the potential of analysis of aerial photographs, becoming common at that time, within a systemic approach from geography and ecology and as a bridge of convergence of natural and social sciences. Carl Troll called "aerial photo-interpretation as a high degree of landscape ecology" (Forman & Godron 1986, Schreiber 1990, Antrop 2000b). By the 1960s and 1970s, a new environmental consciousness, supported by ecology, afforded an alternative appreciation of nature influencing design and landscape planning (e.g., McHarg 1969 1981, Steiner 1991, Thompson & Steiner 1997).

In the last decades of the 20^{th} century there was an increasing recognition of humans as an integral component of most ecosystems and that human activities influence all ecosystems to a greater or lesser extent. Evidences of rapid global change, degradation of natural landscapes and loss of biological, scenic and cultural resources were also amply recognized. Concerned with such themes, attempts have been made to develop a broader and more pragmatic view of landscapes, based on different approaches and for different purposes (e.g., Forman & Godron 1986, Naveh & Lieberman 1994, Zonneveld 1995, Forman 1995, Van Mansvelt 1997, Bosshard 1997, Ahern 1999, Johnson et al 1999, Wiens & Moss 1999, Palang et al 2000, Antrop 2000a, Brandt 2000, Oreszczyn 2000, Brunckhorst 2000, Naveh 2000, Selman 2000, Tress et al 2001, Fry 2001, Opdam et al 2002, Blaschke 2006).

Despite a growing recognition of the need to integrate the "objective" with the more "subjective" areas of research (e.g., Szaro & Johnson 1996, Orians & Soulé 2001, Johnson et al 1999, Cordell & Bergstrom 1999), landscape research tends to focus either on the human or the non-human landscape aspects, but rarely both. Landscape literature is generally concerned with people's perceptions and values of landscape and nature, while landscape ecological literature focuses mainly on aspects concerning its biological components (Oreszczyn 2000). Researchers within different theoretical concepts and cultural backgrounds have different attitudes and worldviews; each scientist has its "own lens" and those from a particular science field, represented by goals, paradigms, and validation methods (Weber 1999, Wiens 1999, Brandt 2000, Ludwig 2001, Robertson & Hull 2001).

Many researchers from the natural sciences stressed the importance of human beings as fundamental agents of landscape change and many researchers from the social sciences and humanities were aware of the physical-material reality of landscape. Even though, if researchers rooted in natural sciences included human effects, they did not equally considerer the mental and cultural parts of the landscapes. In the same way, researchers rooted in the humanities, social sciences and arts did not relate the human perceptions and ideas of landscapes to the geophysical and biological reality (Tress & Tress 2001, Moss 2000, Forman 1995, Schreiber 1990, Zonneveld 1995). "Their results on the same subject, the landscape, which are all corrected in their limited way, but fail to grasp the full reality of landscapes" (Tress & Tress 2001).

Cooperation is required to tackle the various environmental and social problems related to landscapes. However, collaboration and, thus, transfer of knowledge across disciplines is seldom realized because a common approach that bridges the gaps between disciplines is missing (Tress & Tress 2001). Instead different landscape concepts exist side by side. Furthermore, while there is much concern over the need of interdisciplinary and participatory strategies in environmental planning and management, landscape research in general has played a generally non-participatory role. Consequently, the layperson, stakeholders and decision makers may fail to see the relevance of the research (Oreszczyn 2000).

Little time is spent understanding natural and social processes and patterns: how they operate on their own, how historical social systems interact with nature, how nature influences social conditions, and how natural processes are transformed by social interactions (Clark & York 2005). A pragmatic concept of landscape is an important step to apply science to "real world" conservation problems. The discussion to follow will deepen the concept of landscape as it was employed along this dissertation research.

2.1.1 Landscapes as Synthesis of Ecological and Cultural Phenomena

A concept of landscape designed to enable transdisciplinary landscape research was presented by Tress & Tress (2001). Their transdisciplinary landscape concept is based on five dimensions of landscapes: a) the spatial entity; b) the mental entity; c) the temporal dimension; d) the nexus of nature and culture, and e) the systemic properties of landscapes. In contrast to other approaches, it unites dimensions that are usually the domain of individual disciplines and makes it, thus, possible to capitalize on plurality on landscape research. The concept promotes landscape, as the combination of the sub-systems knows as the geo-, bios- and noo-sphere, and is illustrated by the people-landscape interaction model[1]. Constructing on the concept of landscape as presented by Tress & Tress (2001), these dimensions of landscapes are following discussed.

2.1.2 Landscape as a spatial entity

The geographic concept of landscape, word, largely employed since XIX century, referred to the interactions among the climate, bedrock material, water, and soil types, resulting in a recognized set of biophysical features in a geographical portion of the earth surface. In geology and geomorphology are employed the terms geological landscapes, and just landscapes. Fortscue (1980) discuss the landscape geochemistry and in pedology the term soilscape defined as the pedological portion of the landscape (Hole & Campbell 1985) is employed. The concept of vegetation landscape is common (e.g., Zonneveld 1990, Doing 1997), and Zonneveld (1995) has presented the landscape as ecosystem.

Expressions as riverscapes (Karr 1994, Wiens 2002, Fausch 2002), seascapes (Kelleher & Craik 1996), and agrolandscapes (Barrett & Skelton 2002) have been discussed, from a landscape ecology perspective, respectively on rivers as expressions of their territorial watersheds, marine and costal environments, and agricultural

[1] The people-landscape interaction model will be further discussed on section 2.4 - A Postmodern Perspective: An Integrated Landscape Conservation Approach

environments. Within a more strictly biological frame of reference there are also differing views. Thus the landscape may be a level of organization falling somewhere between the community or ecosystem and the biome, or a scale somewhere between local and regional, or a templet on which spatial patterns influence ecological processes (Wiens 1999a, Picket & Caldenasso 1995).

From an organism point of view a landscape is a mosaic of habitat patches and non-patches across which organisms move, settle, reproduce, and die. The dynamics of an organism is strongly influenced by the abundance and location of suitable habitat through a geographical area or a landscape. The size of a landscape depends on the organism. For any species, the landscape containing a population can, in principle, be mapped as a mosaic of suitable and unsuitable patches (Meffe & Carrol 1998). Therefore, a butterfly (Hanski et al 1995), an owl (Lamberson et al 1994), a gray wolf (Mladenoff et al 1995), a vole (Delattre 1999), a jaguar (Ortega-Huerta & Medeluy 1999), or a manned wolf (Pontes Filho et al 1997) landscape can be assessed and described.

Landscape spatial structure is of central importance in understanding the effects of fragmentation on population survival (Fahrig & Merriam 1994). Several important factors in a landscape analysis for an organism: e.g., patch quality, boundaries, context, connectivity, and organism responses - will change with changes in the scale of analysis. The size of the "window" through which an organism views or responds to the structure of its landscape (its extent), for example, may differ for organisms of different body sizes or mobility, and organisms may discern the patch structure of the landscape within this "window" with differing levels of resolution (grain). As a result, the organism-defined "landscape" is scale-dependent (Wiens 2002, 1989).

Ecological processes, such as disturbance regimes, hydrologic and nutrient cycles, and biotic interactions, are essential for maintaining biodiversity at landscape and regional scale. Mechanisms and processes controlling biodiversity in various levels of organizations (genes, habitats, ecosystems, etc.) also operate in different temporal and spatial scales; biodiversity is a multiple scale phenomenon (Levin 1992, 2000). Other ecological processes, like primary production, evapotranspiration and decomposition are all influenced by the spatial heterogeneity (Forman 1995). Understanding landscape diversity can help identify areas that are least vulnerable to disruptive outside influences, such as pollution, introduced species, or creating suburban sprawl (Malk et al 1999).

From an ecological point of view, different landscape definitions can be converged to the formulation of a more scientific and useful concept from an applicability point of view (Forman & Godron 1986). These authors, defined landscape as "a heterogeneous land area composed of a cluster of interacting ecosystems that is repeated in similar form over a kilometer-wide area". This aspect of heterogeneity that gets the most attention in schools of landscape ecology with emphasis on wildlife species; they are interested in the landscape in the sense of distinction between the shape and nature of patches and corridors and the like, both as habitat and trails of organisms through the landscape (Zonneveld 1995).

Landscapes have a physical-material dimension and thus are a palpable realty. Landscape as a spatial entity was the cornerstone of all scientific debate about landscape, to which other meanings were added. Traditionally the spatial-material dimension is manifested in the abiotic, biotic and artifactual spheres that are related to each other (Tress & Tress 2001). The abiotic components of geosphere (e.g., rocks, water) form the conditions for life in the biotic realm, the biosphere, consisting of flora, fauna and including humans. Animal, plants and the myriad natural processes that regulate ecosystems both respond to and help to create distinctive landscapes (Malk et al 1999). People form artifacts (like buildings, roads, machines) out of abiotic and biotic elements (Tress & Tress 2001) and employ them to change landscapes.

2.1.3 Landscape as a mental entity

Research rooted in the social sciences, humanities and the arts, dealt with landscapes as a human idea, cultural invention, social product and aesthetic object, investigating its shifting meanings in relation to human history and its manifestation of property and power (Tress & Tress 2001). Landscape is seemed as mental constructs to be understood and handled in a social and historical context. Accordingly, Greider & Garkovich (1994) discuss the landscape as the social construction of nature and the environment. Landscape, as such, is the symbolic environment created by human acts of conferring meaning on nature and the environment, reflecting the self-definitions of the people within a particular cultural context.

From a critical theory standpoint Duncan & Duncan (2001) discuss the relationships among landscapes and social identity as mechanism of social exclusion; Mitchell (2002) discusses cultural landscapes as dialectical landscapes and its role in counter-hegemonic practices. Arler (2000) discusses the landscape quality as a component of "the human welfare", and O'Neill & Walsh (2000) address social conflicts concerning the future of landscapes as public environments. Williams & Patterson (1999) discuss and present a conceptual framework for mapping landscape meanings.

Price (2000) discusses the landscape of sustainable economics, Dabbert et al (1998) the economics of landscape conservation, and Roe (2000) the social dimensions of landscape sustainability. Kaltenborn & Bjerke (2002) analyzed values orientations and landscape preferences. From a landscaping perspective, Burle-Marx (1987) discuss Art and Landscape. Hepburn (1996) discusses the landscape as metaphysical imagination.

Our personal view of landscapes is a product of culture and culture shapes landscape. Landscape observation is primarily subjective and can be understood only relative to the characteristics of the observer. Therefore, different people can perceive the same landscape differently. These approaches imply that the cultural, societal and psychological values of an individual as well as the community shared values will strongly influence the "way one sees" a given landscape. Each person has a unique "lens" with which will focus his own perspective over the ecological phenomena represented by the landscape (Wesman & Nell 1994, Antrop 2000a, Williams & Patterson 1999, Nassauer 1997, Tress & Tress 2001). The public controversy about the Chicago urban park restoration project (Gobster 2001, Gobster & Hull 2000) is an example of conflict and incompatibility about different visions of nature.

To consider the mental dimension of landscape is to regard people not only as external disturbance factors or as external steering mechanisms, causing - mostly unwanted - changes in a biophysical ecosystem. Many landscapes have developed in a coevolutionary process with people and would not exist in its present state without human influence. Vernadsky coined in 1945 the term "noosphere" (from the Greek, "noos", or mind) for the mental sphere in which human function. He recognized that people were a determinant factor in geo-biological processes on Earth due to their mental abilities (Tress & Tress 2001, Naveh 2001). The noosphere concept is used here as the mental space of people, structured by perception and adaptation. By means of the noosphere, human beings are able to perceive and to influence the physical material reality of the geo and the biospheres. Both motivations and the actions that result are part of the noosphere (Tress & Tress 2001).

The two dimensions of the landscape concept above presented illustrate the dualistic relationship between people (culture) and the landscape (nature). "People are - as part of the biosphere - part of the physical material reality of landscape, and as such they are not a precondition for its existence. On the other hand, people as thinking, acting, and reflecting beings - also creates landscape. It is mental reflection that first creates the landscape. As acting beings, people influence the natural conditions and create artifacts, which shape and organize their environments. As being capable of reflection, people have the ability to take themselves out of the landscape and to reflect upon it from this perspective" (Tress & Tress 2001).

2.1.4 Landscapes as a temporal dimension

Physical and biological systems exist and are relevant from the human and from an organism perspective at many different temporal and spatial scales. Both the spatial and mental dimensions of landscapes underlie the temporal dimension. Landscapes are not static, but subject to change over time. Space is the issue on which landscape researchers have often focused; time in contrast, is often relegated to the background. The temporal dynamic of landscapes concerns all landscape dimensions and changes appear on all spatial scales; both concepts spatial and temporal scales are interlinked. While single landscape elements - i.e. soil particles, plants, buildings, and water molecules - are being exchanged constantly, the landscape as a whole persists. In a similar way, people ideas and perceptions of landscape elements or cultural conventions can endure across generations (Tress & Tress 2001, Cordell et al 1999).

The question of development and maintenance of spatial and temporal patterns in an ecological community and the relation with the scales of observation and analysis of hierarchical systems has been presented as central problem in ecology and landscape ecology (Levin 1992, 2000, Wiens 1989, 2002, Peterson & Parker 1998). Virtually all ecological systems will exhibit a pattern of heterogeneity and variability in a broad temporal, spatial and organizational scale. The heterogeneity of patches in a landscape, patterns of elements in a mosaic, is a product of the interaction among the distinct factors that have shaped its characteristics along the evolution of the landscape, including, geomorphological, climate, soils, vegetation, communities, and human disturbance, among other factors. The interplay among these elements through time and space scales will produce patterns of differences over the regional mosaic.

Hierarchical theory predicts that each level in a hierarchy functions at rather distinct temporal and spatial scales. Phenomena at broad scale are more persistent or stable then those at fine scales. Fine scale phenomena should be more variable in both time and space (Forman 1995, Withers & Meentemeyer 1999). Physical system evolution is typically referenced in millions, even billions of years, as the cycles of plate movement, eruption, erosion, and deposition proceed. The evolution of new species or the transition from one dominant ecosystem composition to another may range from thousands to millions of years. At smaller spatial scales, change usually can be observed within short seasonal time frames. Human activities, however, carried out in a short time of a human life can have lasting effects that span thousands of years into the future (Cordell et al 1999).

A landscape can be viewed as a mosaic of heterogeneous land use patterns, resulting from the interaction of physiographic features, vegetation types and land management systems, that change spatially and through time. The recognition of the importance of spatial and temporal heterogeneity in the landscape to ecological dynamics at all levels adds another dimension to the conventional population community, and ecosystems approaches. Because biological systems are heterogeneous, valid ecological questions at the single species (population) or multispecies (community with evolutionary or ecosystems with thermodynamic conceptual foundation) levels must generally be examined with explicit recognition of the landscape heterogeneity. Much mathematical theory in ecology from the past, illustrates the influence of assumed equilibrium and homogeneity in ecology (Karr 1994). Landscape functions have been explained with static models and the perception of a static landscape is still present.

2.1.5 Landscape as nexus of nature and culture

Landscape evolution is based on the dynamic interaction between structure and functioning and also on history, which makes each landscape unique (Antrop 2000a). Geocomponents (defined by lithosphere, hydrosphere, atmosphere and biosphere) exist in mutual interrelationship and interact with each other in a hierarchically ordered way. Bedrock, the least component subject to change, plays a leading role. Hydro-climatic components occupy a subordinate position in this hierarchy and they, in turn, determine the edaphic and biotic components such as soils, flora, and fauna (Solon 1999). Since humans evolved, they have been influencing and changing landscapes.

Accordingly, a landscape is the outcome of the interaction through time of geophysical, biological and human factors and reflects, today, the accumulated register of life evolution as well the history of the preceding and present cultures. Landscapes come into existence neither solely from natural process nor solely from cultural processes. "We can easily observe the interplay between nature and culture at the landscape level" (Fry 2001). Today's landscapes are the visible product of this geo-biological and historical process. Naveh (1995) coined the definition of landscape as the tangible meeting point between nature and mind. As such, landscape is the very point where nature and culture come into contact (Tress & Tress 2001).

Distinct societies had flourished in specific regions around the globe and, working upon land, typical landscapes and cultural groups had simultaneously coevolved. The transformation of the physical environment into landscapes produces mosaics of land use systems that reflect the cultural characteristics of such groups. In this process, the social and cultural phenomena and the natural environment are merged and become part of the shared symbols and values of individuals and the social group. Through socio-cultural phenomena, the biophysical environment is transformed into landscapes that are the reflection of the people's definitions of themselves (Greider & Garkovich 1994, Naveh 1995, Nassauer 1997, Williams & Paterson 1999).

The perceptive dimension in landscape is fundamental as the concept of landscape combines a piece of land with its appearance, the scenery. Integration between perception of the environment leads to "landscaping", i.e. changes in the landscape, by shaping and organizing land according to needs of a local society and accordingly to its cultural values, aesthetics and ethics. As needs and values change, views of landscaping change accordingly. Landscape is dynamic and in continuous transition, not only by natural processes, but also by changing economical needs and cultural values (Antrop 2002b). As socially constructed place a given landscape can be described as the intersection of natural forces, social realms, and meanings (Williams & Paterson 1999).

The collective process of landscape transformation and how these landscapes are reconstructed is a response to people's changing definitions of themselves (Greider & Garkovich 1994). Thus, when events or a technological innovation challenges the meanings of these landscapes, it is the conceptions of them that change through a process of negotiation new symbols and meanings. People not only influence landscapes but also are influenced by landscapes that, therefore, are reconstructed in response to the people's changing definitions of themselves (Williams & Paterson 1999, Greider & Garkovich 1994). Configurations among human activities with biophysical characteristics have produced the large variety of landscapes of the planet. Therefore, to analyze landscapes "we need to understand how reality is both a social construction and a construction of nature" (Weigert 1997).

Landscapes at different scales will be shaped by multiple cultures, whose particular history and values must be assessed and integrated into planning for sustainable management. Processes of social differentiation of human ecological systems have a spatial dimension that is reflected by patterns of territoriality and spatial heterogeneity (Grove 1999). To take seriously the view that people are part of the landscape, good landscape management therefore will require a thorough map of landscape meanings

(Williams & Patterson 1999). "Meanings exist within an ecological context, that places or landscapes represent socially constructed systems of meaning. Of particular importance is the identification of the meanings various individuals, groups or cultures assign to specific piece of the landscape and understand the extent to which people agree or disagree on these meanings" (ibid).

2.1.6 Landscape as a complex system

The landscape is a complex of relationship systems (a complex relationship system of higher order, with many subsystems), together forming a recognizable part of the earth's surface. It is formed and maintained by the mutual action of abiotic and biotic forces as well as the human action. Landscape is complex system involving the geo-, bio, and noo-spheric subsystems, and their expression over spatial and temporal scales. System thinking is a method of scientific inquiry that allows one to understand and investigate complex realities. The fact that a system has its own characteristics in addition to the properties of its components (every level is a functional entity, but at the same time part of a larger whole) is the core of the general system theory (Lessard 1999, Zonneveld 1995, Tress & Tress 2001).

The key relevant property of systems to landscape research and ecosystem analysis is the interconnectedness of the components of landscapes (Moss 2000). Regarding the landscape as a system is to focus on the relationships among these subsystems and see them in the context of the whole and not only as separate entities. Each subsystem, as well as the manner it change over time can be examined independently of one another, but it is only when the four subsystems are combined that we can speak of the landscape as such. This whole has distinct qualities and a higher level the complexity. Insofar as the subsystems of landscape are combined in one system, and consequently are also treated as a single system in the research, we are applying a holistic approach (Tress & Tress 2001).

The holistic nature of landscapes has been recognized. Holism is an abstract concept and therefore difficult to handle and apply; analysis and holistic character are difficult to integrate. Holistic thinking is considered the opposite of reductionism and provides the basis for studying certain wholes or systems, without knowing all the details of its internal functions (Antrop 2000a; Zonneveld 1995). Holism expresses the concept that the whole is more the sum of their parts; also means that each element receives its significance only because its position and relationship with the surrounding elements. Therefore, changing one element always means changing the whole in some way (Antrop 2000a).

To Bastian (2002), the holistic approach in the context of human-nature-relations is the real challenge of modern landscape ecology regarding the background of loss of biological diversity, environmental problems, global change and the search for sustainability. A co-evolutionary relationship exists between socio-cultural, economic and environmental systems within the context of a landscape, and they cannot be addressed in a reductionism manner. Integrative approaches in landscape research and planning can contribute to overcome the overspecialization and fragmentation of environmental sciences, policies and education that lead to fragmentary attempts in the solution of environmental problems, and they may help to close the often-wide gaps existent between theory and practice.

The systems concept not only has affinities in the scientific world. In fact, common "holistic" land concepts are familiar to the layman. Pre-scientific names for landscapes or regions such as Swamp, Bog, Marsh, Tundra, Wood, Forest, Sahara, Desert, Savanna, Steppe, Prairies, *Pampas*, *Campos*, *Caatinga, Cerrado* etc, are much more than physiognomy descriptions or indications of a mosaic at the land surface. They indicate a comprehensive whole, a correlative complex including physiognomy of vegetation, relief and soil conditions, and land use, the visual and the otherwise know aspects as well as the unknown ones, which may be discovered after more intensive study. As a consequence, the system concept of landscape is the logical, and hence most feasible, base for land evaluation, the assessment of the environment in relationship to human use and management (Zonneveld 1995).

Landscapes evolve continuously by "internal" and "external" factors. Internal factors are those that may be controlled at the local level, for example by the direct action of the inhabitants. External factors are mostly indirect. International economical strategies and policies may influence, in the long term, the landscape conditions. Decisions are made on different hierarchical levels of policymaking and manifest themselves by actions on different scale levels (Antrop 2000a). Because most of the world's landscapes bear imprint of human actins, it would be naïve to conduct basic scientific investigations of those landscapes without considering the anthropogenic forces that have shaped them (Wiens 1999).

Such conceptions led to the understanding of landscapes as: a) a spatially defined mosaic of elements that differ in quantitative and qualitative properties; b) the mosaics formed by heterogeneous patterns of land use, as observable in aerial photographs or satellite images; c) the synthesis, as visual expressions on land, of the interaction among subsystems components that had shaped it through time; d) as the interface between nature and culture; e) as the consequence of human presence in the natural environment; f) the imprint of the natural environment on the culture and way of life of its residents, past and present

In the transdisciplinary concept of Landscape as presented by Tress & Tress (2001), landscape is understood as a complex and dynamic system, made-up of the interrelated subsystems, the geo-, bio, and noosphere. "Due to these coexisting subsystems, landscape is the concrete nexus of nature and culture. As a spatial and mental entity, landscape is part of the totality of the forming subsystems. People are part of the landscape by means of their actions and thoughts. Through human thought, landscape also becomes part of the people" (Tress & Tress 2001).

2.2 Landscape Structure and Analysis: a Systemic View

2.2.1 Patterns, Land Mosaics, and the Patch-Corridor-Matrix Model

Mosaic patterns are found at all spatial scales, from submicroscopic to the planet and universe. Land mosaics, however, are at the human "scale', measured in kilometers to thousands, of kilometers. Thus, landscapes, regions, and continents are three scales of land mosaics (Forman 1995). The pattern, the type of landscape mosaic, is an important feature if one studies the relationship between the various horizontally arranged complexes of landscape elements and also a very helpful classification characteristic. It also has important diagnostic value in the observation of landscapes from above (remote sensing, aerial photography, satellite images, etc). As a consequence, it is most important in mapping methodology (Zonneveld 1995).

The concept of pattern is common in various landscape sciences such as geomorphology, soil and vegetation science. It points to the occurrence of landform, soil bodies, and vegetation units in recognizable, often recurrent, patterns (Zonneveld 1995). The patterns are generated by process in different scales, and are the "hallmark' of a landscape. Three mechanisms create patterns. Substrate heterogeneity, such as geology, hills and slopes, wet spots, and different soil types, causes vegetation patchiness. Natural disturbance, including fire, tornado, and a pest outbreak creates heterogeneity. Human activity, such as plowing fields, cutting woodlots, building roads, creates patches, corridors, boundaries, and mosaic pattern. Various biological processes commonly modify or enhance patterns (Forman 1995).

Land heterogeneity is directly dependent on thermodynamically open conditions, with solar energy creating and maintaining structure. The basic identifiable elements in a landscape are the results of flows of energy through a region, following the general principles of thermodynamics (Forman 1995, Naveh 1994, Forman & Godron 1986, McHarg 1981), forming a heterogeneous mosaic of relatively homogeneous landscape units. Each landscape unit will show similar internal ecological properties. Boundaries or transitions among units imply change in at least one characteristic of the landscape, such as geomorphological and physiographic features, soil types, soil fertility, vegetation community, micro-climate, and historical and cultural aspects of the human settlement.

All landscape mosaics as ecological units will present a basically fundamental structure constituted by three types of spatial elements: a) Patches, b) Corridors and the c)

Matrix (Forman 1995, Forman & Godron 1986). Any single point in the landscape is within a patch, a corridor, or in the background matrix. This simple model provides a handle for analysis and comparison, plus the potential for detecting general patterns and principles (Forman 1995). Despite ontological and epistemological debates about limitation of the patch-corridor-matrix model (Bastian 2002, Haynes-Young 1999, Ahern 1999, Naveh 1995), we considered compatible with the people - landscape interaction model (see item 2.4.1) of Tress & Tress (2001). While the later express the systemic reciprocal influences of people and landscapes through time, the former reflects the visual expressions of such influence on land.

Since a mosaic at any scale may be composed of patches, corridors and matrix, they are the basic spatial elements of any pattern on land. They may be of natural or human origin, and thus apply to the spatial pattern of different ecosystems, community types, successional stages, or land uses. The size, shape and nature of boundaries are the main features of a patch and they can be categorized by the origin of the disturbance that had resulted in the specific patch. The origin of the disturbance mechanisms, either natural or human, will determine the stability of the basic elements and species dynamic (Forman 1995). In a particular observation scale, each identifiable unity, patches in the mosaic, will present similar disturbance arrangement.

A disturbance is a natural or man made event that, in a temporal scale, has cause a significant transformation in the normal or the current pattern of an ecological system. Disturbance regimes effects on the landscape structure or function can vary from short duration to the geological time scale and from few meters to thousands of square kilometers in the spatial scale (Forman & Godron 1986, Forman 1995). The emerging scenery of this analysis is a mosaic composed of elementary landscape units of different sizes, origin and in distinct stages of fragmentation or restoration. As a principle each unit will exhibit a unique combination of biophysical and cultural aspects.

Patches and corridors have long been a focus of human activity and research attention. Ecologists originally focused on patches and patchiness. Many became interested in corridors when discussing possible applications of island biogeography theory on land, and the ecological roles of hedgerows and windbreaks (Forman 1995). Width, connectivity, narrowing, nodes, gaps, and stepping-stones are important features of corridors acting as a conduits and barriers. A matrix can be extensive to limited, continuous to perforated, and variegated to nearly homogenous. The matrix, the most extensive and interconnected of the elements, is the dynamic landscape determinant (Forman 1995, Zonneveld 1995, Forman & Godron 1986).

2.2.2 Patches and land units: fundamental concepts for landscape planning and management

The concept of spatial unit and landscape classification has been the focus of several landscape approaches, particularly in the European and Canadian traditions. It is also common in various landscape sciences and shares similar perspective with the soil unit concept (polypedon) or the vegetation community, as example. Distinct definitions of land unit presented by different authors reflect schools traditions, scale of mapping and research goals. Conceptually designed to be referential to planning and management, distinct names are given; among them: bioregion, ecoregion, ecotope, geocomplex, geochore, patch, environmental unit, site, ecological unit, landscape unit, and land unit

(Schreiber 1990, Zonneveld 1995, Moss 1999, Bastian 2000, Antrop 2000a, b, Galochet et al 2002).

Mugavin (1993) described the concept "landscape unit' to structure the connection between planning and projects of development at the landscape scale, involving biophysical and cultural aspects in a National Park's buffer zone in South Australia. Makhadoum (1992) presented the concept of "environmental unit', acquired from the integrated analysis of social, economical and ecological factors to assessment and definition of more suitable productive system and land use planning in Iran. Ruzicka & Miklos (1990) discuss spatial units "ecologically homogeneous' as synthesis of natural and cultural systems in their LANDEP – Landscape Ecological Planning Model.

Haber (1990) has pointed out the importance of the "site", with unique features and hierarchically related, as a basis to sustainable landscape planning. Schreiber (1990) emphasized the ecotope - a geomorphic and ecological "quasi-homogenous" landscape unit. Fedorowick (1993) applied the concept of patches and corridors (Forman & Godron 1986) to design strategies for rural landscape restoration in the Ontario, to improve wildlife habitats in a context of intensive agriculture landscape. The aim of this study was to develop a new land mosaic with symbiotic relations among elements from an ecological, structural and agricultural point of view, based on diversification and introduction of new elements in the farm level.

Galochet et al (2002), used the concept of land units to assess the plant diversity of forest islets, wooded areas that were shaped by man in Poland. They used remote sensing techniques, aerial photographs, ground survey and ancillary information to delimit land units. Bastian, (2000) applied the concept of landscape unit, (micro-geochore) and classification based on a physical-geographical context as reference units for a holistic regional planning. Antrop (2000b) described a method for visually defining and mapping landscape units based on the interpretation of aerial photographs and compared the results with landscape metrics from digital land use maps.

The concept of land unit is comprehensively discussed by Zonneveld (1995) as a tract of land that is ecologically relatively homogenous at the scale level concerned. "Ecological' in this definition, points out to the set of factors ruling the functional processes inside the land unit; those factors whose variance appears to be important for land use and management are particularly important. Homogeneous means that, within the tract of land as a whole, relatively large gradients as such from wet to dry, or poor to rich cannot be distinguished. In reality there are always differences; the larger the area concerned, the more internal differences occur. However, we may still call such complex units relatively homogeneous if the composing elements occur in a regular or at least characteristic pattern.

The term, "relatively homogeneous" should not be misunderstood. A land unit can be considered homogeneous and constitutes a whole with its own identity. It refers to "being a unity in relation to a particular land ecological process or land management" (Galochet et al 2002, Zonneveld 1995), or, as expressed by Young et al (1983) "the relationship between the unit and the whole". The boundaries of a patch/land unit/geocomplex are only significant in relation to a given scale of study. Each spatial unit will present similar inside spatial variability with distinguished properties from the neighborhood relative to the productivity potential and to the response for a given management practice.

"Patch" is here considered as synonymous of "land unit": both concepts, patch and land unit, can be defined as an ecological relatively homogeneous spatial unit in a defined scale of analysis in relation to the heterogeneity of the surrounding surfaces (Gallant et al 1989, Zonneveld 1995, Solon 1999, Antrop 2000a, b, Moss 2000, Galochet et al 2002). Patches and land units can be distinguished at various scale levels, and thus a hierarchy of land units exists. In this dissertation project, both concepts will share the same meaning as described above as fundamental concepts, but will be employed for describing patterns at different scales: patches in a broad regional mosaic; land units at farmland /local level.

Land unit is here considered as the expression on land of the interactions among ecological, cultural and social economic factors in the farmland/local context. Each land unit is defined by a particular physiognomy and expresses the structure of regional land use systems. It is regarding land units that management decisions and actions in the field are taken. In agricultural landscapes, land units are the spatial unit to be evaluated and mapped for planning purposes and as subject of management. It will be further discussed[2] that land units should be the basic elements of the spatial dimension of agrolandscapes upon which a dialectical process and dialogues (Kvale 1996, Denzin & Lincoln 1998) concerning conservation with stakeholders should focus. "Landscape management should be conducted on spatially explicit entities, not poorly define concepts" (Hobbs 1998).

2.2.3 The nature and selection of boundaries

The ability to detect patterns is a function of both the extent and the grain of an investigation. Extent is the overall area encompassed by a study or the population we

[2] See Section 5.2.2 - Mapping land units at farm level

wish to describe by sampling (Wiens 1989, 2002); it can also be considered as time period over which observations were collected (Gustafson 1998). Grain is the size of the individuals units of observation, the quadrats of a field ecologist or the sample units of a statistician. Extent and grain define the upper and lower limits of resolution of a study. For logistical reasons, expanding the extent of a study usually also entails enlarging the grain. The enhancement ability to detect broad scale patterns carries the cost of a loss of resolution of fine scale details (Wiens 2002).

Land is spatially heterogonous, an uneven (non random distribution of objects), that always has structure. Spatial heterogeneity occurs in two flavors. A gradient or series of gradients has a gradual variation over space in the objects present and thus has no properly boundaries, no patches and no corridors, but is still heterogeneous. The alternative form of spatial heterogeneity is a mosaic, where objects are aggregated, and forming distinct boundaries (Forman 1995). Although the patch model is best suited to many landscape studies, some landscape mosaics are better represented as gradients or continuously varying surfaces of systems properties (Gustafson 1998). The spatial scale of a study has an important role in conceptualizing the definition of continuous or discrete boundaries.

Solon (1999) discusses such topic as the principles of "relatively discontinuity of natural environment" and "delimitation of partial geocomplexes". In accordance to the principle of the relative discontinuity, it is accepted that geocomponents can form natural "geocomplexes". The boundaries of a geocomplex (spatial unit, patch or land unit) are only significant in relation to a given scale of study. Even a relatively discrete patch boundary between two areas becomes more and more like a continuous gradient as one progresses to finer and finer resolution. One example is to compare soil-mapping units on a reconnaissance map with those of a detailed map.

The variability of ecological systems has been typically represented by categorical maps or by a collection of samples taken at specific spatial locations - point data (Gustafson 1998). Mapping is a powerful way to represent the spatial distribution of ecological units, and is a particularly useful tool for various planning and management objectives (Johnson et al 1999). Categorical maps are intuitive and consistent with ecological theory by identifying patches that are relatively homogenous and that exhibit a relatively abrupt transition to adjacent areas.

Alternatively, point data analysis is applied to data collected by sampling rather than to maps. Point data analysis assumes that the system property varies continuously in space and applies mathematical techniques for modeling gradual spatial changes (Gustafson 1998). Such techniques includes multi-scale sampling, point pattern methods, surfaces pattern methods, and spatial or geostatistical tools such as spatial autocorrelation, semivariograms and kriging. Applications of geostatistics have showed to be useful in areas as geology, geography, soil science, and ecology (Rossi et al 1992, Gustafson 1998, Fortin 1999).

The EPA's Regionalization Model (Gallant et al 1989) was designed to isolate environmental spatial diversity through the identification and delineation of land units with inside spatial variability lower than the outside neighborhood. Landscape units, thus, can be analyzed with any necessary detail and are useful to different objectives in the natural resource management field. They discuss two methodological approaches to delineate boundaries: a) qualitative method, employing continuous and interactive judgment from specialists to selection, analysis and classification of the available data towards regional delineation; and, b) quantitative methods, based in the statistical analysis of locally collect data as representative of a geographic area.

They argued that quantitative methods are not yet sufficiently developed to incorporate the multiplicity of judgments necessary to the delineation of patches. Advances in geostatistical tools (e.g., Rossi et al 1992, Gustafson 1998, Fortin 1999) together with GIS, analysis of remote sensing and spatial modeling, have improved the potential for quantitative assessments. The significance of the qualitative analysis, however, is that all available data, including the spatial distribution of patterns, which can or cannot be quantitative based, and the professional experience of those involved in the project can be integrated in the delineation process (Gallant et al 1989). The local expertise and the professional experience in data integration for boundaries delineation are likewise discussed by Zonneveld (1995) and Naveh & Lieberman (1994) and involve subjective judgment.

In many cases such as natural landscapes where landform and vegetation differences coincide, pattern components can be quite obvious. Geomorphology is very often a good guide in defining broad land units' boundaries within regions with same climate and lithology. Vegetation types are often useful indicators particularly at detailed scales, but vegetation boundaries are less temporarily stable than landform. In land that has been intensively cultivated such as traditional agricultural landscapes pattern are also often obvious. In these regions, soil types are likely to coincide with the delineation expressed in the land use pattern (Zonneveld 1995). On the regional mosaic of study, landforms, soil types, natural vegetation and land use patterns coincide to a great extent and, hence, boundaries can be quite objectively drawn (Rocha 1995, Moro et al 1996, Rocha et al 1997).

In modern intensive agricultural area, farming is likely to develop new boundaries where homogeneity previously existed in nature, through changing vegetation, land use, or even the landform. With increasing technological power, human influence becomes more and more a land unit-determining characteristic (Zonneveld 1995). Human imprints in the landscape can also be mapped as a component system (e.g., property limits, land use system, landscape meanings, road network, etc) and integrated into analysis. Mutual relations among various systems of units can be determined and the integrated analysis (e.g., overlaying) of "partial geocomplexes" (Solon 1999), would propitiate the referential basis for mapping landscape units.

The delineation of partial geocomplexes (Solon 1999) refers to the mapping of spatial units of individual geocomponents (e.g., physiographic units, soil, vegetation, habitats, etc). Each spatial unit in a particular geocomponent represents an area that is "homogeneous" in that particular point of view. Partial geocomplexes reflect the variability of individual geocomponents with respect to the differentiation of the natural environment as a whole. Theoretically, all systems components can be used in the delineation. However, in the delimitation of comprehensively understood natural and cultural spatial units it is not possible (and certainly not necessary) to account for all components and the interactions between them. Rather, the delineation of units can be based on a limited number of key sociocultural and biophysical indicators (Grove 1999).

Concerning the selection of boundaries, Solon (1999) argues that the basic spatial units (geocomplexes) should be identified on the basis of an objective function. Instead of “discovering” objectively existing geosystems, spatial units can be “constructed” according to the need or, more likely, to an objective function. In such approach the definiton of systems (geocomplexes or patches) depends on the integrating function to be adopted; e.g., if the life requirements of a given species are accepted as an integrating function, then habitat patches should be defined relatively to the organism’s perceptions of the environment. Landscape size differs among organisms because each organism defines a mosaic of habitat or resource patches differently and on different scales.

Similarly, if a network of remnant patches and corridors of natural vegetation in a fragmented agricultural landscape is considered an integrative function for biological conservation and sustainable management of agroecosystems (Barrett & Peles 1994, Noss 1996, Mander et al 1999, Ahern 1999, Bennett 1999, Marshall & Moone 2002, Freemark et al 2002, Barret & Skelton 2002), remnant patches should first be mapped at a broad regional scale where the network would make ecological and spatial sense. As an efficient network design must be integrated across the landscape, conservation practices are likely to be developed within private lands and stakeholders have to be involved. Hence, remnant patches should also be mapped relatively to stakeholders’ perceptions of the agrolandscape.

Another important tool concerning boundary selection and mapping of land units is based on remote sensing and geographic information systems. The synoptic view depiction provided by satellite images has revolutionized the perception and approaches to understanding landscapes and regions. For the first time a whole region could be examined in a single image (Forman 1995). Remotely sensed data offer the potential to develop detailed spatial data bases and maps for virtually any spectral phenomenon, or for any phenomenon that can be linked reliably to spectral data. Infrared images underscore the contrasting patterns of vegetated and non-vegetated surfaces, and a variety of spectral wavelengths and color enhancement techniques can be use to separated subtle nuances, such as of vegetation types (Avery & Berlin 1992).

Remote sensing offers the possibility of systemic division of space with the help of software and algorithms for digital classification of images. However, when compared to aerial photographs, digital classified satellite maps shows that mixed pixels causes significant differences in category assignment, as well as in a spatial delimitation. Such outliers can greatly affect further statistical analysis and classification in thematic maps (Antrop & Van Eetvelde 2000). The constant technological advances in GIS data storage capabilities, computational power, and automated optical processing capabilities, computer digital analysis of remote sensed data offers staggering potential for multi-scale landscape analysis (Galochet et al 2002, Withers & Meentemeyer 1999).

Geographic information Systems (GIS) have rapidly expanded in use, flexibility, and affordability and is one of the most extensively used tools in modern landscape ecology. These are a set of tools for storage, analysis and display of spatial data. The cartographic modeling allows map layers to be overlaid in various arithmetic or functional relationships to portray complex statistically or mechanistic simulations in geographic space. The information is stored digitally and presented visually or graphically, and available for efficient comparisons and correlations. The information may be stored in raster form, cell by cell (pixel by pixel) in a grid, or may be in vector form at varying distances and directions from points (Withers & Meentemeyer 1999).

2.2.4 Human perception and the "art" of patch delineation

The hierarchical interaction among landscape system components will produce on land, patterns of spatial units that enable one to discern in a given region, patches represented by "degrees of homogeneity within a heterogeneous mosaic". The human perception of distinct spatial patterns on land and the correlation of their expression with ecological process and cultural features has been the motif for identifying and mapping landscape units. System theory has been applied for such analysis taken into account that some distinct features among components of the landscape will dominated over others in the process of shaping boundaries and developing a relatively homogeneous environment within in relation to a spatial and temporal context.

Boundaries between patches (or land units) represent zones of transition on the ground, where the characteristics of one relatively homogeneous area blended with those of another. The transition width of some boundaries can be very narrow and recognizable from the ground, for others will be less distinct and can best be distinguished from a distance (Gallant et al 1989). In general land units are obvious at any scale provide one can oversee a large area as in a satellite image or airphoto. As a scientific object, recognition should be done methodologically (Zonneveld 1995). The proper techniques for delineating spatial boundaries are a subject area of continuing study and its cartography will vary in accordance with the problem, research questions and the research field of the involved team (Grove 1999, Johnson 1999, Schreiber 1990).

The selection of boundaries is clearly a classification by subdivision. An experienced landscape surveyor is able to make quick reconnaissance survey in this way, only mapping the higher spatial hierarchic level. The pattern within these large units will not be mapped, but the patterns as such, visible on aerial photographs or other remote sensing media, indicates the content and the boundaries of the complex units. The more time and resources available, the more details can be describes and sampled (Zonneveld 1995). Methods to delineating boundaries by agglomeration of smaller units, described as opposite and complimentary view of subdivision, have been described as top-down/bottom-up (Solon 1999) or as descending/ascending approaches (Zonneveld 1995).

To Zonneveld (1995), delineation of land unit boundaries is preferably done by aerial photography, using the stereoscope or another remote sensing means. Interpretation of aerial photography provides a powerful tool to get a full systematic and objective coverage of the study area (Ihse & Lindahl 2000). The main advantage is a very good stereoscopy, three-dimensional overview of the whole landscape and detailed information at different scales of both natural and cultural components. The experienced photo-interpreter-landscape ecologist recognizes similarities as well as differences in textures, colors, shades and patterns in the photo elements, and by constant mutual comparison and associative thinking and reasoning he arrives at an optimal distinction of units. At this stage the content of the polygon as expressed in the photographic features is more important than strict location of the boundaries. The preliminary units can be used to guide a stratified sampling strategy to field checking and data collection necessary to classify polygons and to improve the process of drawing boundaries (Zonneveld 1995).

The concept of "convergence of evidence" is a general guiding principle for photo and image interpretation. It means that in one group of objects different kinds of variations in properties converge or coincide in contrast with other groups of objects. Diagnostic characteristics may be selected from those converging properties and should be selected as a set of converging systems characteristics and not just a single property of the composing parts. Multivariate analysis can be employed to select converging systems. The employment of point data analysis will require an intensive effort for data collection and a highest accuracy must be achieved (and paid for). In most projects in data poor areas, visual interpretation of patterns using remote sensing and aerial photography is sufficient (Zonneveld 1995).

Interpreting patterns and identifying units is related to the ability and training one has in recognizing patterns. Human perception is extremely powerful in analyzing and recognizing complex patterns, spatial structures and images. As stated by Antrop (2000a), "humans are the best in pattern recognition". When individual elements in a pattern are recognized, new partial structures are immediately constructed to form new objects, which are identified on a higher level of abstraction. The recognized objects are compared and linked to our existing knowledge or identified as unique elements that can be given a proper name. Perception, as a complex learning process, analyses the results with our knowledge and past experiences (Antrop 2000a).

Human perception is holistic and psychological Gestalt-theory describes some laws that explain how we tackle complex patterns. The capability of human perception to recognize and interpret complex spatial patterns demonstrates many of the Gestalt laws simultaneously. Shapes are simplified and grouped according to similarity and proximity, and wholes are defined. This capability forms the basis of image interpretation, as applied in aerial photo interpretation (Antrop & Van Eetvelde 2000). The work of experts, however, based on qualitative and subjective analysis, can lead to ambiguous results. Even experts from the same field working isolated from each other and mapping the same area, are likely to produce rather distinct boundaries and maps, an unacceptable outcome regarding reliability as a paradigmatic scientific attribute.

A digital classification of satellite data instead, defined by a unique logical statistical algorithm would produce a unique and reliable map. Reliability, however, does not ensure accuracy. Commission and omission classification errors (Jensen 1996) are likely to occur, particularly for categories that have a mixed electro-magnetic reflectance such as tropical and mixed forests, suburban landscapes, intensively managed agrolandscapes or mixed riparian areas. Map categories from digital classification are often too broad for specific purposes in large-scale projects. The fully automated processing and interpretation of remotely sensed data remains an elusive goal and the estimation of ecologically meaningful data from them, remains inadequate and often inappropriate for many phenomena (Withers & Meentemeyer 1999).

Visual image interpretation of remote sensing imagery offers an alternative and efficient method to classify complex and heterogeneous landscapes and spatial units with image pattern characteristics. Visual interpretation of images is a non-numerical approach starting from the image characteristics perceived in screen or hard copy. Software techniques for preprocessing and enhancement of the image are important because they can and can direct the interpretation in highlighting particular spectral responses that are linked to particular landscape features in different band intervals. Similarly to the interpretation of aerial photos, the basic characteristics of the image used during visual interpretation are shape, size, pattern, tone or hue, texture, shadows, geographic or topographic site and associations between features and identified objects. These landscape units can be used as aggregating areas to calculate landscape metrics of patches generated by automatic grouping procedures in GIS (Antrop & Van Eetvelde 2000).

Visually defined land units are based on holistic properties of perception that automatically resolve image noise caused by data quality and that neglect the outliers that affect quantitative classification methods (Antrop & Van Eetvelde 2000). The task of visually defining boundaries will be improved by integrating transdisciplinary expertise. Rather than having a unique digitally classified but "inaccurate" map, an improved map would result if achieved from consensus among complementary perspectives in the art of delineating boundaries. Quantitative and qualitative spatial information derived from satellite and aerial photo interpretation open together new perspectives in defining land units. The process of defining patches and land units that are meaningful to stakeholders in addressing "real world" conservation issues, is the main focus of this research project.

2.2.5 Landscape Analysis and the Importance of Scale

One of the most perplexing issues facing ecosystem management is the appropriate spatial scale for organizing analysis and assessments. Similarly, the challenge for ecologists in general, is to match the scales of their observations and experiments to the characteristic scales of the phenomena that they investigate (Wiens 2002). Scale has recently been called "the new frontier in ecology" and it is now a common topic discussed in many ecological research papers. The problem of multiple scales permeates the study of ecological process and pattern, uniting aspects of space, time and organizational complexity. In particular it supports the maintenance of biological diversity (Levin 2000). The physical and cultural processes that produce landscape patterns and the responses of organisms to those patterns are scale-dependent.

Various ecosystems components (e.g., species, soils) and processes (e.g., fires regimes, nutrient cycling) exist at different scales. As a consequence, relationships that are apparent at one scale may disappear or be replaced by other relationships at other scales (Malk et al 1999). Roth et al (1996) found that measures of stream biotic integrity for stream fish were strongly correlated with the extent of agriculture, wetlands, and forest in the surrounding terrestrial landscape at a catchment's scale, but were weaker or non-significant at a local scale. Local-scale riparian vegetation was only a weak, secondary predictor of stream biotic integrity and the regional land use overwhelmed the contributions of local streamside vegetation in enhancing stream conditions for fish.

Research and management of natural resources carried out at a single scale has a history of unpleasant surprises. For example, research in the 1950s and 1960s shows that the richness of local species and the abundance of game species generally increased in proximity the habitat edges. This prompted natural resources managers to recommend increasing edge areas through small dispersed clearcuts. Landscape scale analyses in the 1980s, however, led researchers to a different conclusion - creating lots of edge may increase local species diversity, but the resulting habitat fragmentation may lead to a net loss in biodiversity at the landscape level. The realization that analyses at different scale can lead to significantly different conclusions has spurred the rise of ecosystems management (Malk et al 1999).

Ecosystems and landscapes are not close self-supporting systems, but rather are parts of larger interacting systems. This is alto true of social and economic systems. Like biological aspects of ecosystems, social structures, processes, and meanings need to be considered at multiple spatial scales, although social phenomena are not necessarily spatially organized nor determined by bio-ecological boundaries (Williams & Paterson 1999). When surveying the economic and social objectives of an area, local community interests may be different from state or national level interests (Steel et al 1994, Shindler et al 1993). Regardless of the particular issue or question, there is always a need for a larger scale perspective to deal with cumulative impacts and to establish context and framework for actions. Lack of a larger perspective is the most common scale-related problems in forest and natural resource management (Malk et al 1999).

Successful studies need to rely on the identification of appropriate scales and their linkages in the design of a landscape study, whether experimental, quasi-experimental, or observational. Larger scale ecosystems and landscape perspectives are relatively new and tools for assessing larges scale and incorporating them into scientific decision making are underdeveloped. Language describing phenomena and processes (biological and social) in terms of their spatial and temporal scale is still emerging, but shows promise in addressing complex problems which involve human and natural systems. It has also become commonplace to consider landscape scaling hierarchically (Hobbs 1998, Withers & Meentemeyer 1999, Malk et al 1999, Wiens 2002).

The landscape system is a nested hierarchy with each level containing the levels below it. Hierarchy theory refers to how a system of discrete functional elements or units linked at two or more scales operates. It can be applied to the systemic analysis of spatial and temporal patterns at landscape level. This paradigm allows the study of an event at a particular scale, while recognizing that there will be other significant scales of analysis for that given event. Such an approach is fundamental in a landscape analysis, since varying the observation scale, different patterns will arise, and new spatial units will be distinguished. A landscape unit consequently, analyzed in a fine or coarse grain, will show distinct patterns and new elements will be identifiable.

Spatial hierarchies represent useful heuristic devices, as an aid in perspective and perhaps to help identify constrains on the landscape elements being studied (Withers & Meentemeyer 1999). Hierarchy theory provides a framework for identifying the components of an ecosystem and the linkages between the hierarchical scales of ecological organization (Lessard 1999). A landscape analysis based on a hierarchical approach allows a cognitive understanding of the relationship between biophysical, social, economic and cultural systems components with habitats and ecosystems and the integration of this information with landscape design for biodiversity conservation (Barrett & Peles 1994).

In planning, management and policy, time and spatial scales play highly significant roles. At each defined spatial and temporal scale, different sets of factors and factor interrelationships become more or less relevant in management considerations (Cordell et al 1999). There is not a single scale to the analysis of natural phenomena; the system description will vary accordingly to a particular selected scale (Levin 1992). Therefore, the description of the variability or predictability of environmental factors will have no sense, without reference for a particular set of scales that will be relevant to the organisms or process being analyzed. Hence, rather than determining the proper scale, there should be an analysis to understand how the description of the system will change through the scale. Different intensities of details (grain size) will be necessary through scale to accomplish with a set of objectives of a particular project.

A wildlife habitat analysis for example, is likely to include various components from a variety of species (i.e. nest sites, habitat patterns, feeding areas, amount of edge, patch size, and connectivity). The appropriate scale for assessing wildlife habitat will vary by species and habitat components and purpose of the study. In the case of environmental impact statements that are especially sensitive to the scale of analysis, one scale of analysis will rarely be adequate, because they frequently involve assessing multiple impacts and require examination of attentive actions. Different scales, determined by the types of potential impacts and details of the alternatives actions will likely be more adequate (Malk et al 1999).

The scaling properties of many ecological (and socio-cultural) patterns and processes are still poorly understood; in part because these properties are usually site, region, and time dependent, making generalizations difficult (Lessard et al 1999). Scale considerations in a study for landscape management should be defined based on the following practical guidelines (Malk et al 1999):

a. **Determining the boundaries of the planning landscape**. Once management objectives are defined, the next step is to determine the extent and boundaries of the planning landscape. The spatial coverage of the planning landscape must be large enough to address population viability, biodiversity, or other factors addressed by planning objectives. However, the planning landscape should be small enough to include only as much ecological variation as needed to address those objectives and to ensure it is practical for developing feasible collaborative partnerships and can make use of existing information and databases.

b. **Determining spatial and temporal resolution to address management objectives**. The resolution of mapping units and data can significantly influence the conclusions of an ecosystem analysis. Typically, management objectives are related to various ecosystems processes, each with their own unique scales in time and space. It is critical that the data used can detect the relevant processes and phenomena. Spatial resolution should be set by the minimum size of the object or phenomena of interest. The appropriate temporal resolution should be determined by the shortest increment of time needed to detect the periodicity of the process or phenomena of interest.

c. **Determining the relevant planning horizon**. Some management objectives can be safely achieved with a relatively short planning timespan or horizon while others cannot. Given that ecosystems typically have successional trajectories that last for decades or even centuries, long term planning horizons are frequently needed. On the other hand, social and economic conditions rapidly change and relatively short-term planning horizons may be more appropriate. In some cases, it may be appropriate to set long term planning horizons for certain objectives, while setting shorter horizons, or periodically parts of the long-term plan, for others.

d. **Assessing an appropriate timespan for an historical perspective**. Historical reference points can help set ecological objectives. An appropriate timespan for an historical perspective on ecological conditions will be determined by the period of interest. This must be set regarding that time spans for biological significance can be very different than the time scales of human significance, particularly in decision making.

2.3 Conservation Science and the Need of a Human Dimensions Approach

Contemporary understandings of ecology recognize that extensive and intensive human-brought changes have irreversible propelled all Earth's ecosystems along new trajectories of change. Because much biodiversity loss is caused by political and economic forces, conservation biology, therefore, cannot afford to overlook the active role of humans as an integral component in ecological, evolutionary, and environmental processes (Robertson & Hull 2001, Song & M'Gonigle 2001). However, throughout most of the 20th century, both ecological science and conservation philosophy have tended to ignore the historical fact that people are part of nature.

In the midst of fragmented ecosystems, invasive species, and global warming, conservation biology needs a vision of nature, ecological science, and environmental management that includes human society. If we hope to halt the tide of biodiversity loss and environmental degradation, then we should turn our attention to the managed landscapes (Hobbs & Sunders 1993, Szaro & Johnston 1996, Rambaldi & Oliveira 2005), to the places where we live, work, and play. It should not be assumed that nature, if left alone, will take care of itself. Rather, if we want environment to be a certain way, we must actively manage for the conditions desired. People, therefore, "must be part of the equation" (Robertson & Hull 2001).

Meffe (1998) has noted the "interface between science and society is the most critical endeavor we can collectively pursue over the coming decades" and that scientific work should be geared towards influencing conservation policy. A conclusion also reached by many scholars who said that to be able to do ecosystem management, conservation biologists must be able to view specific problems in political, social, and economic contexts (e.g., Redman 1999, Holling 2000, Song & M'Gonigle 2001, Sheil 2001). Conservation biology, therefore, needs to incorporate more human dimensions into its scientific pursuit (e.g., Knight & Landres 1998, Cordell & Bergstrom 1999, Özesmi 1999, Robertson & Hull 2001, Mascia 2003, Bawa et al 2004, Acharya 2004, Berkes 2004).

As stated by Mascia (2003), "the disconnection between biological knowledge and conservation success has led to a growing sense among scientists and practitioners that social factors are often the primary determinants of success or failure". Although it may seem counterintuitive that the foremost influences on the success of environmental policy could be social, conservation interventions are the product of human decision making processes and require changes in human behavior to succeed. Thus, "conservation policies and practices are inherently social phenomena, as are the intended and unintended changes in human behavior they induce" (ibid).

Recognizing that conservation is about people as much as it is about species or ecosystems, suggests a significant shift in the nature and use of science in conservation (Robertson & Hull 2001, Mascia 2003). To preserve the earth's natural heritage, the social sciences must become central to conservation science and practice. Political science, anthropology, economics, psychology, sociology, geography, legal studies, and other social science disciplines all have analytic tools and established knowledge that can help to understand the patterns of human behavior and the dynamics of the political and economic structures within which conservation biology operates. The integration of these insights is considered vital to the success of local, national, and international conservation efforts (Cordell & Bergstrom 1999, Song & M'Gonigle 2001, Bawa et al 2004).

Therefore, in connection with the biophysical and structural analysis of the landscape[3], this research will pursue a fundamental social component in the development of a landscape-based conservation approach. As a basic component of the "mental

[3] See discussion on Section 2.2 - Landscape Structure and Analysis: a Systemic View

dimension" of the landscapes[4], social values play a fundamental role in shaping the landscapes of the future. Hence, in the next topic we will address the literature developed within the human dimensions of natural resources as it concerns social values, the cognitive hierarchy, and environmental values orientation and attitudes.

As social science has a fundamental role in shaping the present research approach on landscape conservation, following we will also address the main theoretical perspectives (research paradigms) in social research: "Positivism", "Constructivism - Interpretivism", and "Critical Theory". The discussion to follow was primarily developed based on the theoretical perspectives in social research as presented on the works of Argyris et al 1985, Kvale (1996), Denzin & Lincoln (1998), Guba & Lincoln (1998), Kincheloe & McLaren (1998), Schwandt (1998), Cordell & Bergstrom (1999), Stringer 1999, Blaikie (2000), and Acharya (2004).

2.3.1 Social Values and Landscapes

Social values are socio-cultural codes that help individuals to map out what is desirable or undesirable in reality and the standards by which members of a culture define what is good or bad, beautiful or ugly. They are not descriptive statements but evaluations and judgments, from the standpoint of the culture, of what ought to be. These broad principles are reflected in virtually every aspect of people's way of life. Values are formed, internalized, and transformed by humans interacting within personal, socio-cultural system about desired end-states of existence and desirable modes of actions for attaining them. Values are thoughts, emotions, desires, and dreams that link us with reality and guide us toward the future. Something with values arouses our emotions and

[4] See discussion on the concept of the "noosphere" on section 2.1.3 - Landscape as a mental entity

motivates us to act. Values also serve to justify or explain past, present, and future attitudes and courses of actions of individuals or societies (Rokeach 1973, Peine et al 1999).

Values typically vary with education, age, gender, source and amount of income, place of residence, location of upbringing, and family history and are formed gradually within an individual (James 2002). Rokeach (1973) identifies 36 values, disaggregating them into two broad sets: a) 18 terminal values referring to conceptions about ultimate goals or desirable end-states of existence, such as freedom, happiness, wisdom, equality, peace, and salvation, that "are worth striving for"; and, b) 18 instrumental values referring to conceptions about desirable modes of behavior such as being loving, ambitious, honest, hardworking, logical or responsible, that are essential to the attainment of desirable end-states (Fulton et al 1996, Peine et al 1999). Values are the building blocks of people's socio-cultural worldviews that "color the way we see (and shape) reality" (Peine et al 1999).

Over time, certain socio-cultural values systems and values tend to predominate over others because they enjoy more political, economic, institutional, technical, and/or public support. Such is the case for dominant socio-cultural worldviews. They are principles that are used to translate and transform physical, biological, personal, and social systems in ways that reflect their own specialized values and interests. Socio-cultural worldviews in general help define and determine what is desirable and undesirable (i.e., what has terminal value) in the individual, society, and nature during a particular historical period. Furthermore, anything that is believed to be a bridge to a desired end-state is valued (i.e., it has instrumental value), while something that is believed to be a barrier tends to be neutralized, devaluated, or devoid of value. In turn dominant socio-cultural worldviews become part of the socio-cultural heritage of particular group or society that is transmitted to the next generation through various social institutions (Peine et al 1999).

Values conflicts arise when different groups of people desire different end-states or use different means of attaining desired end-states. Strong emotions can emerge during values conflicts because people believe that the bridges or means (instrumental values) of attaining their version of a "good life" are being threatened or blocked or when their dreams or goals (i.e., terminal values) are being unrealized (Peine et al 1999). The emergence of ecosystem management paradigm in public lands in the USA takes place in a broader context: as agencies try to turn toward ecosystem and adaptive management models of forest and rangeland stewardship there has been increasing debates about the role of federal government, society's values regarding endangered species, and rights associate with private lands have been debated. These issues have been reported as dichotomies such as "jobs versus the environment", or "commodities versus amenities"; the main issue being debated, however, are differing values regarding what benefits society should receive from public lands. "Values are really what's being debated, not ecosystems management" (McCool & Burchfield 1999).

Values help define what is desirable and undesirable within ourselves, in society, in the environment, and, consequently, they help to shape the future. As a component of the mental dimension of landscapes (noosphere), values play a fundamental role in shaping the landscapes of the future. Identifying, understanding and adapting social values are major bridges to a future of sustainable development. Individual needs and responsibilities (personal values), can no be longer be separated from socio-cultural needs and responsibilities (socio-cultural values) or from the needs and responsibilities of the environment (environmental values). All of these social values (personal, cultural, and environmental) must be linked together to create a sustainable future based on shared "eco-sociological" visions and values (Peine et al 1999).

The Cognitive Hierarchy and Fundamental Values

The way people interact with the landscape is driven by how they value it; therefore we need to understand what these values are and who holds them. Individuals develop cognitive models that help them to understand and act on their world; other individuals with whom they socialize reinforce those models. Theory suggests that an individual's view of the environment can be organized into a cognitive hierarchy consisting of values, basic beliefs, values orientations (patterns of basic beliefs), attitudes and norms, behavioral intentions and behaviors (Rokeach 1979, 1973). Each of these elements build upon one another in what has been described as an inverted pyramid (Figure 2.1), with values forming the foundation and indirectly influencing numerous behaviors in the top of it (Ajzen & Fishbein 1980, Fulton et al 1996, Vaske & Donnelly 1999, Vaske et al 2001).

Next to actual behaviors, behavioral intentions are the highest order constructs in the cognitive hierarchy and are close antecedents of behaviors. Thus, intentions to engage in specific behaviors are the best predictors of actual behavior. Higher order attitudes and social norms concerning specific attitudes objects and behaviors are the direct antecedents of the behavioral intentions and the next highest order constructs in the cognitive hierarchy. There are many of these high order attitudes and norms with the number limited only by the number of direct or indirect experiences an individual has with specific objects and situations. Also, because the higher order cognitions are less central in the cognitive structure, they are more easily changed than the more basic cognitions (Rokeach 1979, Ajzen & Fishbein 1980, Herbelein 1981).

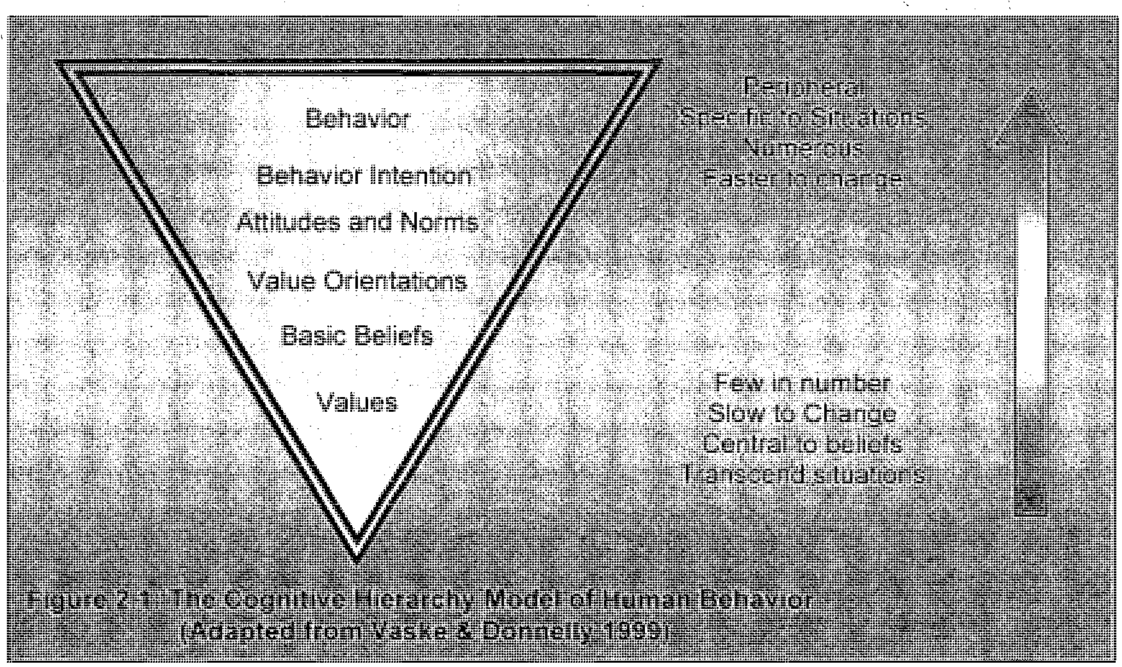

Figure 2.1: The Cognitive Hierarchy Model of Human Behavior (Adapted from Vaske & Donnelly 1999)

The higher order attitudes and norms are preceded in the cognitive hierarchy by more general attitudes towards and beliefs about relatively abstract concepts. These constructs have been demonstrated to affect behavioral intention through their impact on more specific attitudes. The second and third order cognitions are proximate to the fundamental values as basic beliefs and the value orientations. Value orientations can be viewed by the pattern of direction and intensity among a set of basic beliefs regarding specific objects or situations. Basic beliefs serve to strengthen and give meaning to fundamental values. Patterns of these basic beliefs create value orientations. Value orientations are predicted to be influential to a person's attitudes (Rokeach 1973, Manfredo et al 1997, Vaske & Donnelly 1999).

Fundamental values are the first order cognition that forms the foundation of the cognitive hierarchy; they are the most central to the cognitive structure, the fewest in number and the most stable. Rokeach (1973) defines a value as "an enduring belief that a specific mode of conduct is personally or socially preferable to an opposite or converse mode of conduct or end state of existence". Values represent social cognitions that facilitate adaptation to one's environment and are the more abstract of the social cognitions. They reflect the most basic characteristics of adaptation. These abstractions serve as prototypes from which attitudes are generated (Vaske & Donnelly 1999).

Fundamental values are not focused on specific objects or situations with which an individual has contact or experiences, rather they are more abstract cognitions that are concerned with what are more desirable end-states and modes of conduct, in general (Fulton et al 1996). Unlike specific attitudes, norms and beliefs, values transcend specific situations and, thus, influence behaviors, attitudes, norms and beliefs across the broad array of experiences in life (Rokeach 1973, Fulton 1996, Vaske & Donnelly 1999). Numerous studies have also demonstrated that values influence behavior through their impact on higher order beliefs and attitudes (Fulton et al 1996, Vaske & Donnelly 1999, Vaske et al 2001).

As Values are the most abstract of the social cognitions and few in number, they tend to be widely shared by all members of a culture. Thus values are unlikely to account for much of the variability in the specific attitudes and behaviors. Rather the influence of values on attitudes and behavior occurs indirectly via other components in the cognitive hierarchy (Vaske & Donnelly 1999, Fulton et al 1996). The influence of fundamental values on higher order cognitions is primarily indirect and transmitted via several intermediate levels of increasing specific cognitions in the cognitive hierarchy. Within a given domain of interest, basic beliefs serve to strengthen and give individuals meaning to the more general values. In this way they serve to orient higher order cognitions in a way that makes these higher orders cognitions consistent with fundamental values, but also introduce individuals differences within the cognitive structure (Fulton et al 1996).

Environmental Value Orientations

Several research efforts have attempted to identify and explore environmental values (e.g., Steel et al 1994, Stein et al 1999, Vaske et al 2001, Kaltenborn & Bjerke 2002) and attitudes towards landscapes, conservation and other environmental issues (Shindler et al 1993, Solecki 1998, Zinn et al 1998, Walpole & Goodwin 2001, Erikson et al 2002), which are held by various members of the public. The aim of these studies is to understand the basis for public specific environmental concerns and conflicts as a means to improve management decisions for landscapes and finding areas where competing users may have common values and attitudes.

Most people evaluate environmental issues, thereby expressing their environmental value orientations. Attempts to measure aspects of environmental value orientations were made based on the "New Environmental Paradigm Scale" as developed by Dunlap & Van Liere (1978), (e.g., Gooch 1995, Scott & Willits 1994, Dunlap et al 1992). More recent, research in the domain of the human dimensions of natural resource management suggests that value orientations regarding natural resources can be arrayed along a continuum, ranging from a more anthropocentric view to a more biocentric value orientation (Steel et al 1994, Vaske et al 2001, Kaltenborn & Bjerke 2002).

The anthropocentric value orientation represents a human centered view of the non-human world; providing for human uses and benefits is the primary aim of natural resource allocation and management. Traditional natural resource management has been based on this utilitarian philosophy. This approach assumes that providing for human uses and benefits is the primary aim of natural resource allocation and management, whether those uses are for commodity benefits (e.g., timber) or for aesthetic, spiritual, or physical benefits (e.g., wildlands and recreation). There is no notion that the non-human parts of nature are valuable in their own right or for their own sake. An anthropocentric value orientation emphasizes the instrumental value of forests for human society, rather than their inherent worth (Steel et al 1994).

In contrast, a biocentric value orientation is a nature centered or eco-centered approach. The value of all ecosystems, species, and natural organisms is elevated to center stage. Human desires and human values are still important, but are viewed from a larger perspective. This approach assumes that environmental objects have inherent as well as instrumental worth and that human economic uses and benefits are not necessarily the most important uses of natural resources. In matters of natural resource management, these inherent values are to be equally respected and preserved, even if they conflict with human centered values (Vaske et al 2001, Vaske & Donnelly 1999).

As noted by Steel et al (1994), biocentric and anthropocentric value orientations are not mutually exclusive. Rather, these values orientations can be arranged along a continuum with biocentric viewpoints on one end and anthropocentric orientations on the other. The mid point of this scale represents a mixture of the two orientations. Research conduct by Steel et al (1994) and Shindler et al (1993) comparing national and Oregon public' values orientation regarding forest lands, Vaske & Donnelly (1999) and Vaske et al (2001) comparing wildland preservation, voting intention and demographic influences in Colorado, and Klatenborn & Bjerke (2002) in Norway regarding landscape preferences, support this conceptual continuum. James (2002) employed the expressions "stewards" and "utilitarians" as referring to an equivalent continuum of different values towards land held by landowners

Not all of the research related the biocentric/anthropocentric value orientation continuum, however, has supported the concept of a single continuum. Manfredo & Fulton (1997) compared wildlife values in Colorado and Belize. Results indicated that the single protection/use continuum (considered to be similar to the biocentric/ anthropocentric continuum) was evident in the Colorado data, did not emerge for the Belize sample. For this latter group of respondents, both wildlife rights and use value orientations were held simultaneously. The authors speculated that as "cultures become more technologically complex, and citizens become more removed from interaction with wildlife, their values regarding wildlife become more simplistic and less complex".

Environmental Attitudes

The attitude construct is a major focus of theory and research in the social and behavioral sciences. Attitudes are a central concept in social psychology and environmental attitudes is a central concept in environmental psychology. Attitudinal studies are also common in human dimensions of natural resources. A larger number of studies in the area dealt with the relation between environmental attitudes as predictors of ecological behavior intentions and as the role of mediators" variables in the structural models of this relation (e.g., Manfredo et al 1995, Vaske et al 2001, Bright & Porter 2001, Ajzen 2002). Most studies concerned with the prediction of behavior from attitudinal variables (e.g., Daigle et al 2002) were conduct in the framework of the theory of planned behavior and to a lesser extent, its predecessor, the theory of reasoned action (Ajzen 2002).

There is a general agreement within this field, that attitude represents a summary evaluation psychological object captured in such attribute dimensions as good-bad, harmful-beneficial, pleasant-unpleasant, and likable-dislikeable (Ajzen 2002). Attitudes represent an individual's consistent tendency to respond favorably or unfavorably toward the object in question. Attitudes have been defined in a variety of ways, but a commonalty among definitions is that attitudes are an evaluation or a feeling state about a person, action or an object. Thus, attitudes can be interpreted as an association in memory between an object and an evaluation. Evaluation refers to the imputation of some degree of "favor" or "disfavor" to an object and is crucial to the definition of attitude. The objects that are evaluated are referred to as attitude objects and can be virtually anything, including, persons, particular entities, behaviors, wildlands or landscapes (Manfredo et al 1995, Fulton et al 1996, Vaske & Donnelly 1999).

Human dimensions research often purports to measure "preferences", "opinions", "perceptions" or "images" yet these studies employ methods which would more appropriately classify them as attitudinal investigations. Statements such as " I like fishing"; "My taking a trip to go hunting would be a positive experience" are attitudinal in nature. As measures in survey research, such affect is typically defined on scales ranging form positive to negative evaluations (Manfredo et al 1995). When studying a controversial natural resource issue it is important not only to know a person's attitudinal position, but why they hold that position. In this situation, measures are taken of attitudes and related beliefs that are salient to the population of interest (Manfredo et al 1995, Vaske & Donnelly 1999).

The survey of local and regional attitudes has been the focus of several studies. Walpole & Goodwin (2001) examined local attitudes towards protected areas tourism and the effects of tourism benefits on local support for a National Park in Indonesia. Similarly, Alexander (2000) examined resident attitudes towards conservation in Belize and Mehta & Kellert (1998) the local attitudes towards community-based conservation programs in Nepal. Solecki (1998) analyzed local attitudes regarding the Pinelands regional ecosystems management in New Jersey. Fly et al (2000) assessed the knowledge of and attitudes toward wilderness in the Southern Appalachian Ecoregion. Scott & Willits (1994) surveyed environmental attitudes and behavior in Pennsylvania.

Erickson et al (2002) evaluated landowner motivations and their management attitudes regarding the conservation of woodlots in a rural watershed landscape case study in Michigan. Their results showed that aesthetic appreciation and environmental protection are important for farmers and non-farmers, while economic motivations were significantly less important. This study is congruent to several other analyses (e.g, Peine et al 1999, Malk 1999, McCool & Burchfield 1999) that public attitudes toward natural resource use are shifting, and environmental concerns are becoming an important component of societal values and attitudes systems at global level.

Relatively few cross-regional comparative studies of environmental attitudes have been conducted and those have shown that the bases of environmental concern can differ in different regions or countries. Gooch (1995) compared environmental beliefs and attitudes in Sweden and the Baltic States of Latvia and Estonia. Steel et al (1994) and Shindler et al (1993) in a survey of public attitudes towards the management of Federal Forests at two scales (Oregon and nationwide), reported significant higher support to ecosystems based management in the national sample than among Oregon residents. Similarly, Pate et al (1996) found significant differences in attitudes toward reintroducing the gray wolf into Colorado, between eastern urban and western rural communities that are more likely to be affected by the reintroduction.

The study of farmer's behaviors and what motivates those behaviors are not new. However, the number of studies that have considered farmer's attitudes towards conservation is small, notwithstanding the discourses on the conservation issues in the countryside. In Greece, Pyrovetsi & Dautopoulus (1997) and Klavdianou et al (2000) observed contrasts in the environmental attitudes and agricultural practices adopted by farmers managing distinct agricultural systems.

Radaeke et al (2001), pointed out the concerns of landowners in the Missouri Ozarks that voluntary participation in ecosystem management programs could lead to future land use regulations on their properties. Landowners who were more trusting (more positive attitude) of the agencies involved in the process were less likely to be concerned. Beedell & Rehman (1999) have assessed the hedge management behavior of farmers in Bedfordshire - England, and found that farmers with a positive conservation attitude are more likely to engage in conservation management of hedges.

2.3.2 The Major Paradigms of Social Science

A paradigm, or theoretical perspective, encompasses three elements: epistemology, ontology, and methodology (Guba & Lincoln 1998). Epistemology asks "how do we know the world"? Ontology raises basic questions about the nature of reality. Methodology focuses on how we gain knowledge about the world. "A paradigm provides a particular language, a conceptual framework, or collection of theoretical concepts and related propositions, within which society and social life can be described and explained. Some perspectives attempt to establish a set of principle that provides the ultimate foundation for social life and a basis for its explanation" (ibid). Social sciences have had a long theoretical tradition of claiming epistemological supremacy over processes occurring within the realm of "the social".

In general, theoretical perspectives provide images of society or social life (ontologies) and they tend to disagree on: the ontological and epistemological assumptions and what the knowledge should be used for (Blaikie 2000). A Paradigm may be viewed as a set of basic beliefs that deals with ultimates or first principles. It represents a worldview that defines, for his holder, the nature of the "world", the individual's place in it, and the range of possible relationships to that world and its parts. Habermas (1971) has outlined three types of knowledge-constituting interests: a technical, and understanding, and an emancipatory interest (Argyris et al 1985, Kvale 1996).

The "empirical-analytic sciences" fit the description of the mainstream account; they seek hypothetical-deductive theories that describe regularities between dependent and independent variables. They serve "technical" interests in the sense that they enable human beings to extend their control over nature. Second, the "historical-hermeneutic sciences" fit the descriptions of science held by the counterview. They are concerned with communicative action, and their methodologies are those appropriate to the interpretation of texts and the understanding of meaning. They serve "practical" interests that are guided by consensual norms. And, finally, "critical social science" goes beyond the description of empirical regularities and the interpretation of meanings. It serves "emancipatory" interests by offering a critique of what is from the perspective of what might be (Argyris et al 1985, Kvale 1996).

Positivism

Ontologically most research in humans-nature relationship tends to be based on the assumption that psychological responses to environments are predictable. Environmental parameters and psychological functioning are seen as independent but to larger or lesser extend related variables. Positivists assume that the whole of the universe can be generalized and defined, that researchers are the experts in the area, and that they are capable of generating laws. Generally, a cause effect relationship is assumed with systematic associations between variables, and as a result of cause and effect relationships, research can find the truth (Guba & Lincoln 1998, Denzin & Lincoln 1998). The ontology of the positivist in a concrete world is “realist”, which asserts that there exists a single reality (naïve realism).

The social world is also seen as objective and like natural world, and based on facts or truths. Epistemologically most social research follows reductionist quantitative techniques measuring amounts of environmental variables and relating them with amounts of physical benefits (e.g., wildlands and recreation) and other psychological or health outcomes. The epistemological consideration in relation to positivism is whether social science and human behavior should be studied according to the same principles and procedure as in natural science. Therefore, positivists are sometimes labeled as "reductionists or objectivists", as they rely on conventional thinking, i.e., the truth is only one and it can be known (Guba & Lincoln 1998).

The epistemology of positivists is considered "dualist and objectivist". The investigator and the investigated "object" are assumed to be independent entities, and the investigator to be capable of studying the object without influencing it or being influenced by it. The observer has to stay on periphery of the phenomena being studied, and distant from it, so that the researcher is not likely to be attached or connected with the world being studied. The inquirer is cast in the role of "expert" and the role of research is to provide information for the development of generalizable laws (Guba & Lincoln 1998, Acharya 2004). From a strictly positivist outlook science and policy, like facts and values, are considered incompatible and distinct discourses (Robertson & Hull 2001).

Positivism is often based on experimental and manipulative methodologies for the study of social world, as the purpose of the theory is to generate hypothesis that can be tested. Possible confounding conditions must be controlled to prevent outcomes from being improperly influenced. The aim of inquiry is explanation, ultimately enabling the prediction and control of the phenomena; the ultimate criterion for progress is that the capability of scientists to predict and control should improve over time, and the research is claimed to find the truth and a way to the truth (Guba & Lincoln 1998, Acharya 2004).

Reductionist approaches work well when applied for simple systems[5], but break down when analyzing complex and complicated systems (Guba & Lincoln 1998).

The use of quantitative (and qualitative) positivist methods and assumptions on social science has been rejected by a new generation of qualitative researchers who are attached to poststructural, postmodern sensibilities. Guba & Lincoln (1998) argue that the positivism paradigm overestimates the relevance of research outcomes in terms of applicability and generalizability. Human behavior and its meaning can not be studied only through "factual" and quantitative data. Critiques from within the paradigm of this approach have highlighted concerns, such as contextual stripping, exclusion of meaning and purpose, inapplicability of general data to individual cases, and lack of balance between discovery dimension and inquiry (Guba & Lincoln 1998, Acharya 2004).

To Guba & Lincoln (1998) positivist methods are but one way of studying the social world. They may be no better or o worse than any other method; they just tell a different kind of story, although this tolerant view is not shared by everyone. Many members of the critical theory, constructivist, poststructural, and postmodern schools of thought reject positivist and postpositivist criteria when evaluating their own work, and contend that "these criteria reproduce only a certain kind of science that silences too many voices". These researchers seek alternative methods for evaluating their work, including political praxis and dialogues with "subjects" (Denzin & Lincoln 1998).

Critical Theory and Critical Research

Critical theory usually refers to the theoretical tradition developed by the Frankfurt school, a group of writers connected to the Institute of Social Research at the

5 See previous discussion on environmental value orientations and environmental attitudes – Section 2.3.1

University of Frankfurt. In its beginnings, Max Horkheimer, Theodor Adorno, and Herbert Marcuse, initiated a conversation with the German tradition of philosophical and social thought, especially Marx, Kant, Hegel, and Weber. From the vantage point of these critical theorists, whose political sensibilities were influenced by the devastations of World War I, the postwar, and strikes and protests in Germany and in Central Europe, they defied Marxist orthodoxy while deepening their belief that injustice and subjugation shaped the live world (Kincheloe & McLaren 1998).

Focusing their attention on the changing nature of capitalism, the early critical theorists analyzed the mutating forms of domination that accompanied this change. Many critical traditions have been further developed based on the works of social theorists such as Michel Foucault, Jürgen Habermas, Jacques Derrida, and Paulo Freire. Critical theorists seek to produce transformations in the social order, producing knowledge that is historical and structural, judged by its degree of historical situatedness and its ability to produce praxis, or action. These theorists often regard their work as political action towards the injustice encountered in the world through their research (Denzin & Lincoln 1998).

The purpose of inquiry in critical theory is the critique and transformation of the social, political, cultural economic, ethnic, and gender structures that constrain and exploit humankind, by engagement in confrontation, even conflict. The criterion for progress is that over time, restitution and emancipation should occur and persist, and advocacy and activism are key concepts. The inquirer is cast in the role of instigator and facilitator, implying that the inquirer understands a priori what transformations are needed. The judgment about need transformations, however, should be reserved to those whose lives are most affected by transformations: the inquiry participants themselves (Guba & Lincoln 1998).

The transitional nature of inquiry requires a dialogue between the investigators and the "subjects" of the inquiry; that dialogue must be dialectical in nature to transform "ignorance and misapprehensions" (accepting historically mediated structures as immutable) into more "informed consciousness" (seeing how the structures might be changed and comprehending the actions required to effect change). The investigator and the investigated object are assumed to be interactively linked, with the values of the investigators inevitably influencing the inquiry. Findings are therefore value mediated. As Guba & Lincoln (1998) noted, similarly as in the constructivist approach, "this posture effectively challenges the traditional distinction between ontology and epistemology; what can be know is inextricably intertwined with the interaction between a particular investigator and a particular object or group".

Transformational inquires demonstrate "transformational leadership" and a major outcome of this approach can be changes in the historical perception of community about the subject or issue (Guba & Lincoln 1998). Instead of having the benchmarks of "rigor" (validity, reliability, and objectivity), the appropriate criteria for judging the goodness or quality of an inquire are "historical situatedness of the inquiry" (i.e., that it takes account of the social, political, cultural, economic, ethic and gender antecedents of the studied situation), and "the extent to which the inquiry acts to erode "ignorance and misapprehensions", and the extent to which it provides a stimulus to action, that is, to transformation of the existing structure" (ibid).

Ontology of the critical theorist is "historical realism", which is a major departure from the constructivist approaches, based on the ontological relativism. Results of a critical research are shaped by various factors, such as social, political, cultural, economic, ethnic, and gender over time. The Epistemological concerns of critical theorists are value-mediated findings as a result of influence coming from investigators. The methodology is "dialogic" and "dialectical". The theorists highlight a constant dialogue and interaction between investigators and the subjects of the inquiry. They believe that the dialogue should be open and intensive and that this can facilitate change in perspective that was previously held to be unchangeable (Guba & Lincoln 1998).

Kincheloe & McLaren (1998) defined a critical researcher or theorist which attempts to use his or her work as a form of social or cultural criticism and who accepts certain basic assumptions:

- that all thought is fundamentally mediated by power relations that are social and historically constituted;
- that facts can never be isolated from the domain of values or removed from some form of ideological inscription;
- that the relationship between concept and object and between signifier and signified is never stable or fixed and is often mediated by the social relations of capitalist production and consumption;
- that language is central to the formation of subjectivity (conscious and unconscious awareness);
- that certain groups in any society are privileged over others and, although the reasons for this privileging may vary widely, the oppression that characterizes contemporary societies is most forcefully reproduced when subordinates accept their social status as natural, necessary, or inevitable;

- that oppression has many faces and that focusing on only one at the expanse of others (e.g., class oppression versus racism) often elides the interconnections among them;
- that mainstream research practices are generally, although most often unwittingly, implicate in the reproduction of systems of class, race, and gender oppression.

Critical research, therefore, can be understood in the context of the empowerment of individuals. Inquiry that aspires to the name critical must be connected to an attempt to confront the injustice of a particular society or sphere within the society. Traditional researchers see their task as the descriptions, interpretation, or reanimation of a slice of reality, whereas critical researchers often regard their work as a first step toward forms of political action that can redress the injustices found in the field site or constructed in the very act of research itself. Kincheloe & McLaren (ibid) quoting Horkheimer[6], put it succinctly that "critical theory and research are never satisfied with merely increasing knowledge".

Research in the critical tradition takes the form of self-conscious criticism - self conscious in the sense that researchers try to become aware of the ideological imperatives and epistemological presumptions that inform their research as well as their own subjective, intersubjective, and normative reference claims. Thus critical researches enter into an investigation with their assumptions on the table, so no one is confused concerning the epistemological and political baggage they bring with them to the research site (Kincheloe & McLaren 1998).

Upon detailed analysis these assumptions may change. Stimulus for change may come from the critical researcher's recognition that such assumptions are not leading to

[6] Horkheimer, M. (1972). Critical Theory. New York: Seabury.

emancipatory actions. The source of this emancipatory action involves the researchers' ability to expose the contradictions of world of appearances accepted by the dominant culture as natural and inviolable. Such appearances may, critical researchers contend, conceal social relationships of inequality and injustice (Kincheloe & McLaren 1998).

Constructivism and Interpretivism

Constructionist and interpretivist approaches to social science developed on the ideas stemming from the critiques of scientism and positivism in the social sciences, and can be traced to works of the German sociologist Max Weber and philosopher Wilhelm Dilthey. They are credited to elevating the role of understanding (*Verstehen*) as a process of sociological interpretation, contrasting it with the pre-Kantian, Cartesian practice of explanation. Dilthey emphasized the lived-experience of individuals as central role of his project that occurs within historical social reality; the relationships between individuals and their social, historical, and cultural matrix of their lives were phenomena that could be explored by the human sciences (Hamilton 1998).

These social science paradigms can also be connected to the German intellectual tradition of hermeneutics, which refers to a method to obtain a valid and common understanding of the meaning of a text. Although the subject of classical hermeneutical interpretation was the texts of literature, religion, and law, there has been an extension of the concept to include the interpretation of discourse (including the transcripts of interviews and group discussions), and of human action (Kvale 1996). These traditions are also based on the *Verstehen* tradition in sociology, on the phenomenology of Edmund

Husserl and Alfred Schutz and on the works of G.H. Mead, Hebert Blumer, and Martin Heidegger, among others (Schwandt 1998, Guba & Lincoln 1998).

Interpretivists held that human sciences were different in kind than in natural sciences. The goal of the later is scientific explanation, whereas the goal of the former is the grasping or understanding (*Versthen*) of the meaning of social phenomena. Interpretivism was conceived in reaction to the effort to develop a natural science of the social. Its foil was largely logical empiricist methodology and the attempt to apply that framework to human inquiry (Schwandt 1998). Constructivists share this concern, and they resonate with the interpretivists' emphasis on the world of experience as it is lived, felt, undergone by social actors. Yet, "their particular foils are the notion of objectivism, empirical realism, objective truth, and essentialism" (Schwandt 1998).

Proponents of constructivism and interpretivism approaches to human inquiry shared the goals of understanding the complex world of lived experience from the point of view of those who lived it. The world of lived reality and situation-specify meanings that constitute the general object of investigation is thought to be constructed by social actors. That is, particular actors, in particular places, at particular times, fashion meaning out of events and phenomena through prolonged, complex process of social interaction involving history, language, and action. In brief, constructivists claim that human beings construct meanings as they engage with the world they are interpreting. This accepts that the viewpoints of people are never as simple and obvious as they may seem on the surface (Schwandt 1998, Acharya 2004).

The constructivist or interpretivist believes that to understand this world of meaning one must interpret it. The inquirer must elucidate the process of meaning construction and clarify what and how meanings are embodied in the language and actions of social actors. As stated by (Schwandt 1998) "to prepare an interpretation is itself to construct a reading of these meanings; it is to offer the inquirer's construction of the constructions of the actors one studies". Although both traditions share this general framework for human inquiry, they are unique in the way they answer the questions of the purpose and aim of the human inquiry and how can we know about the world of human action?

As discussed by Schwandt (1998), there are several interpretivist research approaches (e.g., interpretive anthropology, symbolic interactionism, and the interpretive interactionism) as well as constructivist approaches (e.g., radical constructivism, social constructionism, and feminist standpoint epistemologies). More recently, constructivist approaches have been being employed to address conservation and natural resources issues in many parts of the world for different purposes (e.g., Steins & Edwards 1999, Oreszczyn & Lane 2000, Lal et al 2001, Douthwaite et al 2001, Oettlé & Arendse 2003, Fischer & Bliss 2004). As elaborated on these works, constructivist approaches has the potential to explore the meanings people give to associated natural resource issues, and, by working with these meanings, to collectively construct news understandings for directing actions and social change.

Constructivism is an ontological position that asserts that social phenomena and their meaning are continually being captured by social actors; the "constructions" are the account of the researcher about the social world. The ontology of the constructivist is that realities are relative, and they depend upon ones' mental perception and understanding of the world (Guba & Lincoln 1998). Constructivism assumes the relativism of multiple social realities, recognizes the mutual creation of knowledge by the viewer and the viewed, and aims toward interpretive understanding of subjects' meanings. Constructivists are deeply committed to the view that what we take to be objective knowledge and truth is the result of perspective. As expressed by Schwandt (1998), "knowledge and truth are created, not discovered by mind".

"Social constructivism rejects distinctions between social and material worlds and argues that the ways people conceptualize environmental and other phenomena affect the meaning of these phenomena or what is commonly accepted as the nature of these phenomena (Greider and Garkovich 1994, Fischer & Bliss 2004). Our realities, which are multiple and different, are based on social construction and experiences of the world.

Constructivists emphasize the pluralistic and plastics character of reality - pluralistic in the sense that reality is expressible in a variety of symbol and language systems; plastic in the sense that reality is stretched and shaped to fit purposeful acts of intentional human agents. They endorse the claim that, "contrary to common-sense, there is no unique real world that preexists and is independent of human mental activity and human symbolic language" (Schwandt 1998 p 236). In place of a realist view of theories and knowledge, constructivists emphasize the instrumental and practical function of theory construction and knowing.

Guba & Lincoln (1989) presented their constructivism (naturalistic) approach as idealist; that is they assume that what is real is a construction in the minds of individuals. It is also pluralist and relativist; there are multiple, often conflicting, constructions, and all (at least potentially) are meaningful. The question of which or whether constructions are true is socio-historically relative. "Constructions are resident in the minds of individuals; they do not exist outside of the persons who create and hold them; they are not part of some objective world that exists apart from their constructors". Constructions therefore are not more or less "true", in any absolute sense, but simply more or less informed and/or sophisticated on which there is consensus at a given time (Schwandt 1998).

The Epistemology of constructivists is that the investigator and object of investigation are interactively connected; as a result, the findings are literally created as the investigation develops and the conventional distinction between ontology and epistemology disappears. Guba & Lincoln (1998) hold the opinion that the inquirer and the respondents are so interlinked and related that the findings of the investigations are the creation of the process which did not exist earlier. Hence, constructivists believe that there are alternative paradigms. The major assumption therefore, is to move from ontological realism to ontological relativism (Guba & Lincoln 1998).

The main methodological considerations of constructivists are hermeneutical and dialectical. The researchers, together with the respondents, extract and refine social constructs through am interchange between, and among investigators and respondents in an open and transparent interaction. These varying constructions are interpreted using hermeneutical techniques (analogous to the interpretation of a text), and are compared and contrasted through a dialectical interchange in order to interpret people's constructions of reality. The methodology consists of continuous analysis, reanalysis and interaction, leading to the emergence of joint meaning (Schwandt 1998, Acharya 2004).

As already stated, the aim of constructivist paradigm is to come to a consensus construction, which is more informed and sophisticated than the previous understanding for both respondents and the inquirer. This paradigm is also concerned with achieving an empathic understanding of human behaviors. As multiple often conflicting constructions are possible and potentially meaningful, constructions are alterable, as are their associated "realities" (Guba & Lincoln 1998), which points out for intervention and innovation in conservation-based social research (Acharya 2004).

2.3.3 Postmodern Social Science Perspectives

A recent genre of theory, know collectively as "postmodern", provides a distinctive way of envisioning the social world that enables us to understand human experience in different ways. The postmodern thought emerged in the 1980s and represents a broad movement in current art and philosophy, particularly as expressed in different versions by thinkers such as Michel Foucault and Jacques Derrida (Kvale 1996). The postmodern is characterized by a disbelief in universal systems of thought. "There is a lack of credibility toward meta-narratives of legitimation - such as the Enlightenment belief of progress through knowledge and science, as well as the Marxist utopia to be reached through emancipation of the working class, and the modern belief in economic growth" (ibid).

The following discussion is primarily based on the interpretation of postmodern perspectives in social science as articulated by Stringer (1999) while providing a theoretical perspective for his view on community-based action research. Following, we will address the role of the social researcher within a critical postmodern perspective as elaborated by Hamilton (1998). This discussion is then concluded by a brief review about action-research based on the works of Argyris et al (1985) and Stringer (1999), and its potential role for developing landscape-based conservation strategies.

Although modern perspectives of the world are bound to scientific visions of fixed and knowable world, postmodernism questions the nature of social reality and the very process by which we can come to know about it. Elements of postmodernism suggest that social knowledge can no longer be accepted as an objective set of testable truths because it is produced by processes that are inherently captured by features of the social world it seeks to explain. "Scientists, as products of particular historical and cultural experiences, will formulate explanations of the social world that derive from their own experiences and hence tend to validate their own perceptual universes" (Stringer 1999).

Scientific rationality, a key feature of modern organizational life, has itself become subject to forms of philosophical investigation that raise doubts about many of the taken for granted assumption on which our understanding of the social and physical universe rest. As stated by (Stringer 1999), "an exploration of postmodern perspective assist us to extend our understanding of the frustrations experienced by practitioners as they work in social, community and organizational contexts". We should add the frustrations experienced by conservation practitioners around the world.

As argued by Stringer (1999) "the postmodern theory derives much of its power from the way it deconstructs - that is, pulls apart for examination - mechanisms of knowledge production. From a postmodern perspective, attempts to order people's lives on the basis of scientific knowledge largely constitute an exercise in power. Knowledge, and the research that produces that knowledge, is as much about politics as it is about understanding. An understanding of what research is about is not just an exploration of method but an inquiry into the ways in which knowledge is produced and the benefits that accrue to people who control the processes of knowledge production".

Michel Foucault's (1972) exploration of social life reinforces the notion that there can be no objective truth because there is an essential relationship between the ways in which knowledge is produced and the way power is exercised. Foucault's study of the development of modern institutional life led him to conclude that there is an intimate relation between the "systems of knowledge" (discourses) by which people arrange their lives and the techniques and practices through which social control and domination are exercised in local contexts. "Humans are subject to oppression, Foucault suggests, not only because of the operation of large-scale systems of control and authority but also because of the normally accepted procedures, routines, and practices which we enact our daily public and personal lives" (Stringer 1999).

If we accept Foucault's analysis, then many negative features of society (including environmental hazards and habitat fragmentation and destruction) are intimately related to the ways in which people organize and act out their everyday lives. Feelings of alienation, stress, and oppression are as much products of everyday, taken-for-granted ways of defining reality and enacting social life as they are the products of systems that are out of people's control. The means by which people are subjugated is to be found in the very "codes" and "discourses" used to organize and enact their day-to-day lives. "Oppressive systems of domination and control are maintained not by autocratic process but through the unconsciously accepted routine practices people use in their families, communities, and occupations" (Stringer 1999).

Foucault suggests that the only way to eliminate this "fascism" in our heads is to explore and build on the open qualities of human discourse and, thereby, intervene in the way knowledge is constituted at the particular sites where a localized power-discourse prevails. He is concerned that people should cultivate and enhance planning and decision making at the local level, resisting techniques and practices that are oppressive in one way or another. Foucault (1984) suggests "that we become more flexible in the ways we conceive and organize our activities to ensure that we incorporate diverse perspectives into our social and organizational lives" (Stringer 1999).

West (1989) provides a compelling argument for a more pragmatic approach to our ways of understanding the social world, pointing to the need for an explicitly political mode of cultural criticism. He suggests that philosophy - more generally, intellectual activity as scholarship - should foster methods of examining ordinary and everyday events that encourage a more creative democracy through critical intelligence and social action. He advocates ways of living and working together that provide greater opportunities for people to participate in activities that affect their lives.

"West urges philosophers, academics, researchers, experts, and professionals to give up their search for the foundations of truth and the quest for certainty, to shift their energies to defining the social and communal conditions by which people can communicate more effectively and cooperate in the process of acquiring knowledge and making decisions" (Stringer 1999). This assertion can be broadened up to include the process of making decisions about landscape management and conservation. The underlying notion in West's work is not that philosophy and rational deliberation are irrelevant but that they need to be applied directly to the problems of the people.

West's pragmatism reconceptualizes philosophy, and therefore research, "as a form of cultural criticism that attempts to transform linguistic, social, cultural and political traditions for the purposes of increasing the scope of individual development and democratic operation". He advocates fundamental economic, political, cultural, and individual transformation that is guided by the ideals of accountable power, small-scale associations, and individual liberty. This transformation can be attained, he implies, "only through the reconstruction of the practices and preconceptions embedded in institutional life". On the political level, he acknowledges the need for solidarity with the "wretched of the earth," so that "by educating and being educated by struggling peoples, we will be able to relate the life of the mind to the collective life of the community" (Stringer 1999).

Habermas (1987), although often not classified as postmodern, has provided important ideas that can assist on the understanding of human social life and liberation. He proposes that the emphasis in institutional and organizational life on the factual, material, technical, and administrative neglects the web of intersubjective relations among people that makes possible freedom, harmony, and mutual dependence. His universal pragmatics attempt to delineate the basic conditions necessary for people to reach an understanding.

The Researcher's Role

Hamilton (1998) has argued that "perhaps the most noteworthy outcome of the epistemological disarray of the 1970s has been a return to Kant's concern with the human freedom and social emancipation". There has been a significant reexamination of the observer-observed Cartesian dualism and the observer-observed dialectic redefined by

Kant and activated by neo-Kantians. "The freedom of thought and action of the privileged observer is transferred to the less privileged subject of the observation. Similarly, the assumed disinterest of the observer is rejected, along with the passivity of the researcher or practitioner" (ibid).

An influential contemporary view argues that the theorist should adopt a normative position that offers a basis for criticism of the status quo. This position has been developed by theorists of the Frankfurt School, whose most influential member in recent years has been Habermas. The Frankfurt School has championed "critical theory," an approach to social inquiry that seeks to unite knowledge and action, theory and practice. The critical theorist, it is said, takes a practical interest in improving human existence (Argyris et al 1985).

Hamilton (1998) has observed that there is a distinct emancipatory sentiment, for instance, in the works concerning action research such as: *The Pedagogy of the Oppressed* (Freire 1970), and *Extension or Communication?* (Freire 1974), *Action Science: Concepts, Methods, and Skills for Research and Intervention* (Argyris et al 1985), *Participatory Action Research* (Whyte 1991), *Participatory action research and social change* (Selener 1997), and *Action research: a handbook for practitioners* (Stringer 1999).

Hamilton (1998) noted that at least three propositions seem to have been adopted by researchers of this movement. First, late twentieth-century democracies should empower all citizens, not just privileged elites. Second, liberal social practice can never be morally or politically disinterested. And third, social research should not be separated from action and practice. Accordingly to him "the managerial separation of conception (research) from execution (practice) is psychologically, socially, and economically inefficient" (ibid). These propositions organize much of action research as well as participatory, cooperative, and collaborative research. It is no longer the case that researchers can choose which side they are on, for sides have already been taken (Denzin & Lincoln 1998).

Sophisticated rationales for participatory action research are beginning to emerge from this theoretical conjuncture. One popular source, also with Kantian roots, has been also the work of Habermas. Like many recent interviewers of social theory, Habermas points to the objectivist illusion of the pure theory. Instead, he spouses the Kantian posture that there are indissoluble links among knowledge, methodology, and human interests. Not surprisingly, therefore, Habermas explicit eschews the objectivism of Cartesian science "with its attempts to describe the universe theoretically in its law-like order, just as it is" (Hamilton 1998).

As representative of the dialectical strand of neo-Kantian thought, Habermas (1971, 1987) holds that "unreflected consciousness" could, through "self-reflections", serve "emancipatory" cognitive interests such as that "knowledge and interest are one". He has suggested that "objectifying attitude in which the knowing subject regards itself as it would entities in the external world is no longer privileged" and the Cartesian "paradigm of the philosophy of consciousness" be replaced with the "paradigm of mutual understanding" (Hamilton 1998).

From Habermas's perspective, social research is an interactive rather than a controlling process. Participants aim for mutual understanding over the coordination of their subsequent actions. Applied research, therefore, is not about social conformity but social justice. Applied research, action research, qualitative research, humanist research, and their consociates become the pursuit of democratic forms of communication that, in their turn, prefigure planned social change (Hamilton 1998).

This has important consequences for a Landscape Conservation Approach. In contrast to linear models, research can no longer stay "outside" and investigate objective, transparent, and predictable elements of a system. Researchers need to understand themselves as part of an actor system contributing to innovation processes that are not controllable and predictable. The roles of different types of research (e.g., basic, applied, adaptive) can no longer be separated clearly because they are all part of a simultaneous innovation process (Hagmann et al 2002). Hence, innovation is much more than research, involving a whole system that is creative, multi-actor, motivating, and inspirational.

As put by Tognetti (1999), "in a project-based and constructive approach, considered more appropriate to a problem driven post-normal science, researchers can provided information they had in a balanced way, which improved landowners' knowledge of the issues, allowing their decisions to be based on a richer set of information, and helped researchers better understand needs and wants of landowners", which also helped to build reciprocal trust. The decision-making framework then became a process that gave individuals and institutions an opportunity to exchange perspectives and reconsider their objectives in light of new information.

Participatory and Community-Based Action Research

Action-science or action-research is usually situated as an outgrowth of the traditions of John Dewey in the 1930s, and Kurt Lewin, a social psychologist writing in the 1940s (Argyris et al 1985, Schon 1995, Stringer 1999, Bacon et al 2005). Accordingly to Argyris (1985), "Dewey was eloquent in his criticism of the traditional separation of knowledge and action, and he articulated a theory of inquiry that was a model both for scientific method and for social practice. He hoped that the extension of experimental inquiry to social practice would lead to an integration of science and practice, and based this hope on the observation that science in becoming experimental has itself become a mode of directed practical doing".

This observation, that experimentation in science is but a special case of human beings testing their conceptions in action is at the core of the pragmatist epistemology. The Lewinian tradition of action science, in contrast, is that of scholar-practitioners in group dynamics and organizational science who have sought to integrate science and practice. Members of this tradition have emphasized the "continuities between the activities of science and the activities of learning in the action context, the mutually reinforcing values of science, democracy, and education, and the benefits of combining science and social practice" (Argyris et al 1985).

Action research, however, has links to and is informed by a variety of intellectual traditions, although it is not defined by any of them. Action research has much in common with a range of other traditions, including practitioners research, action inquiry, action science, and community and rural development. To Stringer (1999) the intellectual roots of action research are likewise diverse; action research has been linked to J. Moreno, Paulo Freire, and the critical theory associated with Habermas and the Frankfurt school. Argyris et al (1985) suggested that action science is an exemplar of critical theory as formulated by the Frankfurt School; a critical theory "that seeks to engage human agents in public self-reflection in order to transform their world".

Historically, action research is related to models of research that sought to apply the tools of anthropology and other disciplines to the practical resolution of social problems. Action research suffered a decline in favor because of its association with radical political activism in the 1960s. It has reemerged in response to both pragmatic and philosophical pressures and is now more broadly understood as "disciplined inquiry (research) which seeks focused efforts to improve the quality of people's organizational, community and family lives" (Stringer 1999). As an evolving approach to inquiry, community-based action research speaks to current crisis of research by envisaging a collaborative approach to investigation that seeks to engage "subjects" as equal and full participants in the research process.

A fundamental premise of community-based action is that it commences with an interest in the problems of a group, a community, or an organization. Its purpose is to assist people in extending their understanding of their situation and thus in resolving problems that confront them. Put another way, community-based action research provides a model for enacting local, action-oriented approaches to inquiry, applying small-scale theorizing to specific problems in specific situations (Denzin & Lincoln 1998, Stringer 1999).

The concept of action-research has since been further developed by numerous researchers. While researchers may differ in their emphasis on action or research, most agree on the cyclic nature of action, followed by reflection, followed by further action (Fitzgerald 1999), and the look – think - act routine, as described by Stringer (1999). In action research, the aim is responsiveness. In this case principally to the community, its concerns, and what it might see as problems to be addressed. The work typically proceeds through cycles of action/intervention and reflection, and is therefore iterative and adaptive (Fitzgerald 1999).

Action research and its variations have since been adopted in a variety of disciplines, including education, psychology, community health sciences, and, more recently, to address rural development strategies and conservation issues (e.g., Bosshard 1997, Fitzgerald 1999, Lal et al 2001, Hagmann et al 2002, Wali et al 2003, Bacon et al 2005). Participatory action research is a term that started appearing more widely in the 1990s, and was associated with activities related to rural and agricultural development in developing countries. Like community-based research and action research, it seeks to generate both research results and change, or actions (Bacon et al 2005).

Community-based action research works on the assumption that all stakeholders - those whose lives are affected by the problem under study should be engaged in the processes of investigation. On Stringer's view (1999), stakeholders participate in a process of rigorous inquiry, acquiring information (collecting data) and reflecting on that information (analyzing) to transform their understanding about the nature of the problem under investigation (theorizing). This new set of understandings is then applied to plans for resolution of the problem (action), which, in turn, provides the context for testing hypotheses derived from group theorizing (evaluation).

Collaborative exploration helps practitioners, agency workers, client groups, and other stakeholding parties to develop increasingly sophisticated understanding of the problems and issues that confront them. As they rigorously explore and reflect on their situation together, they can repudiate social myths, misconceptions, and misrepresentations and formulate more constructive analyses of their situation. By sharing their diverse knowledge and experience, "expert" professionals, and "lay" stakeholders can create solutions to their problems and, in the process, improve the quality of their community life (Stringer 1999).

The role of the research-facilitator, in this context, becomes more facilitative and less directive. Knowledge acquisition/production proceeds as a collective process, engaging people who have previously been the "subjects" of research in the process of defining and redefining the corpus of understanding on which their community or organizational life is based. As they collectively investigate their own situation, stakeholders build a consensual vision of their life-world, which can results not only in a collective vision but also in a sense of community. Community-based action research operates at the intellectual level as well as at social, cultural, political, and emotional levels (Stringer 1999).

Traditional research projects are complete when a report has been written and presented to the contracting agency or published in an academic journal. Community-based action research can have these purely academic outcomes and may provide the basis for rich and profound academic theorizing and basic knowledge production, but its primary purpose is as a practical tool for solving problems experienced by people in their professional, community, or private lives. If an action research project does not make a difference, in a specific way, for practitioners and/or their clients, then it has failed to achieve its objectives (Stringer 1999).

Change is an intended outcome of community-based action research: not necessarily the revolutionary changes envisioned by radical social theorists or political activists, but more subtle transformations brought about by the development of new programs or modifications to existing procedures (ibid). These development, and modifications, however, must necessarily be carefully planned and derived from the research processes to provide people with the means to more effectively deal with the investigated. As put by Stringer (1999), "the analogue of hypothesis testing in action research is some form of change or development that is tested by its ability to enhance the lives of the people with whom it is engaged".

Action research can also be ecological research and, in the case of conservation and development initiatives, an action research approach can help link both social and ecological research questions (Bacon et al 2005). The potential for applying such strategies to address conservation issues on farming landscapes is evident. As expressed by Picket et al (2004) "ecologists are only beginning to explore participatory action research and they have much to learn in applying this strategy adopted from social sciences and rural community development. It is extremely costly in terms of money, time, and commitment, and there are few ecological models or resources available for ecologists to pursue this strategy".

2.3.4 Conservation Science and Postmodern/Post-Normal Perspectives

Scientific method seeks to test theories that purpose to explain why or how the world is as it is. The ultimate aim is to derive law-like statements that explain the nature of the world or the nature of reality. Scientific method seeks to generate knowledge that is objective (not amenable to the subjectivity or authoritative judgments of individuals, organizations, or institutions) and generalizable (applicable to a wide variety of contexts). It must also be realizable (the results should describe a "true" state of affairs). Most conventional research methods gain their rigor by control, standardization, objectivity, and the use of numerical and statistical procedures, aiming to avoid type-I error, or false positives. Avoidance of finding an effect when there isn't one is considered a conservative approach, best serving the development of a realizable body of knowledge (Stringer 1999, Weber 1999, Johns 2000).

This powerful approach and inferences are convincing and effective evaluation of specific effects and progress in science is presumed to occur only though the hypothetic-deductive method. Science seeks to provide invariant forms of knowledge that enable prediction of future events on the basis of a preexisting set of conditions. In recent history, this ability to predict, and, therefore control many facets of the physical world has provided humanity with the ability to manipulate the environment to an unprecedented degree (Stringer 1999, Roosenburg 2000, Johns 2000). The technological artifacts of the modern world, as well as the negative consequences of it, are a testament to the power of knowledge derived from the application of the scientific method.

The growing awareness of the pathologies of the industrial system, threats of unknown, irreversible and potentially dangerous developments in the technologies of information, have brought the message that science must join the polity. As expressed by Ravetz & Funtowicz (1999), "the historic mission of the European science, the reduction of complex whole systems to their simple atomic elements, is becoming understood as the production of the tools of technological power without the means of societal control.

Hence the traditional claims to truth and virtue made for science can no longer protect it from the checks and balances that are applied to all other societal institutions. What important area of scientific progress is immune from problems of uncertainty and value-conflict? That is the measure in which all of science has become post-normal".

Many science scholars (e.g., Habermas 1971, Foucault 1984) have compiled extensive empirical evidence to support their claims that science is a historically situated cultural practice, and the knowledge constructed by scientists inevitably reflects the social context in which it is produced and used. As put by Robertson & Hull (2001), "these science scholars see scientific knowledge less as an objective reflection of the way the world is and more as an inter-subjective social activity that (re)produces and extents particular visions of reality through and with networks of power. Many of these scholars contend that scientific knowledge is not only contingent but also purposeful; knowledge is knowledge for some purpose. They also argue that science is a persuasive discourse constructed to serve specific sociopolitical goals. "In this sense, knowledge is more powerful (i.e., effective) the more finely it is tuned to its intended use".

Contemporary science and scholars, including philosophers, historians, and sociologists of science as well as self-reflexive, practicing scientists, have critiqued the ideals of modern science - objectivity, value neutrality, and logical positivism - as wishful thinking and naïve optimism (e.g., Funtowicz & Ravetz 1995, Dahlberg 1996, Song & M'Gonigle 2000, Ludwig 2001, Robertson & Hull 2001, Clark & York 2005). In addition to recognizing the limitations of science resulting from its contingent and purposeful qualities, scientists have increasingly recognize the extent to which uncertainty limit the role science can play in many environmental decisions (Holling

1998, Robertson & Hull 2001). Reductionist and experimental studies of isolated variables and components are not sufficient to understand the organization of complex systems.

Recent ecological theory put in evidence that nature is both chaotically complex and continuously changing at many interconnected spatial and temporal scales. Systems theory suggests that ecosystems and the environmental phenomena are inherently complex, and the general hypothetic-deductive paradigm is limited because of the uniqueness of ecological phenomena. Hence, from an empirical point of view, complexity and uniqueness hamper the elaboration of a simple, general set of hypothetico-deductive laws to explain most ecological phenomena. Conservation biologists are aware of problems of uncertainty and scientific management and recognize limitations of a reductionist approach to understanding complex systems (Kay & Schneider 1995, Shrader-Frechette 1995, Holling 1998, Robertson & Hull 2001).

In response, many ecological and conservation studies, including those assessing the effect of development and/or exploitation take a more holistic approach, with an appreciation for spatial and temporal scales and natural variation in biological patterns and processes. Useful insights have been generated by recognizing ecosystems as dynamic and heterogeneous and management focus shifted from single species to an ecosystem approach terms (Song & M'Gonigle 2001). Uncertainty, in the face of overwhelming complexity, is increasingly accepted as a given. "The world and how it works is so complex, chaotic, and changing that, relative to what might be know about it, we know very little, and we are not likely to ever know all that much" (Robertson & Hull 2001).

These physical characteristics of environmental processes have consequences on what can be called the societal characteristics of environmental issues. Biodiversity loss is caused by political and economic forces, and conservation biology cannot afford to overlook the active role of humans as an integral component in ecological, evolutionary, and environmental processes. As a consequence, there will always remain an irreducible uncertainty in the predictions concerning the future evolution of complex natural and social systems including the evolution of socioeconomic systems in their inter-relation with ecological systems and under the perspectives of global climate change. Hence indeterminacy is not the sign of the limitations of the knowledge capacity and of approximations; it is a fundamental trait of human relationship to reality (Song & M'Gonigle 2001, van den Hove 2006).

As previously observed, recognizing that conservation is about people as much as it is about species or ecosystems, suggests a significant shift in the nature and use of science in conservation. If the ultimate purpose of conservation science is to inform and affect conservation policy (Meffe 1998, Robertson & Hull 2001), policies to have an impact, must be implemented. In many "hotspots" countries, implementation of conservation strategies, however, has not been markedly successful, whether in the realm of conservation policy, or in the realm of strategic planning in organizations (O'Connell 1996, Terborgh 1999, Kiss 2002). As observed by Argyris (1985), "implementation has rarely been a central concern of scientists and social theorists, and it has been seen as a problem of application, of practice, perhaps of politics, but not of the main stream theoretical science".

Accordingly to Argyris et al (1985), implementation means that human beings must design action in concrete situations. "Any particular situation is a complex field of multiple, interdependent, conflicting forces. Theory for practice should help the practitioner to grasp the pattern of forces operative in the situation at hand, what Lewin (1951)[7] called the "social field as a whole. Yet human beings cannot take account of everything; we have limited cognitive capacity". This suggests that theory should try to identify patterns that, suitably combined, will be useful in many situations. It also suggests that theory should lend itself to testing in the action context so that the practitioner can make corrections on-line (ibid).

In terms of intervention methodology, making an Integrated Natural Resources Management project operational requires a "learning paradigm" with a flexible combination of concepts and methodologies (Hagmann et al 2002). An interventionist requires knowledge that can be used by human beings in the action context, including knowledge relevant to the forming of purposes. As an agent who seeks to bring about some states of affairs rather than others, the action scientist will be advocating a normative position (Argyris et al 1985). Accordingly, landscape conservation practices are implemented through facilitation of process interventions at all levels and scales, and are guided by a clear vision and strategy to form the foundation for approaches geared toward collective action and human, as well as social, capital-building.

Most important in designing and implementing such approaches are pragmatism, empathy, and common sense. It would be reductionist to consider any single concept, approach, or methodology as the panacea methodology (Hagmann et al 2002). Hence,

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[7] Lewin, K. (1951) Frontiers in Group Dynamics. In K. Lewin, Field Theory in Social Science. New York: Harper & Row. Cited by Argyris et al 1985.

new conceptions and models of how to apply scientific knowledge to effectively address complex environmental and conservation issues are in demand; new paradigms for conservation science are necessary. Reductionist approaches have, evidently, their place, and an important one, but alone are inadequate for the situations presented by today's environment-economic development issues.

To address conservation biology in the fragmented regional mosaic it is necessary a conservation science able to conjugate the development of conservation practices and eco-friendly land management strategies, by addressing such issues on the real landscapes of intensive farming and scattered fragments of remaining natural vegetation. It is necessary to apply available scientific knowledge and commonsense to develop a landscape-based conservation praxis structured on the development of partnerships with stakeholders, to build new sustainable landscapes, able to deliver important social and environmental goods such as jobs, recreation opportunities, water quality, and biodiversity protection.

2.4 A Postmodern Perspective: An Integrated Landscape Conservation Approach

There are important convergences as well as fundamental differences among the philosophies and paradigmatic stances as discussed on the previous section. As summarized by (Kvale 1996): "Heidegger's existential philosophy, based on Husserl's phenomenology and on the hermeneutical tradition, is now regarded as anticipating postmodern thought, as is Merleau-Ponty's phenomenological philosophy. Sartre developed phenomenological and existential philosophy within a dialectical context, and Lyotard's early works focused on phenomenology and dialectics". Though they converge on conceptual reflections of major aspects of understanding the social world these philosophies were developed with different aims and for different areas. There are many conflicting assumptions among, as well as within, these philosophies (Kvale 1996).

"The idealistic focus on consciousness and texts in phenomenology and hermeneutics contrasts with a dialectical materialist emphasis on the social and economic contradictions of society. Both phenomenology and dialectics seek the essence beneath the manifest appearances, while in some postmodern thinking the appearance has become the essence. Phenomenology attempts to obtain presuppositionless descriptions, hermeneutics emphasizes foreknowledge by interpretations. Hermeneutics attempts to obtain interpretations free of contradiction, whereas dialectics focuses on these very contradictions of consciousness and actions as reflections of social and material contradictions. And whereas hermeneutics aims at consensus of interpretation, postmodern thought emphasizes the plurality of diverging interpretations. Dialectical materialism presupposes a basic material reality; postmodern thought emphasizes the linguistic and social construction of a social reality" (Kvale 1996).

Coffey & Atkinson (1996) discusses that "most of those paradigmatic statements are muddled and try to erect barriers and opposition where none exist, or try to make differences of emphasis into insurmountable epistemological clashes". They recognized that there are differences, and would not wish to convey the impression that qualitative methods are all of a piece. They think that approaches that elevate all or some qualitative methods to the status of a paradigm have dangers. "In particular, it is all too easy to fall into rigidly stereotyped thinking, of that there is one and only one way to approach a given problem or research project. Research problems and research methods thus may become compartmentalized, to the detriment of creativity and genuine variety. It is, we think, far better to exploit a variety of approaches" (ibid).

The differences among paradigmatic stances will not be explored in the present landscape research; the philosophies will be use pragmatically to highlight different aspects as it apply to the present qualitative research. Hence, in addressing landscape conservation issues based on a qualitative research framework we do not intend to imply any privileged status for those methods above all others. As suggested by Kvale (1996), "different paradigms will be applied to conceptualize and reflect upon issues encountered throughout the method stages of the research inquiry. These involve methodologic choices in questioning, interpreting, validating, and reporting interviews studies, choices that are often at odds with traditional concepts in modern science".

Conservation decision making within complex ecological and socio-cultural contexts involves a larger and pluralistic body of knowledge, information, and values. Post-positivists scientists, including many conservation biologists, are striving to bridge what appear (from the point of view of positivism) to be a gulf, but is actually a fine line, between science and policy, facts and values (Robertson & Hull 2001). As outlined by these authors "conservation decision making can be represented by a "tournament of value" wherein many stakeholders compete to advance their agenda; the tournament is inherently political and shamelessly unscientific. In the decision making process some values are held up and exalted, others are dismissed and ignored, and still others remain implicit and unnoticed".

Another important and defining characteristic of conservation decision making process is the large number of stakeholders with diverse interests willing and able to involve themselves in decision making by setting and negotiating the goals of conservation. Hence understanding that people see reality differently and the ability to negotiate shared realities are likely to be a fundamental tool for a successful conservation strategy. Historically science has provided the language and techniques for the physical management of the world within which our political and economy systems are embedded, and it was accepted that "experts", or those who are authorized by credentials that signal their access to scientific knowledge, should provide answers to ecological or social problems (Song & M'Gonigle 2001, Ludwig 2001).

Researchers, however, are becoming increasingly aware of the limitations of this perspective. Scientific knowledge is partial, incomplete, and reductionist (i.e., it reduces phenomena to minute components) and is often of limited practice use. Professionals armed with limited scientific formulations and theories about human behavior tend to prescribe behavior or action according to routines, recipes, values, and perceptions derived form their own histories and cultural experiences or according to the institutional imperatives of the organizational contexts within which they work (Johns 2000, Song & M'Gonigle 2001, Ludwig 2001).

In contemporary social understanding the conception of knowledge as a mirror of reality is replaced by a postmodern conception of "the social construction of reality" (e.g., Berger & Luckmann 1967, Greider & Garkovich 1994, Steins & Edwards 1999, Oreszczyn 2000), where the focus is on interpretation and negotiation of the meaning of the social world. "With the breakdown of the universal meta-narratives of legitimation[8], there is an emphasis in the local context, on the social and linguistic construction of a perspective reality where knowledge is validated through practice" (Kvale 1996).

[8] See previous discussion on item 2.3 - Postmodern Social Science Perspectives.

In the postmodern thinking there is openness to qualitative diversity, to the multiplicity of meanings in local contexts; knowledge is a perspectival, dependent of the viewpoint and values of the investigator. Human reality is understood as conversation and action, where knowledge becomes the ability to perform effective actions. "Today the legitimation question of whether a study is scientific tends to be replaced by the pragmatic question of whether it provides useful knowledge" (Kvale 1996).

As a post-normal rather than positivist approach to knowledge, a landscape conservation science "requires that the knowledge constructed for conservation decision making reflect the pluralist and pragmatic context of decision making, while striving for the rigor and accountability that earns scientific knowledge its privileged place in the sociopolitical arena where conservation decisions are made" (Robertson & Hull 2001). "Although scientists and managers have traditionally had a strong advisory role, innovative processes will necessarily disrupt such relationships by relocating decision making power to represent different view points and types of knowledge systems. In this light, the key to "good science" is a participatory process with open dialogue and paradigmatic debate" (Song & M'Gonigle 2000).

The discussion to follow will focus on the theoretical and conceptual foundations on which we developed our Integrated Landscape Conservation Approach as research framework for addressing conservation issues on the agrolandscapes of the Campos Gerais. The conceptual framework which was developed iteratively along this research was constructed based on the theories and perspectives discussed bellow.

2.4.1 The People-Landscape Interaction Model

The concept of landscape as previously discussed[9] and the related discussions that followed on conservation theory and research and its interface with human systems and social science, can be illustrated by the People-Landscape interaction model (Figure 2.2), developed by Tress & Tress (2001). As put by them, "it is not a mathematical model that allows for one form of application but a conceptual model that can serve as framework to integrate transdisciplinary research on complex landscapes issues. The concept is designed to be helpful in practical investigation of landscapes and allow for individual adaptation to fit specific research situations or questions. Hence it can be applied to all human landscape-relate research".

In the Landscape concept of the Figure 2.2, the noosphere is put next to biosphere and the geosphere as a third field of equal importance. The geo- and biosphere represent the spatial dimension of the concept; the noosphere, the mental dimension. They form a dynamic system that changes over time, which is indicated by the time arrow. Nature and culture are visualized with two horizontal yellowish ovals: in landscapes, nature and culture are complimentary to each other. The noosphere represents the cultural aspects of the landscape concept, the geo- and biosphere, the natural ones. The systems dimension of landscapes is represented when all the five dimensions - spatial, mental, temporal, *nexus*, and system are realized. The green oval represents the landscape in the model. People play a dual role in the people-landscape interaction. They are part of the biosphere but as reflecting and acting, they can also set themselves apart from the landscape (Tress & Tress 2001).

[9] Section 2.1 – Landscape: An Evolving and Versatile Concept.

"The people-landscape interaction is material and mental and proceeds in mutually influencing loops of actions and reactions. By means of their actions people affect the landscape, the subsystems bio- and geosphere. In return these subsystems provide the precondition for human existence and action. Landscapes also affect people by means of their appearance. People reflect upon them, which is to say they also reflect about the changes they have undertaken. By thinking and reflecting about the landscape, people create a mental image of it. People compare their conceptions (expected reality) with actual perception (perceived reality) and draw conclusions. This comparison

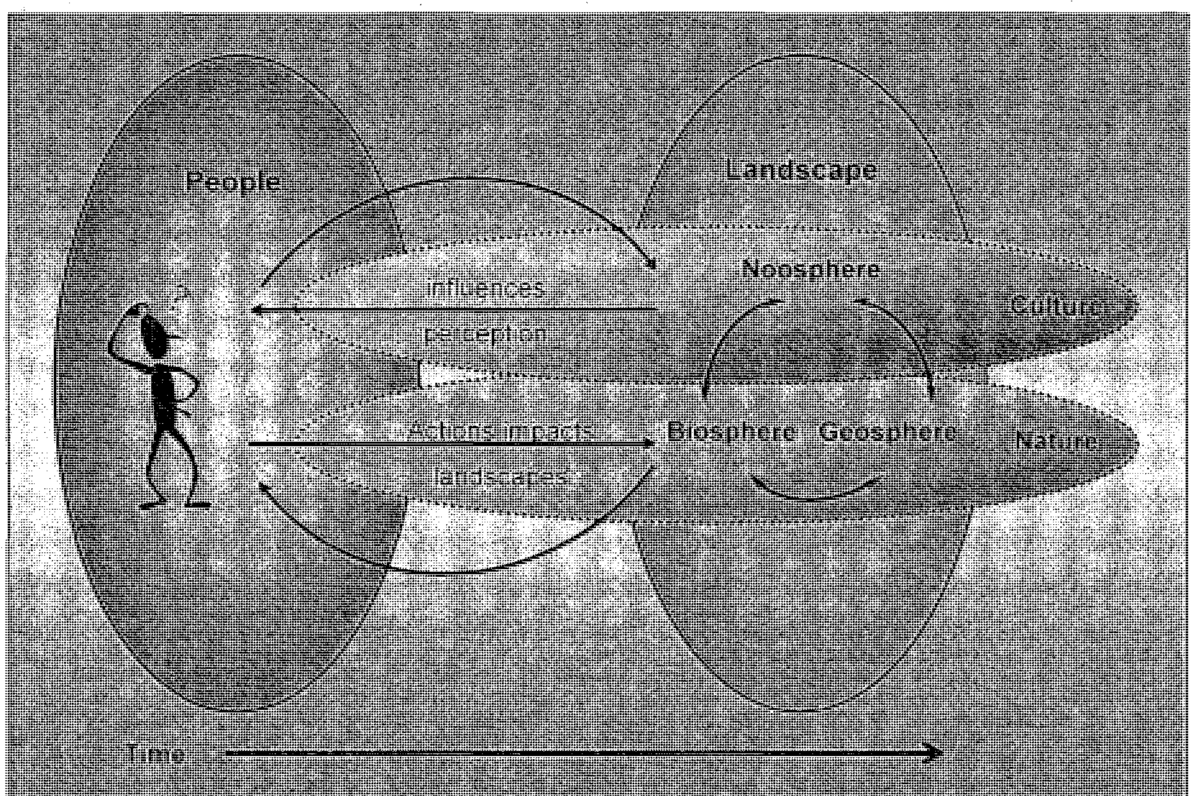

Figure 2.2 The people-landscape interaction model (Adapted from Tress & Tress, 2001)

influences peoples' subsequent actions as it may cause them to modify future behavior. In this way, it steers the course of the landscape around us" (Tress & Tress 2001).

By reflecting and acting on landscapes people transform landscapes, which generated further reflections and actions. Such decisions are based on the values and meanings people place on land. People - stakeholders, landowners, policy makers, farmers, managers, scientists, have the potential, by reflecting together, to trigger collaborative action for managing land based on shared landscape meanings. To "interact and work with people in the landscape' (Luz 2000, Oreszczyn 2000; McCool & Burchfield 1999, Knight 1999, Bosshard 1997) seems to be the key for addressing the necessary changes in the management of natural resources and a realistic first step towards the conservation of biodiversity. "If we have the capacity to manage anything, at least directly, it is more likely the social systems" (Williams & Paterson 1999).

Papers in the landscape and landscape ecology research arena have observed the lack of theory, methodology, and conceptual focus, or the excess of particularity, reductionism, as well the need for pragmatism and integration to fill the gaps between spatial planning and ecology to effectively address conservation, environmental and sustainable development issues. Landscape offers this challenge of working with mixed methodologies (Fry 2001). As a common feature that expresses the views of stakeholders and can be addressed simultaneously by several research areas, the landscape has the potential to be an integrative function. It is on this arena that demands for different forms of land use are real, planning decisions are made and changes performed.

The relevance of the people - landscape interaction model for conservation purposes relays on its holistic perspective, potentially combining different research areas in a complimentary framework to define relevant conservation issues. Every landscape/region is shaped by a specific combination of natural and cultural factors (subsystems); consequently knowledge derived from every subsystem will have specific contributions towards the perception and the comprehension of the whole. A pragmatically conceived landscape conservation approach needs a creative framework to define the most relevant research questions and the epistemological approach to address them. Conservation practices (praxis) are necessarily the main focus to define the data to be collected and should be based on the integration of the information derived from a particular arrangement of components subsystems collected and analyzed in multiple complementary scales. It must be framed accordingly to the scientific knowledge, including the human, economical and technological resources available.

2.4.2 A System Approach for Landscape and Conservation Research[10]

A complex adaptive systems often has a number of attributes not observed in simple systems, including non-linearity, uncertainty, emergence, scale, and self-organization (Levin 2000). These characteristics of complex systems have a number of important implications for conservation and environmental management, as can be seen from a consideration on non-linearity and scale (Berkes 2004). Biodiversity has many levels of measurement and many dynamic dimensions. Applying reductionist approaches in complex systems can only produce reductionist fragmented theories.

An alternative to the positivist paradigm in social science is offered by the constructivist paradigm, and an alternative to reductionism is dynamic systems theory. Dynamic systems theory is based on the idea that complex systems give rise to simple behavior - that is, complex systems organize themselves into emergent patterns. Studying

[10] See also complimentary discussion on section 2.1.6 – Landscape as a Complex System

these emergent patterns simplifies the study of complex systems, revealing simple underlying principles (Grove 1999, Antrop et al 2000, Antrop 2000).

In systems thinking and practice the properties of the parts can only be understood in the context of the larger whole which has emergent properties that arise as a result of the relationships and interactions of the system's parts (Oreszczyn & Lane 2000). As explained by Bosshard (1997), "every analysis must start form a superior whole, which perhaps has only been grasped unconsciously, and has thus usually not reached the conscious mind. The whole is not given as such (a priori), but is only called into being by a concrete (e.g., a project) situation, that is the intention of the observer, or the way the question is put, and thus the whole itself shows us how to divide the space. As soon as we are able to comprehend the leading function of the whole, we concluded that the partition of the whole already existed, and is therefore objective and universal".

Systems thinking and practice has been used in different ways across a wide spread of disciplines ranging from pure sciences to family therapy. In systems as science, systems scientists engage in the study of collections of processes to determine their nature and how they behave in pursuit of ever greater accuracy in our understanding of how natural systems work (Oreszczyn & Lane 2000). It was from the work of von Bertalanffy early in the twentieth century in the biological sciences that General Systems Theory first emerged (von Bertalanffy 1971). This use of systems ideas is now most apparent in the work of chaos and complexity scientists (e.g., Capra 1996) where the non-linear nature of the relationships being investigated can be handled more effectively by computers (Oreszczyn & Lane 2000).

The methods of inquiry and analysis used in the many fields of systems-based study have ranged from the purely scientific of researcher as observer to the applied action research characterized by participatory methods that considers people in their own personal "real world" setting and the researcher as a co-participant. In common with developments within other disciplines, in particular, those within the social sciences, applied systems research has moved away from traditional positivistic approaches to relativistic approaches which consider humans as part of a complex system (Oreszczyn 2000, Oreszczyn & Lane 2000).

One of the insights of system thinking is that environmental phenomena have multiple scales each one with its own emergent properties and the systems must be analyzed simultaneously at different scales[11]. Such a systemic approach, investigating the situation in terms of the connectedness and relationships between parts set in a particular context, as opposed to looking at parts in isolation, must inform the landscape research theoretical framework, the methodology, the fieldwork, the analysis and the conclusions (Oreszczyn & Lane 2000). This approach calls also for case studies to address landscape conservation based on contextual knowledge.

2.4.3 Place, Land Unit, and Landscape Meanings

The human mind is essentially a meaning making system. It seeks to impose meaning on the world through the acquisition and application of culturally transmitted cognitive structures or mental representations of the world, which in everyday parlance, are commonly recognized as taxonomies, categories, norms, rules, grammars, and so forth. Most of the human disciplines in some way struggle to understand and articulate

[11] See also previous discussion on section 2.2 – Landscape Structure and Analysis: A Systemic View.

the meaning of places, things, events, and relationships and describe how these meanings are acquired and transmitted (Williams & Patterson 1999, Greider & Garkovich 1994).

Each discipline has its own interpretation of meaning. In psychology, meaning refers to the interpretation or context an individual perceiver associates with a stimulus event and can generally be understood as constituting ideas, values and beliefs. Sociological approaches emphasize symbolic meanings and how these are mediate through interaction with objects, events, or places in a social context. Anthropology seeks to understand the meaning system of a given culture; hence symbols (objects, words, and the environment) objectify meaning (Williams & Patterson 1999, Greider & Garkovich 1994).

The value of an object to humans, an Araucária wood growth forest for example, is in the importance attached to its various meanings, that is, the value is derived from an object's various meanings. Where a forester sees a first class wood production system needing inventory, harvest, and regeneration, a logger sees the value of the standing timber, a birdwatcher thinks of rare prime habitat for members of the *Psittacidae* family, a forest ecologist sees a plant community, a recreationist a place for rest, a hiker sense a spiritual connection to creation.

Sociologists Greider & Garkovich (1994) noted such differing views of an old growth forest and see competing symbolic transformations of nature. Forest meanings that are not perceived cannot be valued. As a new meaning is perceived, say for wilderness or as heritage then a value or preference can be assigned to it. In many contexts the act of identifying something as holding a particular meaning is to indirectly imply that one value that meaning, thereby confounding the two concepts. Focusing on meaning, helps natural resource managers understand the broader social processes, which create, negotiate, and assign value meaning (Williams & Patterson 1999).

Meanings exist within a landscape ecological context, that places or landscapes represent socially constructed systems of meaning. Landscapes are the symbolic environments created by human acts of conferring meaning to nature, of giving the environment definition and form a particular angle of vision and through a special filter of values and beliefs. The meaning is not inherent in the nature of things; "rather, cultural groups transform the natural environment into landscapes through the use of different symbols that bestow different meanings on the same physical object or conditions" (Greider & Garkovich 1994). These symbols and meanings are sociocultural phenomena; they are social constructions and they result from ongoing negotiations in a cultural context. Thus, "every landscape is a symbolic environment" (ibid).

As social constructions of nature are linked to the dominant group's self definitions and collective interaction with the environment, power emerges as decisive in group struggles over conflicting definitions of nature to explain which definition prevails in shaping and motivating collective interactions with the environment. A strong theoretical synthesis need to link group self-understanding with definitions of physical surroundings, and shows the impact of power in imposing a definition on a social group to legitimate collective action toward the environment. An interpretivist perspective considers meaning as a taken-for-granted social construction that individual and collective actors impose on experience and that symbolically transforms the natural environment into an objective consistent with prior social meanings and current power arrangements. These meanings are inherited typifications or currently negotiated definitions (Weigert 1997).

More important than understanding how meaning in general is created, maintained, transmitted, abandoned, or destroyed, is for resource managers to be able to identify the particular meanings various individual, groups, or culture assign to specific piece of the landscape and understand the extent to which people agree or disagree in these meanings (Williams & Paterson 1999). A pragmatic approach to the problems of meaning is simply to characterize the range and diversity of meanings people seem to associate with objects, events, or places. Viewing landscapes as repositories of socially constructed meanings has implications for what counts as ecosystem knowledge, how we conceptualize and value ecosystems, and how we integrate this knowledge into theory and practice. For landscape management the concept of place or, more properly, of land unit, as we will employ on this research[12], draws our attention to the processes by which resources and ecosystems are socially constructed.

The concept of place as defined in human geography involves understanding how the landscape is related to local human culture and history. Place refers to the physical locale and the social, economic and political relationships, which give meaning to locales and constitutes meaning-filled space. In effect, a landscape is a kind of place, socially created by conferring particular kinds of meaning (including scientific) on some piece of land. Moreover, viewing meaning as place defining comports well with a major feature of landscape management, which is to enlarge the spatial and temporal context of management decisions. Attending to larger scale processes (moving from typically site or

[12] See discussions on Sections 2.2 - Landscape Structure and Analysis: a Systemic View, and 8.6 - Land Units and Landscape Conservation Alternatives.

stand level to landscape or ecosystem level) presumably facilitates a more integrated view of a social understanding of the impacts of resource policies and management (Williams & Paterson 1999). Weigert (1997) has argued that we can more adequately grasp human-environment relations with a metatheoretical understanding of meaning broad enough to include both symbolic and physical responses as active components of a conceptual framework.

Mapping Landscapes Meanings

Williams & Paterson (1999) presented a framework for mapping landscape meanings recognizing four approaches to understanding the meanings people assign to landscapes: a) inherent/aesthetic; b) instrumental/ goal directed; c) cultural/symbolic; and d) individual/ expressive. The application of meanings to natural resource management has focused primarily on the first two approaches. However, the predominant way of assign meaning to landscapes, which has historically guided natural resource management and planning, is based on the instrumental/goal paradigm, aiming to assess resource's capacity to promote behavioral and economic/commodity goals.

Most of the twentieth century natural resource management has been guide by this interpretation of resource meanings and values. Particularly because these approaches address relatively tangible environmental qualities that can be linked more or less directly to the physical properties of the environment, they have been readily integrated into the utilitarian philosophy. This ability to link meaning to physical attributes has facilitated inventory strategies that allowed resource managers, at least in principle, to integrate various and competing aesthetic and instrumental meanings in prioritizing land management goals (Williams & Paterson 1999).

As technology, information, economy, public values and attitudes change, news landscape meanings surface. As we recognize that landscape are places we begin to assign unique meanings to them. Some meanings associated with an environment do not derive so much from how it can be used but simply what it represents symbolically. Landscape planning and management will continue to benefit from assessments based on instrumental meanings. However, meanings instrumentally defined, will fail to adequately address the more emotional, symbolic, and spiritual benefits of wildlands and how these are socially produced (Williams & Paterson 1999).

From a sociocultural perspective the same landscape unit in the mosaic of study, can symbolize a remnant patch of grassland, habitat for individuals of an endangered metapopulation, a piece of land linked to family tradition, a potential land for commodity farming expansion or intensive forestry. Therefore, in mapping sociocultural/symbolic meaning, natural resources are valued not only for instrumental purposes, but also exist as places that people become attracted to and even attached to because such places posses emotional and symbolic meaning.

The study of individual/expressive meanings also emphasizes a socially constructed and more voluntaristic view of reality. However it is more rooted in a subjectively oriented phenomenology, emphasizing individual level processes and a recognition that individuals have the potential to assign intangible and relatively unique meaning to places and things. According to Williams & Paterson (1999), the significance of individual/expressive meanings is captured in concepts such as place-identity, place-attachment and place-dependence.

Cultural and expressive forms of meaning, often the most intangible and contentious forms of environmental meaning, have received less attention in resource management. While they have been the subject of environment and behavior research, there has been little systematic effort to map these meanings within natural resource management, a prospect made more difficult by the lack of correspondence to on the ground features. The systemic approach of Oreszczyn & Lane (2000) and Oreszczyn (2000) to assess hedgerows meanings among English farmers has added an important epistemological contribution for this task.

Recognizing that landscapes and, therefore, landscape management are social constructs serves to remind the limits of highly generalized theoretical and operational conceptions of management. The heart of management is to guide decisions affecting a place based on a rich understanding of its natural and cultural history (Williams & Paterson 1999). Filling the scientific knowledge gaps on cultural, symbolic, spiritual, and expressive meaning of the landscape will require a long term and continuous commitment to acquire a local knowledge of place and integrate that knowledge with larger regional and national meanings and values.

This represents a continuous engagement in public and pragmatic discussion about the meaning of places. Hence, the management of landscapes is not so much a matter of applying technology and technique, but also of building trust in a relationship with stakeholders and learning the art of participating in ongoing public dialogue. This dialogue is a major part of the process of creating and negotiating landscape meanings (Williams & Paterson 1999).

A place-based conceptualization of partnerships is critical if the full potential of collaborating for landscape conservation is to be achieved. People participate in partnerships because they care about places. The utilitarian paradigm of natural resource management lacks such specific context. From a place-based perspective, one of the greatest challenges is to determine at what scale to operate. The contextual factors that define place operate at a variety of overlapping scales ranging from the very local to the international (Williams & Paterson 1999, Michaels et al 1999).

The focus of this project will return to the concept of land units, mapped in the farmland/landscape scale level[13] as a "relatively homogeneous ground features". The conceiving of a tangible subject - the land unit, will mediate a dialectic construction of new shared landscape meanings with stakeholders, aiming the conservation of the region's biological diversity. Meaning that includes responsive and definitional moments can celebrates a range of analyses, from strong social constructionist interpretations to biophysical empirical patterns and on to syntheses of human ecological issues. "Science then directly participates in the overall struggle to fashion definitional meanings that more adequately grasp responsive meanings so that humans may gain a better chance to anticipate futures they are fashioning in fact" (Weigert 1997).

2.4.4 Public Ecology and Conservation

To be effective in affecting conservation policy, conservation knowledge must also possess qualities that make its effective in the political arena of decisions making. To

[13] See also discussion on Section 5.2.2 - Mapping land units at farm level.

their proponents (Robertson & Hull 2001, Hull & Robertson 2000), "Public Ecology is a philosophy and practice of conservation science that goes beyond biology and beyond the norms of modern science to construct knowledge that is useful for conservation decision making". They argued that environmental decisions will be more useful and effective if the knowledge on which they are based is explicitly evaluative, contextual, multiscalar, integrative, adaptive and accessible. As "post-normal" conservation science, public ecology is defined by these six attributes concerning knowledge.

The importance of integrative (i.e., interdisciplinary and cross-cultural and cross-institutional knowledge), and multiscalar knowledge were previously addressed (respectively on sections 2.1 - Landscape as Synthesis of Ecological and Cultural Phenomena, and on section 2.2.5, when we discussed Landscape Analysis and the Importance of Scale). The need of accessible knowledge will be analyzed later on this discussion under the Theory of Communicative Action (Section 2.4.6 - A Critical Postmodern Landscape Research Approach). Thereafter, we will focus the discussion on the other three conservation-effective knowledge attributes, as discussed by Robertson & Hull (2001).

Contextual Knowledge

Although environmental quality may be conceptualized in the abstract (e.g., biological integrity and ecosystem health), the specific goals and objectives of landscape management must be determined in the context of the place-based projects to which they apply (Shrader-Frechette 1995). Land management situations are unique in that both the people involved and the places where the projects occur are unique. If environmental knowledge is to have utility in environmental decision making, it must be particular to both the people using it and the places where it is used (Robertson & Hull 2001).

Because there is no universal theory of ecology - there are no generalized, mathematical model of ecosystem structure and process to tell us what nature looks like and how it works in real places. Therefore, understanding nature for the purpose of making decisions about the goals and objectives of management requires a more case-specific knowledge that is constructed in the context of the specific places involved and to the people using it. Professionals who are engaged in constructing environmental knowledge should be cognizant that their research will be used by specific people, for specific purposes, in specific contexts. Therefore, "environmental research must strive not only to be generalizable but must seek to be specifically applicable" (Robertson & Hull 2001).

Shrader-Frechette (1995), while addressing the problem of uncertainty and imprecision of scientific information and methodologies in public decision making, suggested a more "practical ecology", as middle path between "hard", mathematical-oriented ecology and the untestable and definitional "soft ecology". "Both, hard and soft ecology, seem to fail to address the uniqueness, particularity, and historicity of many ecological phenomena". The author pointed-out to the need of more practical ecology of case-studies and natural history to provide useful information in decision making process.

Evaluative knowledge

The challenge to ecological science and conservation biology is to develop constructs that are not just descriptively precise and hence powerful scientifically at describing situations, but also evaluatively rich and hence powerful politically for deciding which situation are "best". Conservation decisions are decisions about socially valued environmental conditions. They are decisions that require society to make tradeoffs, not just between environmental conditions producing different types of environmental qualities such as education, human health, and economy. To be effective in the arena of conservation decision making, the terms describing ecological conditions must describe conditions valued by society and must explicitly connote those values to the people using the terms to negotiate land-use decisions (Robertson & Hull 2001)

Indicator or surrogates of environmental quality are powerful and increasingly common tools for environmental management. Indicators are the qualities of the environment that science can monitor and can trigger corrective management actions when they exceed some negotiated level. Indicators can engage affected and concerned communities in dialogue about the desired future conditions for their environment. These measures of environmental quality cannot be free of social value and contextual relevance. They must reflect the values, norms, and goal of the society for which the environment that society cares about and is willing to allocate its limited resources to maintain. Regardless of how descriptively precise, reliable, and theoretically rigorous a measure might be, it is likely to be ignored or ineffective at influencing conservation decision if it fails to reflect environmental qualities society understand ands and cares about (Robertson & Hull 2001).

Adaptive Knowledge and Management

Adaptive knowledge has been promoted as a flexible and self-conscious process of stewardship whereby practitioners of environmental management learn about the place for which they are responsible through well-intentioned and systematic efforts of trial and error (Lee 1993, Szaro 1996). Under a paradigm of adaptive management, landscapes become laboratories. The environment itself is a place for cautious experimentation. The lessons learned through adaptive management are documented and advanced through case studies of specific projects and places. Adaptive management and adaptive knowledge are considered a cornerstone of a more public ecology (Robertson & Hull 2001).

Adaptive management recognizes as starting point that information will never be perfect (Holling 2001). The use of imperfect information necessitates close cooperation and risk-sharing between the management agency and local people. Such a process requires collaboration, transparency, and accountability so that a leaning environment can be created and practice can be built on experience. This approach, bringing the community actively into the management process, is fundamentally different from the command-and-control style. Hence a new kind of approach to science and management must be created through a process by which researchers and stakeholders interact to define important questions, objective of study, relevant evidence, and convincing forms of argument (Berkes 2004).

Over the past few decades, different fields dealing with complex systems have developed convergent approaches for deciding how to take action in the face of risk and uncertainty (Salafsky et al. 2001). This includes: theories on change management, learning processes, local organizational development, integrated natural resource management, participatory approaches, systemic intervention, participatory action research, experiential learning, and adaptive management of ecosystems (Lee 1993, Gunderson et al. 1995, Shindler & Cheek 1999, Douthwaite et al 2001, Hagmann et al 2002).

Adaptive management combines research and action. Specifically, it is the integration of design, management, and monitoring to systematically test assumptions in order to adapt and learn. Adaptive managers attempt to reconcile these viewpoints: they want to change the world and achieve a defined goal, but they are also willing to invest effort in systematically learning about whether their actions work or do not work and why (Salafsky et al 2001, 2002).

2.4.5 The Fundamental Role of Participatory Approaches

The mainstream approach to environmental management has tended to be centralized and exclusionary and to take a narrow view of what constitutes the "environment". It has been implemented by hierarchically-organized bureaucracies that often exclude public input and participation, and has often been supported by an orthodox scientific paradigm that neglects the long-term environmental and social consequences of the unfettered exploitation of nature. However, there is an emerging body of literature supporting a participatory approach which is decentralized, community oriented and holistic in its view of the environment. Participation here is aimed at making environmental decision making socially inclusive and environmentally sustainable (Kapoor 2001, Berkes 2004).

Participatory approaches are institutional settings where stakeholders of different types are brought together to participate more or less directly, and more or less formally, in some stage of the decision making process (van den Hove 2006). Stakeholders are deemed to be of different types if, for a given issue, they hold different worldviews, and act on the basis of different rationales. Participation on the analysis of this author refers to the implication in the decision making process of persons external to the formal politico-administrative circle, involving interactions among public actors, civil society stakeholders (such as NGOs, trade unions, consumer groups, scientists, etc.), business actors, and/or individual citizens. In our present research, landowners have a key role on the landscape management process.

Participatory methods and techniques took root in the late 1970s and early 1980s in response to highly centralized, top-down approaches to research and planning (Kapoor 2001, Erickson 2006), and was initially inspired by the work of critical theorists as Paulo Freire (1970). They offered an alternative to formal social research techniques, as well as conventional development intervention models and technologies (such as the green revolution, based on research conducted in industrialized countries and adapted for use in the non-industrialized world). Questions later arose about the appropriateness of first world solutions for the social and economic contexts of the third world especially when imposed by government or international aid organizations because the results were often short-lived and often socio-environmentally damaging (e.g., Carruthers 1996, Cordeiro 2000, Weid & Altieri 2002).

In contrast, participatory methods were designed to incorporate local knowledge and perspectives, priorities and skills in the development process while facilitating the empowerment of local people. Essentially participatory methods offer local people a role in research and planning that can result in solutions, which are more appropriate for the local context and longer lasting (Pretty 2002, Erickson 2006). By the early 1990s a global level of interest in stimulating local participation had developed among NGO's, governments, communities, international development agencies and academic institutions. Since the milestone inclusion of participation in Principle 10 of the 1992 Rio Declaration, institutional uptake of participation has been tremendous (Kapoor 2001, van den Hove 2006).

Today this approach, originally designed to avoid the limitations of top-down planning and large-scale research techniques has become standard practice in many fields including biodiversity conservation (Pretty 2002, Erickson 2006). Donor organizations such as the World Bank and the Global Environment Facility that provide billions of dollars to both biodiversity conservation, rural and urban development programs in some of the world's poorest areas have revised their strategies to recommend public participation and consultation with affected populations in project assessment and implementation (Erickson 2006).

A variety of studies of rural development reviewed by Pretty & Ward (2001) have shown that when people are well organized in groups, and whose knowledge is sought, incorporated and built upon during planning and implementation, then they are more likely to sustain activities after project completion. One study of 25 completed World Bank agricultural projects found that continued success was associated clearly with local institution building[14]. Twelve of the projects achieved long-term sustainability, and it was in these that local institutions were strong. In the others, the rates of return had all declined markedly, contrary to expectations at the time of project completion.

[14] Cernea M. M. 1987. Farmer Organizations and Institution Building for Sustainable Development. Regional Development Dialogue 8, 1-24; Cited in Pretty & Ward (2001).

Outcomes were unsustainable where there had been no attention to institutional development and local participation.

Participatory Approaches and Integrated Landscape Management

Decision making process on integrated landscape management for conservation and sustainable pathways requires the integration of complex interactions between ecological, economic and social aspects. In this process, one has to take into account not only "the hard-data", but also values, asking what ought to be honored, protected, sustained, or developed. It is particularly relevant when dealing with problems falling into the so-called "post-normal science" paradigm, when "facts are uncertain, values in dispute, stakes high and decisions urgent" (Ravetz & Funtowicz 1999, Robertson & Hull 2001, Song & M'Gonigle 2001, Ludwig 2001, Antunes et al 2006). This constellation requires the active participation of all relevant stakeholders and their early involvement in the process.

Participatory approaches have been increasingly advocated as effective decision making processes to address complex environment and sustainable development issues (van den Hove 2006). In these cases, which cannot be tackled by "normal" scientific approaches, the policy dialogue has to be extended to all those who have a stake in the issue, that is, to the extended peer community. In fact, the results of decision processes which rely solely on formal assessment techniques and in which the analysts are in full control of decision support have been questioned - raising issues such as equity, trust and representativeness (Antunes et al 2006). Sustainable development decisions require the active engagement of stakeholders.

The characteristics of complexity, uncertainty, large temporal and spatial scales, and irreversibility of environmental processes have consequences on what can be called the societal characteristics of environmental issues. These include (van den Hove 2006): societal complexity and conflicts of interests, transversality, diffused responsibilities and impacts, no clear division between micro and macro-levels, and short-term costs associated with potential long-term benefits. In turn, these physical and societal characteristics determine the type of problem-solving processes needed to tackle environmental issues. Participatory approaches have the potential to meet these problem-solving requirements.

Participatory approaches frequently involve interdisciplinary research by social and natural science. Whereas the orthodox scientific approach saw reality as universal and objective, the participatory approach sees it as socially constructed and culturally specific (Greider Garkovich 1994, Kapoor 2001, Fischer & Bliss 2004). "Truth", "fact" and "cause-effect" are not revealed through the single lens of the outside "expert", but constructed inter-subjectively through the multiple perspectives of all relevant program participants or "stakeholders".

Conservation planning without adequate local consultation alienates local stakeholders, and many conservation interventions are seen as just one more attempt by outsiders to gain control over land and natural resources. At best, this fails to develop a local constituency for conservation; at worst, it sparks conflict (Sheil et al 2006). Surveys that integrate biodiversity inventories with information on how people view and value their natural environment can help improve conservation planning, address the needs of local people, and advance the management of landscapes. Conservation can be undertaken by recognizing and building on what local people find important

Rather than outside program managers and policymakers unilaterally defining environmental programs, stakeholders are empowered, through a process of group learning and consensus-building, to create and manage their own programs. Local communities are encouraged to develop this participatory process on their own, or if required, with the help of outsiders (government, international agency or NGO staff) who act as catalysts or facilitators of the process (Kapoor 2001).

Participation Typologies

Given that local participation has been heralded as a critical component in determining the success of conservation, ecosystem management or sustainable development projects (Shindler & Cheek 1999, Pretty & Ward 2001, Erenstein 2003, Bawa 2004, Tabarelli et al 2005, Rambaldi & Oliveira 2005, Sheil et al 2006, Erickson 2006), it is important to clarify the meaning of participation and identify the numerous forms it can take. Participation typologies identify seven levels in which the term participation can be used and interpreted of participation (Pretty & Ward 2001): manipulative, passive, consultative, bought, functional, interactive, and self-mobilization.

These typologies range from passive participation in which local people are silent partners or donors of information, and control over content is maintained by outsiders; to consultation-based participation in which local people do not share in decision making but their opinions influence the problems and solutions defined by outsiders; to interactive and self-motivated participation in which local people take active and independent roles in identifying problems and solutions, and in making decisions (Erickson 2006). If the goal is to fully engage local people in conservation programs the most desirable forms of participation would be the highly active, perhaps even self-motivated, forms, and the least desirable would be the contractual and passive forms (ibid).

Although a few years ago most experiences represented the less effective passive, bought or consultative forms of participation in the management and formation of protected areas, the 1990s saw an increasing understanding of how to develop these operating systems through the transformation of both social and human capital (Pretty 2002). More cases are appearing that illustrate collaborative forms of participation where local people are taking active roles (Fitzgerald 1999, Pretty & Ward 2001, Pretty 2002, Erickson 2006), based on social learning - a process that fosters innovation and adaptation of technologies embedded in individual and social transformation.

Social learning it is associated, when it works well, with participation, rapid exchange and transfer of information, with trust among participants, better understanding of key ecological relationships, and rural people working in groups (Pretty 2002). Practices of social learning have lead to greater innovation as well as increased likelihood that social processes producing new practices will persist. In the face of growing uncertainty (e.g., economies, climates, political processes), the capacity of people both to innovate and to adapt technologies and practices to suit new conditions becomes vital (Pretty & Ward 2001).

For conservation biologists, communities can diversify scientific practice. Direct participation by communities educates both scientists and community members. This way, community members are collaborators rather than variables (Song & M'Gonigle 2001). Working with the local knowledge requires new skills, including diplomacy and negotiation and a willingness to engage the "other" in a respectful manner over long periods of time. Many attempts to work with local knowledge have focused more on documenting the knowledge than on using it to set the course of research. This is the natural bureaucratic response – to get the local data out – but it merely commodifies local knowledge rather than exploring it as a new direction for research and understanding. "At stake is the opportunity for science to develop conservation solutions" (ibid).

Recent years have seen an extraordinary expansion in collective management programs throughout the world, described variously by such terms as community management, participatory management, joint management, decentralized management, indigenous management, user participation and co-management. There is a danger, of course, of appearing too optimistic about local groups and their capacity to deliver economic and environmental benefits Pretty (2002), as well there are the risk of naïve articulation or manipulative and rhetorical forms of "pretended participation".

The Risks of "Participation"

The term "participation" is now part of the normal language of most development agencies. It is such a fashion that almost everyone says that it is part of their work. This has created many paradoxes. The term has been used to justify the extension of control of the state as well as to build local capacity and self-reliance; it has been used to justify external decisions as well as to devolve power and decision making away from external agencies. It has become increasingly clear that social learning is a necessary, though not sole, part of the process of adjusting or improving resource management (Pretty 2002).

As put by Pretty (2002) "not all forms of social capital, however, are good for everyone in a given community. A society may be well organized, have strong institutions, have embedded reciprocal mechanisms, but be based not on trust but on fear and power, such as feudal, hierarchical, racist and unjust societies. Formal rules and norms can also trap people within harmful social arrangements. Again a system may appear to have high social capital, with strong families and religious groups, but contain some individuals with severely depleted human capital through abusive conditions or other exploitation".

Some associations can also act as obstacles to the emergence of sustainable livelihoods. They may encourage conformity, perpetuate adversity and inequity, and allow certain individuals to get others to act in ways that suit only themselves. These characteristics can severely impede well-meaning attempts at participatory biodiversity. As put by Kapoor (2001), "at the heart of the question of the quality of participation lies the question of power relations". The danger of using participatory approaches in ecosystem management is that, ironically, they can cut themselves off from politics.

Communities participate in programs without being empowered to change, dismantle or even criticize power structures. Minorities, feminists and women's groups warn, in this regard, that participation in programs can be meaningless or even counter-productive unless minorities and women are also empowered to reform the patriarchal relations and institutions that marginalize them in the first place. Others point to instances where elites or private corporations have captured or manipulated participatory processes

(Kapoor 2001, van den Hove 2006). We will address this point later in the research when discussing the Federal proposition of creating three new Protected Areas on the region (Chapter 6: Strategies for Conservation on Priority Landscapes).

In this sense, local participatory decision making may sometimes proceed as though all participants have an equal say, oblivious to the fact that, outside the community meeting hall or participatory workshop, elites wield socio-economic power that can influence or silence people's voices inside these spaces. Frequently, elites do not have to be present or directly represented in these spaces; the perceived threat of their power is sufficient to influence participants (Kapoor 2001). Whether due to these outside influences or not, there are several "micro-power" processes at play within participatory spaces.

Some participants may be more influential than others because they have well-supported and persuasive arguments. This is particularly true when high social differences occur within the same community groups. Others may manipulate participatory deliberations for their own ends: they may misrepresent their positions, employ false evidence or use rhetorical language to persuade, influence or silence participants. In particular, strategic manipulation of the process by some actors is always a risk in participatory approaches (Kapoor 2001, van den Hove 2006). There are, though, concerns that the establishment of new community institutions and users' groups may not always benefit the poor.

There are signs that they can all too easily become a new rhetoric without fundamentally improving equity and natural resources. This is an inevitable part of any transformation process (Pretty 2002). "The old guard adopts the new language, implies they were doing it all the time, and nothing really changes. But this is not a reason for abandoning the new. Just because some groups are captured by the wealthy, or are run by government staff with little real local participation, does not mean that all are fatally flawed. What is does show clearly is that the critical frontiers are inside us" (ibid). Transformations must occur in the way we all think if there are to be real transformations and improvements in biodiversity and the lives of people. These are the basic objectives of the critical research.

Social institutions based on trust and reciprocity, and agreed norms and rules for behavior, can mediate this kind of unfettered private action. It is clear that new thinking and practice are needed, particularly to develop forms of social organization that are structurally suited for natural resource management and protection at local level (Pretty & Ward 2001). This usually means more than just reviving old institutions and traditions. More commonly, it means new forms of organization, association and platforms for common action. The past decade has seen a growing recognition of the effectiveness of such local groups and associations for sustainable environmental and economic outcomes (ibid).

2.4.6 A Critical Postmodern Landscape Research Approach

A postmodernized critical theory accepts the presence of its fallibility as well as it contingent relation to progressive social change. In light of this reflectivity, critical researchers do not search for some method of inquiry that will guarantee the validity of their finding (Kincheloe & McLaren 1998). Critical research traditions have arrived at the point where they recognize that claims to truth are always discursively situated and implicated in relations of power. "Critical research continues to problematize normative and universal claims in a way that does not permit them to be analyzed outside of a politics of representation, divorced from the material conditions in which they are produced, or outside of a concern with the constitution of the subject in the very acts of reading and writing" (Ibid).

A critical postmodern research requires researches to construct their perception of the world anew, not just in random ways but in a manner that undermines what appears natural, that opens to question what appears obvious. Critical researchers must strive to not confuse their research efforts with textual suavities of an "avant-garde" academic posturing in which they are awarded the sinecure of representation for the oppressed without actually having to return to those working-class communities where their studies took place. Rather, they need to locate their work in a transformative praxis that leads to the alleviation of suffering and the overcoming of oppression (Kincheloe & McLaren 1998).

Insurgent researchers ask questions about how what is has come to be, whose interests are served by particular institutional arrangements, and where our own frames of reference come from. To engage in critical postmodern research is to take part in a process of critical world making, guide by the shadowed outline of a dream of a world less conditioned by misery, suffering, and the politics of deceit. As stated by Kincheloe & McLaren (1998), "it is, in short, a pragmatics of hope in an age of cynical reason".

The political-economic structures that constrain and exploit humankind are the same that commodifies nature and promote habitat destruction; intensive farming systems are one of the reproduction forms of such structures. Farmers, on this instance, while managing their lands, whereas expanding croplands, employing GMO crops, spraying pesticides, and applying excessive amounts of nitrogen and phosphorous, are reproducing the very system that oppressed themselves. This contradiction is more evident within familiar farming systems, where shortage of land and capital turned smaller farms economically unfeasible. Such contradiction is also becoming clear in the smaller properties within the agribusiness-oriented farming systems[15].

Landscape Conservation research under this conception becomes a transformative endeavor unembarrassed to consummate a relationship with an emancipatory consciousness. The dialogue must be dialectical in nature to transform accepted historically mediated structures into more "informed consciousness" for seeing how the structures might be changed and comprehending the actions required to effect change. Whereas traditional researchers adhere to the guard rail of neutrality, critical researchers frequently announce their "partisanship in the struggle for a better world" (Kincheloe & McLaren 1998).

Dialectical Situating

As presented by Kvale (1996), "dialectics is the study of internal contradictions - the contradiction between general and the specific, between appearance and essence, between the quantitative and the qualitative". The development of contradictions is the driving force of change. Dialectical materialism involves the fundamental assumption that the contradictions of material and economic life are the basis of social relation and of consciousness. Men act upon the world, change it, and are again changed by the consequences of their actions. Human consciousness and behavior are studied within the

[15] See also discussion on section 3.3.3 - Land use Systems.

concrete sociohistorical situation of a class society and its forces of production and relations of production. The objects of the human sciences are seen as multifaceted and contradictory, consisting of internally relates opposites in continual change and development.

There are marked differences among the many different traditions of dialectics, such as the official dialectical materialism of the former socialist countries, the activity theory developed by Leontiev, the Frankfurt school of Adorno and Horkheimer, and the existential Marxism of Sartre (Kvale 1996, Clark & York 2005). In a dialectical perspective, knowledge is intrinsically related to action. Marx criticized the philosophers for merely interpreting the world differently; "what matters is to change the world". Correspondingly, social scientists have tended to provide different interpretations of the social reality, rather than contribute to its change. For Sartre, knowledge and action are two abstracted aspects of an original concrete relation. Action is an uncovering of reality and at that time a changing of this reality (Kvale 1996).

A dialectical materialist approach to nature provides the means for understanding the complex interactions throughout the natural world, the ability to explain the world in terms of itself, the perception to recognize that contingency and emergence are inherent aspects of a living world, and the capability to study the structural constraints and the inherent potential for change. In this, a materialist dialectic avoids the mechanistic reductionism of economistic approaches, where nature exists in the background, as simply an input to the economic system. It also avoids the idealized notion that nature exists in a state of balance and that a return to such a state is simply a matter of developing the appropriate moral-ethical system (Clark & York 2005).

The dialectical materialist perspective recognizes that the world is one of constant change but not one where anything goes. Constraints and possibilities remain in the structural conditions of the world. Abrupt, punctuated change can radically shift life to new pathways or the environment to conditions that present serious challenges to existing life. It is of utmost importance that nature is understood in terms of itself. Human society is dependent upon the environment and must interact with it to continually reproduce itself. This interaction involves the transformation of the world. The dialectical materialist approach highlights how history involves change. But all change and any change is not good. The interaction between humans and the environment is an enduring struggle to live within a finite world, under emerging conditions (Clark & York 2005).

The linkage between scientific endeavor, technical interventions, and environmental degradation provoked by agents such as chlorofluorocarbons (CFCs) and pesticides is more easily apprehended by the general public. It is less clear that the products of social science such as techniques of financial management, organization of production, quantitative indicators for assessing progress towards development contribute equally to environmental destruction (Jacob 1997). Reconstructing landscape conservation as a critical theory in political practice would, therefore, be beneficial in so far as it would bring all these issues into the conservation debate.

Community-Based Action Research

Community-based research enacts localized, pragmatic approaches to research, investigating particular issues and problems in particular sites, at particular moments in lives of interacting individuals and groups. Based on action science it seeks knowledge that will serve action (Argyris et al 1985). Its purpose is to provide participants with new understandings of an issue they have defied as significant and the means for taking corrective action. The processes are necessarily participatory, enabling all people affected by the issue to have their voices heard and to be actively engaged in research activities (Stringer 1999).

Community-based action research, therefore, is ultimately a search for meaning. As put by (Stringer 1999), "it provides a process or a context through which people can collectively clarify their problems and formulate new ways of envisioning their situation. In doing so, each participant's taken for granted cultural viewpoint is challenged and modified so that new systems of meaning emerge that can be incorporated in the texts – rules, regulations, practices, procedures and policies – that govern our professional and community experience and, in the process, increase the potential for creating truly effective services and programs that will enhance the lives of the people we work with".

Community-based action research suggests a move in emphasis from the creative texts of experimental interpretative ethnography toward the production of "practice scripts". Practice scripts are the plans, procedures, and models derived from the final stages of action research that enable people to take direct action on the problems they have investigated. They also provide the means for people in professional or occupational roles to reformulate policies and practices to enable them to provide programs and services that are more effective. Change, the desired outcome, derives from the here-and-now ideas and concepts taken from the taken-for-granted life world of the participants (Stringer 1999).

In the agrolandscapes of study, the desired outcome of changing the way land is managed towards a conservation-friendly landscape, will more likely stem if derived from the meanings landowners associated to the language, ideas, and concepts that make sense in their land, homes, offices, centers, organization, and institutions, and are part of their everyday experience of farming and family, community, work, professional, and commercial life (Stringer 1999). Accordingly, the products of research should not be only the written reports and publications, but also practice script - plans, procedures, models, maps, and so on - that provide the basis for reformulating practices, policies, programs, and services for enhancing landscape conservation opportunities.

The Theory of Communicative Action of Habermas

Many normative models of participation to address environmental issues (among others) have been grounded, at least partially, on Habermas' communicative rationality (Jacob 1997, van den Hove 2006). The appeal of Habermas' theory is that it is built on an understanding of social phenomena as intrinsically inter-subjective and it proposes an interactive rationality model which recognizes the inseparability of communication and the social world. Building on the Habermas' model allows ensuring that certain key elements are integrated in the design of participatory processes.

Habermas (1987) argues that human interaction presumes what he calls an "ideal speech situation". He argues that all linguistic communication involves four kinds of validity claims: that what is articulated is comprehensible, that the content of what is said is true, that the speaker is being truthful (the discourse is congruent with the speaker's intentions), and that the speech acts being performed are legitimate (Argyris et al 1985).

The criteria for good discourse, that is, for the rationality of the consensus that may be achieved through discourse, are that it approximates the ideal speech situation.

"What it means for a statement to be true is that it would be the one on which all agents would agree if they were to discuss all of human experience in absolutely free and uncoerced circumstances for an indefinite period of time" (Argyris et al 1985). Based on the work of Habermas, van den Hove (2006) pointed-out the following requirements for participatory approaches to address decision making challenges created by the ecological and societal complexity of environmental issues:

- free speech situation, which is (as much as possible) devoid of external constraint and of strategic behavior, accessible to all, and in which only the unforced force of the best argument counts - what Habermas calls the “ideal speech situation”;
- consistency between discourse and beliefs as well as consistency between discourse and behavior: each participant should be “rationally accountable” of what she says, and should commit to strive to respect what she has argued for, by offering justifications and reasons and by acting consistently;
- transparency: each participant’s references and values should be made explicit and the standpoint from which he perceives his interest should be open to others’ critique;
- a focus on common interest: participants should strive to address a common interest beyond the mere adjustment of particular interests.

As pointed by Van den Hove (2006) “these are ideal requirements which will never be fully met in real life situation. They should be interpreted as guides for process design, implementation and evaluation. Neither do it is claimed that these are sufficient requirements to design a participatory process in any real life situation”. Models of participation based on Habermas’ work are often reduced by their detractors to idealistic representations and are criticized on the ground that they put too much emphasis on consensus and disregard conflict and power relations hence negotiation processes. The fourth requirement mentioned above is particularly important in this regard as it points to the difference between common and particular interests (ibid).

Habermas (1987) distinguishes between discussions in which participants strive to apprehend a common interest and reach consensus, and negotiation of a compromise in which participants strive to conciliate individual and diverging interests. The ideal of consensus that he proposes applies primarily to the rational search for universal norms (Habermas 1987). Habermas argues that the ideal speech situation is the grounding for the ideas of rationality, freedom, and justice, as well as the idea of truth (Argyris et al 1985).

Conservation require changing public values in favor of biological diversity, and people sometimes do change what they value when they learn more about the values they care about, and about how their actions may affect biological diversity. People also change what they value when they are inspired by the convictions of others (Maguire 1996). The alternative is neither simple nor mechanistic. It is to do with building the capacity of communities to learn about the ecological and physical complexity in their fields, farms, and ecosystems, and then to act in different ways. The process of learning, if it is socially embedded and jointly engaged upon, provokes changes in behavior (Argyris et al 1985, Habermas 1987, Pretty 2002), and "can bring forth a new world" (Maturana & Varela 1982).

Chapter 3: Setting the Regional Conservation Context

3.1 Introduction

The issues of risk and the environmental degradation have common features that distinguish them from traditional scientific problems: uncertain facts, values in dispute, high stakes, and a pressing need for decision-making (Funtowicz & Ravetz 1997, Ludwig 2001, van den Hove 2006)[1]. Scientists have increasingly recognized the extent to which uncertainty limit the role science can play in many environmental decisions (Holling 1998, Robertson & Hull 2001). Experimental studies of isolated variables and components are not sufficient to understand the organization of complex systems. Accordingly, to address conservation biology issues in the private fragmented landscapes of the regional mosaic it is necessary a scientific approach able to induce within landscapes practices of remnant habitat conservation and eco-friendly land management alternatives.

As a post-normal rather than positivist approach to knowledge (Ravetz & Funtowicz 1999), a landscape conservation science requires that the knowledge constructed for conservation decision making reflect the pluralist and pragmatic context of decision making, while striving for the rigor and accountability that earns scientific knowledge its privileged place in the sociopolitical arena where conservation decisions are made (Robertson & Hull 2001)[2]. Understanding landscape for the purpose of making decision about the goals and objectives of management requires a more case-specific knowledge that is constructed in the context of specific places and to the people using it.

[1] See Section 2.3.4: Conservation Science and Postmodern/Post-Normal Perspectives.
[2] See Section 2.4: A Postmodern Perspective: An Integrated Landscape Conservation Approach.

Thus, a landscape-based conservation research must strive not only to be generalizable, but must seek to be specifically applicable.

This chapter will explore the Landscape Conceptual Framework as it was employed for the development of a broad, holistic, understanding of the regional context. The upper portion of the Figure 1.3[3] shows the detailed version of the Framework which guided data collection and the analytical procedures for developing a broad understanding of the regional mosaic. Drawing on the landscapes of the Campos Gerais ecoregion we followed the framework to outline the biophysical and human context upon which conservation planning and landscape management practices should be developed and operated.

Initially, an extensive collection and review of the available data concerning the regional landscape component systems - geosphere, biosphere and human systems - were carried out in order to construct a GIS-based inventory, which was employed in the analysis of all subsequent chapters. Data from the natural systems components were processed to identify main geo-biological features and to recognize the patterns of vegetation and habitat types at the community and landscape level. The regional analysis, then, allow us to understand how natural landscapes have been modified through regional history, accordingly to the changes on the macro-economical cycles that were prevalent on the State of Paraná and Brazil.

The focus was, then, directed to map current land use types grouped as main systems of land use (LUS), either as an indicator of the environmental impact on the remnant habitats produced by the human activities surrounding them, as well as spatial

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[3] See Section 1.4: Designing a Landscape-Based Research Framework

indicator of the social differentiation in the matrix. Participant observation techniques (P.O.) were employed to draw a broad understanding of the human dimensions associated with the mapped land use systems. Remnant patches of natural vegetation, within broad patterns of land use systems, were then identified, mapped and classified. Based on the broad landscape understanding, landscape conservation goals were then defined to guide the next steps within the research framework.

3.2 Methods

3.2.1 Collecting Ancillary Data - Inventory

A regional conservation plan for biodiversity requires a variety of data, ranging from environmental and biological information on conservation targets to human population trends and land use and ownership patterns. Accordingly, an extensive collection and review of the available data concerning the regional landscape component systems (geosphere, biosphere and human systems) and other information that were considered valuable in assessing conservation issues in the Regional Matrix were carried out. Available information includes spatial datasets, paper maps, satellite imagery, aerial photography, inventories and research publications on the systems components.

This data set is summarized in Table 3.1 by subsystems components, the form of publication, and main sources of information, and constitutes the Inventory, the basic reference for all the subsequent analysis of this research. There was a dearth of information available on all the subsystems components, except for the Vila Velha State Park where information has been more consistently produced. The existing knowledge about the Campos Gerais ecoregion and the regional matrix so far had been disparate in literature, and a holistic landscape understanding has not been developed.

Table 3.1: Compiled Ancillary Data – Inventory

System Component	Subsystem Component	Form of Publication	Main Sources of Information
Geo-Physical	Geology	Maps and Reports	Maack 1968, EMBRAPA 1984, 1999; IBGE 1990, 2004; PARANÁ 1989a, Ponta Grossa 1990, PARANÁ 2004, 2005, Rocha et al 1990, 2005, Rocha 1995, Mello et al 2002, 2004, Weirich Neto 2004, Colett et al 2005.
	Geomorphology	Maps and Reports	
	Climate	Maps and Reports	
	Terrain and Elevation	Maps and Reports	
	Watersheds and Hidrography	Maps and Reports	
	Soils	Maps and Reports	
	Land Use Capacity	Maps and Reports	
Biological	Natural Vegetation	Maps and Reports	Maack 1950, 1968, Klein et al 1971, IBGE 1990, 2004, Rocha et al 1990, 1995, Ponta Grossa 1990, Moro et al 1996, Pontes Filho et al 1997, 1999, Moro 2001, Medri et al 2002, Paraná 2004, 2005, MMA 2002, 2004, 2006.
	Ecological Succession	Reports	
	Biomes and Bioregions	Maps and Reports	
	Regional Fauna	Maps and Reports	
	Species Distribution	Maps and Report	
	Invasive and Exotic Species	Reports	
	Conservation Priority	Maps and Reports	
Socio-Economic	Regional History	Maps and Reports	Pinheiro Machado 1968; Saint-Hilaire 1978, Padis 1981, PARANÁ/SEC 1989b, PARANÁ 2004, 2005, IBGE 1990, 2000; Derspsch et al 1990; Rocha 1995, Ditzel & Sahr 2001, Bigg-Whiter 2001, PARANÁ 2003; IPARDES 2003, Rocha & Weirich Neto 2005, Colett et al 2005.
	Regional Economy History	Reports	
	Land Settlement	Reports	
	Road Network	Maps - Aerial Imagery	
	Socio-Cultural Aspects	Reports	
	Regional Economy	Reports	
	Land Use and Cover Change	Aerial Imagery	
	Land Use Systems	Reports - Aerial Imagery	
	Land Management Systems	Reports - Aerial Imagery	

3.2.2 Setting the Landscape Conservation GIS Data-Base

This work was start by reviewing the literature and analyzing collected information. Spatially explicit and multiscalar data were, then, digitally constructed and organized into the GIS data-base. The spatial distribution of patterns on aerial imagery was interpreted as the reflection of interacting biophysical and socio-cultural components at multiple scales. By combining landscape ecology principles (Forman 1995) with techniques of GIS and remote sensing interpretation, and supported by ground checking, we identified, mapped, and classified bio-physical and human properties of the regional landscape. We utilized information from all available sources, including academia, research institutions, local, state and federal public natural resource agencies, conservation organizations, and individual experts.

By centering the analysis on geology, climate, paleoecology, archeology, vegetation types, soil survey, land use capability, ecology and history, and combining such information on multiple overlays of data using GIS environment, we identified, mapped, and classified landscapes according to its bio-physical properties. Through this interpretative process we develop a systemic framework to enrich our understanding of the main structural features that shaped Campos Gerais ecosystems and associated ecological processes, disturbances regimes and landscapes patterns before European colonization. Through this interpretative process of spatial data analysis, we also mapped the main vegetation and habitat types at the community level.

Thereafter, we combined this natural landscape model with an analysis of how social systems interacted with regional landscapes and how the potential and constraints for land management influences colonization and social conditions. Based on the GIS data-base framework, we analyzed how land use and ecological processes were transformed by social interactions throughout the regional history and regional economic cycles. We studied human induced disturbances in the regional landscapes through time, and the shaping of actual landscapes since the introduction in the 1960s of "green revolution" farming techniques.

We reviewed the currently dominant farming production paradigm, which is supported by powerful interests, both within the agricultural establishment and the agricultural industry (Dahlberg 1996). We studied the ecological, social, and economic consequences of modern farming techniques in Brazil, as well as in Latin America. We analyzed the international political economy of industrial farming as one not only of a global division of labor, with most of the social costs being born in the South (or by Southern migrants into the Northern countries), but also one which often parcels out the most ecologically destructive portions of production processes to the Third World (Carruthers 1996, Cordeiro 2000, Fearnside 2001).

We looked at the recent phenomenon of intensive habitat destruction and fragmentation and analyzed it through overlaying information from multiple sources - geo-bio and the noosphere[4], and as consequence of the global demand for farming commodities. We, thereafter, studied and mapped current land use systems (LUS) as the main landscape types within the broad regional context. LUS are seen as the product of the interactions among ecological and socio-cultural systems that produces landscapes and regions. We mapped the remaining patches of natural habitat and analyzed how land and crop management are practiced within distinct LUS, and how it relates to potentials and constrains for conservation of the remnant patches.

Mapping Remnant Patches of Natural Vegetation and Land Use Systems

Identification and mapping of Remnant Patches of Natural Vegetation and Land Use Systems were obtained by satellite image interpretation combining two methods: a)

[4] See discussion in the Section 2.1: Landscape: an evolving and versatile concept

unsupervised digital classification (Jensen 1996) and, b) visual interpretation of image patterns - *Gestalt* analysis (Antrop 2000, Antrop & Van Eetveld 2000, Zonneveld 1995, Grifith et al 1995) in combination with ancillary data. The matrix of land use elements provides the key to identifying and mapping land use changes, land use systems and remnant patches; such analysis can play an important role in understanding land use pattern and landscape ecological dynamics (Blaschke 2006).

Two LANDSAT 7 ETM$^+$, images from September 2000 (path/row 221_077 and 221_078) were geometric rectified and subset to compose the regional matrix (See Figure 1.1). Univariate and multivariate statistics were computed to assess image quality and to analyze general patterns of spectral response. Techniques of image enhancement were performed for an optimal depiction of land use patterns. Landscape features of special concern were checked through analysis of different spectral responses to improve the ability of visual on-screen interpretation.

The ISODATA clustering algorithm of the Erdas/Imagine software (version 8.4) was employed for an unsupervised digital classification purposes. Initially, 100 cluster classes of the spectral data were defined by the computer analysis with a convergence threshold set at .99 and a maximum of 50 iterations. Once this step was completed, every spectral cluster class was judiciously assigned to one land cover/land use type category as follow: a) croplands, b) bare soil, c) grasslands, d) araucaria woods, e) riparian woods, f) wetlands, g) urban/suburban, h) Commercial forestry, i) roads, and j) others, when spectral pattern resulted from distinct land use or from complex spectral combinations.

A transformed divergence matrix was calculated and inspected for the potential of merging distinct cluster classes representing the same cover type. Cluster busting was employed to separate mixed cluster classes representing distinct categories of land use. The spectral signature editor obtained from the refinement process was employed to run a final supervised classification and a digital Map of Land Use in a raster format was, consequently, produced.

Following this procedure, Remnant Patches of Native Vegetation were on-screen interpreted and delineated based on the analysis *Gestalt* of image patterns[5]. The software ArcView GIS (version 3.2), were used for mapping and data base construction. Basic characteristics of the image used during visual interpretation were shape, size, pattern, tone or hue, texture, shadows, geographic or topographic site and associations between features and identified objects. Both the computer unsupervised classification and the visual interpretation of remnant patches were considered for delineation purposes. The raster Land Use Map was overlaid and displayed as necessary to check and improve the quality and consistency of the delineation process.

The following rule was used for setting boundaries between remnant patches of natural vegetation and modified landscapes: when digital and expert classification agrees, the land cover was assigned; whenever the digital classification was recognized to be incorrect, the expert classification prevailed; whenever doubt arises, ancillary data was consulted and the correspondent map overlaid (when digital format was available), to improve the decision making process. In case of persistent uncertainty, the decision was made based on the most likely land use type. Through this iterative process, and by checking the spatial information at multiple scales as necessary, polygons were then drafted, refined, and completed.

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[5] See discussion in the Section 2.2.4: Human perception and the "art" of patch delineation.

The principle of "convergence of evidence" [6] was the basis for the visual interpretation of patterns of land use and the remnant patches on images, as they correspond to the patterns on the ground and as they relate to the landscape systems components (i.e. geology, landforms, hidrography, soils, vegetation, land use history, land tenure, systems of production, urban areas, and the transport network). Ancillary data (see Table 3.1) were used as complimentary source for interpretation purposes whenever necessary, to deepen the understanding of particular patterns present on the image.

Image visual interpretation and the landscape systemic analysis were processed on the GIS environment at multiple scales to check how landscape patterns change, by changing the scale of observation[7]. Hierarchical theory predicts that each level in a hierarchy functions at rather distinct temporal and spatial scales. One of the insights developing from complexity thinking is that a multiplicity of scale prevents there being one "correct" perspective in a complex system. Phenomena at each level of the scale tend to have their own emergent properties. The system must be analyzed simultaneously at different scales (Hobbs 1998, Berkes 2004, Blaschke 2006).

The visual analysis of patterns and the task of setting limits between remnant and non-remnant patches were supported by: a) knowledge of the spectral responses of different cover types and, b) knowledge of the regional patterns of land use and management systems. Available ancillary data and particularly the time series of aerial photography (from 1952 - scale 1:25.000, 1962 - scale 1:70.000 and 1980 - scale

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[6] See discussion in the Section 2.2.4: Human perception and the "art" of patch delineation.

[7] See discussion in the Section 2.2.5: Landscape Analysis and the Importance of Scale.

1:25.000) and a 1990 and a 1994 LANDSAT TM 5 digital image were used as complimentary source of information for interpretation purposes.

For remnant patch outlining, the total extension of the remaining surface was considered as a unique patch, grouping, thus, distinct types of contiguous natural vegetation into the same unit. Therefore, the mapped remnant patches very often included different vegetation community types, which were delineated together constituting a single patch embedded in the regional matrix. The interception of highways, main roads or railroads - structures that clearly creates barriers to dispersal and movements of wild species and ecological flows over the landscape (Forman 1995) - were also used as criteria to set boundaries among, otherwise, contiguous patches of remnant vegetation.

The Figure 3.1 shows the flow chart for regionalization, employed as general guide for delineating boundaries among remnant patches and transformed/cultivated landscapes. The visual image interpretation resulted in a vector format thematic Map of Remnant Patches. Due to the grain size of the LANDSAT ETM^+ image and the extent of the regional matrix, a threshold area of 40 hectares was set as the minimum mapping unit (MMU), corresponding to a surface of 0.4 cm^2 in a 1:100.000 scale map. Mapped remnant patches were classified into four broad categories of vegetation community types: a) grasslands; b) riparian and araucaria woods; c) mixed riparian landscapes; and, d) mixed alluvial systems, accordingly to the predominant vegetation community type and to regional patterns of natural vegetation (Klein & Hatschbach 1971, Cervi & Hatschbach 1991, Leite & Klein 1992, Moro et al 1996, Moro 2001).

We also combined landscape ecology with techniques of GIS and remote sensing to identify, map and classify patterns of land use that reflect similar landscape bio-

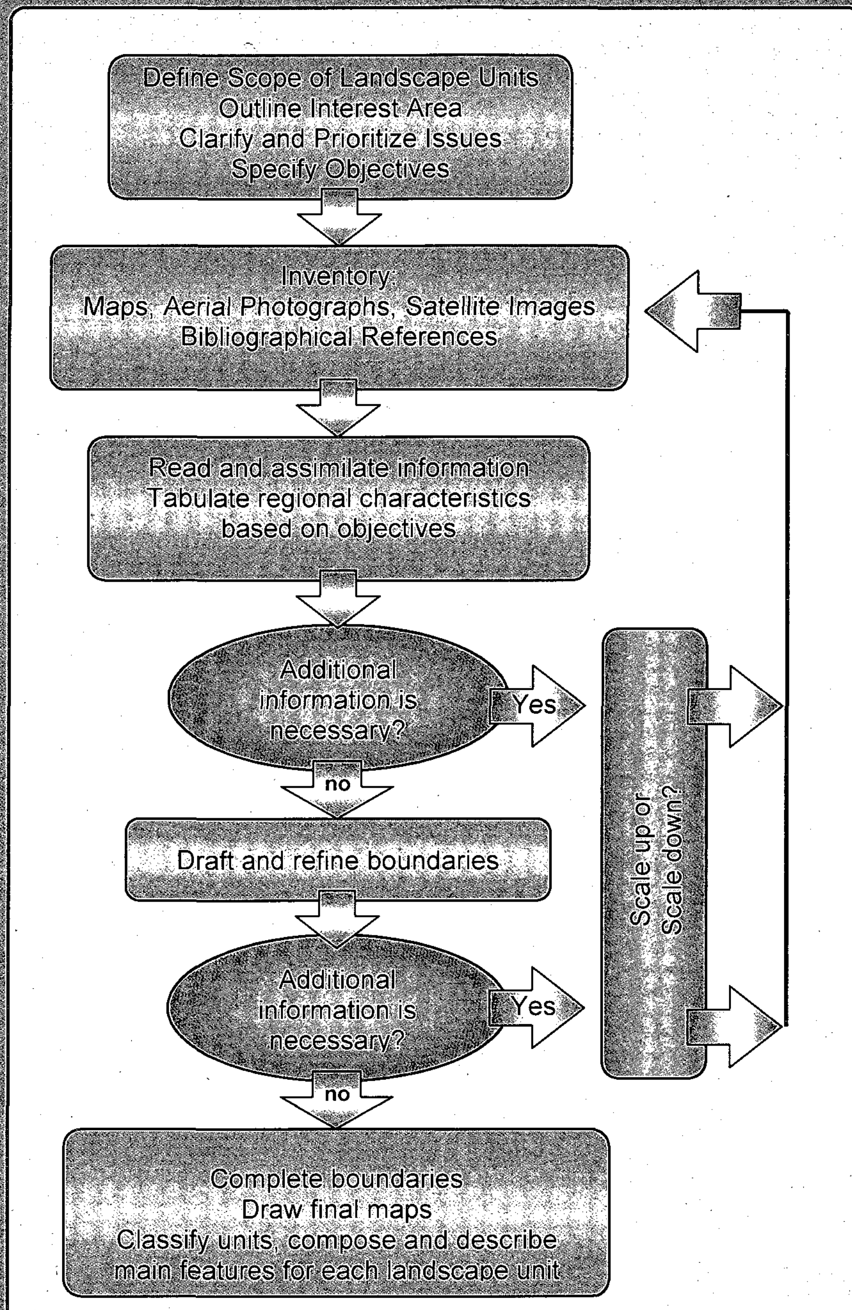

Figure 3.1: Flow chart illustrating the steps in the regionalization process for mapping land use systems, remnant patches, and land units, accordingly to the scale of analysis (Adapted from Gallant et al 1989 and Rocha 1995).

physical properties and interacting social and economical systems and grouping them into classes of Land Use Systems (LUS). By reviewing the literature we analyzed how land use patterns have changed throughout regional history, and how the recent phenomenon of intensive habitat loss and fragmentation was produced by the global demand for farming commodities. The focus of this analysis was at a broader regional scale to identify the predominant patterns of land use and management systems and how they are spatially distributed.

The distinct types of land use systems were then grouped into classes that reflect the most common farming systems in the region (Payes 1989, PARANÁ 2004, Rocha et al 2005, Colet et al 2005): a) Intensive Farming; b) Family Farming; c) Ranching; d) Intensive Forestry; and e) Urban Areas. On assessing present land use systems, in addition to remote sensed imagery, we relied heavily on participant observation (PO) techniques, local informants, and public records, to draw a broad understanding of the human dimensions associated to each Land Use Systems.

Participant Observation (P.O.) Techniques

Participant Observation techniques were employed to deepen our understanding of the social differentiation through the landscapes of study as they are expressed on the Land Use Systems, and as they matter to the conservation issues under analysis. P.O. strategies for colleting social data were developed from January 2004 to April 2006. The discussions to follow, concerning social data derived from P.O. strategies, will draw on the observations developed as participant in meetings with 10 focal groups.

Based on the Map of Land Uses Systems, we selected groups of people managing land under distinct systems of use and locations, to generate a set of information concerning values, attitudes, and opinions held by the stakeholders. The relations of power among the distinct voices were also observed to map different attitudes among and within those groups. Hence, four focal groups were selected within intensive farming system and three on small farming systems; another three groups are considered key informants on these systems. All meetings were coordinated by other personnel, accordingly to the distinct objectives of the gathering and P.O. techniques were carried-out by the researcher.

Open meetings of the four intensive farming systems groups were attended as they were scheduled; the main purpose of these meetings was the discussion and elaboration of strategies to contest MMA's propositions of creating new federal protected areas in the region[8]. These groups of intensive farmers involved: 1 - members of a formal large-farm organization; 2 - a group composed by six large-farm owners and six other persons from other organizations, members of a temporary local committee organized to review MMA's PAs propositions and to suggest adjustments or modifications; 3 - members of a farmers association, constituted by 12 medium farmstead owners; and 4 - a very large group, constituted by more them 250 participants, including landowners, particularly from medium and large farmsteads, and other stakeholders, including landowners from the outside of the regional matrix.

Participants of these groups included rural people from a broad range of ages and participation were predominant male, particularly in the first three of these groups. Three

[8] See discussion on Section 6.3 - Landowners' Views of Conservation Alternatives.

meetings with each group were attended for these groups, while with the fourth, six large meetings were attended. The attendance for these open meetings was considered very relevant as the main issue being addressed on these groups - the planned land expropriation by the federal government for biological conservation purposes, provide an excellent background to observe the attitudes of the many segments linked to the rural sector, how opinions were formed, and how they related to the values and meanings different people attached to land. The particular issues at stake on these open meetings were not the purpose of this study. While addressing the conflict context was obviously not planned in this project, attending these meetings provided such a rich social background for the research purposes.

The three Focal Groups on family farming systems involved members of rural communities, which gathered to discuss, in community open meetings, the municipal master plans in elaboration to their municipalities by a contracted planning office (in the cities of Carambeí and two groups at São João do Triunfo). Each group had two meetings to discuss, review, and set priorities for rural development, and participation varied from 12 to 30 persons. Conservation issues were an important part of their discussions, as will be later addressed on Chapters 6 and 7. Participants of these groups also included rural people from a broad range of age, while participation, perhaps due the difference in the subjects, was more gendered equilibrated than the groups on intensive farming.

Additionally, meetings with 3 other Focal Groups, considered as key informants for mapping and understanding land use systems, were carried out. They included a semi-formal group constituted by 15 small farmers from several municipalities, participants of a local NGO's lead project on agroecology, and a second informal group of 6 small farmers, participants of a agroecological farmers' market. These two groups were selected to deepen the comprehension of how agroecological farming systems has been regionally practiced, and how it can be integrated into the conservation context of the small farming systems.

A third group was constituted by 8 agronomists, who have a long experience on providing technical expertise within intensive farming systems for medium and large farmstead owners (areas larger than 300 ha). These informal groups have regular meetings aiming the exchange of ideas, practices, and sharing of empirical knowledge on crop management systems and other related farming subjects. P.O. techniques were carried within two meetings with each of these groups. The results derived from P.O. were employed to construct the information set on the broad categories of LUS, as discussed on this Chapter, and will be later addressed on the discussion of Conservation Strategies on Chapters 6 to 8.

3.2.3 Setting Landscape Conservation Goals

From the consistencies found in the evidences from these multiple sources, an inductive[9] landscape system understanding, where human dimensions is integrated into landscape ecology and conservation planning, was outlined. We looked at biophysical and human interactions at multiple scales, from farm/local to a broad regional extent, and identified multiple and only partially separable causes to habitat destruction and landscape fragmentation. We analyzed multiple, competing alternatives to frame main causes and consequences in order to search for alternatives to halt and reverse such

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[9] Or abductive reasoning, sensu Coffey & Atkinson (1996), Tognetti (1999), and Blaikie 2000 (see also discussion on Section 1.5 - A Qualitative Approach for Constructing a Landscape Conservation Praxis).

processes. Constructing on this broad landscape understanding, landscape conservation goals were then defined to guide the next steps of the research framework.

3.3 Results and Discussion: The Regional Conservation Context

3.3.1 The Landscapes of the Campos Gerais Ecoregion

Main Physical Attributes

The region of Campos Gerais is located on the reverse of the Devonian Escarpment that separates the first and the second Paraná Plateaus. Along the escarpment the difference in altitudes can reach up to 300 meters, with abrupt slopes and vertical walls facing the east side. Superposed or antecedent rivers, which run from the first to the second plateau, excavated deep canyons through the sedimentary layers of Paleozoic age. The associated consequent drainage network has a typical rectangular pattern that follows the general NW/SE and NE/SW orientation of the geologic lineaments. The Campos Gerais typical relief pattern is shaped by rolling hills with flattened elongated hilltops and gentle slopes, with increasing declivity towards the river valleys.

Singular landforms are found throughout the Matrix, particularly along the Devonian Escarpment, as consequence of the nature of the geological basement. On this region lands forms includes escarps, *insellbergs*, ruiniforms landscapes, towers, pinnacles, grikes, corridors, labyrinths, *furnas* (sink holes), humid depressions, ponds, and weathering pours (Mello et al 2004). Dissected deep-shaped valleys, with a presence of rapids and waterfalls are common landscape features of the region.

In the Regional Matrix, the Tibagi and Iguaçu rivers are the main drainage systems (Figure 3.2 - Map of Hydrography). These watersheds are the two largest of the state of Paraná, and are tributaries of the Paraná River, the second largest watershed of South America. The Tibagi watershed drains about 82% of the total Matrix area and has its headwaters located near the Escarpment at an altitude of 1.100 m a.s.l. Following a consequent course it flows accompanying the main declivity of the bedrock layers. The northern portion of the Matrix is drained by the Pitangui watershed, a right tributary of

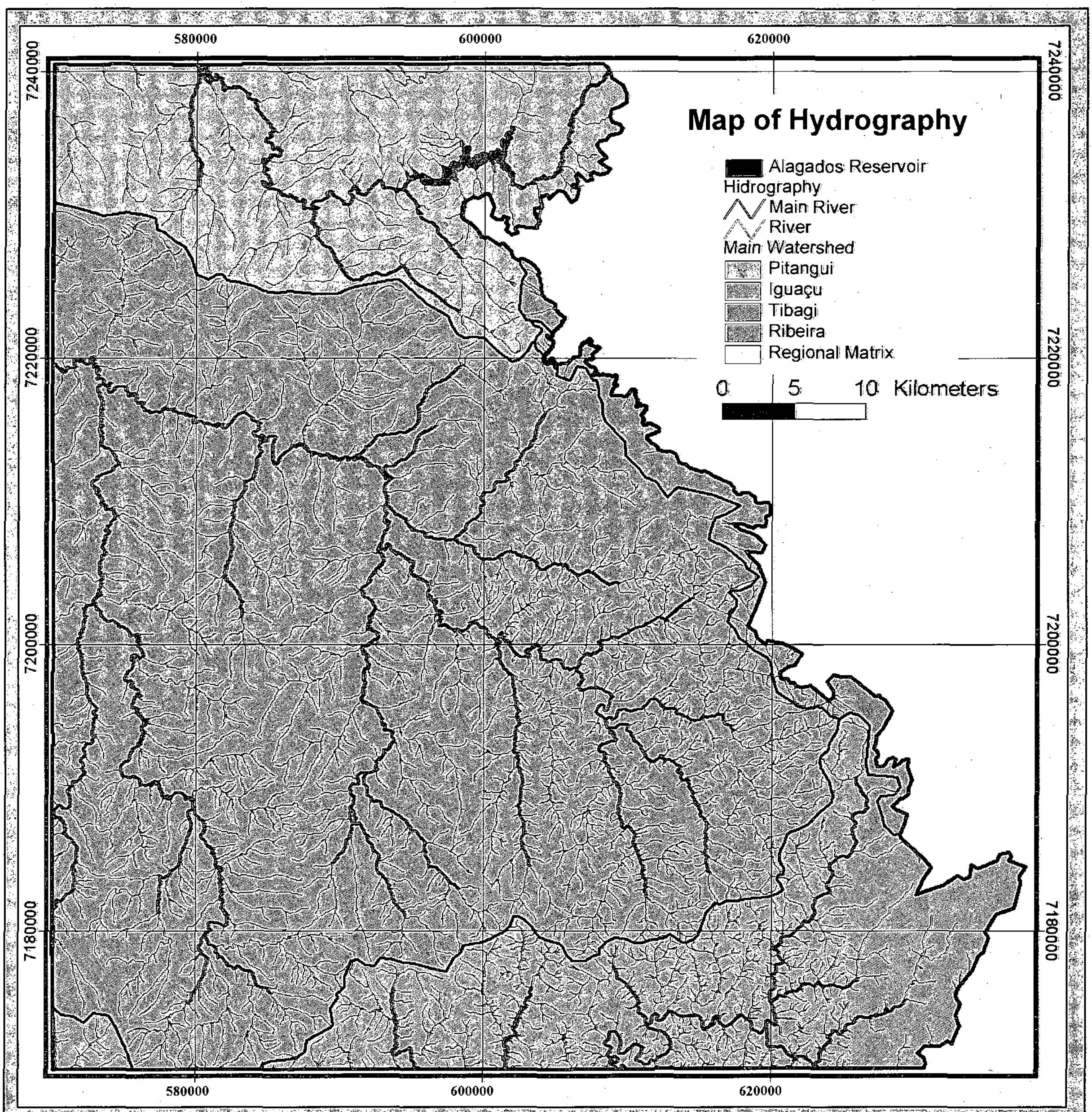

Figure 3.2: Map of Hydrography

the Tibagi River. The Pitangui is an antecedent river, i.e., it had formed before the actual relief and its headwaters are located on the first plateau.

The Iguaçu River, the largest watershed in the State, drains the southern portion of the Matrix (16% of total Matrix area); its headwaters are located outside the Matrix, in the eastern limit of the First Plateau. A small portion of the Matrix (2% of total area) is drained by several small creeks with sources located close to the reverse of the Escarpment, running eastward to the first plateau. These creeks are the headwaters of the Ribeira River watershed, a direct tributary of the Atlantic Ocean.

Three Geologic formations of Paleozoic sedimentary origin exerted fundamental role on the development of the landscapes of the matrix, as they shaped the great majority of the land: the Furnas and Ponta Grossa Formation of the Devonian period, and the Group Itararé of Permian-Carboniferous period. Granites from the Pre-Cambrian crystalline basement, basalt dikes from the Jurassic-Cretaceous period, and Quaternary sediments complete the regional geology (Figure 3.3 – Map of Geology). Sandstones are the typical rocks of the Furnas Formation and are formed by medium to coarse sediments, essentially constituted by quartz minerals cemented by kaolinite, that are relatively resistant to the weathering processes. Soils developed in these formations are generally coarse-grained and shallow, and have a low fertility that favors the persistence of grassland type forms of vegetation.

The Ponta Grossa Formation is constituted by fine-grained sedimentary rocks including shale, siltstones and mudstones, and it is very rich in fossils from the Upper Devonian epoch. Deeper and richer soils have developed on this formation, facilitating the development of woods and forested landscapes. The Group Itararé comprehends three formations with a great variety of rocks types, indicative of several different glacial sedimentary environments, and includes the sandstones formations of the Vila Velha State Park. Soils developed from these rocks are generally deeper and richer than the Furnas soils, but shallower and less fertile than the soils originated from the Ponta Grossa Formation. The combined variability in geology, rock types, climate, land forms, relief,

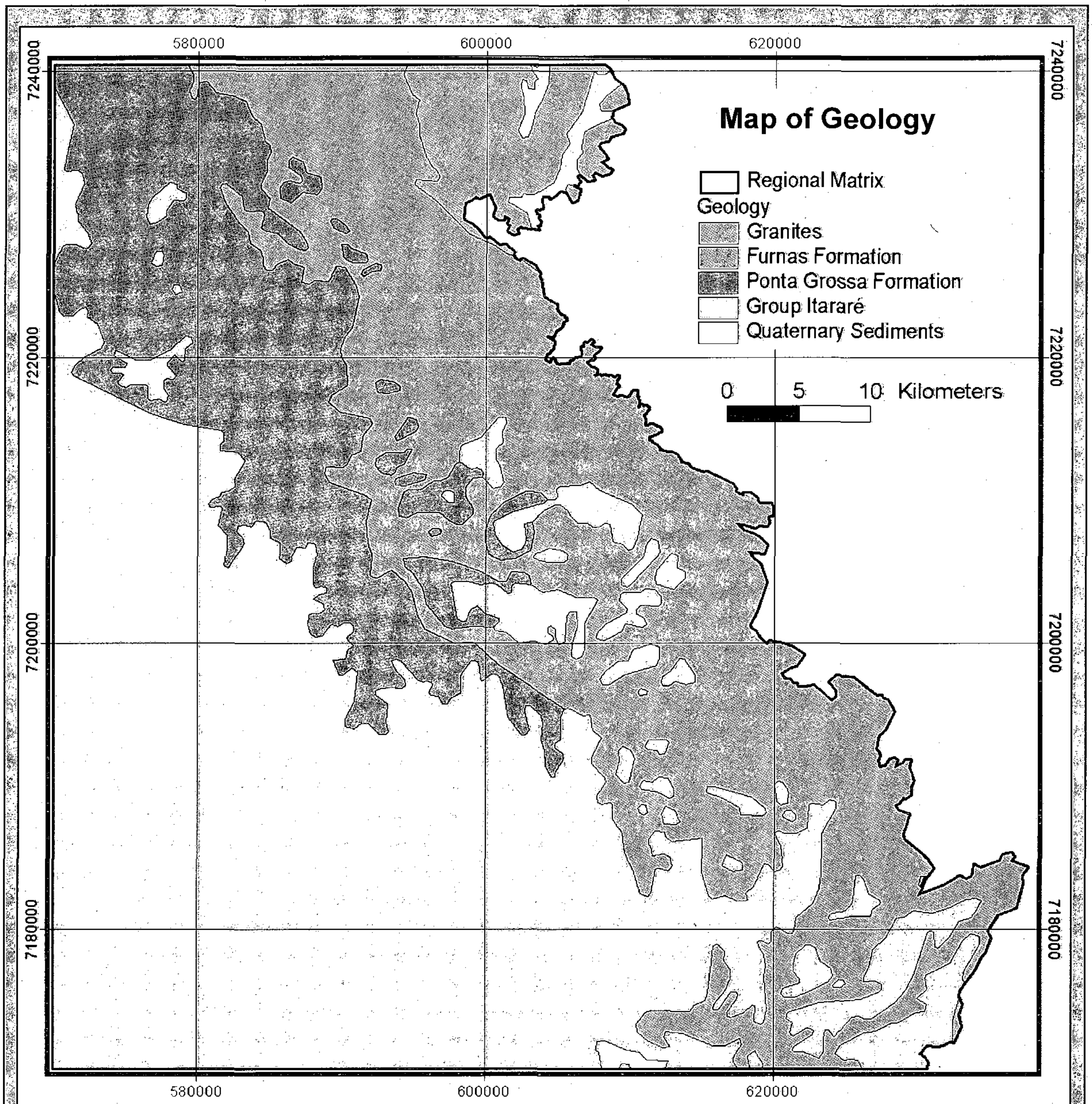

Figure 3.3: Map of Geology (Adapted from Paraná 2004)

soil types and the associated processes of landscape change, have all affected the natural distribution of vegetation types before land colonization (Klein & Hatschbach 1971, Moro et al 1996).

Regional soils are typically rich in Carbon content, very often humic and dark-colored in upper horizons and red-yellow, sandy, acidic and of low fertility on the lower horizons. Chemical analyses of soil samples collected on grass ecosystems, yield pH values between 4.0 and 5.0, usually saturated with Aluminum, and phosphorous levels are typically lower then 6 ppm. Argillic lower horizons are sometimes found on soils derived from lenses of finer sediments on the Furnas Formation or, more commonly, from the other sedimentary and crystalline rocks. A typical regional soil catena involves a sequence of deeper Oxisols on the hilltops, Ultisols on gentle slopes, Inceptisols on steeper slopes, and Entisols or poorly drained Lithosols close to the creeks and rivers. Histisols and Alluvial soils are common on the floodplains. On the more dissected landforms, generally close to the escarpment, shallow Lithosols are common found in several positions on the landscape (EMBRAPA 1984, Rocha 1995).

The region is characterized by a mesothermic humid climate without a marked dry period (Maack 1968). The study area is located in a zone where average annual rainfall ranges between 1400 and 1500 mm. Mean annual temperature is 17.6° C, the average annual temperature of the warmest month (January) is about 22° C and of the coldest (July) 16° C. The lowest ever recorded temperature was -7° C. The atmospheric circulation of South Brazil is dominated by the South Atlantic anticyclone, a semi-permanent high pressure system which transports moist tropical air masses over the continent from an easterly and northeasterly direction during the whole year.

Disturbances to this pattern are related to perturbations of polar cold fronts, which upon meeting tropical air masses, produce strong rainfall in South Brazil followed by a drop in temperature. Higher than usual rain fall or draught regimes are related to the sequential El Niño and El Niña events (Maack 1968, Nimer 1990).

Main Biological Attributes

Essentially linked to a region of predominant wet subtropical climate, the Campos Gerais differs from the other grasslands and savannas of Brazil by the less intensive solar radiation and by the presence of relatively cold winters, with frequent frosts, particularly on the higher altitudes and on its southern portion. The region's vegetation is mainly composed by an herbaceous plant association and extensive grasslands are the typical and main decisive landscape feature. Occupying specific positions in the regional landscape, four main types of natural vegetation interspersed with the grassland predominant matrix and increases landscape diversity: a) Cerrado[10]; b) Riparian Woods; c) Mixed Wetlands; and d) Atlantic Rain Forest[11] (Mata Atlântica).

Explanations for the presence of grasslands ecosystems in the currently wet conditions have been long pursued, until the recognition of its occurrence as relict

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[10] *Cerrado* is the Portuguese word for central Brazil's plateau of woodlands, savannas, grasslands, and gallery and dry forests. The Biome Cerrado in Brazil has the richest flora among the world's savannas (>7000 species) and high levels of endemism. Species richness of birds, fishes, reptiles, amphibians, and insects is equally high, whereas mammal diversity is relatively low. It is the second largest of Brazil's major biomes and occupies 21% of the country's land area, and it is in the present, one of the world's last great farming frontiers (Klink & Machado 2005).

[11] The Atlantic rain forest (Biome Mata Atlântica) zone forms a 100 to 200-km wide strip from the Northeast to the South, along the Brazilian coast. With more them 8,000 endemic species, the Atlantic Rain Forest harbors one of the world's highest biodiversity concentrations. Mammals, birds, amphibious, and reptiles add to 1810 species, 389 are endemic of the Biome. It is the 3rd largest Biome of Brazil and occupies 16% of the country land area. The history of Brazil is closely linked to the Mata Atlântica and it's the most modified Biome; less than 100,000 km2 (about 7%) of the forest remains (MMA 2004, Tabarelli et al 2005).

formations from semiarid-pluvial climatic shifts, predominant in the past million of years. Linked to the dynamic process of climatic fluctuations along the Quaternary Period, the prevalence of cold and dry climates in the Pleistocene had propitiated the predominance of open ecosystems such as savannas, grasslands or semi-arid vegetation in the central-southern Brazil. During the last-glacial period the landscapes were covered by extensive areas of subtropical grasslands and small patches of gallery forests along the main rivers (Maack 1946, 1968, Kuhlmann 1952, Klein 1963, Klein & Hatschbach 1971, Leite & Klein 1990, Behling 1997, Safford 1999, Behling & Negrelle 2001).

Grassland formations, therefore, are considered the oldest vegetation type of Paraná and the different typologies of the Rain Forest that, by late 19th century covered about 85% of the state, had been advancing from the river valleys after the Last Glacial Maximum (ca. 27,500 to ca. 14,500 yr B.P.), into the former *campos* habitats, accordingly to the shifts in the climate (Bigarella 1964, Maack 1968, Klein & Hatschbach 1971, Leite & Klein 1990). Forest advance was increased in the last ca. 3.000 yr B.P. (Behling 1997, Behling & Negrelle 2001), after a shift to a warm and wet period. However, the barrier imposed by the Devonian Escarpment and local soil and climatic conditions, slowed down the process of forest advance into the region's grasslands. An increase in Amerindian fire management by ca. 3000 to 1500 yr B.P. (Behling 1997), and colonization from the early 18th century, where are also important factors on the dynamic of forest expansion into the grasslands.

On the north portion of Campos Gerais, where current climate are slightly drier and warmer than the southern part, isolated patches of the typical Cerrado vegetation were frequent, as the southernmost limit of the occurrence of this Biome (Maack 1950, 1968; Moro 2001, IBGE 2004). The grassland-cerrado mosaic interspersed, along the rivers valleys, with the surrounding phyto-ecological forest formations of the *Mata Atlântica* Biome (Atlantic Rain Forest). These gallery forest communities includes the Araucária forest (*Floresta Ombrófila Mista*), located on the subtropical and wetter higher altitudes, and the tropical semi-deciduous forests (*Floresta Estacional Semidecidual*) located on the warmer and lower altitudes in the northwestern limits.

On the southern portion, where the study area is located, grasslands are the typical vegetation and the most common species are from the genera *Andropogon*, *Aristida*, *Axonopus*, *Baccharis*, *Eragrostis, Erianthus, Hypoginium, Panicum, and Paspalum.* Vegetation composition, however, is highly diverse and closely controlled by local topography, drainage network, soil types, and position on the landscape. Vegetation on the hilltops and convex slopes are characterized by many species adapted to well drained soils, mainly belonging to the following families: *Apocynaceae, Compositae, Euphorbiaceae, Labiatae, Fabaceae, Malvaceae, Malpighiaceae, Melastomataceae, Mimosaceae, Myrtaceae, Palmae, Poaceae, Pteridaceae, Rubiaceae, Solanaceae, Umbelliferae,* and *Verbenaceae* (Klein & Hatschbach 1971, Leite & Klein 1990, Cervi & Hatschbach 1990, Rocha 1995, Moro et al 1996).

Close to the small order streams, on the secondary drainage channels, moist depressions, or wherever the water table is close to the surface, there is the occurrence of wet grasslands that includes species from many families, more commonly: *Cyperaceae, Droseraceae, Eriocaulacea, Poaceae, Polygalaceae* and *Xyridaceae*. In the rocky outcrops, frequent in the canyons, dissected valleys, and close to the Devonian Escarpment, a typical adapted vegetation type are found and are mainly composed by lichens, bryophytes, pteridophytes, and other species from the families *Amarilidacea, Bromeliaceae, Cactaceae, Compositae, Cyperaceae, Euphorbiaceae, Gesneriaceae, Iridacea, Melastomataceae, Myrtaceae, Orchidaceae, Poaceae, Umbelliferae*, among others (Klein & Hatschbach 1971, Moro et al 1996, Moro 2001).

Along the main rivers the predominant grassland matrix is interspersed by gallery forests and mixed sub-tropical woodlands, both dominated by the Paraná Pine. The woodlands (Capão de Mato[12]) are typically islands of Araucária forest, naturally isolated within the grassland vegetation on altitudes above 900 m asl, often originated from gallery forests, with a clear tendency of expansion upslope when soil conditions favors forest advancement. Specie basically endemic from the highlands of southern Brazil and originally extended over an area of 200.000 km^2, Araucaria forest mainly occurred as continuous and extensive forests at altitudes ranging from 500 to 1100 m asl. Currently, there are few expressive remnants of Araucaria forests, and it is one of the most degraded forest formations of Brazil, very poorly represented in the Brazilian Protected Areas System (Silva & Dounuti 1999, MMA 2004).

The associated vegetative tree cover of the Araucaria woods and gallery forests is dense and very diverse, and include, trees from the genera *Cedrella, Drimys, Ilex, Lithraea, Luhea, Myrcia, Myrsine, Mimosa, Nectandra, Ocotea, Podocarpus, Sebastiania, Schinus, and Tabebuia.* Many others species of trees, shrubs, epiphytes, herbs, grasses, and lianas are found on the Araucaria forest; the most common species belongs to the families *Asteraceae, Aquifoliaeae, Bromeliaceae, Compositae, Convolvulaceae, Dicksoniaceae, Lauraceae, Fabaceae, Flacourtiaceae,*

[12] Capão de Mato is a regional word employed to designate such woodlands and it is derived from the *tupi-guarani* language, meaning rounded wood.

Melastomataceae, Mimosaceae, Monimiaceae, Moraceae, Myrtaceae, Palmae, Poaceae, Rubiaceae, Sapindaceae, Solanaceae, Orchidaceae, Pteridaceae, and *Verbenaceae* (Moro et al 1996, Moro 2001, Paraná 2004).

Along the floodplains and riparian areas of the upper Tibagi River, and on the lower section of some left tributaries (Caniú, Santa Rita, Guaraúna and Imbituva rivers), alluvial plant communities, subject to periodic flooding, are the main vegetation type. Associated to Quaternary sediments, these rivers form meanders and many oxbow lakes and vegetation community is very diverse and composed by wetlands, wet grasslands, grasslands, riparian forests and Araucária woods, accordingly to the flooding regimes, topography and soil types. Species found on these mixed wetlands includes many of the genera and families cited above; typical plants such as the moss *Sphagnum* and the *Pteridaceae Licopodium sp.* found in the peat bogs, herbs as the *Senecio sp.* and *Ludwiga sp*, and the trees *Erythrinna sp.* and *Salix sp.* on the gallery forests are also found (Moro 2001).

Regional Matrix's Vegetation Community Types

The distribution of the natural vegetation in the Regional Matrix, as it was likely to be distributed by the time of colonization (early 18th century), was mapped based on the Phytogeographic Map of Paraná (Maack 1950), and on the interpretation of the aerial photography and images of the study area. The Table 3.2 shows the area distribution by vegetation type and the Figure 3.4 (Map of Vegetation)[13] shows the spatial-geographic

[13] The Map of Vegetation includes a boundary of 3 km beyond the limits of the Regional Matrix. This buffer was employed to evaluate the Context of remnant patches, located along the limits of the Matrix (see Chapter 4 - Designing a Network of Protected Areas).

distribution on the Regional Matrix. For mapping purposes native vegetation was grouped into three main formations: a) Grasslands, which covered 75.2% of the total area; b) Ecotone Forest - Grasslands covering 20.1%; and c) Wetlands covering 4.7%. The amount of forest cover on the areas classified as Ecotone was basically maintained until the turn of 19th to the 20th century, when European colonization and the just arrived railway propitiated the intensive logging on the Araucaria forests. The conversion of grasslands to croplands was started only on the 1960's and the drainage of wetlands becomes a common practice in the early 1980's

Table 3.2: Distribution of Vegetation Community Types in the Regional Matrix before colonization

Vegetation Type	Number of Mapped Units	Área (ha)	Área (%)
Mixed Wetlands	3	15,965	4.7
Ecotone Forest/Grassland	4	68,995	20.1
Grasslands	3	257,248	75.2
Regional Matrix	10	342,208	100

The three vegetation units mapped as Grasslands, besides the predominant herbaceous cover, comprise a diverse phyto-physiognomy, where different formation types occupy specific positions on the landscape mosaic. Community vegetation types consist of mixed riparian areas that can vary from wet grasslands to Araucaria forests, Araucaria woods, distinct plant compositions of the rocky outcrops, and of the deep valleys; as they are largely present as small patches of natural vegetation types they were mapped as inclusions within the grassland patch.

The four mapping units classified as Ecotone correspond to a transitional landscape among the grasslands of the east side of the second Plateau, and the continuous

Araucaria Forests of the west side. An Ecotone unit was also mapped on the northeastern limits of the Matrix, a transitional grassland-forest zone among the first and the second plateaus, along the antecedent valley of the Pitangui River. On these areas, more fertile soils, derived from finer sedimentary and crystalline rocks, propitiated the expansion of forest formations. The three units mapped as Mixed Wetlands correspond to the floodplains and riparian vegetation as discussed above.

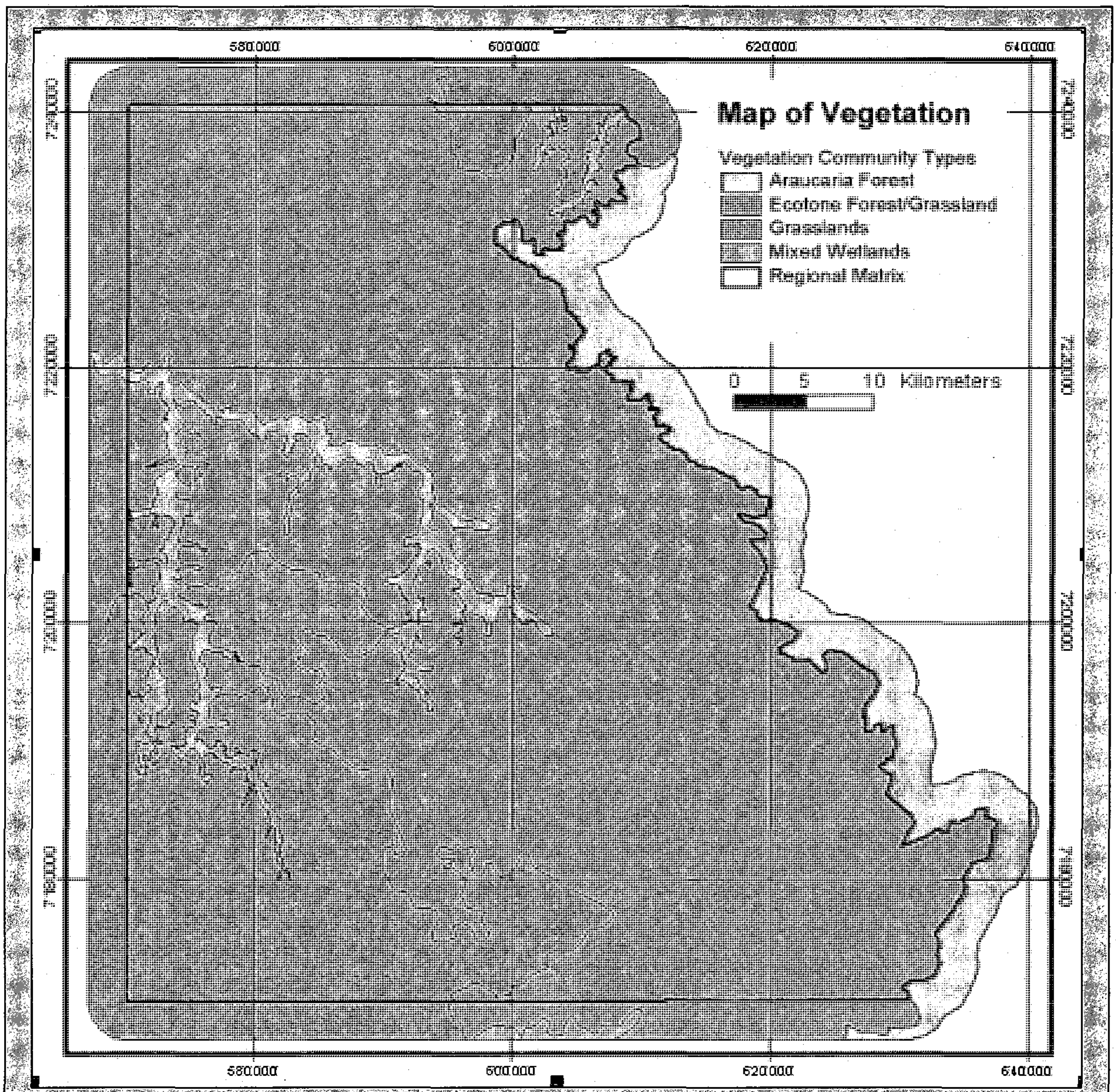

Figure 3.4: Map of Vegetation

Landscape Fragmentation: a Brief Historical Review

The First Habitants and Explorers

Before European settlement, the Campos Gerais were occupied by diverse Amerindians people. Palynological analysis of lake sediments from the early and mid-Holocene (9660 - 2850 ^{14}C yr Before Present) showed an increase on the presence of charcoal particles, suggesting an increase on fire frequency (Behling 1997), and fire's use for grassland management and hunting. Evidence of Amerindians' presence are also found in many archeological sites with rock inscriptions sheltered under cave-like sandstones bulges, scattered along the Devonian Escarpment. These nomad societies had on hunting, fishing, and gathering, the basis of their living support (Pontes Filho 1989, Melo et al 2002).

Europeans explorations of the region started early in the 16th century, when the first expeditions in the route to the western Spanish provinces (corresponding to present Paraguay and Argentina) had started to cross the territory (Maack 1968). The first settlements in the present state of Paraná were established on early 17th century by Spanish Jesuits which group several thousand Indians on reductions located in the west, on the margins of the Paraná River and some of its main tributaries. These reductions would soon be destructed by the "*bandeirantes*", the descendents of the Portuguese settlers in São Paulo, searching for slaves to the new sugar cane plantations, then the most important product of early colonial Brazil. These "hunting" expeditions were tolerated by Portugal and Spain which found very inconvenient the perspective of a Jesuit independent nation, on the context of their economic and territory ambitions.

Throughout the first two centuries of the colonial period, the most part of the actual Paraná territory had been emptied as the reductions' Indians had been captured, killed, or had to flee to the large reductions located in the southernmost part of Brazil. The discovery of gold, first in the littoral and after in the interior of Paraná, had attracted the first permanent settlers; the miners and an associated farming and livestock activity for supplying the mines. This economic cycle was very short and, as gold had run out, by the end of the 17th century, most of the settlers had migrated to the newly discovered gold regions in the states of Mato Grosso and Minas Gerais (respectively in the central-west and south-eastern Brazil). The remaining scant population had their living based on subsistence farming and livestock keeping (Padis 1981, Wachowicz 1977).

The "Tropeirismo" of the 18th and 19th Centuries

The new mines of central Brazil proved to be very rich and gold became the most important economic cycle of colonial Brazil along the 18th century. The mining activities imposed the formation of many nucleuses to support the mines on their demands for goods and animals for transport (Ritter 1980). The economic activities linked to the transport, commerce and animal keeping, between the southern province of Rio Grande do Sul - where wild mules and horses were abundant on the regions' vast native grasslands, and São Paulo - the main market to serve the mining regions of central Brazil, were the reason for the first permanent settlement in the Campos Gerais. Land titles were granted by the king of Portugal to rich landowners who had requested land to establish ranches along the main route opened to link these regions.

By the mid 18th century the "Troops' Route" had become the main way to link the south to the northern part of the country. The places where it was possible to cross the main rivers were determinant for the location of the main paths. The very large properties system that established on the region were basically dedicated to three main economic activities: a) cattle and mule keeping; b) rangeland renting for the troupes coming from the south; and, c) the activities linked to the *tropeirismo*, of buying animals in the south, fattening in the regions' rangelands, and selling on the Sorocaba market (province of São Paulo) at very good prices. From "Indian's seekers", the descendents of the *bandeirantes* became then "horse's seekers" (Pinheiro Machado 1968, Ritter 1980).

Along the corridor formed by the Troops' Route, the disturbance patches produced on the matrix of campos by the settling of the ranches, symbolize the beginning of more intensive ways of human interference on the regional landscapes. The spatial distribution and intensity of such interferences, along the 18th century, however were still very incipient and, therefore, not significant for the extensive regional grasslands. The *tropeirismo* remained as the most important economic activity of Campos Gerais throughout the 18th and 19th centuries (Ritter 1980, Pinheiro Machado 1968).

The mild climate throughout most of the year and the extensive hydrographic network could afford animal's forage and water with abundance and quality. Due the low fertility of the campos soils, farming were restricted to subsistence and developed on the forestland, managed based on shifting farming system of clear-cutting, burning, cultivating by 3 to 4 years, and, thereafter, resting the land for long periods of up to 20 or more years. The Araucaria woodlands associated to the campos vegetation were also important landscape elements as cattle shelters and as source of complimentary forage along the winter season.

Distinct cultural values had developed in the region meaning new ways of landscape perception and valuation. The extensive grasslands represented, then, a way to capital accumulation and, consequently, economic and political power. The activities linked to the *Tropeirismo* have deeply shaped regional history and were decisive to the occupation of the territory, leading the urban settlements as well as by influencing the way of life and the region's cultural traditions (PARANÁ 1989). By the moment of the emancipation of the province of Paraná from São Paulo (1853), the largest fortunes were on the hands of the Campos Gerais landowners, which constituted the dominant political oligarchies of the province.

The continuous division of the land among the new generations had conditioned a more intensive use of the rangelands, including excessive burning and overgrazing, leading to soil exhaustion, low forage's quality and productivity and the lowering of the profitability of the ranching enterprise. By the last decades of the 19th century a continuous deterioration of the *tropeirismo* business was evident. After the introduction of the first railways to serve the coffee plantations in São Paulo (then the most important export product of the country), and its expansion towards the south reaching Ponta Grossa in 1894) the ranching economy, and its associated power, had already collapsed (Pinheiro Machado 1968).

The lower profitability of the livestock operations produced a rupture on the links of the larger rural family with the land. Landowners started to abandon their large ranches and migrated to the urban areas, dedicating themselves to the new economic and public activities that were flourishing in the state. The commerce was strengthened and had started the period of political and economic power centered on the urban areas. Regional political and economic power, however, would strongly be linked to the latifundia systems until the recent history as the majority of the large farms were kept within the same families by some of their descendents (Pinheiro Machado 1968, Balhana et al 1969).

The new economic conjecture of the early 20th century in southern Brazil was demanding the mobilization of capital not available on the hands of the ranch landowners. Such capital would be available on the hands of other social segments: the "*ervateiros*", the owners of the erva-mate mills - the main exported product of Paraná; the "*madeireiros*", the sawmills owners - as the Araucaria trees were becoming an important economic segment; and, later, with enriched European immigrants (Pinheiro Machado 1968, Balhana et al 1969).

European immigration to Brazil was stimulated after the independency (1822) aiming the colonization of the vast unoccupied territory trying to reproduce the typical rural 19th century communities of Europe in south Brazil, based on small family properties for producing staple food (Pinheiro Machado 1968). In 1877 the first immigrants (from the Volga region) arrived in Paraná, and several colonies were developed in the campos the Regional Matrix.

The failure of the first colonies to establish farming communities on the Campos Gerais had spread a generalized opinion that land on the campos region would not support any other activity, except the traditional ranching system. By the turning of the 20th century, new flows of immigration were promoted, but redirected to the Araucaria forestlands of central-southern Paraná. Many European colonies were established, and are the origins of the majority of the rural communities throughout the region, and parcels of these immigrants gradually interweaved within the regional economic structure.

The transition of the 19th to the 20th century marks also the begging of the massive deforestation of the Araucaria forests in Paraná. The extension of the railroad systems made possible the transportation of heavy goods to the seaports, and, hence, sawmills proliferated throughout the Araucaria region. Landowners of the Campos Gerais started to sold, rent, or deal their "*pinheiros*" (Araucária trees) and, in addition to ranching activities, were added selective and clear cutting of the woodlands and forests (Pinheiro Machado 1968). Such activity was fundamental to the state economy until the mid century and it was still important for the southern region, until the last decades of the 20th century.

Landscape Fragmentation in the 20th Century

In the beginning of the 20th century, Ponta Grossa had an urban population larger then the rural, and was the most important commercial center to serve the new state's frontiers being opened towards the north and, later to the west. The first industrial enterprises had also just started to be implanted. The intensification of European immigration along this period, had increased the transformation of the regional landscape mosaic, based on intensive land use systems on small properties organized around colonies (Pinheiro Machado 1968). Ranching, however, practiced on large farmsteads, would still be the spatially predominant land use type in the matrix until the end of the 1960s.

The process of land use change, from extensive cattle growing on native grasslands to intensive crop farming systems is quite a relatively recent phenomenon. The analysis of the 1952 aerial photography shows almost all land in the Matrix being managed as native grazing lands, except for the urban areas. As consequence of the low pH and soil fertility, farming practices, until the end of the 1960s, were still predominantly developed on forestlands based on shifting farming system. Few patches of cultivated areas were evident in the 1962 aerial photography, regionally scattered and associated to land with higher farming capability.

Intensive farming systems based on the use of agro-chemicals, pH correction by application of lime, heavy machinery and inexpensive rural credit, associated to a global demanding for soybeans, had triggered a fast change in the land use systems since the early 1970s. Most growers, since then, rely on increased pesticide use. Intensification of production has, in most Latin America counties, been supported and encouraged by government, trade, and international aid organizations in a bid to raise production[14].

The more fragile and farming limited land in the eastern portion of the Matrix, along the Devonian Escarpment, were not transformed until the beginning of the 1990s, when the fully development of the non till farming system, provided the technical basis for the cultivation of such lands. Modifications on the landownership structure by family subdivision and the need of increasing the productivity levels had influenced the fate of the landscapes along the Devonian Escarpment in the 1990s. Increasingly soybeans price in the international market, which have made soybean farming more profitable in late

[14] Such support has been mediated largely through the provision of subsidies, many originating in the United States. The U.S. Agency for International Development has been a major supporter of the modernization of cash crop production in Latin America (Donald 2004).

1990s and early 2000s (Fearnside 2001, Donald 2004) has pushed the last wave of grasslands conversion into croplands. Lands with very low farming capacity were, by the turning of the century, the last remnant surfaces of grasslands.

Economic subsides were also important to the introduction of commercial forests of *Pinus spp*, in de 1960s. These species had an optimum adaptation to the ecological conditions of southern Brazil, and continuous large tracts of grassland were also converted into commercial forestlands. By the beginning of the 21st century, remnants of the large rangeland of the past were very restricted and just found as isolated fragments alongside the Escarpment. The most expressive fragments of the Campos Gerais ecosystems were found only in three main sectors (Melo 2002, Paraná 2004): in the north, in the south, and around the Vila Velha State Park (See Figure 1.1 in Chapter 1). The last was defined as the Regional Matrix for the present study.

The Intensive Farming System

The modernization of agriculture in Brazil has been promoted by public policies since the late 1960s, through the expansion of the agricultural area, a subsided credit system, and educational, research, and extension services oriented to promote "modern technologies". This process, aimed basically at the export market, relied on the basis of the green revolution: intensive use of hybrid seeds, chemical fertilizers, pesticides and mechanization, as well as consuming huge amounts of energy (Cordeiro 2000). Regionally, farmers have started to adopt this model since the late 1960s, and the larger farms, within the more productive lands, had more access to financial credit and economical subsidies, and were the main beneficiaries.

Within five years of intensive cultivation on the typical regions' landscape of rolling hills and sandy soils, yields began to sharply decline because of erosion caused by a strong rain fall regime coinciding with the time for soil preparing based on the conventional tillage[15] system. Even the adoption of the formerly available technologies for runoff control was not enough to overcome the increasing rates of soil losses and its environmental and economical consequences. As erosion challenge agricultural profitability, some innovative farmers (later helped by researchers from several institutions - public and private rural extension services and research, cooperatives, agrochemical companies and universities), took the initial lead in the development of a new system of land cultivation based on no-till (direct drilling) farming systems.

The no-till system consists of planting in non-revolved soil, protected by a mulch of residues from harvested crops, cover crops, and herbicide desiccated weeds. The three basic principles that characterize the system are minimum soil-overturn, maintenance of crop residues, and crop rotation. The utilization of crop rotation is imperative, considering characteristics of soil and climate to produce enough mulch cover. In Campos Gerais, this system is usually applied in summer cultivations; most farmers apply the "minimum tillage" in winter cultivations, which is done by spreading the seeds of a cover crop, generally black oat (*Avena strigosa*) over the land, followed by grading. This technique is especially problematic where soils are extremely sandy and therefore highly susceptible to erosion (Collet et al 2005, Schimandeiro 2006).

There are several evidences that no-tillage farming systems can improve soil structure and stability thereby facilitating better drainage and water holding capacity that

[15] The term conventional tillage defines a tillage system in which a deep primary cultivation, such as disk ploughing, is followed by a secondary cultivation (grading) to create a seedbed.

reduces the extremes of water logging and drought. These improvements to soil structure also reduce the risk of runoff and pollution of surface waters with sediment, pesticides and nutrients. Reducing the intensity of soil cultivation lowers energy consumption and the emission of carbon dioxide, while carbon sequestration is raised though the increase in soil organic matter. Under conservation tillage, a richer soil biota develops that can improve nutrient recycling and this may also help combat crop pests and diseases. The greater availability of crop residues and weed seeds improves food supplies for insects, birds and small mammals (Derspch et al 1991, Holand 2004).

The new system developed in the late seventies has changed the way intensive farming is practiced in the region and became the basis of the high developed agricultural system of the Campos Gerais. Later, it was largely adopted throughout the corn and soybean growing areas in the southern and central-western regions of Brazil. Primarily used as a way to protect soils from erosion and compaction, the no-till system also improved soil biophysical properties, fertility and the conditions to conserve moisture, as well have reduced production costs.

Economical profitability is also linked to the continuous expansion, since the 1970s, of soybean cultivation throughout the country. Research for the development of soybean-bacteria (*Rhizobium spp*) combinations that spare application of nitrogen fertilizer as well the development of soybean varieties tolerant to high soil aluminum, also played an important role in the profitability of soybean cultivation. The technological advance in crop and soil management and conservation were, therefore, critical to the economical improvement of intensive farming systems in the region. The economical profit and capitalization of such enterprises has been positive in the balance since them, particularly for the larger areas. A significant number of today's economic and political elite in the region, as well in Brazil, is formed by people and representatives from the larger farming and agribusiness sector.

Except for years of low soy prices in the international market or, more rarely, by harvest failure due bad weather conditions, the typical region's farming enterprise[16] are quite comfortable with their economical profit and technological experience to try new farming approaches, such as organic or low-input farming systems, without enough evidence of potential economical gains. Such economical advantage, however, can be vanished as result of the following scenarios: a) a lower international demand for soybean pushing prices down (as it already happened for the 2006 harvest with a 50% decrease in the soybean price); b) the likelihood of continuous expansion of soybeans cultivation into the Central-West region, potentially more profitable with the planned improvements in the transportation and grain storage infrastructure (Cordeiro 2000, Fearnside 2001, Donald 2004).

As consequence of the main regional physiographic features, a majority of the farms, croplands have to be cultivated on many isolated plots. Farming activities thus, takes more time, demands higher fuel consumption, and increases costs for machinery maintenance and depreciation. In opposition, in the cerrado region (Central-West) huge tracts of land can be continuously cropped, with substantial reduced production costs. This will made the regional soybean production less competitive, particularly for farmers cultivating smaller areas (< than 300 ha). Such issues can trigger farmers' interests towards more sustainable agricultural practices.

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[16] Here refers to rural properties farming areas from 300 to 800 hectares.

Today, the typical region's crop and livestock farms have high levels of productivity and are among the most dynamic of Brazil. The region is recognized as the birthplace of the advanced techniques of soil management and conservation based on the no-till and crop rotation farming systems. Such practices are long recognized as environmentally friend systems when compared with the traditional intensive land management systems (Derpsch 1991, Sá 1993, Fawcett et al 1993, Holland 2004). Such practices, however, had propitiated to farmers a higher capacity to cultivate land with lower farming capacity, and, consequently, expressive remnants of grasslands were converted to produce the actual state of landscape fragmentation.

Regional Biodiversity and Conservation Overview

Until recently the grassland formations of southern Brazil have attracted little attention by the many institutions linked to the formulation of conservation policies and actions. In this respect the grasslands lost space on the conservation scenario to the Brazilian's forest formations, particularly to the different formations of the Atlantic Rain Forest, notable by its high levels of endemism, diversity of species and environments. This circumstance can be consequence of the erroneous idea that campos formations in Brazil are homogeneous and of little diversity.

Klein and Hatschbach (1971) and Klein (1978) had called the attention to the richness of the grasslands located on the highlands of the southern states of Paraná and Santa Catarina, respectively. Previously, Maack (1948, 1968) described Campos Gerais' phytogeography and Araujo (1949) and Schreiner (1972) had discussed the potential of grasslands as pastures. Despite the increase on vegetation surveys in the last 10 years, inventories of the Campos Gerais flora diversity, however, are sparse and still very restricted to some regions (Moro et al 1996, Menezes 1999, Moro 2001).

In the Regional Matrix, Klein & Hatschbach (1971) surveyed the Quero-Quero region and reported the occurrence of 173 species for the grasslands and wet grasslands ecosystems. Hatschbach & Moreira-Filho (1972) surveyed the vegetation of the Vila Velha State Park and reported 636 species; Cervi & Hatschbach (1990) reported the occurrence of 27 rare or endemic species for the same park. In a survey of a small watershed (2.800 ha) located on the reverse of the Devonian Escarpment, Moro et al (1996) found 98 genera with 142 species belong to 50 botanic families. More recent botanical surveys carried out in the Matrix include the works of Takeda et al 1996, Oliveira Jr. 1997, Moro 2001, Oliveira 2001, Segecin 2001, and PARANÁ 2004.

These works constitute a fundamental contribution to the understanding of the diversity and importance of the regional ecosystems from a botanical point of view. As the regional landscape have been managed since the early 18th century and intensively fragmented more recently, so increased the threatens to these habitats and ecosystems. The "Red List of Threatened Plants in the State of Paraná" (PARANÁ 1995) includes 237 species typical of the grasslands, cerrado, and wetlands, corresponding respectively to 70%, 21%, and 9% of these threatened species list. Some overlapping of species occurs among these formations and is likely to be related to the austral limits of the Brazilian Cerrado, and the consequent contact among these formations (Moro et al 1996). Due its inaccessibility, many areas on the region have still not been surveyed, particularly on canyons, deep dissected valleys, and wetlands associated to alluvial floodplains.

Among the original wildlife present in the Campos Gerais, and actually subject to some level of threat[17], can be cited the: manned wolf, (*Chrysocyon brachyurus*); howling monkey (*Alouatta fusca*); giant ant-eater (*Myrmecophaga tridactyla*); felids as the ocelot (*Leopardus pardalis*), little spotted cat (*Leopardus tigrinus*), margay (*Leopardus* wiedi), cougar (*Puma concolor*), and the jaguar (*Panthera onça*); the tapir (*Tapirus terrestris*), white-lipped peccary (*Tayassu pecari*), an the pampas deer (*Ozotoceros bezoarticus*). Among these species, the giant ant-eater, the pampas deer, and probably the jaguar are extinct in the Matrix; the cougar and signs of individuals have been related by rural residents and researchers. The manned wolf is still present on the Matrix as signs of its presence are still relatively common, but it is under a high degree of threat throughout the region (PARANÁ 2004, Pontes Filho et al 1999, 1997).

The largest of all South American canines, the manned wolf is rare and once occupied the grasslands and cerrados of the Central Brazil and Southern Highlands. Destruction of its natural habitat, arising from agricultural development on its natural range distribution, is the most hazardous threat to this specie. The lack of habitat availability in the region, a problem for the manned wolf's need for a broad range to live, may lead to reproductive isolation, inbreeding and possibly extinction of populations. Although contacts with humans are not usual, they seem to be incorporating intensive managed areas into their range; in the study area, however, direct interaction with rural population are rare (Pontes Filho et al 1997). These authors also studied the symbolic meanings linked to the manned wolf hold by the rural residents.

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[17] Based on the criteria of the International Union for the Conservation of Nature and Natural Resource (IUCN 1994), CITES (Conservation International on Trade in Endangered Species), IBAMA's (Brazilian Institute for the Environment and Natural Renewable Resources) decree number 1522/89, and the State of Paraná (PARANÁ 1995).

From the original distribution estimated in 19.060 km^2, only 9.2% of the Campos Gerais ecoregion were remnant in 1990 (Rocha 1995). Field observations and analysis of more recent satellite images reveals through the area an increasing conversion of grasslands into croplands and intensive forestry, fragmenting the Matrix and isolating remnant patches; essential areas previously pointed out as essential habitats and potential corridors (Rocha 1995, Moro et al 1996) have been transformed. The Vila Velha and Guartelá State Parks (3.122 and 800 ha respectively) are the only implemented protected areas and are too small to guarantee the conservation of these unique ecosystems (Rocha & Weirich Neto 2005).

Due to the restricted original surface, and recent land use intensification on the regional landscape the Campos ecosystems and Araucaria Forests can be included among the most endangered formations of Brazil. Small areas, lack of adequate funding and personnel, and deficient management strategies are common problems of these and the majority of the Protected Areas in Brazil. Currently, there are few expressive remnants of these vegetation types, which are among the most degraded vegetation formations of Brazil and also poorly represented in the National Protected Areas System - SNUC (Silva & Dinouti 1999).

The region focused on this study comprehends areas mapped as High, Very High, and Extremely High Priority for "Conservation, Sustainable Use, and Benefit Sharing of the Brazilian Biodiversity" (MMA 2004 – Ministry of Environment of Brazil). This region has been also pointed as one of the 66 valuable areas for the conservation of the Pampas and Grasslands of Argentina, Uruguay and Southern Brazil (Bilenca & Minarro

2004), and one of the three priority areas for conservation on the Campos Gerais (Moreira & Rocha 2007).

To protect some of the most important remnant patches of Araucaria forests, grasslands, and wetlands of southern Brazil, the Ministry of Environment (MMA) has proposed in 2005 the creation of 3 Protected Areas (PAs): the Campos Gerais National Park – CGNP (22.000 ha), the Araucarias Biological Reserve – REBIO (14.900 ha), and the Rio Tibagi Wildlife Refuge – TWR (30.500 ha) to establish a network of PAs among them and to connect with previously existing Vila Velha State Park (3.200 ha), Irati National Forest (3.500 ha), and the Fernandes Pinheiro Ecological Extension (532 ha) - See Figure 3.5. These propositions within a major main farming region had sparked an

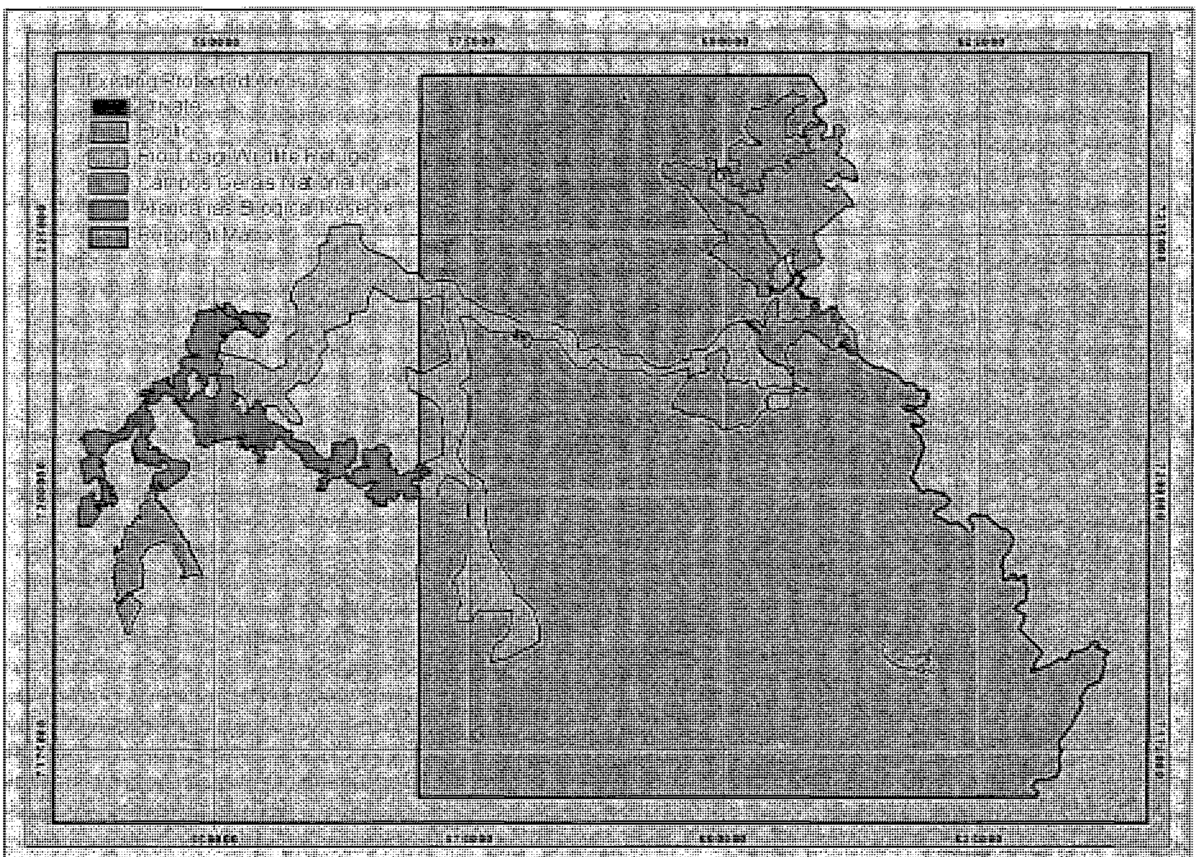

Figure 3.5: Federal Proposed and Existing Public and Private Protected Areas

intense conflict with landowners and the rural sector[18].

After a year of debates and judicial disputes, the CGNP and the REBIO were inaugurated on 22nd of March 2006; the Wildlife Refuge is still under analysis within the MMA. Despite their importance, theses three PAs are expected to stay as "paper parks" for a long period as human and financial resources for land acquisition and PA management have been chronically short in Brazil. Therefore, the top priority for conservation is to address strategies to slow, halt, and even reverse the process of habitat loss in areas that are recognized as the most important sites for conservation in both, within and outside the designated PAs. We are also looking for to promote eco-friendly land use strategies to make the matrix more conservation compatible.

3.3.2 Remnant Patches of Natural Vegetation

Within the Regional Matrix, two-hundred and forty five (245) remnant patches of natural vegetation have been mapped (Figure 3.6 – Map of Remnant Patches of Natural Vegetation), totaling 105,049 ha, which corresponds to 30.7% of the total surface of the Regional Matrix (342,211 ha). Table 3.3 summarizes the characteristics of remnant patches of natural vegetation and the Figure 3.7 shows the Histogram of Remnant Patch Area. The maximum and minimum patch areas were respectively 13,561 and 40 ha, the mean patch size is 428.8 ha and the median is 119.1 ha. Among them, 51 units have been mapped as Native Grasslands, 116 as Araucaria Forests and Riparian Woods, 72 as Mixed Riparian Systems and 6 as Mixed Alluvial Floodplains. These remnant patches are regarded as the basic spatial elements of the landscape to be considered for conservation

[18] See also discussion on Section 6.3 - Landowners' Views of Conservation Alternatives

purposes on the Matrix. The Regional Mosaic, on which remnant patches are embedded, comprehends a range of human systems including cultivated forests, intensive and family farming systems, and groups of urban/sub-urban/industrial land cover, totalizing 237,145 ha, encompassing the majority (69.3%) of the Matrix area.

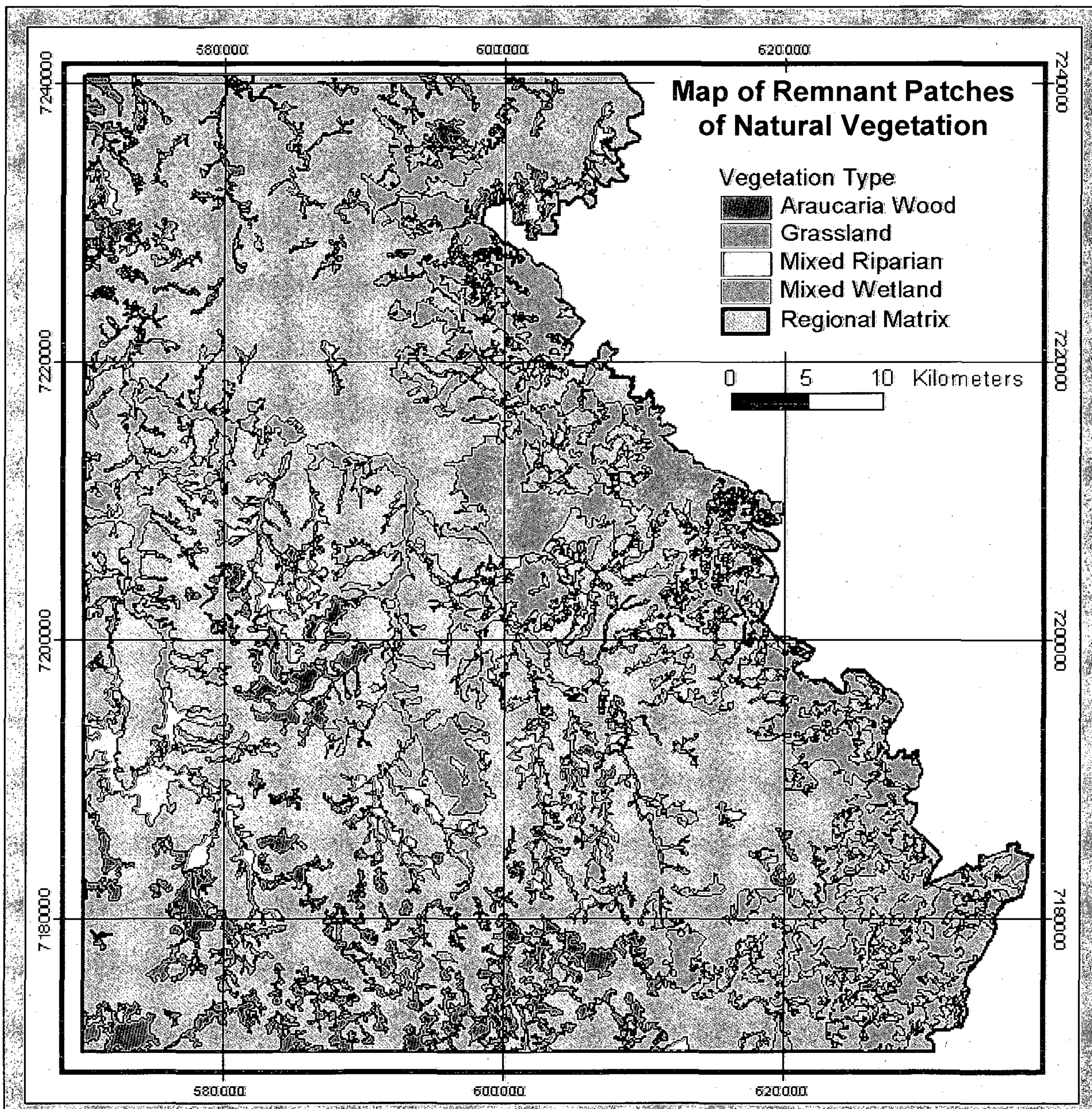

Figure 3.6: Map of Remnant Patches of Natural Vegetation

Table 3.3: Characteristics of Remnant Patches of Natural Vegetation[1]

Remnant Patches	Number of Mapping Units	Remnant Area (ha)	Remnant Area (%)	Remnant Area % of Total	Core Area (ha)	Mean Patch Area (ha)	Range Area (ha)	Number of Patches > 429 ha[2]	Number of Patches > 1.000 ha
Native Grasslands	51	51,332	48.9	15.0	30,839	1,006.5	43-13,561	19	13
Araucaria Forests & Riparian Woods	116	21,033	20.0	6.1	7,957	181.3	40-2,362	6	2
Mixed Riparian Systems	72	21,054	20.0	6.2	7,332	292.4	41-3,883	13	3
Mixed Alluvial Floodplains	6	11,647	11.1	3.4	5,362	1,941.2	94-5,113	4	3
Total	245	105,049	100	30.7	51,490	428.8	-	42	21

[1] Data based on a 2000 LANDSAT ETM+ 7 Image
[2] Mean patch size

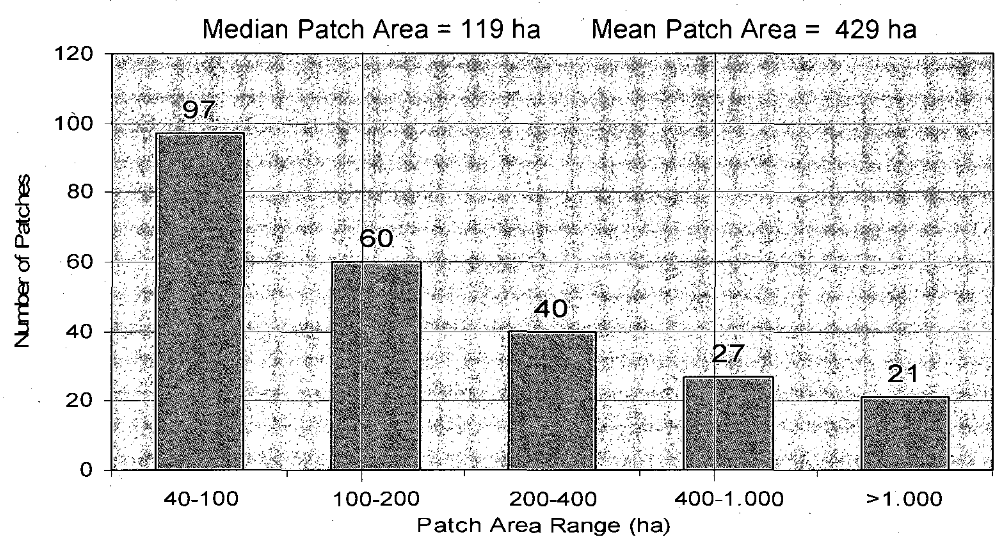

Figure 3.7: Histogram of Remnant Patch Area

Among the 245 remnant patches, only 42 (17%) have an area larger than the mean patch size (429 ha), totaling 76,620 hectares (73% of total remaining area) and, among them, only 21 (9%) present an area larger than 1,000 hectares, totaling 63,031 hectares (60% of total remaining area). Core areas[19] comprehends 51,490 ha

[19] Core Areas in this study correspond to the remaining surface of a Patch considering an inward edge of 100 meters from the limits (See discussion on section 4.4.1 Selecting Conservation Priority Patches).

(49% of remaining) and edge areas totals 53,576 ha (51% of remaining). The edge effect is clearly more prominent for the Araucaria Forest and Riparian Woods patches (62% of total remaining area) and to the Mixed Riparian Systems (65% of remaining area) as they are generally located along the drainage network and are likely to be narrow straight remnants, surrounded by a predominant mosaic of farming land.

These area metrics and the great number of remnant mapped patches (245) confirm the marked alteration of the natural landscapes in the Matrix and characterize a highly fragmented landscape, a typical situation in southern Brazil. The regional matrix is mainly formed by small (median = 119.1 ha) and isolated patches, located within inhospitable landscapes, particularly for poorly dispersal species. The 122 patches smaller than the median sum 9.360 ha and, among them, only 1.982 ha are core areas. These numbers made critical the fact that the matrix is located within areas mapped as an "Extremely High" and "Very High" Priority for the conservation of Brazilian's biodiversity (MMA/SBF 2002, 2004). It is emphasized, thus, the importance of setting conservation goals, selecting priority areas, and achieving practical conservation outcomes throughout the regional landscape.

3.3.3 Land Use Systems and Remnant Patches

Based on the interpretation of aerial imagery and ancillary data, eight main types of land use systems were distinguished and mapped through forty-three mapping units on the Regional Matrix[20]. The following classes of Land Use Systems (LUS) were mapped:

[20] This discussion on Land Use Systems was also developed later in the research based on the analysis of the interviews with farmers and from participant observation techniques with focal groups as presented earlier.

a) Intensive Farming; b) Intensive Farming with significant presence of Remnant Patches; c) Family Farming; d) Family Farming with significant presence of Remnant Patches; e) Ranching; f) Intensive Forestry; g) Protected Areas and, h) Urban/Suburban/Industrial. The Figure 3.8 - Map of Land Use Systems, displays the spatial distribution of the LUS on the Matrix[21] and the Table 3.4 presents relevant area metrics by classes and subclasses of land use, as well as a synthesis of important agronomic characteristics that differentiate them.

Land Use Systems can be illustrated by the concept of "styles of farming", as employed by Koelle et al (2003): "a complex but integrated set of notions, norms, knowledge elements, experiences etc, held by a group of farmers in a specific region that describes the way farming practice should be carried out. Heterogeneity in farming is thus a reflection of a particular organization of the process of production and represents the specific connections between economic, social, political, ecological and technological dimensions".

On the regional matrix, LUS are expressed on distinct patterns on aerial imagery as they are related to the patterns on the land (e.g. patch size, land cover, farming systems, size of the farmsteads) that represent different forms of land use, tenure, and management. The pictures on Figure 3.9, exemplifies through ground photography, land use systems as they correlated to patterns observed and interpreted on aerial imagery. LUS are also related to the typical patterns of the network of remnant patches present in each class (e.g. patch size, type of remnant vegetation, connections among remnants).

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[21] The map of Land Use Systems (Figure 3.8) includes a buffer of 3 km beyond the limits of the Regional Matrix which was considered in the evaluation of the Context of remnant patches located close to the area limits.

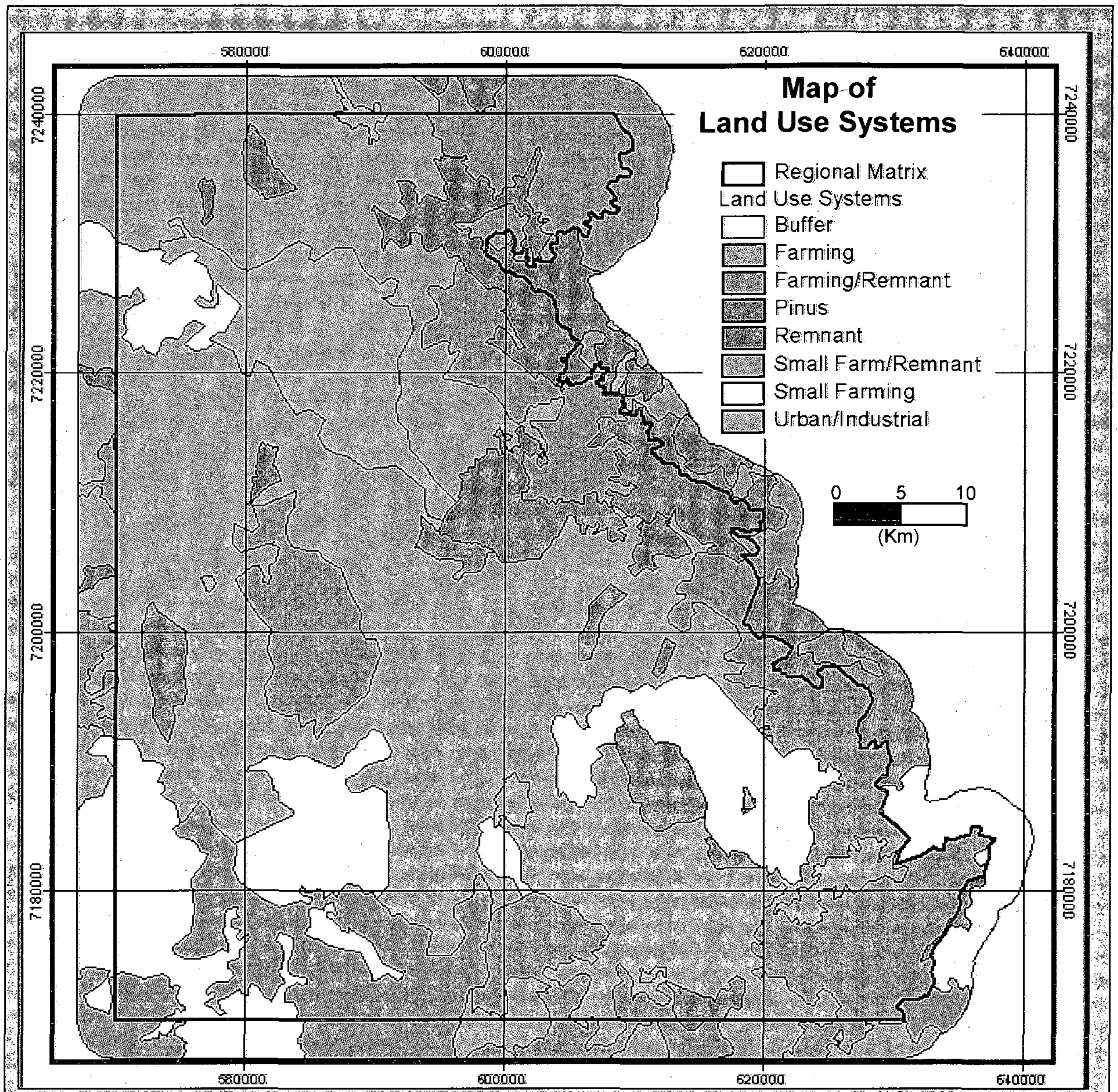


Figure 3.8: Map of Land Use Systems

The principle of "convergence of evidence" [22] was the basis for interpreting the mosaics of successive patterns of land use and remnant patches on aerial images, as they correspond to the patterns on the ground and as they relate to the landscape systems

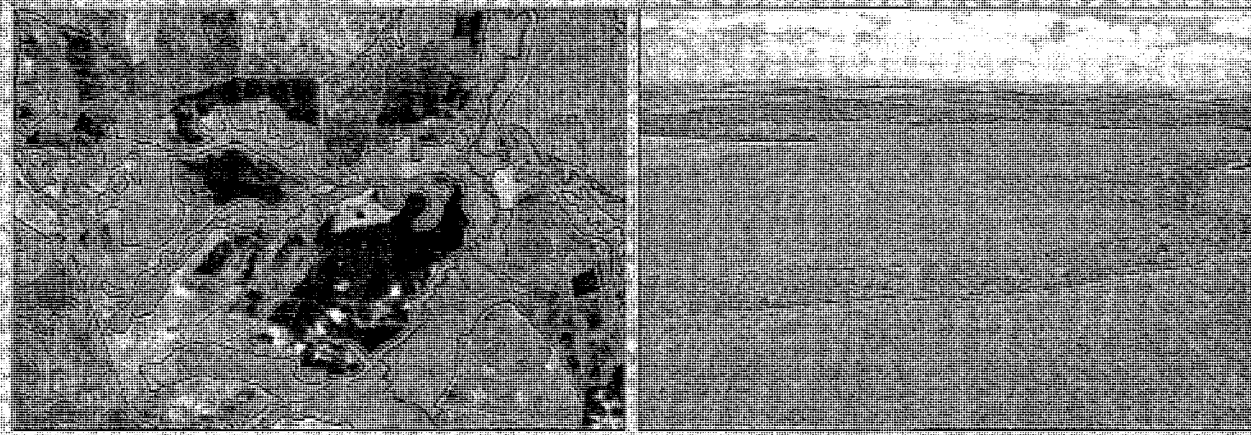
[22] See discussion in the Section 2.2.4: Human perception and the "art" of patch delineation.

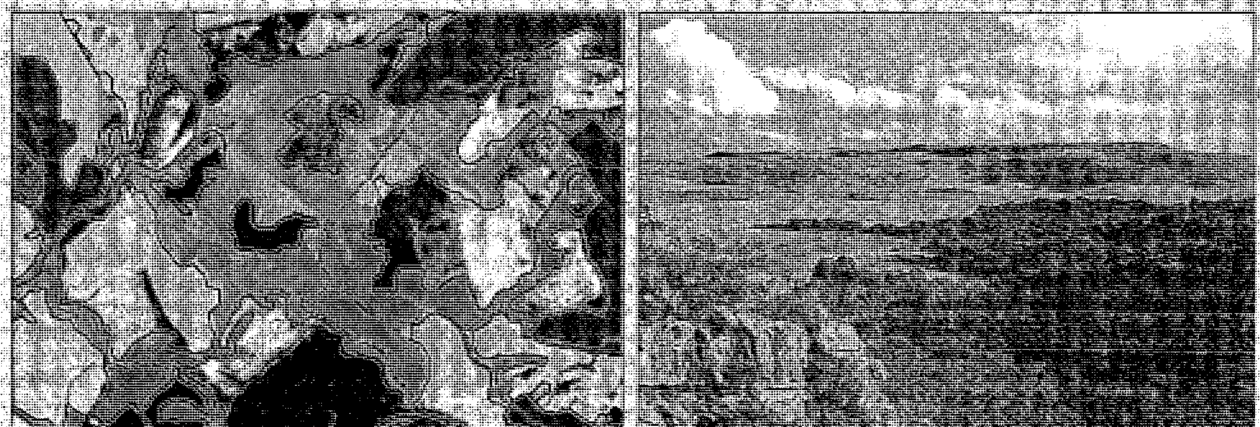
components (i.e. geology, landforms, hidrography, soils, vegetation, land use history, land tenure, systems of production, urban areas, and the transport network).

LUS also reflects the socio-economic patterns on the Matrix, represented by the typical range of land tenure by class of land use and the by the general profitability of these systems (see Table 3.4). Land owners on each class of LUS are members of different social categories, with diverse historical backgrounds, which face different economic challenges in the present. LUS, thereby, is considered an indicator of social differentiation in the matrix. Landowners within different systems of land use had distinct attitudes when discussing nature conservation and farming profitability issues, which reflect distinct fundamental values among them (see further discussions on Chapters 6, 7 and 8).

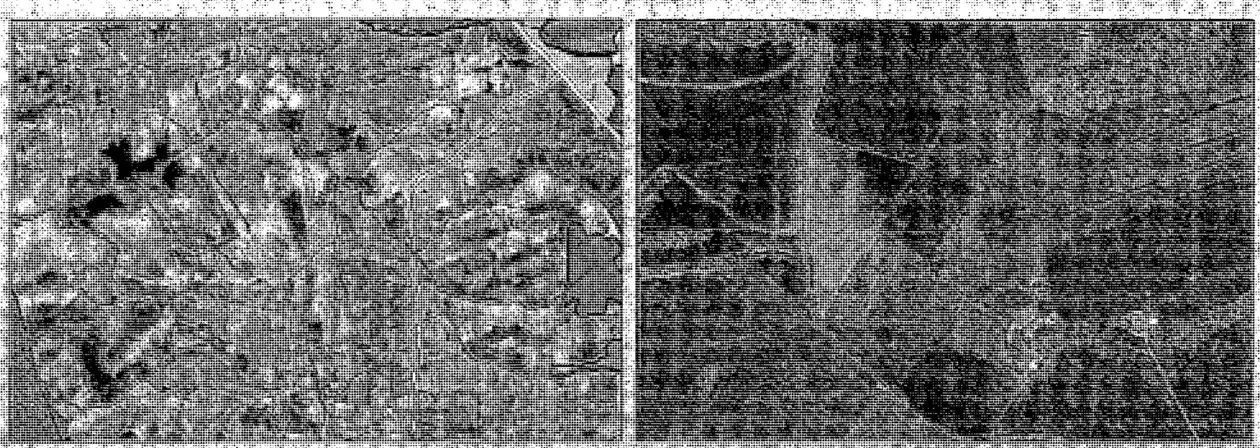
Each mapped spatial unity represents also a portion of the land that is considered homogeneous concerning the type and the intensity of the human activities (as summarized on Table 3.4), when compared to the adjacent units. The management intensity on each class exerts influences on the potential of remnant patches to provide suitable habitats for wildlife populations. The type of land use also influences the viability of wild populations as the landscape can facilitate or constrain functional connections throughout the Matrix. Every mapped unit of land use systems, therefore, posits different potentials and constrains for conservation and is considered as the Context on which every remnant patch is embedded and on which conservation must be focused.

LUS, therefore, are regarded as the main landscape types within a large regional context and are the product of the interaction among ecological and socio-cultural systems that generate landscapes and regions. The potential drawbacks from the present



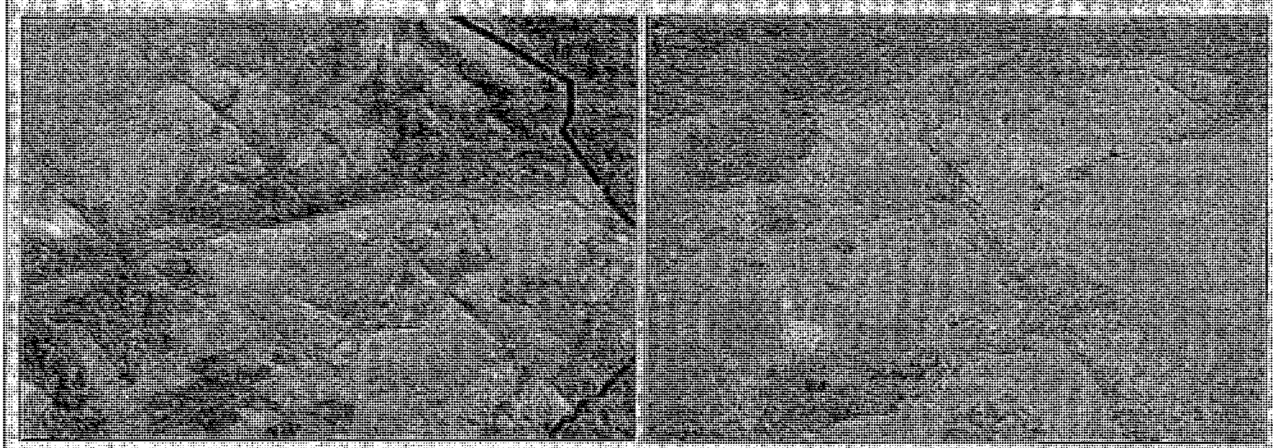


3.9 b) Intensive Farming with significant presence of Remnant Patches

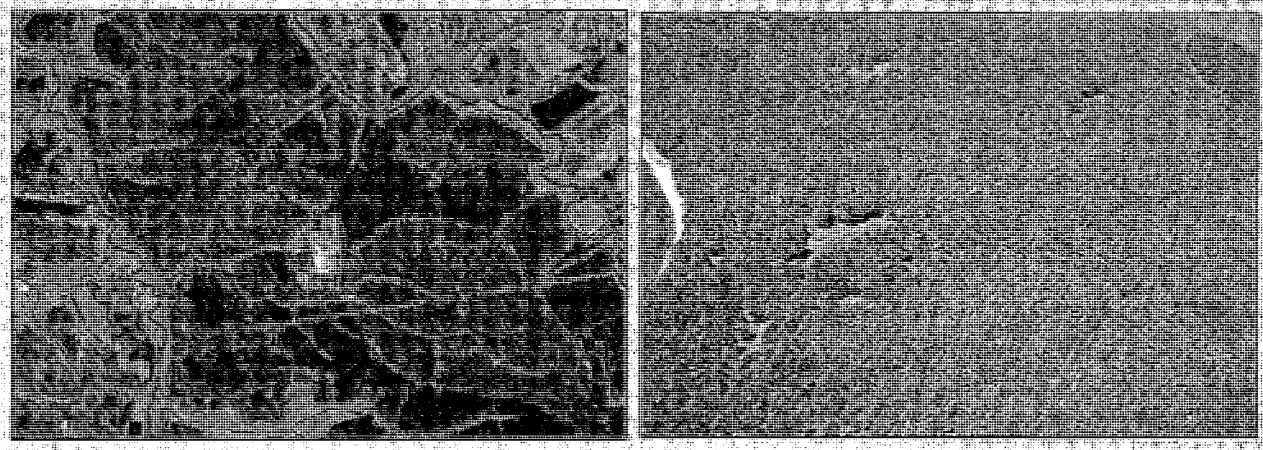


3.9 c) Family Farming Systems

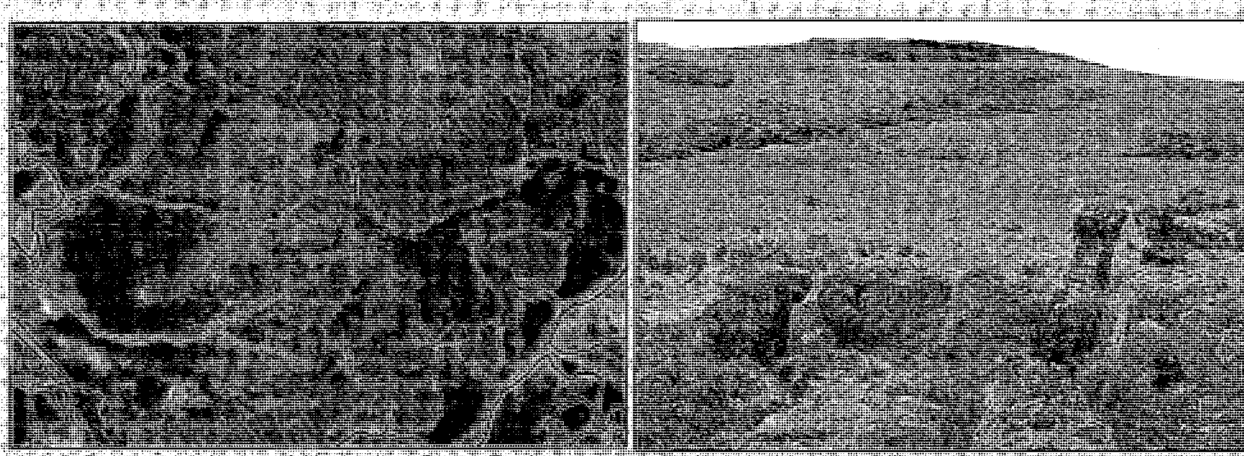
Figure 3.9. Typical patterns of Land Use Systems overlaid by remnant patches (white semi-transparent polygons) on LANDSAT ETM^{+} 7 Image (September 2000) and field patterns correspondence on aircraft and ground photography.



3.9 d) Ranching Systems



3.9 e) Intensive Forestry Systems



3.9 f) Protected Areas (Vila Velha State Park)

Figure 3.9. Typical patterns of Land Use Systems of Ranching on IRS Image (2005), Intensive Forestry overlaid by remnant patches (white semi-transparent polygons), and Protected Areas, both on LANDSAT ETM+ 7 image (September 2000), and field patterns correspondence on aircraft and ground photography.

Table 3.4: Area Metrics and Main Agronomic Characteristic of Land Use Systems in the Regional Matrix
(The colors of lines match the Legend on the Map of Land Use Systems - Figure 3.8)

Class of Land Use System	Area Metrics			Sub Class of Land Use System	Indicators of Land Management Intensity				Socio-Economic Indicator	
	Number of Units	Area Total (ha)	Area (%)		Land Use Capacity	Typical Land Use, Crop & Livestock Production	Level Use of Pesticides	Level Use of Fertilizers	Typical Farmland Size (ha)	Profitability of the System
Intensive Farming	4	157,238	45.9	High Technology & Capital	Moderate to High	Soybeans/Corn/Wheat/ Beef Livestock	High	High	> 600	Very High
				High Technology	Moderate to High	Soybeans/Corn/Wheat/ Dairy/Beef Livestock	High	High	300 – 800	Moderate to High
				Low Technology	Moderate	Soybeans/Corn/ Wheat/ Dairy/Hogs Livestock	High	High	100 – 500	Moderate
Intensive Farming and Remnants	7	65,926	19.3	Same as Above, but with significant patches of remnant vegetation (Grasslands, Araucaria Woods, or Forest)						
Family Farming	6	45,379	13.3	Family Intensive	Low to Moderate	Onion/Beans/Potato/ Soybeans/Corn/Dairy/Hogs	High	Moderate to High	25 - 100	Low to Moderate
				Subsistence & Cash Crop	Low to Moderate	Tobacco/Beans/Corn/ Dairy/Hogs/Poultry	Moderate to High	Moderate	< 25	Low to Moderate
				Agroecological	Low to Moderate	Beans/Corn/Fresh Vegetables/ Livestock	None	None	< 25	Low to Moderate
				Subsistence	Low to Moderate	Beans/Corn/ Fresh Vegetables/Livestock	Rare	None/Rare	< 10	Very Low
Family Farming/ and Remnants	2	19,396	5.7	Same as Above with significant patches of remnant vegetation (Araucaria Forest)						
Ranching	3	16,779	4.9	Ranching/ Land lease	Low to Moderate	Beef/Sheep Livestock	Rare to Moderate	Rare to Moderate	> 800 ha	Moderate to High
Intensive Forestry	11	12,626	3.7	High Capital	Moderate to High	Wood Pulp and Timber	Moderate to High	Low	>1,000	Very High
Protected Areas	4	4,601	1.3	Comprises Vila Velha State Park (4.181 ha) and 3 RPPNs - Particular Reserve of the Natural Heritage (420 ha)						
Urban/Industrial	6	20,263	5.9	Small Woodlands and Riparian Woods within the Urban/Suburban/Industrial Context						
Total	39	342,208	100							

forms of land use suggest that land management should be compatible with the particular ecological features of each LUS to enhance the conservation potential of remnant habitats and landscapes. The total area occupied by remnant patches and its scattered pattern of distribution in the regional matrix also indicates the urgent need of conservation efforts.

Within the Regional Matrix intensive and family farming systems have a key ecological position as it occupies the majority of the land (84.2% of the total land in the Matrix), as the main cause of transformation and fragmentation of the natural landscapes, and as fundamental economic component of the rural communities. Livestock production systems, including intensive poultry and hogs, semi-intensive dairy systems and extensive beef production are complementary economic farming activities for the majority of the farmsteads and rural communities (See Table 3.4 for the general correlation between LUS and Livestock systems). Such level of intensity of land use call attention to the importance of low input and ecological farming systems (e.g., Altieri 1995, Mander et al 1999, McNelly & Scherr 2002, Beecher et al 2002, Vandermeer & Perfecto 2007) to improve the conservation potential of the agrolandscapes throughout the Matrix.

The mapping of landscape units that reflects environmental and socio-economic factors throughout the Matrix was a powerful instrument to address land management issues at relevant farm and regional scales for the enhancement of the conservation potential of remnant patches. The economic component of each class of LUS, as it challenges the profitability of the farming enterprises and the socio-cultural components are potential topics for rapport building, negotiation, and establishment of partnerships with landowners. As it will be later reasoned (Chapter 6 and 7), such dialogues can result in ecological improvement on land management practices and can also result in effective alternatives for the conservation of the remnant patches.

The following discussion is centered on the results of the area metrics and the main socio-cultural, economic and agronomic characteristics of each class of Land Use System. It is also presented relevant biological features of the remnant patches within each class of LUS and the related landscape context where conservation issues must be addressed. Figure 3.10 displays the Map of Remnant Patches overlaying the Map of Land Use Systems. The Table 3.5 summarizes important area metrics and the types of remnant vegetation on each class of LUS.

The arguments to follow are based on the results of remote sensed imagery interpretation as they are related to the patterns of land use on the ground, as well are resulting from the data collected on the individuals in-depth Interviews, discussions with Key Informants and Participant Observation techniques with Focal Groups.

Intensive Farming Systems

Land mapped on the class of Intensive Farming Systems includes 4 mapping units and amounts 157,238 hectares, corresponding to 45.9% of the total area in the regional matrix (See Table 3.4 and Figure 3.8). Intensive Farming with significant areas of Remnant Patches basically differs by the amount and the type of natural vegetation within the unit and includes another 7 mapping units that amounts 65,926 hectares and corresponds to 19.3% of the total area. These farming systems amounts together 65.2% of the Matrix and correspond to the land under intensive cash crop farming, and are based on the employment of high agriculture technology, high capital investment and intensive use of pesticides and fertilizers.

Typical farmstead is larger than 300 hectares, although intensive farming on properties ranging from 100 to 300 hectares is common. The labor force and often the management of such farms are based on hired employees. The great majority of the

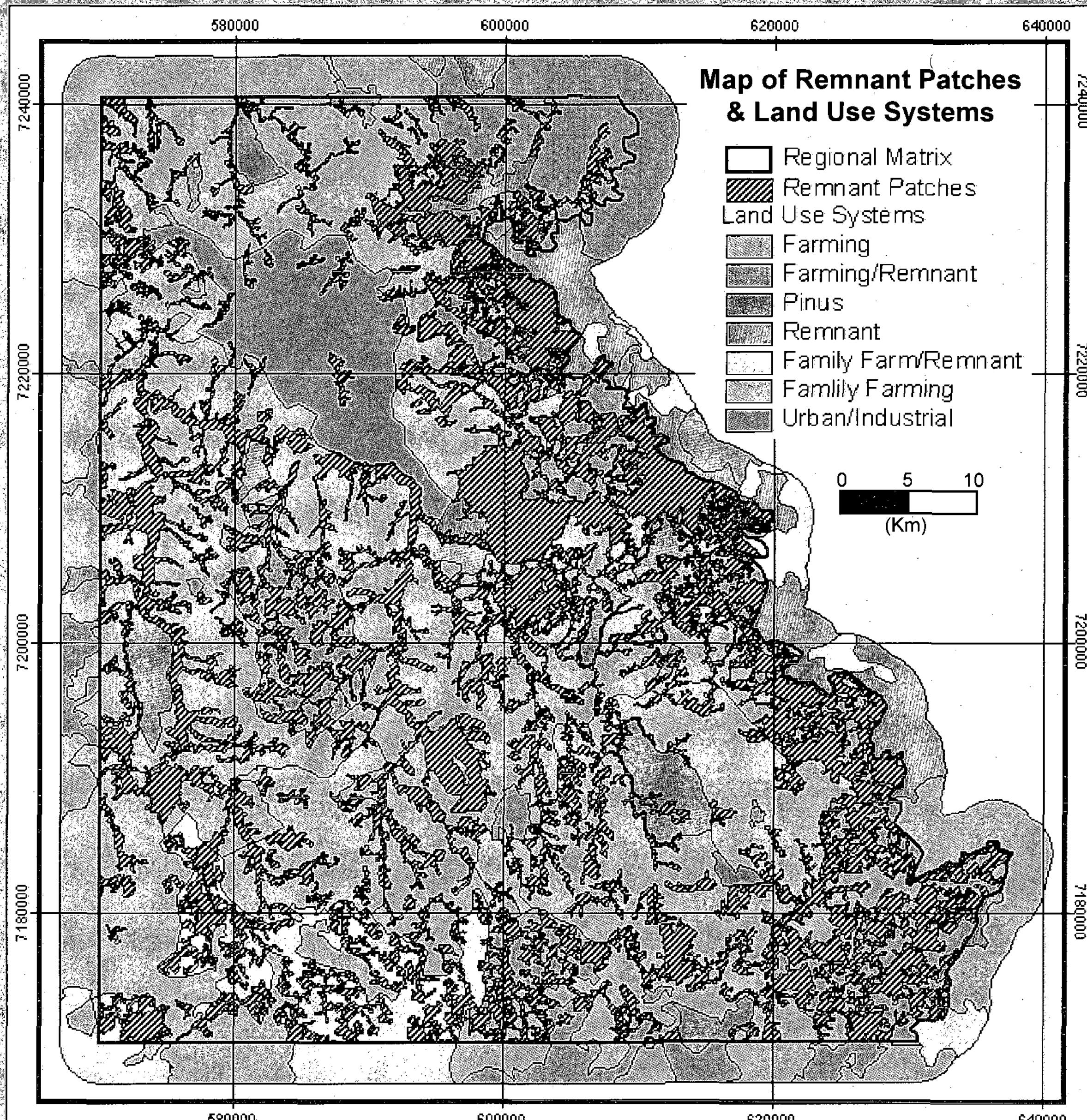


Figure 3.10: Map of Remnant Patches & Land Use Systems

intensive farming is developed on previously rangelands based on the native grasslands, but also includes land on previous forests and woodlands. In general, these farms occupy the best farming land and have a high net profit, that are proportional to the size of available cropping land. Soybeans and corn are typical summer crops as wheat and black oats are the main crops in the winter. Beans and potatoes are often cultivated within these systems, as cash crop alternative when the prices of soybeans are low. Such crops, however, particularly potatoes, are more demanding on intensive farming and cultivation practices, fertilizers, and pesticides than are soybeans and corn.

Schimandeiro (2006) has distinguished 3 main types of Intensive Farming as it is practiced in the Campos Gerais and her classification was adapted accordingly to the responses from the Interviews, to represent Intensive Farming Systems in the regional matrix as follow: A) high technology & capital; B) high technology; C) low technology. Systems A and B are characterized for having constant agronomic supervision, crop rotation planning, monitoring of the crop fields for weeds, insects and diseases, regular soil analysis, and diagnosis-based pesticide and fertilizer recommendations. Systems A and B represent the typical no-tillage, high technology, high investment and profitable farming of Campos Gerais, but in two different levels.

System A farmers make the highest investments in products for plant protection and growth stimulation. The pattern is to make preventive fungicide applications, and use of state-of-the-art product releases, which are generally more expensive than long-established products (Interviews 4, 6, 7, 10, 13, 16). System B farmers invest in high technology products and practices, but are not as capitalized as System A. The general pattern is to observe the economic level of damage when deciding on pesticide applications, and to choose generic, usually less expensive products (Interviews 1, 5, 8, Focal Group 7, Schimandeiro 2006).

Farming System C is represented by low-technology and medium-investment capacity that can be characterized by poor planning, last minute changes based on present economic situation, breaking in the crop rotation plan, utilization of prescheduled pesticide applications, and lack of expertise consulting, constant monitoring or recurring soil analysis. In this case, the farmer is relatively capitalized, but not well-informed, paying no attention to research updates and technological advances. In this case, it is common for such farmers to buy the whole "technological package" from one company. A commissioned sales representative makes general recommendations for plant protection products such as herbicides, fungicides, insecticides, seeds and fertilizers (Interviews 9, 12, 15, 17, Schimandeiro 2006).

Livestock production, or cattle beef in the case of larger farmsteads, and dairy, sheep, and swine in the case of the medium sized farms, is a common complementary farming strategies on these systems. Swine production is always industry-integrated within intensive systems. When linked to the industrial sector (swine and dairy cattle), livestock management on these systems is high developed and animal environment, feeding strategies and animal genetics are common management practices (Weirich Neto & Rocha 2007).

Dairy livestock are based on a semi-intensive management that includes grazing lands and complementary feeding strategies such as harvested forage (hay) from the more productive, very often cultivated grasslands, and, more commonly, corn silage made on the later summer as source of forage through the period of limited forage growth. Winter pastures, mainly black oats (*Avena strigosa*) and ryegrass (*Lolium multiflorum*) and other permanent no-native pastures (e.g. *Brachiaria spp* and *Hermathria spp*) are largely cultivated and mineral supplementation are ypical practices to attain high levels of productivity (Interviews 5 and 21, and members of Focal Groups 7, 10, and 11).

Remnant Patches within Intensive Farming Systems

The majority of the land comprised by the remnant patches in the Matrix (38.5% of total remnant area) is embedded in a context of Intensive Farming Systems (See Table 3.5 and Figure 3.10), which comprehends 40,320 hectares of remnant vegetation (corresponding to 25.7% of total land on this class of LUS). It includes all types of remnant vegetation, but with a significant presence of Mixed Riparian and Mixed Alluvial (>70% of the remnant area). Remnant patches within these 4 mapped LUS units are located along the extensive drainage network that comprehends the riparian woods and grasslands along the river network and the wetlands and riparian forests linked to the alluvial systems of main Tibagi, Caniú and Guaraúna rivers.

Another significant portion of the total land on remnant patches (29.8% of total) is located within Intensive Farming Systems associated to a significant presence of Remnant Patches. This class of land use comprehends 31,317 hectares of remnant patches (corresponding to a considerable 47.5% of the land on this class) with a significant presence of Grasslands (69% of the remnant area on this class), Araucaria Forests and Riparian Woods (24% of the remnant area), and Mixed Riparian Systems (7% of the remnant area). Remnant patches within these 7 mapped units are distributed into two main locations accordingly to the vegetation types: Grasslands are located in the eastern portion of the regional matrix along the Devonian escarpment; Araucaria and Riparian Systems are located along the drainage network, comprehending permanent preservation areas (APPs) with significant contiguous remnant patches of Araucaria woods.

Table 3.5: Characteristics of Remnant Patches within Classes of Land Use Systems

Land Use System (LUS)			Remnant Patches			
			Remnant Area			
Class of LUS	Number of Mapped Units	Total Area (ha)	Within the Class of Land Use (ha)	Within the Class of Land Use (%)	Remnant as % of total	Main Remnant Vegetation Type
Intensive Farming	4	157,238	40,320	25.7	38.4	Riparian Woods and Mixed Alluvial
Intensive Farming/ Remnant	7	65,926	31,258	47.5	29.8	Grasslands and Riparian Woods
Family Farming	6	45,379	6,866	15.1	6,5	Araucaria and Riparian Forest
Family Farming/ Remnant	2	19,396	7,489	38.6	7.1	Araucaria and Riparian Forest
Ranching	3	16,779	13,545	80.7	12.9	Grasslands and Riparian Woods
Commercial Forest	11	12,626	787	6,2	0.7	Grasslands and Riparian Woods
Protected Areas	4	4,601	3,846	83.6	3,7	Grasslands and Mixed Riparian
Urban/Industrial	6	20,263	938	4.6	0.9	Araucaria and Riparian Woods
Total	43	342,208	105,049	30.7	100	

Many areas within remnant grasslands have farming potential, including some areas of prime farming land, which is expected to be cultivated soon after. High land use capacity is also found within remnant patches under Araucaria forests, but current state and federal legislation prevent deforestation on the Atlantic Forest biome; small illegal clear-cuttings however is difficult to control. The significant presence of large remnants, particularly in the case of grasslands, within this class of LUS, put in evidence the need to effective conserve such remnant patches as well as the need to improve the land management surrounding them. Landscape Conservation will only be achieved if these remnants are effective protected and connected throughout the Matrix.

Family Farming Systems

Land under Family Farming Systems includes 6 mapping units and amounts 45,379 hectares, corresponding to 13.3% of the total area on the regional matrix. Family Farming with significant areas of Remnant Patches basically differs by the amount of natural vegetation (Araucaria and Riparian Forests) within each unit, and includes another 2 mapping units that amounts 19,396 hectares, corresponding to 5.7% of the total area (See Table 3.4 and Figure 3.8).

Typical farmstead is smaller than 100 hectares and, by definition, such farms are managed based on family labor force and generally occupies land with lower farming potential; the economical profit is reduced, proportional to the size and soil farming capacity of available cropping land. The great majority of the land on the Family Farming Systems was previously covered by Araucaria forests or large woodlands managed through the shifting farming systems. Based on the information from the individual and focal group interviews, four types of Family Farming Systems were distinguished: D) Family Intensive; E) Cash Crop and Subsistence; F) Subsistence; G) Agroecological.

Family Intensive Farming System (System D) share several similarities with the Intensive Faming System C in the way land is managed, but farmsteads are smaller (typically smaller than 100 hectares) and the capital for investment is also reduced. Typical cash crops are soybeans and corn and are based on the use of intensive technology. Intensive labor cash crops like tobacco, onions and potato are common crops on smaller farms and are based on intensive use of pesticides and fertilizers (members of Focal Groups 6, 10, and 11). Cash Crop and Subsistence Family Farming (System E) is also similar to both previous systems, but is developed on even smaller farms (generally less than 25 hectares). Beans and corn are typical summer crops for subsistence and usually tobacco or onions are cultivated as cash crop. Farmers on this category often complement family income as temporary hired workers on larger farms or companies (members of Focal Groups 6, 10, and 11).

Subsistence Farming Systems (System F) comprehends the smaller farmsteads (less than 10 ha), including a significant number of very small farms (less than 2.5 ha) and peasants without land that must rely on hiring small tracts of land to cultivate. Cultivation is mainly directed to subsistence and eventually tobacco as cash crop; the majority tries to complement income as hired rural workers (members of Focal Groups 6, 10, and 11). Agroecological Farming Systems (System G) is a brand new regional farming movement that started about 20 years ago as a way to minimize farm dependence on external inputs and avoids the use of pesticides and fertilizers. Typical farmstead is smaller than 25 ha and production systems includes corn and beans for farm subsistence as well as cash crop and fresh vegetables, sold in alternatives markets at varying premium prices ranging from 10 to 30% higher than similar conventional products (Focal Group1, Interviews 20 and 21, and few members of Focal Groups 6 and 10).

Livestock are common as complementary farming activities in all Family Systems and is usually industry integrated, essentially within intensive systems. Livestock holdings are diverse and mainly include beef and dairy cattle, sheep, pigs, poultry and horses and are an important element of the livelihood strategies of the small landholdings families on the Araucaria Forest Landscapes. The majority of the poor rural families depend on livestock to some degree as a source of financial capital for the rural poor or as subsistence in the case of very small areas. For many, livestock ownership is the only form of savings available.

Under smallholder conditions milk is more important output than meat and dairy livestock it is the main source of income for several small landholders in the Matrix. Industrial integration of poultry and swine on small farms have significantly increased on the last five years and, currently, is the main source of income for another significant number of families in many rural communities throughout the matrix, as they can offer cheap family labor to the intensive regimes of livestock management (Interviews 18, 19 and 20, and some participants of Focal Groups 1, 6, 10, and 11).

Remnant Patches within Family Farming Systems

Family Farming Systems harbors 6.8% of the total area of remnant patches (See Table 3.5 and Figure 3.10). This class of land use comprehends 6,684 hectares of remnant patches (corresponding to 15.5% of the land on this class) including all types of remnant vegetation but with a significant presence of Araucaria and Riparian Forests (55% of the remnant area within this class) and Mixed Alluvial Systems (36% of the remnant area within this class). Remnant patches within these 6 mapped units are mainly located along the drainage network comprehending permanent preservation areas (APPs) and some contiguous remnant patches of Araucaria woods. The great majority of these riparian and woodlands remnants are secondary forest at intermediate stages of the ecological succession.

Most of these remnants patches were not converted to cropland because they are part of the management of natural resources within small farmsteads. Such woodlands were components of the slash-burn-fallow farming system, employed since the beginning of colonization in the early XVIII century until the 1970s, when it begun to be replaced by intensive farming systems. As hundreds of small farmstead owners had to sell or lost their land to bankruptcy, or went out of agricultural business, as effects of green revolution and globalization, many forested areas are now under ecological succession. Still most of these remnants are managed for forest products such as the harvesting of tea mate leaves (*Ylex paraguariensis*), the gathering of Araucaria Pine seeds, management of the Bracatinga tree (*Mimosa scabrella*) as a source of energy, and the selective extraction of other trees and several other species used as traditional herbal medicines (Interviews 18, 19, 20, 21, Focal Groups 1, 6, and 10).

Family Farming Systems associated to a significant presence of Remnants Patches comprise 7.1% of the total area of remnant patches. This class of land use comprehends 7,489 hectares of remnant patches of Araucaria forests and riparian woods (38.6% of the land on this class). The total area of remnant patches of Araucaria forests on this class is actually higher, but as it is comprised by several scattered small woodlots smaller than the minimum mapping area (40 ha), which were not considered on this analysis. Remnant patches within these 2 mapped units are located along the drainage network comprehending permanent preservation areas (APPs) with significant contiguous remnant patches of Araucaria woods. Some land under Araucaria forests, have agricultural potential including some prime farming land. As pointed above, current state and federal legislation prevent deforestation on this biome. Large illegal clear-cutting is unlikely to happen on these lands, except, in the case of small and isolated areas.

Selective extraction for many in farm purposes, however, is likely a normal occurrence. On the areas where tobacco is the main cash crop, illegal wood extraction is the main source of energy for drying up harvested leaves. The great majority of this riparian and woodlands are secondary forest at intermediate stages of ecological succession, but there are many areas in more advanced stages. Most of this remnant patches were not transformed by the same motives as in the small farming systems. On this system, however, forests are much more important as component of the farming living as source of income or subsistence. Much of the low income rural families in the regional matrix are found on this land use system. These systems demand conservation strategies that can contribute to the improvement of socioeconomic conditions based on the sustainable management of forest products as will be later discussed.

Ranching

Land under Ranching Systems includes 3 mapping units amounting 16,779 hectares, corresponding to 4.9% of the total area in the Regional Matrix (See Table 3.4 and Figure 3.8). Typical farmstead is located along the reverse of Devonian escarpment and is larger than 800 hectares, but there are also some smaller landholdings. In general, these farms occupy land with low farming potential and beef livestock, the main for-profit activity, is developed within extensive systems on the natural grasslands.

The rangeland plant community is mainly composed by sub-tropical and tropical grassland species and tallgrass species are predominant under natural conditions; short height, however, is predominant under intensive management regimes. The rangelands correspond to the most significant remnants of natural grasslands on the Matrix that still maintain evident the typical landscape features of the grassland community physiognomy, as function of the low intensity management regimes they undergone through the more recent history. Currently, the less altered and most expressive grasslands remnants are located on the larger farms under less intensive range management.

The cattle production system in the Campos Gerais (as well in Brazil) is almost entirely grass fed, and depends on permanent pastures for maintenance. The most largely used practice in the traditional ranch management is the continuous grazing system based on the permanent pasture on large fenced fields for long periods of time. This negative practice promotes selective plant harvest by the animals, leads to soil compaction and induces a less vigorous sprouting as consequence of not allowing plant to fully recover. The continuous division of the former very large landholdings promoted more intensive grazing regimes and a more frequent burning of the grasslands to provide enough forage during the critical winter period. The combination of these factors led to the impoverishment of soils and rangelands and a consequent decrease on ranching profitability observed since the last decades of the 19th century (Pinheiro Machado 1968).

Among the traditional practices of rangeland management, the use of the fire is conspicuous. In the beginning of the European colonization the act of burning the fields represented the symbolic act of land tenure. Since them, by the early winter pastures were divided and fire were lighted in different time schedules to stimulate new plant sprouting, nutritionally richer and more palatable to cattle in a way to always warrant new pastures throughout the critical winter season. Maack (1968) made the clear observation that ranchers (by that time) had no other option instead of setting fire on the natural grasslands; otherwise their herds would starve to death among senescent and dry grasses.

The traditional grazing practice also involves free grazing along the riparian zones and free access to streams and rivers. Cattle developed preferential points to access water and on these areas and along the preferred routes, constant trampling provokes elimination of the vegetative cover, induces soil compaction and bank erosion. The fragility of the wet grasslands soils and riparian environments favor degradation and this practice has caused intensive ecological modifications along the majority of the riparian habitats and consequent decrease of the water quality on the watersheds.

Large cultivation of winter pastures such as the black oat (*Avena strigosa*) and ryegrass (*Lollium multiflorum*) as currently practiced, were only later introduced as component of the crop rotations within the no-till farming systems because their demand for fertilization and modern farming techniques. As recent as the mid of the 1990s it was very common, from July to November, the occurrence of several simultaneous fires happening on the grasslands located along the eastern portion of the Matrix. This practice became less evident because the reduced area of grasslands and to the legal restrictions to burn natural vegetation. Nevertheless, setting fire on grasslands is still today a largely used procedure, used by the local people in several situations and setting fire on grasslands is a long time embedded cultural practice.

Two main ranching systems, as it concerns the importance of beef cattle on the farm total income, were identified in the Regional Matrix. In the first, developed on the larger farms, ranching is the central economic activity and cropland is practiced as a complementary management strategy mainly as a way to produce winter pasture, very often by leasing land to another specialized crop farmer. On this system calves are bred and finished on the farmland or sold, very often to another ranching region for fattening (Interviews 2, 3, and 26). These landowners also demonstrated to hold a significant cultural link to the ranching systems.

In the second, cattle breeding are a secondary profit activity within cropland systems, and animals vary in numbers from just a few (Interviews 1, 4, 10, and 17) to a few hundred of cows and/or sheep (Interviews 5, 6, 8, 9 and 14). The number of animals and land area under pasture also vary on these systems accordingly to the fluctuation on the international prices of soybeans and in the national beef market. Level of technology on animal management varies from farm to farm, accordingly to the economical importance of the activity, although there are high levels of investment on animal management in both systems.

Remnant Patches within Ranching Systems

Ranching Systems comprises 12.9% of the total area of remnant patches (See Table 3.5 and Figure 3.10). This class of land use comprehends 13,545 hectares of remnant patches (corresponding to a significant 80.7% of the land on this class of land use). Remnant patches within these 3 mapped units are located along the reverse of Devonian Escarpment, and includes lands on the watershed that drains to the Vila Velha State Park and the adjacent remnant patches. These areas correspond to the most significant patches of remnant grasslands that are being managed as natural pastures with significant cultural aspects linked to the ranching activity.

In the mapping of this land use system Araucaria and riparian woods were included and, despite most of them are secondary forests, either cut down in the shifting farming or under past selective cutting, the majority of them are actually in advanced ecological successional stages. As these forests are small wood patches or riparian corridors, they were mapped as inclusion within ranching systems. Such woods of variable size are fundamental as shelters for birds, mammals and other typical wildlife. It is also important to note that the present cultural context is more favorable to the conservation of Araucaria Woods and riparian areas, but not to the grasslands.

Many areas located on the top of the hills have developed deeper soil profiles and, consequently have higher farming potential, including some prime farming land, which is expected to be cultivated soon after. The considerable presence of the most significant grassland remnants within this class of LUS put in evidence the need of effective conservation strategies for these patches as well the need of improvement in the management practices on the rangelands as well and on the surrounding land. Conservation in the Regional level will only be achieved if these remnants are effective protected and connected throughout the Matrix.

Intensive Forestry

Land under Intensive Forestry, includes 11 mapping units scattered on the regional matrix, and amounts 12,626 hectares, corresponding to 3.7% of the total area (See Table 3.4 and Figure 3.8). The majority of the intensive forestry are owned and managed by large companies that employs high forestry technology and are based on intensive capital. Typical farmstead is larger than 1,000 hectares and, normally, forested areas occupy prime farming land. Slash Pine, (*Pinus taeda and Pinus elliotti*) are the most common species and have been cultivated in large areas in southern Brazil since the early 1960s, when it was based on subsided governmental incentives. These species had a good adoption to the region's soil and climate and thousands of hectares of native ecosystems were replaced them. A solid pulp industry was established by that time that was complemented in the 1990s by the development of high technology board industries.

The global demand for board wood and pulp, and the legal restrictions for natural forest management have significantly increased the amount of land under Intensive Forestry in the last ten years, mainly the exotic slash pine. Today forest related industry is an important component of the regional economy and source of many rural and industrial jobs. The prediction of future timber and pulp shortage in the country has stimulated several medium and large farmers to start planting *Pinus* as economical alternative on the marginal lands, mainly on remnant grasslands and very often illegally within the APPs (Permanent Protected Areas). Economic profit is generally high on the medium term (12 to 25 years), but it is totally dependent on the international market and is related to the type of industrialization (pulp or board) and the size of the forested land.

From an environmental standpoint Commercial Forest have a dual perspective. A growing supply of forested wood in the State of Paraná, and particularly at the regional level, has reduced the demand from native wood, helping thus the conservation of the last native forest stands. Industrial Forests are also a less intensive land use system that relies on smaller amounts of pesticides and fertilizers by area unit than agriculture. By another point of view, large monocultures have been implanted, quite often by replacing native vegetation, simplifying ecosystems and changing wildlife habitats. Intensive use of herbicides is also common in the first years of cultivation. Due to its high capacity of dispersing seeds and its adaptability to the soil environment of grasslands, *Pinus* are very aggressive species that have a high capacity of invasion, even on shallow and rocky soils, and are regionally becoming a serious problem for the conservation of remnant grasslands, requiring intensive management to its control.

Remnant Patches within Intensive Forestry

Within Intensive Forestry are found only 0.7% of the total area of remnant patches (See Table 3.5 and Figure 3.10). This class of land use comprehends 787 hectares of remnant patches (corresponding to 6.2% of the land on this class) including basically mixed riparian systems and wet grasslands. Remnant patches within these 11 mapped units are mainly located along the drainage network on permanent preservation areas (APPs). The totality of these remnants patches were not converted because they are not suitable land for reforestation due its shallow soils and/or to the excess of water in the soil profile. The main problem for these remnants is the potential invasiveness of the *Pinus* into the grasslands. The majority of these remnants, particularly the ones located on older plantations are becoming *Pinus* Forests. Management of these lands can be improved for conservation purposes based on better management of riparian (APPs) and the maintenance of Legal reserve connected by the APPs along the river network.

Protected Areas

Land Use System classified as Protected Areas includes 4 mapping units that amounts 4,601 hectares, corresponding to only 1.3% of the total area in the Regional

Matrix (See Table 3.4 and Figure 3.8). It includes the Vila Velha State Park (3,122 hectares) and 3 small RPPNs - Private Natural Heritage Reserves (420 hectares). The Park of Vila Velha was established in 1953 and was the first state park and the second park in the state (after Iguaçu National Park). As many protected areas in the world, Vila Velha was designated protected area not by its biological importance, but by the peculiarity of its sandstone formations, testimony of marine (Devonian period) and glacial environments (Permian-Carboniferous), and the scenic potential of the surrounding landscape.

By the year of the Park's inauguration conservation of grasslands and associated ecosystems was not a State priority as the majority of the land on the Campos Gerais was still managed as extensive rangelands. Rather than focusing on conservation as priority, the park hosted since the early 1960s a agronomic research facility[23]. To overcome the low fertility of the region's soils, the main limitation to cultivate grasslands, was still a challenge that time and a priority for the state research. As available public lands were scarce on the region, about 870 hectares (about 25% of the original perimeter of the Park) were set aside for farming and forestry research. It was only recent (2001) that farming activities have been ceased and these lands are currently under natural regeneration.

The VVSP is one of the main Paraná tourism destinations reaching more than 200.000 visitors by year. Visitation is restricted to tree main points of interest: a) the Vila Velha sandstones formations; b) the Furnas (erosional crater-like sinkholes, typical on the Furnas Formation); and c) the Lagoa Dourada (Golden Pond). Visitors' management had been deficient and many conservation problems had arisen on the trails and on the

[23] IAPAR – Instituto Agronômico do Paraná.

sandstones, culminating with park closure to visitation in 2002, followed by a rehabilitation program, and re-opening in 2004. Since then visitation has been about 130.000 visitors by year. The remainder area of Park has the most significant remnants of natural grasslands on the Matrix as function of the low intensity management regimes they undergone in the past and the setting aside as conservation units. In the year 2002, an additional area of 1,060 hectares was designated to be added to the Park perimeter.

The Private Natural Heritage Reserve - RPPN[24], is a protected area category established by a Federal Decree in 1992, where private land can be voluntarily set aside for conservation purposes. To be classified as a RPPN, an area must have features relevant for protecting biodiversity, be a place of natural beauty, or where environmental recovery would help to preserve fragile or threatened ecosystems or habitats. RPPN owners, individuals or companies, do not pay land tax on the part of their property classified as a RPPN, they have priority in obtaining resources from the National Environment Fund (FNMA), and can count, at least on theory, on IBAMA's (Brazilian Environment and Renewable Natural Resources Agency) support to the management of the area, protection against fires, hunting or deforestation. Three small RPPNs were established in the Matrix and occupy areas of 60, 80 and 280 hectares, respectively of Mixed Alluvial, Araucaria Wood, and Mixed Riparian ecosystems.

Urban/Industrial Areas

Land under Urban/Industrial Areas, includes 6 mapping units and amounts 20,263 hectares, corresponding to 5.9% of the total area in the regional matrix (See Table 3.4 and

[24] See also discussion on Section 6.2 - Private Natural Heritage Reserves - RPPN

Figure 3.10). Mapped units correspond to the city of Ponta Grossa (280,000 inhabitants) and its industrial district, the towns of Palmeira (18,000), Porto Amazonas (2,800), and the southern portion of Carambeí (12,000), and the villages of Guaragi (1,000) and Witmarsun (1,000). There exists another twenty one small rural communities with scarce and scattered population which were not mapped.

Urban and Industrial areas are a great source of air and water pollution due deficient urban sewages systems, industrial effluents, and other environmental hazards, often potentially dangerous. The urban areas and the highway network are structures that clear create barriers to dispersal and movements of wild species and ecological flows over the landscape. The road network clearly divide the regional matrix, and, not only there is a gap in the natural habitat imposed by two or more lanes of paved roadway, but traffic sounds, lights, chemical emissions and the potential death or injury by vehicles, impose a complex hazard for animals attempting to cross (Bennett 1999).

Remnant Patches within Urban and Industrial areas

Urban and Industrial areas comprise 0.9% of the total area of remnant patches (See Table 3.5 and Figure 3.10). This class of land use comprehends 935 hectares of remnant patches (corresponding to 4.6% of the land on this class), basically Araucaria and riparian woods. Remnant patches within these 6 mapped units are mainly located along the drainage network comprehending permanent preservation areas (APPs). These remnants patches were not transformed because they are not suitable land for urbanization or industrial use, but they represent very important areas within the urban context and as stepping stones for many species dispersal and migration.

Reports of wild mammals such as the paca (*Agouti paca*), peccary (*Tayassu tajacu*), deer (*Mazama spp*) and capybara (*Hydrochaeris hydrochaeris*) are relatively common on these remnants, as they are functionally linked through corridors with more suitable habitats located outside of the urban/industrial context (Interviews 22 and 23). As small, relatively isolated areas, such patches are prone to invasion by exotic weeds, *Pinus spp.* and other potential invasive trees (e.g. *Melia azedarach*, *Hovenia dulcis*, and *Eucalyptus spp.*). The collect of fire wood by poor urban settlers is becoming a serious treat for the conservation of these urban remnant patches.

3.3.4 Defining Landscape Conservation Goals

The grasslands ecosystems are among Earth's most endangered terrestrial habitats. The region-size reserves required to support the unique ecological processes of these systems make acquisition of sufficient ranch land and cropland to restore grazing ecosystems prohibitively expensive. Instead, protection of the few grazing ecosystems that remain is the only feasible option for preserving this rare habitat. As threats to these ecosystems intensify, it becomes increasingly important to develop measures for their preservation (Frank et al 1998). Loss of natural habitats, as a result of conversion to agriculture or other uses, is the single greatest source of biodiversity decline and loss world-wide (Kiss 2002) as well as in Southern Brazil.

Destruction and degradation of natural habitats and biodiversity loss is caused by the political and economic forces that acts on many scales, which by demanding intensification on farming systems, are shaping today's landscapes throughout the world, as well as promoting land and resources concentration. Additionally to conversion of natural habitats and landscape fragmentation, modern agriculture has caused serious environmental problems such as soil erosion, pollution of surface and groundwater, presence of agricultural chemicals on food quality, hazards to human and animal health from pesticides and food additives.

Meanwhile, the general profitability of intensive farming systems on the regional matrix has been producing direct and short-term economic benefits to farmers, particularly on the moments of high prices in the global soybeans' market, regionally the most cultivated cash-crop. The trend toward more specialized, high-yield farming systems is well established on most of the regional matrix, particularly on the Intensive Farming Systems and reflects technological and socioeconomic factors that are firmly embedded in recent history and agricultural policy in Brazil. Pressures for commodities production are increasing and are not likely to diminish in the foreseeable future.

Increasing the production of commodities has been achieved by employing intensive farming technology and expanding the scale of production, either by migration to new farming frontiers (i.e., Cerrado, Caatinga, Amazonia, but also Paraguay and Bolivia) or buying smaller farmsteads from landowners unable to keep themselves on the intensive agribusiness. Large-scale farming is more economically competitive because of production efficiencies and is the limiting factor for the success of intensive systems on the smaller farmsteads.

Intensification of production systems, however, is also increasingly becoming a serious limiting factor for the medium sized farms in the regional matrix. The same trend that made economically unfeasible more than 200.000 small farmsteads (< 50 ha) along the 1970 and 1980s in Paraná, is now reaching the medium-sized farm. The search for economic alternatives is evident on the majority of the medium-seized farming enterprises and is particularly challenging on the smaller farmsteads. We will return to this point, later on the dissertation, when addressing eco-friendly strategies for the management of the matrix.

It was stressed on the previous section the current state of landscape fragmentation in the regional matrix's; remnant patches are mainly formed by small and isolated habitat patches, most located within intensive farming inhospitable context, particularly for poor dispersal species or demanding of larger, high-quality habitat. On this regional context, the conservation of remnant patches located along the Devonian Escarpment is the only possibility for conserving the last stands of region's grassland biodiversity (See Figure 3.6: Map of Remnant Patches of Natural Vegetation).

To avoid further fragmentation and reversing the current levels of massive habitat loss on the regional matrix will require improved law enforcement and innovative incentive mechanisms including those aimed at improving the way land is managed, the adoption of more ecologically sound farming practices, as well as promoting economic development and social justice. As pointed out by Tabarelli et al (2005) for the Atlantic Rain Forest, "the challenge is how to integrate the diverse regulations and public policies, new opportunities and incentive mechanisms for ecosystems protection and restoration".

To diminish the negative consequences of current habitat fragmentation and enhance the connectivity of populations across landscapes, conservation biologists and planners have long proposed the maintenance or restoration of habitat corridors (Noss 1983, Forman 1995, Bennett 1999, Jongman et al 2004). The value of corridors, however, is much debated, in large part because the lack of empirical data on the subject (Noss

1987, Simberloff et al 1992). In this regard, one of the most familiar concepts of landscape ecology may be seen as “precautionary principle”: “we cannot truly demonstrate that corridors work, but their alleged benefits seem eminently plausible and their loss or non-replacement would probably accelerate the decline of biodiversity” (MacFarlane 2000).

Connectivity is an essential component of ecosystem and landscape integrity, reserve design and metapopulation dynamics (With 1999), and, therefore, the delineation of linked systems of habitats within the broader context is an essential strategy to be pursued for an integrated landscape approach to conservation. Networks of linked habitats that maintains effective connectivity for populations and ecological processes has been pointed as the basic foundation for an effective strategy of biodiversity conservation in highly fragmented landscapes (Bennett 1999) and biomes such as the Atlantic Rain Forest (Rambaldi & Oliveira 2005, Tabarelli 2005).

Besides its biological importance, stream corridors are also well-know for their roles in controlling water and mineral nutrient flows. Water runoff and consequent flooding are both minimized when effective stream corridors are present. Bank erosion and mineral nutrient runoff are also inhibited and the amount of sedimentation and suspended particulate matter in the stream is minimized. Stream water quality is usually high in a wide stream corridor (Forman & Godron 1986).

Within the Brazilian conservation context, corridors have been largely accepted as a fundamental concept, and adopted as a general conservation strategy[25] (e.g. Rylands & Brandon 2005, Tabarelli & Gascon 2005, Klink & Machado 2005, Costa et al 2005). The

[25] E.g., the law of the SNUC (SNUC 2000) makes mandatory for protected areas planning to analyze the possibilities of establishing a corridor network to provide connections throughout the buffer zone.

biodiversity corridor concept was introduced in Brazil as a strategy of the parks and reserves component of the Pilot Program to conserve the Rain Forest – (PP-G7[26]), with the rationale of creating protected areas that increase connectivity through major landscapes and between existing protected areas. A particularly innovative move was the adoption of a model for broad regional landscape planning and conservation based on the concept of ecological corridors. This model is now an important element of conservation planning in Brazil (Mittermeier et al 2005).

On the conservation scenario of the study area, the Regional and Landscape Conservation Priority remnant patches are the most valuable landscape units to constitute the core elements for the establishment of a reserve network system. Such patches must be transformed in what are usually unmanaged lands into well-managed entities that can effectively be integrated in a network system to conserve biodiversity (Rylands & Brandon 2005). These core reserves and the corridor network, however, will be only a small proportion of the overall landscape and will remain too small for conservation purposes on the long term. This point out to the need of multi-functional landscapes, ranging from greenways to whole farmscapes and forests

Consensus is developing among ecologists that biological diversity will not be effectively conserved in natural reserves alone and a focus strictly on reserves, will miss many opportunities for conservation. Therefore, many are recommending that reserves be complemented by surrounding and connecting semi-natural lands where ecological principles are used to manage for a combination of commodity production and resource

[26] The Pilot Program to Conserve the Brazilian Rain Forest (PP-G7) is an initiative supported by the Group of Seven (G7) countries since 1991, and, accordingly to Tabarelli et al (2005) is the most important program in terms of external funding for biodiversity conservation in the Amazon and, to a lesser extent, the Atlantic Forest.

conservation purposes. Hence, the landscape matrix should be included in our thinking for conservation planning, either as a potential reserve of biodiversity and as the medium through which migrations must occur to protect against the process of turning isolated local extinctions to regional or even global extinction (Forman 1995, Meffe & Carroll 1997, Bennett 1999, Vandermeer & Perfecto 2007).

The complexity of biological and socio-cultural factors involved for successfully addressing conservation issues on intensive managed lands requires the development of a practical, yet scientific based approach as conservation model. In designing a successful conservation program or research, one of the first and most critical steps is to develop clear goals and objectives. Therefore, based on the considerations above, an integrated landscape conservation strategy on the regional matrix should pursue the following five general goals:

a) To halt further landscape fragmentation and habitat destruction;

b) To effectively conserve and enhance the quality of existing habitats;

c) To recover and expand the area of protected habitats;

d) To improve structural and functional connectivity among remnant patches;

e) To minimize ecological impacts from surrounding land uses.

The landscape conservation goals will be further addressed on the following chapters. The Chapter 4 - Designing a Network of Protected Areas, will explore the application of the conceptual framework for the selection of conservation priority areas. As the total area of remnant patches on the matrix are not enough to guarantee the conservation on the long term of several key species, such as top carnivores, or for the maintenance of the grasslands ecosystems, it is necessary to define broad conservation landscapes, where conservation strategies should be addressed and implemented.

Regional and Landscape Priority remnant patches are only found on privately owned land (except for Vila Velha State Park), and, consequently, the establishment of partnerships with landowners for the development of landscape conservation strategies is regarded as the primary approach for planning and implementing a system of nature reserves. As private lands, conservation plans need to be tuned with economic production activities and other key cultural values and meanings stakeholders may attach to the landscapes they managed.

The basic question, therefore, is how to plan and carry out management on such privately owned, multipurpose lands to minimize loss, maintain, and even enhance biodiversity? Accordingly, in the Chapter 5 we will address the methodological procedures for developing participatory strategies to address conservation issues on priority landscapes and to soften the management of the matrix, i.e., ecologically sound forms of land use. On the Chapters 6, 7, and 8, we will address the dialogues on constructing conservation strategies with stakeholders.

3.4 Setting the Regional Conservation Context - Conclusions

In this chapter we have explored the Landscape Conceptual Framework in the development of a broad, holistic, understanding of the Regional Matrix. Constructing on the available data from different research areas and multiple convergence of evidences, we built a_Landscape Conservation GIS Data-Base which was employed for the analysis of the landscapes on this chapter, as well as on the chapters to follow. From the consistencies found in the evidences from these multiple sources, a landscape system framework, where human dimensions is integrated into landscape ecology and conservation planning, was outlined on the previous sections. We will conclude this chapter by reflecting on the validity of the research conceptual framework for mapping landscape units on the scales of the research and to define landscape conservation goals.

3.4.1 Research Framework and the Mapping of Landscape Units

Although no systematic precision assessment of the map of remnant patches and land use systems were carried out, the mapping framework, based on the visual analysis for clustering image patterns that reflects LUS and remnant patches of natural vegetation, is considered adequate. As landscape interpretation was performed based on best knowledge and data available, the resulting maps reflect the ability in the art of "delineating boundaries", in the same way as digital classification reflects the interpreter's skills on identifying image patterns that will be expressed by the appropriateness of the algorithm to cluster image patterns.

When errors or land use change were detected during field work (from 2002 to 2006), the delineated polygons were promptly adjustable. In general, errors were related to the boundaries of patches within complex patterns of land use, reflecting bio-physically heterogeneous landscapes, and/or within small farming land use systems under intensive management. A higher familiarity with the patterns of land use and management in the region together with an interdisciplinary process of pattern interpretation could lead to more reliable results.

The following factors are considered fundamental for the visual image interpretation and polygon outlining process: a) previous knowledge of regional land use and management systems; b) previous knowledge of natural vegetation phyto-physiognomy and patterns of ecological succession; c) constant checking of the relationship between land use patterns with the spectral response in the LANDSAT image; d) ancillary data available, particularly those related to the analysis of land use systems evolution through the temporal collection of aerial images; e) the process of association among those previous factors and the elements in the image already identified or previously kwon.

Remotely sensed images are essential data sources for landscape analysis and offer the potential to develop detailed spatial data bases and maps for virtually any spectral phenomenon that can be linked reliably to spectral data (Avery & Berlin 1992). Aerial photography and satellite imagery are useful in characterizing landscape because variation in the image is usually highly correlated with variation in the landscape. No other survey technique can operationally provide a regularized survey of landscape with which to assess landscape level patterns and change (Blaschke 2006).

Visually defined land units and patches are based on holistic properties of perception that automatically resolve image noise caused by data quality and that neglect the outliers that affect quantitative classification methods (Antrop & Van Eetveld 2000). Visual image interpretation of remote sensing imagery offers an alternative and efficient method to classify complex and heterogeneous landscapes and spatial units (Antrop 2000). Such approach is particularly adequate to the analysis of tropical, subtropical, and intensively managed fragmented landscapes that present a high spatial and temporal variability.

On the typical complex landscapes of Southern Brazil, digital classification systems of LANDSAT images would be adequate for the analysis of large areas where the spatial variability of patterns on the landscape scale would be minimized by the broader effect of the landscape components such as geology and soilscapes imprint on land. The spatial resolution limits of the LANDSAT ETM^+ image employed limit landscape interpretation to scales smaller than 1:30.000; the study on larger scales will demand analysis on higher levels of detail and, thus, the visual analysis of high spatial resolution ortho-photography or other satellite image with better spatial resolution would be more adequate. Like every GIS work, the digital data base construction requires intensive labor, considered the most limiting factor of the framework.

Virtually no digital spatial information was available in the beginning of this research and digital data had to be constructed along the research. The task of image analysis and polygon delineation is particularly time consuming, and extensive field knowledge of the patterns of land use systems is required. In this process, however, coherent criteria and parameters for image interpretation are produced for the delineation of the subsequent polygons as well as for interpreting the indicators of landscape ecological integrity (i.e., the parameters of Conservation Status, Habitat Diversity and Patch Context). The constitution of a georeferenced digital cartographic data base is a fundamental tool for the subsequent conservation actions and other environmental studies, monitoring, land use planning and landscape management.

3.4.2 Research Framework and Landscape Conservation Goals

Environmental phenomena present physical characteristics of complexity, uncertainty, large temporal and spatial scales, and irreversibility (Ravetz & Funtowicz 1999, Ludwig 2001, Robertson & Hull 2001). As put by van den Hove (2006) "these physical characteristics of environmental processes have consequences on what can be called the societal characteristics of environmental issues, which include: societal complexity and conflicts of interests, transversality, diffused responsibilities and impacts, no clear division between micro and macro-levels, and short-term costs associated with potential long-term benefits. In turn, these physical and societal characteristics determine the type of problem-solving processes needed to tackle environmental issues".

Every landscape and region is shaped by a specific combination of natural and cultural factors (subsystems). Consequently knowledge derived from every subsystem will have specific contributions towards the perception and the comprehension of the whole. Conservation practices (praxis) are necessarily the main focus to define the data to be collected and should be based on information derived from a conceptual framework of bio-physical and socio-economical subsystems. It must be framed accordingly to the scientific knowledge, but also to the human, economical and technological resources locally available.

The method employed for analyzing the regional matrix allowed to pull together scattered information and to weave a coherent tapestry of the natural and human systems components. The landscape tapestry showed an interrelated patchwork defined by geo-physiographic units at multiple scales, and upon which different land uses systems have been developed, producing the typical privately owned agrolandscapes throughout the matrix. We looked at biophysical and human interactions at multiple scales, from farm/local to a broad regional extent, to the global demand for farming commodities, and identified multiple and only partially separable causes to habitat destruction and fragmentation. We analyzed multiple, competing alternatives to frame main causes and consequences in order to search for alternatives to halt and reverse such processes at local and regional scales.

A vision of conservation emerged that enlarged the focus from conserving the remaining patches of natural habitat to the management practices of the matrix in which they occur and the need of eco-friendly land use alternatives. This process of analysis provided a suitable foundation to identify and prioritize conservation problems, and, constructing on these issues, to set landscape conservation goals, to guide the next steps of the research framework, but also applicable to the real agrolandscapes of the matrix. A major purpose of a landscape planning is likely, therefore, to be the pursuit of the "future natural" rather than the "past nostalgic" (Selman 2000). The relevance of the landscape conservation approach relays on its holistic perspective, potentially combining different research areas in a complimentary framework, to define relevant conservation issues.

Chapter 4 - Designing a Network of Nature Reserves

4.1 Introduction

Several initiatives developed along the 1990's, focused on identifying conservation areas of prime importance as one of the keys to conserving the planet's disappearing species, genes, and ecosystems. These studies, based on criteria such as biological diversity indicators, degree of vulnerability and ecoregions, resulted in the identification of areas of global conservation concern. World Wildlife Fund (WWF) and Conservation International, e.g., have identified priority ecoregions in the American continent and the 25 global biodiversity "hotspots" that represent some of the most significant regions for conserving the world's biological diversity (Olson & Dinerstein 1998, Myers et al 2000).

In Brazil cooperative efforts developed since 1996, among public institutions, non-governmental organizations, and researchers from many institutions, produced in 2002, the map of the "Priority Areas for Conservation, Sustainable Use, and Benefit Sharing of Brazilian Biodiversity"[1] (MMA 2002, 2004). In this work 900 areas, representative of the Brazilian main biomes[2], were identified as priority areas for conservation and classified into four categories of priority: a) Extreme, b) Very High, and c) High biological importance, and d) insufficiently known, but of probable biological importance. The identification of those priorities at macro-regional scale was a

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[1] In Portuguese "Áreas Prioritárias para a Conservação, Utilização Sustentável e Repartição de Benefícios da Biodiversidade Brasileira" (MMA 2004).

[2] Amazon, Cerrado, Caatinga, Pantanal, Atlantic Rain Forest, Southern Grasslands and Coastal Ecosystems.

fundamental step in the effort towards the conservation of Brazilian biodiversity, to guide more efficiently decisions and resources that can be translated into actions.

Due to the country's dimension and the broad goals of that initiative, mapping efforts were developed in a small scale, each priority unity encompassing vast territorial surfaces. For the typical landscapes of southern Brazil, composed of mosaics of cultivated lands and fragmented natural ecosystems, private landownership, and intensive use of resources, this map is indicative of priorities regions, but very generic for defining conservation areas and actions at larger scales. It is necessary to refine this coarse-scale map of Brazilian Priority Areas in order to set conservation priorities at landscape, farm, and local scales, the scale where decisions concerning land use change and management are taken by landowners and managers.

Accordingly, this chapter will present the Research Conceptual Framework as employed for selecting conservation priority areas and designing a network of nature reserves in the regional mosaic to integrate the five conservation strategies of: a) halting habitat fragmentation, b) maximizing the quality of habitats, c) recovering intensive managed lands, d) improving connectivity, and e) minimizing the impacts of land use and management in the matrix, as previously discussed[3].

We will start by presenting a review about methodologies for selecting conservation priority areas as well as their potential and limits when applied in fragmented landscapes and regions where adequate biological data base is not available. To select priority patches on the regional matrix's we developed a Conservation Priority Model based on surrogates for priorities identified by means of aerial and satellite image

[3] (See discussion on section 3.3.4 - Defining Landscape Conservation Goals)

interpretation and ground checking; the model's efficacy was then assessed against previously known areas of occurrence of indicator species. The landscape research was then followed by designing a network of nature reserves and corridors to provide structural connections throughout the matrix, and the chapter is concluded by evaluating the potential and limitations of the presented model.

4.2 Literature Review

4.2.1 Selection of Priority Areas for Conservation

The selection of priority areas for conservation has gained a considerable attention in the scientific literature in the past 40 years (e.g. MacArthur & Wilson, 1967, Diamond 1975, Pickett et al 1978, Baker 1989, Franklin 1993, Scott et al 1993, McKelvey et al 1993, Prendergast et al 1999, Haufler 1999, Margules & Pressey 2000, Poiani et al 2000, Van Langevelde 2000, Menon et al 2001, Groves et al 2002, Rothley et al 2004, Löwenberg-Neto & Carvalho 2004, Hunter 2005, Newburn et al 2005, Wiersma & Urban 2005). Most of these priority-setting assessments have a common trait: they focus on plant or animal species located on relatively large spatial areas or regions inhabited by thousands of species, many identifiable natural communities and low degrees of human interference (Groves et al 2002).

The Island Biogeography theory of MacArthur & Wilson (1967) was an important historical step in ecology and principles derived from this theory were thoroughly discussed and applied to the formulation of rules for selecting reserves. This theory tells us that bigger reserves are better, the closer they are and the more circular the better, and that reserve should be linked by habitat corridors (Margules & Pressey 2000). It is generally accepted that larger areas would permit higher probability of species persistence over the long term; several small reserves, however, can harbor higher habitat diversity within regions with predominantly heterogeneous environments; grouped or connected reserves (despite the controversies regarding corridors) facilitates dispersion and colonization for metapopulation persistence; more circular shaped areas contain larger core areas, potentially minimizing deleterious edge effects.

The long debate between a single large reserves versus several small reserves (SLOSS) yield no satisfactory conclusion, probably because there is no single answer (Prendergast et al 1999). Depending on the taxa and the geographical locality and position of the reserve(s) in the landscape, various sizes and numbers of reserves may maximize the number of species within a reserve system. Few people would use applications of the island theory today as a primary model for studying, planning, or managing the mosaic on land as they were replaced with theory from the emerging fields of landscape ecology and metapopulation theory (Franklin 1993, Forman 1995, Wiersma & Urban 2005).

With roots in the modern conservation biology, several models and algorithms have been proposed for reserve selection and design. The main criteria used to identify such areas are biodiversity (the broad equivalent of taxonomic richness), rarity, population abundance, environmental representativeness, and site area. Among these criteria taxonomic richness has pre-eminence (Prendergast et al 1999, Franklin 1993). Where distribution data are both comprehensive and accurate, it is possible to identify areas of high species richness (hotspots) for certain taxa, focusing on threat level (e.g. endangered species) or bio-geographical status (e.g. endemic species).

Conservationists often use the metaphor of coarse and fine filters to convey two complementary strategies for maintaining biodiversity; the first focuses on conserving habitats, ecosystems or landscapes and the second focuses on species (Haufler 1999). Fine filter strategies attempt to maintain biological diversity by providing for specific needs of individual species, guilds or other groupings of species. The assumption of these approaches is that biodiversity can best be maintained by managing for the needs of all species by either considering species individually or by aggregating this species into groupings. Species exploited by humans (e.g., game species) and rare species (e.g., plants confined to rare substrates that might not be "captured" through ecosystem protection) are often candidates for fine-filter conservation (Hunter 2005).

The availability of reliable species richness data for any taxon usually lags far behind conservation threats, and reserve selection may have to rely on easier-to-collect surrogate data. This is the rationale behind the use of indicator taxa: areas occupied by many species from a well-studied indicator taxon are also considered species-rich for other taxa. In the past the protection of individual – usually rare – species has figured prominently in reserve sitting (Prendergast et al 1999). Arguments can be made that biodiversity cannot be maintained without considering the needs of the ultimate indicators of biodiversity, populations of individuals species (Haufler 1999).

A refinement of the species richness approach would be to quantify genetic diversity. The presence of rare or private alleles in small populations can be extremely important to the conservation of genetically impoverished populations (Schneider et al 2005). Several methods in the molecular biology field have been used to the investigation of genetic variability of animal or plant populations. It's a logical extension of counting individual species to incorporate a measure of how different they are, but this approach requires a level of resources and technical expertise that make impractical for several situations (Prendergast et al 1999).

The goal of coarse-filter strategies is to provide for ecosystem integrity or biodiversity by maintaining a mix of habitats, ecological communities, or ecosystems at an appropriate landscape scale. These strategies assume that biodiversity and ecosystems integrity can be maintained if the correct mix of ecosystems or ecological community is provide; many approaches for coarse-filter strategies have been proposed (e.g. Franklin 1993, With 1999, Bennett 1999, Poiani et al 2000, 2001, Menon et al 2001).

The coarse-filter approach seeks to protect a representative array of natural ecosystems and their constituent processes, structures, and species. Management for habitat diversity has the assumption that a mix of successional stages, characterized by the various types of plant communities or series, provides sufficient habitat diversity to support all biodiversity. Management within historical ranges of variability assumes that the native species of a region adapted to and occurred within the historical range of ecosystem conditions and that by maintaining ecosystems within this range, the needs of all species will be met (Haufler 1999).

Some types of conservation targets, however, such as rare or endangered species, do not always co-occur in a predictable fashion with certain communities or ecosystems. For these targets, individual or fine filter approaches tailored to fit particular species are necessary. When rigorously undertaken in concert, these two strategies are efficient and reasonably comprehensive. They are efficient because coarse filters conserve large numbers of species, the majority of which are too poorly known to be conserved individually. Together, the two strategies are reasonably comprehensive because all species known to be in jeopardy can receive needed attention (Hunter 2005).

Although the coarse-fine filter strategy is a practical approach to an otherwise complex problem, it can be confusing with regard to the spatial scale at which various coarse and fine filter targets occur. A more useful approach may be to recognize that conservation targets can be identified at a variety of levels of biological organization and spatial scales from local (fine) to regional (Groves et al 2002). These authors suggested three general classes of conservation targets: a) communities or ecosystems, b) abiotic targets based on physical variables, and c) species not likely to be subsumed under the other two classes of targets. Which targets are used in any particular planning exercise will depend to a great extent on what information is available (Margules & Pressey 2000).

Mesofilter conservation (Hunter 2005) is another complementary approach that focuses on conserving critical elements of ecosystems that are important to many species, especially those likely to be overlooked by fine-filter approaches, such as invertebrates, fungi, and nonvascular plants. Critical elements include structures such as logs, snags, pools, springs, streams, reefs, and hedgerows, and processes such as fires and floods. Mesofilter conservation can be particularly appropriate for semi-natural ecosystems that are managed for both biodiversity and commodity production (e.g., forests managed for timber, grasslands managed for livestock forage, and aquatic ecosystems managed for fisheries) and is relevant for managing some agricultural and urban environments for biodiversity (Hunter 2005).

Another approach to site selection over lager areas (e.g., ecoregions) is to classify sites according to how well they represent the climatic and physiographic variables of an ecoregion, rather than their biological attributes. The assumption of such models is that components of the landscape: climate, geological substrate, landforms, and soils co-occur in unique associations which can be described and mapped. Vegetation is often mapped as the surface expression of these determining factors to provide a biological component to the regionalization. The most representative sites of their class are taken to be most appropriate candidates for protection. But if maximizing number of species protected is the conservation goal, sites on ecotones between biogeographic units may harbor mores species (Margules et al 1994, Prendergast et al 1999).

Gap Analysis is a useful means of identifying sites that ought to be preserved but that currently fall outside existing conservation networks. Being able to identify gaps in an existing network is a simple and appealing concept and has been emphasized in the literature (e.g., Scott et al 1993, Prendergast et al 1999, Jennings 2000, Margules & Pressey 2000). The National Gap Analysis Program (GAP) of the US Geological Survey's Biological Resources Division has been using biological survey data, remote sensing, and geographic information systems (GIS) technology at the state level to identify those native species and ecosystems that are not adequately represented in existing conservation lands - in other words, the aim of the program is to detect conservation "gaps" (Jennings 2000).

Wiersma & Urban (2005) used a geographic information system in a study of disturbance sensitive mammals of the Yukon Territory, Canada, to design a protected-areas network that maintains a historical assemblage of species goals for component ecoregions. They simultaneously determined patterns of diversity as Whittaker's beta and compositional turnover and examined how these two measures could give further insights into reserve location and spatial arrangement. In this study, both regional heterogeneity and compositional turnover between nonadjacent sites were significant predictors of the number of protected areas necessary to represent mammals within each ecoregion.

Besides attending goals of ecological representativeness, an effective system of protected areas must observe the likelihood of persistence of species or conservation targets in the long-term (Margules & Pressey 2000). To analyze species persistence over some specified time period, population viability analyses (PVA) and minimum viable population (MVP) models can be employed. Spatially explicit models incorporate the exact spatial and temporal location of key landscape elements into their structure, and offer a considerable potential for designing reserves (e.g., McKelvey et al 1993, Lamberson et al 1994, Kautz & Cox 2001).

Key landscape elements might include patches of habitat, individual organisms, barriers to dispersal, foraging and breeding locations, or items associated with mortality such as human-dominated features (Reed et al 2002). Sensitivity analysis can be used to identify the model parameters on which model performance is most dependent. Once these critical parameters are identified, researchers can concentrate field efforts for gathering habitat-specific data on them (Reed et al 2002).

Spatially explicit, individual-based models, however, are extremely data-hungry. This is true to some extent of all PVA, but spatially explicit models add the requirements of several unique kinds of data: the distribution and quality of habitat in the real world, local habitat-specific demography, and an idea of dispersal patterns and movement rules.

Such details are rarely available for most species, with few exceptions for the developed world for which data are relatively plentiful.

Algorithms have been continually refined. Some versions preferentially select sites that are closer together, an arrangement recommended, at least in theory, for metapopulation persistence (Nichols & Margules 1993). Complex algorithms which involves the combination of biological and human dimension factors have been presented. For the human-dominated landscape of the Netherlands, Van Langevelde et al (2000) discusses a model for selecting potential areas for enlargement of existing reserve sites and allocation of stepping stones, based on the habitats exigencies and population dynamics of an umbrella specie, against the suitability of the land for competing human uses such as agriculture and forest restoration.

Menon et al (2001) used geographic information system and a spatially explicit, predictive, land-use change model to assist in identifying conservation-priority areas in a context of rapid deforestation in the tropical forests of the state of Arunachal Pradesh in northeast India. They examined the correlation of land use cover and land use patterns with biogeophysical characteristics to project future patterns of land use change. In this approach, forested areas currently unprotected and susceptible to future deforestation are defined as priority areas for biodiversity inventory and conservation action.

Newburn et al (2005) explored the site-selection problem in Sonoma County, California, according to three components: biological benefits, land costs, and likelihood of land-use change. They compared their benefit-loss-cost targeting approach with strategies that omit or inadequately address either land costs or likelihood of land-use change. Their proposed strategy aims to minimize the expected losses in biological benefit resulting from future land-use conversion while considering the full or partial costs of land acquisition. The authors argued that their approach is particularly important within fragmented landscapes, with intensive use of resources and land with high market values.

Prendergast et al (1999) have pointed that a common characteristic of most of these models is the necessity of an adequate base about species, population biology and distribution. While in some areas of the world, such as parts of the United States, Australia, and Europe, are relatively rich in information on individual species, for the most part information is scarce and inadequate. Probably because they have been developed in countries where resources tend not to be the most critical issue, reserve selection algorithms are comparatively resource hungry. To work effectively, sophisticated methods of site selection usually require higher-quality data than most land managers can ever expected to have (Prendergast et al 1999).

Data collection can be prohibitively expansive and the absence of systematic recording schemes usually means that species distributions must be inferred from fragmentary occurrence records. Despite constant improvements, applications of quantitative models for selecting areas based on taxonomic classes have several practical limitations (Franklin 1993, Prendergast et al 1999, Poiani et al 2000, Menon 2001). The need to define conservation priority areas in biodiversity rich regions with incomplete biological information is a problem scientist faces worldwide, and constitutes a challenge for the science (Poiani et al 2001).

This particularly important for tropical regions where high levels of biodiversity are associated to inadequate information about species and populations, limited resources and accelerated rate of biodiversity loss that can be countered only by immediate conservation action. In those countries conservation is grossly under-funded, and for many organizations the cost of hardware, an expert operator, and the experimentation required may inhibit the use of reserve selection algorithms (Prendergast et al 1999).

The approaches to conservation and natural resource management are maturing rapidly in response to changing perceptions of biodiversity and ecological systems. Mechanisms and processes that control biodiversity in various levels of organization (genetic, habitats, ecosystems, and landscapes) operate in a variety of temporal and spatial scales (Noss 1992, 1996, Forman 1995, Hobbs 1998, Wiens 1999, Levin 2000, Poiani et al 2001). Each level of the biological organization exhibits characteristic and complex composition, structure and function.

Contemporary recommendations focus on the need to conserve dynamic, multiscale ecological patterns and processes that sustain the full complement of biota and their supporting natural systems. Although higher levels in the biological hierarchy lose biological precision, there are other advantages (Margules & Pressey 2000). They can integrate more of the ecological processes that contribute to the maintenance of ecosystems function and the relevant data are more widely and consistent available or collected. As in the coarse-filter strategies, the basic assumption is that the conservation of the ecological functioning of an ecoregion, the great majority of the species and their complex interaction would also be preserved.

Because habitat loss and degradation are the leading causes of imperilment for most species, it is equally clear that more lands and waters need to come under conservation management if future losses are to be prevented (Groves et al 2002). Thus, some type of conservation target instead of species-specific must be used to direct priority areas selection as well as conservation action. The only spatially consistent types of information available in most parts of the world are for physical variables (e.g., elevation, climate, soil type) and for communities or ecosystems classified according to vegetative composition (Margules & Pressey 2000). Nevertheless, such information can relatively easy be compiled from aerial imagery.

As the list of endangered species grows longer, it is clear that additional strategies and approaches are needed to conserve biological diversity. To implement conservation actions on priority regions requires a pragmatic yet science-based planning framework for the conservation of biodiversity within these regions (Prendergast et al 1999, Poiani et al 2001, Menon et al 2001, Groves et al 2002, Shi et al 2005).

4.2.2 Selection of Priority Areas in Fragmented Landscapes

In many parts of the world the fate of biodiversity is believed to depend on the remnants of vegetation within human-dominated landscapes. Such regions are responsible for sheltering a significant portion of the Brazilian biodiversity (Ribon et al 2003, MMA 2004, Rambaldi & Oliveira 2005), as well as of the Campos Gerais ecoregion (Moro et al 1996, Moro 2001, Melo et al 2002, Paraná 2004, 2005, Rocha & Weirich Neto 2005). In fragmented landscapes, lack of information is compounded by a high degree of habitat loss and isolation and a great sense of urgency to conserve remaining resources. Existing reserves in fragmented landscapes are often constrained to relatively small, isolated habitat patches surrounded by a potentially inhospitable matrix.

Such complexity is compound further by the multiple demands placed on land. In both developed and developing nations it is increasingly necessary to integrate conservation with regional development (which may include tourism, urban planning, road building, waste management, agriculture, mineral extraction, and job creation) within the same conservation area. Each potential reserve is geographically unique and for each the acquisition of the site or the development of an integrated management strategy in multiple ownership may be a complex process involving questions of price, tenure, availability, present and future use of adjacent land, access management, and protection regimes (Prendergast et al 1999).

On these circumstances reserves are and will remain only a small proportion of the overall agrolandscape and a focus strictly on reserves will miss opportunities for good conservation. Consequently, we must include the landscape matrix in our thinking for conservation planning (Meffe & Carrol 1997). In recent years, the conservation community has come to realize that the long-term survival of biodiversity depends on the effectiveness with which landscape between the remnant patches can be managed.

New thinking in Europe is moving away from the reserve mentality, in favor of a less isolationist approach to conservation. In order to increase the total area of land under protection, managers are increasingly turning their attention to approaches such as habitat re-creation, ecological restoration, and the reconditioning of degraded habitats. Techniques like these may be especially effective when extending existing reserves because of the proximity of existing populations. This requires that entire landscapes are made less hostile to wildlife and that the protection of habitat-creating process becomes priority. Through this approach the needs of wildlife and human development will be ultimately integrated rather than differentiated (Prendergast et al 1999).

A similar approach to sustaining diversity combines habitat distribution analysis with patches, corridors and matrix (Forman 1995). Large patches of natural vegetation are surrounded by ample edge habitat distributed throughout the matrix. The edge may be produced by many small patches, by corridors, or by convoluting the boundaries of large patches. With this approach it is unnecessary to previously know the population, distribution, name, or even existence of all species. Most or all species will be included in the several large patches. However, the locations of large patches are important. Thus a collection of nature reserves effectively incorporates: a) patch context, i.e., surrounding habitats and connectivity, in addition to b) combinations of habitat types, and c) disturbance and regeneration regimes.

Combining large patches in carefully chosen locations with connecting corridors and stepping stones across the landscape produces a "nature reserve system" rather than a collection of reserves. In a system the interactions among reserves are as important as the reserves themselves. Yet, natural-resource reserves are not the goal. Rather, they are important pieces in a mosaic where every piece counts. Planning of the whole landscape mosaic is required to enhance wildlife and protect biodiversity (Forman 1995, Lugo & Brown 1996, Bhagwat et al 2005).

It had been amply recommended that conservation measures in agricultural landscapes should include corridors along streams and rivers to minimize impacts from surrounding farming practices, and stepping stones of native woodlands and vegetation for maintaining diversity and gene flow (e.g., Bennet 1999, Bhagwat et al 2005). A network of reserves, therefore, should be an essential component of a conservation strategy to include representatives of targets species or ecosystems, promote the persistence of these targets, support biodiversity, and help to sustain ecological and evolutionary processes (Margules & Pressey 2000, Rothley 2005).

Network reserves can be designed by the use of a variety of techniques that utilize a combination of remotely sensed imagery, reconnaissance overflights, selective biological inventories, and visual display of information with a GIS, to cost effectively gather biological and ecological information about an area (Groves et al 2002). Consultations with experts, often in a workshop setting, have proven extremely useful to both governmental and nongovernmental organizations involved in natural resource management or biodiversity conservation planning (Dinerstein et al 2000). However, planners need to be aware of some of the assumptions, difficulties, and inherent biases of using expert-based information (Groves et al 2002).

4.3 Methods - A Landscape-Based Approach for Selecting Priority Areas

4.3.1 Mapping Conservation Priority Patches

Conservation priority patches were defined by selecting ecological indicators that could provide tangible information about the conservation state of remnant patches and its relative importance. An assessment of the conservation state of each individual mapped remnant patch was performed based on qualitative analysis of three indicators of Ecological Integrity (Noss 2000, 1996, Forman 1995): a) Conservation Status (CS), b) Habitat Diversity (HD), and c) Patch Context (PC); and two basic Landscape Structural Metrics (Antrop 2000, Antrop & Van Eetvelde 2000, McGarigal & Marks 1995, Riitters et al 1995): d) Patch Area (PA), and e) Core Area (CA). These indicators were combined to produce the Conservation Priority Model.

Every mapped remnant patch (see Figure 3.6 - Map of Remnant Patches of Natural Vegetation – Chapter 3) was assessed based on a set of criteria to generate indicators of integrity and metrics indexes that were then summed up to form a composite Conservation Priority Index (CP). In practice, a qualitative rank based in a process of iterative comparison among patches and assigning a corresponding quantitative index was used to evaluate each ecological integrity criterion. Individual patch landscape metrics indexes were obtained directly from the GIS data base.

The range of values and intervals of each index were defined iteratively and adjusted in conjunction with sound judgment and personal knowledge of the study area, in a manner to assign a weighted relevance to the five indexes to produce a final rank that could yield meaningful landscape conservation priorities. The Table 4.1 presents the range of values of each indicator. To define an overall priority rank remnant patches were clustered based on the CP indexes normalized by an evenly distribution of the area covered by remnant patches within each class of conservation priority.

Table 4.1: Range of values for Conservation Priority Indicators

Conservation Status (CS)	Habitat Diversity (HD)	Patch Context (PC)	Patch Area (PA)	Core Area (CA)
1 – 3	1 - 3	-2 - 2	Proportional to the mean patch area	Proportional to the mean core area

a) Conservation Status Index (CS)

Conservation Status represents the ecological conditions of remnant patches and is an integrated measure of the composition, structure, and biotic interactions that characterize the occurrence of a conservation target, like the typical canopy or understory structure of an Araucaria forest community, or the presence of management sensitive species (e.g., *Desmodium adscendens, Leguminosae Fab.*, or *Allagoptera campestri, Palmae*) on grasslands patches. Characteristics of structure and composition of vegetation affects interaction in the species level and are determinant factors to regional biodiversity.

It is becoming increasingly apparent that the internal condition of an individual fragment can be as important or more important than the spatial pattern of fragments in determining biotic abundance and distribution and, hence, conservation value (Hobbs 2001). It is therefore necessary to consider both the spatial pattern and internal fragment characteristics in unison to understand what's happening in fragmented landscapes and to develop appropriate management strategies. As discussed by Groves et al (2002), in assessing the condition of patch, it is often helpful to examine the extent of anthropogenic impacts (e.g., habitat fragmentation, degradation, and introduction of exotic species).

The conservation status of a patch reflects also the intensity of previous human activities (disturbances) on which the ecosystem was submitted through history. Human actions in the Campos Gerais, since pre-colonial times, have interfered in several ecological processes and patterns (e.g. habitat destruction, population dynamics, colonization and extinctions rates, species succession, organic matter levels, soil fertility, rate of water infiltration, etc). The management history of a remnant patch presents a direct relation with disturbance frequency regimes and the amount of energy to subside its modification, maintenance, and the necessary time for the ecological restoration (Forman & Godron 1986).

Habitat quality may be the most important factor to determine the presence or absence of a species at a given site (Duelli 1997). Identification of high-quality habitats for wildlife species may be the most important strategy in areas where inventory data are lacking or are very poor or sparse (Poiani et al 2001). A higher index of CS therefore indicates a higher carrying capacity of a patch to support and maintain an integrated adaptive community of organisms having species composition, functional organization, and resilience comparable to that of natural habitats of a bioregion. A remnant patch's CS index reflects, thus, the quality of its habitats and indicates the capacity to recover the structure and the patterns of the native vegetation and the associated ecological processes, when submit to environmental disturbances (Noss 1996).

To determine the CS index a qualitative procedure based on sound judgment was employed. Previous field assessments had been conducted conjunctly by flora, wildlife, and soil science experts, to assess conservation status of typical regions' grasslands and typical patterns of ecological succession of forest formations. Complementary research has analyzed the correspondence of such field patterns with the patterns of spectral response on satellite and aerial imagery (Rocha 1995, Moro et al 1996, Rocha & Weirich Neto 2005). These previous interpretative exercises propitiated the basic knowledge to enhance the criteria for image interpretation.

The Conservation Status index (CS) of remnant patches was operationalized by a comparative evaluation of the spectral responses among patches of the same class of natural vegetation (i.e., Araucaria and riparian woods, grasslands, wet grasslands, wetlands, or rock outcrops). The pattern of plant physiognomy on the image, as it represents patterns of ecological succession, was the ecological attribute assessed for each patch. In practice, a qualitative rank of high, medium, or low conservation status was iteratively assigned for each patch. Table 4.2 presents the matrix for conservation status classification and corresponding CS indexes.

Table 4.2: Matrix for evaluating Conservation Status of remnant patches, based on visual analysis of satellite image, aerial photography and corresponding field patterns of natural vegetation, and CS index assignment

Class of Remnant Patch	Land Use History and Management Intensity[1]	General field correspondence of features with degree of disturbance by human management	Conservation Status	CS Index
Grassland	Never cultivated	Good grassland soil cover Mainly native plant species Typical pattern of natural prairie land physiognomy and no apparent erosion	Pristine	3
Grassland	Never cultivated; Previous overgrazing rangeland management	Fair grassland soil cover Most native plant species In process of restoration from overgrazing rangeland	Fair	2
Grassland	Previous farming (>20 years) or currently under overgrazing rangeland management	Poor grassland soil cover Clear signs of soil erosion Predominance of indicative species of modified environments and presence of invading native and introduced plant species	Disturbed	1
Araucaria and Riparian Woods[2]	Never clearcut; Few patches or signs of old (> 50 years) selective cutting	Primary forest or riparian woods dominated by *Araucaria sp* and typical forest-physiognomy Presence of patches of advanced secondary forest	Primary Forest	3
Araucaria and Riparian Woods[2]	Patterns of previous selective cutting or old (> 50 years) clearcut	Advanced secondary forest or riparian woods with dominant Araucaria trees and typical forest phytophysionomic pattern	Secondary Forest	2
Araucaria and Riparian Woods[2]	Patterns of more recent selective cutting or clearcut (<50 years)	Forest under natural regeneration from disturbance occurred during the time range of available aerial photography with the presence of Araucaria trees.	*Capoeirão*	1
Mixed Riparian and Alluvial Systems	Never managed or disturbed No urban or industrial watershed discharge	Mainly pristine wetlands and other riparian vegetation types	Pristine	3
Mixed Riparian and Alluvial Systems	Never managed and few disturbed sites; No urban or industrial watershed discharge	Mostly pristine wetlands and other riparian vegetation types with evidences of anthropic interference	Fair	2
Mixed Riparian and Alluvial Systems	Previous drainage, sand extraction or agriculture activity; Urban/Industrial watershed discharge	Vegetation/ecosystem disturbed by human activities and significant presence of introduced or invasive exotic species Urban and industrial pollution	Disturbed	1

[1] Based on historical time range of the aerial photography available
[2] Based on the ecological succession of Araucaria Forests (Klein & Hatschbach 1971, Maack 1968)

The CS analysis was executed by following these steps: a) visual analysis of patterns of satellite image and the interpretation of spectral responses as on the different bands of the LANDSAT ETM^+ image; b) checking of image patterns with available ancillary data; and c) analysis of the land use change assessed by the information available on the time range of aerial photography and satellite imagery and current land use systems.

Accordingly, patterns on satellite images of grasslands patches located in places previously assessed in the field as having high conservation status were comparative evaluated against other

grasslands patches. A qualitative rank of pristine, fair or disturbed, was then, iteratively assigned for each patch. Classification of Araucaria and riparian woods, mixed riparian systems and mixed alluvial patches followed the same reasoning. Forest patches were classified as Primary Forest,

Secondary Forest, or "*Capoeirão*"[4]. The correspondent CS index, therefore, reflects the broad quality of habitats within each mapped remnant patch.

b) Habitat Diversity Index (HD)

Spatially and temporally heterogeneous areas are generally superior to homogenous areas as conservation reserves if the goal is to maintain high biological diversity. This principle stems from the observation that nature is dynamic and changes over time and space through biotic and abiotic disturbance. Spatial heterogeneity of habitat patches within a reserve accommodates disturbance better than does a

[4] *Capoeirão* is the Portuguese word to designate an intermediated stage of ecological succession on forests.

homogeneous reserve by offering species a diversity of habitat types at any given time (Meffe & Carroll 1997). Wiersma & Urban (2005) noted that beta diversity, the diversity among habitats, may be as important as within-site (alpha diversity) for conservation. Margules et al (1994) observed that selection of reserve sites based on the diversity of habitats may be more efficient than a selection based on species.

Higher levels in the biological hierarchy, such as species assemblages, habitat types and ecosystems lose biological precision, but have other advantages. They can integrate more of the ecological processes that contribute to the maintenance of ecosystem function and the relevant data are more widely and consistently available or attainable. In addition there are sound theoretical reasons why environmental variables should be good estimators of the spatial distribution pattern of species and there are now some empirical studies that add support. Additionally, it is relatively easily to compile information in natural community distributions from aerial imagery (Margules & Pressey 2000, Franklin 1993).

Accordingly, the DH Index of remnant patches was directly assessed by identifying the types and number of natural vegetation communities within each remnant mapped patch. Remnant patches were delineated continuously and, consequently, often incorporated more than one of the typical regional vegetation community types (Araucaria woods, riparian woods, rock outcrops, dry prairies, wet prairies and wetlands), within the same mapped remnant unit. Each vegetation community, therefore, corresponds to distinct habitats for different assemblages of species supported by that particular composition of biotic and abiotic factors. Accordingly, patches with higher number of community types were assigned higher index values. Table 4.3 shows the referential matrix to assign DH Index to remnant patches.

Table 4.3: Matrix for determination of the Habitat Diversity Index (DH)

Number of vegetation community types within mapped remnants patches	6	5	4	3	2	1
Habitats Diversity Index (DH)	3	2,5	2	1,5	1	0,5

c) Patch Context (PC)

Biodiversity in a fragmented matrix is influenced by the ecological dynamics within the remnant patches and by the context of the larger landscape where they are situated, which must be considered at multiple scales. Recent advances in metapopulation theory, landscape ecology and macroecology have revealed the strong impact of landscape configuration on local diversity and community structure and how diversity within a patch depends on the structure of the surrounding landscape. The composition of a landscape is one of the key factors explaining species richness at the regional scale (Dunning et al 1992, Dale et al 2000).

These so-called 'matrix effects' have been demonstrated by various authors (e.g., Jonsen & Fahrig 1997, Miller et al 1997, Baudry et al 2000). Fahrig (2001) has argued that an improvement in matrix quality can reduce extinction thresholds when the amount of habitat is decreasing. Conservation strategies for sustaining biodiversity must consider that species richness and ecological processes are controlled by parameters operating at a wide array of scales. Matrix effects are due to a variety of processes which includes source-sink dynamics and neighborhood effects (Dunning et al 1992, Wiens et al 1993). These in turn are modulated by the mobility, the migratory behavior and the specific demands of the species involved (Dauber 2003).

Ecological processes in fragmented landscapes are dynamic, with extensive movement by plants and animals, as well as material transport and energy flux, occurring within and among habitats. Within patches, remnant vegetation communities are spatially located in the context of other remnant communities, which may have been under distinct forms of management (e.g., overgrazed grasslands or previous selective cutting on Araucária forests). Outside patch limits, at smaller scales, patch dynamics functions in the context of surrounding patches of remnant vegetation, relative position and distance from other remnant fragments or other human-dominated and intensive forms of land use.

As put by Margules & Pressey (2000), "changes in the ecological fluxes of wind, water, and solar radiation can lead, in turn, to changes in vegetation structure, microclimate, ground cover and nutrient status. These changes may favor some species, but they also lead to reduced population sizes and local extinction of others. Once isolate and expose habitat remnants may be placed on a trajectory of continued change. Deleterious effects can feed back on themselves to increase their magnitude, they can simply accumulate within time, or they can cascade, with a change in a species' abundance or productivity leading to unforeseen changes in the population of other species".

In the regional matrix, the landscape mosaic around patches is shaped by different landscapes contexts (urban, suburban, industrial, managed for cash-crop and family farming systems, commercial forestry, and grasslands), which may present distinct problems for the normal functioning of ecological processes and for the capacity of a remnant patch to sustain biodiversity. At smaller scales, the regional matrix is embedded within a larger regional context on which interactions among natural and human systems produces spatial and temporal landscape change.

Problems that may affect remnant patches from its context may be resulted from urban sprawl, pesticides spraying, excessive soil fertilization, GMOs and monocultures, frequent fire (or lack of it), exotic species invasion, presence of domestic animals, barriers to wildlife migration, and severe pollution contamination. If reserves become fragments of natural habitat surrounded by alien habitat, changes brought about by isolation and exposure has implications for persistence of species within them (Franklin 1993, Forman 1995, Meffe & Carroll 1997).

Raster modeling was employed to assess the Patch Context Index (PC) based on the Spatial Analyst extension of the Arc View software. To the vector map of Land Use System[5] a correspondent PC index was assigned (Table 4.4), and then converted to a grid format. These indexes were defined based on the detrimental or beneficial impacts of the distinct land use types may provoke on biodiversity. Accordingly more intensive land use systems surrounding a remnant patch may produce greater deleterious effects and, accordingly, a lower PC index values were assigned. The final PC index (see Attached 1) was defined by setting a 1 Km buffer polygon around each remnant patch, converting them to a grid format and then summarizing the mean value of PC indexes within the buffer context.

The Patch Context of a remnant patch as employed on this model reflects, therefore, the intactness of dominant ecological processes that help maintain conservation targets (e.g., natural hydrological flow and fire regimes) and connectivity, which allows

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[5] [1] See discussion on the Section 3.3.3 – Land use systems and remnant patches

species to disperse, migrate, and otherwise move to adjacent habitats to meet life cycle needs (Groves et al 2002).

Table 4.4: Matrix for the definition of the Patch Context Index (PC)

Class of Land Use System[1]	Patch Context Index (PC)
Urban/Suburban/Industrial	- 2,0
Intensive Farming System	-1.5
Family Farming System	-1.2
Intensive Forestry (*Pinus/Eucaliptus*)	-1.0
Family Farming with Remnant Patches	-1.2
Intensive Farming with Remnant Patches	-0,5
Ranching/Remnant Vegetation	2,0

d) Patch Area Index (PA)

The area of each mapped patch is perhaps the single most important and useful of the landscape metrics (McGarigal & Marks 1995). Patch size represents a fundamental attribute of the spatial character of a patch has a great deal of ecological utility in its own right. Most landscape metrics either directly incorporate patch size information or are affected by patch size. Large habitats blocks typically harbor larger, more viable populations, particularly to interior and extensive territorial demanding species, offer greater resources and habitat diversity, support more intact ecological processes, and provide large undisturbed core areas (Forman 1995, Riitters et al 1995, Meffe & Carroll 1997, Poiani 2001, Singer et al 2001).

Biodiversity within small vegetation fragments is often subjected to serious ecological problems over the long term, including competition from invasive species, edge effects, lack of viable populations, and degraded natural processes. Factors such as changes in micro-environmental conditions, weed invasion, and nutrient inputs from surrounding altered matrix are all likely to have a greater impact in small reserves than in large ones, simply as a result of the larger edge-to-area ratio of smaller reserves (Poiani 2001, Hobbs 1998).

Small habitats are more susceptible to transformations in the case of catastrophic events, present a higher genetic vulnerability and lower chances of persistence in the long-run (Meffe & Carroll 1997, Hobbs 1998). The smaller the patch habitat, the greater the effect of the surrounding areas as a source of problems, and the greater the need for habitat buffers that minimize habitat differences between the core reserve and adjacent areas. Kiviniemi & Eriksson (2002) observed that reduction in grassland fragment size is linked to signs of degradation at edges of smaller grasslands, i.e. reduction in species richness and a decreased similarity to the grassland interior.

In the regional matrix, the Patch Area Index (PA) of each remnant mapped unit was determined by the following equation:

$$\mathbf{PA = (Patch\ Area/Mean\ Patch\ Area)^{1/2}}$$

Patch area corresponds to the size (in hectares) of each mapped remnant patch, acquired directly for the GIS data base and mean patch area is the average for all mapped remnant patches. The PA Index was normalized by the square root function of the quotient between patch area and mean patch area, resulting in a continuous index proportional to the size of each patch. Thus, accordingly to the equation, a patch with an area equal to the mean (428.8 ha) will have a PC index of 1. A patch four times larger than the mean area will result an index of 2; for a patch nine times larger, an index of 3 was assigned and so on. Conversely, for a patch with half the size of the mean patch area, the PC index is 0.7 and a patch four times smaller results an index of 0.5.

e) Core Area Index (CA)

Core area is defined as the area within a patch beyond some specified edge distance or buffer width. A lower value of the area/perimeter ratio of a patch, as in small or elongated units, implies patches with proportionately more perimeter length per unit of interior area on which interior species, those requiring undisturbed habitat away from edges, presumably will do poorly. A lower area/perimeter ratio also means that more management, and thus more energy, money, and time is necessary to maintain desirable interior ecological conditions of a patch (Meffe & Carroll 1997).

Several influential studies suggested increased densities of nest predators and parasites near edges were inhibiting reproduction of some native bird species in small forest remnants and increasing the establishment of invasive species in adjacent habitats. Since the 1980s, edge effects have come to be seen as negative influences on biological diversity (Sisk & Margules 1993). The edge concept comprises a wide range of processes that occur at edges particularly to the influence of flows of energy, nutrients and species across the mutual edge of adjacent ecosystems, resulting in a change of species composition, structure and ecological processes at the edge (Herlin 2001).

Core area metrics, thus, reflect both landscape composition and landscape configuration. Core area has been found to be a much better predictor of habitat quality than patch area for some forest interior specialists. For ecological processes or organisms adversely affected by edge, it seems likely that core area would better characterize a patch than total area would. Core area is directly affected by patch shape and the amount of borders; thus, while a patch may be large enough to support a given population of specie, it still may not contain enough suitable core area to support that specie (McGarigal & Marks 1995).

In the regional matrix, Core Area Index (CA) of each mapped unit was determined by the following equation:

$$\mathbf{CA = (Core\ Area/Mean\ Core\ Area)^{1/2}}$$

Core area corresponds to the size (in hectares) of the polygon formed within each mapped remnant patch beyond the edge distance of 100 meters and it was operationalized directly from the GIS data base. Mean core area is the average core area of all mapped remnant patches. CA Index was normalized by the square root function of the quotient between each patch's core area and mean core area, resulting, thus in a continuous index proportional to the size of each patch's core area. Thus, accordingly to the equation, a patch with a core area equal to the mean (210.2 ha) will have a PC index of 1. A core area four times larger than the mean core area will result an index of 2; for a patch with a core area nine times larger, an index of 3 was assigned and so on. Conversely, for a patch with half the size of the mean patch core area, the PC index is 0.7 and a patch four times smaller results an index of 0.5.

Conservation Priority Index (CP)

The resulting indexes were then summed up in the GIS environment to produce a Conservation Priority Index (CP) to each patch, accordingly to the following equation:

$$\mathbf{CP = \sum (CS, HD, PC, PA, CA)}$$

Following this procedure, remnant patches were classified into three classes of conservation priority: a) Regional; b) Landscape; and c) Local/Farm, corresponding to higher, medium and lower categories of priority. The intervals of CP index to define classes of Conservation Priority were defined by allocating the amount of remnant land area evenly among the three classes of priority. Accordingly, a Map of Conservation Priority Patches was produced by mapping the spatial distribution of patches' conservation priority.

Evaluation of the Conservation Priority Model

To evaluate the efficacy of the Conservation Priority Model a comparative analysis was performed between conservation priority results against the previously known occurrence areas of new, new for the region, rare, endemic, and endangered species in the regional mosaic. The Attached 1 shows the list of indicator species, their respective conservation status, and the sources of references. The known spatial distribution or occurrence of these indicators species was then introduced into the GIS environment.

The model's efficacy was assessed based on screen comparison of occurrence areas and the matching with the Map of Conservation Priority Patches. An efficient model should incorporate the majority of the mapped occurrence of indicator species within higher conservation priority patches (Regional and Landscape priority). Pearson correlation coefficients were also calculated between conservation priority index and indicators of ecological integrity and landscape metrics in order to explore further insights about indicators and the conservation priority model.

4.3.2 Designing the Network of Nature Reserves

Although there is no systematic data of movements along the regional river network, field evidences in the regional matrix (Pontes Filho et al 1997, PARANÁ 2004, Polatti 2005) indicated the use of riparian areas as habitats for species such as the tapir (*Tapirus terrestris*) and the *white-lipped peccary* (Tayassu pecari), and as corridors by species such as the manned wolf (*Chrysocyon brachyurus*) and the cougar (*Puma concolor*). In addition, streams corridors (riparian vegetation) are well-known for their roles in minimizing impacts from surrounding intensive land use and farming practices on fragmented landscapes, although the effectiveness of different widths and vegetation types is yet poorly known (Forman 1995, Wiens 2002, Vondracek et al 2005),

Therefore, in order to provide structural connections among remnant patches throughout the regional matrix, as well as to minimize impacts from surrounding land use systems, the next step on the landscape research was to design a nature reserve system, based on the hidrography. As already discussed[6], the combination of climatic, geologic, and soil characteristics had favored the development of an intensive regional drainage system and a river corridor network was defined by buffering a 100m stripe on both sides of the low order streams (1^{st} and 2^{nd} order) and a 200 m stripe for the main rivers (higher than 3^{rd} order). Within Urban/Industrial areas, river connectivity was analyzed individually to check prospective networks. Following this task, by combining the maps of remnant patches with the river corridor network, the Regional Network of Nature Reserves was designed.

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[6] See Section 3.3.1: The landscapes of the Campos Gerais ecoregion.

4.4 Results and Discussion – The Regional Network of Nature Reserves

4.4.1 Conservation Priority Patches

Remnant Patches were classified accordingly to the sum of the Conservation Priority Indexes (Area, Core Area, Patch Context, Conservation Status, and Habitat Diversity), and by distributing the total remaining surface in an equally manner into three classes of conservation priority: a) Regional; b) Landscape; and, c) Farm/Local. The Table 4.5 presents the landscape metrics for the classes and the Figure 4.1 - Map of Conservation Priority Patches, displays the spatial distribution of Conservation Priority Patches in the Regional Matrix. The Attached 2 shows the data of computed indexes (Area Metrics, Ecological Integrity and Conservation Priority Index of Remnant Patches) for the 245 mapped patches. The Figure 4.2 shows the maps for each conservation index, equalized by same area distribution among classes of conservation priority.

Table 4.5: Classes of Conservation Priority Patches

Conservation Priority	Number of Patches	Remnant Area (ha)	Remnant Area (%)	Mean Patch Area (ha)	Median Area (ha)	Smaller and Larger Patch Area (ha)	Smaller and Larger Patch Core Area (ha)
Regional	7	37,070	35.3	5,296	4,370	1,991 – 13,561	1,194 – 9,433
Landscape	31	33,946	32.3	1,095	807	101 – 3,883	25 – 3,445
Farm/Local	207	34,050	32.4	164	104	40 – 922	0.4 – 561
Total	245	105,066	100	429	119	-	-

Regional Conservation Priority Patches comprise 7 mapping units with total surface of 37,070 hectares, corresponding to 35.3% of the remnant total surface. Two of the four regional vegetation types[7] are included in this class: a) Grasslands, distributed

[7] See Section 3.3.1: The landscapes of the Campos Gerais ecoregion.

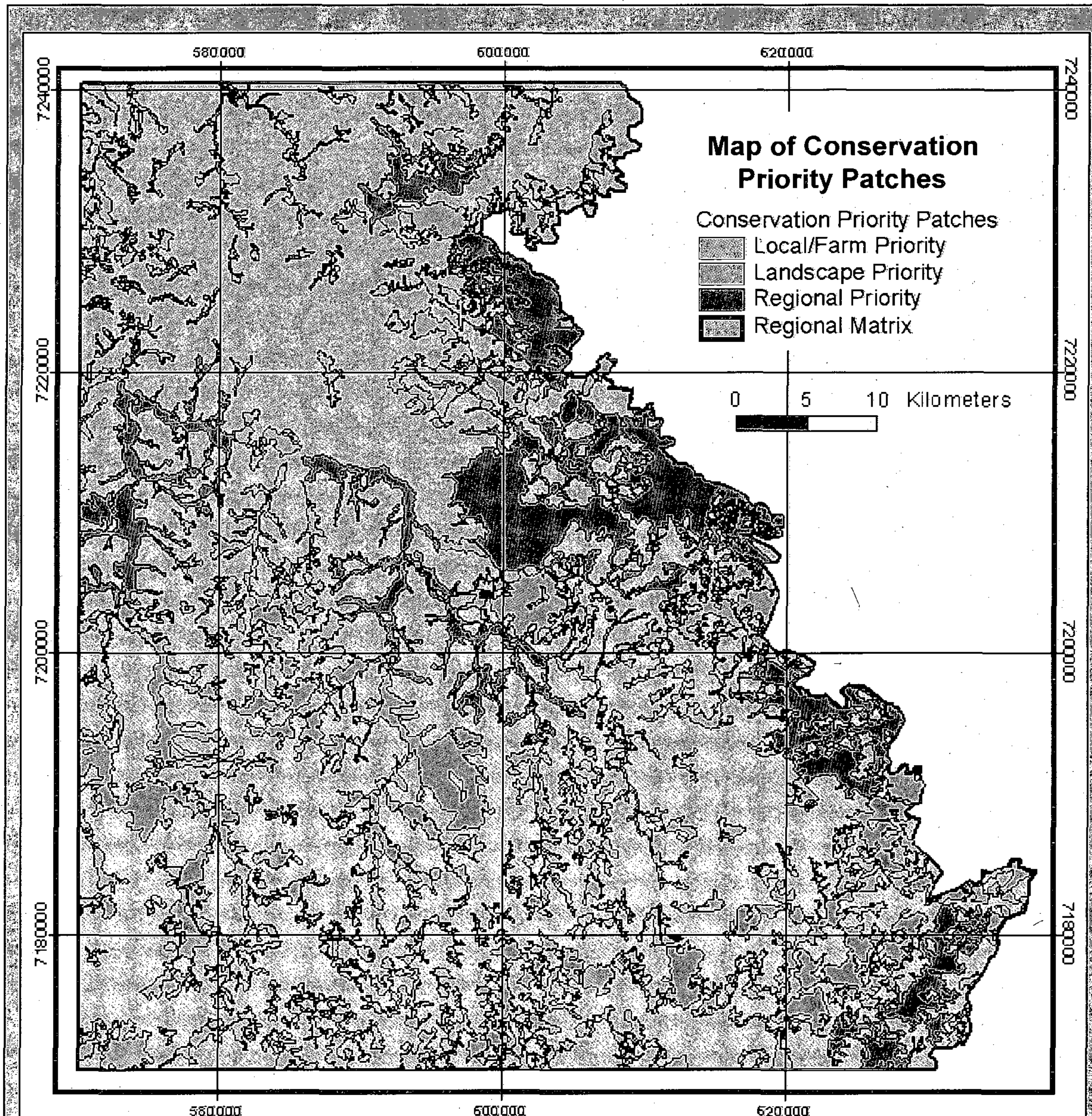
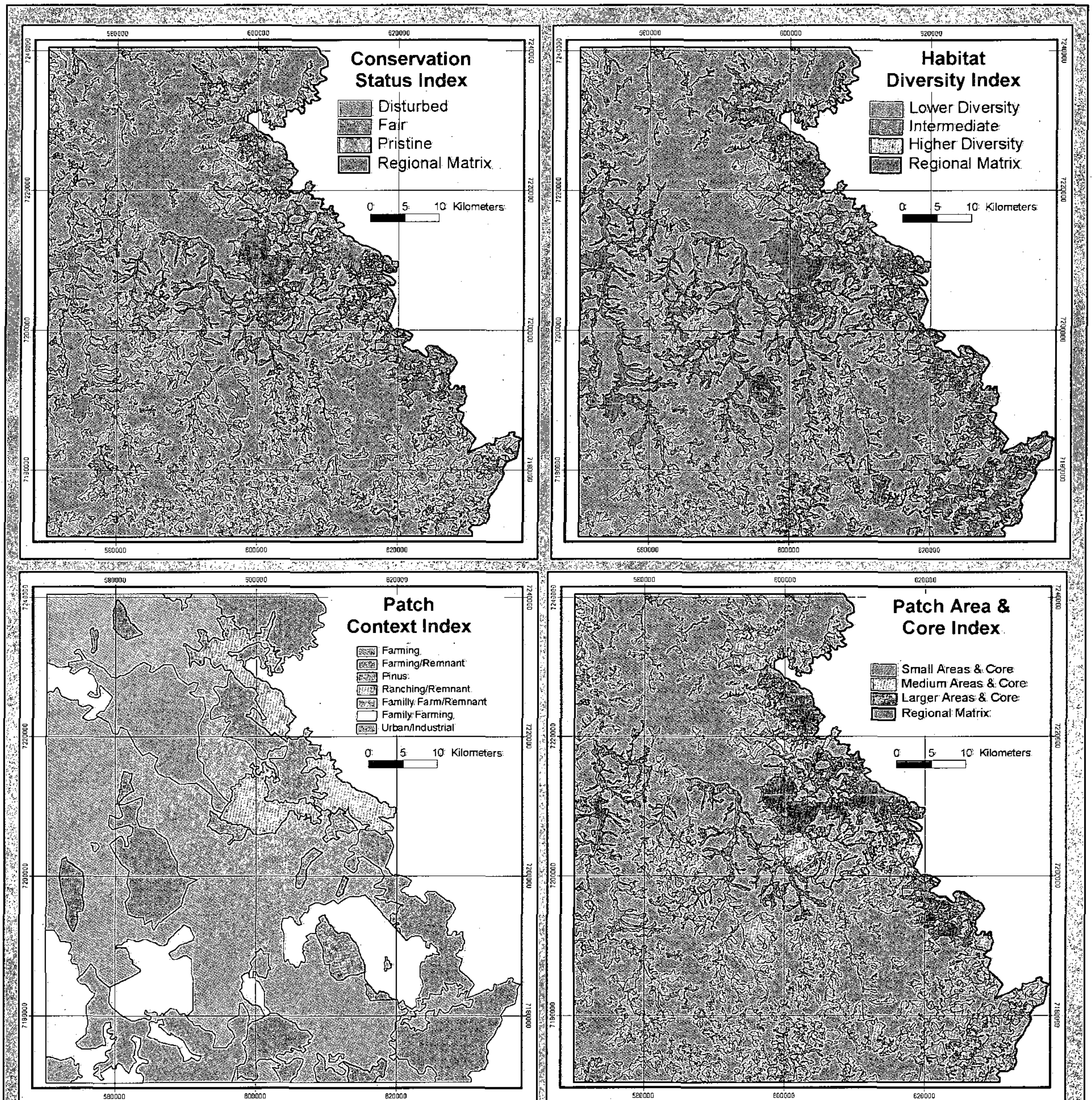


Figure 4.1: Map of Conservation Priority Patches

alongside the reverse of Devonian Escarpment, with significant presence of dry prairies on the top of the hills, and Araucaria Woods, Riparian Woods, and Wet Prairies in the base of the slopes and at the bottom of valleys (5 units, total area = 27,314 ha – 73.7% of the class); and, b) Mixed Alluvial Floodplains of the Tibagi and Guaraúna rivers, and their main tributaries, which includes a significant presence of Wetlands and Riparian Woods (2 units, total area = 9,756 ha - 26.3% of the class).



Range and labels of Conservation Priority Indexes – CPI (See Table 4.4 for Patch Context Index Range and Values and Attached 4.2 for the CPI results of individual Patches)

Conservation Status Index		Habitat Diversity Index		Patch Area + Core Index	
Index Range	Label	Index Range	Label	Index Range	Label
0.5 – 1.0	Disturbed	0.5 – 1.0	Lower Diversity	0.4 - 2.7	Small Areas & Core
1.1 – 2.0	Fair	1.1 – 2.4	Intermediate	2.8 - 6.4	Medium Areas & Core
2.1 – 3.0	Pristine	2.4 – 3.0	Higher Diversity	6.5 - 12.3	Large Areas & Core

Figure 4.2: Spatial Distribution of Conservation Priority Indexes

This category includes the larger remnant patches (areas between 1,911 and 13,561 ha), with mean area equal 5,296 ha and the most expressive core areas (between 1,194 to 9,433 ha). They are, therefore, subject to a lower antagonistic influence of the adjacent areas (lower edge effects). Historically, as observed in the aerial photography, remnant patches of grasslands classified in this group have been less intensively managed and the patches of woodlands are in later stages of ecological succession. High number of vegetation community types within mapped patches (high habitat diversity index) is a common feature of this category.

Forman (1995) has recognized eight ecological values are recognized for larger natural vegetation patches in rural areas: 1) water quality protection for aquifer and reservoirs; 2) connectivity of a low-order stream network for fish and overland movement; 3) habitat to sustain populations of patch interior species; 4) core habitat and escape cover for large-home-range vertebrates; 5) source of species dispersing though the matrix; 6) microhabitat proximities for multi-habitat species; 7) near natural disturbance regimes; 8) buffer against extinction during environmental change. These ecological values are considered relevant to the patches within this class of higher regional priority.

The predominant mosaic context on which these mapping units are located includes intensive agricultural landscapes intersected by the highway system which exert unfavorable pressures for conservation. Introduction and spreading of exotic species, illegal hunting, and uncontrolled burning are likely to happen along main roads. Three locations of manned wolf car hitting were mapped along the main regional highways by Pontes Filho et al (1997), and corresponds to about half of the registered death of that specie in the Matrix during that study.

The remnant patches alongside the Devonian Escarpment present a more favorable context, adjacent to significant remnants of Araucaria Forest (located in the Paraná 1st Plateau). The spatial configuration of these units allows a potential structural and functional connectivity when considered jointly with other regional and landscape priority remnant patches. Regional Priority Patches are considered essential areas as habitats for some species and for the maintenance of ecological processes, including decomposition, nitrogen cycling, pollination, seed dispersal, energy capture, food webs, insect outbreaks, disease, herbivory, and predation, and, therefore, for the conservation of the regional biodiversity.

To such remnants, society should warrant special attention in the form of resources for the development of collaborative strategies to achieve the defined Landscape Conservation Goals[8]: a) halting landscape fragmentation and habitat destruction; b) effective conservation and enhancement of the quality of existing habitats; c) recover and expansion of the area of protected habitat; d) improving structural and connectivity among remnant patches; and, e) minimizing the ecological impacts from surrounding landscapes. These patches are also considered as priority areas for the establishment of strict nature reserves (IUCN Categories I to III) either as public or private reserves.

Landscape Conservation Priority Patches comprise 31 mapping units with a total surface of 33,946 hectares, corresponding to 32.3% of the total remaining surface. Two vegetation community types are predominant: a) Grasslands located along the eastern and

[8] See discussion on Section 3.3.4: Defining Landscape Conservation Goals

central portion of the Regional Matrix, with significant presence of dry prairies associated to patches of Araucaria woods, riparian woods, and wet prairies in the base of the hills and alluvial valleys (16 units, total area = 17,233 ha - 50.8% of the class); and, b) mixed riparian systems located in the southern and eastern portion, including mainly riparian woods, dry and wet grasslands (11 units, total area = 11,315 ha – 33,3% of the class). Two other community types are also present: Araucaria forest and riparian woods (2 units, total area = 4,119 ha – 12.1% of the class), and mixed alluvial floodplains (2 units, total area = 1,279 ha – 3.8 % of the class).

This category comprises remaining units that present surfaces with intermediary areas (between 101 to 3,883 ha), mean area equal to 1,095 ha, greater edge/interior areas ratio, thereby submitted to higher negative edge effect and decreased true interior habitat (core area between 25 and 3,445 ha). These patches present several attributes more or less favorable to conservation: high diversity of vegetation types (habitats), grasslands submitted to anthropic exploitation under diverse intensities, and woodlands at intermediate to later stages of ecological succession. The mosaic context were they are situated includes intensive farming systems, family farming, commercial forests, and ranching systems. Proximity to the main road and highways exerts an unfavorable pressure on biodiversity conservation.

These patches are considered of high relevance to nature conservation as habitats for various species and for the maintenance of landscape structural connectivity, which particularly applies to the larger and more ecologically intact patches, potentially linking Regional and other Landscape Conservation Priority Patches. Hence, these patches have as fundamental attribute to be corridors and stepping stones for many species throughout the Matrix. They are also import for the maintenance of water quality, controlling the flux of nutrients and decreasing erosion and run-off from cultivated lands. They are also considered priority areas for the establishment of Protected Areas of Integral Protection (IUCN Categories I to III), either public or private, or, associated to each patch context, as Protected Landscapes (IUCN category V).

Local/Farm Conservation Priority Patches comprise 207 mapping units, with total surface of 34,050 hectares, corresponding to 32.4% of the remnant total surface. They comprise remaining units in three vegetation community types scattered throughout the Matrix: a) Araucaria Forest and Riparian Woods (114 units, total area = 16,914 ha – 49.7 % of the class); b) Mixed Riparian Systems, including Araucaria Woods, Wet Grasslands and Wetlands (61 units, total area = 9,739 ha – 28.6% of the class); and, c) Grasslands (30 small units, total area = 6,785 ha – 19.9%). It also include 2 patches of Wetlands (total area 612.6 ha – 1.8% of total class). This category includes remnant patches with smaller areas (between 40 and 922 ha), mean area = 166 ha, and little expressive core areas (between 0.4 and 561 ha) with clear predominance (66%) of edge habitats.

These patches present differentiated combinations of less favorable conservation attributes: intensive managed grasslands and wet grasslands, woodlands at intermediate stages of ecological succession, and low level of vegetation diversity (habitats). They are situated on a mosaic context less favorable to conservation including predominantly intensive farming systems and urban/sub-urban/industrial areas and few scattered remnants patches of natural vegetation. Proximity to the main and secondary roads exerts a negative additional pressure for conservation. Biodiversity within such small vegetation fragments is often subjected to serious ecological problems over the long term, including competition from invasive species, edge effects, lack of viable populations and degraded natural processes.

On the other hand, five ecological values are recognized for small natural vegetation patches in rural areas (Forman, 1995): 1) habitat and stepping stones for species dispersal and for recolonization after local extinctions; 2) high species densities and high population sizes of edge species; 3) matrix heterogeneity that decreases run off and erosion, and provides escape cover form predators; 4) habitat for occasional small-patch restricted species; and 5) protection of scattered small habitats and rare species.

Farm/Local Priority Patches are considered fundamental units at farm and local level as components of a conservation network as Legal Reserves (*Reserva Legal - RL*) and Permanent Preservation Areas (*Áreas de Preservação Permanente - APP*)[9]. The conservation goals for these patches include the task of improving connections among higher priority remnant fragments and as corridors and stepping stones throughout the matrix. When located among Regional Priority patches such attributes are particularly significant. The landscape context where such patches occurred can be considered as priority to the establishment of Protected Landscapes (IUCN Category V) and the remnant patches can be considered priority to the establishment of Private Natural Heritage Reserves (RPPN)[10].

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[9] Both defined by the Brazilian Law 4771/1965. See also discussion in the Section 6.2: The Legal Framework and Incentives for Conservation in Brazil.

[10] See also discussion in the Section 6.2: The Legal Framework and Incentives for Conservation in Brazil.

4.4.2 Evaluation of the Conservation Priority Model

Priority Patches and Occurrence of Indicator Species

As a means to evaluate the efficacy of the proposed model, a comparative analysis was performed between the conservation priority results and the know occurrence areas for new, rare and endemic species and the occurrence areas of the Manned Wolf (*Chrysocyon brachyurus*), previously identified in the Regional Matrix. The Figure 4.3 shows the spatial distribution of indicator species overlaying the map of conservation priority patches. All the occurrence areas for new, rare and endemic species are situated in remnant patches classified as Regional Conservation Priority, with three exceptions: two occurrences were located in patches classified as Landscape Priority, and the third is situated in a remnant patch smaller than the minimum mapping area, managed as intensive tourist visitation area at Vila Velha State Park.

The seven occurrence areas of the Manned Wolf previously mapped in the Matrix coincide with the mapped remnant patches. Among them, three (manned wolf occurrence areas 2, 3, and 6) are located in areas of higher priority (Regional and Landscape). Other two occurrence areas are inserted in a context of higher priority patches associated with farming landscapes (occurrence areas 5 and 7). Such fact may indicate a low availability of suitable habitats for this specie, suggesting the use of low quality sites as supplementary habitats or dispersal routes. Unexpectedly the two other occurrence areas (areas 1 and 4) comprise units mapped as low priority areas (Farm/Local) associated to considerable amount of cultivated landscapes.

This main contradiction with the model can be explained by the relatively recent fragmentation of previous prairie landscape. As the field work for mapping manned wolf occurrences was carried out between 1994 and 1999, the fragmentation occurred after this time lag have contributed to a lower Conservation Priority Index of those units (developed based on a LANDSAT image from 2000). These occurrence areas also include several small patches of wet grassland patches, smaller then the minimum mapping area, which may be used as supplementary habitats.

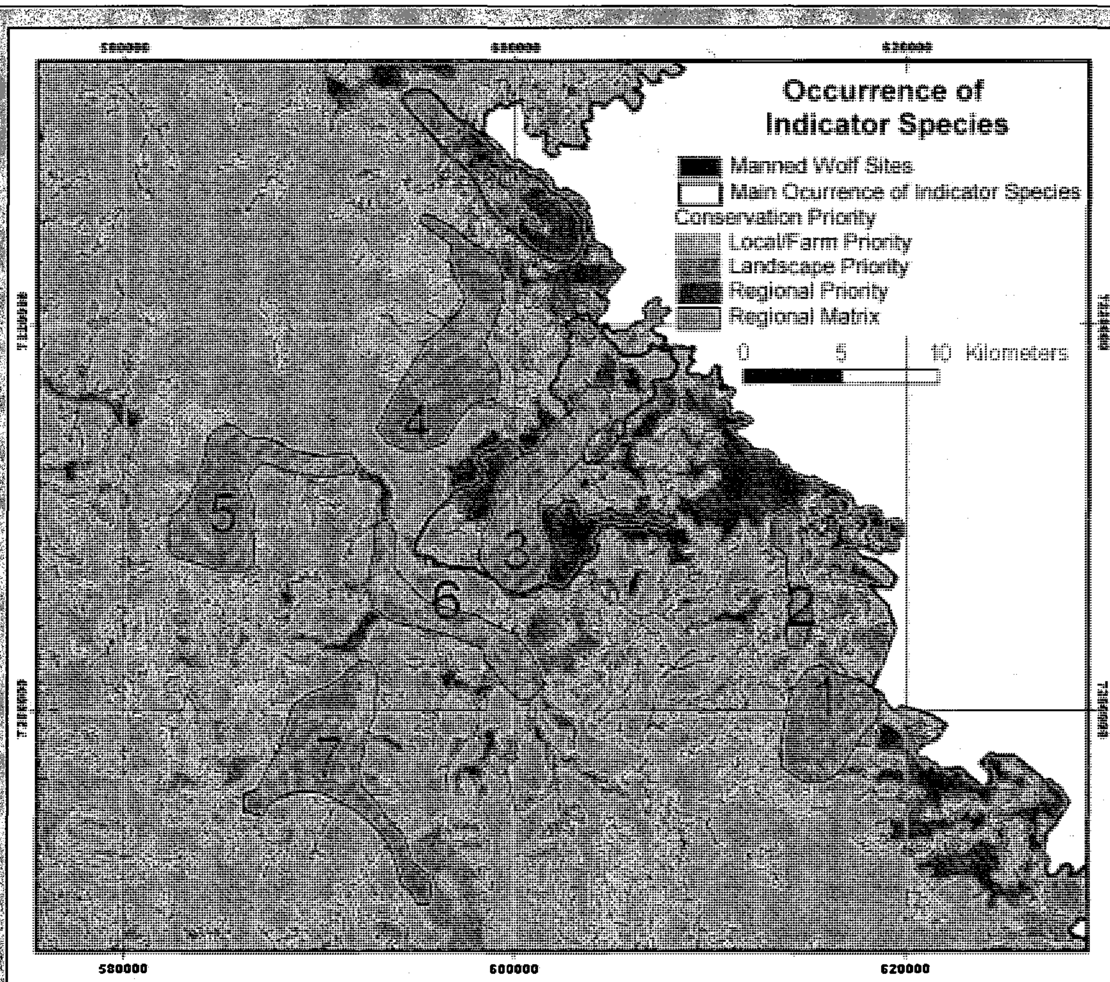

Figure 4.3: Spatial Distribution of Indicator Species and Conservation Priority Patches

The fact that those places are located close to higher priority areas (not include in the manned wolf occurrence surveys) may also had contributed to the occurrence of the manned wolf in those areas. High Habitat Diversity Index (HD) with pristine humid areas and wetlands is a common attribute to all manned wolf occurrence areas. Diversity of habitats is certainly an important indicator of preferential sites for the manned wolf in fragmented landscapes, for making available different resources through the territory in different times of the year. The Conservation Status (CS) of Remnant Patches also showed to be a good indicator of occurrence for this specie.

The general good fitting of the Conservation Priority Model with the mapped occurrence of indicator species, suggests a good approach for defining and selecting priority areas for conservation in fragmented landscapes. The effective conservation of remnant patches can ensure the habitat maintenance for several species in the matrix. Strategies for effective interconnection among remnant patches may provide a better conservation context compared to the actual landscape shaped by isolated patches scattered in the fragmented matrix. Every remnant patch, thus, has an important role to play in the Matrix. As stated by Lugo & Brown (1996), "the time has come to assign a use to every square kilometer on the planet to their best potential use for a more sustainable world".

Parameters for the Definition of Priority Areas

The validity of a model depends on its structural adequacy, parameters used and defined values. Equation selection and parameterization determine the behavior of a model (Reed et al 2002). The structure of the Conservation Priority Model, as well as the construction of the indexes used, are simple and straightforward, and has yielded results considered satisfactory, when compared to the know distribution of species through the Regional Matrix. The Index values were defined in such a way to consider a reasonable balance among parameters, and the criterion of breaking the CP index into three categories equalized by similar areas is justified as a way to define categories of priorities. Different arrangements between values and intervals can be assigned to the same parameters if they are compatible to significant ecological features for the conservation planning of a particular bioregion or landscape component.

The analysis of the correlation between the parameters provides a strategy to interpret the values and intervals used in the model. The Area Index (AI) and the Core Area Index (CA) presented the highest correlation with Conservation Priority Index ($r = 0.89$ e 0.88, respectively). Despite the high correlation between them ($r = 0.98$), both indexes were maintained in the equation. The other indexes presented lower, but still high correlations with the Priority Index (Conservation Status (CS): $r = 0.77$; Habitat Diversity (HD): $r = 0.78$ and Patch Context (PC): $r = 0.47$; all $p < 0.01$).

The high weight of the area indexes (AI and CA) on the final CP index seems to be adequate to the regional landscapes. Effective conservation of larger patches can potentially lead to the recover of many ecological functions in the intermediate to the long term; pristine but small and isolated patches presents a tendency to lost important ecological features (Kiviniemi & Eriksson 2002), over the long term. However, small areas, even isolated remnant patches among cultivated fields, may contain rare species of the Matrix (Polatti 2005, Paraná 2004) and can be important sources of habitats and perform an important role as stepping stones in animals' dispersion through the matrix. Therefore, small patches should also be considered in the planning of a protected area network.

The Core Area (CA) Index was operationalized considering only a fixed 100 meters inside buffer from de limits of each remnant patch. Several distinct interval widths (ex. 50, 100, 200 meters) could be employed as a way to add more variability in the edge effect, particularly if empirical evidence of edge effects to the regional biomes is present. Consistent data about edge effects for Brazilian biomes are rare, but such studies are beginning to appear in the literature (e.g. Oliveira & Rambaldi 2005, Primack & Rodrigues 2002) and could be employed in the parameterization of edge effects and intervals.

The Habitat Diversity Index (HD) was straightforward determined by computing the number of vegetation community types inserted within every remnant patch. A more robust approach may include the number of community types present normalized by their relative area, composing thus a more representative index of diversity. In this case, variability among patches would be larger than that provide by the strict intervals employed and would better reflect diversity within patches. However, an intensive delineation effort would be necessary to map within patch community type diversity when employing visual image interpretation. Alternatively, a digital classification of satellite image could be employed on an image with a better spatial resolution. Altitude gradients are another source of variability within patches and can be an important element for diversity differentiation, particularly in regions with large elevation range.

The Conservation Status Index (CS) was qualitative assessed based on the visual analysis of the LANDSAT image. This index can be digitally evaluated by employing indexes of vegetation such as NDVI (Normalized Difference Vegetation Index). This index expresses the difference in spectral responses between the visible red and near infra red wavelengths, reflecting information related to vegetation types, seasons and have been employed to differentiate conservation quality of remnant patches (e.g. Muldavin et al 2001). The use of a digital vegetation index, however, would depend on long term studies to calibrate satellite's digital data with environmental and temporal characteristics that conditioned spectral response of vegetation.

The Patch Context (PC) Index was also qualitatively determined. A combination of Landscape Metrics such as Isolation, Contagion, Interspersion, Contrast, and Connectivity, can produce and automatic and replicable PC index. Metrics, however, should be used parsimoniously, because the parameters to generate reliable data that represent ecological patterns require a thoughtful qualitative assessment of the regional landscape. A landscape's metrics value depends on how the landscape and the observation scale have been defined (McGarigal & Marks 1995).

This analysis did not include a parameter related to the importance of preserving remnants situated in the watershed of the Alagados reservoir, the water storage for the city of Ponta Grossa (21 patches situated in the Matrix's northwest portion). It's clear the potential of mutual benefits that could arise from the conservation of such remnants for biodiversity and water quality. Likewise, six remnants patches of grasslands situated in public areas under semi-intensive grazing systems could be evaluated with a different weight as the conservation of those units could potentially be easier to negotiate.

4.4.3 The Regional Network of Nature Reserves

The network of nature reserves was designed by buffering 100 or 200 m, accordingly to the stream order, along the river network (see Figure 4.4: Regional Network of Nature Reserves). The network has the objectives of minimizing impacts from adjacent land use systems on the river systems and enhancing structural and functional connections among remnant patches, potentially connecting remaining core habitat throughout the matrix. Many habitat corridors, both de facto and planned, encompass riparian zones, which are natural elements in the landscape that guide animal movement.

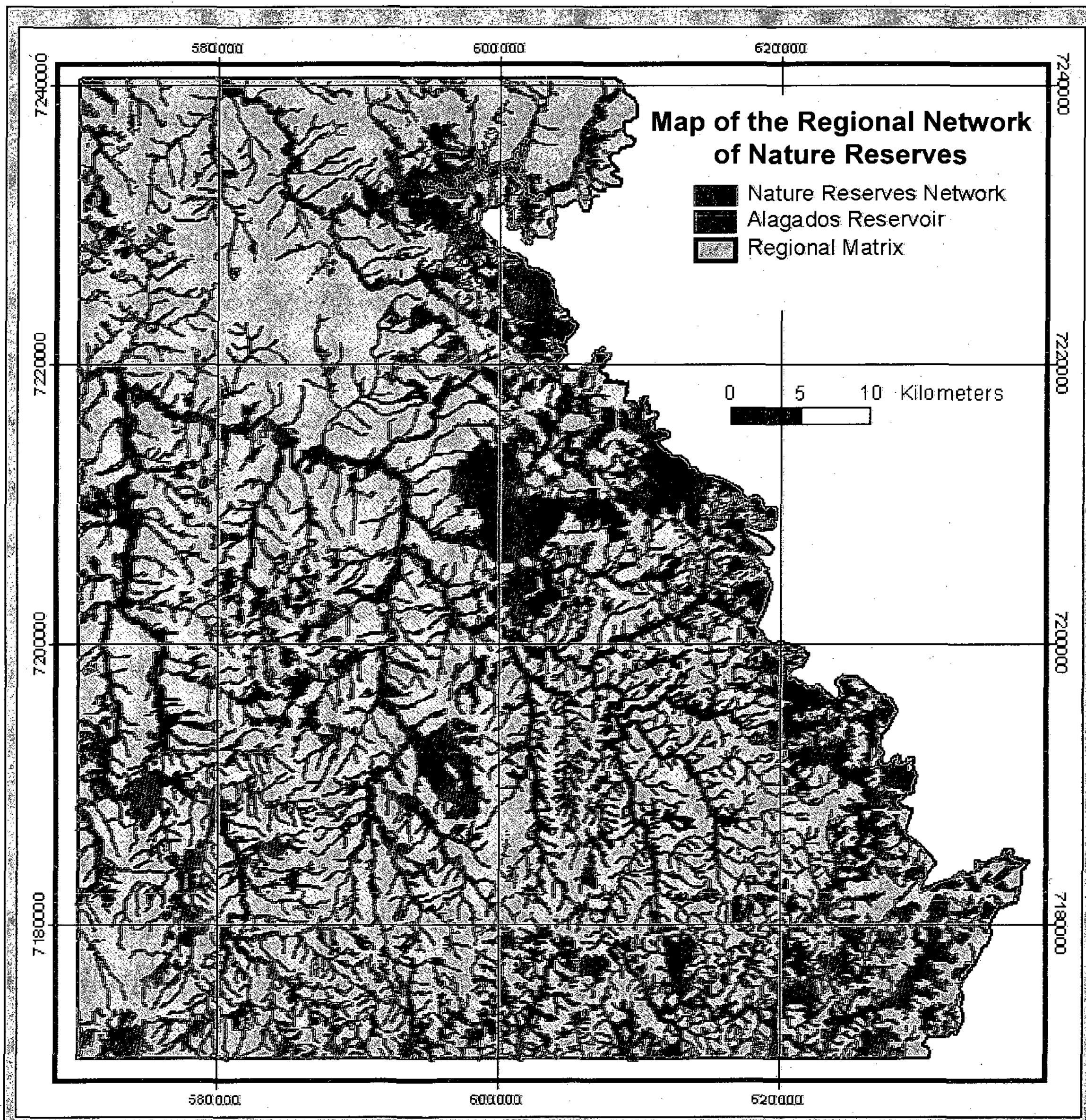

Figure 4.4: Map of the Regional Network of Nature Reserves

The legal requirement of a minimum width of natural vegetation on both margins of the river network[11], improved by a general good conservation status of the habitats associated to the riparian environments in several sectors of the matrix (e.g. Vila Velha State Park buffer zone and along the Devonian Escarpment), conferred to the regional river network the function of providing fundamental landscape linkages. In the Regional Matrix, 30 m is the minimum width for the majority of the river network, while for the two major rivers, Tibagi and Iguaçu, minimum width is 50 m (See Figure 3.2: Map of Hidrography – Chapter 3). However, to improve landscape connectivity for wildlife, river corridors should be wider than the minimum legally required.

Based on a simple design generated by the GIS software and easy to be located in the on field, the river network, as designed here, would add a surface of 44,621 ha to the 105,066 ha of existing remnant patches, totaling the reserve network 149,687 ha. Therefore, the river corridor network, as mapped on this research, should be amply recognized by agencies and landowners as main landscape ecological elements and be managed accordingly, in order to provide structural and functional connections, and potentially improving linkages among landscapes, habitats, species and populations. Maintaining wide and well-vegetated riparian corridors may be important in maintaining the connectivity of native predator populations to ensure their long-term survival (Hilty & Merenlender 2003).

An effective integrated landscape approach to sustaining diversity combines habitat distribution analysis with patches, corridors and matrix. It is also recommended

[11] See further discussion in the Section 6.2: The Legal Framework and Incentives for Conservation in Brazil.

that conservation measures in agrolandscapes should include stepping stones of native vegetation for maintaining diversity. As previously noted, combining the priority patches in carefully chosen locations with connecting corridors and stepping stones across the landscape produces a nature reserve system rather than a collection of reserves (Forman 1995).

A functional network of protected areas can provide an adequate spatial context configuration and connectivity among patches to conserve regional scale species (Poiani et al 2000a). Sites or landscapes within functional networks can be arranged contiguously, within one region or in several adjacent regions to protect high territory demanding species such as the manned wolf (*Chrysocyon brachyurus*) or the cougar (*Puma concolor*). Complementary, small remnant patches may form a series of stepping stones spread over many regions to protect migratory species such as certain birds, insects, and bats.

The nature reserves system designed by the landscape, a collection of priority patches and the river network effectively incorporates: a) combinations of habitat types and disturbance/ regeneration regimes within remnant patches; b) the patch context, i.e., surrounding habitats and surrounding land-use systems; and c) connectivity throughout the matrix. In a nature network system the interactions among reserves (the remnant patches and the corridors) are as important as the patches. Yet, natural-resource reserves are not the goal. Rather, they are important pieces in a mosaic where every piece counts. Planning of the whole landscape mosaic is required to enhance wildlife and protect biodiversity (Forman 1995, Lugo & Brown 1996, Bawa et al 2004, Bhagwat et al 2005).

Whether the nature reserve system will be successful in conservation within the regional context of land use systems will largely depend on how well conservation initiatives can orchestrate the actions of the disparate actors that affect land uses within each landscape. Strengthening the management of the existing protected areas (VVSP and three small Private Reserves), while creating the array of new protected areas of sufficient size needed to conserve biodiversity, are essential for conserving biodiversity. Similarly, strengthening alliances with other land managers, especially farmers and landowners, as well as other stakeholders, will be vital to ensure the long-term viability of the region's last stands of natural vegetation.

4.5 The Research Framework and the Nature Reserve System - Conclusions

There are many methodological approaches about how best to identify priority conservation areas. To some extent this diversity is welcome as it arises from attempts by people with varying backgrounds to solve different problems in different parts of the world. Some of the divergence, however, is less useful and seems to reflect different poorly defined conservation goals and different, often implicit assumptions about the constraints under which conservation action will be applied (Margules & Pressey 2000).

As the science of conservation ecology matures so does the appreciation that no single procedure for identifying areas of conservation interest is likely to be universally appropriate (Prendergast et al 1999, Rothley et al 2001, Newburn et al 2005). In most planning scenarios there are more areas of biological value than it would be possible to declare as public reserves. Therefore, it usually necessary to identify a subset, but how to know which the best subset is and how they can be functionally integrated?

Based on the research conceptual framework, we have outlined a model for identifying the most important remaining areas for conservation in the Regional Matrix and designing its functional integration through the river network. The amount and the spatial distribution of remnant units indicated that conservation strategies should include a network of protected areas basically located within private rural properties. A patch-scale study alone is insufficient to understand its role in conservation; a landscape approach is essential. Hence, Landscape and Regional Priority patches and the managed matrix where they are embedded, were considered, in conjunction with the river network, the basic units for designing the nature reserve system.

The guidelines presented in the Conservation Priority Model point to the selection of larger areas, with more significant cores areas, higher diversity of community and habitat types, higher quality habitats as represented by the conservation status, and located within more propitious landscape context. The combination of these factors has produced a consistent model with the previously know occurrence of indicator species. Availability of mapped occurrence of indicator or key species can, evidently, be incorporated into the model.

The model was not designed to estimate the contribution magnitude of each parameter to conservation as well as not to define the minimum area size or the minimum viable population and estimate probabilities of species conservation. The method can also not to predict which species can be retained or how many tends to be extinct in the medium and long term. While this approach has these limitations, the continuous landscape fragmentation in intensively managed regions requires urgent actions. The model indicates that the areas categorized as Regional Priority are likely to be more effective for conservation than the other remnant patches and, hence, to where should resources and conservation efforts be directed.

The Conservation Priority model showed to be valid for the proposed objectives of selecting areas in the matrix. The combination of complementary parameters for the Conservation Priority Index produced a more consistent method for selecting priority areas than any of the indexes individually employed. The Index construction is relatively simple and direct and has produced a reliable result; selected priority areas had an excellent geographic correspondence with the known areas of indicator species occurrences. This model can also contribute to direct efforts in survey of species for inventory purposes or for the refinement of priority areas defined at small scales.

Regionally (as well throughout most of Brazil), there exists very limited information on species ecology to direct selection of priority areas; such studies are likely expansive and time-consuming to generate consistent data for selection purposes. Meanwhile, identification of new species, or new to the Campos Gerais bioregion, has been frequent in the last years as a result of the intensification on field surveys, which have been occurring in parallel to the fragmentation process. Nevertheless, the urgent demand for conservation actions demand that planning efforts should be based on the best scientific information available, while explicitly acknowledging their limitations and working toward their improvement. These regional circumstances suggest a landscape-based action research approach to conservation.

The characteristics of multiple use of resources, landscape fragmentation in the study scales, and the importance to preserve the remaining landscapes were the reference to the development of the conservation priority model. Under these circumstances the model can be considered a pragmatic tool for mapping and selecting priority areas for conservation in the landscape scale, that means, the scale on which land use management decisions are taken. As with any qualitative ranking scheme, results should be used in conjunction with sound judgment and exchanged personal knowledge about conservation areas among members of a planning team and other experts.

The CP model can be applied to study other regions of Campos Gerais at similar scales to select remnant units and constitute a broad regional mosaic of potential areas for conservation. The selection of priority areas in this model is based on qualitative decisions and it is influenced by the level of available knowledge about natural landscapes and land use systems in the Regional Matrix. The model reproducibility is, therefore, limited. On the other hand, the qualitative-based analysis is one of the models strengthens allowing an approach for analyzing landscapes at multiple scales to identify factors that can contribute or be unfavorable for the implementation of conservation practices at local and landscape scale.

This methodological reference could also be potentially applied for selecting priority areas on other distinct fragmented landscapes within intensive managed matrixes. Distinct landscape features considered essential for the maintenance of the patterns and processes that support biodiversity in a particular ecoregion, could be emphasized and added to the model. If other relevant parameters are available, or can be collected (e.g., data on species occurrence), they can be incorporated into the model, producing, thus, more reliable results.

It could also be applied for planning connectivity among protected areas for an ecoregion, involving public and private lands. The interdisciplinary analysis of patterns for the purpose of remnant patches mapping, and definition of ecological integrity indicators will certainly produce more consistent results. The information generated from such analysis can direct conservation efforts and resources into more promising areas. Involving local people in management is also key to successful biodiversity conservation, because of the anthropogenic nature of such landscapes.

In the regional context of fragmented landscapes and private land ownership, conservation strategies must be based on partnerships with rural communities in the search for strategies of rural development that can be more compatible than the current land use systems. Consequently regional and local cultural, economic and social aspects of the mosaic should be considered in the design of more effective protected areas systems. The perspective is that, from the definition of areas considered essential, integrated landscape management and conservation programs can be fostered (Rocha & Milano 1997). These issues will be addressed on the following chapters.

Complementary to its inherent ecological and biological aspects, conservation policies and practices must also be comprehended as inherently social phenomena (Mascia et al 2003). The biological sciences have the theoretical and analytical tools to identify rare and threatened species and ecosystems, but the failure to integrate social aspects in the priority setting process may lead to either partial success or total failure of conservation initiatives. Conservation interventions are the product of human decision making processes and require changes in human behavior to succeed. Thus, conservation policies and practices are social phenomena, as are the intended and unintended changes in human behavior they induce (Shi et al 2005).

Although biologists and practitioners, at least in recent years, have increasingly recognized that social factors are often the primary determinants of the success or failure of conservation efforts biological criteria continue to dominate the literature on priority-setting and the conservation community continues essentially to look to the biological sciences to design conservation policies and practices (Shi et al 2005). The integration of biological and social aspects is likely to provide important outcomes that should enrich conservation planners and practitioners' understanding of priority setting for conservation areas. To preserve the earth's natural heritage, the social sciences must become central to conservation science and practice (Mascia et al 2003).

Thus, "the demography, economics and sociology of local peoples are as important to preserving the biodiversity in an area as the design of regional reserves, and that, in fact, when they tackle a conservation problem the two must be considered hand in glove" (Daily & Ehrlich 1999). Recognizing that conservation is about people as much as it is about species or ecosystems - an acknowledgement seldom explicitly made in conservation circles - suggests a significant shift in the nature and use of science in conservation (Mascia 2003). The integration of the social science approach in the landscape-based research framework for conservation in the regional matrix will be addressed in the chapters to follow.

Appendix 4.1: Indicator species and place of their occurrence for the evaluation of the efficacy of the Conservation Priority Model

Taxon and Conservation Status	**Family**	**Species**	**Source**	**Localization**
Endemic and new species of fishes	*Characidae*	*Astyanax sp*	Artoni e Almeida 2001, PARANÁ 2005	Furnas 1 e 2
New species of fishes	*Characidae*	*Characidium spp. (2spp)*	Artoni e Almeida 2001, PARANÁ 2005	Rio Quebra Perna, Guabiroba e Lagoa Dourada
	Trichomycterus	*Thrichomycterus sp.*	Paraná 2004	VVSP
	Hypoptopomatinae	*New*	Paraná 2005	Várzea do Rio Guabiroba
New species of butterflies	*Hesperiidae Hesperiinae*	*Artines sp.,*	PARANÁ 2004	site 9 - VVSP
		Corticea sp.,	PARANÁ 2004	sites 6, 12, 13
		Nastra spp. (2spp)	PARANÁ 2004	site 9 - VVSP
		Papias sp.,	PARANÁ 2004	site 11 - VVSP
		Pompeius spp. (2spp.)	PARANÁ 2004	site 9 - VVSP
		Vidius spp. (2 spp.)	PARANÁ 2004	Campo da Igreja VVSP
	Nymphalidae Satyrinae	*Euptychia sp. 2*	Paraná 2005	Várzea do Rio Guabiroba
Rare species of butterflies	*Nymphalidae, Charaxinae:*	*Memphis hirta*	PARANÁ 2004	site 6 - VVST
	Riodinidae Riodininae	*Aricoris monotona*	PARANÁ 2004	Campo da Igreja VVSP
		Lemonias albofasciata	PARANÁ 2004	Arenitos
	Hesperiidae Pyrginae - Pyrgini	*Staphylus ascalon,*	Paraná 2005	VVSP
	Hesperiidae Pyrginae - Hesperiini	*Copaeodes castanea*	PARANÁ 2004	sites 1, 6, 9 e 17 VVSP
		Cymaenes warreni	PARANÁ 2004	Arenitos
		Thargella evansi	PARANÁ 2004	Arenitos e site 13 VVSP
		Thespeius haywardi	PARANÁ 2004	VVSP
		Thespieus homochromus	PARANÁ 2004	Topo Arenitos
		Thespieus xarina	PARANÁ 2004	site 16
		Vehilius celeus vetus	PARANÁ 2004	sites 6, 9, 12 e 13
		Vettius diana diana	PARANÁ 2004	site 7
		Vidius mictra	PARANÁ 2004	site 9
		Virga riparia	PARANÁ 2004	site 9
Endangered butterfly	*Lycaenidae Theclinae*	*Arcas ducalis,*	PARANÁ 2004	VVSP

Appendix 4.1: Indicator species and place of their occurrence for the evaluation of the efficacy of the Conservation Priority Model (cont.)

New specie of amphibious for the region	*Leptodactylidae*	*Proceratophrys boiei*	PARANÁ 2004, Polatti 2005	Bacia do Cercadinho
Endangered and new specie of bird for the region	*Apodidae*	*Streptoprocne biscutata*	Paraná 2004	VVSP
	Caprimulgidae	*Caprimulgus longirostris*	Paraná 2004	Platô da Fortaleza
	Rallidae	*Laterallus leucopyrrhus*	Paraná 2004	Várzea do Rio Guabiroba
New specie of bird for the region	*Threskiornithidae*	*Platalea ajaja*	Paraná 2004	VVSP
Endangered bird	*Tyrannidae*	*Heteroxolmis dominicana,*	Paraná 2004	VVSP e Fazendas Cambiju Moss e Rivadavia
		Alectrurus tricolor	Paraná 2004	VVSP
		Culicivora caudacuta	Paraná 2004	Sitios 2, 4, 9 - VVSP
	Cracidae,	*Penelope obscura*	Paraná 2004	Capão Arenitos
	Psittacidae	*Amazona vinacea*	Paraná 2004	Furnas
	Cariamidae	*Cariama cristata*	Paraná 2004	Fazenda Capao Grande
	Caprimulgidae	*Eleothreptus anomalus*	Paraná 2004	Sitios 1,11, 17, 21 VVSP
	Passeridae	*Anthus nattereri*	Paraná 2004	Sitio 17
	Fringillidae	*Sporophila bouvreuil*	Paraná 2004	VVSP
	Apodidae,	*Chaetura cinereiventris*	Paraná 2004	Capão Arenitos
	Fringillidae	*Euphonia pectoralis*	Paraná 2004	Capão Arenitos
	Accipitridae,	*Harpyhaliaetus coronatus,*	Paraná 2004	VVSP
	Fringillidae	*Amaurospiza moesta*	Paraná 2004	Arenitos
Rare and endangered reptile	*Colubridae*	*Ditaxodon taeniatus*	Paraná 2004	Lagoa Tarumã
Endangered reptile	*Viperidae*	*Bothrops itapetiningae*	Paraná 2004	VVSP
Endemic reptile	*Colubridae*	*Pseudoboa haasi*	Paraná 2004	VVSP

Appendix 4.1: Indicator species and place of their occurrence for the evaluation of the efficacy of the Conservation Priority Model (cont.)

Endangered mammal	*Canidae*	*Chrysocyon brachyurus*	Pontes Filho et al. 1999; 1997	VVSP e Entorno
Rare and endangered mammal	*Cervidae*	*Ozotoceros bezoarticus*	Paraná 2005	Campo Seco-VVSP
	Myrmecophagidae	*Myrmecophaga tridactyla*	Paraná 2005	Campo Seco-VVSP
	Tayassuidae	*Tayassu pecari*	Paraná 2005	VVSP
	Tapiridae	*Tapirus terrestris*	Paraná 2005	VVSP
	Felidae	*Panthera onca*	Paraná 2005	VVSP
Endangered Pteridophyte	*Dicksoniaceae*	*Dicksonia sellowiana*	SEMA/GTZ 1995, Moro et al. 2001, Paraná 1995	Mata da Fortaleza Bacia do rio São Jorge
Endangered Gymnosperm	*Araucariaceae*	*Araucaria angustifolia*	SEMA/GTZ 1995, Moro et al. 1996, Moro 2001, Paraná 1995	VVSP & Buffer Zone Bacia do rio São Jorge
Endangered Angiosperm	*Lauraceaea*	*Ocotea porosa*	SEMA/GTZ 1995, Moro et al. 2001, PARANÁ 1995	Mata da Fortaleza, Bacia do rio São Jorge
		Ocotea odorifera	Paraná 2005, Moro et al. 2001, PARANÁ 1995	Capão Arenitos , Bacia do rio São Jorge
	Apocynaceae	*Aspidosperma polyneuron*	Paraná 2005	Capão Arenitos VVSP
	Rhamnaceae	*Crumenaria polygaloides*	Paraná 2005, Moro et al. 1996, PARANÁ 1995	Campo da Igreja – VVSP, Bacia rio São Jorge
	Moraceae	*Dorstenia brasiliensis*	Paraná 2005	Campo da Igreja-VVSP
	Cucurbitaceae	*Cayaponia espelina*	SEMA/GTZ 1995 Paraná 2005	Arenitos
	Amaranthaceae	*Pfaffia jubata, Gomphrena gramínea, G. paranaensis*	Cervi & Hatschbach, 1990	VVSP

Rare or endemic Angiosperm	*Amarantaceae*	*Gomphrena macrocephala*	Paraná 2004	Campo da Igreja VVSP
	Apocynaceae	*Mandevilla coccinea*	Paraná 2005	Campo da Igreja- VVSP
	Arecaceae	*Butia microspadix*	Paraná 2004	Sitio 8 - Arenitos
	Asclepiadaceae	*Ditassa edmundoi*	Cervi & Hatschbach, 1990	VVSP
		Oxypetalum spp.;	Paraná 2004, Moro 2001	Arenitos
	Borraginacea	*Heliotropium salicoides*	Cervi & Hatschbach, 1990	VVSP
	Bromeliaceae	*Tillandsia sp.;*	Paraná 2004, Moro 2001	Arenitos VVSP
	Cactacea	*Parodia sp.*	Moro 2001, Paraná 2004, Rocha et al. 2005	Arenitos e Platô da Fortaleza - VVSP Afloramentos de Rocha Bacias São Jorge e Quebra Perna
	Compositae	*Gochnatia orbiculata, G. argyrea; Baccharis aphylla, Isostigma speciosum, Pamphalea smithii, Chaptalia graminifolia*	Cervi & Hatschbach, 1990	VVSP
	Ciperaceae	*Bulbostylis paradoxa*	Cervi & Hatschbach, 1990	VVSP
	Eriocaulaceae	*Syngonanthus chrysanthus*	Estreiechen & Moro 2003	Capão da Onça Bacia Rio Verde
	Gesneriaceae	*Sinningia sp.*	Paraná 2004, Moro 2001	Furnas e Platô da Fortaleza - VVSP
	Hypericaceae	*Hypericum cordatum*	Paraná 2004	Sitio 9 - Campo úmido - VVSP
	Labiatae	*Hyptis apertiflora*	Cervi & Hatschbach, 1990	VVSP
	Leguminosae	*Desmodium dutrae*	Cervi & Hatschbach, 1990	VVSP
	Melastomataceae	*Leandra dusenii*	Cervi & Hatschbach, 1990	VVSP
	Myrtaceae	*Campomanesia aurea var. hatschbachii*	Cervi & Hatschbach, 1990	VVSP
	Orquidaceae	*Chloraea penicillata; Cleistes paranaensis; Cyrtopodium dusenii*	Cervi & Hatschbach, 1990	VVSP
	Passifloraceae	*Passiflora lepidota*	PARANÁ 2004 Moro 2001	Campo da Igreja- VVSP
	Poaceae	*Pasplum rojasii*	Cervi & Hatschbach, 1990	VVSP
	Sapotaceae	*Pradosia brevipes;*	Cervi & Hatschbach, 1990	VVSP
	Verbenaceae	*Verbena strigosa*	Cervi & Hatschbach, 1990	VVSP
	Winteraceae	*Drosera communis*	Paraná 2005	Arenitos

Appendix 4.2: Area Metrics, Vegetation Community Types, Ecological Integrity Assessment and Conservation Priority Index of Remnant Patches[1]

Patch ID	Area (ha)	Edge Length (Km)	Edge Area (ha)	Core Area (ha)	Vegetation Community Type	Patch Conservation Status	Patch Context	Area Index	Core Index	Context Index	Conserv. Status Index	Habitat Diversity Index	Conserv. Priority Index
1	53,0	3,6	30,1	23,0	Araucaria Wood	Capoeirão	Farming	0,35	0,33	-1,5	0,5	1,0	**0,68**
2	124,6	10,7	89,0	35,5	Riparian Wood	Capoeirão	Small Farming	0,54	0,41	-1,2	0,5	0,5	**0,75**
3	85,7	9,6	74,6	11,1	Mixed Riparian	Fair	Farming/Pinus	0,45	0,23	-1,3	1,5	2,0	**2,88**
4	105,6	12,6	94,9	10,7	Mixed Riparian	Disturbed	Small Farm Wit./Pinus	0,50	0,23	-1,2	0,5	1,5	**1,52**
5	270,0	19,9	173,9	96,1	Grassland	Disturbed	Farming/Pinus	0,79	0,68	-1,3	0,5	2,0	**2,67**
6	44,7	5,6	43,0	1,7	Mixed Riparian	Disturbed	Small Farm/Remn	0,32	0,09	-0,2	0,5	2,0	**2,71**
7	73,0	9,6	69,2	3,8	Riparian Wood	Capoeirão	Small Farm/Farm	0,41	0,13	-1,3	0,5	0,5	**0,25**
8	157,3	8,6	72,2	85,2	Grassland	Disturbed	Farming	0,61	0,64	-1,5	0,5	1,5	**1,74**
9	184,9	21,3	160,2	24,7	Mixed Riparian	Disturbed	Farming	0,66	0,34	-1,5	0,5	2,5	**2,50**
10	273,4	21,0	176,3	97,1	Grassland	Disturbed	Pinus	0,80	0,68	-1,2	0,5	1,5	**2,28**
11	65,1	8,9	61,5	3,6	Mixed Riparian	Disturbed	Pinus/Small Farm	0,39	0,13	-1,2	0,5	1,5	**1,32**
12	93,1	5,0	45,2	48,0	Araucaria Wood	Capoeirão	Farming	0,47	0,48	-1,5	0,5	1,0	**0,94**
13	413,0	42,3	334,4	78,6	Mixed Riparian	Fair	Farming/Pinus	0,98	0,61	-1,3	1,5	1,0	**2,79**
14	703,4	55,5	483,8	219,6	Mixed Riparian	Fair	Farming	1,28	1,02	-1,5	1,5	2,0	**4,30**
15	219,1	23,6	183,2	36,0	Mixed Riparian	Disturbed	Farming/Pinus	0,71	0,41	-1,3	0,5	1,5	**1,83**
16	174,3	12,9	111,8	62,5	Grassland	Fair	Farming	0,64	0,55	-1,5	1,5	2,0	**3,18**
17	40,2	4,6	34,7	5,4	Mixed Riparian	Disturbed	Farming	0,31	0,16	-1,5	0,5	1,5	**0,97**
18	133,0	7,7	70,3	62,7	Araucaria Wood	Capoeirão	Farming/Pinus	0,56	0,55	-1,3	0,5	0,5	**0,80**
19	115,4	5,4	50,4	65,0	Grassland	Fair	Farming/Pinus	0,52	0,56	-1,3	1,5	1,5	**2,77**
20	272,2	10,9	102,0	170,2	Grassland	Pristine	Farming	0,80	0,90	-1,5	3,0	1,5	**4,70**
21	51,3	7,4	50,3	1,0	Mixed Riparian	Fair	Farming/Pinus	0,35	0,07	-1,3	1,5	1,5	**2,12**
22	191,2	8,8	81,5	109,7	Grassland	Fair	Farming	0,67	0,72	-1,5	1,5	1,5	**2,89**
23	101,7	11,2	89,7	12,1	Mixed Riparian	Disturbed	Farming/Pinus	0,49	0,24	-1,3	0,5	2,0	**1,93**
24	78,2	4,7	40,4	37,7	Araucaria Wood	Capoeirão	Farming/Pinus	0,43	0,42	-1,3	0,5	0,5	**0,55**
25	125,8	7,0	60,3	65,5	Araucaria Wood	Capoeirão	Farm/Small Farm	0,54	0,56	-1,4	0,5	0,5	**0,70**
26	116,1	13,7	99,3	16,8	Riparian Wood	Capoeirão	Small Farming	0,52	0,28	-1,2	0,5	1,0	**1,10**
27	78,0	7,9	62,2	15,8	Riparian Wood	Capoeirão	Small Farming	0,43	0,27	-1,2	0,5	0,5	**0,50**

28	442,3	28,7	252,6	189,7	Mixed Riparian	Fair	Farming	1,02	0,95	-1,5	1,5	2,5	**4,47**
29	103,3	6,5	56,1	47,2	Araucaria Wood	Capoeirão	Small Farming	0,49	0,47	-1,2	0,5	0,5	**0,76**
30	69,4	4,0	34,6	34,9	Araucaria Wood	Capoeirão	Small Farming	0,40	0,41	-1,2	0,5	0,5	**0,61**
31	59,7	7,4	52,4	7,3	Riparian Wood	Capoeirão	Small Farming	0,37	0,19	-1,2	0,5	1,0	**0,86**
32	56,5	6,7	48,0	8,5	Araucaria Wood	Capoeirão	Small Farming	0,36	0,20	-1,2	0,5	0,5	**0,36**
33	60,2	7,0	54,6	5,6	Riparian Wood	Capoeirão	Small Farming	0,37	0,16	-1,2	0,5	1,0	**0,84**
34	42,5	4,4	31,5	11,0	Araucaria Wood	Capoeirão	Small Farming	0,31	0,23	-1,2	0,5	0,5	**0,34**
35	51,8	2,8	24,2	27,6	Araucaria Wood	Capoeirão	Farming	0,35	0,36	-1,5	0,5	0,5	**0,21**
36	287,2	22,8	198,9	88,3	Mixed Riparian	Disturbed	Farming	0,82	0,65	-1,5	0,5	2,0	**2,47**
37	118,8	14,4	104,7	14,1	Riparian Wood	Capoeirão	Small Farming	0,53	0,26	-1,2	0,5	0,5	**0,59**
38	75,2	12,0	74,2	1,0	Riparian Wood	Capoeirão	Small Farming	0,42	0,07	-1,2	0,5	0,5	**0,29**
39	59,3	5,1	40,7	18,6	Araucaria Wood	Capoeirão	Farming	0,37	0,30	-1,5	0,5	0,5	**0,17**
40	106,4	12,5	94,9	11,5	Riparian Wood	Capoeirão	Small Farm/Farm	0,50	0,23	-1,3	0,5	0,5	**0,43**
41	434,3	32,5	284,4	149,9	Mixed Riparian	Fair	Farming	1,01	0,84	-1,5	1,5	2,0	**3,85**
42	688,7	37,4	345,0	343,7	Mixed Riparian	Fair/Pristine	Farming	1,27	1,28	-1,5	2,0	2,5	**5,55**
43	3456,0	124,0	1111,1	2345,0	Grassland	Fair/Pristine	Farming	2,84	3,34	-1,5	2,0	2,5	**9,18**
44	93,6	9,3	76,8	16,8	Mixed Wetlands	Disturbed	Small Farming	0,47	0,28	-1,2	0,5	1,0	**1,05**
45	210,1	14,3	116,5	93,6	Riparian Wood	Capoeirão	Small Farming	0,70	0,67	-1,2	0,5	0,5	**1,17**
46	234,8	13,0	114,7	120,0	Grassland	Capoeirão	Small Farming	0,74	0,76	-1,2	0,5	1,0	**1,80**
47	49,6	6,4	40,9	8,8	Riparian Wood	Capoeirão	Small Farming	0,34	0,20	-1,2	0,5	0,5	**0,34**
48	224,8	15,6	134,4	90,5	Araucaria Wood	Capoeirão	Small Farming	0,72	0,66	-1,2	0,5	0,5	**1,18**
49	815,1	27,9	254,2	560,9	Araucaria Wood	Capoeirão	Small Farming	1,38	1,63	-1,2	0,5	0,5	**2,81**
50	48,3	3,7	32,5	15,8	Araucaria Wood	Capoeirão	Small Farming	0,34	0,27	-1,2	0,5	0,5	**0,41**
51	40,9	4,0	32,6	8,3	Araucaria Wood	Capoeirão	Small Farming	0,31	0,20	-1,2	0,5	0,5	**0,31**
52	269,9	20,1	171,4	98,5	Araucaria Wood	Secundária	Small Farming	0,79	0,68	-1,2	1,5	0,5	**2,28**
53	84,1	5,7	48,8	35,3	Araucaria Wood	Capoeirão	Small Farming	0,44	0,41	-1,2	0,5	0,5	**0,65**
54	786,0	35,3	319,2	466,8	Mixed Riparian	Disturbed	Small Farming	1,35	1,49	-1,2	0,5	2,5	**4,64**
55	221,4	15,6	132,0	89,4	Riparian Wood	Capoeirão	Small Farming	0,72	0,65	-1,2	0,5	1,0	**1,67**
56	86,8	7,8	61,6	25,2	Riparian Wood	Capoeirão	Small Farming	0,45	0,35	-1,2	0,5	1,0	**1,10**
57	61,5	6,1	46,7	14,9	Riparian Wood	Capoeirão	Small Farming	0,38	0,27	-1,2	0,5	0,5	**0,45**
58	395,7	27,3	236,8	158,9	Mixed Riparian	Fair	Small Farming	0,96	0,87	-1,2	1,5	2,0	**4,13**
59	78,1	9,6	66,1	12,0	Riparian Wood	Capoeirão	Small Farming	0,43	0,24	-1,2	0,5	0,5	**0,47**

60	207,2	17,1	125,8	81,3	Riparian Wood	Capoeirão	Small Farming	0,70	0,62	-1,2	0,5	0,5	**1,12**
61	89,5	12,6	83,5	6,0	Riparian Wood	Capoeirão	Small Farming	0,46	0,17	-1,2	0,5	0,5	**0,43**
62	78,9	11,0	67,0	11,8	Riparian Wood	Capoeirão	Small Farming	0,43	0,24	-1,2	0,5	0,5	**0,47**
63	275,0	13,4	113,9	161,0	Araucaria Wood	Capoeirão	Small Farming	0,80	0,88	-1,2	0,5	0,5	**1,48**
64	86,4	8,0	64,5	21,9	Araucaria Wood	Capoeirão	Small Farming	0,45	0,32	-1,2	0,5	1,0	**1,07**
65	41,3	2,6	22,5	18,7	Araucaria Wood	Capoeirão	Small Farming	0,31	0,30	-1,2	0,5	0,5	**0,41**
66	650,4	27,0	238,3	412,2	Araucaria Wood	Secundária	Small Farming	1,23	1,40	-1,2	1,5	1,0	**3,93**
67	58,7	7,3	52,9	5,8	Araucaria Wood	Capoeirão	Small Farming	0,37	0,17	-1,2	0,5	1,0	**0,84**
68	313,3	21,4	188,3	125,0	Riparian Wood	Capoeirão	Small Farming	0,85	0,77	-1,2	0,5	1,0	**1,93**
69	119,3	10,5	85,1	34,2	Riparian Wood	Capoeirão	Small Farming	0,53	0,40	-1,2	0,5	1,0	**1,23**
70	125,2	10,6	88,1	37,2	Riparian Wood	Capoeirão	Small Farming	0,54	0,42	-1,2	0,5	1,0	**1,26**
71	98,0	8,8	67,2	30,8	Riparian Wood	Capoeirão	Small Farming	0,48	0,38	-1,2	0,5	0,5	**0,66**
72	58,1	4,0	32,4	25,7	Araucaria Wood	Capoeirão	Farm/Remnant	0,37	0,35	0,0	0,5	0,5	**1,72**
73	184,1	8,5	77,8	106,3	Araucaria Wood	Secundária	Small Farm/Remn	0,66	0,71	-0,2	1,5	0,5	**3,17**
74	172,0	13,0	99,2	72,8	Riparian Wood	Capoeirão	Small Farm/Farm	0,63	0,59	-1,3	0,5	0,5	**0,92**
75	90,2	8,5	66,9	23,2	Riparian Wood	Capoeirão	Farm/Remnant	0,46	0,33	0,0	0,5	1,0	**2,29**
76	59,6	6,9	47,9	11,7	Riparian Wood	Capoeirão	Farming	0,37	0,24	-1,5	0,5	0,5	**0,11**
77	75,8	8,1	67,1	8,7	Mixed Riparian	Disturbed	Farming	0,42	0,20	-1,5	0,5	1,5	**1,12**
78	317,9	23,8	198,2	119,6	Riparian Wood	Capoeirão	Farming	0,86	0,75	-1,5	0,5	1,0	**1,62**
79	338,8	24,8	211,2	127,6	Riparian Wood	Capoeirão	Farm/Small Farm	0,89	0,78	-1,4	0,5	1,0	**1,77**
80	103,2	13,1	90,2	13,0	Riparian Wood	Capoeirão	Small Farming	0,49	0,25	-1,2	0,5	0,5	**0,54**
81	46,0	4,2	30,8	15,2	Araucaria Wood	Capoeirão	Small Farming	0,33	0,27	-1,2	0,5	0,5	**0,40**
82	597,3	59,2	468,0	129,4	Riparian Wood	Capoeirão	Small Farming	1,18	0,78	-1,2	0,5	0,5	**1,76**
83	45,1	5,0	35,8	9,3	Riparian Wood	Capoeirão	Small Farming	0,32	0,21	-1,2	0,5	0,5	**0,33**
84	290,4	19,7	170,9	119,5	Riparian Wood	Capoeirão	Small Farming	0,82	0,75	-1,2	0,5	0,5	**1,38**
85	111,4	8,7	71,5	39,9	Riparian Wood	Capoeirão	Small Farming	0,51	0,44	-1,2	0,5	0,5	**0,75**
86	102,0	9,4	72,0	30,0	Riparian Wood	Capoeirão	Small Farming	0,49	0,38	-1,2	0,5	0,5	**0,67**
87	67,8	8,8	61,4	6,4	Riparian Wood	Capoeirão	Small Farming	0,40	0,17	-1,2	0,5	0,5	**0,37**
88	131,4	11,5	86,5	44,9	Riparian Wood	Capoeirão	Small Farming	0,55	0,46	-1,2	0,5	0,5	**0,82**
89	71,3	9,6	65,1	6,2	Riparian Wood	Capoeirão	Small Farming	0,41	0,17	-1,2	0,5	0,5	**0,38**
90	119,2	11,2	90,3	28,8	Riparian Wood	Capoeirão	Small Farming	0,53	0,37	-1,2	0,5	0,5	**0,70**
91	408,1	28,8	235,2	173,0	Riparian Wood	Capoeirão	Remnant/Farm	0,98	0,91	0,5	0,5	0,5	**3,38**

92	388,5	31,6	260,3	128,2	Riparian Wood	Capoeirão	Small Farming	0,95	0,78	-1,2	0,5	2,0	**3,03**
93	67,6	6,0	50,0	17,7	Riparian Wood	Capoeirão	Small Farming	0,40	0,29	-1,2	0,5	0,5	**0,49**
94	89,8	5,6	50,1	39,7	Grassland	Disturbed	Small Farm/Road	0,46	0,43	-1,5	0,5	1,0	**0,89**
95	1793,8	94,0	819,7	974,1	Grassland	Disturbed	Farm/Remnant	2,05	2,15	0,0	0,5	2,5	**7,20**
96	163,9	16,0	124,4	39,5	Grassland	Disturbed	Remnant/Small Farm	0,62	0,43	0,8	0,5	2,0	**4,35**
97	77,3	8,6	57,8	19,5	Mixed Riparian	Disturbed	Farming	0,42	0,30	-1,5	0,5	2,0	**1,73**
98	1869,7	93,4	821,8	1048,0	Grassland	Fair/Dist	Farming	2,09	2,23	-1,5	1,0	2,5	**6,32**
99	1080,2	44,7	398,0	682,2	Grassland	Fair	Farming	1,59	1,80	-1,5	1,5	2,5	**5,89**
100	73,8	5,8	49,5	24,4	Araucaria Wood	Capoeirão	Farming	0,41	0,34	-1,5	0,5	0,5	**0,26**
101	328,3	9,9	92,0	236,3	Araucaria Wood	Capoeirão	Farm/Remnant	0,87	1,06	0,0	0,5	1,0	**3,44**
102	292,4	27,4	210,3	82,1	Riparian Wood	Capoeirão	Farming	0,83	0,63	-1,5	0,5	1,5	**1,95**
103	130,7	7,2	64,1	66,6	Mixed Riparian	Disturbed	Farming/Pinus	0,55	0,56	-1,3	0,5	1,5	**1,81**
104	92,0	9,9	76,7	15,3	Mixed Riparian	Disturbed	Small Farming	0,46	0,27	-1,2	0,5	1,0	**1,03**
105	223,1	15,3	130,6	92,5	Riparian Wood	Capoeirão	Farming	0,72	0,66	-1,5	0,5	1,0	**1,38**
106	551,3	43,3	377,7	173,7	Riparian Wood	Capoeirão	Farm/Small Farm	1,13	0,91	-1,4	0,5	1,5	**2,64**
107	68,9	4,8	37,3	31,5	Grassland	Fair	Farming	0,40	0,39	-1,5	1,5	1,5	**2,29**
108	59,3	5,2	38,4	20,9	Araucaria Wood	Capoeirão	Farming	0,37	0,32	-1,5	0,5	0,5	**0,19**
109	139,1	9,5	78,3	60,7	Araucaria Wood	Capoeirão	Farming	0,57	0,54	-1,5	0,5	1,0	**1,11**
110	224,2	21,2	169,0	55,2	Mixed Riparian	Disturbed	Farming	0,72	0,51	-1,5	0,5	2,0	**2,24**
111	54,7	4,7	37,7	16,9	Araucaria Wood	Capoeirão	Farming	0,36	0,28	-1,5	0,5	0,5	**0,14**
112	102,2	6,6	56,2	46,0	Araucaria Wood	Capoeirão	Farming	0,49	0,47	-1,5	0,5	0,5	**0,46**
113	2362,0	159,6	1395,8	966,3	Riparian Wood	Capoeirão	Farm/Remnant	2,35	2,14	0,0	0,5	2,5	**7,49**
114	104,4	11,9	82,3	22,1	Mixed Riparian	Disturbed	Farm/SubUrban	0,49	0,32	-1,7	0,5	1,0	**0,62**
115	198,9	12,9	113,3	85,6	Grassland	Fair	Farm/Road	0,68	0,64	-1,8	1,5	2,0	**3,02**
116	72,0	12,9	70,7	1,4	Mixed Riparian	Disturbed	Farming	0,41	0,08	-1,5	0,5	1,0	0,49
117	149,8	10,8	91,2	58,5	Mixed Riparian	Disturbed	Small Farm Wit./Pin	0,59	0,53	-1,2	0,5	2,0	**2,42**
118	714,2	48,1	423,3	290,9	Mixed Riparian	Fair	Farm/SubUrban	1,29	1,18	-1,7	1,5	2,5	**4,77**
119	454,1	38,7	318,9	135,2	Mixed Riparian	Fair	Farm/Road	1,03	0,80	-1,8	1,5	1,5	**3,03**
120	92,8	7,8	68,2	24,6	Grassland	Disturbed	Small Farm W/Road	0,47	0,34	-1,5	0,5	1,0	**0,81**
121	1696,5	71,6	649,1	1047,3	Grassland	Fair	Remnant/Road	1,99	2,23	0,2	1,5	2,5	**8,42**
122	187,3	13,3	107,8	79,6	Grassland	Fair/Pristine	Small Farm Wit/Road	0,66	0,62	-1,5	2,0	1,5	**3,28**
123	44,2	3,5	28,3	15,9	Grassland	Fair/Pristine	Small Farm Wit.	0,32	0,28	-1,2	2,0	1,0	**2,40**

124	106,5	8,1	67,9	38,6	Araucaria Wood	Capoeirão	Farming	0,50	0,43	-1,5	0,5	1,0	**0,93**
125	209,7	10,4	88,5	121,2	Araucaria Wood	Capoeirão	Farming	0,70	0,76	-1,5	0,5	1,0	**1,46**
126	226,5	25,1	189,6	36,8	Mixed Riparian	Fair	Farming	0,73	0,42	-1,5	1,5	2,0	**3,15**
127	315,3	31,8	229,3	85,9	Riparian Wood	Capoe/Sec	Farming	0,86	0,64	-1,5	1,0	1,0	**2,00**
128	54,4	9,3	53,3	1,1	Riparian Wood	Capoeirão	Farm/Small Farm	0,36	0,07	-1,4	0,5	0,5	**0,03**
129	130,9	17,6	121,9	9,0	Mixed Riparian	Disturbed	Farming/Pinus	0,55	0,21	-1,3	0,5	1,5	**1,46**
130	85,9	11,6	78,7	7,2	Mixed Riparian	Disturbed	Farming	0,45	0,19	-1,5	0,5	1,5	**1,13**
131	92,2	9,6	71,7	20,5	Mixed Riparian	Disturbed	Small Farming	0,46	0,31	-1,2	0,5	1,5	**1,58**
132	57,8	8,2	54,7	3,1	Riparian Wood	Capoeirão	Small Farm/SubUrb.	0,37	0,12	-1,6	0,5	0,5	**0**
133	74,7	11,7	73,3	1,4	Riparian Wood	Capoeirão	Small Farm/Farm	0,42	0,08	-1,3	0,5	1,0	**0,70**
134	91,7	11,9	84,1	7,6	Riparian Wood	Capoeirão	Urban/Farm	0,46	0,19	-1,8	0,5	0,5	**0**
135	82,4	10,6	67,4	15,1	Mixed Riparian	Disturbed	Urban/SubUrban	0,44	0,27	-1,9	0,5	1,5	**0,81**
136	285,3	30,3	218,7	66,6	Riparian Wood	Capoe/Sec	Farming	0,82	0,56	-1,5	1,0	0,5	**1,38**
137	153,8	27,6	147,9	6,0	Riparian Wood	Capoeirão	Farming/Pinus	0,60	0,17	-1,3	0,5	1,0	**0,97**
138	78,9	11,3	78,2	0,7	Mixed Riparian	Disturbed	Farming	0,43	0,06	-1,5	0,5	1,5	**0,99**
139	54,1	6,1	46,4	7,7	Riparian Wood	Capoe/Sec	Urban	0,36	0,19	-2,0	1,0	0,5	**0,05**
140	149,1	17,0	130,9	18,2	Mixed Riparian	Disturbed	Urban/SubUrban	0,59	0,29	-1,9	0,5	1,5	**0,98**
141	42,9	4,2	32,5	10,4	Grassland	Disturbed	Urban/SubUrban	0,32	0,22	-1,9	0,5	1,5	**0,64**
142	72,3	9,0	67,4	4,9	Mixed Riparian	Disturbed	Farm/SubUrban	0,41	0,15	-1,7	0,5	1,5	**0,86**
143	57,4	8,1	55,3	2,0	Grassland	Disturbed	Farming	0,37	0,10	-1,5	0,5	1,0	**0,46**
144	78,9	8,3	63,0	15,9	Riparian Wood	Capoeirão	Farming	0,43	0,27	-1,5	0,5	0,5	**0,20**
145	146,6	10,4	88,8	57,8	Riparian Wood	Capoeirão	Farm/Small Farm	0,58	0,52	-1,4	0,5	0,5	**0,71**
146	107,9	9,2	79,2	28,7	Mixed Riparian	Disturbed	Farming	0,50	0,37	-1,5	0,5	1,5	**1,37**
147	84,4	7,5	63,0	21,4	Mixed Riparian	Disturbed	Farm/Small Farm	0,44	0,32	-1,4	0,5	1,0	**0,86**
148	125,8	9,4	82,2	43,6	Mixed Riparian	Fair/Dist	Farm/Small Farm	0,54	0,46	-1,4	1,0	2,0	**2,60**
149	221,5	14,6	129,9	91,6	Mixed Riparian	Fair	Urban/SubUrban	0,72	0,66	-1,9	1,5	1,5	**2,48**
150	121,2	7,1	64,3	56,9	Grassland	Disturbed	Urban/Farm	0,53	0,52	-1,8	0,5	1,0	**0,75**
151	260,4	13,3	115,9	144,4	Grassland	Disturbed	Farm/Road	0,78	0,83	-1,8	0,5	1,0	**1,31**
152	397,6	13,8	130,5	267,1	Grassland	Disturbed	Farm/Road	0,96	1,13	-1,8	0,5	1,0	**1,79**
153	70,4	6,9	57,5	12,9	Riparian Wood	Capoeirão	Farm/Small Farm	0,41	0,25	-1,4	0,5	0,5	**0,25**
154	174,3	15,0	125,5	48,8	Grassland	Fair	Farm/Remnant	0,64	0,48	0,0	1,5	1,0	**3,62**
155	401,8	23,6	213,3	188,5	Grassland	Disturbed	Farming	0,97	0,95	-1,5	0,5	1,0	**1,92**

156	252,5	12,9	115,6	136,8	Grassland	Disturbed	Farm/Road	0,77	0,81	-1,8	0,5	2,0	**2,27**
157	337,8	15,5	138,6	199,1	Araucaria Wood	Capoeirão	Small Farm/Remn	0,89	0,97	-0,2	0,5	1,0	**3,16**
158	106,7	12,4	94,6	12,1	Capoeirão	Capoeirão	Farming	0,50	0,24	-1,5	0,5	1,0	**0,74**
159	51,8	4,8	40,9	10,9	Araucaria Wood	Capoeirão	Small Farming	0,35	0,23	-1,2	0,5	0,5	**0,38**
160	55,3	4,1	33,2	22,1	Araucaria Wood	Capoeirão	Farming	0,36	0,32	-1,5	0,5	0,5	**0,18**
161	164,2	11,1	102,6	61,6	Mixed Riparian	Disturbed	Farming	0,62	0,54	-1,5	0,5	1,5	**1,66**
162	73,3	4,8	40,0	33,3	Grassland	Disturbed	Farming	0,41	0,40	-1,5	0,5	1,0	**0,81**
163	210,3	11,7	102,2	108,1	Grassland	Fair	Farm/Remnant	0,70	0,72	0,0	1,5	1,5	**4,42**
164	60,4	7,5	55,8	4,6	Mixed Riparian	Disturbed	Farming	0,38	0,15	-1,5	0,5	1,0	**0,52**
165	64,0	8,5	60,1	4,0	Mixed Riparian	Disturbed	Farm/Remnant	0,39	0,14	0,0	0,5	1,5	**2,52**
166	474,4	31,7	273,0	201,4	Mixed Riparian	Fair/Dist	Remnant/Farm	1,05	0,98	0,5	1,0	2,0	**5,53**
167	58,9	4,1	33,5	25,4	Araucaria Wood	Capoeirão	Remnant/Farm	0,37	0,35	0,5	0,5	0,5	**2,22**
168	114,3	8,8	68,2	46,1	Araucaria Wood	Capoe/Sec	Farm/Remnant	0,52	0,47	0,0	1,0	1,0	**2,98**
169	95,1	12,2	79,7	15,4	Mixed Riparian	Fair	Farm/Remnant	0,47	0,27	0,0	1,5	2,0	**4,24**
170	55,9	9,6	52,6	3,4	Mixed Riparian	Disturbed	Farm/Remnant	0,36	0,13	0,0	0,5	1,5	**2,49**
171	432,0	32,4	249,2	182,8	Mixed Riparian	Fair	Remnant/Small Farm	1,00	0,93	0,8	1,5	2,5	**6,74**
172	79,6	9,7	71,3	8,3	Mixed Riparian	Disturbed	Farming	0,43	0,20	-1,5	0,5	1,0	**0,63**
173	85,4	11,0	75,9	9,6	Riparian Wood	Capoe/Sec	Farm/Small Farm	0,45	0,21	-1,4	1,0	1,0	**1,26**
174	101,5	10,0	82,5	19,0	Araucaria Wood	Capoeirão	Farm/Small Farm	0,49	0,30	-1,4	0,5	0,5	**0,39**
175	70,7	11,6	70,3	0,4	Mixed Riparian	Disturbed	Farm/Small Farm	0,41	0,04	-1,4	0,5	1,0	**0,55**
176	105,8	8,7	71,7	34,0	Mixed Riparian	Disturbed	Farming	0,50	0,40	-1,5	0,5	1,5	**1,40**
177	1911,4	82,6	717,2	1194,2	Grassland	Pristine	Remnant/Farm	2,11	2,38	0,5	3,0	2,5	**10,49**
178	952,2	63,7	522,9	429,4	Grassland	Fair	Farm/Road	1,49	1,43	-1,8	1,5	2,0	**4,62**
179	1617,6	49,8	440,3	1177,2	Grassland	Pristine	Farm/Remn/Road	1,94	2,37	-1,0	3,0	2,5	**8,81**
180	519,0	28,1	243,9	275,1	MW - Disturbed	MW - Disturbed	Farming/Pinus	1,10	1,14	-1,3	0,5	2,0	**3,44**
181	216,1	9,8	92,0	124,1	Mixed Wetelands	Pristine	Pinus/Road	0,71	0,77	-1,5	3,0	2,0	**4,98**
182	128,5	7,3	67,0	61,5	Araucaria Wood	Secundária	Remnant/Farm	0,55	0,54	0,5	1,5	1,0	**4,09**
183	1054,3	38,1	341,2	713,1	Grassland	Fair	Remnant/Farm	1,57	1,84	0,5	1,5	2,5	**7,91**
184	97,9	10,6	83,5	14,4	Mixed Riparian	Disturbed	Farming	0,48	0,26	-1,5	0,5	1,0	**0,74**
185	422,7	53,5	369,9	52,8	Mixed Riparian	Disturbed	Farming	0,99	0,50	-1,5	0,5	2,0	**2,49**
186	395,1	26,4	221,6	173,4	Mixed Riparian	Disturbed	Farming	0,96	0,91	-1,5	0,5	2,0	**2,87**

187	107,2	8,9	71,6	35,6	Araucaria Wood	Capoeirão	Farm/Road	0,50	0,41	-1,8	0,5	0,5	**0,11**
188	415,5	39,9	296,7	118,8	Araucaria Wood	Capoeirão	Farm/Small Farm	0,98	0,75	-1,4	0,5	1,0	**1,84**
189	114,4	10,9	83,2	31,2	Mixed Riparian	Disturbed	Farm/Small Farm	0,52	0,39	-1,4	0,5	1,5	**1,50**
190	149,0	14,4	102,8	46,3	Mixed Riparian	Fair/Dist	Small Farm/Urban	0,59	0,47	-1,7	1,0	1,5	**1,86**
191	92,2	13,1	86,3	5,8	Riparian Wood	Capoeirão	Small Farm/Farm	0,46	0,17	-1,3	0,5	0,5	**0,33**
192	78,8	14,6	78,4	0,4	Mixed Riparian	Disturbed	Farm/Small Farm	0,43	0,04	-1,4	0,5	1,0	**0,57**
193	583,3	60,6	444,8	138,5	Mixed Riparian	Fair/Pristine	Farm/Small Farm	1,17	0,81	-1,4	2,0	2,5	**5,08**
194	92,1	9,4	77,4	14,7	Mixed Riparian	Disturbed	Farm/SubUrban	0,46	0,26	-1,7	0,5	1,5	**1,03**
195	3883,1	200,1	1796,6	2086,5	Mixed Riparian	Fair	Farming/Pinus	3,01	3,15	-1,3	1,5	2,5	**8,86**
196	1062,5	65,5	586,4	476,1	MW - Fair	MW - Fair	Pinus/Small Farm	1,57	1,51	-1,2	1,5	2,5	**5,88**
197	154,5	16,9	123,4	31,1	Riparian Wood	Capoeirão	Small Farming	0,60	0,38	-1,2	0,5	0,5	**0,78**
198	383,7	27,9	226,8	157,0	Araucaria Wood	Capoeirão	Small Farm/Farm	0,95	0,86	-1,3	0,5	0,5	**1,51**
199	1959,7	133,1	1180,0	779,6	Mixed Riparian	Pristine	Farm/Small Farm	2,14	1,93	-1,4	3,0	2,5	**8,16**
200	388,9	18,0	162,3	226,6	Araucaria Wood	Capoeirão	Farm/Small Farm	0,95	1,04	-1,4	0,5	0,5	**1,59**
201	221,9	21,5	164,9	57,0	Mixed Riparian	Pristine	Farm/Remnant	0,72	0,52	0,0	3,0	2,0	**6,24**
202	101,8	9,3	76,4	25,5	Grassland	Pristine	Farm/Remnant	0,49	0,35	0,0	3,0	1,5	**5,34**
203	49,0	7,6	46,1	3,0	Mixed Riparian	Pristine	Farming	0,34	0,12	-1,5	3,0	1,0	**2,96**
204	509,7	39,8	335,3	174,4	Grassland	Fair	Farming/Pinus	1,09	0,91	-1,3	1,5	2,0	**4,20**
205	316,0	40,8	279,9	36,1	Mixed Riparian	Fair	Farming	0,86	0,41	-1,5	1,5	2,0	**3,27**
206	807,3	46,6	390,2	417,1	Grassland	Fair	Remnant/Farm	1,37	1,41	0,5	1,5	2,5	**7,28**
207	3859,1	151,3	1286,0	2573,1	Grassland	Pristine	Remnant/Farm	3,00	3,50	0,5	3,0	2,5	**12,50**
208	922,1	71,2	534,1	388,1	Grassland	Disturbed	Farming	1,47	1,36	-1,5	0,5	2,0	**3,83**
209	5113,0	148,5	2964,8	2148,2	Mixed Wetlands	Pristine	Farming	3,45	3,20	-1,5	3,0	2,5	**10,65**
210	1129,1	111,5	847,1	282,2	Mixed Riparian	Fair	Farming/Pinus	1,62	1,16	-1,3	1,5	2,5	**5,48**
211	1239,3	99,7	775,5	463,8	Grassland	Pristine	Farm/Remnant	1,70	1,49	0,0	3,0	2,5	**8,69**
212	4370,2	189,2	1652,0	2718,2	Grassland	Pristine	Remnant/Farm/Road	3,19	3,60	0,5	3,0	2,5	**11,79**
213	4642,6	268,4	2120,2	2372,5	Mixed Wetlands	Fair/Pristine	Farming	3,34	3,12	-1,5	2,0	2,5	**9,61**
214	105,7	10,6	82,4	23,3	Mixed Riparian	Disturbed	Farming	0,50	0,33	-1,5	0,5	1,5	**1,33**
215	44,8	7,2	42,4	2,4	Mixed Riparian	Disturbed	Small Farm Wit/Pinus	0,32	0,11	-1,2	0,5	2,0	**1,73**
216	272,0	26,8	203,3	68,7	Mixed Riparian	Fair	Farming	0,80	0,57	-1,5	1,5	2,5	**3,87**
217	81,0	11,6	72,4	8,6	Riparian Wood	Capoeirão	Small Farming	0,43	0,20	-1,2	0,5	0,5	**0,44**
218	41,9	7,3	41,3	0,6	Riparian Wood	Capoeirão	Farm/SubUrban	0,31	0,05	-1,7	0,5	1,0	**0,17**

219	1757,3	106,0	898,4	858,9	Riparian Wood	Capoeirão	Farm/Small Farm	2,02	2,02	-1,4	0,5	2,5	**5,65**
220	69,0	6,6	50,7	18,3	Mixed Riparian	Disturbed	Farming	0,40	0,30	-1,5	0,5	1,0	**0,70**
221	91,0	9,4	76,2	14,8	Riparian Wood	Capoeirão	Small Farm/Farm	0,46	0,27	-1,3	0,5	0,5	**0,43**
222	49,1	5,4	40,9	8,1	Araucaria Wood	Capoeirão	Farming	0,34	0,20	-1,5	0,5	2,0	**1,53**
223	41,3	7,1	39,6	1,7	Riparian Wood	Capoeirão	Farm/Small Farm	0,31	0,09	-1,4	0,5	0,5	**0,00**
224	60,3	6,6	53,4	7,0	Araucaria Wood	Capoeirão	Farming	0,38	0,18	-1,5	0,5	0,5	**0,06**
225	113,0	14,5	99,4	13,7	Grassland	Disturbed	Farming	0,51	0,26	-1,5	0,5	2,0	**1,77**
226	58,3	8,0	51,4	6,9	Araucaria Wood	Capoeirão	Small Farming	0,37	0,18	-1,2	0,5	0,5	**0,35**
227	84,4	9,2	70,0	14,4	Araucaria Wood	Capoeirão	Small Farming	0,44	0,26	-1,2	0,5	0,5	**0,51**
228	782,1	19,0	430,9	351,1	Grassland	Disturbed	Remnant/Small Farm	1,35	1,29	0,8	0,5	2,5	**6,44**
229	198,4	11,4	104,6	93,8	Grassland	Fair	Remnant/Small Farm	0,68	0,67	0,8	1,5	2,5	**6,15**
230	101,2	7,4	60,7	40,5	Grassland	Pristine	Remnant	0,49	0,41	2,0	3,0	1,5	**7,42**
231	72,3	4,9	43,9	28,4	Grassland	Disturbed	Remnant/Small Farm	0,41	0,37	0,8	0,5	2,0	**4,08**
232	138,0	10,3	89,8	48,2	Grassland	Disturbed	Farm/Remnant	0,57	0,48	0,0	0,5	1,0	**2,55**
233	318,5	28,2	230,9	87,5	Grassland	Disturbed	Farming	0,86	0,65	-1,5	0,5	2,0	**2,51**
234	3612,4	181,2	1598,0	2014,4	Grassland	Fair	Remn/S.Farm/Road	2,90	3,10	-0,4	1,5	2,5	**9,60**
235	94,0	6,8	66,2	27,7	Riparian Wood	Capoeirão	Small Farming	0,47	0,36	-1,2	0,5	1,0	**1,13**
236	43,5	6,4	41,1	2,4	Mixed Riparian	Disturbed	Farming	0,32	0,11	-1,5	0,5	1,0	**0,43**
237	412,4	33,7	292,9	119,5	Mixed Riparian	Disturbed	Farming	0,98	0,75	-1,5	0,5	1,5	**2,23**
238	155,5	14,9	127,0	28,6	Mixed Riparian	Disturbed	Farm/SubUrban	0,60	0,37	-1,7	0,5	1,5	**1,27**
239	83,8	12,2	77,6	6,2	Mixed Riparian	Disturbed	Farming	0,44	0,17	-1,5	0,5	1,5	**1,11**
240	779,6	51,4	455,7	323,9	Grassland	Fair	Farm/Road	1,35	1,24	-1,8	1,5	1,5	**3,79**
241	107,9	15,8	103,1	4,8	Riparian Wood	Capoeirão	Small Farming	0,50	0,15	-1,2	0,5	0,5	**0,45**
242	171,6	14,3	114,1	57,5	Mixed Riparian	Disturbed	Farming	0,63	0,52	-1,5	0,5	0,5	**0,66**
243	122,5	9,7	86,9	35,6	Grassland	Disturbed	Farming	0,53	0,41	-1,5	0,5	2,0	**1,95**
244	82,3	10,0	69,1	13,2	Riparian Wood	Capoeirão	Urban/Farm	0,44	0,25	-1,8	0,5	0,5	**0**
245	13.561,0	489,9	4128,3	9432,7	Grassland	Pristine	Farm/Remn/Road	5,62	6,70	-1,0	3,0	3,0	**17,32**

Total 105.066 **Mean Patch Size** 428,8

[1] The Green colored lines specify data from Regional Conservation Priority Patches, blue from Landscape Priority Patches and no color from Local/Farm Priority Patches

DISSERTATION

AN INTEGRATED LANDSCAPE CONSERVATION APPROACH FOR THE AGROLANDSCAPES OF SOUTHERN BRAZIL: THE CASE OF CAMPOS GERAIS, PARANÁ

(VOLUME 2 – CHAPTERS 5 - 8)

Submitted by

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In partial fulfillment of the requirements

For the degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

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Chapter 5: A Research Framework for the Dialectical Construction of Strategies for Landscape Conservation

5.1 Introduction

This chapter provides a methodological link between the landscape analysis developed at broad regional scale and the finer watershed and on-farm analysis. It builds on the results described on the previous chapters and lays out the conceptual framework for developing a dialectical landscape conservation approach with stakeholders; landowners who will ultimately implement the necessary changes in the landscape (Figure 5.1). Initially, we will address the method for selecting priority landscapes and places for the collection of social data. Next we addressed the methods for mapping land units at the farm level which will provide the spatial information to be used for interviewing landowners. This is, followed by a discussion of how interviews fit into the research process. The chapter finishes by presenting the methodological procedures for: a) understanding landowner views regarding conservation alternatives; and b) developing a dialectical approach for the construction of landscape-based conservation strategies.

Figure 5.1 presents the conceptual framework for the analysis in the context of the landscape and farm/local level. The inverted pyramid associate to the figures of the landowner and the researcher represents how the cognitive hierarchy[1] (perceptions) of those interviewed (some combination of values, basic beliefs, attitude and norms) will influence the landowners' conservation intentions (behavioral intention), and their practices (behaviors) regarding future land management or conservation actions. In-depth

[1] See discussion on Section 2.3.1 - Social Values and Landscapes

interviews were used to probe the perceptions of those owning and managing land identified as priority for conservation. Later this information was used to evaluate the likelihood of achieving conservation goals on those lands.

We also recognize that the researchers also bring to the field some set of perceptions of their own about the construction of conservation alternatives. As put by Kincheloe & McLaren (1998): "critical researchers enter into an investigation with their assumption on the table, so no one is confuse concerning the epistemological and political baggage they bring with them to the research site". Accordingly, we made explicit during the interviews our interest in and goals for landscape conservation– including the desire to understand where conservation actions might occur along a consensus-oriented cooperation and compromise-oriented negotiations continuum[2].

The aim was to use interviews that utilized spatial information, on-the-ground tours and true dialogue (ideal speech situation) to construct landscape-based conservation alternatives, which would be feasible for implementation on the scale of the land and the type of agriculture in question. It was hoped that this information could then be transferred to the broader landscapes of the regional mosaic.

The idea was to develop pragmatic conservation alternatives that would be informed by the perceptions, assigned meanings, interests and future plans of landowners. While the emphasis of the research is placed on the development of farm level strategies, these must also be in tune with the existing or likely legal framework, the broader socio-

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[2] See previous discussion on Section 2.3.6 - A Critical Postmodern Landscape Research

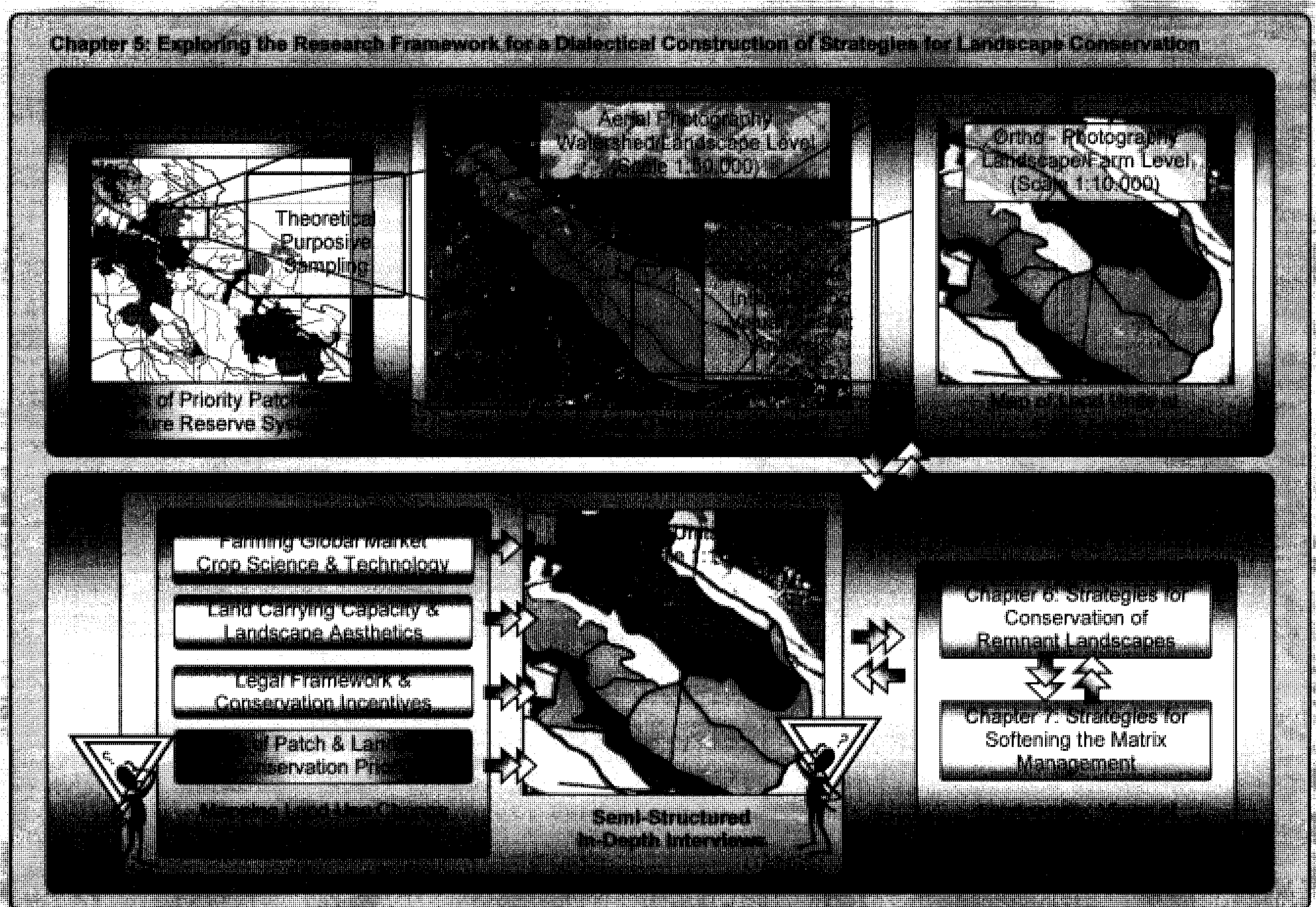

Figure 5.1: Research Framework for a Exploring a Dialectical Construction of Strategies for Landscape Conservation

Legend: Methods, Results, Previous Results, Research Step, GIS-Based Digital Analysis, Landscape-Based Qualitative Analysis economic variables affecting landowners such as development policies and present and potential markets for regionally produced goods.

5.2 The Sampling Frame

5.2.1 Mapping Conservation Priority Landscapes

A Landscaped-based and purposive sampling strategy (Kvale 1996, Strauss and Corbin 1998, Blaikie 2000) was employed for defining the area where interviews would be conducted, specific watersheds and rural properties having a representative diversity of landowners applicable to the regional matrix and later to a conservation strategy. This may be thought of as a landscape-based action research approach on the agrolandscape of interest. The objective of this sampling approach is not to draw a statistically representative sample, but rather to anticipate the factors expected to produce variation in the natural and social phenomenon being studied, i.e., the dialectical construction of conservation strategies on selected priority landscapes. This approach also intends to go beyond the collection and analysis of social data to a dialectical and interactive development of landscape conservation strategies based on the establishment of partnerships with stakeholders.

A GIS-based analysis was employed to define the lands and landowners to be sampled. The main road network and the urban/industrial areas, structures that clearly divide the regional matrix, were used to define major landscape units for analysis. A Gestalt[3] analysis was employed for selecting conservation landscapes, by overlying spatial information of the following parameters: a) vegetation community types and

[3] See discussion on Section 2.2 – Landscape Structure and Analysis – A Systemic View

remnant habitats (see Figures 3.6 and 3.10 – Chapter 3); b) conservation priority patches and the network of nature reserves (see Figures 4.1 and 4.4); and, c) the land use system categories (see Figure 3.8 – Chapter 3), either as indicators of the environmental impact on remnant patches produced by surrounding land uses, as well as spatial indicator of the social differentiation (large landowners, family farms, ranches etc.) in the matrix.

Major Conservation Landscapes were defined by selecting all the Regional and Landscape Priority Patches (Conservation Priority Index > 4.4) located within the polygons shaped by the intersection of the highway network and urban areas (see Figure 5.2). As wetlands ecosystems have been recently regulated at Federal level as areas of permanent preservation[4] (APPs), the major landscapes with significant presence of wetlands were not included as priority landscapes for the human dimensions component. Therefore emphasis was placed on selecting places previously covered by Grasslands and Araucaria Forest ecosystems.

Accordingly, two clusters of Conservation Priority Patches were selected for the in-depth landowner interviews (See Figure 5.3). These two polygons will be, thereafter, referred as the Conservation Priority Landscapes. The first sampling polygon contains landscapes located along the Devonian Escarpment, which is predominated by ranching and intensive farming systems with significant remnant patches of grasslands ecosystems. This sampling unit was defined by selecting all the 13 Regional and Landscape Priority patches (Conservation Priority Index – CPI > 4.4), plus 15 other Farm/Local Priority patches, located eastern of the BR 376 - the main highway to cross the matrix.

[4] In Portuguese: *Áreas de Preservação Permanente* – APP (see discussion on the Section 6.2: The Legal Framework and Incentives for Conservation in Brazil and Paraná).

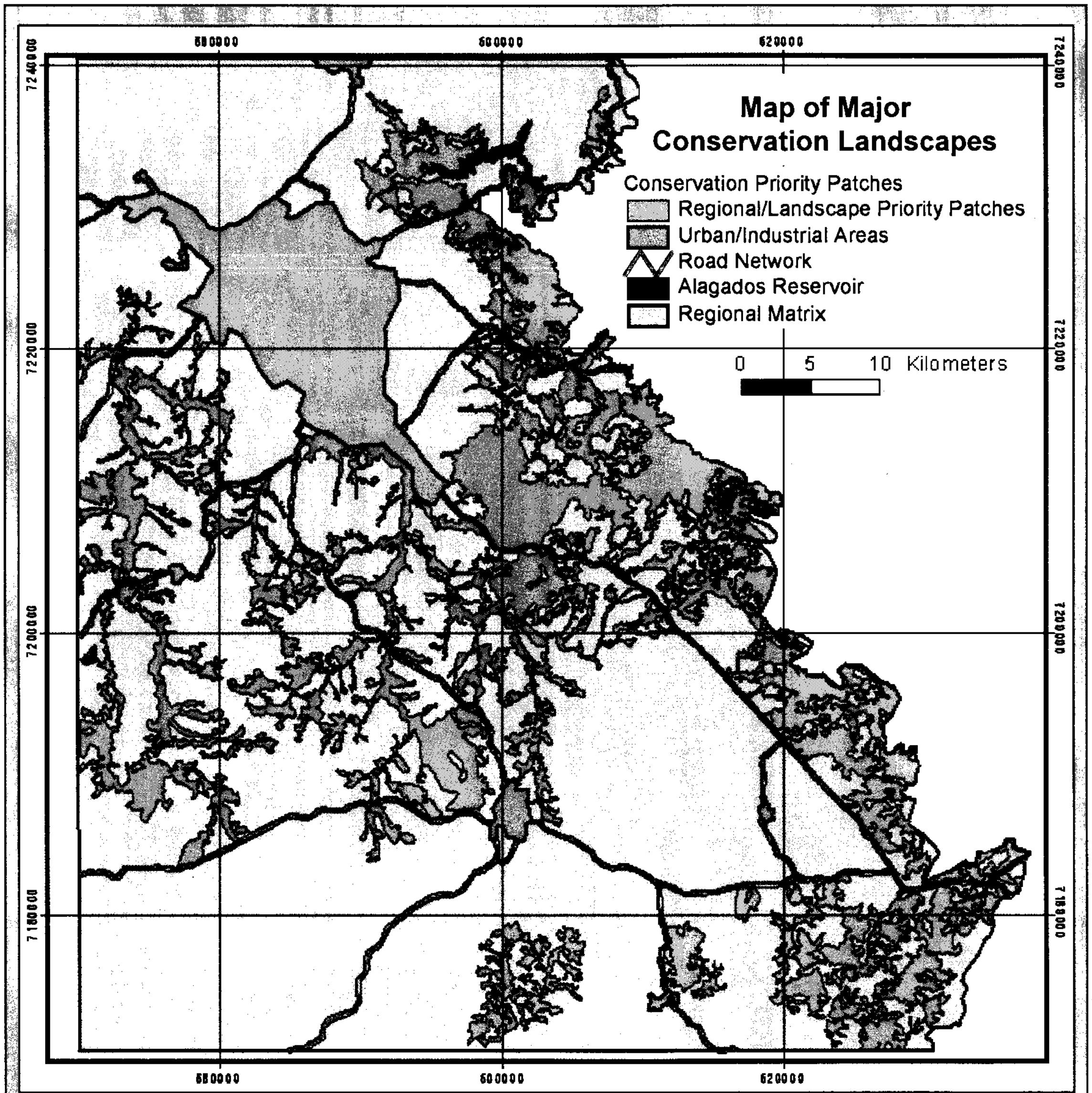

Figure 5.2: Map of Major Conservation Landscapes

The second sampling area is located on the southern portion of the Matrix, having smaller scale family farming systems with significant remnant patches of Araucaria Forest. This sampling unit was selected to include the patch with the highest CPI (CPI = 7.49) among the remnant patches of Araucaria Forest. Later, during interviews, the initial sampling polygon was expanded to include additional patches of family farming systems, which were seen as likely to require different approaches to conservation.

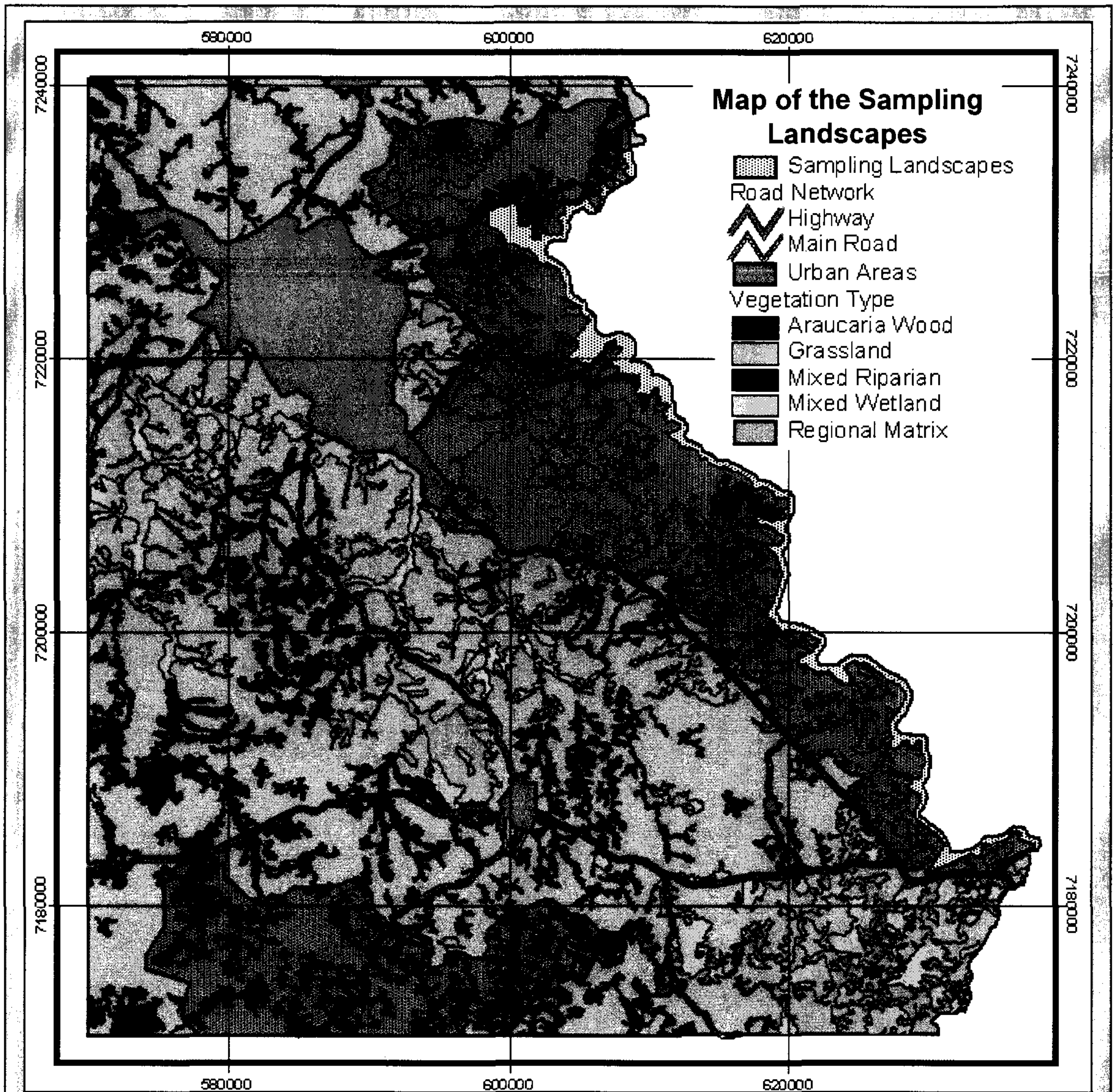

Figure 5.3: Map of the Sampling Landscapes

As previously discussed[5], large, medium, and small farmsteads and ranches are distributed in the matrix in a way that varies according to the land use systems and practices employed as well as socio-economic and cultural patterns. Each has somewhat different spatial dimensions and produces differing biophysical effects (Grove 1999). It was assumed that there would be differences in the landscape meanings assigned by residents. All of these are important elements to be taken in consideration when constructing and negotiating conservation strategies and land management alternatives.

Landowners from distinct socio-cultural backgrounds employing different land use systems are likely to face distinct challenges and to have different priorities for managing and making their lands profitable. Earlier participant observation at various meetings (described in Chapter 3) revealed that members of the same rural social groups seemed likely to share particular values, attitudes, and landscape meanings. Hence, particular attention was directed at trying to understand how these might affect the establishment of partnerships for a landscape conservation strategy.

5.2.2 Mapping Land Units at Farm Level

Land Units were identified among remnant patches and delineated based on aerial photography interpretation techniques (Avery & Berlin 1992, Zonneveld 1995, Antrop 2000) using aerial color photography from August 2002 (scale 1:30.000). Available ancillary data (topographic and thematic maps in different scales, including geology, topography, soil, vegetation and road network) were employed as complimentary sources of information[6]. Mylar paper was overlain on the photos and interpreted using tri-dimensional stereoscopy.

The main landscape features assessed in the photo interpretation process as sources of spatial variability to delineate boundaries among land units were: a) landforms; b) drainage patterns; c) shape and degree of slope; d) soil types and soilscapes; e) vegetation types; f) physiognomy of distinct stages of ecological

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[5] Section 3.3.3 - Land Use Systems

succession; f) land use systems; and g) other relevant natural or cultural features. Aerial photographs in digital format were imported into the GIS environment and geometrically rectified, using the software SPRING/INPE (version 4.2). The polygons resulting from the stereoscopic aerial photo-interpretation, were "on-screen" re-delineated into a vector format in the ArcView (version 3.2) GIS environment.

The resulting geo-corrected polygons were, then, ready for measurement purposes and other GIS applications. The orthophoto-maps, overlaid by the land unit polygons, were color printed in a 1:10.000 scale, for each sampled farm (see discussion bellow). These orthophoto-maps (see Figure 5.4 for example) were used to establish rapport and guide conversations with landowners that explored landscape meanings and conservation actions with landowners. It was expected that land units, as well as their productive potential and other attributes would be identifiable by landowners as they looked at the orthophoto-maps.

5.3 Describing Drivers of Land Use Change and Conservation

Bio-physical attributes and human socio-economic systems interacting at multiple scales and constitute the main drivers of local land use change. Farmers are the *de facto* managers of the most productive lands on Earth, and thus, conservation will require that society appropriately motivate and reward agriculturalists for the production of both food and ecosystem services (Tilman et al 2002). Hence a creative but pragmatic landscape conservation approach should initially define relevant interview questions related to agricultural practices and the epistemological approach to framing them with

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[6] See also discussion on Section 2.2: Landscape Structure and Analysis: a Systemic View

stakeholders. To inform the structure of the interviews, we used a review of literature to explore drivers of both land use intensification and those that might also promote or place sideboards on landscape conservation.

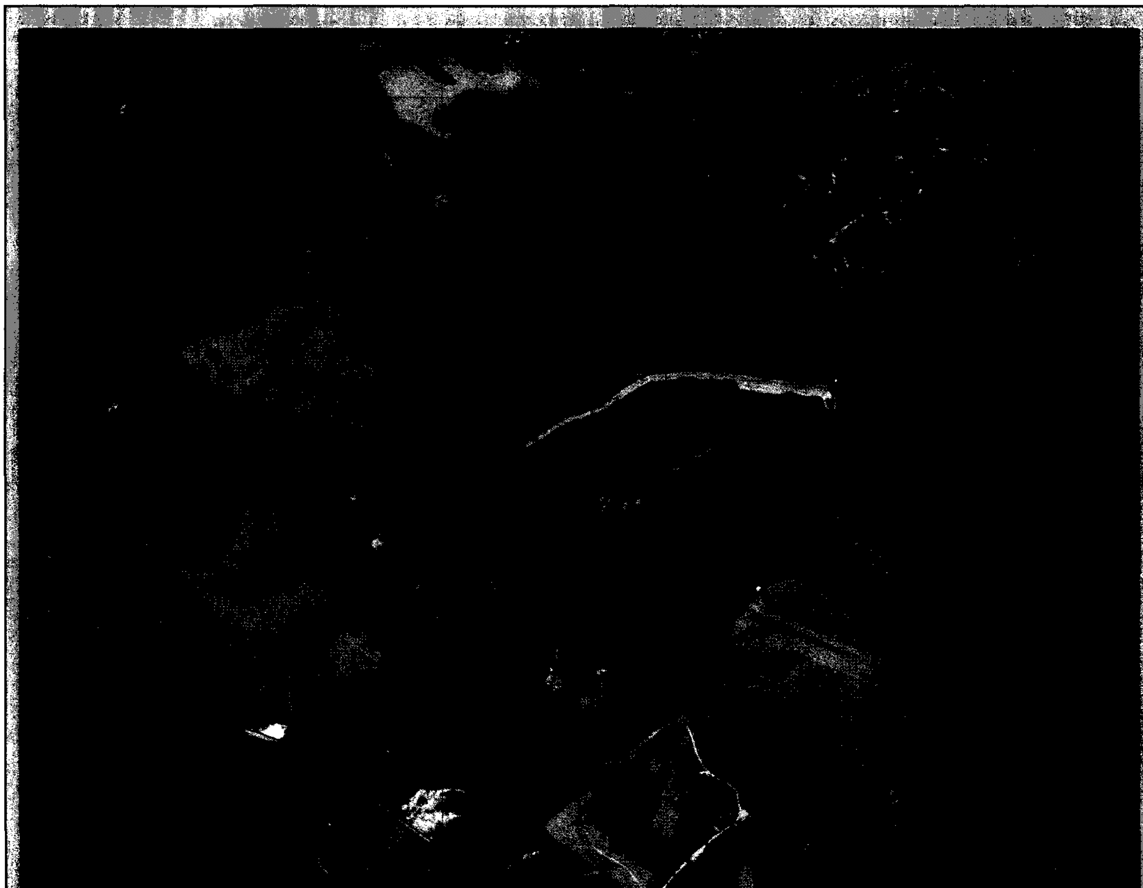

Figure 5.4: Example of orthophoto overlaid by land unit polygons mapped at farm scale. Each grid is 1 km X 1 km.

5.3.1 Global Demand for Farming Commodities

Agriculture, urbanization and other forms of direct intensive land use management are responsible for much of the change in the distribution and abundance of the world's biota, as well as major alterations to the Earth's material and hydrological cycles (Robertson 2000, Kiss 2002, Donald 2004). The impact of agriculture on the Earth's ecosystems is likely to accelerate in the next 50 years as advancements in industrial agriculture, coupled with the growing demand for produce, outpace policy development aimed at reducing environmental problems (Tilman et al 2002, DiLeva 2002).

The introduction of green revolution techniques has already changed the social and ecological landscape in many regions of Brazil (Fearnside 2001, Tabarelli et al 2005), as well as in the regional matrix[7]. Further technological advances, such as the production of transgenic crop varieties and precision farming techniques, may reduce inputs of water, pesticides, nutrients, and energy for food production. At the same time, these innovations may consolidate the vertical integration of agribusiness, ensure the continuation of current farming practices, and reduce the contribution of farmers' knowledge to the management of agricultural lands (Robertson 2000, Altieri 2004).

In the views of Clark & York (2005) "the alienation of rural workers and nature, in a competitive, profit-driven agroecosystem, increases the exploitation of landscapes as the natural world becomes increasingly organized for the capitalist economic system that requires increasing throughputs for production, given that it is inherently expansionary and continually reproduces itself on a larger scale". Given the global operations of capital and its short-term focus on profit, which excludes any serious consideration of the environment, capitalism freely appropriates landscapes, as it organizes the environment and labor for the production of commodities (ibid).

The international political economy of industrial farming and the global division of labor, is how the modern state operates to advance economic production and growth - a process that is often inimical to sustainability (Caruthers 1986, Song & M'Gonigle

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[7] See discussion on Section 3.3 - The Regional Conservation Context

2001). These are fundamental issues to be addressed by conservation planning that occurs on managed agricultural landscapes. Accordingly, the global market and agriculture economy, is a main driver of land use changes including the intensification of soybean production and conversion of grasslands in the regional matrix of Campos Gerais.

It was anticipated that these topics would be raised during interviews if stimulated by questions about farming practices and the commercial aspects of farming inputs and outputs (see discussion bellow). Interviews were directed to exchange views on how such activities are located within the regional and global agribusiness sector. As globalization directly impacts the way land is managed and the profitability of the farming enterprises, discussing landscape management alternatives was seen to be important for developing any conservation strategy.

5.3.2 Pre-Interview Mapping of Land Capability & Aesthetics

Land capability (sometimes referred to as carrying capacity), is a function of factors like slope, soil type, erodibility, fertility – all of which determine suitability for farming purposes. In this study these characteristics were assessed as a "by-product" of the photo-interpretation process for mapping land units. Land qualities are direct related to the geo-biophysical features of landscapes, and as such, are considered inherent and instrumental meanings[8] of land units. The agricultural potential of land units, represented by soil and land characteristics has also been pointed out as a fundamental driver of land use changes in the region (Rocha 1995).

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[8] See discussion on Section 2.4.3 – Place, Land Units and Landscape Meanings

The landscape aesthetics (sensu Parsons & Daniel 2002) of a land units is another inherent and instrumental meaning, and one that was assessed through the photo-interpretation and complemented by field explorations of potential sites (see Figure 5.5 for examples). Some places, such as Vila Velha State Park, and the Buraco do Padre, are well known tourist destinations and recreational sites. Hence, landowners having unique or scenic landscapes may be able to generate additional income from them. The photo interpretation of such sites was used along with spatial information about land capability and conservation potential during interviews to assist with the meanings assigned with stakeholders at the farm level, and to stimulate discussions about conservation compatible land management systems.

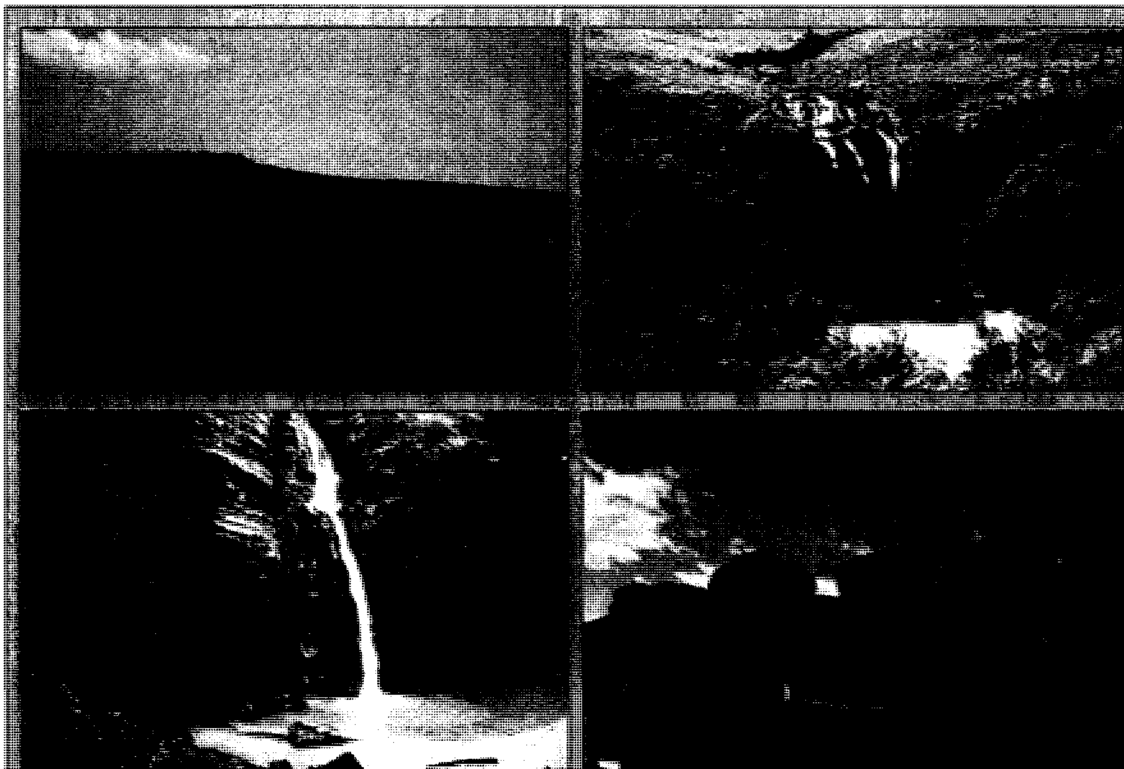

Figure 5.5 Selected places and landscapes with high aesthetics and potential recreation sites (Clockwise from upper left 1 - Quebra Perna Valley, 2 – Mariquinha Falls, 3 – Vila Velha State Park, 4 – Buraco do Padre - Photos by Eduardo Isa).

5.3.3 Setting the Legal Framework and Incentives for Conservation

An extensive review of literature and information from key informants was used to identify the legal framework within which landscape conservation might be operationalized in the landscape matrix and elsewhere in Southern Brazil. This analysis yielded a set of legal instruments, benefits and possible incentives for implementing a landscape conservation strategy and the particular context that made some of them successful where they had already been implemented. Informants included personnel from public agencies, legislators, attorneys and other experts.

It is in the portion of the agricultural landscape matrix, where intensive farming systems are the predominant form of land use, that a regional conservation plan can be used to modify production activities. Accordingly, ecologically friendly alternatives that could be used to minimize impacts from agricultural activities while still providing economic gain for stakeholder partnerships were also researched. Land management that is compatible with reserved or protected areas is of fundamental importance[9]. The compatibility of human actions near wildland conservation areas differs, depends on the scale of activity and can either enhance or reduce the effectiveness of remnant or restored habitat patches across the landscape matrix.

5.4 Understanding Landowners' Views of Conservation Alternatives

5.4.1 The Interview as Dialogue

The mode of understanding inherent in qualitative social science research involves uncovering and interpreting alternative conceptions of social knowledge and meaningful

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[9] See Discussion on Chapter 3: Setting the Regional Conservation Context

relationships. There is a move away from obtaining knowledge primarily through external observation and experimental manipulation of human subjects, toward an understanding by means of conversations with the human beings to be understood (Kvale 1996). "Interviews are particularly suited for studying people's understanding of the meanings in their lived world, describing their experiences and self-understanding, and clarifying and elaborating their own perspective on their lived world" (ibid).

An interview is a dialogue that has a structure and a purpose. It goes beyond the spontaneous exchange of views as in everyday conversation, and becomes a careful questioning and listening approach with the purpose of obtaining thoroughly tested knowledge. The interview is not a normal conversation between equal partners, because the researcher defines and controls the situation. The topic of the interview is introduced by the researcher, who also critically follows up the subjects answers to the questions. The emphasis on the interview as conversation and in the interpretation of its meanings brings interview research closer to the domain of the humanities (Kvale 1996).

During interviews, the subjects not only answer questions prepared by an expert, but themselves formulate their conceptions of their lived world. The sensitivity of the interviewer and its closeness to the subjects' lived world can lead to knowledge that can be used to enhance the human condition. Thus, within a postmodern critical landscape approach we will, in line with Kvale's "traveler" metaphor of the interviewer, emphasize the constructive nature of knowledge created through the "dialogue" or two way interactions of the partners who enter into mutual learning in the process of conversing.

In discussing his postmodern traveler metaphor Kvale (1996) says, "the interviewer wanders along with the local inhabitants, ask questions that lead the subjects to tell their own stories - which is the original Latin meaning of the word conversation as "wandering together with". In other words, both the interviewer and the person interviewed are reflecting and learning during the research activity, and that learning may include the highlighted understanding of things previously taken for granted.

5.4.2 Semi-Structured and In-Depth Interviews

Semi-structured interviews are a flexible method of compiling information from dialogue between two people or among a group of people. This method has been widely used in participatory rural appraisals and similar approaches, and has the advantage of allowing people to exchange information with much less restriction than in a closed-ended survey. If used correctly it opens a space for the voices of the local actors to be heard and documented (Bacon et al 2005). Pre-tested questions (Appendix X) are used to generate responses from participants but the interviewer is permitted to insert additional questions to explore ideas that the respondents have raised. Likewise, it is possible for the researcher to respond to the perceptions and questions raised by respondents (Acharya 2004). The main focus, however, is on the informant's perception of self, life, and experience, as it relates to a specific topic and is expressed in their own words.

5.4.3 The Selection of Respondents

The sample of interviewees used in this study was selected using the method of "Theoretical Purposive Sampling". This meant interviewing a number of persons selected in advance, and then determining the selection of further interviewees on the basis of the information being collected until reaching "theoretical saturation" for the theme (Kvale

1996, Strauss and Corbin 1996, Blaikie 2000), in this case perceptions related to the special question of landscape conservation.

It is also essential that qualitative samples are selected purposively to facilitate the range and diversity present in the target population, in this case landowners across the regional matrix. Purposive sampling facilitates the production of a coherent and comprehensive map of circumstances, attitudes, behaviors and experiences, which enable the generation of salient explanations to answer research questions (Acharya 2004), in this study ''what empirical data will be suitable to advance the development of participatory conservation strategies?''

The decisive criterion for integrating statements of interviewees into the holistic analysis was the relevance of the additional information for providing a more comprehensive understanding of underlying motivations to acceptance, resistance, or opposition to conservation of remnant patches and to alternative landscape management. Interviews were conducted until no further data informing the research question was forthcoming (Strauss and Corbin 1998, Stoll-Kleemann 2001).

Accordingly, a total of 23 in-depth interviews were undertaken with landowners. The Table 5.1 summarizes the landscape-based sampling strategy by land use systems and classes of remnant landscapes. Ten additional interviews with Key Informants (see discussion bellow), and participant observation on ten meetings with specific stakeholder groups were used to deepen the understanding of the social differentiation (among landowners) in the matrix. This enabled the creation of a land use system typology[10].

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[10] See Section 3.2.2 - Participant Observation (P.O.) Techniques

In-depth interviews were carried out from October 2005 to May 2006 with owners of farmsteads located within the priority landscapes. Where possible the interviews were conducted with both male and female adult household members together (in 7 out of 23 interviews). The interview process was informal and open-ended, with the questions covering the property and its history, the family, farm or other production, land management issues for the property, local community structure and dynamics, and issues facing the community, including land and crop management and problems (see interview guide, Appendix 3).

Table 5.1: A Landscape-Based Purposive Sampling in the Regional Matrix and Priority Landscapes

Methodologies For Collecting Qualitative Data	Land Use System & (Main Remnant Communities Type)			
	Ranching (Grasslands)	Intensive Farming (Grasslands)	Small Farming (Araucaria Forest)	Other[1] (Grasslands & Araucaria Forest)
Participant Observation	-	4, 5, 7, 8	6, 9, 10	1, 2, 3
Interviews with Key Informants	33	16	18, 19, 20	22, 24, 25, 31, 32
In Depth Interviews	2, 3, 14, 26	1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 15, 17	21, 29,30	23, 27, 28

[1]Rural Tourism, Intensive Forestry, Farming Systems Experts and other Public Agency Personnel
Numbers on cells are the identification of interviewees as they are cited throughout this report

Interviews were often conducted while walking or looking at the property and at spatial information about the property discussed in section 5.3. The interview guide had eight main topics to be addressed during the interviews and another fifty additional items as potential thematic questions to address the development of conservation strategies and to promote a “good interview interaction” (Kvale 1996).

5.4.4 Interviews as a Dialectical Approach for the Construction of Landscape-Based Conservation Strategies

A principal focus for the interviews was to find out how willing landowners are to set aside particular mapped land units for conservation? Or, in other words: what benefits and incentives are required for setting aside or restoring remnant conservation priority land units for conservation? Preliminary contacts with interviewees were made to clarify the nature, goals, and the ethical issues of the research and to obtain the landowner's consent for the interview and to arrange a time – anticipated to take from 2 to 4 hours. These preliminary contacts were considered strategic for establishing an initial rapport with stakeholders.

Interviews typically started by directing the conversation to the land use system as developed on the farm and in the neighborhood using the spatial imagery and maps previously prepared. Questions concerning soil and crop management systems, use of technology, levels of productivity and about the profitability of the farming systems and the farming enterprise were raised. Issues of market for farming commodities, particularly soybean and corn - the two most important cash crops in the region, and livestock markets - in the case of ranchers, were also raised to understanding potential and limitations of the existing commercialization networks and to explore another potential networks for land use alternatives.

Later, maps of natural vegetation were presented to interviewees to point out the uniqueness of the regional landscape ecosystem. Examples of biodiversity and cultural resources were given at which point the conversations that followed allowed interviewees to talk about their experiences and knowledge concerning the ecological and cultural features of their own and surrounding landscapes. Questions also prompted interviewees to provide additional information about family history and change prompted by regional events like the intensification of the agricultural landscape from ranching to cropping systems.

The conversation about conservation issues was opened by a general characterization of the Campos Gerais' remnant biodiversity and the importance of the conservation of these last remnants. The maps of the nature reserve network systems and conservation priority patches (Figures 4.1 and 4.4) were shown and explained and the interviewees' farm and surroundings located on the maps. The map of conservation priorities was then presented, followed by a general explanation of how it was produced. Remnant units were then located to test how recognizable such elements were to them. Field trips were often used to review boundaries and discuss inherent/instrumental properties of land units.

After discussing mapped units as a common ground for negotiations, farmers were queried about their willingness to set aside each mapped land unit for conservation and/or restoration purposes. Information regarding the legal framework for conservation and incentives, or the eco-friendly management alternatives (see, softening the matrix, Chapter 7) were discussed as necessary. Final discussions focused on conservation alternatives that seemed compatible with the interviewee's situation. These were approached in several ways. In some cases, the conversation naturally led to the issues of land management alternatives and at other times, had to be stimulated with secondary questioning, which led to the construction of alternatives in some cases.

Landscape conservation strategies were further discussed within 10 additional interviews with key informants, conducted in order to better understand relevant conservation and land management issues emerging during the interviews. Key informants included a small farmer and two farming advisers working within familiar agroecological systems in the Araucaria Forest region; two experts on intensive farming systems; an independent regional planning adviser; two state officials working on regional conservation issues; two landowners managing rural tourism enterprises, and an expert on ranching systems. These informants were also selected to address specific information and to obtain a diverse mix of experiences and perspectives.

During the interviews, the farm setting was helpful as the interviewees were literally at home but tape recording did not seem appropriate (Stringer 1999). Field notes were taken in outline form along with salient quotes and connections to main ideas. After each interview, extensive notes were developed and put in chronological order with and the most important ideas highlighted. The challenge, however, was to "listening without prejudice", allowing the interviewees' descriptions of their experiences unfold without interruptions from interviewer's questions or presuppositions (Kvale 1996, Oreszczyn & Lane 2000).

In Chapter 6 we will first address the legal framework and potential incentives for conservation and then the results from the interviews. In Chapter 7 we will address the potential of ranching as alternative to enhance landscape conservation and the dialogues that followed from discussing ranching as economic and cultural alternative for minimizing the environmental impacts of the management of the matrix.

Three other potential land use alternatives were also addressed with stakeholders: organic farming systems as alternative for intensive farming, agro-ecological farming systems for small familiar systems, and rural and ecotourism as economic alternative based on the scenic aesthetics qualities of the regional landscape. Despite the rich set of information gathered on the dialogues about these issues, due to restriction in length of this dissertation, such discussions will not be addressed on the chapters to follow, except as complementary topics along the main discussion.

Appendix 5.1

Colorado State University

Department of Human Dimension of Natural Resources

The Interview Guide (In Portuguese)

Roteiro para Entrevistas – Ponta Grossa – PR - 2006

1. **História da Família na Região/Propriedade**
2. **Características da Propriedade**
3. **Uso e Manejo Atual das Terras**
4. **Aspectos Econômicos da Atividade Agropecuária**
5. **Grau de Satisfação com a Atividade Agropecuária**
6. **Relação com Meio Ambiente e Biodiversidade Regional**
7. **Unidades de Manejo das Terras**
8. **Alternativas para Conservação**

1. História da Família na Região/Propriedade

Quanto tempo/gerações a família esta nesta terra?
Histórico do uso das Terras. (Local Regional) Como era a paisagem/fazenda/manejo/antigamente?
Experiências Pessoais na Infância em relação à terra (Place Attachment).

2. Características da Propriedade

Descrição da Propriedade
Qualidade e Potencial para Uso Agropecuário das Terras
Outros aspectos importantes (Água, rios, história, paisagem)
Quais os Problemas mais Importantes em sua propriedade

3. Uso e Manejo Atual das Terras

% de Uso das Terras (Agricultura/ Pastagem Plantada/Nativa/ Florestas/ Sem Uso)
Área Plantada/Arrendamento
Sistemas de Produção Agrícola
Sistemas de Produção Animal
Tipo de Pastagens/Alimentação
Erosão e Formas de Controle
Uso de Agrotóxicos (como diminuir)
Fertilizantes (custo e manejo)
Assistência Técnica/Informações
Que tipo de mudanças estão acontecendo no mercado agropecuário?
Que organizações/pessoas são importantes para o Sr./Sra. em relação a decisões de manejo das terras
Com que a Sr. /Sra. conversa /consulta sobre planos de mudanças, mercado, manejo (vizinhos, amigos, parentes, assitencia técnica, profissionais)?

Que organizações a Sr. /Sra. aponta como interessados em suas opiniões/preocupações e atua neste sentido?

4. Aspectos Econômicos da Atividade Agropecuária

Ocupação Principal (% renda total oriunda da atividade agrícola)
Custeio da Safra/Produção
Produtividade Agrícola (sacos/ha) /Comentários
Produção Animal /Comentários
Mercado e Rentabilidade
Origem das Informações sobre Mercado/Comercialização

5. Grau de Satisfação com a Atividade Agropecuária

Satisfação com os resultados econômicos da atividade
Esta mais fácil ou mais difícil viver da terra hoje comparado com "antes"?
Quais as suas preocupações com a viabilidade econômica da propriedade em relação ao mercado agrícola?
Que ações de outras organizações influenciam suas preocupações com a fazenda e aspectos econômicos?
Planos de futuras mudanças uso das terras (< 5anos)
Será necessário futuras mudanças no uso das terras (> 5 anos)

6. Relação com Biodiversidade e Meio Ambiente Regional

Vegetação Nativa: (Capões de Mata/ Campos Nativos/ Rochas/ Banhados
Fauna Silvestre: Pequenos Roedores/Veado/ Lobo Guará/Onça /Cobras/Anfíbios
Aspectos Históricos e culturais relevantes
Qualidade das águas dos rios
Importância da Biodiversidade Regional

7. Unidades de Manejo das Terras (Land Units)

Mapeamento do produtor
Identificação/Correções
Potencial p/Conservação
Valor p/Conservação

8. Alternativas para Conservação

Reserva Legal e APP
Assistência Técnica para Conservação vs Fiscalização
Manejo Integrado de Pragas/Doenças/Ervas Daninhas
Agricultura Orgânica
Criação Animal em Pastagem Nativa
Turismo Rural e Ecoturismo
Interesse em Participação em Programa DS&CN

Chapter 6 - Participatory Strategies for Conservation on Priority Landscapes

6.1 Incentives for Biological Conservation on Private Lands

Loss of natural habitats, as a result of conversion to agriculture or other uses, is the single greatest source of biodiversity decline and loss world-wide (Kiss 2002, Donald 2004, Green 2005) as well as in Brazil (Fearnside 2001, Tabarelli et al 2005, Klink & Machado 2005). Destruction of natural habitat over the past several decades on the 25 so-called world's biodiversity hot-spots has been driven mainly by logging for timber, and by the expansion of beef, soybeans, palm oil, coffee and cocoa production (Hardner & Rice 2002). In many countries most of remnant ecosystems remains under the control of the commercial sector and the pressures for the production of commodities are increasing and are not likely to diminish in the foreseeable future (Kiss 2002, Di Leva 2002, Tilman et al 2004, Mattison & Norris 2005).

As pointed out by Kiss (2002), it has become popular to say that factors such as poverty and over population in developing countries are the root causes of biodiversity loss, which must be addressed if conservation is to be sustainable. Clearly, the large-scale loss of nature and natural resources is tied to dire poverty throughout much of the developing world, and elimination of poverty is fundamental to guarantee long term biodiversity conservation. Domestic plants and animal consumed by a growing human population have grown in number and have expanded their range with human assistance (DiLeva 2002, Kiss 2002). A global demand for farming commodities reduces natural habitat as land is converted to intensive cash crop farming systems.

The external flow of private resources to many developing countries has significantly surpassed official development assistance during the 1990s, and the commercial sector has had a decisive impact on natural resources sustainability (Di Leva 2002). Rather than poverty or human population growth *per se*, the fundamental cause of biodiversity loss worldwide is that those in a position to preserve it, farmers, growers, and landholders in general, on the high-valued biodiversity landscapes throughout the world, lack sufficient incentives to do so. Governmental "command and control" conservation policies have provided few incentives for landowners or local communities to pursue conservation strategies (Kiss 2002, Forest Trends 2006). This is particularly true for rich biodiversity countries such as Brazil.

Most people throughout the world do not routinely sacrifice short-term personal gains in order to achieve long-term benefits for the wider community, regardless of whether they are living on the edge of survival or directing commercial enterprises. Like most people, landholders and resource users in developing countries make their decisions based on their perceived self-interest, with a strong bias towards the short term. Unfortunately, the benefits of conserving biodiversity tend to be long-term, poorly understood, indirect and diffuse, while the benefits of activities that destroy or degrade biodiversity tend to be short-term, direct, financially supported, and more easily captured by individuals (Kiss 2002, James 2002, Carolan 2006).

The introduction of green revolution farming technologies in the Campos Gerais and the general profitability of such systems have been producing direct and short term economic benefits, and, consequently, the majority of the matrix's land (65%) is currently under intensive farming systems (See Figure 3.9: Map of Land Use Systems –

Chapter 3). A the top priority for conservation investment must be to slow, halt, and even reverse this process of habitat loss in areas that are recognized as the most important sites for conservation (See Figure 4.4: Regional Network of Nature Reserves – Chapter 4). As pointed out by Kiss (2002), the key question therefore is: "how can we encourage those who make the land use decisions in these areas to forego the benefits associated with destructive activities in favor of conserving biodiversity"?

To counter the adverse impact of intensive farming and development, there are a series of legal instruments or actions that can be taken to protect biodiversity or offer positive incentives to the private sector and landowners who conserve (Kiss 2002, Wallace 2004, Wallace et al 2005, 2008). Such actions or instruments include: the designation of parks and protected areas, the collection and ex-situ conservation of species, land use regulations that prohibit or limit the extent of farming on certain lands or promote farming practices that produce fewer impacts (Di Leva 2002).

Public land acquisition has been the most used mechanism in the past for biodiversity protection. An estimated range of 4 to 12% of each continent land area lies within official Protected Areas such as National Parks or Forest Reserves (Miller 1997). According to the United Nations' List of Protected Areas (UNEP/WCMC 2002), in 2002 there were 12,754 PAs worldwide, covering an area of 13,2 million Km^2. Biodiversity conservation can also be a "side benefit" when land is secured for other purposes, such as maintaining watersheds, by restricting the conversion of natural habitat to other uses. Additionally a growing number of individuals, community groups, and corporations have established private PAs in countries such as Colombia, Costa Rica, Guatemala, Australia, South Africa, and Brazil, among others (Kiss 2002).

Conservation groups may buy land outright to establish or add to PAs, or they may secure land for conservation by acquiring certain use and development rights through conservation leases or easements. Land purchase, leasing and easements have been the principle tools employed by some of the largest conservation organizations operating in the developed world (Kiss 2002). In the U.S. alone, The Nature Conservancy has a system of more than 1,300 reserves protecting over half a million hectares, comprising the largest private natural reserve system in the world.

In another approach, The Revolving Fund for Nature, administered by the Trust for Nature, Victoria - Australia, purchases lands of conservation significance, places a binding covenant on them specifying permitted and prohibited activities to ensure that they are used for conservation in the future, and then resells them (Trust for Nature 2006). Conservation easements incentives are much less common in developing countries as the lack of financial resources is a significant constraint, although conservation organizations are increasingly experimenting with this approach (Kiss 2002, Di Leva 2002, Wallace 2006) as well as payments for ecosystems services on agricultural landscapes (Pagiola et al 2004).

On the typical intensively managed agrolandscapes of Southern Brazil, where public-sector resources are dwarfed by commercial interests, a complementary market-based approach is vital. Accordingly to Di Leva (2002) such an approach can be distributed into three broad categories: a) traditional revenue-raising measures such as eco-taxes or promoting environmentally sensitive activities such as ecotourism; b) standard real property instruments such as conservation easements; and c) protection through a variety of more recent legal measures, such as economic incentives for carbon sequestration, ecolabeling, conservation concessions and the use of transferable quotas. These techniques can also generate close partnerships with the public and private sectors.

Biodiversity conservation on private land is a new and rapidly growing field and the existing stock of knowledge has come from innovators who have forged ahead despite uncertainty and lack of precedent. Di Leva (2002) argued that business leaders, non-governmental organizations, conservation groups, and governments should encourage innovation within their own organizations and in collaboration with other sectors to develop market-based tools that blend economic, social and environmental values.

Regardless of whether we focus on habitat loss, over-exploitation or alien invasions, the important question is how well our responses match the nature and scale of the problem (Kiss 2002). In particular, we must recognize that the forces behind biodiversity loss operate on many geographic scales, from global to local, and involve the actions of huge numbers of people and institutions. Local communities are sometimes the direct consumers, sometimes only act as agents for distant buyers, and sometimes are only indirectly involved (Kiss 2002).

This chapter will explore potential incentives that can be meaningful to land owners as a way to slow, halt, and reverse the process of habitat loss on the conservation priority landscapes, as well as on the regional matrix. First we will review the legal framework and potential incentives for conservation on public and private lands. The emphasis is placed on the mechanisms already available under the Brazilian and Paraná's environmental legislation as they can be regionally employed for the conservation of remnant patches and restoration of croplands. The quest for funding conservation initiatives in Brazil, as an essential component for biodiversity protection, finishes this review.

The review of the legal framework and incentives is followed by presenting landowners' views of those mechanisms and a discussion how conservation initiatives can be developed locally. A central research question asks "how can we encourage those who make the land use decisions in these areas to forego the benefits associated with destructive activities in favor conserving biodiversity?" to be answered as far as possible by landowners themselves, pointing out to alternatives for potential conservation consensus and compromises.

6.2 The Legal Framework and Incentives for Conservation in Brazil and Paraná

The development strategy that began in Brazil in the 1950s was based on massive industrialization, farming modernization and deforestation. Since the mid-1970s, there has been a surge in concern and actions taken to deal with the degradation and environmental issues that this strategy produced. Early regulations resulted basically from centralization and planning policies conducted by a development-oriented state. However, legal instruments for environmental safety and to protect biodiversity have not been sufficient to counteract the economic dynamics of environmental degradation. Hence, the combination of insufficient law enforcement and poor economic returns from conservation resulted in large-scale and often illegal conversion of natural ecosystems to managed landscapes (Seroa da Motta 1996, Tabarelli et al 2005).

During military rule, public involvement on environmental issues was constrained and localized to few centers. The internal shift towards democracy in the 1980s, combined with a new international stance, stimulated the emergence of environmental awareness, movements, organizations, legislation, and policies. Indeed, the most recent regulations were demanded by a more environmentally aware and more organized civil society, armed with improved escientific knowledge and requirements (Silva 2005, Tabarelli et al 2005, Drummond & Barros-Platiau 2006). Particularly in terms of effective mechanisms for protecting biodiversity, many initiatives are, emerging, from public policies and from an escalating involvement of nongovernmental organizations (Tabarelli et al 2005, Drummond & Barros-Platiau 2006).

Conservation and landscape management focus on dynamic ecological processes that cross boundaries, and the consequent need to work across them, clashes with the notion of property (Knight & Landres 1998, Hurley et al 2000). The property owner in Brazil is the primary planner and manager of the land. It is the owner who determines how to utilize the land in light of geographic, economic, legal and personal circumstances, and who determines when a change in existing land use should occur. It is also owners' decisions to change the use of land that triggers the public reactive role, and the creation of environmental legislation for protecting the environment or acquiring private land for conservation.

Even though many rural people are sympathetic to environmental issues and express interest in conservation initiatives, inappropriate, actions on landscapes often indicate otherwise. As put by (James 2002), "instead of pointing fingers from a distance, conservationists and public agency officials should make an effort to understand why certain land use practices are implemented by actually talking with the landowner".

The discussion to follow will concentrate on selected State and Federal laws and land use planning tools that might potentially be employed for the conservation of remnant patches and restoration of intensively managed lands. A review of the literature as well as interviews with stakeholders reveals that the most prominent regulatory and incentive-based mechanisms already available in Brazil are: a) the Forest Code, b) the National System of Protected Areas, c) the Private Reserve System, and d) the "Ecological" Value-Added Tax. These mechanisms will be fully discussed, followed by a discussion of other major initiatives and funding initiatives as they have been employed or are potentially applicable.

6.2.1 The Forest Code

The Forest Code of 1934 (Federal Decree 23.793) was the first legal provision explicitly regulating forest use in Brazil, which was later substituted by the New Forest Code of 1965 (Federal Law 4771). Forests and other native floral communities were declared of the "common interest", deserving that "limits" be set to their private possession and use. A "damaging" use of private property is considered a violation of the code and subject to criminal prosecution under the civil code (Drummond & Barros-Platiau 2006). Since then, Brazilian landholders have been required to keep a specified proportion of each rural property under natural vegetation. This "Legal Reserve" (LR), is considered necessary to the maintenance of essential ecological processes, and fauna and flora protection. Currently, LR requirement is 20 percent of the total area property for the most regions of the country, including the southern states and Atlantic Forest biome; in the region legally defined as the Amazonia, requirements is 35% for the Cerrado vegetative communities and 80% for the Forest communities. Landowners may use the legal reserve area for limited purposes, including sustainable extraction, but it may not be clear-cut.

The Legal Reserve requirement is additional to another regulation of the Forest Code that places under "Permanent Protection" areas of natural vegetation in specific locations (Areas of Permanent Preservation – APP[1]). These include areas next to streams, rivers, lakes, and springs; fragile environments such as steep slopes (> 100%); vegetation that help sand dunes stabilization; mangrove protection; hilltops or on any land above 1,800 meters; and other sensitive locations. The required width for vegetative riparian buffers varies accordingly to the width of the watercourse. Rivers less than 10 m. wide require a minimum of 30 m. on both sides; rivers ranging from 10 to 50 m. require a 50 m., and so on, increasing up to a 500 m. protective buffer for rivers wider than 600 meters. A 50 m. vegetative buffer is also required around springs, ponds and reservoirs smaller than 20 ha. When a lake is bigger than 20 ha, a 100 m. buffer is required.

Despite substantial reforms in Brazilian environmental policy in the 1980s-90s, the enforcement of environmental laws remained lenient. Enforcing compliance with the LR and APPs regulations is challenging, particularly in the southern states, where native vegetative cover has been lost as a result of agricultural expansion in recent decades. In many places, aggregate vegetative cover has dropped well below the 20 percent limit, particularly in richer soils of the western and northern regions of Paraná, because of profitable opportunities to cultivate soybeans, vegetables, coffee, or other cash crops. Strict enforcement of the legal reserve requirement would be extremely expensive in

[1] In Portuguese: *Área de Preservação Permanente* – APP.

these locales if landholders were required to abandon cropland or perennials to restore the original vegetative cover (Chomitz et al 2004).

In heavily-worked properties and regions with intensive land use systems, with little remaining natural vegetation, the rate and quality of natural regeneration might be extremely slow. Such isolated and poor-quality stands of regenerated vegetation might provide little biodiversity benefit. In many places, however, remnant patches of natural vegetation persist as fragments of varying sizes. Often, these fragments represent the last, and consequently, the most valuable vestiges of the regions' natural landscapes, now reduced to less than 9 percent of its original area (Rocha 1995). Such fragments harbor important biodiversity found nowhere else.

Strict property-by-property enforcement of the legal reserve limit might be ecologically and economically inefficient in already fragmented or deforested ecoregions. Forced compliance could impose large costs on profitable farms, with little environmental gain, at least in the short run. A regulatory approach would fail to provide incentives to maintain and expand the valuable remaining areas of primary habitat (Chomitz et al 2004). For the states where law enforcement effort has been stepped up (such as in the State of Paraná in the late 1990s), there has been increased attention to mechanisms that allow out-of-compliance landholders to meet their legal reserve limits by doing offsite mitigation.

Indeed, an elaborate system of legal reserve enforcement and trading, the SISLEG[2], was put in place in the state of Paraná (State Decrees 387/1999 and 3320/2004). Each property in the state is required to come into compliance with the Legal

[2] In Portuguese: *Sistema de Manutenção e Proteção da Reserva Florestal Legal e Áreas de Preservação Permanente do Estado do Paraná* – SISLEG.

Reserve requirement by the end of 2018 (i.e. a 1/20th native vegetation restored every year through 20 years). This can be accomplished through on-site regeneration, with patches of natural vegetation at another property of the same owner, or within a property of a different owner. Cross-property compensation must take place within one of the ten zones defined on the basis of ecoregions and river basins.

Recent federal provisional regulations (*Medida Provisória* 2166–67/2001) allow landholders to satisfy the RL requirement for one property by creating or protecting legal reserve land located on another property. A "condominium" purchase that preserves a large forested property could offset the LR requirement for several smaller properties. Since an off-site legal reserve may be owned by another party, a market in legal reserve rights is created. The regulation has been repeatedly renewed, and contains a provision that specifies that compensation take place within the same watershed (Chomitz et al 2004). The APPs requirement, however, must be met on the landowner's own property.

This issue is of particular relevance to Brazil, where the Transfer of Development Rights and TDRs-like programs are emerging. In principle, a TDR program can minimize the social cost of achieving a conservation target and can reward those already undertaking conservation. In the U.S., tradable development rights and conservation easement purchases have been used to preserve farmland and natural areas (Hunter 1997, Wright 1998, Wallace 1998), but have been little used in Brazil as an economic instrument for conservation. Trading of these rights would tend to allow conversion of the plots most suitable for agriculture and retention under natural vegetation lands with high conservation value and with the lowest opportunity cost (Chomitz 2004).

A new policy supported by the MMA, and currently under public consultation and discussion on the CONAMA forum, is the development of the Forest Reserve Quota - CRF[3]. The excess reserve and within a rural property could generate trading titles that could be market commercialized, accordingly to the rules of The Exchange and Security Commission of Brazil - CVM[4]. Farmers needing to provide Legal Reserve land could buy LR titles from other landowners. Some geographic and quantitative restrictions are defined in the proposal. The CRF will be a title correspondent of the natural vegetation, ballasted by the exceeding legal reserves.

In the regional matrix, where the great majority of the suitable land was already converted to cropland, the regulation of CRF would be a valuable planning tool to help halting landscape fragmentation. Such quotas, depending on their market value, could be an effective economic device for protecting remnants areas with high conservation value such as rangelands, which are likely to be converted to more intensive land uses, as permitted by legislation. It can also be a useful instrument to stimulate the protection of important natural landscape elements such as corridors, and even the restoration of valuable conservation areas now under intensive management, such as the cropping areas adjacent to Vila Velha State Park, ecologically sensitive areas, and croplands with low farming potential.

6.2.2 The National Protected Areas System - SNUC

The concept of public protected areas (PAs) for the protection of extraordinary landscapes was put into practice in Brazil in 1937, when Itatiaia National Park was

[3] In Portuguese: *Cota de Reserva Florestal* – CRF.

inaugurated in the mountains of the Rio de Janeiro state, followed by the Serra dos Orgãos, Iguaçu, and Sete Quedas National Parks in 1939, the last two in the state of Paraná. The awareness of the need to conserve Brazil's biodiversity did nor emerge until the first half of the 20th century, and it was only in the last 30 years that Brazil has experienced major progress in conservation action, policy making, and capacity building. The past two decades have witnessed an explosion in the number of PAs and in the surface area covered by them (Jorge Pádua 1997, Mittermeir et al 2005, Rylands & Brandon 2005).

A major review of the Brazilian protected area system began in 1988 and, after 12 years of discussion, deliberations, and refinement, by both government and the public in 2000 - the National Protected Areas System - SNUC (*Sistema Nacional de Unidades de Conservação da Natureza* – Federal Law 9.985/2000) was legally created. Three government institutions administer the SNUC: the National Environment Council (CONAMA), a consultative and deliberative organ of the National Environment System (SISNAMA) that is linked directly to the presidency; the Ministry of Environment (MMA); and within the MMA, the Directorate of Ecosystems of the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA) is responsible for creating and managing federal PAs (Silva 2005).

The National Protected Areas System (SNUC) defines and regulates protected area categories at federal, state, and municipal levels, dividing them into two types: strictly protected, with biodiversity conservation as the principal objective, and

[4] In Portuguese: *Comissão de Valores Mobiliários* – CVM, the equivalent of the US Exchange and Security Commission.

sustainable use areas, allowing for varying forms of use or extraction, with biodiversity protection as a secondary, complementary objective.

Strictly protected areas with the main objective of biodiversity conservation include National Parks (World Conservation Union - IUCN category II), Biological Reserves (Ia), Ecological Stations (Ia), Natural Monuments (III), and Wildlife Refuges (III). In 2005 there were 111 of these federal areas totaling 282,457 Km^2 (42% of all federally protected areas). National Parks are the largest strictly protected areas whose mission includes environmental education, recreation, and scientific research. Biological reserves are generally smaller than national parks and are closed to the public except for environmental education. Ecological stations are similar, differing only in the emphasis of their prospective role as research stations (Silva 2005, Rylands & Brandon 2005, MMA 2002).

Protected areas with sustainable mission use and biodiversity conservation as a complementary objective include: National Forest (IUCN category VI), Environmental Protection Area (IUCN category V), Area of Relevant Ecological Interest (IV), Extractive Reserve (VI), Fauna Reserve (VI), and Sustainable Development Reserve (VI). There are 141 federal PAs for sustainable use totaling 301,950 km^2 (58% of all federally PAs) Other categories of protected areas in Brazil include Private Natural Heritage Reserves (IUCN category IV), which are generally small but proving important for the conservation of restricted-range and highly threatened species, and indigenous reserves, which are increasingly recognized as vital for biodiversity conservation because of their enormous size (Silva 2005, Rylands & Brandon 2005, MMA 2002).

There are 478 Federal and state strict protection areas totaling 370,197 km^2. There are 436 sustainable-use areas totaling 745,927 km^2 (Silva 2005, Rylands & Brandon 2005), which corresponds to about 13% of the country's total area under some form of legal protection. Large numbers alone, however, are not sufficient and the system is far from adequate (Fonseca et al 1997, Sá & Ferreira 1999, Rylands & Brandon 2005, Young 2005, Tabarelli et al 2005). Although Brazil has created an enormous number of protected areas over the last two decades, enormous challenges remain for their administration and management. The lack of trained staff and adequate financing in government environmental agencies severely limits the level of their protection and management.

The uneven distribution of protected areas among the different biomes of Brazil is also problematic. In the case of the Atlantic Rain Forest protected areas cover less then 2% of the entire biome and strictly protected areas cover only 24% of the remnants. Most of the existing UCs are too small (about 75% of protected areas are <100 km^2) to guarantee long-term species persistence (Silva & Tabarelli 2000). Among the 104 threatened vertebrate species, 57 have not been recorded in any protected area (Paglia et al 2004, Tabarelli et al 2005). The majority of the species officially threatened with extinction in Brazil are inhabitants of the Atlantic Forest (Tabarelli et al 2003). Currently, more than 530 plants, birds, mammals, reptiles, and amphibians of the Atlantic Forest are threatened - some at the biome level, some at the country level, and endemic species at the global level (Tabarelli et al 2005).

As pointed out by Rylands & Brandon (2005), Brazil's status as a megadiverse country confers a major global responsibility to protect three biodiversity wilderness areas - the Amazon, Pantanal, and Caatinga, and two biodiversity hotspots - the Atlantic Forest and the Cerrado. Protected areas are the key to conserving what remains. But there are a number of challenges that face the protected area system: some internal to each PAS, others to the protected area system, and still others in countering the set of human actions that protected areas are intended to prevent. The circumstances and social context for the creation of a PAS influences that area's management, even years later (Brandon 1998). How effective any given park can be is often shaped when it is created. Whether it is seen as a benefit or a barrier by local people is one example of this.

One significant change brought by the SNUC is the requirement that a participatory approach must be used for process of Protected Area creation, planning and management. These changes are evident in the law that regulates the SNUC. The process of creating new protected areas must be conducted under public examination, involving state and municipal governments, landholders, rural producers and workers, universities, nongovernmental organizations, and other interested stakeholders (Silva 2005).

Once created, the management of protected areas is, ideally, participatory, involving local communities. Under current law, an executive council or consultative committee must be set up to advise the management and administration of each protected area, with fair representation of all interested stakeholders, including government and nongovernmental organizations from the local and regional communities (Silva 2005). Financial resources have been placed for the training of council members and other strategies for community involvement in many PAs in Brazil on competitive basis (MMA 2006).

6.2.3 Private Natural Heritage Reserves - RPPNs

Until recently, the federal and the state governments gave priority to the traditional, publicly administered protected areas, without due consideration to alternative models, other levels of government, or the private sector. Recently, considerable success has been achieved through a program that provides incentives for the establishment of reserves on private land (Silva 2005). The Private Natural Heritage Reserve - RPPN[5], is a protected area category established by a Federal Decree in 1990, where private land can be voluntarily set aside for conservation purposes in perpetuity. This legal instrument is a major advance for biodiversity conservation in Brazil.

To be classified as a RPPN, an area must have features relevant for protecting biodiversity, be a place of natural beauty, or where environmental recovery would help to preserve fragile or threatened ecosystems or habitats. RPPN owners, individuals or companies, do not have to pay property or rural land tax on the part of their property accredited as RPPN. They also have priority for obtaining resources from the National Environment Fund (FNMA), and can count, at least on theory, on IBAMA's (The Brazilian Environment and Renewable Natural Resources Agency) support for the management of the area, protection against fires, hunting or deforestation.

Private natural heritage reserves were included in the SNUC (Federal Law 9985/2000) and are registered with IBAMA or with each state equivalent, when existing similar legislation. By 2006 some 425 federal RPPNs have been created in Brazil, covering approximately 450,000 ha. Although the total area is relatively small when compared with federal public lands, RPPNs protect key habitat for numerous threatened species in the Atlantic Forest, the Cerrado, and the Pantanal. They also protect important patches of natural vegetation that are too small for federal or state categories. In Paraná, a state decree was enacted in 1994 (Decree 4262/1994) and by 2006, 183 state RPPNs were recognized by IAP (the State Environmental Institute) and 7 were federally recognized, covering 38,000 ha.

The RPPN category has been defined as "a private area, protected in perpetuity, for the purpose of conserving biological diversity". The SNUC established that activities related to scientific research, low impact tourism, recreational and educational purposes may be developed within a RPPN. After the acknowledgement of the RPPN as Protected Areas, in order to better regulate their creation, IBAMA, enacted the Directive 16/2001, which provides specific information, to landowners interested in designating all or part of their properties as RPPN (Ferreira et al 2004).

Voluntary conservation measures are becoming more common in the private sector, mostly in the form of RPPNs, but also as specific projects for the conservation of flagship species. In general, RPPNs are created based on the initiative, dedication, and enthusiasm from landowners, rather than as a part of a systematic conservation planning for a particular ecoregion (Young 2005).

Before the legislation creating RPPNs, forests and other native vegetative cover were considered an "unproductive" use of land and subject to higher taxes than intensive managed areas. Today private protected areas - created by formal registration with IBAMA – or by the state equivalent legislation, assigned greater value and are exempt from this tax. Although the impact of this incentive has been limited because the practice of tax evasion, the tax exempting for setting land aside in perpetuity for conservation is a

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[5] In Portuguese: *Reserva Particular do Patrimônio Natural* – RPPN.

significant shift in the country's conservation culture (May et al 2002, Young 2005, Rylands & Brandon 2005).

6.2.4 The "Ecological" Value-Added Tax – The ICMS-Ecológico

The ICMS-Ecológico is the first economic instrument to pay for services provided by protected areas in Brazil (May et al 2002, Young 2005, Tabarelli 2005). It is an "ecological" value added-like tax, the ICMS[6], with environmental revenue-sharing criteria, ("green" ICMS or ICMS-*Ecológico*), and is now being adopted by many Brazilian states. It is an instrument of fiscal reform that rewards local governments for the areas, within municipal boundaries, committed to the protection of biological resources.

The ICMS is a state levy on the circulation of goods, services, energy and communications (enabled by Article 155 of the Federal Constitution). It is the largest source of state revenues in Brazil and, under the Federal Constitution, 25% of ICMS revenues are allocated to the municipalities. Of the latter share, 75% are distributed according to an index of municipal economic output, which is defined by the federal constitution, while the remaining 25% are distributed according to criteria defined by each state's legislation. It is through these complementary state laws that the ICMS-Ecológico was introduced into state tax legislation (May et al 2002).

This scheme was first introduced in the state of Paraná in 1992, where 1.25% of the total ICMS revenue is directed to reward municipalities for protected areas and watershed reserves within their territories, for the resulting loss of potential revenue that might have been generate by farming or other development activities. The extent of compensation is linked to the proportion area of the municipality designated to reserved areas of this sort. As a positive externality, the instrument also seeks to stimulate both improvement of these areas and the creation of new conservation units. This policy has been very effective in encouraging the creation of new protected areas and 9 other Brazilian states have already introduced similar laws for the allocation of ICMS resources based on a set of environmental criteria (Seroa da Mata 1996, May et al 2002, Young 2005).

Complementary state laws and regulations define the criteria, establishing the specific conditions for its operation and the resulting revenue-sharing reallocations. Distribution of the compensation allowance is set according to the importance of the protected area, as determined by the degree of restriction stated in the creation decree (strict protection or sustainable development areas). In Paraná the state environmental protection agency evaluates the compliance of the municipalities with the required environmental quality in the protected areas to determine the amount to be paid (May et al 2002). The compliance monitoring system is still under adjustment, but it already has successfully encouraged several municipalities to consider more environmentally friendly land use activities such as ecotourism.

The compensatory impacts have been considerable for some municipalities, especially those with large areas under protection. The ICMS-Ecológico provides incentives for conservation that are sufficiently attractive to motivate municipalities with low-productivity agriculture to increase the area under conservation, and provides a valuable fiscal instrument to reward local governments for efforts to protect forests and

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[6] In Portuguese: *Imposto sobre Circulação de Mercadorias e Serviços* - ICMS

unique biological resources. Since the state of Paraná adopted this program, the number of protected areas in the state increased by 165% (May et al 2002, Alger & Lima 2005).

The adoption of local laws that earmark where and how the ICMS-Ecológico is to be spent is one aspect that remains undefined, in part because of the need for constitutional amendment. (May et al 2002). Another option to be explored is the direct payment of some of the funds raised to RPPN proprietors, commensurate with their contribution to municipal revenues. In Brazil fiscal incentives are more often directed toward development purposes than toward conservation. The redirection of revenues from traditional economic activities toward conservation effected by the ICMS marks a substantial shift in policy. Reinforcement to improve the sustainability of the areas conserved would be a logical next step (May et al 2002, Alger & Lima 2005).

6.2.5 Other Conservation Initiatives in Brazil

One of the major conservation initiatives in Brazil, the National Biodiversity Program is a biome-level conservation-planning launched in 1996 by the Brazilian Ministry of the Environment (MMA), and supported by the World Bank and the Global Environment Facility (GEF). An important component of this strategy is the Project for the Conservation and Sustainable Use of Brazilian Biological Diversity (PROBIO), for which MMA has partnered with numerous organizations - universities, research centers, and NGOs - to establish priority areas and conservation action in Brazil (MMA 2004, Silva 2005, Tabarelli 2005, Young 2005).

Through this project the MMA has been able to support numerous studies and workshops that have assessed the scale, nature, and geography of Brazilian biodiversity and allowed for the identification of priority areas for its conservation and sustainable use. Five workshops were conducted, which reviewed and analyzed present understanding of the biogeography, socio-economy, human demography, land use, development tendencies, and threats in all six terrestrial biomes and the marine and coastal zones. The workshops resulted in the identification of 900 priority areas throughout the country (MMA 2004).

The importance of these areas was officially recognized by the federal government by the Federal Decree 5.092/2004 and the corresponding map of priority areas and the map of remnants in each Brazilian biome form the basis for proposals of new protected areas and conservation policies (Silva 2005). It was also outlined essential measures required for the protection of its unique biota. For the Atlantic Forest Biome and Southern Grasslands it was mapped 182 priority areas for biodiversity conservation (MMA 2004), which includes Vila Velha State Park (VVSP)'s buffer zone in the project area. The MMA proposition for the Campos Gerais National Park designation was based on this mapping and by fieldwork done in 2005.

Another program is the Critical Ecosystem Partnership Fund (CEPF), launched in 2002 to safeguard threatened biodiversity hotspots in developing countries. The CEPF is supporting projects in the Atlantic Forest that attempt to optimize the spatial relationships between public and private protected areas, and forest fragments (CEPF 2001). Within three broad programs (species protection, support for private reserves, and institutional strengthening), support has been specifically provided for: a) innovative economic incentives for conservation; b) expansion of the protected area system; c) implementation of corridor conservation strategies; d) studies that fill gaps in biodiversity knowledge; and

e) public awareness of biodiversity issues. Particular emphasis is placed on ensuring that the initiatives supported complement existing strategies and frameworks established by local, regional, and national governments (Young 2005).

Among the initiatives focused on the protection of threatened and flagship species, the conservation programs for the four species of lion tamarins (*Leontopithecus spp*) and the muriqui monkeys (*Brachyteles spp*) are the most visible (Tabarelli et al 2005). Since the early 1980s, these projects have matured from focusing on saving endangered species to focusing on broad multidisciplinary conservation programs. These species have been studied and managed intensively, combining research on ecology, captive breeding, reintroduction and translocation, habitat restoration and protection, and environmental education. The programs have yielded important insights and innovations for designing community level conservation strategies, including technical capacity building (Kleiman & Mallinson 1998, Valadares-Padua et al 2001, Costa et al 2005, Tabarelli et al 2005).

Three other projects with flagship species also deserve mention. Since 1991, the Hyacinth Macaw (*Anodorhychuns hyacinthinus*) Project, in the Pantanal, has been monitoring the populations of this species and conducting education initiatives for local communities, with recorded positive results for Macaws' recovery. The second, also in the Pantanal, is the Jaguar (*Panthera onca*) Conservation Fund, a project promoting environmental awareness among rural communities and providing compensation to ranchers for cattle losses (Harris et al 2005). Finally, the well known Marine Turtle Project (TAMAR), started on the early 1980s, is one of the most successful attempts in

Brazil of multiple coordinated actions, developed on 21 stations along the Brazilian coast, for species recovery and conservation (TAMAR 2005).

Land-use regulations such as zoning are based on the fact that the public can limit future development to protect public interests and compensation is not necessarily provided. Zoning represents the "police power" of the public to reduce externalities from private landowner decisions and it is a critical tool for private land conservation. More often, zoning regulations act as a partial restriction to development by limiting the size and intensity of future development. Conservation programs can take advantage of zoning restrictions because the developable land value is generally lower than it would be without developing limitations (Newburn et al 2005). Many states in Brazil, including Paraná, have defined, or are producing, Economic-Ecological Zoning as strategy to direct economic development and environmental concerns, but with limited results (e.g. Di Leva 2002, over World Bank's zoning experience for the Amazon State of Rondônia).

Environmental Protection Areas (APAs), are sustainable use protected areas (equivalent to IUCN category V) as previewed by the SNUC, and are designed to constrain human activities and to provide natural resource conservation and environmental quality for local communities, through regional zoning and land-use management plans. This mechanism has been widely adopted in Brazil in buffer zones for strict reserves and to protect watersheds for urban water supply. The APA basically involves the definition of management zones for strictly protection and for restricted use. Despite the large numbers of APAs created throughout Brazil, particularly by the states, and the evident potential of this legal instrument for zoning and wise land use management, field implementation, with few exceptions, have failed so far due to the lack of public investment and political commitment.

Attempts to incorporate environmental restrictions in the banking system's procedures for granting loan concessions have been attempted with limited results (Young 2005). In 1995, five government controlled banks, the countries major sources of development credit loans, signed a *Letter of Sustainable Development Principles (Green Protocol)* committing themselves to incorporate the environmental dimension in their project analysis and evaluation systems, and for prioritizing sustainable development proposals. In the case of industrial, utility and commercial activities, environmental licensing, regulated by environmental agencies, is the mechanism for compliance with environmental legislation (Seroa da Mata 1996, Young 2005).

Since 1995, environmental licensing is also one of the conditions for obtaining agrarian credits from public banks (Wertz-Kanounnikoff 2005), but it has never been implemented effectively (Young 2005). The compliance requirement for the Legal Reserves and APPs, however, became an official credit requirement in Paraná with the introduction of the SISLEG. With the obligation to comply with their regulations (federal law and official bank agreements), public banks became additional enforcers of the SISLEG obligations. However, banks only require the environmental license, and do not monitor effective environmental law compliance after credit approval.

Legislation regulating water resources (Federal Law 9433/1997) have emphasized water as a collective good, instead of something designed to appease individual and particular interests. The law established the watershed as planning unit, which requires participatory management, and fees for water use and discharge. Funds raised by the fee must be used for watershed protection, with the most obvious measures being reforestation and conservation. Unfortunately, the legal obligation to earmark the funds for environmental activities has not been respected, especially by state governments, which lack clear criteria for defining environmental priorities (Alger & Lima 2005, Young 2005, Drummond & Barros-Platiau 2006).

Another innovative law on "environmental crimes[7]" (Federal Law 9.605/1998) reflects an effort to enhance compliance with environmental laws and regulations by establishing heavy financial and other penalties for damaging the environment. This law specifies ecological crimes, in an effort to consolidate and to add enforcement capability to previous laws, particularly the article of the 1965 Forest Code about Civil Code violations. The major contribution of the law is to consider collective entities (companies, organizations, and so on) as active subjects of ecological crimes. This is a break from the previous Brazilian tradition of considering only individual citizens as liable for environmental crimes (Reid & Sousa Jr. 2005, Drummond & Barros-Platiau 2006).

Drummond & Barros-Platiau (2006) have argued that Brazil has a rich and progressive body of environmental legislation, but suffers from weak supported laws and enforcement, especially in the case of powerful economic actors. Despite recent political efforts of the MMA, there is little support for making executive agencies more efficient. The judiciary is usually poorly prepared in respect to environmental issues, and there is very little control over many destructive activities, such as predatory logging in the Amazonia.

Still having vast wild frontiers, Brazil, could see an increase in a type of environmental concern which aggressively promotes the unsustainable use of natural resources. For decades, governmental policies were directed to transform Brazil into a developed country at any cost and it may still take another generation before Brazilians realize that economic growth and environmental quality must be mutually complementary. Nevertheless, the increasing involvement of civil society in environmental issues, via NGOs, public hearings, participatory councils and civil action suits, may lead to a future stronger conservation mentality (Silva 2005, Drummond & Barros-Platiau 2006).

6.2.6 The Quest for Conservation Funding

A lack of financial resources is a significant constraint to conservation in developing countries, and the situation is no different in Brazil where most of the conservation funding comes from the public sector where many other social and economic issues are likely to be top policy priorities. Brazil's environmental spending is closely connected to its fiscal and overall macroeconomic situation and changes in the country' fiscal and monetary policies have important consequences for conservation. Young (2005) has discussed three major aspects of Brazil's macroeconomic policies over the 1990s that have made the implementation of environmental policies more difficult.

First, the country's commitment to generate huge fiscal surpluses, as demanded by the financial sector and international development agencies, has led to significant cutbacks in social and environmental spending. Accordingly, federal environmental spending in Brazil did not increase during the 1990s, but instead oscillated between 0.3% and 0.5% of the total budget, and for 2002, the Ministry of the Environment (MMA) had the smallest budget among all federal ministries and took the largest mid-term budgetary

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[7] In Portuguese: *Lei dos Crimes Ambientais*.

cuts (in proportional terms). Environmental issues are still not a political priority in Brazil (Drummond & Barros-Platiau 2006).

Second, Brazil's high interest rates, implemented to control inflation, have led to a bias toward short-term gains in economic decision making, even when they are prejudicial in the long term and involve the depletion of the natural resource base. Third, following mainstream economic theory, developing countries should exploit their existing competitive advantages in the international trade, including cheap and abundant natural resources. Over the long term, however, as prices of these resources oscillate and put pressure on the balance of payments, pressure to encourage exports increases (Young 2005). The best example is the on going expansion of soybean cultivation at the expense of the native vegetation in the study area and other parts of the country (Fearnside 2001).

One of the main financial tools for the implementation of protected areas is the so-called "Environmental Compensation Fund" established in 2002, as part of the SNUC - the National Protected Areas System. Based on the "polluter-pays" principle, every public or private project of significant environmental impact (e.g., hydroelectric dams, roads, gas pipelines) must pay at least 0.5% of the total cost of development projects as compensation for the project's unavoidable damages. The exact value is fixed according to degree of the impact; so far the values have been set around 2.0 - 3.5% of the project value (Silva 2005, Young 2005).

This compensation was designed to be used for the creation and maintenance of strict protected areas (including parks, biological reserves, and ecological stations at state or federal level). The public agency responsible for granting the environmental license for projects is responsible for determining the destination and subsequent use of the compensation. Revenue of approximately US$ 67 million (Silva 2005) has been generated using this mechanism since the SNUC Law was approved in 2000. Of this sum, 78% was used to consolidate land tenure for federal, state, and municipal protected areas. The remaining funds were used mostly in preparing management plans and providing developing PA infrastructure (Silva 2005).

A recent and important proposition in Brazil is the Federal Law Project 5162/2005, the "Ecological Income Tax" (*Imposto de Renda Ecológico*), which would allow a 40% tax deduction for companies and an 80% deduction for income tax deduction for personal donations to environmental public agencies or recognized environmental funds. This bill is currently under discussion on the National Congress and has been positively evaluated by many sectors of society, including the private sector. It could substantially increase the financial base for conservation in the country.

External funding is another major source of support for environmental projects and has accounted from 6% to 17% of total environmental expenditures in Brazil during the 1990s, but declined after 1994 (with the exceptions of 1996 and 1998). Most external resources come from credit operations (loans), meaning that they represent an additional burden on the national budget in the long term. Donations reached a high of R$ 30 million in 1996, but declined to less than half of this value (R$ 14 million) in 2000. The proportion of international donations to total expenditures in 2000 thus fell to the lowest level (2%) in the last decade, indicating a declining trend of international support for environmental projects in Brazil (Young 2005).

A good example of international support is the Pilot Program to Conserve the Brazilian Rain Forest (PP-G7), an initiative supported by the Group of Seven (G7) countries since 1991 (MMA 2004), and the most important program in terms of external funding for biodiversity conservation in the Amazon and, to a lesser extent, the Atlantic Forest Biome (Tabarelli et al 2005). Another large initiative is promoted by the German *Kreditanstalt für Wiederaufbau* (KFW) Bank in close partnership with some of the state agencies in southeastern and southern Brazil. This initiative has involved a major investment in the implementation of a number of protected areas in the states of Paraná and São Paulo and is being extended to other states (Tabarelli 2005).

Funding from foreign development and cooperation agencies can also affects conservation because, in many instances, it includes environmental criteria that must be met in the high-impact projects, such as the expansion of road networks or improvement in primary forest areas. This has reinforced the legal requirements for Brazilian counterparts to minimize, mitigate, or otherwise avoid environmental damage when doing development projects (Young 2005).

Seroa da Mata (1996), Hardner & Rice (2002) and Young (2005) have pointed out a concern associated with external funding related to the bias toward priorities established abroad, which do not necessarily coincide with those of the public agencies, counterparts, and local communities. For instance in Brazil, most external funding goes to the Amazon region, whereas considerably fewer resources are dedicated to environmental challenges in other threatened biomes, such as the endangered Atlantic Forest, or the Cerrado, and the Caatinga.

Ecolabeling is becoming a well-known instrument within some niches of the Brazilian business sector (Young 2005). Markets for "green certified" products such as organic produce, sustainably harvested timber and shade grown coffee represent a form of subsidy, in this case from consumers who are willing to pay a premium price for products produced in particular ways. A myriad of international development projects have promoted (so-called) sustainable practices in forests and farms around the world. Biodiversity can benefit even where conservation is not the main objective. An example is organic produce, which is mainly driven by health considerations but also benefits biodiversity by reducing the use of pesticides and fertilizers (Kiss 2002, Di Leva 2002, Hardner & Rice 2002).

Efforts to develop green products deserve support and praise and these niche markets play an important role in conservation efforts, but they have serious limits in the context of the global economy (Hardner & Rice 2002). The extent to which consumers are willing to pay the premiums, trade limitations, and unreliable profits restrict the markets for such products. Whether or not they produce green goods, all must face the uncoordinated nature of global production, which often results in vast oversupply. For green consumerism to work in this context, conservationism must find ways not only to make cultivation and harvesting ecologically sound but also to ensure that the products will be profitable in a competitive global market (Hardner & Rice 2002, Kiss 2002).

A growing area of direct payment is the conservation concession, in which organizations bid against logging companies to win logging concessions and then take them off the market (Hardner & Rice 2002). International willingness to pay for conservation reflects growing demand for protection of the world's biodiversity, which many developing countries can readily supply. This alternative is particularly important as public concessions of the National Forests on the Amazonia region are another policy under discussion on the sphere of the MMA. Long-term leasing contracts of large tracts of forests will be made by international auction to private corporations and contract clauses would specify accepted conditions for the use of land and natural resources; non-compliance with sustainable practices defined in the concession would be subject to sanctions and concession termination (MMA 2006).

Conservation concessions, according to Kiss (2002) and Hardner & Rice (2002), provides a potentially powerful way to expand the green market from its present dependence on products to the broader notion of green services, the opportunity to purchase biodiversity preservation directly. Conservation concessions not only would protect the land but could also finance conservation services and provide employment for local people. A properly executed conservation concession enables host countries to capitalize on their ample supply of biodiversity-rich habitats and to benefit economically by protecting their natural resources, and alleviates economic reliance on volatile timber and agricultural commodity markets. This benefit can be achieved without depreciating the value of the natural resource and without damaging wildlife habitat or other aspects of the environment (Hardner & Rice 2002).

The emerging global market for carbon emissions reductions units under the Kyoto Protocol of the United Nations Framework Convention on Climate Change is a likely future financial opportunity based on the "carbon sequestration trading" for removing carbon from the atmosphere and sequestering it in the form of long-lived organic matter such as trees or soil reservoirs (Kiss 2002, Di Leva 2002). Carbon markets are expected to be a major funding source for conservation in developing countries (Young 2005). The regions' grasslands are naturally rich on carbon content (3 - 5%), and grassland restoration are likely to increase carbon levels on the soils. When coupled with restoration or protection of natural habitats, payment for the service of carbon sequestration can yield biodiversity benefits.

In 2000 the World Bank, a major player in this arena, helped launch global carbon offset trading through the Prototype Carbon Fund, which mainly focused on carbon emissions by power producers and industry (Kiss 2002, Di Leva 2002). An ongoing project is a deal brokered by The Nature Conservancy, in which General Motors will provide $10 million to restore tracts of rainforest in Paraná, previously devastated by water buffalo ranching, in exchange for credits for the carbon dioxide that the new forest will absorb over 40 years (SPVS 2006). The World Bank is now in the process of launching a new "Biocarbon Fund" and a "Community Development Carbon Fund," which aims to link carbon offsets with biodiversity conservation impacts and community level economic development benefits (Kiss 2002, Di Leva 2002).

6.3 Landowners' Views of Conservation Alternatives

Among the owners of farms and ranches located within the study area's Conservation Priority Landscapes, 23 were purposively sampled (Straus & Corbin 1996, Oreszczyn 2000) for their perceptions regarding development of conservation alternatives. Semi-structured in depth interviews (Kvale 1996) with landowners were the main strategy used for this purpose; the number of interviewees was determined during the research process by reaching theoretical saturation on the theme (Straus & Corbin 1996, Blaikie 2000). In addition to data from the interviews, data was gathered from Key Informants and Participant Observation as well as from the literature review.

The nature, goals, and the ethical issues of the research were explained to participants, followed by questions about the current land use systems as developed on the farm and neighborhood. The interviewer then gave a general characterization of the Campos Gerais' biodiversity and the importance of conservation of the last remnants. Maps of Conservation Priority Patches and Landscapes (Figures 4.1 – Chapter 4, and 5.2 – Chapter 5) were shown and explained, and the landowner property surroundings were located on the maps. The majority of the landowners easily recognized important landscape elements on the aerial and satellite imagery presented to them.

Sequentially, an ortho-photography of the landowner's farm with delineated land units (scale 1:10.000) was presented, as a base for the discussion on the conservation priority patches, i.e. remnant patches and other managed land units considered important for restoration purposes (See Figure 5.4 – Chapter 5, for examples of these maps). Then, landowners were asked what they would require to conserve or restore priority patches. During each conversation necessary information was added (e.g. the Legal Framework for Conservation and incentives as previously discussed). Responses were diverse but a general correlation between the land use capacity of each land unit and willingness to conserve was observed.

Since we were analyzing how individuals could add conservation measures to their normal practices of land management, it was particularly important to contrast information found at one farmstead, with that provided by its neighbors or by other landowners within the same group of Land Use Systems (LUS) and also to contrast with information gathered at other LUS. Triangulation then implied collecting the information from different sources and using this to cross check its veracity (Bacon et al 2005).

Thus, a topic might be discussed in a household interview and could be checked against the next interview in the neighborhood. If the outcomes of the discussion are very different, additional questions, informants or research to explain the disparities were explored. For example, during interviews we noted that some assertions of accomplishment with the Forest Code were not true as such information had been previously analyzed on the aerial imagery. Similarly, statements of not hunting by some interviewees were denied by complaining neighbors who did not agree with their attitudes. As both situations are unlawful, most interviewees would not admit such illegal practices by fear of being fined.

The discussion that follows will concentrate on landowner' attitudes towards conserving the remnant patches and land units, and on their views of the four main conservation regulations or incentives enabled by the legislation: a) the Legal Reserve requirements of the Forest Code and potential sale of credits for exceeding reserved areas; b) the tax exemption for RPPNs and other associated potential incentives; c) direct payments and easement-like incentives; and d) land acquisition for public conservation purposes.

Landowner's views, as they expressed their opinions (first-order constructs), and how such views were re-interpreted (second-order constructs)[8] are presented. Relevant opinions and attitudes expressed by the key informants and members of participant observation groups, as they related to the landscape conservation issue, will also be discussed. Particular emphasis is given to how such meanings and attitudes can be

[8] First order constructs take a particular social stock of everyday knowledge for granted and are designed to deal with a social problem – to make social interaction possible and understandable to the participants. Second order constructs are designed to deal with a social scientific problem – to explain social phenomena – and have to relate to a social scientific stock of knowledge (Blaikie 2000)

addressed in order to establish partnerships for a landscape conservation strategy based on the search for consensus on conservation issues that are unproblematic and negotiating compromises on issues that are potentially conflictive. As articulated by Habermas (1989, 1994), we searched for creating conditions that approximate the "ideal speech situation," which would allow human beings to come to a rational consensus about how to conduct their affairs.

6.3.1 Landowners' Attitudes towards Nature Conservation

The majority of Paraná's forests vanished along the 20th century, following European colonization into the southern region and internal migrations to northern and western parts of the state. The devastation of the vast forestlands, most significant after the 1950s, for timber, farming and urban settling purposes, is still alive in the memory of many state residents. Recent polls have showed that the majority of the state's population is supportive of public initiatives for the Araucaria forest conservation[9]. Evidences of similar attitudes can be found in some agrolandscapes of the regional matrix.

The majority of the landowners interviewed (18 out of 23) acknowledge the need to preserve the last stands of the Brazilian's Araucaria forests. Throughout the ranching history of the Campos Gerais, Araucaria woods were important winter shelters and supplementary feeding sources during the cold season. As consequence, Araucaria woods in the regional matrix had been thinned for valuable tree species in the past, but rarely had they been clear-cut. Some small patches however have been cleared for cultivation in the intensive and familiar farming systems.

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[9] Published by the newspaper Gazeta do Povo – Curitiba – Paraná, April 8th, 2005.

Since the introduction of intensive farming systems in the matrix in the 1960s, grasslands have been the main ecosystem converted to croplands while the great majority of the woodlands have been spared, given the higher investments necessary to clear forests and the physiographic limits imposed by forestlands. Indeed, the analysis of the most recent available aerial cover photography (2002) of VVSP' buffer zone showed a continuous improvement on the quality of the woodlands and forests stands, when evaluated against the patterns assessed on previous aerial photographs (1952, 1962 and 1980).

Interviewees recognized the need to preserve riparian forests and the native vegetation around headwaters to maintain water quality and supply, as recurrent drought periods had strongly taught many of them. These opinions were reinforced during the last part of data collection, when the state and the region were experiencing one of the longest drought periods ever recorded. The drainage of wetlands and wet grasslands, clear cutting and intensive farming in the headwaters region, and lack of riparian vegetation were often cited by rural people in the participant observation instances and interviews, as the main causes for water shortages (Groups 1, 6, 7, 9, and 10).

Conversely, there were successful examples where headwaters and riparian conservation had sustained water availability, even for high demand situations such as dairy cattle supply. In two rural communities with predominance of small landholders, where irrigated onion fields and dairy livestock are the main source of income, strategies to guarantee future water supply were discussed as priorities for local public investments (Groups 9 and 10). The drought had also raised important questions concerning the right to drain large areas of grass wetlands or farming close to watercourses and the lack of enforcement by the environmental agency. Consequences to the communities living down the river were noted.

These factors: the recent history of forest devastation in the State and the comprehension of the need to conserve riparian areas and wetlands in headwaters, as well as the general increase on environmental awareness, have shape public opinion in favor of the conservation of the riparian areas and Araucaria woods in the Regional Matrix. One large landowner proudly stated: "*last year (2005) we produced about half million of native trees, mainly Araucaria (Araucaria angustifolia) and Imbuia (Ocotea porosa), to reforest several areas on the lands we manage*" (Interview 27).

The same reasoning does not necessarily apply for the conservation of grasslands and the other associated vegetative communities. The importance of conserving grasslands was a novelty for the great majority of the landowners (and even for many environmental state agency officials), as only relatively recently have scientists called attention to the biological importance of such formations. The following statement from a farmer, who otherwise had a conservation-oriented attitude and good land management practices illustrates this point: "*I planted Pinus on the grasslands located on steeper slopes as it is the only thing that can grow on such lands with shallow and poor soils; otherwise they are worthless*" (Interview 10).

Since early colonization grasslands were the most valuable land in the region given their grazing potential and later through the advent of intensive farming systems and improvement of the non-till systems, grasslands acquired a new value related to cropping potential. Due to the costs and restrictions for forestland clearing, the current price of grassland is 5 to 6 times greater than for forestland. Since the early 1960s, soybeans have become the predominant crop throughout the regional landscape. The protection of the remnant grassland ecosystems with cropland potential is the greatest conservation challenge in the region. Some landowners, however, particularly ranchers and traditional families with long historical ties to the rangelands, showed a particular interest on rangeland conservation, as it will be further discussed on the Chapter 7[10].

The new generation landowners, as well as decedents of the older generation interviewed, were likely to be more articulate as they have received much more information on environmental related issues in the last two decades. Among older interviewees more conservative opinions prevailed; some of them, however, showed clear conservationist attitudes and many had stated they have a quite different understanding and, consequently, behavior today, than they had some decades ago (e.g. on subjects as illegal hunting, pesticide use, wetland drainage). Global warming, water pollution and supply, soil erosion, species extinction, and other environmental related themes were subjects they raised during many interviews.

The past challenge for cultivating the very low fertility grasslands' soils that prevented intensive farming until the 1960s, was quickly replaced, in the 1970s, by the challenge of halting the very high levels of soil erosion provoked by the use of inappropriate farming technology to the region's landforms and soil features. These experiences, necessarily undertaken by all farms in the intensive farming systems, had also taught them important lessons about the need of intensive soil conservation practices and high standards of land management, to keep land productive and the farming enterprise economically profitable.

[10] Section 7.4 - Landowners' Views of Ranching as Conservation Alternative

The regional development of the no-till system technology and its associated ecological and economic advantages, and its widespread use in the region, is today a matter of regional pride among farmers. The need for intensive soil conservation practices directed the development of the no-till systems, and both, intensive soil erosion and the no-till system have molded a broad general soil conservationist attitude among them. Although the employment of better practices of the no-till technology is not uniform in the region, high levels of productivity are always associated with good soil and crop management practices[11].

There are large differences among individual attitudes as rural landowners are a diverse group of people not bound by a single land philosophy (James 2002). As already discussed[12], values vary with education, age, source and amount of income, place of residence, location of upbringing, and family history. In general, it is the younger, more educated landowners with an urban background and outside sources of income who are most willing to adopt environmentally friendly practices. According to many authors, value orientations concerning natural resources can be expressed along a continuum, ranging from a more anthropocentric to a more biocentric value orientation (e.g., Steel et al 1994, Vaske et al 2001, Kaltenborn & Bjerke 2002). In the study area, as observed in many instances, landowners' values, attitudes, and opinions vary also accordingly to the land use systems they are involved with.

We will, thereafter, refer to individuals as "Stewards" or "Utilitarians". Stewards are those individuals with a land ethic and who are most willing to adopt environmentally friendly practices; they consider themselves as caretakers of the land and adopt

[11] See discussion on Section 3.3.3 - Land Use Systems& Remnant Patches
[12] See Section 2.3.1 - Social Values and Landscapes

conservation strategies so that future generations may benefit. Proud of their rural heritage and ties to the land, stewards are more prone to sympathize with environmental issues and participate in conservation programs and societies. In contrast, Utilitarians have a more economic, exploitative view and act largely to maximize profit. To not use good land is immoral and wasteful, and less thought is given to the effects of current practices on sustainability. However, this is not a strict dichotomy as landowners exhibited both attitudes on different conservation issues as they seem to be affect by them. Some examples will be given in the discussion that follows.

6.3.2 Landowners' Attitudes towards Wildlife

Landowners showed also a general positive discourse towards the conservation of charismatic species, such as the manned wolf (*Chrysocyon brachyurus*) or the pampas deer (*Ozotoceros bezoarticus*) on theirs lands, corroborating data previously presented by Pontes Filho et al (1997). Their answers, however, were not as straightforward when talking about predators such as the puma (*Puma concolor*) or other potentially disturbing wildlife such as the growing populations of capybara (*Hydrochaeris hydrochaeris*) that are affecting crops.

The issue of predation has long been a source of conflict between ranchers and environmental agencies in the ranching regions of Brazil, including the Campos Gerais. Mountain lion (*Puma concolor*) predation incidents are the most significant conflict with livestock in the region, affecting mainly sheep but also calves. Such incidents are likely to occur when weather and light conditions are unfavorable to human activity and preference is shown for attacking free-ranging flocks with only occasional incidents occurring near farmhouses. Despite the fact that lethal removal by hunting or other means is prohibited by law, it has been the most used form of control (Mazzoli 2002 et al).

Ironically, the assertion "*I never had problem with puma predation*" was, surprisingly, often repeated in the interviews (e.g. Interviews 1, 2, 3, 4, 5, 9, 15 and 17),. "*Just once we lost a dog near the crop field, but I am not sure if it was a cougar attack*" said one of them. As they are afraid with the heavy penalties and legal consequences of killing a wild animal, they will not openly admit the practice of killing. Such statements are, however, questionable in many cases, as different information about predator control was provided by some interviewees. The killing of wildlife was also amply recognized by the rural population interviewed on the manned wolf study of Pontes Filho et al (1997).

Another landowner expressed a distinct view: "*A hunting puma close to the farmstead is not common and shows a deviant behavior; in these cases we should be allowed to eliminate them*" (Interview 3). Some landowners seem to hold a more positive attitude towards predators. "*I lost 5 calves in a season but I don't see it as a big problem. It is much easier to breed new calves than a mountain lion*" reported one very large farmstead holder with a clear conservation attitude, whose main source of income is not on the ranching activity (Interview 27). Predator incidences can be easily reduced to acceptable levels when flocks are corralled at night and other management techniques such as guard dogs are applied (Mazzoli 2002 et al).

When directly affecting important economic activities, however, the attitudes towards wildlife can change as it was revealed by the same interviewee who did not express similar positive attitude towards the populations of the crested capuchin monkey (*Cebus apella*), which have been damaging his commercial plantations of *Pinus spp.*, also a common problem in many other regions of the state. A general positive attitude towards predators was expressed by other landowners, particularly when their main source of income was not from ranching (e.g., Interviews 5, 7, 13, 14, 20 and 26).

Another potential source of conflict with farmers is related to the recent increasing number of wild herbivores such as the capybara (*Hydrochaeris hydrochaeris*), paca (*Agouti paca*) and the peccary (*Tayassu tajacu*), which are the prey base of mountain lions, and, in their absence, increase the reliance on crops for nutrition, particularly corn fields, as it was related in several interviews. "*We lost about 2 hectares of corn near the wet grasslands to capybara herds. Always we had some crop damage, but this has been increasing in the last years. We should be allowed to hunt them, otherwise there will be an increase in number as well the level of damage*" (Interview 9).

Despite these particular concerns, it is possible to assert that most of the landowners are likely to hold a general positive attitude towards charismatic wildlife, such as the deer, monkeys or the manned wolf. Although illegal hunting is still common in many places, the new generation of landowners or the heirs of the traditional ones, are more likely to avoid illegal hunting or deliberately harming such type of wildlife (e.g. Interviews 1, 5, 7, 8, 13, and 20). "*I hunted before when I was a teenager, but now I am against hunting as it became rare to see some types of wildlife. We need to protect them*" (Interview 20). Pontes Filho et al (1997) interviewed 122 rural citizens in the matrix including rural workers and landowners, and found a positive attitude towards the manned wolf in 38% of the interviews, a neutral attitude in 38% and a negative attitude only in 24%.

6.3.3 Landowners' Views of the Forest Code and SISLEG

Over the last few years the Legal Reserve (LR) requirement has been contested by farmers and their lobbyists in many regions of Paraná and Brazil, particularly where land has been intensively managed. A national movement against the LR was orchestrated by the agribusiness sector, mobilizing cooperatives, large farm owners associations and their strong political ties with Federal and State representatives, to push for changes in the Forest Code and reductions in the legally defined percentages of private properties that must be set as reserve. Despite an increase in flexibility to accomplish with the LR requirements[13], small farmers' representatives had also been debating and contesting some of the requirements as they can significantly affect the amount of for-profit land available on the very small farmsteads.

Conversely, landowners interviewed showed a general agreement with the requirements of the Legal Reserve and with the requirements for Areas of Permanent Preservation (APPs) along rivers, streams, and steep slopes. As the regions' physiographic features, such as the high density of the hydrographic network and the pattern of steeper slopes on the bottom of the valleys, imposed natural limits for continuous farming, the general agreement with the Forest Code was typical easy-to-achieve consensus (van den Hove 2006). None of the interviewees had expressed a strong contrary opinion.

When asked about their commitment for conserving such lands, the great majority of the interviewees manifested a prior agreement, and in the discussion that followed, many further expressed favorable attitudes. Some had called attention to difference

[13] Rural properties smaller than 50 ha located in the Biome Mata Atlântica and 150 ha in the Amazonia and Pantanal.

among Campos Gerais and the other regions: "*the great majority of the farmers in our region have preserved much of the riparian areas and are in compliance with the Legal Reserve requirement, in contrast as other regions of Paraná, where forests were put down and crops are now planted adjacent to the rivers*" (Interview 3).

The "stewards" shared similar opinions as expressed by one landowner: "*We recognize the importance of protecting these lands (APPs and LR) for water protection and wildlife conservation, and we know that we are required to legal designate and look after such reserves. These areas are of little value for economical purposes in the typical regional farmland operation and this had forged a different behavior among the farmers here, when compared to the other regions' farmers*" (Interview 5).

They also acknowledge that the region's natural limits were the main reason for the compliance with the Forest Code's requirements and recognized that whenever potential crop land was available on APPs or LR, such land are more likely to be already cultivated. They also agree, in such cases, that land must be restored. An influential rural leader from the large farming sector went deeper, and had publicly stated (in an interview with a local cable TV) that "*a landowner that does not respect the APPs along the rivers should be jailed*" (Member of Group 4).

Although not systematically assessed on each farmstead, the majority of the rural properties on the priority landscape are likely to be in compliance with the requirements of the LR and APPs. In the VVSP's buffer zone this means a required area of 7,884 ha, including 5,565 ha of Legal Reserve and 2,319 ha of APPs, and corresponding to 28% of the total area outside Park's boundaries. The 11,145 ha of remnant patches on the buffer zone is 41% larger than the required (7,884 ha) for Forest Code compliance. As the

SISLEG becomes implemented statewide, this remnant land surplus of 3,261 ha has the potential to be negotiated as compensatory LR to farmsteads where natural vegetation was previously suppressed. This TDR-like procedure, which is in agreement with state and provisional federal legislation, seems to be the most prominent option for the conservation of the surplus remnants in the regional matrix.

Indeed the first transfers in the region started in 2004. To someone in debt, buying new land, or restoring previously used land to natural conditions, can be expensive and time consuming. To a farmer with surplus of LR it will be appealing to, soon or later, convert such areas to a more profitable economic activity, such as intensive farming or forestry. Landowners, therefore, should be encouraged to trade areas of high conservation but marginal agricultural value for more agriculturally productive areas, and to reduce the fragmentation of the lands with high conservation value.

To comply with the requirements of the SISLEG, landowners must develop a land use plan for the property and locate on georeferenced aerial imagery cropping and other and uses, and the APPs and LRs. Farmers requiring any type of environmental license, selling land, or for credit applications, are required to be in compliance with the law. The elaboration of the farm plan and mapping, requires a technical expertise that must be contract by landowners with a relatively high cost associated (ranging from R$ 3 to 5/ha – U$ 1.4 to 2.3/ha). Following, the required documents must be submitted to rather lengthy and bureaucratic process for analysis within the state environmental agency.

Therefore, a regional conservation plan which could assist landowners with the technical requirements, help through the bureaucratic procedures, and lessening or eliminating some of the associated costs, is likely to be the basic incentive necessary for a massive legal compliance with the Forest Code on the Priority Landscape as well throughout the Matrix. To enhance the potential for biodiversity conservation on larger regions, such as on State level, an integrated plan is required and should be based on the selection of priority landscapes as the most representative remnants of Paraná's Biomes in order to direct conservation efforts and resources[14]. A logical next step would then be to connect landowners in need of restoring their properties' LRs with those with having surpluses LR on priority landscapes.

An integrated large landscape approach could then include APPs, public protected areas, and RPPNs, potentially establishing a network of reserves of different types and sizes across boundaries throughout the state. The Forest Code's requirements of natural vegetative cover on every rural property can amount significant areas in many regions and constitutes the legal base for designing a network of remnant areas throughout the priority landscape and the regional matrix. Such practice would ensure a new perspective for biological conservation throughout the State.

By means of the SISLEG, the State of Paraná has enacted a legal procedure that can be considered highly positive for the conservation of the last stands of natural vegetation, by recognizing the inadequate law enforcement in the past, the need for restoration, and by setting a time limit for the achievement of the 20% LR native vegetation cover goal. However, as it has been bureaucratically administered, the SISLSEG requires several adjustments to take full advantage of the requirements of the Forest Code and the associated TDR-like incentives to enhance the potential for conservation achievements on the priority landscapes.

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[14] A new act (State Decree 3320/2004) have defined some priorities to Legal Reserve compensation which include PAs' buffers zones, protected landscapes, and along some rivers defined as priority corridors.

Agency personal shortages make environmental licensing a lengthy procedure and promoting rural producers to pay off the regulators to speed up the process. Even worst, some interviewees reported the approval of forged maps that reduce the required amount of APPs by excluding small creeks, springs or wetlands. Despite recent advances to combat fraud and corruption in Brazil, the system is still undermined by such practices among some agents. This is nourished by low public salaries and inadequate training.

Despite the commitment of many individuals within the state agency that have resulted in the defining of Protected Areas buffers zones and major river corridors as priority areas for receiving compensations, the SISLEG, as it has been administered at local level, runs the risk to becoming just another bureaucratic procedure. As expressed by a large farmstead owner, "*the SISLEG is just another environmental requirement to collect fees and promotes corruption that undermines the competitiveness of the rural enterprise in Brazil*" (member of Group 8), an opinion somewhat shared, from many different view points, by many (e.g., Interviews 9, 15, 19, 21, 27, and members of Groups 3, 4, 7, and 8).

6.3.4 Landowners' Views of the RPPN

The potential for converting LR, APPs, and remnant patches into RPPNs was another subject explored during interviews with landowners. Most of them were previously aware of the possibility for designating forest patches on their lands as RPPNs, and have at least the basic information about what a Private Reserve means. The designation of grasslands as part of a Private Reserve, however, was new to all of them. It was stressed by the interviewer that the perpetual easement conferred on RPPNs, and their restrictive use, imposes a greater degree of permanent protection on these areas than that conferred by the Forest Code and the only for-profit use allowed in a private reserve is low impact tourism. Following, they were asked to consider the possibility of establishing a RPPN on the remnant patches on their landholdings.

Several questions concerning the advantages and obligations of a RPPN were raised by interviewees, suggesting the need for providing more accurate information to landowners. Their responses were mixed and varied according to landscape attributes associated with each property, particularly: a) land use potential of remnant patches; b) current land use systems; c) landowners' educational background; and d) socio-economic group[15]. The majority of the interviewees were reluctant to give a conclusive answer to the question, and, although none of them gave a definitively "no", "maybe" was the typical answer. To permanently give up the flexibility and permitted uses of a LR, as well as the restriction for future land use change on exceeding LR areas, seems to be the important constrains as they were often mentioned on the conversations that followed.

The remnant patches of grasslands with low farming potential, however, can easily be converted into intensive forestry, given that *Pinus* species have satisfactory growing rates even when cultivated on marginal lands. As the national and global demand for pulp and wood have increased, many interviewees manifested an interest, or already have started, to cultivate forest on marginal lands to complementary farming activity (e.g. Interviews 1, 2, 7, 10, 13, and 17). Some had illegally placed commercial forests within the APPs. Commercial forestry, as already discussed, is regionally an important economic activity and about 4% of the matrix's land and 15% of the land within VVSP's buffer is currently under intensive forestry. Large forest companies are promoting the introduction of intensive forestry on small properties, and such a trend in land use could prevent conservation of such patches.

The most significant constraint raised by landowners was the ability to respond to new economic circumstances. Other frequent concerns included: a) the legal requirements like title updating; b) the increased responsibility of conservation; c) the technical expertise needed for mapping reserves with by georeferenced aerial photography and for developing RPPNs' management plans as required by legislation; and d) the financial and bureaucratic costs associated to these tasks (Interviews 1, 2, 3, 4, 5, 7, 8, 13, 14, 22, 27). Additionally some raised fears of future additional land use restrictions or even land seizure, once lands were improved for conservation (Interviews 1, 3, 4, 5, and 27).

Despite these mixed feelings, 3 small RPPNs were already accredited in the Regional Matrix, with one located within the Conservation Priority Landscape. Another three landowners said they had started the process for having accredited as RPPNs part of their landholdings. These declarations were later confirmed by Agency personnel. Reasons given for protecting these lands in perpetuity included: a) indirect benefits such as potential protection against squatters; b) direct benefits such as the land tax exemption and the protection of their water supplies; c) their desire to contribute to the conservation of Araucaria woods and the regional wildlife; and d) to avoid the risk of having land expropriated. Two have also mentioned they were motivated by environmental state agency officials or and by the municipality.

Remnant patches located in the APPs, in addition to having lower agricultural capacity are the areas where RPPN designations are the most likely to be agreed, as no

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[15] See discussion on Section 3.3.3 - Land Use Systems.

relevant objections were raised during interviews. The great majority of remnant patches within the priority landscape as well as on the regional matrix are located on land with little potential for intensive farming, a fact that already prevented conversion to cropland. As modern farming technology has become available, whenever soybeans prices increased on the global market, available farming land has been converted from grasslands and other previously uncultivated lands.

Therefore, a regional plan to promote RPPNs, which could assist landowners with the technical requirements, bureaucratic procedures, and lessen or eliminate some of the associated costs, is likely to be the necessary. Incentives are generally defined in the new RPPN's legislation (State Decree 4890/2005), although not in detail. The necessary financial sources for incentives are lacking. Partnerships among state agencies, farmers associations, cooperatives and the rural communities could provide the necessary expertise, financial resources and a common ground for negotiations and compromises needed to increase the designation of RPPNs.

A new incentive to the establishment of RPPNs in Brazil is related to the share of the ICMS-Ecológico funds that municipalities with RPPNs on their boundaries are entitled to receive. Some municipalities in Paraná had promoted the creation of private reserves as a way to increase their share on the ICMS-Ecológico (Loureiro 1998, May et al 2002). Another option to be further explored, and potentially appealing to landowners, is the possibility for redirecting the part of these to the property owners, commensurate with their contribution to municipal revenues. New regulations make this possible.

However specific municipal legislation enabling the transfer of the revenue, or a percentage of it, is necessary. Although the potential revenue per hectare is considered low by many landowners[16], such revenue was welcomed by the RPPNs owners as well as by some of others interested in such an arrangement (e.g. Interviews 1, 2, 4, 5, 7, 23, and 28, and members of Groups 1, 3, 5, and 7).

Complementary, and financially more appealing to landowners, is the fact that RPPNs, when exceeding the minimum LR requirement of the property, can be classified as Compensatory Legal Reserves with preferential compensatory status, which improves the potential market value of such lands to be sold as offsets for landowners who are in need of restoring native vegetative communities on their properties. Such incentives have been promoted by the Brazilian Association of RPPNs as a potential conservation incentive and the approval of the pending Forest Reserve Quota (CRF) policy can even strengthen this potential.

Therefore, conservation of remnant patches in the Regional Matrix can be increased using a combination of the mechanisms discussed above, and, on the majority of the properties are likely to result from a consensus-oriented collaborative process. The protection of remnant patches in their current fragmented state, however, is not sufficient. The conservation of regional grasslands communities and their unique associated ecosystems demands conservation of large areas to allow for the occurrence of disturbance regimes and guarantee the persistence of associated species, even when connections are large enough to provide functional corridors. Hence, restoration of some high-valued conservation landscapes currently under intensive management is required. This will likely not be attainable using only through the set of possibilities and incentives discussed so far.

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[16] E.g. in 2005 the RPPN within the Conservation Priority Landscape averaged to the municipality R$ 64,00/ha/year - U$ 29,00/ha/year.

As previously observed, most RPPNs are created based on commendable whim, dedication, and enthusiasm of some landowners that may not be based on regional conservation priorities. Reliance on the good will and economic circumstances of owners, or on proper enforcement of existing laws, is not sufficient to assure the ecological integrity on the regional landscape matrix. The restoration of croplands with high and medium farming potential, is needed and will demand further direct or indirect financial incentives.

Such conservation incentives were raised during a review of the literature and were further explored during the interviews: a) conservation easements or other direct forms of payment to landowners to set aside cropland and/or other managed areas for conservation; b) land acquisition for public protected area designation; c) changing the way lands are managed to conservation compatible farming systems. The are following discussed here and the third topic will be further discussed in the next chapter (Chapter 7: Participatory Strategies for Softening the Management of the Matrix).

6.3.5 Landowners' Views of Direct Payments and Easements-like Incentives

Direct payments such as those provided by conservation easements and other similar instruments are new alternatives in Brazil and are, potentially, an appealing inducement to the majority of the landowners in the region. Recently a Paraná based NGO (SPVS – *Sociedade Paranaense de Vida Silvestre*) provided direct payments to 4 landowners who agreed to preserve important remnant fragments of Araucaria Forest in the southern region of Paraná. Contracts were set for a 5-year period and, according to a NGO director (personal information), values paid to forest owners by hectare are equivalent to the values for leasing cropping land in the region. The financial resources for this program were provided by major corporations who agree to fund the project (SPVS 2006).

A participant landowner was interviewed concerning his participation on the program and showed his satisfaction with the financial opportunity. "*I have about 450 hectares of Araucaria forest in good condition as the forest was never clear-cut. I was criticized by neighbors for not having cut the forest when it was possible. It's the first time I could get financial compensation for having preserved it*" (Interview 31). Opportunities to enlarge such programs or to launch similar term easement conservation schemes in the state or in the country, however, are limited, as most of Brazil's conservation funding comes from the public sector and is scarce. Additionally, direct payments from public sources to landowners for setting land aside for conservation have not been enable by Brazilian legislation.

Interviews made it clear that financial compensation is the most feasible possibility for setting cropland aside for conservation purposes (e.g. Interviews 1, 2, 3, 5, 9, 11, 14, 20, 21, 28, 29, 30 and 31). Such initiatives would demand a program such as the Conservation Reserve Program – CPR in the USA, or the Agri-Environmental Policy Schemes of the EU. In these programs, environmentally sensitive land is voluntarily be converted from cropland and managed for conservation goals, in return for direct payments to landowners.

When asked how much would they need as compensation for setting cropland aside for conservation purposes, some interviewees were prompt to give an answer: "*the financial amount equivalent to 8-10 sacks (of 60 kg) of soybeans per hectare, per year -*

the standard "price" paid to landowners in the region by those leasing land for soybeans on the less productive land" (Interviews 1, 2, 3, 5, and 8). Despite the high yearly fluctuations in the soybeans prices, this arrangement has been used for the majority of the land-leasing contracts throughout the region.

In 2005-2006 farming year, this cost was between R$ 200 to 250 per hectare (equivalent to U$ 92 – 115/ha, based in the 2006 U$/R$ average exchange rate). In the previous year, however, the amount per hectare reached up to R$ 550/ha (U$ 255/ha) as soybeans prices were much higher on the international market. The historic average price at about U$ 12.00 (per sack) would yield U$ 96 - 120/ha/year. Higher quality farming land, however, usually requires higher payments of up to 12-13 sacks by/ha, based on the soil quality and location of the land.

A comparative analysis of the financial resources necessary for placing temporary conservation easement on cropland versus the necessary amount for public land acquisition provides further insights on this alternative. To place easements on all cropland within VVSP' buffer zone (11,500 ha) thereby creating a core conservation area of about 30,000 ha, would require a budget of U$ 1,380,000 annually, based on the average value for leasing cropland (10 sc/ha) and the historic average price of soybeans (U$ 12/sc). In contrast, that amount would be sufficient for the acquisition of nearly 300 hectares for public protection (setting cropland at the average value of R$ 10,000/ha - U$ 4,600/ha), not considering the costs for managing land and any other associated costs for either alternative.

For the short term, negotiating conservation easements could potentially place a large amount of valuable land into ecological recovery; however when incentives end, long-term conservation would be compromised. Another potential option is to acquire a permanent easement on portions of these croplands as an intermediate strategy. It is likely that a combination of both practices would be the best alternative. Funding for acquiring land can be provided by the "environmental compensation fund", established as part of the National Protected Areas System – SNUC, based on the "polluter-pays" principle. This fund must be used by agencies to create and maintain strictly protected areas and, although the amount of resources already collected is significant (Silva 2005, Tabarelli et al 2005), its use is limited by the bureaucracy for land expropriation and by the huge demands on revenue from all the protected areas in Brazil.

A complementary alternative, and potentially more appealing, is linked to the possibility of placing conservation easements for converting cropland to grasslands, while allowing the extensive use of the land for ranching purposes. While creating a direct conservation incentive, such alternative would keep land in private productive ownership and landowners as potential partners and land stewards, significantly decreasing the necessary resources for land restoration.

Some landowners, particularly owners with a ranching tradition[17], showed an interest in ranching as an alternative. However they found difficult to define how much compensation would make this worthwhile. They asked time for further thinking; two were later contacted and expressed that "*the equivalent of 6 sacks of soybeans*" would be fair compensation for the smaller economic return expected (Interviews 1 and 5). Based on this "price", a yearly budget of U$ 830,000 would be sufficient to direct compensate landowners for the re-conversion of all cropland to rangeland within VVSP' buffer zone. If we consider the ranching easement only for land with low farming capacity (nearly

3,000 ha) to form a mixed mosaic of different land use types, the yearly amount budget would be lessened to U$ 216,000.

Low capacity cropland is consistently located adjacent to valuable conservation patches such as riparian areas and wet grasslands, steep slopes, or around ponds, springs and rocks outcrops. Land with high production potential cost are typically more expensive than low-vulnerability sites with poor land quality (Newburn et al 2005). Therefore, land-use change and land costs need to be addressed jointly to improve spatial targeting strategies for land conservation and to maximize benefits and any financial resources made available.

Therefore, the basic issue is how to make available financial resources to pay for landowner compensation? The necessary funds are not likely to be available from local or regional sources and neither are likely to come soon from federal or state budgets. At State or Federal level some form of tax-compensation could be offered for private donations to support such programs, as already under discussion on the National Congress[18], but are likely to take some time until made operational for local level procedures. A possible source for direct payments seems to be linked to the municipalities' share of the ICMS-Ecológico.

Based on the 2005 value per hectare generated by the local the remnant patches within the buffer zone (11,145 ha) accredited as private reserves, could generate up to R$ 700,000 (U$ 323,000) available for the municipality of Ponta Grossa. Similarly, Campos Gerais National Park designation will, with time, increase its participation of the shared

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[17] See discussion on Chapter 7 – Ranching as Conservation Alternative

[18] Federal Law Project 5162/2005, the Ecological Income Tax (*Imposto de Renda Ecológico*), which would let up to 80% tax deduction donations for environmental funds or to public agency and recognized institutions.

revenue; using the 2006 values per hectare generated by the VVSP, the new park could generate up to R$ 620,000/year (U$ 286,000) on the current municipality share of R$ 275,000/year (U$ 127,000). Such revenues could be employed for purchasing conservation easements on priority areas. New municipal legislation to enable the transfer of funds from the municipality to landowners will be required to do this.

6.3.6 Landowners' Views of Land Acquisition for Public Protected Areas

Interviews probed landowners perceptions concerning the purchase of land for public protected areas accordingly to the SNUC. The MMA's proposal to purchase land for the Campos Gerais National Park has greatly influenced landowners' opinions and provoked a mostly negative reaction in the farming sector. The majority of the interviewees, particularly when directly those affected by the park's limits, were very annoyed (to say the least) by the proposition. Most of those interviewed had been involved in the movement against the Federal PAs designation since 2005. A "diplomatic" approach was necessary when discussing the purchase of private land for a large National Park.

Responses from large farmsteads owners ranged along a continuum from "*something to be worried about*" (e.g. Interviews 2, 3, 4, 6, 9, 17 and 27), to "*this is coordinated and dangerous initiative of the reds - leftists in the current federal government and social movements, greens - NGOs and public environmental institutions, and corrupt and incompetent public officials*" (a point of view given by some members of the Group 8). Other views fell in between these 2 positions.

The discussion on land expropriation provoked mixed responses among those categorized as "stewards". While they expressed pride in having conserved a significant part of their lands, particularly Araucaria woods and forest, often the last remaining wildlife habitats in many areas - they regretted having forest land that might be expropriate by a park. Land use restrictions on buffer zones were often cited as a source of concern (e.g. Interviews 5 and 13, and members of Groups 7 and 8).

However, very often the opinions they expressed were just repetition of the arguments they heard at the many meetings of the movement and also over exploited by the local media. Their strong attitudes against the Park were based on information that had been manipulated and purposively distorted by the movement leaders "*as a political tactics of confrontation with the park proposal*", accordingly to a member of Group 4. A similar attitude was expressed by a member of the same group: "*we are in a war, and therefore we need o use all the weapons we have on our hands to get support; we need to be strong in the negotiation with government officials, and, if we demonstrate weakness in the process, we will not succeed in our intents*".

These group members, which are among the leaders of the Movement for Social and Sustainable Protected Areas, as they called their interest group, were aware of the legal procedures concerning land expropriation. On this matter they were well informed and assisted by their lawyers and by federal and state representatives. Others tried to manipulate participatory deliberations for their own ends: they are known to have misrepresented their positions, employed false evidence and used rhetorical language to persuade, influence or silence participants (e.g. members of Groups 4 and 8).

Strategic manipulation[19] of the process was also performed by many other actors, as they deliberately manipulated rather than informed landholders in order to increase the adherence of the rural communities, the agribusiness sector, and urban citizens to their cause: the avoidance of land expropriation by the federal government. Their economic and ideological reasons and the full social-psychological analysis of processes at work are beyond the scope of this project.

The discussion that follows concerning this theme is directed to the potential for landscape conservation through land acquisition by federal or state government, and potentially maintaining the perspective of developing partnerships with landowners as a landscape conservation strategy. The focus of the interviews, therefore, was directed to the search for consensus on conservation matters that are less problematic and to set the conditions for negotiating compromises on issues that are potentially conflictive. As the conversations on the land acquisition for conservation purposes were often taken to mean land expropriation for the Park's proposal, the designation of Campos Gerais National Park was further explored with interviewees, despite not originally being included in the research plan, in order to develop possible ways towards possible reconciliation.

The conversation on this theme was started by listening landowners' complaints concerning Park's proposal and about the authoritarian posture of the federal government and "environmentalists" against them. The subsequent subjects raised can be grouped into three main clusters: a) the rationale for the park creation, such as the conservation importance of the grasslands and wetlands - a new concept for the majority, the appropriateness of including cropping land and productive farms within the park, and the

[19] Strategic manipulation of the process by some actors and the risk of cooptation is always a risk on participatory approaches, and may in reality subvert democracy and provide elites with a method of

likelihood of natural recovery of the grasslands; b) the associated social, economic, and psychological impacts to landowners, employees and their respective families and to the rural sector in general; c) the financial aspects of land expropriation, such as the appraisal of the real estates and property values, the process of indemnity and payments, and the availability of budgetary resources for expropriation purposes.

These subjects had been continuously discussed on the meetings of the movement and were raised again by landowners in the interviews and indicate the need for more appropriate information concerning the process of Park creation. After this discussion, landowners were asked to consider the possibility of having their land, or part of it, including remnant or intensively managed patches, being acquired for conservation purposes, either as defined within the limits of the National Park or according to the map of conservation priorities, for farms located outside the park.

When confronted with the possibility of facing land expropriation, opinions varied accordingly to particular landscape or patches attributes on each property, fairly corresponding to the opinions they expressed when discussing RPPN accrediting of remnant patches; i.e. their opinions on this theme are also related to the current and potential land use systems, educational background, and social and economic groups they belong. Land attachment and personal and familiar ties were also important variables affecting their attitudes. Their responses to the question of land acquisition can be distributed along a continuum between the avoidance of any land expropriation and partial acceptance on specific situations. This continuum will now be discussed based on the landscape conservation goals of protecting remnant patches and restoring intensively

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masking the reproduction of inequalities with symbolic pluralism (van den Hove 2006).

managed ones. The conservation goal of softening the matrix will be discussed in the next chapter.

Acquisition of Remnant Patches

The reasons for rejecting land expropriation are based on the conservative ideological positions of some rural leaders and individuals. A number of angry statements were given during interviews and participant observation: "*This socialist project of land expropriation is a mistake and the government will not be able to protect forests, wildlife, or anything; it is just leftist politics in the government for taking land from their owners*" (Interview 27, and similar comments[20] by members of Groups 4 and 8). Interviewees and group participants saw land as symbol of status and economic power and many described strong family ties.

When facing the likelihood of land expropriation by the federal government to implement Campos Gerais National Park some interviewees manifested they would rather prefer to designated the remnant patches on their lands as RPPNs. As stated by a farmer with remnant forestland area within the park's limit: "*I am taking care of my forests better than the federal government will if my land is expropriated for the National Park. I want to keep this forest as it is part of the farm and I prefer to accredit this land as RPPN. It will not demand public money and I can assure that the conservation of this area will be well managed*" (Interview 4). Similar preferences for RPPN accrediting, were rather shared by the landowners who got a significant share of their income from

[20] Often the expression "socialist" on the phrase was substituted by "communist" or "nazi", accordingly to the speaker's background and to the context of the speech.

non farm activities or those who owned very large farmsteads (e.g. Interviews 6, 16, 27, and members of Groups 4, 7, and 8).

Interviews revealed the importance of the financial aspects associated to the process of land expropriation as the information on this subject, hold by the majority, do not always correspond to what is previewed on the legislation, suggesting that the strategy of distorting information by the rural leaders was efficient, at least on this logic. The concern with real states' assessment and payments by the public sector seems to be the strongest component on the attitudes of the majority, reinforced by the strategic manipulation of information and by the strong disbelief with governmental programs and intentions. Some more business-oriented individuals expressed their strategy, in the case of everything else fails to avoid the park's creation, "*to get, through judicial process, the highest possible compensation for any land or real state expropriation they may face*" (e.g. Interviews 4 and 27, and members of Groups 4 and 8).

When acknowledging the fact that expropriation, accordingly to legislation, must be based on the regional market prices and payments must be previous to the ceasing of any current land use, many interviewees manifested rather different positions, as public acquisition of woodlands and other remnant patches with limited farming capacity could potentially be an interesting deal. As manifested by one of them: "*I own about 150 ha of forestland and the government has, in practice, taken it from me, as I am not allowed to cut trees or convert into cropland; if I can received the regional market value for this particular forested area*[21]*, it would be a good deal*" (Interview 11). Similar opinions were also implicit manifested on other interviews (e.g. Interviews 1, 2, 3, 5, 7, 9 and 17, and

[21] Forestland has average values ranging from R$ 2,000 – to 3,000/ha (U$ 900 – 1,400/ha), depending on the location and the size of the area.

members of Groups 3, 5, 7 and 8), despite the fact that most of them would not to public admit their interest in having part of their land expropriate.

Another retired landowner expressed related interest: "*I owned about 120 ha of forestland outside but close to the park's limits. Part of this forest had been thinned long time ago (> 40 years) and now is recovered as there are many Araucaria trees of various ages. I would like to sell this land, but the market price is low as nobody want to buy it because the forestland will not be licensed for clearing. The acquisition of this land by the government would be acceptable deal for me. The same is true for some small landowners I have talked in my neighborhood, which own small tracts of forestland*" (Member of Group 8). This statement was later corroborated by two of the cited small farmstead owners.

This landowner has also brought another important point to this discussion as it concerns the strategies being used in the Parks' dispute. "*It is disappointing to see that the most of the rural leaders do not want to comprise anything; they just want to put ahead their personal economic interests, as some of them have plans to buy forestland at the lowest price possible*". Similar opinions were also shared by members of the Groups 1 and 3, by Key Informants 18, 19, 20, 22, and 25, and was also expressed by a large farmstead owner, and potentially interested in negotiating part of his family's land within the Park: "*some of the rural leaders had just thrown gasoline on the fire in order to defend their own interests*" (Interview 8).

Potentially receiving a considerable amount of money as indemnity for large landholdings, which otherwise are likely to have a low market value, is business potential that many are not inclined to relinquish. This assertion can be exemplified by the statement of a retired large farmstead owner, which property is totally located within the park: "*If our land is expropriated and the government pays the right market value, we will live in Paris*" (Member of Group 5). As these owners do not live on the farm and their land is leased for ranching and cash-crop, they are not attached to the place or to the rural life; although they are not likely to deliberate sell their land as familiar ties thwart them, land expropriation on such case could represent the source of revenue for particular life projects. Or for new business opportunities, as it was placed by a retired inheritor of another large farmstead within the park (Interview 3).

Public Acquisition of Cropping Lands

The responses on this subject were the hardest to draw out and to evaluate, specially when land acquisition for conservation purposes was interpreted as park expropriation. Therefore, interviewees could use many arguments contrary to its creation in a public meeting that did not necessarily express their opinion. As expressed by one farmer. "*I am participating in the movement and I am giving technical advice to the lawyers as familiar relations demand it; but have our land at the market value we own would not be too bad business at all*" (Interview 1).

So it was difficult to evaluate how strong was their opinion against land acquisition; when faced with possibility of receiving a reasonable amount of money for forested areas, not allowed to be cut, or land with low crop farming potential, their opinions can change. On three occasion landowners were contacted after the interview, and some of the strong opinions concerning the Park they had expressed had diminished or changed after the initial discussion.

Opposition increased when discussing the inclusion of cropping land within parks boundaries and the need of restoring grasslands through public land acquisition. Landowners which expressed strong opinions against remnant patches expropriation, had even stronger opinions: "*It is an absurd that the government wants to take cropping land from farmers*", was often repeated (e.g. Interviews 4, 6, and 27, and Members of the Groups 4, 5, 7 and 8). Some opinions, however, were more pragmatic on this point, as it was objectively synthesized by one interviewee: "*well, it will depend on how much we will get for the land and the conditions of payment*" (Interview 9), an opinion shared, on different degrees, by many others (e.g. Interviews 1, 5, 8, 9, and 17, and members of Group 8).

Regarding the inclusion of high capacity cropping land in the park's boundaries, opinions converge and are strongly opposed. None of the landowners agree with expropriation of prime farmland. Landowners facing land expropriation clear expressed a desire to continue farming on their lands as usual and manifested many motives such as their knowledge of the land, region and neighborhood, management history, family ties and landownership tradition. Payment of market price for high valued farming lands[22] is not enough compensation to overcome land as it is valued by landowners.

Many "utilitarian" principles, varying from "*nobody can stop progress*", or "*it will be an absurd to stop planting on these lands*" and "*it is morally incorrect to not farm on these lands*", were mentioned. Comments such *as "should a country like Brazil promote the abandonment of farming*?" and other similar arguments were often mentioned (e.g. Interviews 2, 3, 4, 5, 6, 7, 9, 11, 13, 16, 27, and members of Groups 4, 7,

[22] Cropland has average values ranging from R$ 9,000 – to 12,000/ha (U$ 4,100 – 5,500/ha), depending on the land use capacity, location, and the size of the area.

and 8). Their fears about the process used to assess land values and procedures for payment also had an effect on their opinions.

Expropriation of high-valued farming land is a very sensitive subject and is likely to be strongly opposed by the members of the rural elite and the most influential stakeholders. Therefore, the conservation alternative for most medium to high farming capacity cropland patches can be assessed from two landscape conservation perspectives: a) the judicial expropriation of the land, as permitted by the SNUC, and the inevitable confrontation with landowners and its negative consequences for the establishment of conservation partnerships; or, b) the negotiation of change in land use to other conservation compatible forms of land use based on incentives which could enhance potential partnerships.

Conversely, grounded on the data collected during stakeholder interviews, it is possible to assert that public acquisition of land within an integrated landscape conservation approach based on a "Habermasian"[23] collaborative planning is likely to produce many consensus-like situations. As already pointed out, low capacity croplands are located adjacent to valuable conservation patches and agreements on protecting these can be expected to be reached with some landowners.

For a hypothetical land-use planning scenario, the maps of Conservation Priority Patches and Conservation Priority Landscape (Figures 4.1 and 5.4 – Chapter 5) would be the basic guides to define where the most important conservation lands are located. The bio-physical attributes of remnant patches, land units and land use systems can be associated with landowner attitudes expressed during interviews, in order to anticipate

[23] See discussion on Section 2.4.5 – The Theory of Communicative Action of Habermas.

locations where consensus, negotiations, and compromises are most likely to succeed. The combination of both types of data is the key for conservation efforts.

The conservation of remnant patches is the easiest to achieved using the legal land use restrictions and incentives of the Forest Code and by the RPPN. The share of the ICMs-Ecológico and TDRs-like incentives, already enabled by the state legislation and federal provisional measures, are likely to increase in the near future the value and tradability of exceeding legal reserves land. Land acquisition and expropriation are also fundamental complementary tools, which were made available through the inauguration of the Campos Gerais National Park and the Biological Reserve of the Araucarias by the Federal Decree signed by President Lula on March 22nd, 2006.

The designation of these Protected Areas, after the conclusion of the social data gathering, has re-kindled the regional opposition to protected area designation controlled by powerful interests. Strong local opposition to PAs has often jeopardized or prompt destruction of the biological resources to be protected (e.g., Tchamie 1994, Terborgh 2000). Nevertheless, in the regional context, this is just an initial challenge as implementation will demand financial and human resources that are not likely be available in the next few years. Also questioned during opposition meetings and many interviews was the enduring lack of public financial and human resources for Park creation, land expropriation and management.

One of the most frequent statements by movement members was: "*there is no money for anything in the Park, including land acquisition or for the development of visitors' infrastructure. We will have to face many decades ahead, living within a Park with many restrictions on the use of our land, without any type of reimbursement*". The case of the São Joaquim National Park[24], inaugurated in 1961, and currently with less than 5% of its area legalized, and the many problems faced by the rural communities, were frequently mentioned during meetings.

The potential success of regional conservation will depend using on an array of conservation strategies and incentives to be worked out with each landowner and based on land units mapped on the local farm scale[25]. Encouraging is the fact that even on the discussion of the most controversial techniques, such as land acquisition or expropriation, it was possible to talk to landowners about specific places where conservation consensus might be achieved. Participatory approaches, based on the search for consensus-oriented cooperation in the pursuit of a common interest and compromise-oriented negotiations aiming at the adjustment of particular interests (van den Hove 2006), is the key for conservation achievements on the regional matrix as well as on the fragmented agricultural landscapes of southern Brazil.

6.4 The Quest for Conservation Dialogues

The need for establishing dialogue between landowners and conservation entities was highlighted by the constant complaints observed during interviews and participant observation, concerning the lack of interaction between the MMA's Araucária Forest Conservation task group, which proposed the Campos Gerais National Park and landowners and their organizations (e.g., cooperatives, farm associations, and trade unions). This absence of communication exacerbated opposition from property-rights

[24] Inaugurated on 1961, Sao Joaquim National Park (*Parque Nacional de São Joaquim*) encompass about 24 800 ha of grasslands and Araucaria forests and is located on the highlands of the southern state of Santa Catarina.

[25] See discussion on Section 8.6 Land Units and Landscape Conservation Alternatives.

advocates and other conservative oriented rural leaders representing mining, agribusiness, and timber interests. They are joined many opportunists, including lawyers offering expertise, conservative and populist politicians mining votes for the next elections, the local and regional media. His, in turn led to the "strategic manipulation" of information going to the other landowners and groups.

During interviews, even the strongest opinions against the Park, manifested by some of the landowners at the outset had, to some extent, faded away. As one farmer said: "*If we had been told about this* (the requirement for a fair market assessment of land and other properties values, and a pre-payment for land expropriation), *we would not be as worried as we are. Of course we will not be happy having our land expropriated, but at least we would not totally lose our assets and need to live under the bridges, as it was postulated many times by many speakers in the meetings we had been. Why didn't personnel from MMA come to talk with us? It would had prevented many headaches and high blood pressures at least*" (Member of Group 8, but similar comments from Interviews 1, 5, 7, 8, 9, 11, 17, and members of Groups, 3, 7, and 8).

Another interviewee, whose family's crop land had been included within Parks boundaries, voiced a strong opinion against the Park's creation, but otherwise expressed consistently favorable opinions towards conservation. The general good conservation status of his farmstead indicated that he was a prospective partner for a landscape conservation approach even though he said: "*I would prefer to be conquered by the Park, rather than to be rapped by it*" (Interview 5). The conflict created by a lack of communication and trust, basic requirements for conservation planning and participatory approaches, is reflected in his statement.

As argued by Sheil et al (2006), "conservation planning without adequate local consultation alienates local stakeholders, and many conservation interventions are seen as just one more attempt by outsiders to gain control over land and natural resources. At best, this fails to develop a local constituency for conservation; at worst, it sparks conflict". Study results illustrate the value of creating a shared understanding of what is important to both parties as a foundation for dialogue between conservationists and landowners. Surveys that integrate maps and biophysical information about a farm or ranch, while collecting information on how people view and value their natural environment can help improve conservation planning, address the needs of local people, and tie directly to the management of actual landscapes.

Despite the challenge of talking about conservation issues and potential conservation incentives just after the conflict over Park designation, the interviews with landowners went well. All the interviewees contacted were willing to participate and provide valuable information to the development of this landscape conservation research. Even during the discussion of the most sensitive themes, such as land acquisition or expropriation, it was possible to define places and situations where consensus might be reached.

This same cordiality however was not observed during all instances of social data collection. While observing activities of Group 8, this researcher was recognized by some participants as someone "compromised" by their association with conservation groups. When conflict arises in a group setting, stakeholders (landowners, public agency personnel, researchers, and politicians) are likely to see each at either on "our side" or with the "other side", without a place for neutrality. Some of the strongest voices against the Protected Areas were motivated by special interest, which were kept hidden to allow for their strategic use during the process. Ideological positions included fear of further regulations and loss of competitiveness in the global market.

Some involved in high impact activities in the buffer zone of the National Park, such as sand and talc mining, and some large land owners who had been occupying areas larger they actually owned (and had evaded paying property tax) and companies looking to buy new lands at low prices, were among the strong voices against PAs creation. These sectors are also likely to be strong voices against many other future conservation initiatives and they can influence potential partners to stay away from conservation initiatives.

The inherent ecological and societal complexity of environmental issues has important consequences regarding the conflict resolution processes that can be called upon (van den Hove 2006). Participatory approaches emerge as a consequence of the acknowledgement of a plurality of standpoints that stems from the complex nature of the issues at hand. Hence, in a landscape conservation approach, communication becomes central. But not just any form of communication can do the job. Interactive communication is needed which brings together those holding different viewpoints". Therefore, a type of landscape conservation partnerships must be developed that allows the discussion the ideas from the very beginning.

The type of conversation that developed during interviews might be thought of as part of an action research agenda in that they established trust and promoted mutual learning and useful knowledge about the incentives that might motivate the conservation of priority landscape parcels. Results suggest that trust building must be based on the strengthening of an institutional framework that promotes the flow of information and networking, that is flexible, and that takes into account human and social concerns as a significant part of the overall strategy. Mutual confidence must be established and it takes time and continuous effort to build understanding (Bawa et al 2004). Chapter 8 will discuss the specific findings that can guide the implementation of a landscape conservation praxis in the Campos Gerais ecoregion.

Chapter 7 – Participatory Strategies for Softening the Management of the Matrix

7.1 The Softening of the Matrix through Rangeland Management

Grasslands are subtle ecosystems in which the patterns that change through time and space are nor obvious to inexperienced observers. Perhaps this is the reason why the advent of cattle and plows has been far less controversial than the influx of axes to forests and why there are so few grassland reserves in the world (Frank et al 1998); the grazing ecosystem is among Earth's most endangered terrestrial habitats. As threats to these ecosystems intensify, it becomes increasingly important to develop measures for their preservation. The region-size reserves required to support the unique ecological processes of these systems make acquisition of sufficient ranch land and cropland to restore grazing ecosystems prohibitively expensive (Hunter Jr. & Calhoun 1996, Frank et al 1998).

It is on the remnant rangelands of the regional matrix that resides the only feasible option for the conservation of the last stands of the previous grasslands that once predominated, over the last million of years, in most of the central and southern Brazil. The protection of the rare habitats associated to the remnant patches of grasslands, as already discussed on the previous chapter[1], can partially be achieved through the existing incentives and legal mechanisms (i.e., the Forest Code, the RPPNs, and the ICMS-Ecológico) and, it is likely that, on several properties, would result from consensus-oriented cooperation processes.

The protection of these remnants grasslands on the current state of fragmentation, however, is not sufficient and restoration of high-valued conservation landscapes

[1] Chapter 6 – Participatory Strategies for Conservation on Priority Landscapes.

currently under intensive farming or forestry management is required. This requisite will not be attainable only through the set of incentives and the land use restrictions previewed in the Brazilian legislation. Hence, easement-like incentives and the acquisition of land for conservation were also discussed on the previous chapter as alternatives to increase the reserved area on the matrix.

The unreserved portion of the landscape can be broadly referred to as the landscape matrix, in the sense that it is the matrix within which any system of reserves is embedded (Franklin 1993). It is on this "semi-natural matrix", where intensive farming systems are the predominant form of land use, that conservation must be played. A conservation-compatible land management strategy in the regional matrix, in addition to reserved areas, is of fundamental importance. As private land, a regional conservation plan, therefore, need to be tuned with production activities.

The matrix has been pointed as a critical locale for conserving biological diversity and can play at least three critical roles in the conservation of biological diversity (Franklin 1993): a) by providing habitat at smaller spatial scales; b) increasing the effectiveness of reserved areas; and, c) controlling connectivity in the landscape, including movements between reserves. The provision of habitat at smaller spatial scales is a primary function of the matrix. Conserving biological diversity requires the maintenance of habitat across a wide array of spatial scales.

Depending upon the management we can either "soften" the matrix, making it less hostile for the dispersion of organisms, or enhance its lethality. There are many ways in which management practices can be modified to maintain higher levels of biological diversity including the maintenance of biological structures (e.g., snags and down logs in forests, and hedgerows and riparian vegetation on agrolandscapes) and less-intensive manipulations (e.g., integrated pest management, no-till systems, organic farming, or extensive management of rangelands). Management of the matrix also offer approaches to corridors for facilitating connectivity in the landscape (Franklin 1993, Noss 1996).

The importance of the matrix in buffering reserves is well conceptually known, but, unfortunately, it has largely been ignored on academic research and the design and management of buffers are rarely addressed as management strategy (Franklin 1993, Noss 1996, Prendergast et al 1999, Groom et al 1999, Vandermeer & Perfecto 2007). If a reserve is embedded in a matrix that is highly dissimilar – has a high contrast – a much larger reserved area is going to be required to achieved the same level of protection (Franklin 1993).

New thinking on intensively managed European landscapes is moving from the reserve mentality, in favor of a more comprehensive approach to conservation, requiring that entire landscapes are made less hostile to wildlife and that the protection of habitat-creating processes rather than habitats themselves becomes the priority. "If this theoretical landscape and processes approach to conservation receives practical support, the needs of wildlife and human development will be ultimately integrated rather than differentiated" (Prendergast et al 1999).

The compatibility degree of human actions on wildland conservation differs widely among uses and depends on the scale of activity. For all human activities there is a gradient between compatible and incompatible uses. Compatible uses are those that do not interrupt process such as nutrient cycling, key interactions among species, or reproduction. Incompatible uses are those that interrupt processes, compromise ecosystem integrity or population viability, or cause irreversible changes in these processes (Groom et al 1999). The intensity of the land management and conservation is driven largely by socioeconomic imperatives.

In the regional matrix land management varies greatly in its characteristics, since the degree of human use varies[2] from minimal (Vila Velha State Park - VVSP, RPPNs, APPs, and existing Legal Reserves), to both extensive exploitation of natural resources (domestic livestock grazing on native grasslands and recreation), and intensive (cash crop farming, forestry, and urban-industrial). Rangelands are related to the most significant remnants of natural grasslands on the regional matrix that still maintain evident the typical landscape features of the grassland community as function of the low intensity management regimes they had been submitted since colonial times. Currently, the less altered and most expressive grasslands remnants are located on the larger farms under less intensive management.

Therefore, a land use system based on semi-extensive ranching is assumed as the most appropriate eco-friendly alternative for land use in the region. Hence, this chapter will focus on alternatives for softening the management of the regional matrix through ranching as a potentially compatible land use, within a grassland and landscape conservation initiative and as for-profit alternative to farmsteads. We begin this discussion by reviewing the literature concerning the sustainability of grazing ecosystems, followed by the analysis of the environmental impacts of domestic livestock systems and the conservation compatibility of sustainable management of rangelands.

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[2] See discussion on section 3.3.3 – Land Use Systems.

The development of a strategy for sustainable management of rangelands is following discussed, based on the region's ecological conditions, ranching cultural tradition, and on the results of the rangeland research regionally developed. These theoretical considerations are complemented by the views expressed by landowners on the dialogues concerning ranching as an economic and conservation alternative. We concluded with a discussion on ecolabeling as strategy to add value on the livestock production systems as complementary incentive for landowners in the designing of a new landscape mosaic, centered on ranching as compatible land use for softening the way the matrix is managed.

7.2 Rangeland Management and Grasslands Conservation: A Review

7.2.1 The Potential Sustainability of Grazing Ecosystems

Grasslands and populations of wild ungulates have coexisted for millions of years. Their simultaneous emergence during the Late Mesozoic and concurrent adaptive radiations during the Miocene are among the most thoroughly documented evolutionary patterns in the fossil record (Axelrod 1985, Frank et al 1998, White et al 2000). This long co-evolutionary history between grasslands and ungulates is testimony to the potential high sustainability of the grazing ecosystem. Key stabilizing elements of this habitat are the large spatial and temporal variation in mineral-rich forage; the migratory behavior of ungulates, which track high-quality forage across a large region; and the intercalary meristem of grasses, which allows defoliated plants to regrowth.

A continuum exists among grazing ecosystems, from relatively less productive and moderately grazed temperate grassland to highly productive and heavily grazed tropical grassland. Because of feedback mechanisms in which herbivores promote plant growth, grazers are important regulators of ecosystem processes in grazing ecosystems. Stronger feedbacks, including larger ungulate effects on grazing efficiency and aboveground primary production, suggest that herbivores and other ecosystem components are more tightly linked in tropical grazing ecosystems than in temperate grazing ecosystems (Frank et al 1998).

The role of herbivores in controlling plant species richness is a critical issue in the conservation and management of grassland biodiversity. Because animals are continually on the move, grazing at any site, although often intense, never lasts long. Furthermore, because ungulates tend to graze grasslands early in the growing season, when forage is the most rich in minerals, and then migrate off sites while conditions are still favorable for plant growth, defoliated plants are provided with both sufficient time and suitable conditions to regrowth. Thus, the spatio-temporal dynamics of grazing ecosystems promotes sustainability despite the high chronic herbivory that these habitats experience (Frank et al 1998, Knapp et al 1999).

Numerous field experiments in grassland plant communities show that natural populations of herbivores often, but not always, increase plant diversity. The same is found when domesticated large grazers are managed at low stocking rates on productive grasslands, but high stocking rates can decrease diversity (Frank et al 1998). Olff & Ritchie (1998) suggested that the mechanisms of these effects involve alteration of local colonization of species from regional species pools or local extinction of species and that herbivore effects on plant diversity should vary across environmental gradients of soil fertility and precipitation.

Another source of variation in herbivore effects on plant diversity arises from the spatial or temporal scales at which diversity is measured or affected. Herbivores can influence species richness at both the local scale (plant neighborhood) and the regional scale (spatial range of an individual or population of herbivores). Local disturbances and selective grazing can enhance diversity at local scales, but strong selection for grazing tolerant plant species within the species pool might reduce diversity at larger scales. In addition, herbivore body size might interact with the scale of diversity, because local effects of large herbivores can occur over a much larger spatial scale than local effects of smaller herbivores (Olff & Ritchie 1998).

Grazers have important indirect effects on grassland energy and nutrient flows in addition to their direct consumption of plant biomass. Defoliation promotes shoot growth. Grazing removes phenologically older, less productive tissue that increases light absorption by younger, more photosynthetically active tissue and improves both soil moisture status and plant water-use efficiency. Grazers enhance mineral availability by increasing nutrient cycling within patches of their waste. In addition, grazing decreases microbial immobilization of nitrogen, resulting in greater rates of net nitrogen mineralization and nitrogen availability to plants. Consequently, ungulates stimulate allocation to shoot growth while simultaneously enhancing light levels, soil moisture, and nutrient availability (Frank et al 1998).

Wild ungulates are an inextricable component of the web of energy and nutrient flows in grazing ecosystems. When ungulates are removed from grasslands, the functional character of the system is altered, transforming a consumer-controlled, rapidly cycling ecosystem into one that is detritivore based and slowly cycling. Eliminating grazers that migrate over vast, spatially heterogeneous environments and fragmenting grazing ecosystems into grassland remnants similarly alters the fundamental ecological character of those fragmented habitats (Olff & Ritchie 1998, Frank et al 1998, Knapp 1999, Peco et al 2006).

Fire is also another important factor in maintaining grassland ecosystems (Collins 1992, Menke & Bradford 1992, Frank et al 1998, White et al 2000, Ramos-Neto & Pivello 2000). Fires is a natural part of most grasslands systems and disturbance caused by fire usually increases animal and plant species diversity and forage quality for both wild and domestic herbivores. Fire prevents bush encroachment, removes dead herbaceous material, and recycles nutrients. Therefore, controlled burning of grasslands can be used as a tool to maximize diversity. The timing, frequency, and intensity of fires determine specific effects of these events on the functioning of grassland ecosystems.

Several environmental benefits may be brought by fire in savannas type environments, especially the stimulus to nutrient recycling and to sprouting, fruiting, and seeding of several plant species; it also increases the vigor and palatability of a number of herbaceous species. Different fire regimes (fire type, frequency, intensity, and season) may favor distinct groups of species or may consume more or less intensively the accumulated fuel. Such fire outcomes may result in management ends, as wildfire control, food supply to native fauna, weed control, and the maintenance of biodiversity and ecological processes (Ramos Neto & Pivello 2000). Present-day discussions on the causes of wild land fires may be important to management approaches and policies for conservation areas in Brazil as well in the regional matrix.

Fire prone environments need prescribed burning programs to ensure the long-term persistence of biotic resources. There are now many evidences that eliminating processes, such as fire, that occur at large spatial scales disrupts the long-term structural integrity and biodiversity of grassland fragments. Worldwide, fire prevention programs themselves have allowed woody plants to spread onto grasslands and prescribed burning is usually the only economically feasible removal alternative for large land areas. Patch burns, which create openings in otherwise large sense expanses of impenetrable brush, improve access to forage for both wildlife and domestic livestock while lowering wildfire hazard (Knapp 1999, Menke & Bradford 1992).

Natural fires triggered by lightning in the wet season, previously considered unimportant episodes in the Brazilian Cerrado, were shown to be very frequent and probably represent the natural fire pattern in that region (Ramos Neto & Pivello 2000). Lightning fires should be regarded as ecologically beneficial, as they create natural barriers to the spread of hotter and more damaging winter fires. Little concern has been given to the natural fire dynamics in Brazil, and common misconceptions about fire effects in open natural environments led public agencies to reject any fire management in cerrado protected areas (or other open ecosystems), either natural or prescribed (Ramos Neto & Pivello 2000)[3].

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[3] In fact, the environmental legislation in Brazil has permitted the use of fire since 1989 for managing reserves (Federal Decree 97635/1989) but, in practice, decision-makers in the public agencies rarely allow fire management in parks and reserves, even though it can be a very useful and cheap management tool (Ramos Neto & Pivello 2000). In the Management Plan of the Vila Velha State Park – VVSP (Paraná 2004) the discussion on fire is limited to it is negative influence on plants and wildlife, and as such, an occurrence that need to be avoided through fire prevention programs. Both, lack of fire and absence of grazers on VVSP has facilitated the invasion of brushes and woody species into grasslands, and despite the accumulation of biomass and the risk of uncontrolled fires hazards, even to the forest formations, fire

7.2.2 The Environmental Impacts of Domestic Livestock Systems

The Impacts of Domestic Livestock on Grassland's Biodiversity

The introduction of domestic animals to a natural plant community has profound effects on the composition of the vegetation, soil erosion, and on population density and species composition of native organisms. A comparison of the grazing of grasslands by wild ungulates and domestic livestock underline important transformations in grassland ecosystems. Domestic livestock are raised to maximize animal biomass through various techniques, including veterinary care and predator control, as well as water, mineral, and feed supplements. The result is generally higher biomass of domestic animals on pasture and rangelands than biomass of wild ungulates on grasslands (Frank et al 1998).

Despite most of the rangelands worldwide have coevolved with large herbivores and are more tolerant of today's' domestic cattle grazing, the dominant force affecting biological diversity and conservation on human managed grasslands is introduced domestic animal (Menke & Bradford 1992). In high densities, grazing animals can change floristic composition, structural characteristics of vegetation, reduce biodiversity, and increase soil erosion by water and wind; in extreme situations, grazing may eliminate much vegetation cover. The extent to which these changes occur may depend not only on the number of livestock but also on the pattern of their grazing (Dormaar & Willms 1990) and to the physical and biological characteristics of the area.

Human herding of domestic livestock does not replicate the movements of wild ungulates; the use of water pumps and barbed-wire fences transformed grasslands throughout Earth, leading to more sedentary and concentrated use of grasslands by

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management of the grassland ecosystems was not considered. In 2007 a workshop was conduct to analyze domestic animals. Densities of domestic livestock may be higher than those of wild ungulates, and the grazing patterns of domestic animals may limit the recovery of defoliated grasses. Therefore, not only are the densities of domesticated ungulates higher than those of wild ungulates, but also the spatiotemporal pattern of grazing, which play an important role in the recovery of defoliated grasses, has been disrupted on rangelands grazed by domesticated herbivores (Frank et al 1998, White et al 2000).

In addition to the local loss of species, there has been a significant restructuring of many of the plant and animal communities. Within intensive continuous grazing systems (regionally the most common system of pasture management), many of the more palatable native plant species are reduced or eliminated and replaced by more tolerant species. When the grasslands were widespread and relatively intact, plant populations continuously fluctuate in size, and local extinctions were commonly reestablished from nearby populations (Steinauer & Collins 1996, Risser 1996). However, in the current fragmented landscape (as in the Regional Matrix' grasslands), local sources of seeds for reestablishment are limited or absent, leading to the long-term loss of species.

Domestic livestock can control grassland diversity through mechanisms that affect the colonization-extinction dynamics of the species. They are generally regarded as disturbance generators because they consume leaves, fruits and roots and involve mechanical action such as trampling and play an important role as dispersers of viable seeds. Livestock produce changes in the physical and chemical soil properties and made influence on the spatial distribution of fertility and nutrient cycling due to dung and urine inputs. Large herbivores also produce soil disturbance by pressure or trampling, which

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fire as a management tool for the VVSP.

can increase site regeneration and soil heterogeneity and, thus, create more opportunities for coexistence but can also create widespread erosion processes that reduce plant diversity (McLaughlin & Mineau 1995, Olff & Ritchie 1998, Peco et al 2006).

These differences between systems grazed by wild and domesticated ungulates help to partially explain the discrepancy between the generally positive feedbacks of wild ungulates on forage properties versus the positive, neutral or even negative influences of domesticated herbivores on forage. Environmental gradients producing spatial variability in forages, including landforms, soil fertility, habitat types, micro climate conditions, past disturbance levels, and the evolutionary grazing history, mainly defined by climate and productivity, are also influential factors (Milchunas & Laurenroth 1993, Frank et al 1998, Olff & Ritchie 1998, White et al 2000, Peco et al 2006).

Intensive or highly intensive range management systems may use several techniques to increase agricultural productivity, often at the expanse of plant diversity. Fertilization usually increases the dominance of robust, common plants at the expanse of smaller, less common species. Exotic grasses or legumes are seeded to restore ranges in poor conditions or to replace undesirable weedy species with plants of improved forage value. This practice may be detrimental to conservation interests, but on a severely degrade range such strategies can favor both production and conservation goals. In addition to the regulation of grazing pressure, rangeland vegetation may be altered by re-seeding, pesticide use, removal of brush, and suppression of wildfires (Menke & Bradford 1992, McLaughlin & Mineau 1995).

Concerning wildlife, domestic livestock management may directly affect them in two major ways: a) consumption of forage that could be used by wildlife; b) alteration of vegetation as it influences escape, thermal and protective cover. Several animals are more narrowly adapted to vegetation structure for thermal and hiding cover than they are to particular plant species for food. Structural diversity of rangeland vegetation also relates positively to wildlife diversity, except if the mosaic is on a scale too small to meet the home range needs of species that require large blocks of uniform vegetation (West 1996).

Domestic livestock management indirectly affects wildlife by (West 1996): a) human and livestock presence, b) fencing, c) salting, d) water developments, e) roads, f) trails, g) predator control, and h) other physical and chemical manipulations, such as prescribes burning, chaining, cabling, root plowing, brush beating, reseeding, herbicides. These later practices usually simplify and homogenize habitat structure. The maintenance of an appropriately diversified range landscape is essential for wildlife species, as areas lacking scrub, hedges, trees or a variety of herbaceous vegetation cannot provide browse, nesting or shelter (McLaughlin & Mineau 1995).

In the tallgrass prairies of North America, habitat loss and degradation, as well as competition from edge species and nonnative species and chemical pollution, have been the greatest threats to invertebrates and birds populations (Arenz & Joern 1996). The wide-scale destruction of habitat and the alteration of remaining habitat have also led to the extermination of keystone mammals and locally of several top predators with a frequently increase in generalist mammals species. The same trend toward generalist species is also true of the fish species in the tallgrass region (Rabeni 1996, Benedict et al 1996, Anderson et al 1996).

The Impacts of Domestic Livestock on Rangelands

Choice of management objectives in raising domestic livestock, in addition to the physical and biological characteristics of the area, plays a fundamental role in rangeland condition. There are numerous key decision variables used by range livestock managers that affect the quality of the rangelands, including the kind (species) of livestock (e.g., cattle, sheep, horses), the class of livestock (cows, calves, steers, heifers, ewes and lambs), the numbers of animals (stocking intensity per unit area or per unit of forage available), the seasonality of grazing and browsing pressure of animals, and the frequency of grazing (rotation of grazing and regrowth periods). These factors have been under study, individually and in combination, for many years although most attention has been given to their effects on range productivity such as animal unit (A.U.) months of grazing supported by a range unit, or in the case of very intensive pasture management, average daily gain in weight per animal (Menke & Bradford 1992).

Worldwide, the primary issue in range management is overgrazing (Menke & Bradford 1992). Overgrazing results in reduced abundance of palatable species, productivity of forage bellow potential, and soil cover bellow that which can sustain natural ecosystem structure and function. Chronic overgrazing can lead to soil erosion and/or desertification. From the perspective of both sustainable farming productivity and biological diversity, the consequences of overgrazing are undesirable. The most common cause of overgrazing is maintaining numbers of domestic livestock in excess of the carrying capacity of the land, but factors such as random or cyclical variation in rainfall and the removal of predators can also contribute to overgrazing.

In a long term research (40 years of observations) developed to determine the carrying capacity of prairie lands in dry subhumid climate on fertile soil in Alberta, Canada, Dormaar & Willms (1990) reported fundamental issues concerning the impacts of different grazing systems on rangelands that must be observed to improve the sustainability of range management. On this study, parcels with greater stocking rates had increased forage use and increased grazing pressure, a reduction in range condition and increased grazing-resistant species that were shorter, less productive, and shallow rooted. Such changes in the vegetative cover led to a reduction of organic matter and a loss of soil structure, which contributed to surface sealing, reduced water infiltration rates and increased evaporation. The net effect was reduced soil water.

The presence of domestic animals, together with concomitant changes in the range vegetation, affects the natural dynamics of the soil resource and its water-intake characteristics. Dormaar & Willms (1990) observed that as grazing intensity increased, water intake decreased, but, provided that the soil was covered by vegetation, type of cover had little influence on water-intake rate. Water-holding capacity, representing field water capacity plus the water held in organic matter, was lower in the heavy grazing than in the light grazing treatments. The consequence of reduced infiltration and water holding capacity was increased run-off and soil erosion started when about 15% of the soil surface became bare, condition presented on some of the much overstocked fields.

Water infiltration is also affected by the soil bulk density, which is affected by large animals that exert physical pressure on the soil by their weight. The effect of animals on bulk density is a function of stocking rate, which describes the frequency and duration of impact. Persistent trampling affects the physical and chemical characteristics of soil over an entire field, but also on microsites within a field. To maintain plant vigor and to allow carryover in the following year, Dormaar & Willms (1990) argued that range should be stocked season-long at a moderate rate. This leads, however, to the formation of patches where intensive trampling on microsites increases bulk density; they also found higher bulk densities on paths than in grazed land. In this study, soil organic matter, carbohydrates and depth of the A horizon were greater in under-grazed than in overgrazed patches (Dormaar & Willms 1990).

Rangelands are typically fragile, and the rate of recovery from over exploitation is slow particularly in arid and semiarid landscapes (Savory 1999). Overgrazing effects are imposed either on a short or long term and their duration, after corrective action is take, may be described similarly. Retrogression in the composition of plants species, caused by overgrazing occurs rapidly, but succession, following rest from grazing, is generally slow. The rate of retrogression and succession depends upon the plants species and grazing pressure and can take several years to an ecological succession of the plant community to reach a near "climax state" (Dormaar & Willms 1990). The recovery of degraded soils and its characteristics properties will require even longer periods of time.

Conversely, grazing abandonment or long rest periods will lead to a shift in the vegetative cover (Savory 1999). Peco et al (2006) analyzed the changes to floristic composition, species richness and heterogeneity as well on soil and light resources, in relation to grazing abandonment in grasslands located on a continental Mediterranean climate context in Central Spain. Results showed that the impact of low intensity grazing in the rangelands systems affects the vegetation structure and composition, the soil physical and hydrological properties, light availability at the ground level and soil chemistry. Long-term grazing abandonment caused the loss of more than 60% of grassland species and although the zones invaded by scrub are also species rich, widespread abandonment produced a reduction in floristic richness at the landscape scale on account of the different floristic composition in grazed and abandoned zones.

After more them 300 years of ranching history on the Campos Gerais, a great deal of impacts and transformation on the grasslands cover had proceeded. As already discussed[4], the continuous division of very large landholdings throughout the regional colonization, promoted more intensive grazing and burning regimes, to provide forage during the and after the critical winter period. The combination of these factors led to overgrazing, erosion and to the impoverishment of soils and rangelands, observed since the last decades of the 19th century. Overgrazing signs, rill and gully erosion are easily observed in the landscapes of most of the remnant grasslands. Grazing abandonment is less common but their effects are clear visible within the VVSP.

Grazing abandonment, lack of fire, or long rest in humid environments, such as the Campos Gerais, generates several changes in the grassland plant community. As consequence of more humid climate, the long term pattern of ecological succession from grasslands to forests can be observed on several stages on areas where fire and grazing have been suppressed. In some places where fire is absent for more than 20 years (e.g., within Vila Velha State Park) succession patterns are clearly more developed. Very few studies, however, have been conducted to analyze the ecological succession from the grasslands to forest formations (e.g., Klein & Hatschbach 1971, Moro 2001). Exceptions

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[4] See "Landscape Fragmentation: a Brief Historical Review" on Section 3.3.1 - The landscapes of the Campos Gerais ecoregion

to this pattern may occur on places with a very thin or wet soil or by the ignition of fire, limiting the successional process at the initial grass level.

The Impacts of Intensive Livestock Systems

Livestock production is traditional in most inhabited regions of the world and plays an essential role in providing food and draught power, often using resources that could not otherwise be employed to the benefit of the human population. Only in the second half of the 20th century, animals have been stretched to increase production. Intensive production systems were developed in the industrialized countries to meet increasing demand, and production per se was substituted by productivity of the system. More recently efficiency of production, mainly based on economical aspects, became the main goal of such systems. By the last decades of the century intensive techniques were becoming common in many developing countries, including the Campos Gerais region particularly for the production of poultry, cattle and pigs (Phillips 2002).

Based on the analysis of future trends in livestock production, this author concluded that livestock production systems have the potential to provide high quality food and employment, especially in marginal areas, and to preserve the land for the benefit of future generations. However, if badly managed, intensive systems may lead to major adverse effects on the environment, damage to human health and a reduction in food supply for those in developing countries. He also pointed public health and environmental hazards linked to intensive systems and advantages of alternative methods.

Regionally, livestock production has become an industrial-scale process in which several thousand pigs or chickens are fed grains and produced in a single facility integrated with large companies or cooperatives. There is a clear tendency for increasing the number of small and medium farmsteads integrated within industrial systems, as alternative to economic farm diversification. Therefore, it is important to point out some major environmental concerns of such systems. Large-scale facilities are economically competitive because of production efficiencies, but have health and environmental costs that must be better quantified to assess their potential role in sustainable development. High-density animal production operations can increase livestock disease incidence, the emergence of new, often antibiotic resistant diseases, and air, groundwater and surface water pollution associated with animal wastes (Tilman et al 2002).

Intensive livestock operations are vulnerable to catastrophic loss of animals to disease; to help prevent disease associated with high-density facilities, livestock are often fed sub-therapeutic doses of the same antibiotics used in human medicines. These prophylactic treatments cause agriculture to use, in total, a larger proportion of global antibiotic production than human medicine. Antibiotic-resistant *Salmonella*, *Campylobacter* and *Escherichia coli* strains that are pathogenic to humans are increasingly common in poultry or beef produced in large-scale operations (Tilman et al 2002). The bovine spongiform encephalopathy (BSE) outbreak in the UK is just another example of a disease caused by intensive livestock farming (Phillips 2002).

In areas of high intensity livestock production, under industrial and intensive mixed farming systems, high concentrations of animals can cause major environmental problems and have been called "the most severe environmental challenge in the livestock sector" (Delgado et al 1999). Intensive industrial production methods, found near urban agglomerations such as areas of northwestern Europe, the eastern and Midwestern United

States, Japan and southern Brazil, result in large nutrient surpluses from animal wastes. The handling and disposal of animal wastes are significant problems of high-density animal confinement facilities.

Manure lagoons, the most common practice for treatment in the regional matrix, can release high levels of hydrogen sulphide and other toxic gases, volatilize ammonium that greatly increases regional nitrogen deposition, and contaminate surface and ground waters with nutrients, toxins and pathogens. These animal wastes pose health and environmental risks similar to those of human wastes and should be treated accordingly (White et al 2000, Tilman et al 2002). However, manure conveniently treated can be a rich source of soil nutrients and soil organic matter. Swine and dairy manure as been regionally employed on two large farms for biogas production as source of energy to grain drying and to insulate animal installations on winter, within a carbon sequestration protocol agreement; the resulting bio-fertilizer has been employed on cultivated lands through irrigation systems, powered by the energy released on the process.

7.2.3 The Conservation Potential of Sustainable Rangeland Management

Privately owned lands are managed to maximize economical outputs, often at the expense of local biological values. Currently, land should be managed according to multiple use objectives including sometimes contradictory uses such as commodity production, maintenance of biodiversity, and aesthetic values. The challenge is how to plan and carry out management on such multipurpose lands to minimize loss, maintain, and even enhance biodiversity. Rangeland farming is a clear option in natural grassland regions as it differs from arable agriculture by utilizing extensive areas, relatively low inputs of labor and capital, limited production manipulation techniques, and low financial return per acre.

Pastoral livestock production makes extensive use of ecosystem services and eliminates many of the problems of confinement and intensive animal production. Pastured animals consume plants growing in a field, and plant growth is increased by animal wastes deposited and recycled in the field. Ruminant production on grasslands takes advantage of the high efficiency of ruminant guts to convert low-quality forage into high-protein human foods, including dairy products and beef. When appropriately stocked and managed, grassland-ruminant ecosystems are an efficient, sustainable method of producing high-quality protein with minimal environmental impacts (Tilman et al 2002).

Ranging has been instrumental in protecting the Canadian prairies from destruction and rangelands are some of the most extensive and well managed tracts of native prairies (McLaughlin & Mineau 1995). In many regions, livestock grazing has proved to be a land use less destructive than large-scale crop production and therefore can be a useful tool for maintaining landscape and community structure, particularly in disturbance-adapted ecosystems such as grasslands, prairies and savannas (Peco et al 2006, Morrison & Humphrey 2001, White et al 2000, Frank et al 1998, Olff & Ritchie 1998, Hoogsteijn & Chapman 1997, Milchunas & Lauenroth 1993). Management of rangelands can also be compatible to the exigencies of many wild species.

Morrison & Humphrey (2001) investigated patterns of distribution and reproductive activity of breeding pairs of caracaras (*Caracara spp.*), a medium-sized bird of prey, in south-central Florida related to the pattern of land use. They found that when land use was cattle ranching, pairs nesting exhibited higher rates of breeding-area occupancy, attempted breeding during more years, initiated egg laying earlier, exhibited higher nesting success, and attempted a second brood after successfully fledging a first brood more often, than pairs nesting on lands managed as natural areas with no agricultural production and limited livestock grazing. They conclude that finding ways to preserve large cattle ranches in southern-central Florida is an important component in conservation planning for this specie, suggesting further studies to identify particular aspects of these grazing lands that influence caracaras.

Walk & Warner (2000) found a significant effect of grassland management regimes (burned, mowed, hayed, grazed and undisturbed) and grass type (cool and warm season grasses and annual weeds) in the abundance of songbirds in the Midwestern USA. They observed a consistently higher frequency of the five species studied in low intensity grazed grasses and a lower frequency in burned grasses. McLaughlin & Mineau (1995) reviewed the effects of grazing by livestock for several bird and ungulate species and related that many species of wildlife can thrive in properly managed rangelands. They observed, however that grazing, under any system, has not been shown to enhance waterfowl production and is frequently detrimental to their populations as consequence of the grazing on such specific ecosystems.

Bellis et al (2004) used radio telemetry to study habitat use by released captive-born greater rheas (*Rhea Americana*)[5], in rural areas in the grasslands of central Argentina. Greater rheas preferred pastures, showed less preference for grasslands, and did not use croplands. No differences in habitat use were found between wild and captive-born greater rheas. Rheas used pastures and grasslands for nesting and no differences in nesting success were detected between these habitats. Their results show that agroecosystems that include grasslands and pasture production would strongly contribute to the Rhea conservation.

In the Chaco region of Argentina the management of grazing lands using domestic livestock under carefully controlled stocking rates and linked to rotational grazing systems, was shown to improve the range for wildlife, including rheas and deer, species that had largely disappeared from that region under the poorly managed systems. Yields of cattle were higher in the systems that also support more wildlife (Menke & Bradford 1992). Where multiple-use concepts are adhered, the goal of modern range management is to adopt systems that enhance both wildlife and livestock production. Since wildlife depends directly on habitat, plant biological diversity goals will often be met if wildlife needs are met. To achieve this goal, policies and individuals attitudes must be modified, both of which require research and education programs.

There is evidence for some grassland/savanna ecosystems that the total production of native herbivores can exceeds that obtained from domestic livestock even when mixtures, such as cattle, sheep and goats are employed (Menke & Bradford 1992). This has led to an interest in potential for managing native animal species for meat production and other uses. The study of such systems could well provide information that would lead to strategies for utilizing natural vegetation to support a sustained harvest of local species rather than converting them to rangeland for domestic livestock or to the integration of

[5] A large (height 1.4 m, mass 20 - 25 kg) herbivorous, flightless bird that inhabits the Cerrado and grasslands, shrublands and open woodlands in South America

both wildlife and domestic livestock (Steinfeld et al 1996, Somogyvari 1993, Menke & Bradford 1992).

There are potential positive aspects of jointly promoting livestock production and conservation of biological diversity and some studies have observed complementarities between wildlife and domestic livestock (Steinfeld et al 1996). Evidence from these studies suggests that raising wildlife and livestock together can support greater biodiversity without lowering incomes for ranchers and may not require large reductions in livestock stocking rates. The existent experiences, however, shows that are often difficult to realize the potential economic gains from the production of wild species, since the market for wild meat is small and because of difficulties of harvesting, processing, packing, transportation, and marketing (White et al 2000).

Commercial production of wildlife animal in Brazil has been subject of Federal regulation and a bureaucratic procedure is required which includes a technical project with detailed plant of installations, animal management strategies, market analysis, commercialization, and discard strategies. Commercial wild animal production systems can make significant contribution to the conservation of some species, as an alternative to the supply of wild meat, skin and other products, and to avoid or at least to contribute to diminish illegal hunting. It can also be a source of alternative income to farmers (Oliveira & Leite 2000). Such practices are still uncommon in Brazil and are mostly restrict to some research settings. There are opportunities to be explored as already demonstrated in the successful husbandry of wildlife species traditionally hunted, such as the agouti and the capybara, within semi-intensive research settings.

7.2.4 Strategies for Sustainable Management of Rangelands

To Menke & Bradford (1992) the effective integration of the three main goals of rangeland management: economic gain through livestock production, management of game animals for recreational use, and conservation of biological diversity, will form the cornerstone for conservation of biological grassland diversity for future generations. When properly managed livestock can help maintain soil fertility, increase nutrient retention and water-holding capacity, and create a better climate for microflora and fauna. The most critical management decision is to determine a stocking rate and a timing of permanence, so that livestock production per unit area of rangeland is maximized while the forage resource is maintained over time (Primavesi 1981, Dormaar & Willms 1990, Menke & Bradford 1992, Delgado et al1999, Savory 1999, White et al 2000).

Livestock grazing systems effects on sustained productivity of vegetation and soil is the primary applied area of study of range science. The basic tenet of range science is that more products could be produced per unit area on the many overstocked lands if the number of livestock animal was reduced. In many situations, compensatory plant growth responses under less intense and less frequent defoliation actually increases milk, meat, wool, and production through improved animal performance with a lower proportion of the forage used for maintenance (Menke & Bradford 1992). In some overgrazing situations, simple control of animal distribution will result in relaxation of grazing pressure on individual plants and provide a similar compensatory response.

Livestock management on rangelands requires a grazing system, i.e., using two or more pastures in alternating time periods. Sustained production avoids overgrazing as well as heavy trampling and waste accumulation. Two particularly important classes of grazing systems have emerged in the field of range science to increase forage quality and quantity: the rest-rotation grazing and the intensive rotation rest system (Primavesi 1981, Menke & Bradford 1992, Savory 1999).

The rest-rotation grazing system allows range plant communities to recover from past overgrazing by fencing land into smaller grazing units and rotating animals to provide an annual development rest period or delay from grazing. This system has been found useful for ameliorating some of the adverse impacts of season-long grazing on wild birds and mammals primarily because certain areas of pasture are left undisturbed at least part of the time (McLaughlin & Mineau 1995).

The intensive rotation rest system was designated for enhanced livestock productivity while maintaining or improving range conditions based on short durations grazing cycles using cells of relatively small pastures through which animal are rotated on a closely managed (typically one to four days) schedule. This scheme reduces grazing animal selectivity and damage by trampling. It also apparently promotes plant regeneration and improves soil surface structure through "hoof action" and "herd effects" improving thus livestock productivity (Primavesi 1981, Menke & Bradford 1992). Variations of both classes of grazing systems have been adapted by researchers and growers to several ecological conditions of Brazil.

On the basis of research conducted at the Konza Prairie Research Natural Area in Kansas, Knapp et al (1999) identified key components for conserving and restoring the biotic integrity of tallgrass prairie: fire and ungulate grazing activities that shift across the landscape. They argue that bison and cattle are functionally similar to large herbivores, and that management strategies such as stocking density and duration are more important to grassland condition than whether cattle or bison are present. Accordingly, it is the interaction of ungulate grazing activities and fire, operating in a shifting mosaic across the landscape that is the key to conserving and restoring the biotic integrity of the remaining tracts of tallgrass prairie.

The condition of grazing lands in six regions of Inner Asia (within south Russia, Mongolia and northern China) has been compared and described in relation to both livestock density and grazing patterns (Sneath 1998). An historical review of land use in these regions shows that in many areas, mobile pastoralism has been largely replaced by more sedentary methods of raising livestock. Comparisons among these regions indicate that the highest levels of degradation were reported where livestock mobility was the lowest. Accordingly, "mobility indices were a better guide to reported degradation levels than were densities of livestock" (Sneath 1998).

In an extensive review of the effects of grazing on vegetation and soils, Milchunas & Lauenroth (1993) examined data from 236 sites across 6 regions (Africa, Asia, Australia, Europe, North America, and South America). Included in the analysis were studies comparing species composition, above-ground net primary production, root biomass, and soil nutrients at grazed and ungrazed sites. The analysis revealed that biomass production, species composition, and root development were generally unaffected by long-term grazing. This finding indicates that the geographic location of grazing and the associated environmental gradients may be more important than how many animals grazed or how intensively an area is grazed.

In Kansas (USA), moderate grazing by bison and cattle increased plant biodiversity on tallgrass, mixed grass prairie, and shortgrass steppe. On the other hand, very heavy grazing that removed 90% of above-ground biomass reduced diversity on mixed-grass prairie. Grazing increased nitrogen concentration in topsoil, accelerated recycling of nitrogen, and created intermediate levels of disturbance. These effects have been proposed as the mechanism whereby grazing increases biodiversity at landscape and smaller scales (Hart 2001, Knapp et al 1999). Light to moderate levels of grazing usually result in a richer diversity of plant species than do heavy levels of grazing or no grazing at all, especially in the more humid grasslands such as the Campos Gerais.

Hart (2001) reported results of a field experiment where shortgrass steppe rangeland near Nunn, Colorado, (USA), has been lightly, moderately, or heavily grazed by cattle, or protected from grazing in exclosures for 55 years. Plant species biodiversity and evenness were greatest in lightly and moderately-grazed pastures. Diversity was least in the exclosures and under heavy grazing diversity was intermediate. Plant community structure and diversity were controlled by selective grazing by cattle and soil disturbance by cattle and rodents. Shortgrass steppe moderately or heavily grazed by cattle was similar to and probably as sustainable as steppe grazed for millennia by bison and other wild ungulates.

In the Mediterranean conditions of central Spain, Peco et al (2006) reported that moderate grazing improves fertility in very poor soils and promoted species richness at the local scale and vegetation cover, which enhanced protection from soil erosion. It also improved soil water retention ability, which can have important consequences for seed germination and seedling establishment in environments where water is the main limiting factor for these processes. Grazing can control the accumulated biomass and reduce the consequences of uncontrolled fire hazards and its degrading processes in vegetation and soil. They conclude that it is advisable to combine areas with different types of grazing pressure to maximize species diversity at the landscape level and use the benefits of low-density grazing in other functions of the ecosystem such as productivity and stability.

Despite a switch from native to domestic animals, properly managed range can sustain agricultural productivity and conserve related resources. To Dormaar & Willms (1990) plants should not be grazed too early in spring when they are mobilizing resources for growth. They also argued that grazing should not remove beyond 50% of current aboveground biomass production to avoid removing stored energy in the stem bases and to allow for carryover into the next year. The carryover not only provides emergency forage but, more importantly, sustains the nutrients status and hydrological properties at an optimum level, thereby stabilizing annual production.

Under tropical and subtropical conditions Primavesi (1981) argues that rangelands' soils will benefit from the rest-rotation systems, particularly when hay harvest is intercalate with grazing to avoid excessive trampling and consequent soil compaction. The ecological management of pastures is a measure that can made viable technical and economically a ranching enterprise because its low costs of implantation and maintenance and optimizing the natural potential of a region or individual farm. However, she points, the rest period of rangelands in rotation systems will only be effective when pastures are well nourish; soil deficiency in phosphorus and calcium, typical of the tropical and sub-tropical regions, are of particular concern and plants will mature earlier producing forage of low nutritional value.

Field experience in the Campos Gerais (Schreiner 1991) indicates that the major benefits that accrue from rest-rotation grazing systems are the better control of livestock distribution on the pastures and reducing overgrazing of sites favored by livestock. But because the large investment in fencing and the need for close scheduling of grazing periods in the short duration rotation system, this approach have been limited applied. The appropriateness of the rest-rotation systems to Brazilian conditions is in general agreement with several authors (e.g., Primavesi 1981, 1992, Schreiner 1991, Nicodemo & Schunke 2003, Melado 2003), but must be considered in a broad regional context including ecological and socio-economic factors.

As early discussed[6], fire is an important factor in the management of rangelands. Its consequences, however, are subject of controversy worldwide (e.g., Menke & Bradford 1992, Frank 1998, White et al 2000), nationally (e.g., Primavesi 1992, 1981, Ramos-Neto & Pivello 2000), and regionally (e.g., Schreiner 1991). There are evident advantages for grazing objectives in the short term, but there are also several environmental and ecological restrictions in the long term, including decreasing soil biological activity and fertility and the selection of fire dependent species with low forage quality, when rangelands are submitted to intensive fires regimes; significant amounts of carbon dioxide are also released to the atmosphere.

Controlled burning of pastures, however, can be used as a tool to maximize diversity; fires is a natural part of most rangelands systems and disturbance caused by fire usually increases animal and plant species diversity and forage quality for both wild and domestic herbivores. Rangelands are the ideal landscape in which fire can be use as a tool to maximize diversity. Periodic burning tends to increase primary production under conditions of average or above-average rainfall but decreases production if fires are too

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[6] Section 7.2.1 The Potential Sustainability of Grazing Ecosystems

frequent and under drought conditions or bellow-average precipitation (Bragg & Steuter 1996, Risser 1996).

Conditions such as soil and air humidity, temperature, atmospheric conditions, and enough intervals between burnings, are main factors that must be considered to minimize the negative effects of fire and maximize its potential benefits. The correct combination of these factors for a fast passage of the fire in a way to do not affect the soil cover can be an efficient way to minimize the negative effects for the maintenance of the quality of the native pastures (Primavesi 1992). Such ideal conditions to minimize impacts of rangeland burning in the Campos Gerais were described as early as 1820 by Saint-Hilaire (1978) when burning was already a largely adopted procedure; he also observed the more evident negative consequences on pastures of intensive fire regimes around and close to the farmhouses.

7.3 The Potential for Sustainable Rangeland Management in the Regional Matrix

From the early 18th century to the late 1960s, the majority of the campos ecosystems had been managed as extensive rangelands and ranching was the main economic activity along this period[7]. Despite the negative consequences of domestic livestock management on these areas, particularly on the more intensively managed lands, the main grassland landscape features were maintained along this period. By the end of the 20th century, extensive management of rangelands was still prominent on the more isolated and remote regions located along the Devonian Escarpment.

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[7] See "Landscape Fragmentation: a Brief Historical Review" on Section 3.3.1 – The landscapes of the Campos Gerais ecoregion

Ranching, in colonial times, was favored by the abundance of creeks and rivers, the relatively mild weather, the absence of significant drought periods, and the quality of the natural pastures. Among the native species, Schreiner (1972, 1991) pointed out as having a high potential value as forage the genera *Andropogon*, *Paspalun*, *Axonopus*, *Panicum* and *Eragrostis* from the *Poacea* (*Graminea*) family, and the genera *Stylosanthes*, *Aeschynomen*, *Desmodium* and *Zornia* from the *Fabacaea* (*Leguminosae*) family. Other grasses (e.g., genera *Aristida, Hypoginium* and *Elionurus*) and other typical species from the families *Cyperaceae*, *Compositae*, *Euphorbiaceae*, *Leguminosae*, and *Verbenaceae*, among others, are also common (Klein & Hatschbach 1971, Schreiner 1991, Moro 2002, Moro et al 1996), but are mostly of low forage value.

The native grassland species have a relative short annual period of more intensive growth during the spring and summer seasons; by mid fall vegetative growth is decelerated and inhibited throughout the winter season. The quality of forage is impoverished as plants became fibrous and have a low nutritional value; forage shortage on the winter seasons, has historically been the main limiting factor for ranching on the Campos Gerais. Low temperatures and frequent frosts are particularly prejudicial to the species with higher forage values. Large tracts of land and/or sources for supplementary feeding are necessary to overcome forage shortage during winter season (Schreiner 1991). Mineral supplementation is also indispensable as the natural grasslands typically have a very low mineral content (Wunsch et al 2005).

In the growing season, however, the forage productivity in the natural grasslands is sufficient to sustain cattle under reasonable performance, even when managed on the natural conditions of low soil fertility. A satisfactory daily gain in weight of 0.5 Kg per head can be reached in a density of 0.7 to 0.8 animal units per hectare at a very low production cost (Schreiner 1991, 1972). These numbers highlight the potential for animal husbandry within natural grasslands in the growing season and are important in the discussion of the economical potential of ranching as a conservation strategy. Experienced range owners recognize the potential value of the natural grasslands and they agreed in pointing out some valuable species (Interviews 2, 3, 4, and 5), particularly the "*capim mimoso*" (*Andropogon tener*).

"*The best range areas were that located on the lands where the "capim mimoso" were abundant on the ridge of the hills, and its presence made such lands more valuable in the past. When my grandfather had to sell part of his landholdings, he kept this land (on the east portion of the Campos Gerais) where this specie was more abundant in order to assured the best rangelands. The choice would be different nowadays, as farming land is much more valuable*" (Interview 2). The occurrence of this species, as well as the majority of the leguminous species, is indicative of grasslands under low intensity management and, currently, are very uncommon on the remnant rangelands, except on some more isolated grassland.

For many decades (since 1910s) rangeland research has been the main focus of the "Fazenda Modelo" (Model Farm), a public research facility located within the Regional Matrix, created to help landowners to overcome the economic decadence of the ranching systems after the fall of the tropeirismo cycle in the end of the 19th century. Since them a considerable stock of knowledge was generated concerning the potential of the region's rangelands for livestock production and the ranching profitability based on grazing systems. Many rangeland and livestock management techniques have been tested and some were largely adopted by ranchers, such as the adaptation of breeds to the region's ecological conditions, introduction of native and exotic grasses and legume species - particularly for winter pastures, and other strategies for food, forage and mineral supplementation.

Rangeland research developed since the mid 20th century includes: a) the nutritional characteristics of forages; b) the ecological limits (low soil fertility and the low-growth season) and the effects on forage production and quality; c) the effects of livestock on vegetation and soil properties; d) range management alternatives and the influences of animal density, rest-rotation, and fertilization of native pastures on the improvement of the quality and the amount of forage through the year; e) fire management and its implications; f) effects of rotation and continuous grazing; g) the introduction of natives and exotic pastures, soil preparation and weed control; h) species for winter cultivation and alternatives for forage supplementation, including haying and silage techniques (Araújo 1949, Postiglioni 1969, Andrigueto et al 1976, Schreiner 1972, 1976, 1977, 1991, Postiglioni & Picanço 1979, Schreiner & Leskiu 1981).

The economic crisis of the 1980s and the liberalization of the Brazilian economy in the early 1990s resulted in reduced financial support for public research and, consequently, on the generation of management alternatives for the regional grasslands. Meanwhile, the continuous division of the land by the successive generations resulted in ranches becoming too small to match the necessary large scale for profitable ranching in the global economy of the turning of the millennium. As farming systems were pulled into the existing international order, the regions' rangelands were converted to more profitable cash-crop systems, and only a small fraction of the native grasslands were retained within large farmsteads.

Lack of sustainability for continuous annual cropping on the sandy, acid, and natural low-fertility soils, typical of the grassland ecosystems of Brazil, has increased the interest and research in the development of nutrient efficient crop-pasture rotations. This strategy is also related to the shift in policies reducing price support and input subsidies for crop production in Brazil. As urban demand for crop staples and livestock products as well as road infrastructure expands, the extensive cattle ranching systems in Brazil are increasingly evolving into such mixed systems (Sere & Steinfeld 1996, Schnepf et al 2002, Kluthcouski et al 2003).

The integration of crop and livestock systems can provide some important sustainable advantages for the farming enterprise through nutrient recycling and adding economic value to the system by grazing on crop residue which would otherwise be under utilized. Many studies have documented the agronomic and economic benefits associated with the interaction of cropping and livestock enterprises on diversified farms (National Research Council 1989). Crop rotations using cover crops such as leguminous hay are readily suited to livestock operations and these rotations can also reduce fertilizer and pesticide needs and provide a valuable feed source.

Many legumes are quality hay crops. In crop-livestock operations, hay crops with a market value ordinarily lower than cash grains have economic value as a feed source in addition to their value as a source of nitrogen. Manure also becomes a valuable source of soil organic matter, nitrogen, and other nutrients such as potassium and phosphorus (National Research Council 1989). Keeping a portion of a farm's land in a cover crop may provide additional erosion control benefits and allows the planting of feed grains on more suitable land.

Diversified crop-livestock operations also have greater protection from input (feed) and output (animal product) price fluctuations and under no-tillage system can be more profitable and decrease the economical risk of farming production systems (Fontaneli et al 2006). One salient issue is how such systems can capitalize on the benefits of integration, particularly with respect to nutrient cycling and other environmental issues, while at the same time allowing for specialization of individual operators to achieve an increase in labor productivity, the essence of economic development (Sere & Steinfeld 1996).

Cattle management in the Campos Gerais has becoming an important strategy component of the summer and winter crop-rotations, a basic requisite for good management practice within the no-till farming system. More recent public and private research at regional level has been directed to the development of strategies for integration of farming and livestock systems within a major field-crop producing region. The integrated management of livestock-cropland, as currently been employed on several farms within the regional matrix, represent a new landscape management strategy and an opportunity for integration with a grassland conservation initiative and it will be further discussed as follow.

7.4 Landowners' Views of Ranching as Conservation Alternative

Landowners of the farms located on the grasslands ecosystems and within the conservation priority landscapes were interviewed and asked how they see ranching as for-profit activity on their lands and complementary to a strategy for rangeland management as a conservation framework. These open question induced interviews to follow several tracks; responses were diverse according to many factors, but they can be clustered into three main groups as function of the importance of the ranching system within the farming enterprise: a) Intensive Crop Farmers; b) Previous Ranchers; and c) Traditional Ranchers.

The Intensive Crop Farmers corresponds to the classes A and B as early described in the discussion on Land Use Systems (Chapter 3). These landowners are, mostly, descendants of the 20th century immigrants to Paraná and, in general, they are skilled farmers, which obtain high indices of productivity, manage land and crops accordingly to the best crop and soil conservation practices available, and have potential for financial investments. Their farming enterprise has been profitable and many increase their cultivated land by leasing land from ranchers, or by establishing partnerships with, on their farming activities based on integrated-crop-livestock systems (e.g., Interviews 6, 7, 10, 12, 13, 16, and member of Group 7).

Intensive crop farmers were not likely to be interested in cattle ranching as they are specialized high-yield farmers and have no traditional ranching skills. Their interest in ranching is directed to the process of leasing cropping land from ranch owners, and providing them annual winter pastures and renovated grazing lands in the leased area by the end of the contracts, usually after 4 to 5 years. New lease contract usually follows, providing a rotation system of croplands and pastures on these large properties, with evident agronomic, ecological and economic benefits for both, ranching and farming systems. Some owners also manage livestock within intensive industrial-integrated systems as a way to aggregate value on their corn production, a fundamental crop on the rotation system, but historically with low prices in the national market.

Conservation aspects of these rotation systems can be enhanced by a better land use planning at farm level based on: a) the land use potential and conservation value of individual land units, b) improved pasture management, c) the maintenance of the connectivity among remnants patches, and, d) the multiple scales that these factors interact. In the most suitable lands there is latent potential for intensifying farming practices and increasing yields and, therefore, potentially sparing land that could be placed under less intensive management or conservation. Such intensification rather than being achieved by increasing external inputs (i.e. fertilizers or pesticides), could employ poultry manure, a source relatively rich in nitrogen and phosphorus, and becoming a widespread available throughout the region, an already being employed by some farmers (e.g., Interviews 7, 10 and 13).

Most of the Previous Ranchers are descendants of the earlier Campos Gerais immigrants and many showed to hold deeper cultural and historical roots. They started to substitute crops for ranching, as their main for-profit activity, during last 20 years, as available land became insufficient for extensive systems of cattle husbandry, and intensive cash-cropping became more profitable. This was also spurred by the technological advances in the regional farming systems, and by the international demand for low-cost protein for animal feeding. The majority of these landholders still managed, small scale, diversified livestock systems, mainly, beef, dairy cattle and sheep, on the remnant tracts of grasslands within their properties (e.g., Interviews 1, 4, 5, 8, 9 and 17, and members of Group 7).

Previous Ranchers could be also identified as "Recent Intensive Crop-Farmers" and they match the descriptions of intensive farmer's classes A, B or C as described in the discussion on Land Use Systems. Therefore, farming skills, level of productivity, profitability of the farming enterprise, crop and land management, and soil conservation strategies, are variable among them accordingly to the farming capacity of the land they manage, the amount of land and capital available, and to their knowledge and management skills - their human capital. Few, among these landowners, have important sources of income outside farming activities.

Their interest in ranching is currently focused on the integrated process of cropping and livestock management; the need for winter pastures and the requirement of a winter cover crop for the summer cultivation in the no-till system, imposed the adoption of complementary farming systems. Based on the actual economic conjecture, all of these interviewees, whose main economic activity is farming activity, manifested interest in ranching as potential economic alternative as many of them, particularly on the average-seized farms, are looking for alternatives. Ranching, also, is the preferred activity of some landholders, and as previous ranchers they have the basic skills on ranching management.

Conservation aspects of the rotation systems within individual farms can also be enhanced based on same points as discussed for intensive farms. Similarly, on the best lands there is a potential for intensifying agriculture to increase yields and to free up land for less intensive uses or conservation. The potential for employing agroecological management principles however is more apparent as managed cropland are become smaller. The potential for exploring ranching as main activity will depend on easement-like incentives as will be discussed in the section 7.4 (Landowners' Views of Conservation Alternatives), and in the development of specialized markets for value added products or ecolabeling environmentally friendly livestock production, discussed in the section 7.5 (The Potential for Alternative and Organic Livestock Production Systems).

Traditional Ranches Owners are descendants of the earlier immigrants to Campos Gerais and are the heirs of the historical ranches of the past. They also have deep familiar cultural and historical liaisons with their landholdings. They are still ranching on a significant percentage of their lands (e.g., Interviews 2, 3, 14, and 26), although they had converted some grasslands to cropland in the last 20 years, as it became more profitable and as a way to integrate livestock and crop systems. Ranching skills, rangeland management, level of productivity, and profitability are generally high, as are the technology employed and the extent of the available land.

Their interest in ranching as main economic activity is evident and clearly manifested during interviews. For them, rangeland conservation depends on the behavior of future markets and on how their land will be divided in the future. They lease land as a way to get the benefits from the rotation system based on the sequence of winter pastures, croplands and renovated grazing lands, which shift temporally across somewhat large landscapes producing evident agronomic, ecological, economical, and conservation benefits for both, ranching and farming systems.

For both, previous and traditional ranchers, ranching is a clear potential alternative for the development of an integrated grassland conservation initiative. Most of the present remnant rangelands are located on areas with clear natural limits for cropping, such as land with very shallow soils, on steep slopes, extensive presence of rock outcrops or wet grasslands. A significant portion of the remnant grasslands within larger farms are locate on potential cropping land, but have been maintained because owners had chosen to keep ranching as for-profit activity. This is partly due to the potential profitability of cattle breeding on larger farms, but also tied to some cultural factors, that will following be discussed.

7.4.1 Cultural Factors and Rangeland Conservation

Many livestock ranchers take great pride in the fact that their lands have been in the same family for several generations and they aspire to maintain this tradition. *"I am the seventh generation on the same land, a tradition that backs on to 1816 and one I would like to carry on*" (Interview 2). The landowners with similar historical familiar tradition on the region expressed similar statements (Interviews 3, 4, 5, 8, 14 and 26 and members of Group 7). They have also demonstrated to have a strong sense of attachment to their rangelands, as well to ranching activities, as inheritors of the large historical ranches of the past and its associated historical and cultural values. The statements and the discussion to follow exemplify these assertions.

"My grandfather and their ancestors were tropeiros. Year after year they traveled to Rio Grande[8] *to buy mules and cows to winter the animals on the rangelands here; latter they took another journey to (the state) Sao Paulo to sale the animals. I was raised listening histories of the troops (cowboys), cattle drivers, and the long travels, journeys under bad weather, animals run away, and the companionship among the man under this*

[8] The Brazil's southernmost state of Rio Grande do Sul.

circumstances" (Interviews 2). All the *Tropeiros* descendants (Interviews 2, 3, 4, 5, 8, 14 and 26 and members of Groups 4, 5, 7 and 8) showed similar attitudes to this common cultural heritage, shared, in different scales, by all the social segments for more them 250 years on the region (Paraná 1989).

Many of these landowners are well acquainted with the regional history and three of them have been researching this subject by their own. One of them manages a rural tourism enterprise and usually talks to customers about the *tropeirismo* and region's history. Another one has been researching land ownership and divisions by municipalities on the 17th and 18th centuries and has 5 books published on the subject. He expressed a strong sense of attachment to the landscape surrounding his property: "*the extensive rangelands seen from my farmhouse are basically the same as it was in the 18th century, as it was depicted in a drawing made when the main drovers-trail crosses over the farm*". Showing the picture reproduced in one of his books he added, "*this landscape view is of historical importance and I am trying to keep it as it was since then*" (Interview 26).

Landowner's attitudes towards the ranching as a way of life are another important cultural driver that can help conservation achievements. An example of such attitudes can be found in the following statement from the same interviewee: "*I want to keep ranching as the main use of the land, even if today it is not as profitable as farming*" (Interview 26). Such statement, however, is uncommon and was expressed by a landowner whose main source of income come from other activity; majority of the landowners interviewed had farming profitability as the primary goal for their. Nevertheless, preferences for ranching over crop farming as economic activity, as well as way of life, are also shared, in different degrees, by the majority of the individuals including the new generation of landowners.

As stated by a young interviewee who inherited and managed two farms (one within the Matrix): "*I was raised in the city, but very often I spent my free time in the ranch my family own near the small village of Passo do Pupo (within the Matrix); I learned what I know about ranching and farming there. Our other farm is larger, has better soils and is much more profitable, and, despite the fact that about 75% of our total farming earnings come from cropland, I prefer to think of myself much more as a rancher then as a farmer*" (Interview 8).

Ranching as a way of living is deeply rooted in the culture of the rural people of the Campos Gerais; as already pointed out in 1820 by Saint-Hilaire (1978): "This type of work can in effect be regarded as a sort of enjoyment by the youngsters. To gallop through extensive rangelands, to throw the lasso, something they practice since boyhood, to herd the cattle, and driving them to somewhere, are activities that make dislikable any other type of sedentary work; in the moments they are not hiding horses or chasing cows and bulls, they generally rest".

The following statement also exemplifies the importance of ranching as cultural driver and raises another important subject always brought during dialogues with the larger farmsteads owners. "*I was born, raised, and I have been most of my life around ranching activities. Ranching is part of my own and family's history. It was my desire to keep the majority of my lands in ranching; it was with a pain on my heart that I had to lease parts of my land (in the early 1990s) to cropping; I was afraid of being seized for* *land reform or, even worst, having my land invaded by people of the landless movement*" (Interview 2).

As a social consequence of the country's huge economic inequalities throughout history, the pressure for land reform increased in the last two decades of the 20th century after the process of re-democratization in Brazil. "Land occupation" (a term use by the Landless Movement - MST) on very large farms with low productivity standards by the MST, became a common practice as the main strategy to push public land expropriation, as previewed by the "Land Statute" (*Estatuto da Terra* - Federal Law 4.504/1964), for landless peasants settlement, despite the violence and the risk of death commonly associated with such conflicts.

Awareness of "invasion" (a contrasting term use by the landowners and the press in general) by the MST or land seizure for agrarian reform is a still present fear among the totality of the large and medium farmsteads owners in the region and was a constant subject on interviews (e.g., Interviews 1 to 17, 26, 27, Groups 4, 5 and 7). For many decades, the extensive management of rangelands has been associated to low indices of productivity and, therefore, could be considered appropriate land for public seizure; consequently range owners in the Regional Matrix seem to be the most afraid.

The fear landowners demonstrated in the interviews, however, are in part exaggerated by the political arena that encompasses such social disputes; rangelands are generally located on shallow and less fertile soils, which should not be considered priority areas for redistribution of land. As protected areas are not available for land expropriation, conservation can be a potential theme to be addressed with landowners as a way to strengthen the potential for rangeland conservation based on the establishment of partnerships with landowners. Conversely, some of the small farmstead owners showed a more general neutral position (e.g., Interviews 20, 29 and 30, Groups 6 and 9), or even favorable positions towards the land reform (e.g., Interviews 21, and 28, Group 1 and members of Group 10).

7.4.2 Economic Drivers and Rangeland Conservation

The search for economic profitability was, as expected, a constant subject raised in all interviews and participant observation groups. Profitability has been challenged by policies reducing price support and input subsidies for crop production in Brazil. Alternatives that increase the economic potential of ranching as a conservation alternative are, therefore, an important subject to be addressed for the development of a landscape conservation program based on the building of partnerships with landowners within conservation priority landscapes.

As clearly stated by one interviewee: "*The main issue related to ranching as a way to conserve grasslands is linked to its potential profitability. Cropping systems, mainly soybeans have been much more profitable per land unit than cattle in the last two decades, and most of the farmers have already converted their rangelands. This situation, however is likely to change somewhat, as soy prices had collapsed and are likely to stay down for a while*" (Interview 8, but also Interviews 1, 2, 3, 4, 5, 7, and 13 expressed similar views). Many also understand that regional soybean production is likely to lose competitiveness in the nearby future against the intensive soybeans production systems of central Brazil. The worldwide tendency for increasing meat consumption, however, are likely to increase the demand for soybean.

The trend toward more specialized, high-yield farming systems is well established on most of the regional matrix, particularly on lands using Intensive Farming Systems and reflects technological and socioeconomic factors that are firmly embedded in recent history and agricultural policy in Brazil. Large-scale farming is more competitive because of production efficiencies (Tilman 2002) and is a limiting factor for small farmsteads. It is also becoming a limiting factor to the medium sized farms in the regional matrix. The search for economic alternatives was evident during several interviews and other instances of social data collection.

The quest for economic development is particularly challenging on the small farmsteads, but a clear alternative can be associated with low input and agroecological farming systems, that have been adopt in many cases throughout the region (Interviews 18, 19, 20, 21, 29 and 30 and Groups 1, 2, 6, and 10). Economic alternatives for medium sized farms seem to be more complicated. Such farms (often ranging from 100 to 400 hectares) are too large for the operations and labor intensive practices of organic or alternative farming systems, but are becoming too small to reach the production scale for profitability within intensive capital production systems (Interviews 1, 5, 9, 11, and 17, and Groups 3 and 7).

As stated by one these farmers: "*We managed about 350 hectares (another 150 hectares are forestland) but our land is becoming too small. Until 1998 we managed these areas as rangeland for beef and dairy production, but because of the low return of cattle on small areas, we converted the most suitable land to cropland. We reached high productivity level on soybeans and corn, but even then, it is becoming hard to be profitable. The high prices of the last few years were great, but we are aware now that* *these prices were an exception in the long term average*" (Interview 5). His opinion is endorsed by the agronomists of the Group 3: "*there is technology available, but the challenge is how to make profitable their farming activity*".

The need and search for economic alternatives is exemplified by the following statement of the same interviewee: "*We still produce milk in partnership on the land of another family member, but dairy prices are irregular and generally too low to overcome high-priced inputs. For some years we produced cheese as a way to add value to our dairy production, but again our scale was too small for profitability. Such trends are likely to make things more difficult in the nearby future. We are looking for alternatives and we would like too much to have a glimpse of what they could be*" (Interview 5).

The process of grassland conversion since the early 1970s on each farm was discussed with landowners, and it became clear that land use change is not necessarily unidirectional: "*We have been converting tracts of rangelands every year since the early 1990s; when the prices went high we converted areas that are not as productive as the best lands. With the soy prices at about 20 US dollars (by 60 Kg sack), as it was two years ago, it was very profitable to cultivate these lands. Now, with prices lower then 11 US dollars we will do the accounting after the harvest, but we are likely to increase our herd (currently of about 400 cows) and convert the less suitable lands to pastures to take the advantage of the higher fertility of these lands. Also the investment and the economic risks of beef cattle production are smaller, helping to produce an economic stability through the years*" (Interview 9).

Some landowners also indicated that on the larger and medium-sized farms: "*the integrated management of cropland-livestock systems seems to be a good alternative to* *minimize risks of both activities; integration is increasing being adopted and are likely to increase in the next years*" (Interview 8). His opinion is in agreement with several other landowners on the grasslands priority landscapes (e.g., Interviews 1, 2, 3, 5, 7 and 13). Crop-livestock integration has agronomical and ecological advantages, as discussed on the section 7.6, above).

The need for a sustainable locally-based economic development approach is fundamental to address conservation in the developing mega-biodiversity countries (Emerton 2000, Margoluis et al 2000, Bawa 2004, Tabarelli et al 2005, Rambaldi & Oliveira 2005)[9], and must be considered for a potentially more conservation-effective Regional Matrix. Despite the many limitations of Community-Based Conservation (CBC), and Integrated Conservation and Development Projects (ICDPs) worldwide, which most failed to achieve either conservation or lasting development benefits (Brandon et al 1998, Kiss 2002, Berkes 2004), the set of conditions needed for a workable ICDP/CBC (Roe et al 2000, Salafsky et al 2001), based on livestock management as a conservation approach, seem to be in place in the study area[10].

The discussions about the cultural and economic drivers opened the door to further explore the prospects for a conservation-based ranching program with those interviewed. As already noted, the conversion of croplands to ranching would be made possible with incentives or compensation for placing conservation easements on certain

[9] There is a current worldwide debate (also in Brazil) about the advantages of pure conservation oriented goals versus sustainable development approaches (e.g. Brandon et al 1998, Soulé & Terborgh, 1999, Terborgh 1999, Salafsky et al. 2001, Bretchin et al. 2002, Pretty 2002, Jeanrenaud 2002, Bawa 2004, Ericson 2006). This debate should not lead to a less fruitful discussion (resembling the SLOSS debate) as there are evident opportunities to benefit strictly protected areas from integrated sustainable development projects on buffer zones and such approaches should be applied together to a particular protected area within a bioregional setting.

parcels. In addition to direct payment, adding value to ranching systems by ecolabeling, marketing of organic beef, and support for alternative livestock systems on small farmsteads, could stimulate market compensation. Landowners' views of these alternatives and the discussion on the conservation potential of such practices will follow.

7.5 The Potential for Alternative and Organic Livestock Production Systems

Higher income, urbanization, other demographic shifts, improved transportation, and consumer perceptions regarding food quality and safety are changing global consumption patterns. Shifts in food consumption have led to increased trade and changes in the composition of world agricultural trade. Given different diets, food expenditure and food budget responses to income and price, changes vary between developing and developed countries. Diet diversification and increasing demand for better quality and labor saving products have increased imports of high-value and processed food products in developed countries. Consumer groups in developed countries have also brought attention to organic production and animal welfare (Regmi 2001).

In developing countries, including Brazil, rising income has resulted in increased demand for meat products as the demand for livestock products increases worldwide. The amount of animal products from developing countries exported to industrialized countries also has increased, stimulated by low input costs, especially land and labor. Livestock production in tropical and subtropical areas has shown itself to be competitive in the world market. The low price of imported livestock products from developing countries has reduced the profitability of livestock enterprises in the industrialized countries, where

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[10] See discussion on Section 8.4 - Cultural and Economical Drivers for a Landscape Conservation

input costs are usually higher. In the short term this trend is likely to continue and the livestock production in industrialized countries is expected to find stronger competition (Phillips 2002).

An increasing number of consumers in the developed countries are choosing to avoid all intensively produced food by purchasing organic produce. Discussions on the quality of food worldwide and have been of fundamental importance for strengthening the growing trend among consumers. Besides offering good nutritional qualities, such consumers demand food that is free of residues, contaminants or agents that are of public health concern. In the case of livestock production, they need to be produced in sustainable food chains that also respect animal welfare (Regmi 2001, Miele 2001, Phillips 2002, Kumm 2002, Sundrum 2003, Häring 2003, Vaarst et al 2005).

The market for organic food and organic livestock production in particular is promising and many authors have been addressing current market and future trends, possibilities and limitations (e.g., Regmi 2001, Neri 2001, Hardner & Rice 2002, Rosati & Aumaitre 2004). Concerning organic livestock production, there is a large difference among products (e.g., meat, dairy, eggs) and among countries. As example, the current value for the organic meat market in the US and Europe are estimated at U$ 1.7 billion; the organic milk market in Denmark is approximately 14% of the total milk consumption and more than 25% of total sales of dairy products in Switzerland is labeled as organic (Nicodemo & Schunke 2003, Rosati & Aumaitre 2004, Sato 2005).

There is a large body of research comparing organic and conventional livestock farming systems, but most of them ignore local and specific factors (Rosati & Aumaitre

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Approach.

2004). A number of studies have also documented the profitability and productivity of animal alternative production systems (e.g., Sato 2005, Häring 2003, Fernandez & Woodward 1999). These systems are generally characterized by less confinement of animals, greater use of pastures, a lower incidence of disease, and, consequently, less use of antibiotics. Such systems have long existed and modifications of traditional animal husbandry systems have been refined to take advantage of current knowledge of animal nutrition and health care (National Research Council 1989).

Sundrum (2003) has reviewed the state of the art of organic livestock farming in Europe on issues of environmentally friendly production, sustaining animals in good health, high animal welfare standards, and producing products of high quality. He argues that the benefits from organic systems are primarily related to environmentally friendly production and to the animal welfare issues, while the issues concerning animal health and product quality are more influenced by specific farm management practices than by the production method. He also pointed that organic livestock farming creates stronger demands and standards for farm management, and has a higher risk of failure.

Methods, practices, the ecological foundations, and the economic profitability of organic and alternative livestock production systems have been reviewed for Brazilian conditions and includes research on: a) beef cattle production systems (e.g., Nicodemo & Schunke 2003, Santos et al 2003, Euclides Filho 2004); b) eggs and poultry meat (e.g., Ludke et al 2003); c) dairy production systems (e.g., Fernandes et al 2001, Aroeira et al 2003); d) alternative disease control and veterinary care (e.g., Lignon & Bottecchia 2005); and e) ecological management of pastures (e.g., Primavesi 1992, 1981, Melado 2003). However there are several clear gaps that need to be improved by research on organic and alternative livestock systems (Fernandez & Woodward 1999, Aroeira et al 2003, Nicodemo & Schunke 2003, Sundrum 2003, Kristensen et al 2005).

The particularities of these productions systems as well their economic potentials and constrains are beyond the scope of this discussion. The discussion to follow is the result of the analysis of a review of the literature concerning organic and alternative livestock production systems as it pertains to the ecological and socio-cultural features of the Regional Matrix. The emphasis is on the potential of such management systems to enhance economic development based on sustainable practices and associated conservation issues. The potential for the establishment of partnerships for a landscape conservation initiative, based on the continuum approach between consensus and compromises, was also analyzed under this context.

7.5.1 The Potential for Green and Organic Beef

Brazil has the largest commercial cattle herd in the world (Schnepf et al 2001) and it might play an important role on this sector, mainly if barriers, which decrease their competitiveness, can be overcome by the supply chains on the main production areas. Brazil's cattle population has been steadily increasing over the past three decades and only recently the country became an important exporter of beef (Kluthcouski 2003, Euclides Filho 2004), becoming in 2005 the largest exporter (Valdes 2005). However, foot-and-mouth disease (FMD) is endemic to most of Brazil's cattle herd and although a few states, including Paraná, have obtained FMD-free status, the disease has been cyclic, so most of Brazil's beef exports are destined for lower-priced processing markets in Europe and North America (Schnepf et al 2001).

In spite of becoming an important player in the international beef market, Brazilian growers will have to be prepared for an increase in global competition, in overseas market subsidies, and expansion of technical barriers to consolidate its position (Euclides Filho 2004). The various sectors which form the Brazilian beef supply chain, therefore, will need to be more efficient and exhibit greater competitiveness. The effective introduction of Brazilian beef onto world economy and to increase its share of the internal market to meet the increase of beef consumption over the next decade, will depend on the ability of the production systems and other segments of the beef supply chain to provide a healthy product, to utilize the natural resources in a sustainable manner, to assure the people's welfare, and to contribute for better social equity.

Accordingly to Euclides Filho et al (2002), one of the most important steps in structuring a competitive beef supply chain in Brazil is to incorporate what they called "good practices" for beef cattle production which provides the necessary steps for producing beef according to the consumers' demands, emphasizing environmental aspects and social concerns as well as profit orientation. Under this new scenario, a holistic approach should dominate the beef agribusiness in Brazil, especially the production systems which will be structured in a sustainable basis and differentiated markets. To Euclides Filho (2004) it is necessary to organize and to align all segments of the Brazilian beef supply chain towards common objectives and goals; the main goal should be to offer high-quality food for the consumers at competitive prices.

Therefore, the quality of the final product to be offered by the beef supply chains in Brazil needs to be competitive, socially fair, environmentally safe and profitable, i.e. sustainable supply chains in the broadest sense. The "good practices" should be introduced in modules as well the orientations and/or adjustments in the most important components of the production system, including items related to choice of the area, cattle management and social aspects of the production. These are the first steps for the installation of more sustainable beef cattle that could eventually be transformed into an organic certified system (Euclides Filho 2004). To apply this approach in organic livestock farming, one should address the conversion carefully, moving forward step by step. During the adaptation process, it is crucial to dedicate a sufficient effort training personnel and establish a new way of producing beef.

Green[11] and Organic beef production is a potential international market for Brazil and is already being developed in the Pantanal region as an economic and conservation alternative to the flooded grasslands in the central-western region. Indeed, according to the Brazilian Organic Beef Association, there are approximately 210 thousand cattle head organically managed in Brazil, about 80% in the central-western states, and most destined to the international market (Nicodemo & Schunke 2003). The question of comparative production costs for organic beef under Brazilian conditions against other continents is a fundamental issue.

As part of a research project that evaluated conventional and organic beef production systems in Minnesota, USA, Fernandez & Woodward (1999) compared the performance and cost of production for beef steers raised on the farm and finished in a confinement feedlot with conventional or organic management practices. Conventionally

[11] "Green Beef" refers to a non-intensive system of beef production, mostly based on rangelands where the use of pesticides are not allowed, while the use of mineral fertilization of pastures, antibiotics, veterinary drugs and conventionally grown supplementary feeding are allowed. The term "Green Beef " has been promoted internally and in Europe by members of the Brazilian supply chain as a marketing strategy of the quality of the Brazilian beef, raised on rangelands, as healthier alternative for the meat produced on the typical intensive beef production systems of USA, Europe and Australia (Euclides Filho 2004).

finished steers had similar dry matter intake, had more rapid weight gains, better feed conversion and required fewer days on feed than steers finished using an organic treatment. Feed costs were the major determinant of total cost of gain and were lower for conventional than for the organic treatment. Using total cost of gain for conventionally finished steers as the basis for comparison, it cost 39% more to finish steers organically on these typical conditions at USA.

In contrast, the production cost of organic meat in Brazil, under favorable conditions (e.g., regional aptitude, adequate infrastructure such as transport, slaughterhouses, etc), can be lower than the conventional production systems, once it can be based on rangelands managed without the use of chemical fertilizers and without the use of antibiotic, synthetic dewormer, and other conventional veterinarian drugs or food additives (Nicodemo & Schunke 2003). As cattle in the United States and Australia, the other main international beef suppliers, are fed primarily concentrated feed rations once they go to feedlots, and permanent pasture is primarily limited to highly marginal land not easily converted to crop production (Schnepf et al 2001), there are a potential economic advantage for Brazilian organic beef in the international market.

The predominant climatic conditions of the Campos Gerais region as well as the long ranching tradition, offers an opportunity to the establishment of grass fed beef production systems and the potential to provide good quality beef year round, based on grazed pastures even though mineral and feed supplementation during the winter season, are necessary. Such conditions, if linked to a premium prices for meat products, can give a tremendous advantage for competing in the international markets where natural foods are in high demand. This combination of factors can be the economic basis for the management of region's grasslands to improve biodiversity conservation.

7.5.2 Landowners' Views of Green and Organic Beef Production Systems

Previous and Traditional Ranchers were asked how they see green and organic beef ranching as potential economic activity and as a way to manage rangelands within a conservation framework. Despite the evident potential of organic ranching to the medium and, particularly to the large ranches, the majority of the interviews admitted a lack information about what is required for the adoption of an organic livestock systems, either as an economical and environmentally friend alternative.

Some have "*heard about organic ranching in the Pantanal and in the Argentina's Pampas*" (one of the main exporter of organic beef) on rural TV programs and specialized magazines. The majority assumed that "*we don't know*" what green or organic livestock management is as "*we do not have visit an organic ranching enterprise yet*". When prompted to discuss the subject, following information concerning worldwide organic ranching and its economic and ecological potential, traditional ranchers and some of the previous ranchers expressed a clear interest on the subject. Three main issues arose during this discussion and they will be explored.

The first is related to the existence of ranching as cultural tradition since colonial times. Most of the traditional practices are the key for the establishment of sustainable ranching systems. As expressed by one interviewee: "*What you are saying about organic ranching is basically what we did in the past to raise cattle and sheep; green beef production is like what we have been doing around until few years ago*" (member of

Group 7). Regional aptitude is fundamental for the implementation of an organic ranching program. In the development of organic supply chains, preference should be given to areas in which climate conditions provide an environment requiring few adaptations (Euclides Filho 2004) and traditional breeding management systems based on pastures on grasslands have been employed (Rosati & Aumaitre 2004).

The second issue is related to the search for a more favorable economical context, as stated by one a large ranch owner: "*This idea of organic ranching can be interesting for us, as intensive investments will not be necessary if we can potentially get more financial returns from our ranching system*" (Interview 3 – Interviewees 1, 2, 4, 5, 8 and 9, also expressed similar views). Despite the high profitability of the last few years, the economic return of the intensive farming systems had sharply declined in the last year of the study. As most of the ranchers get supplementary income from the integrated cropping systems (either by cultivating themselves or leasing land to a partner farmer), the low investment necessary for cattle growing and the potentially higher returns from the ranching activity can, undeniably, be economic motivating.

The third issue concerns the discussion of the requirements necessary for the development of an organic beef ranching program. Rangeland owners generally agreed that it would not be very difficult to convert their ranching system, but such task would be challenging as it would demand several interconnected procedures. Based on the region's socio-ecological features as discussed earlier, on the discussion of Euclides Filho (2004) concerning the supply chain approach for a sustainable beef production in Brazil, on the knowledge of the landowners about the regional supply beef chain, and the opinions and attitudes they expressed in the Interviews, in order to develop a regional organic beef livestock program it would be necessary:

a) To do a detailed technical and economical analysis of the potential for producing, processing, marketing, and commercializing organic meat production. Concerning potential market, the city of Curitiba, the state capital located only 110 km from Ponta Grossa, is the easiest market to be reached. The two largest Brazilian cities, Sao Paulo and Rio de Janeiro (distant 550 and 950 km respectively), are also potential markets for a regional organic beef production chain. The most prominent international market would require a larger supply chain and would be feasible only if integrated into a larger regional or state scale.
b) To stablish a network among the several sectors that form the beef supply chain and establish partnerships among ranchers and the other chain members to the development of a common program, including the organization of compatible slaughterhouses and processing industries based on economic studies in order to add value to the farmer's products.
c) An extension program to link producers and the other components of the supply chain, for technology diffusion and training of personnel from the different sectors of the chain in the production system, which includes the "good practices" related to cattle management (choice of areas and animal breeds, pasture management, feeding strategies, animal management, animal health, nutrition management, and proper installations), the social aspects concerning rural workers and their families, and environmental conservation and certification process issues.
d) An adequate start up funding for the expenditures to initiate such a program and to stimulate producers and potential members of the supply chain to carry out the previous steps. Collect

The production of lamb on rangelands was also pointed by some landowners as an important alternative in the Regional Matrix; lamb production systems (and, by extension, organic lamb production systems) and the potential market for lamb meat was a recurrent topic when discussing livestock alternatives and conservation (e.g., Interviews 1, 2, 3, 5, 6, 8, 9, 14, 17, and 31, Group 7). Often as a secondary activity, to farm subsistence or a source of supplementary income, lamb husbandry is another culturally embedded tradition as old as the cattle breeding. Lamb meat, however, is not part of the common daily diet for the majorities of the Brazilians, and would require the development of a specialized market. Indeed this potential has been investigated by a grower, currently looking for the development of a regional lamb meat chain supply (Interview 31).

As most of the farmsteads are too small for extensive beef cattle systems, lamb breeding has been considered by some landowners as an option for income diversification as it would be less demanding on land. Lamb production was often emphasized by the medium and small farmstead's owners. Other important points raised were that "*lamb would bring a faster economic return to the farming enterprise*", "*can be more profitable than cattle per area unit*" and "*it would permit a mixed production system of cattle and lamb as they are very compatible animals*" (Interviews 1, 2, 3, 6, 8, 9, and 31) and complementary on their grazing strategies.

The potential environmental impacts of sheep overgrazing as it has occurred on the rangelands (Pampas) of Rio Grande do Sul, needs further attention. Sheep grazing is more selective and they give preference to the most palatable species, exerting a higher grazing pressure on them. Furthermore they graze closer to the soil, disturbing the plant growth tissues and thus affecting the persistence of the preferred species and favoring the invasion of weed and brushes. Almost 70 years of sheep overgrazing on the pampas for wool production was the main factor for the impoverishment of the pampas biodiversity and its range quality, which was improved only when the excessive number of animals was decreased, when the wool market was replaced by synthetic fabrics in the 1970s (Stammel 1996).

7.5.3 Alternative Livestock Management on Small Farming Systems

The potential of alternative livestock production can also be important to the small farms which are more likely to be involved in dairy, swine and poultry production systems. The dairy sector has been seriously damaged by the openness of Brazilian market to imports. Until the early 1990s, the Government, in order to complement demand and keep lower prices, controlled the domestic market by both fixing prices and importing during the low production season. After the market deregulation in 1992, the government stops to control prices and imports passed into the hands of private industries (Cordeiro 2000).

The acquisition of national dairy industries by international companies strengthened monopolies. Transnational companies like Nestle, Parmalat, and Fleischmann Royal controlled around 60% of the Brazilian dairy market and to attain the scale requirement, these companies are eliminating small farmers that do not attain the proposed scale of production within the very intensive production systems (Cordeiro 2000, Interview 5, 24, Groups 7 and 11). The increased global trade in livestock products will further threaten the livelihood of small producers because the need of intensification (Phillips 2002).

Milk production is a very important component of regional and country's small farming systems. Beyond the advantage of a continuous cash flow provided by dairy activity, cattle are an important element for the environmental sustainability of small farming. Crop rotation with forage legumes and the use of cow manure on crops and vegetable production are some of the ways that animal and crop production coexist in diversified farming systems. The options for small dairy livestock systems are likely to reduce input costs and develop specialized markets for high quality products ahead of their competitors. For example, the increased potential lifespan of the human population will encourage people to consume products that promote longevity, such as those with minimal contamination by pollutants (Phillips 2002).

Phillips (2002) has shown that the production of high quality traditional dairy products can provide an income for more people than intensive dairy production, thus helping to serve as a functional basis for rural land use. The argument that extensive livestock production cannot produce enough food for the majority of the population, do not comply with reality as such estimates rely on outdated and inadequate levels of output from the traditional systems. Based on United Kingdom conditions, this author points out that modern organic dairy systems should produce at least two-thirds that of intensive systems.

Accordingly to Sato et al (2005) in Wisconsin (USA), the organic dairy farmers sell their milk for almost twice as much as what conventional farmers receive. Organic milk production has created a niche market that has allowed many small dairy farms to stay in business during a time when profit margins are small, the dairy industry is consolidating and many small and moderately sized dairy herds are going out of business. Notable differences between organic dairy farms and conventional farms were lower milk production per cow and smaller herd size. They showed that organic dairy farms, as compared with matched conventional farms, were producing milk without increased rates of reported clinical mastitis, BTSCC (bulk tank somatic cell count), culling rate, lameness and sanitation scores. Similar quality indices of organic dairy production in Europe are also reported by Rosati & Aumaitre (2004), and Vaarst et al (2005).

Other aspects of organic dairy production are drawing increasing research attention in the developed countries and includes: a) comparison among organic and conventional dairy farming systems (e.g., Sato et al 2005), b) management of grasslands for intensive and organic dairy systems (e.g., Kristensen et al 2005), c) animal health, welfare and food safety (e.g., Vaarst et al 2005), d) marketing, animal health and product quality (e.g., Rosati & Aumaitre 2004), e) feeding and management strategies (e.g., Sehested et al 2003), f) production systems, economics and future development (e.g., Häring 2003), g) environmental aspects of organic dairy production systems (De Boer 2003), h) dairy bull calves as a resource for organic beef production (e.g., Nielsen & Thamsborg 2001). Organic dairy research has been also carried in Brazil within a production systems approach (e.g., Fernandes et al 2001, Aroeira et al 2003).

Several major analyses of swine production in confinement versus pastures and hutch systems have shown that confinement and pasture systems produce relatively equivalent returns (National Research Council 1989). Accordingly to this report, pasture or low confinement swine systems require less capital investment and can provide the highest and most consistent returns per unit of input when livestock prices are low or feed prices are high. This consistency of return is an important consideration in the long-term viability of these systems and their effect on net farm family income. Low confinement systems usually provide the greater return per animal for all types of swine operations (feeder or farrow to finish). These animals also exhibit less disease than those in total confinement facilities.

Alternative poultry or egg production systems generally do not cage the birds and usually permit uncontrolled access to feed. Commercialization of organic poultry meat and egg will demand distinct strategies. While the egg production can be sold on individual or small basis, the commercialization of meat will demand forms of associative cooperation among producers to centralize slaughter, packing and marketing of the production (Ludke et al 2003).

Although alternative production systems for poultry and swine can often be profitable, these systems are relatively worldwide few in number because of the drive for uniformity in the vertically integrated poultry, egg and pork industry. Despite the increasing research on alternative methods, in both, industrialized and developing countries including Brazil, animal science research still reinforced this trend, with little funding directed toward the understanding of alternative production systems (National Research Council 1989).

7.5.4 Alternative Livestock Production Systems and Regional Conservation

The integration of alternative livestock management and agroecological farming systems is a potential source of income to small farms and present opportunities for conservation on the forested landscapes of the regional matrix. Animal production is an important feature of organic farming and the basic principle is that livestock is part of the production system with a balance between stock size and the supporting crop production, as the livestock nutrient intake must be based primarily on home grown feed (Kristensen

2005). Animals form part of the rotation fundamental to many organic systems and are involved in recycling of nutrients through the use of animal wastes as organic fertilizer. Each component is as important as the other in contributing to the overall effect (Vaarst et al 2005).

Organic systems are designed to achieve a balanced relationship between the components of soil, plants, and animals. Animal wastes could be treated by composting to create a crop fertilizer that no longer harbors pathogens, and that is applied at appropriate rates and times and with methods that minimize nutrient leaching. This closing of the nutrient cycle decreases dependence on synthetic fertilizer production, and is more efficient when animal and crop production are combined locally; such integration is the basic principle of agroecological and organic farming systems (Lutzenberger 1980, Primavesi 1981, National Research Council 1989, Santos & Mendonça 2001, Gliessman 2001, Aquino & Assis 2005).

Organic livestock farming is not a production method to solve all problems in livestock production. It is primarily a production method for a specific premium market with high requirements for the assessment of animal welfare in a far-reaching quality of the production process, demanding high management qualification. In many parts of the world, but particularly in the central continental land masses, livestock production will be challenged by global warming. Traditional production systems are likely to survive better, as they are buffered against variations in weather (Phillips 2002).

The willingness of an increasing number of consumers to pay premium prices for organic production could enable the farmers to reduce the existing economic pressure on the production costs. As a consequence, organic farming depends to a high degree on the consumers' demands for organically produced products and for added values like biodiversity, species preservation, protection of nature, landscapes, groundwater, etc., which are closely related to the production process. For the development of organic livestock farming it is important to ensure the confidence of the consumers in organic products by realizing the self-created demands to a high degree. This requires a consumer-oriented approach in response to market principles (Sundrum 2003, Vaarst et al 2005).

In several grassland regions of the world there is a demand for knowledge about how grassland and grassland management can be used to improve landscape and biodiversity in parallel with domestic livestock management. Within the context of the regional matrix, green and organic cattle beef, lamb and dairy production systems, seems to be an important opportunity to enhanced conservation strategies for the last stands of grasslands remnants. Organic and alternative livestock systems are also particularly important to improve the economic return on the small farming systems within the Araucaria Forest region.

The intention of a landscape conservation initiative to focus on the added values of farming (e.g., an environmentally friendly production, protecting and conserving nature and the landscape), must be directed by the strengthening of an institutional framework that is flexible, that promotes the flow of information and networking, and that takes into account human and social concerns as a significant part of the overall strategy (Bawa 2004). New strategies for rangeland management and commercial marketing of free-range meat, therefore, can play a central economic role to improve the conservation potential of grasslands remnants.

A regional organic beef or alternative livestock systems project will further contribute to conservation if integrated within a broad sustainable development project. Such an extension project should include: a) the conservation of priority remnants landscapes; b) the connection of fragmented natural landscapes; c) the buffering of these areas throughout the matrix; d) incentives to development of low impact economic alternatives by aggregating value to ecologically friendly production systems and linking them to potential markets.

Chapter 8: A Landscape Conservation Approach for the Agricultural Landscapes of the Campos Gerais – Recommendations & Conclusions

8.1 Introduction

Recognizing that conservation is about people as much as it is about species or landscapes suggests a significant shift in the nature and use of science in conservation (Mascia 2003). Accordingly, this dissertation explores the development of a strategy for conserving a network of natural and restored parcels of varying sizes in the intensively managed agricultural landscapes of southern Brazil, within a region mapped as high priority for biodiversity conservation. As these lands are essentially privately owned, we are looking for the development of a dialogic-dialectical conservation approach, i.e., based on understanding landowner perspectives, assigned meanings, and collectively constructed knowledge, as the theoretical perspective for the development of a landscape-based conservation praxis.

In the previous chapters we have developed a landscape-based research framework using a coherent systematic approach that addresses critical ecological and social conservation issues in the study area; in this chapter we will provide a closing discussion centered on the landscape conservation approach explored by the research. We will start (Section 8.2) by reflecting on the validity of the conceptual framework for outlining an integrated understanding of the regional matrix as well as developing a dialectical process with stakeholders to address landscape conservation goals at the scales of the farms and land units they own or manage.

In the next sections we outline recommendations for the development of a landscape conservation praxis as a way to introduce habitat conservation techniques in the management of natural resources at the farm level. We begin (Section 8.3) by addressing the fundamental role of a conservation-oriented participatory action research process. We follow by reporting our findings from the in-depth interviews with stakeholders concerning the region's cultural and economic features and by addressing the challenges and opportunities represented by these landscape components as potential drivers for a landscape conservation approach (Section 8.4). Drawing on the Habermas' concept of communicative rationality of creating conditions that approximate the "ideal speech situation" (Habermas 1987) we, then, look into the observed coexistence of a plurality of viewpoints among landowners. This leads us to a landscape conservation praxis and a consensus-negotiation model (Section 8.5).

Conceiving of landscape conservation praxis as "located somewhere on a continuum between consensus-oriented processes in the pursuit of a common interest and compromise-oriented negotiation processes aiming at the adjustment of particular interests" (van den Hove 2006), we will analyze the landscape conservation alternatives discussed on Chapters 6 and 7 as they related to the features of land units mapped at farm scale, and to the sociological aspects linked to the Land Use Systems (Section 8.6). The chapter is then concluded (Section 8.7) by summarizing key findings about the landscape conservation approach in the study area, by outlining recommendations for the development of a conservation action research and extension program, and by addressing the role of landscape conservation researchers as reflective practitioners that put a landscape conservation praxis into action.

8.2 Evaluating the Landscape-Based Research Framework

A pragmatically conceived landscape conservation approach needs a creative framework to define the most relevant research questions and the epistemological approach to address them. It would be reductionist to consider any single concept, approach, or methodology as the panacea methodology. The research framework we have explored (Figure 1.2) was iteratively developed, reviewed and refined throughout the development of the present Case Study. It is integrative in nature and multiscalar in focus; it is broad and exploratory, and uses multiple lines of converging evidence from several different but related disciplines and methodologies to address conservation issues in the agrolandscapes that are the focus of this study.

The relevance of the research framework for conservation purposes relies on its holistic perspective, potentially combining ecological, social, and cultural data into a complementary framework that better defines relevant conservation issues and the alternatives to address them. Every landscape, within a given region, is shaped by a specific combination of natural and cultural factors (subsystems). In our landscape study, knowledge derived from every subsystem at different scales contributed to the comprehension of the whole, as we discuss below.

The Landscape of Conservation

In the review of the literature (Chapter 2) we draw on the concept of landscape understood as the synthesis of ecological and cultural phenomena, and outlined a systemic framework to analyze the regional landscape mosaic. Guided by the human dimensions of natural resources literature, we set a theoretical perspective upon which we developed a landscape conservation research framework with a dialogic-dialectical component.

The role of science in the conservation of biodiversity is obvious and critical, but that science must be interdisciplinary and theory-grounded research that integrates biological and social science (Szaro 1996). Although scientists and managers have traditionally had a strong expert advisory role, innovative dialectical processes will necessarily relocate some of that decision-making power by including new viewpoints and types of knowledge systems. As such "good science" becomes a more participatory process with open dialogue and paradigmatic debate (Song & M'Gonigle 2000).

Using this approach, researchers can provide information in a balanced way, which improves landowners' knowledge of the issues and allows their attitudes to evolve and their decisions to be based on richer information, while helping practicioners to better understand needs and wants of landowners. This dialectical process helps to build reciprocal trust. The decision-making framework then becomes a process that gives individuals and institutions an opportunity to exchange perspectives and reconsider their objectives in light of new information (Tognetti 1999).

In the postmodern scientific paradigm[1], there is openness to qualitative diversity, to the multiplicity of meanings in local contexts, and knowledge is admittedly shaped to some degree by the viewpoint and values of the investigator. Human reality is understood as conversation and action, and knowledge becomes the ability to perform effective actions (Kvale 1996). As a post-normal (Funtowicz & Ravetz 1995, 1997) rather than positivist approach to knowledge, landscape conservation science requires that the knowledge constructed for conservation decision-making reflects the pluralist and pragmatic context of decision-making, while striving for the rigor and accountability that earns scientific knowledge its privileged place in the sociopolitical arena where conservation decisions are made (Robertson & Hull 2001). "The legitimation question of whether a study is scientific tends to be replaced by the pragmatic question of whether it provides useful knowledge" (Kvale 1996).

As we concluded in the review, to address conservation biology in the fragmented regional mosaic it is necessary to develop a landscape science able to conjugate the development of conservation practices and eco-friendly land management strategies, by addressing such issues on a real landscape that includes intensive farming and scattered fragments of remaining natural vegetation. It is necessary to apply available scientific knowledge and "common sense" to develop a landscape-based conservation praxis structured on the development of partnerships with stakeholders, on sustainable landscapes that are able to deliver multiple ecosystems services including farm commodities as well as other social and environmental goods such as jobs, recreation opportunities, water quality and biodiversity protection.

Setting the Regional Conservation Landscape

In Chapter 3, we added to the existing information about the Campos Gerais ecoregion, highlighting the landscapes of the Regional Matrix and outlining the biophysical and human context on which conservation planning and landscape management should be developed. The current state of landscape fragmentation in the regional matrix was described. Remnant habitat patches are mainly small and isolated with most being located within an intensive farming landscape and therefore, often an

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[1] See discussion on Section 2.3.4 - Conservation Science and Postmodern/Post-normal Perspectives

inhospitable context. In the regional mosaic, remnant patches located along the Devonian Escarpment were mapped and recognized as having unique conservation potential, being the last examples of the region's native grassland biodiversity.

Rangeland conversion to intensive cropland is a relatively recent phenomenon in the region, although it has been a continuous process since mid 1960s and is related to the increasing global demand for farming commodities. Rising soybean prices in the international market in late 1990s and early 2000s have made this crop very profitable and led the last wave of grasslands conversion, including areas located on very fragile soils and on several important conservation sites. Soybean cultivation on the region is likely to increase and expand into the few remnants, until the global supply exceeds demands, bringing prices down, and determining future changes in the land use systems.

Under these circumstances, an integrated landscape conservation strategy for the regional mosaic was outlined aiming to: a) minimize further landscape fragmentation and habitat destruction; b) effectively conserve and enhance the quality of existing habitats; c) recover and expand habitat areas under protection; d) improve structural and functional connectivity among remnant patches; e) minimize ecological impacts from surrounding land uses.

Based on the landscape research framework outlined in Chapter 4, a model was proposed for selecting conservation priority areas in the Regional Matrix and connecting them structurally and functionally with the network of rivers and streams. The small amount and the spatial distribution of remnant patches indicated that conservation strategies should include an integrated network of protected areas and regional landscape priority patches, complemented by more compatible management practices in the matrix where they are embedded, and by the existing riparian network, as critical units integrated within a nature reserve system.

In such nature network system, the interactions among reserved areas, remnant patches and river corridors with legally prescribed buffers are as important as the patches. Natural resource reserves are not the goal, but are important pieces in a mosaic where every piece counts. Planning of the whole landscape mosaic is required to enhance wildlife and protect biodiversity (Franklyn 1993, Forman 1995, Noss 1996, Lugo & Brown 1996, Bawa et al 2004, Rambaldi & Oliveira 2005, Tabarelli et al 2005).

Another fundamental issue for addressing biological conservation in the study area is the fact that priority remnant patches are mainly found on private land. Consequently, the establishment of partnerships with landowners for developing landscape conservation strategies was identified as the primary strategy for planning and implementing a system of reserves. Conservation plans and actions, therefore, must take into account economic production activities and the key cultural values and meanings stakeholders may attach to the landscapes they manage.

Accordingly, we analyzed the multiple causes and consequences of habitat degradation in order to search for alternatives to halt and reverse such processes at local and regional scales. A vision of conservation emerged that expanded the focus from conserving the remaining patches of natural habitat to the inclusion of eco-friendly management practices able to minimize impacts to biodiversity. This process of analysis provided a suitable foundation for the identification and prioritization of conservation problems for the agrolandscapes of the matrix, as well as landscape conservation goals that guided subsequent research.

Whether the designed nature reserve system can be successful within the regional context of intensive farming systems will largely depend on how well conservation initiatives can orchestrate the actions of the disparate actors that affect land use within landscapes. Strengthening the management of the existing protected areas (VVSP and three small Private Reserves) while creating the array of new protected areas of sufficient size needed to conserve biodiversity (including the newly created Campos Gerais National Park), are top priorities. Similarly, strengthening alliances with other land managers, especially farmers and landowners, as well as other stakeholders, will be vital to ensure the long-term viability of the region's last stands of natural vegetation.

The Dialectical Construction of Landscape-Based Conservation Strategies

Building on the preceding, the next research question was how to plan and carry out management on such privately owned, multipurpose lands to minimize loss, maintain, and even enhance biodiversity? Accordingly, in Chapter 5 we addressed the methodological procedures for developing participatory strategies to construct a landscape conservation praxis. In Chapter 6 we utilized conversations with landowners to analyze participatory strategies and potential conservation alternatives for the remnant patches and to improve connectivity throughout the landscapes. In Chapter 7 we utilized the participatory approach with landowners to construct strategies for minimizing impacts from land use practices, with emphasis on the management of rangeland as an eco-friendly land use alternative.

We acknowledged, and also made clear to interviewees, the conservation goals of our research and, during the interviews, we aimed to approximate an "ideal speech situation, which allows people to come to a rational consensus about how to conduct their common affairs" (Habermas 1987, van den Hove 2006). Although most of the data was collected with and from landowners, as the managers of the agrolandscapes of Campos Gerais, we came to recognize many other institutions, public or private, as stakeholders in local and regional conservation matters. We also have to take into consideration that conservation priorities must be analyzed on different scales, ranging from the broad regional/biome prioritization efforts adopted in Brazil for defining national conservation policies to the farm/local scale where farmers make their land management decisions.

8.3 Landscape Conservation and Participatory Action Research

During the last three decades, the practice of biodiversity conservation, particularly in the tropical regions of the world, has tried to focus on linking the goals of conservation with the goals of development through sustainable use of natural resources (Ericson 2006). Rather than excluding and relocating local people to create parks, such strategy supports engaging local populations in protected area management based on the theory that long-term conservation efforts have a greater chance of success if conservation activities involve local people and provide opportunities for improvement of their economic well being (Pimbert & Pretty 1995, Schwartzman et al 2000, Ericson 2006). In fact many local level conservation organizations embrace a dual mission that seeks to conserve biodiversity and promote sustainable development.

This linkage has inspired heated debate within the conservation community in the last decade. Many authors (e.g., Brandon et al 1998, Terborgh 1999, Kiss 2002) have consistently argued that the integrated conservation development projects (ICDPs) and other community-based conservation (CBC) approaches to conserve biodiversity outside PAs have, in most cases, failed to achieve either conservation or lasting development benefits. Many others (e.g., Salafsky et al 2001, Bretchin et al 2002, Pretty 2002, Jeanrenaud 2002, Berkes 2004, Ericson 2006, Sheil et al 2006) have discussed the actual and potential conservation benefits that have arisen from participatory approaches to conservation and development.

Two main positions have emerged from this debate (Berkes 2004); one holds that the failure of community conservation is not due to the weakness or impracticality of the concept, but rather to its improper implementation, especially with regard to the devolution of the authority and responsibility (Wallace et al 2005); the second holds that the conservation and development objectives, both important in their own right, should be delinked because the mixed objective has not served either objective well. Kiss (2002) argued that project-based approaches have been failing to address the true causes of biodiversity loss and conservation at the scale on which they operate.

This dilemma is part of the larger debate of preservation versus sustainable use and the participation of rural populations in decisions that affect their lives (Berkes 2004). Despite the validity of the arguments from both sides, integrated conservation strategies have reshaped the way many conservation institutions and practitioners think or interact with the people living around protected areas (Ericson 2006). Kiss (2002) has pointed out that the focus of the conservation community has been too much on carrying out project activities and too little on creating incentives for conservation participation. Drawing upon these arguments, we are back to our central research question of how can nature conservation practices be tackled on the agrolandscapes of study?

Bawa et al (2004) have called the attention of the conservation community to the practice of conservation: "our technical abilities and knowledge have outstripped our ability to recognize and support the structures necessary for the practice of conservation. Many different approaches may work under different local conditions, but the common denominator among successful approaches should be the strengthening of an institutional framework that is flexible, that promotes the flow of information and networking, and that takes into account human and social concerns as a significant part of the overall strategy". Accordingly, long term conservation goals in a regional mosaic may best be achieved by a strong focus on building resilience within ecological and social systems.

Complex environmental issues create what Ludwig (2001) has called "wicked problems", those with "no definitive formulation, no stopping rule, and no test for a solution, problems that cannot be separated from issues of values, equity, and social justice". He argues that where there are no clearly defined objectives and where there are diverse, mutually contradictory approaches, the notion of an objective, disinterested expert no longer makes sense. Hence, a new kind of approach to science and management must be created through a process by which researchers and stakeholders interact to define important questions, objectives of study, relevant evidence, and convincing forms of argument and decision structures (Berkes 2004).

To deal with the implications of complex systems, working partnerships can be built between managers and resource users. This is done, for example, in adaptive approaches to management, which recognizes as starting point that information will never be perfect (Szaro 1996, Holling 2001, Wilhere 2002, Jackson et al 2005). As put by Berkes (2004) "the use of imperfect information for management necessitates a close cooperation and risk sharing between the management agency and local people. Such process requires collaboration, transparency, and accountability so that a learning environment can be created and practice can build on experience. This approach, bringing the community actively into the management process, is fundamentally different from the command-and-control style".

Ericson (2006) has argued that "when employed as a research method the participatory approach is perhaps more powerful than other methods of social science research because it gives local people a role in telling their own story". However, the conservation participatory approach is meant to go beyond being a means to facilitate the collection of data or the achievement of specific objectives. In its broadest form, the participatory approach is participatory development that it helps move people towards decision. It is an end in itself, meant to increase the involvement of people in decision-making over their own lives, enabling all people affected by the issue to have their voices heard and to be actively engaged in research activities.

Similarly, Stringer (1999) has developed the argument that "community-based research enacts localized, pragmatic approaches to research, investigating particular issues and problems in particular sites, at particular moments in lives of interacting individuals and groups". Action research, therefore, requires place-based models because understanding the dynamic interaction between nature and society requires case studies situated in particular places (Berkes 2004). Its purpose is to provide participants with new understandings of an issue they have defined as significant and the means for taking corrective action.

Change is also an intended outcome of community-based action research: "not necessarily the revolutionary changes envisioned by radical social theorists or political activists, but more subtle transformations brought about by the development of new programs or modifications to existing procedures" (Stringer 1999). Action research can also be landscape ecological research (Picket et al 2004, Bacon et al 2006) and, in the case of conservation and development initiatives, an action research approach can help link both social and ecological research questions. Therefore, changes in land management "will derive from the here-and-now ideas and concepts taken from the taken-for-granted life world of the participants" (Stringer 1999).

A landscape-based conservation action research, therefore, is ultimately a search for meaning, as "it provides a process or a context through which people can collectively clarify their views of the conservation issue faced and formulate new ways of envisioning their situation. In doing so, each participant's taken for granted cultural viewpoint is challenged and modified so that new systems of meaning emerge that can be incorporated into the texts, rules, regulations, procedures, practices and policies, that govern professional and community experience" (Stringer 1999).

The approach to research suggested by participatory action research is implied within the methodological frameworks of Guba-Lincoln (1989). Their dialogic, hermeneutic (meaning-making) approach to evaluation implies a more democratic, empowering, and humanizing inquiry approach (Schwandt 1998), which is the ideological basis for landscape action research (Stringer 1999). Therefore, the products of a landscape conservation action-research should not be only the written reports and academic publications, but also practice script – plans, procedures, models, maps, and so on – that provide the basis for reformulating practices, policies, programs, and services for enhancing landscape conservation opportunities. In the process, we can increase the potential for creating truly effective programs that will enhance the conservation of the landscapes we work with.

Fitzgerald (1999) had suggested that "before any project or community-based program can get started and meaningful action initiated, local people must feel a genuine need to improve or change the existing situation". Without this recognition, a landscape initiative will be perceived as having little relevance to local people and will be given low priority, or at worst, will be resisted as interference by outsiders. Pretty (2002), while acknowledging the fundamental role of building social capital for conservation purposes, has warned the danger of appearing too optimistic concerning the use of participatory approaches with local groups and their capacity to deliver economic and environmental benefits.

8.4 Cultural and Economical Drivers for a Landscape Conservation Approach

One important observation, continuously emerging in every interview, was the fact that it was much easier to have a dialogue type of conversation when the focus was related to the economic aspects of the farming enterprise or related to some cultural and historic subjects. Conversely, the questions that centered on conservation related issues were always more challenging. Economic profitability has been a challenge for the farming enterprise in Brazil, particularly to the small and medium farmsteads. Economic issues and the search for profitability for their farming enterprise was constantly raised during interviews and observed during other instances of social data collection.

The dialogues concerning the history and other cultural components of the regional landscape were much easier subjects to explore. Some interviewees seemed to be pleased to be sharing their knowledge about some particular historical or cultural issue. They were more confident in the interviews when the theme was the "*tropeirismo*"[2] or their experiences of the ranching practices of the not so distant past. When discussing such issues the conversation took an easygoing direction, and was noticeable as an attitude shift by the interviewees; conversation often moved around the periphery of the central theme.

When time was not a constraint, dialogues concerning cultural (e.g., the history of the farm settlement), or economic aspects (e.g., farming profitability) were used as a way to further explore local knowledge and to gather related cultural and ecological landscape information. Whenever landowners were willing to share information, or raised or emphasized a relevant issue or question, the conversation often led to other relevant issues (e.g., their personal experiences on farming themes like current and past land management practices, dealing with resistant weeds, soil fertilization, pest control, commercialization, market for livestock production, current and past observations of wildlife, dispersal routes and eventual interactions with them, etc).

Such information revealed values, attitudes, and the meanings attached to the landscapes, that later became relevant for the development of conservation and eco-friendly landscape management strategies "to soften the matrix". Cultural, historical and economic questions were employed in the majority of the interviews (except in two cases due to time constrains) as a way of establishing rapport and trust with landowners. As the

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[2] See also discussion on Section 3.3.1 - Landscape Fragmentation: A Brief Historical Review.

ultimate goal of this project is to develop conservation strategies based on the partnerships with stakeholders, trust building is considered a basic first step in any dialectical approach to developing landscape conservation strategies. Consequently, some interviews, particularly with the traditional ranchers, were very long, taking several hours of dialogues (> 4 up to 11 hours).

Farmstead owners showed varying degrees of reserve when discussing conservation themes, particularly regarding the creation of the National Park. The following statement, from a large farm owner (Interview 2), typifies these reservations and the wicked nature of conserving or restoring remnant lands: "*we (landowners) are between two enemy fires, the reds and the greens; the "red" relates to the demand for land reform in Brazil, the strategies of land squatting adopted by the MST*[3]*, and the production indices required by INCRA*[4]*; the "green" issue is more recent and comes from the environmentalists, environmental law enforcement officials of IAP and IBAMA*[5]*, and from the actual policies of the MMA*" (Brazil's Ministry of the Environment).

Many of the interconnected issues that made it hard to discuss conservation are reflected by this statement. Most of the interviewees mention that corruption is a problem in governmental institutions including environmental agency's officials. Some perceived conservation and environmental regulations just as another way to increase taxes, fees, and bureaucracy. Such opinions emerged from many of the key informants (e.g., Interviews 18, 19, 24, and 25) as well as in all the Groups meetings. The "*inefficacy of the public institutions to correctly address environmental issues*" was supported by

[3] The Landless Movement – MST, in Portuguese: *Movimento dos Sem Terra*

[4] INCRA (Instituto Nacional de Colonização e Reforma Agrária), the federal agency responsible for the land reform program.

[5] Respectively, State of Paraná and Federal Environmental Institutes in charge of law enforcement.

innumerous local examples raised by them (e.g., the federal prohibition of hunting and the need to control the increasing populations of capybara, which, by lack of predators, are damaging crops).

Family farmers with smaller holdings often pointed out that environmental laws are just enforced for them but that: "*large farmstead owners can pay officials to cover up irregularities, or contract lawyers to lessen fines and obstruct judicial processes for many years*". Another common observation was that: "*It is very hard for us to get a permit to cut a few trees for fence rebuilding or house repair, while on large farmsteads clearing of large areas for cropping or intensive forestry are still practiced. How can they get the permit*" (Interviews 18, 19, 20, and 21, and members of Focal Groups 1, 10, and 11)?

The ideological dispute over property rights versus collective and social rights is a theme that is becoming important in the contemporary Brazilian society. Since early in the country's history, small groups of large landowners have exercised ample discretion in deciding about the private uses of their typically huge *latifundia* or plantations, not to mention their ability to influence public decisions about law enforcement, taxation, military campaigns, land ownership, and so on. "This trend, combined with slavery and with the immense size of the colony and nation, fostered a permanent, slow-moving, loosely controlled land and resource frontier dynamic, in effect until the present" (Drummond & Barros-Platiau 2006).

The concentration of wealth in Brazil is among the highest in the world (World Bank 1998) and it is well expressed by the extremely concentrated land distribution pattern (IBGE 1998). Land tenure in Brazil, as well as on the study area, is symbolically associated with economic and political power: since colonial times, such values have been deeply rooted in the country and regional history and culture (Pinheiro Machado 1968, Padis 1981). The ongoing process of the country's re-democratization has been challenging rooted structural powers and their institutions as the demand for social justice, land reform, and environmental protection, including biodiversity conservation and protected areas, increases. The dispute over the PAs designation and how it was regionally conducted in the Campos Gerais is just one example of this.

The priority areas for conservation in the Campos Gerais (MMA 2004, 2006) as well as those mapped in the Regional Matrix by this study (Figure 4.2), are mostly located within the large farmsteads and addressing conservation related issues is particularly challenging with this group of stakeholders. The general disenchantment with and low confidence in public institutions is a generalized trend in the majority of the country; consequently initiatives for environmental control and conservation are likely to be seen with great reservation by the majority of the landowners.

Therefore, the next step for the development of a regional landscape conservation initiative should be the delineation of a strategy to overcome this general perception. Trust-building, as early noted in this chapter, "must be based on the strengthening of an institutional framework that is flexible, that promotes the flow of information and networking, and that takes into account human and social concerns as a significant part of the overall strategy" (Bawa et al 2004). Mutual confidence must be established and it takes time and continual effort to build trust and understanding. It is clear that any trust building within landscape conservation initiatives must include regional cultural and economical drivers.

Understanding the meanings that farmers attach to the agrolandscapes they live and manage, and how they are different from the meanings of other social groups within the regional matrix, can shed light on the challenges and opportunities that society faces in conserving the environment. Information about these meanings can help policy makers and planners design conservation initiatives for biodiversity that take into account people's existing knowledge and capacities. It can also help to reduce conflict in conservation (Fischer & Bliss 2004). However, in places of high biodiversity level and rapid land use change, like the study area, just understanding and theorizing on such meanings or giving advice to public agencies is not enough.

Social and economic trends of such regions are pushing towards land use intensification. We ought, therefore, to center attention on the implementation practices, which means that human beings must design action in concrete situations to make differences in the real landscapes. Hence, a landscape conservation praxis based on a continuous process of creating partnerships, negotiating and dialectically constructing new landscape meanings with stakeholders on multiple scales, is required if the intent of progressive laws is to be realized. As clearly articulated by one landowner: "*a cooperative local framework, that includes municipalities, federal and state services, cooperatives and research institutions, putting emphases on local issues, creates the best opportunity for the conservation alternatives in this region*" (Interview 7).

8.5 A Landscape Conservation Praxis: Between Consensus and Compromise

Environmental phenomena present physical characteristics of complexity, uncertainty, large temporal and spatial scales, and irreversibility (Ravetz & Funtowicz

1999, Ludwig 2001). Regardless of whether we focus on habitat loss, over-exploitation or alien invasions, the important question in a conservation praxis is how well our responses match the nature and scale of the problem at hand (Kiss 2002)[6]. "To address conservation we must recognize that the forces behind biodiversity loss operate on many geographic scales, from global to local, and involve the actions of huge numbers of people and institutions. Local communities are sometimes the direct consumers, sometimes only act as agents for distant buyers, and sometimes are only indirectly involved" (Ibid).

As put by van den Hove (2006), "the physical characteristics of environmental processes have consequences on what can be called the societal characteristics of environmental issues, which include: societal complexity and conflicts of interests, transversality, diffused responsibilities and impacts, no clear division between micro and macro-levels, and short-term costs associated with potential long-term benefits. In turn, these physical and societal characteristics determine the type of problem-solving processes needed to tackle environmental issues". The inherent ecological and societal complexity of environmental issues has also important consequences regarding the landscape conservation processes that can be called upon.

"Living in society we are faced with the existence of an irreducible plurality of standpoints, and the problem of coexistence of people with potentially irreducible standpoints becomes central. Life in society can be described as the inevitable and dynamic construction of coexistence" (van den Hove 2006). An important consequence of the irreducible plurality of standpoints is that the existence of divergent interests must

[6] See also discussion on Chapter 2.2.5 - Landscape Analysis and the Importance of Scale

be recognized and decision processes will have to deal with judgments that may be contradictory, without always hoping to reconcile them.

People have different value systems stemming from their different standpoints and no single value system can be defined as superior to, or encompassing all other value systems[7]. These different values may lead to divergent interests. Value disputes are also about conflicts of interests and the distribution of power, and, consequently, modes of resolving disputes through negotiation will also be required (Ludwig 2001, Song & M'Gonigle 2001). "Consensus is far from always being achievable and compromises will have to be found. Hence, most participatory processes will include some degree of cooperation and some degree of conflict" (van den Hove 2006).

While this reasoning can be applied to scales ranging from local communities to the global society of the 21st century, participatory approaches have the potential to meet problem-solving requirements for a landscape conservation approach at local and regional scales. "A participatory process for conservation emerges as a consequence of the acknowledgement of an irreducible plurality of standpoints that stems from the complex nature of the issues at hand and of the necessity of society coexistence" (van den Hove 2006).

To address the conservation of biodiversity at farm and landscape scales, we explored a dialectical approach for the construction of conservation alternatives. From information collected during interviews and participant's observations, we realized the coexistence of a plurality of standpoints among stakeholders as it concerns the land they manage and potential landscape conservation alternatives. In the interview setting we

[7] See also discussion on Chapter 2.3.1 - Social Values and Landscapes

always attempted some form of exchange of knowledge on which to build conservation alternatives for the land units and patches under analysis, according to the different standpoints or worldviews of landowners. These landowner standpoints are also, to some extent, reflected in the way their land has been managed.

Study findings allow us to argue that to achieve conservation outcomes in the intensive managed landscapes of the regional mosaic, some degree of facilitation and coordination among stakeholders is unavoidable; in a landscape conservation approach, communication becomes central. Not just any form of communication will do the job: communication is needed that utilizes an interactive process that brings together the differing views of stakeholders.

Many normative models of participation for addressing environmental issues have been grounded, at least partially, on Habermas' communicative rationality (Jacob 1997, Sköllerhorn 1998, van den Hove 2006)[8]. The appeal of Habermas' theory is that it is built on an understanding of social phenomena as intrinsically inter-subjective and it proposes an interactive rationality model which recognizes the inseparability of communication and the social world. The Habermas' model asks that certain key elements are integrated in the design of participatory processes.

As already noted, Habermas (1987) distinguishes between discussions in which participants strive to apprehend a common interest and reach consensus, and negotiation of a compromise in which participants strive to conciliate individual and diverging interests. The ideal of consensus that he proposes applies primarily to the rational search for universal norms (Habermas 1987). He speaks of creating conditions that approximate

[8] See discussion on Chapter 2.4.6 - Theory of Communicative Action.

the "ideal speech situation", which would allow human beings to come to a rational consensus about how to conduct their affairs (Argyris et 1985, van den Hove 2006).

When dealing with coordination of actions and the practical issues of landscape conservation, if we maintain the position that legitimate standpoints are not always reconcilable, the consensus model, as articulated by van den Hove (2006), proves insufficient. However, it should not be rejected as it may still provide powerful guidelines for the design of participatory procedures. Rather, the consensus model should be combined in some way with a negotiation model. Hence, participatory approaches should be thought of as being on "a continuum between consensus-oriented cooperation in the pursuit of a common interest and compromise-oriented negotiation aiming at the adjustment of particular interests" (van den Hove 2006).

"At the purely consensual end, one finds the ideal discursive situations - according to Habermas, the only suitable ones to assess the validity of universal norms. At the conflictive end one finds pure 'zero-sum' negotiations in which one gains what the other loses. In between we can identify all sorts of processes in which cooperation and conflict can coexist" (van den Hove 2006). It should be noted that neither of these ideal-types do exist as pure types in real life. "Participatory processes should not aim at dulling dissent and conflict but rather at progressively making them explicit. The issue is how to design the participatory process to ensure that conflict is as much as possible a driver for the emergence of creative solution rather than a hindrance to the resolution process" (ibid).

As put by Carolan (2006), "ultimately, it is only through debate and deliberation that these conflicting values and beliefs can be assessed and weighed by decision makers.

The solution, then, to the issue of how to do conservation in a way that allows it to be viewed as historical subject and ecological object, lies in the incorporation of multiple 'expert' voices from inside and outside of the academy".

"In this regard it is important to stress that negotiation in a complex social context is often far from the mere balancing of (once and forever) given preferences and power relations predefined outside the negotiation process. Rather, it can be understood as a dynamic process in which preferences are endogenously constructed during the process itself, and where power relations are susceptible to change. Such an enlargement of the concept of negotiation allows for going beyond a vision of compromise solely in terms of divergent and irreconcilable interests" (van den Hove 2006).

"Not only the cooperative but also the negotiated dimension of participatory processes corresponds to a learning process and creation of meaning can emerge. This is made possible through the intersubjective relation which allows for a restructuring of preferences and the potential emergence of original solutions. So the practical challenge in designing a participatory process for landscape conservation approach lies in the combination of consensus-oriented cooperative aspects of participation with compromise oriented negotiated aspects (ibid)".

Building upon these considerations, in the next section we will discuss the landscape conservation alternatives derived from the application of the cooperation-compromise model in the regional matrix with stakeholders. As the land is essentially privately owned, each individual farm had a key position in the process of negotiating conservation alternatives. As land management decisions at farm level are based on land units[9], conservation dialogues with stakeholders, therefore, were directed to address the conservation of individual land units, within individual farms.

8.6 Land Use Systems, Land Units and Landscape Conservation Alternatives

The mapping of land use systems[10] reflecting environmental and socio-economic factors throughout the Matrix proved to be a powerful instrument to address landscape management issues at relevant farm and regional scales, for enhancing the conservation potential of remnant patches. The economic component of each class of land use systems (LUS), as it challenges the profitability of the farming enterprise, and their socio-cultural components are potential topics for rapport building, conservation negotiations, and establishment of partnerships with landowners. As earlier argued (Chapters 6 and 7), such dialogues can lead to the improvement of land management practices and can also result in effective alternatives for the conservation of the remnant patches.

The map of land units, produced for each parcel on the scale of 1:10.000 (see Figure 5.4 for examples), was also an essential component in the process of addressing conservation strategies with stakeholders. During interviews, we (the researcher and landowner) assessed together the orthophoto maps and our previous observation[11] that such landscape elements would be easily recognizable by landowners was validated. By recognizing mapped land units, boundaries, and discussing related landscape meanings (e.g., soil fertility, erosion risk, productivity of the fields, past land management

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[9] See also discussion on Section 2.2.2 - Patches and Land Units: Fundamental Concepts for Landscape Planning and Management.

[10] See also discussion on Section 3.3.3 – Land Use Systems and Remnant Patches

[11] See Section 5.2.2: Mapping Land Units at Farm Level

practices, scenic potential, and place attachment), common ground for negotiating landscape meanings (Williams & Paterson 1999) was made possible.

When necessary, field trips were made to review boundaries and discuss inherent and instrumental properties of land units (e.g., carrying capacity and conservation status). Field trips with stakeholders were used during some interviews (or carried out before the interviews in the other instances of data collection), to stimulate further discussion and to start building trust. Such interactions with stakeholders were aimed at improving the dialectical construction of conservation alternatives.

Utilizing an array of conservation tools available in Brazil for achieving specific landscape conservation goals (summarized in Table 8.1), farmers were asked about their willingness to implement these conservation and/or restoration practices for each mapped land unit. Using their responses, we classified land units accordingly to the likelihood of being able to reach consensus-oriented cooperation or compromise-oriented negotiation, regarding future land use change, and conservation or restoration of those units.

In Figures 8.1a and 8.1b, examples of land units' conservation likelihood are depicted spatially for the farm/local scale (1:10.000). Land units were classified by their current use (remnant or cultivated) and interpreted by their productive potential (low or medium to high). Together, these factors enable us to expect: a) consensus on low conflictive situations (e.g., on APPs as defined by the Forest Code and remnant LUs on low-farming capacity); and, b) negotiated compromises on more prized or valued areas (e.g., on remnant LUs with higher farming capacity and on managed LUs with low-farming capacity). The conservation of remnant or managed LUs with higher farming

Table 8.1: Summary Evaluation of Landscape Conservation Tools

Landscape Conservation Tools[1] **Enabling Legislation**	**Major applications in the Regional Matrix and Priority Landscapes**[2]	**Potential to achieve specific Landscape Conservation Goals**[3]					**Recommendations for a Landscape Conservation and Extension Program**[4] **Potential Funding Source**
		1	**2**	**3**	**4**	**5**	
The Forest Code Federal Act 4471/1965 State-based enforcement	To set at least 20% of the rural landscape as Legal Reserve (LR); To set springs, riparian areas, and steep slopes as Permanent Protected Area (APP).	**	**	**	***	**	Set a GIS data-base and monitoring of compliance; Negotiate restoration and compliance at farm level; Law enforcement.
SISLEG State Decree 387/89 and 3320/2004	Forest Code enforcement; Map LR and APP at farm level; Design of Nature Reserve Networks; TDRs-like cross-property compensation of the LR.	**	**	***	***	*	Project-Based Public and/or Private Funding; Landowners are required by the SISLEG to map georeferenced LR and APPs.
Private Natural Heritage Reserves – RPPNs Federal Act 9985/2000 State Decree 4262/1994	Voluntary conservation of remnant patches, particularly when located on low farming capacity land.	*	***	***	**	*	Promotion of RPPN as conservation tool and farmers' encouragement; Production of maps and other administrative requisites. Project-Based, Public and/or Private Funded.
ICMS *Ecológico* State Act 9491/1990, but requires local legislation to enable direct payments	Direct payment of the ICMS *Ecológico* share to RPPN's landowners	**	***	*	*	*	Municipal legislative procedures to enable direct payment of the ICMS *Ecológico* share to RPPN's landowners as economic incentive. State-revenue.

Table 8.1 (cont.): Summary of Landscape Conservation Tools: major applications, relevance to achieve specific conservation goals and recommendations for developing a Landscape Conservation Extension Program in the Regional Matrix

Direct Payments and Easement-like Programs Not enabled by legislation to public payments	Conservation of remnant patches, particularly high-valued farmland; Restoring managed lands; Matrix softening techniques[5].	**	***	**	**	***	Project-based partnership with NGOs to coordinate conservation efforts and search for private funding. Local share of the ICMS *Ecológico* Carbon credits for restored grasslands Project-based private funded
Public-funded Land Purchase SNUC - Federal Act 9985/2000	Implementation of the Campos Gerais National Park Implementation of Rio Tibagi Wildlife Refuge	***	***	***	***	***	Articulation with IBAMA and local initiatives for technical and bureaucratic procedures. Federal budget.
Private-funded Land Purchase	Conservation of Remnant Patches, particularly high-valued farmland; To create new RPPNs; Restoring managed lands; Matrix softening techniques[5].	***	***	***	***	***	Project-based partnership with NGOs to coordinate conservation efforts and search for private funding. Project-based private funded

Key: *** = major relevance; ** = moderate relevance; * = minor relevance; - = no relevance. The weightings of landscape conservation tools are indicative of the relevance of each tool to achieve specific conservation goals.

[1] See also discussion on Section 6.2 - The Legal Framework and Incentives for Conservation in Brazil and Paraná
[2] See also discussion on Section 5.2.1 - Mapping Conservation Priority Landscapes
[3] Landscape Conservation Goals: (See also discussion on Section 3.3.4 - Defining Landscape Conservation Goals)
1 - to halt further landscape fragmentation and habitat destruction;
2 - to effectively conserve and enhance the quality of existing habitats;
3 - to recover and expand the area of protected habitats;
4 - to improve structural and functional connectivity among remnant patches;
5 - to minimize ecological impacts from surrounding land uses.
[4] See further discussion on section 8.7 - Towards a Landscape Conservation Praxis - Conclusions
[5] See also discussion on Chapter 7 - Participatory Strategies for Softening the Management of the Matrix

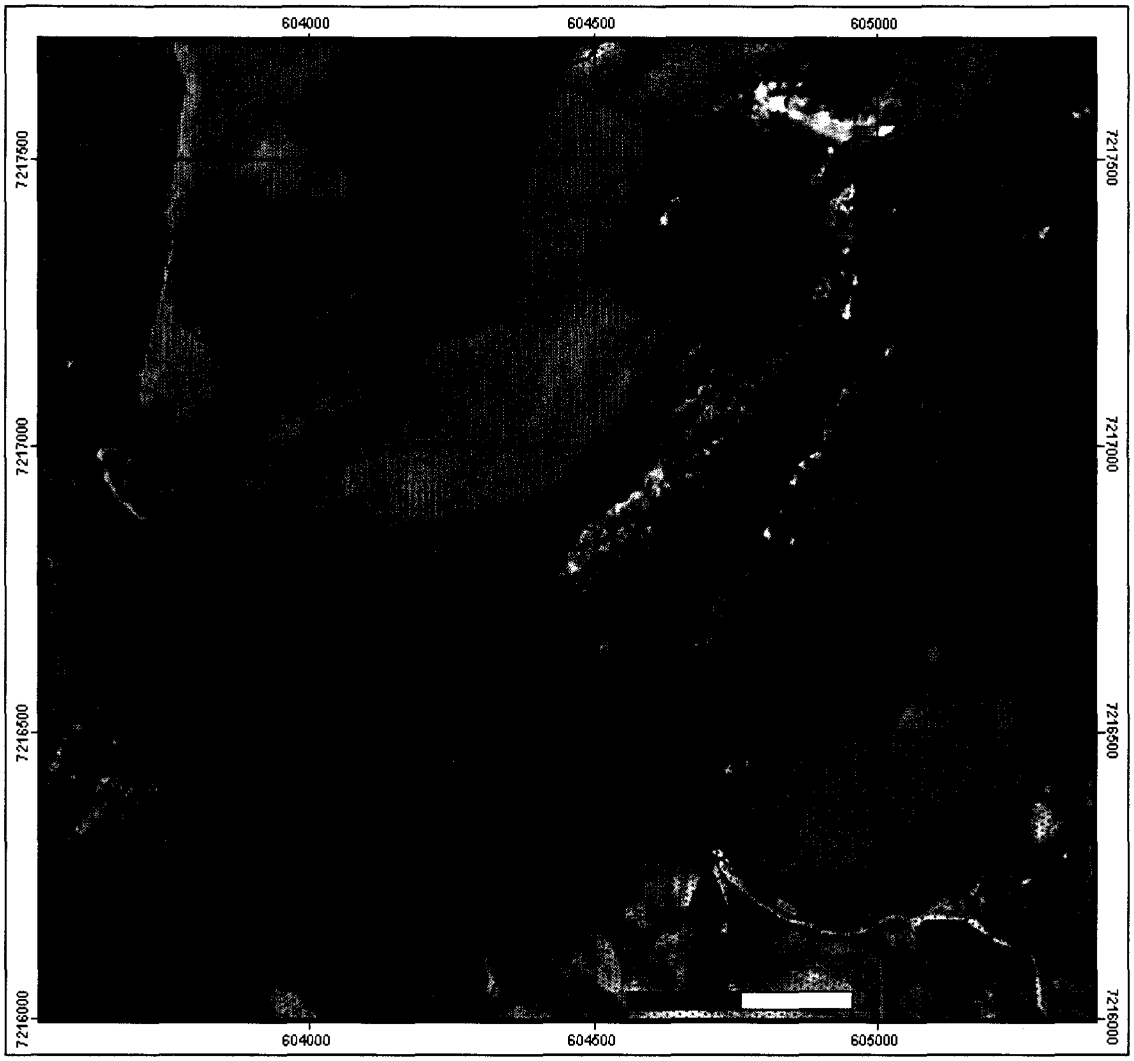
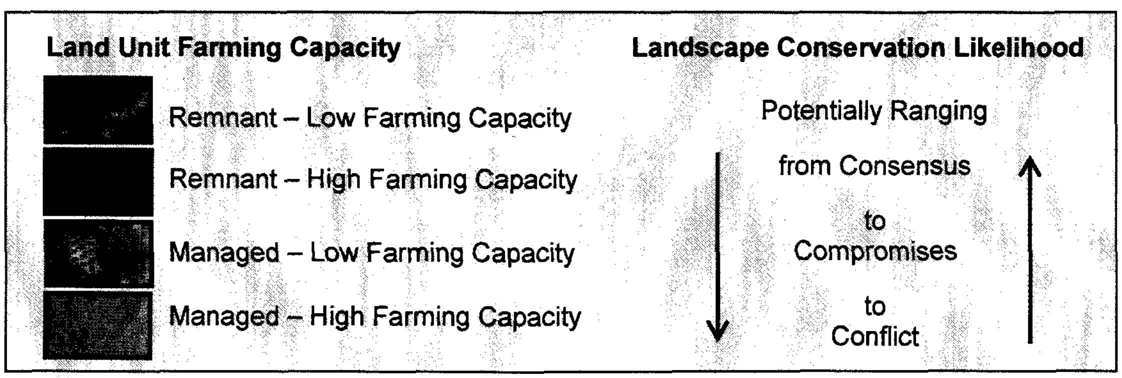


Figure 8.1a: Example of Land Units' Conservation Likelihood (See also Table 8.1)



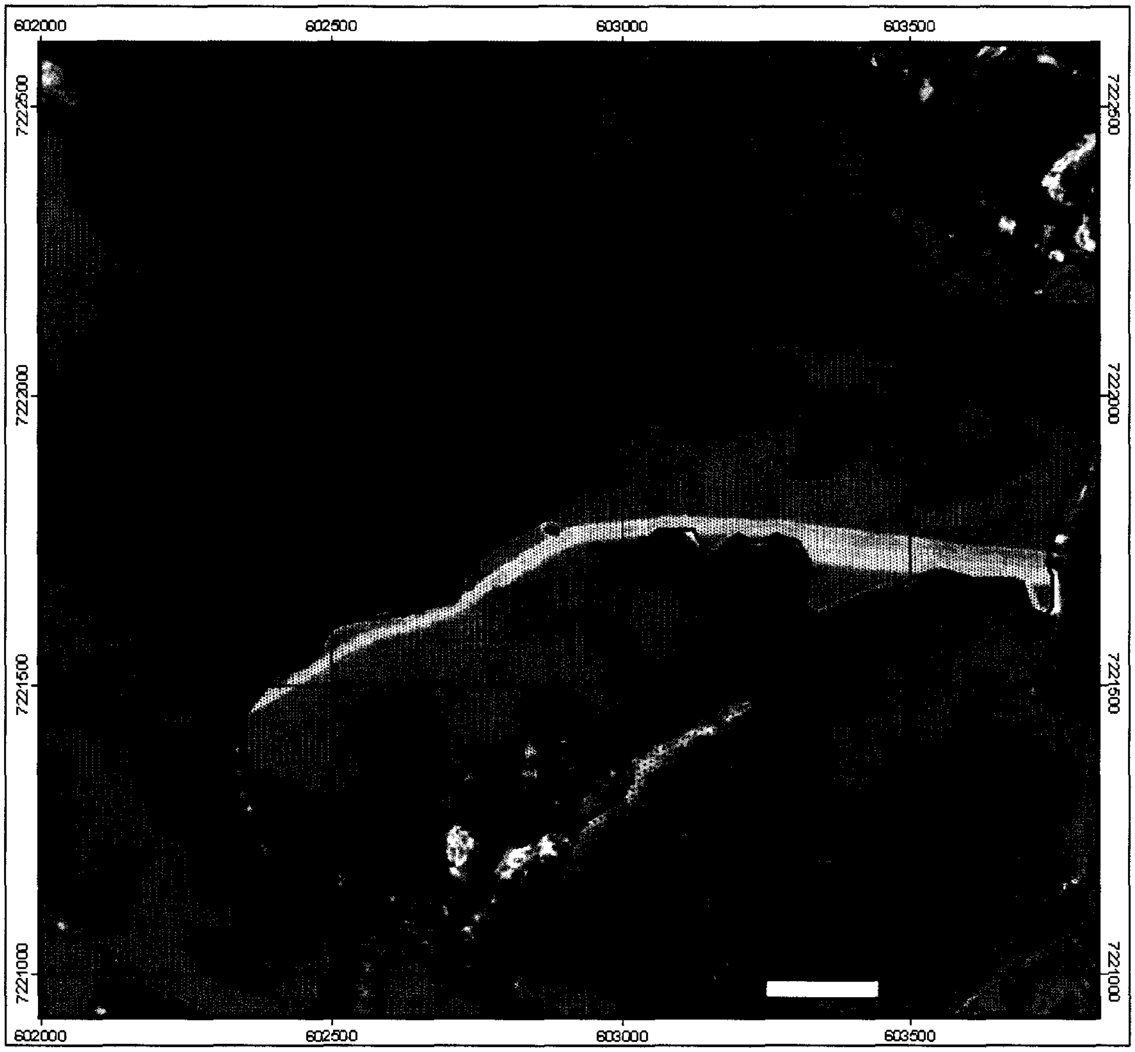
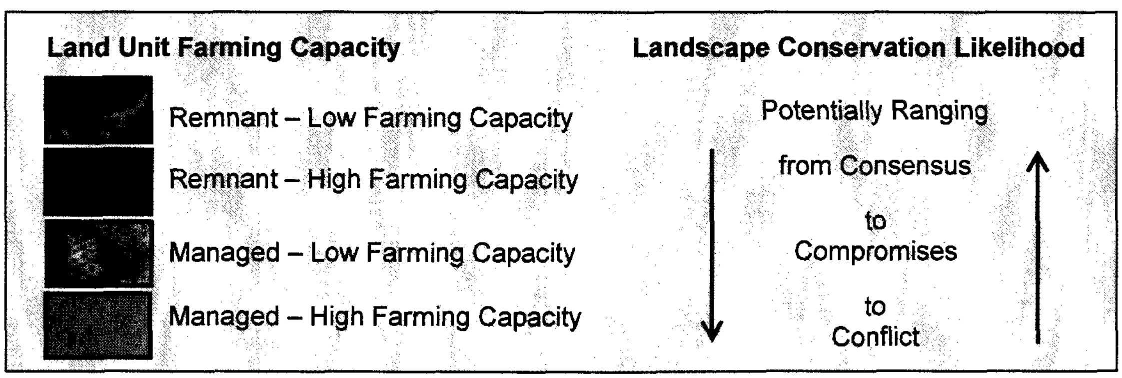


Figure 8.1b: Example of Land Units' Conservation Likelihood (See also Table 8.1)



capacity will require negotiated compromises requiring higher levels of investments and, as previously addressed[12] can lead to potential conflicts on many farmsteads.

Similarly, Figure 8.2 exemplifies how a proper combination of these conservation techniques could affect the landscape in a small (2.522 ha) watershed (rio Cercadinho). The left map in Figure 8.2 depicts the spatial distribution of remnant patches in 2006, amounting 1.060 ha of distinct habitats (42% of the watershed) embedded within a human dominated mosaic, composed mainly by intensive cultivated land. In the right map of Figure 8.2, a new conservation-friendly landscape was designed, based on the consensus-negotiation model, by integrating 605 ha (24%) of managed, low farming capacity land units into habitat conservation. Otherwise, remnant land units are likely to be converted into more intensive economically productive forms of land use. These are the next examples of spatial information that could be used for a dialectical approach to landscape conservation.

Maps of a land units' "conservation likelihood" could also be produced by spatially categorizing the distinct attitudes, beliefs and value-laden positions that individuals expressed during interviews. For ethical reasons we did not map this information, as landholdings would be easily identifiable on the high-resolution aerial photographs, thereby violating the confidentiality promised to study participants.

Table 8.2 summarizes the relevance of the conservation tools and their likelihood that they will achieve specific conservation goals that fit the productive capacity of land units. The conservation potential ranking is placed on a continuum between consensus and compromise and assesses the power of conservation incentives provided by each tool

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[12] See Section 6.3: Landowners' Views of Conservation Alternatives

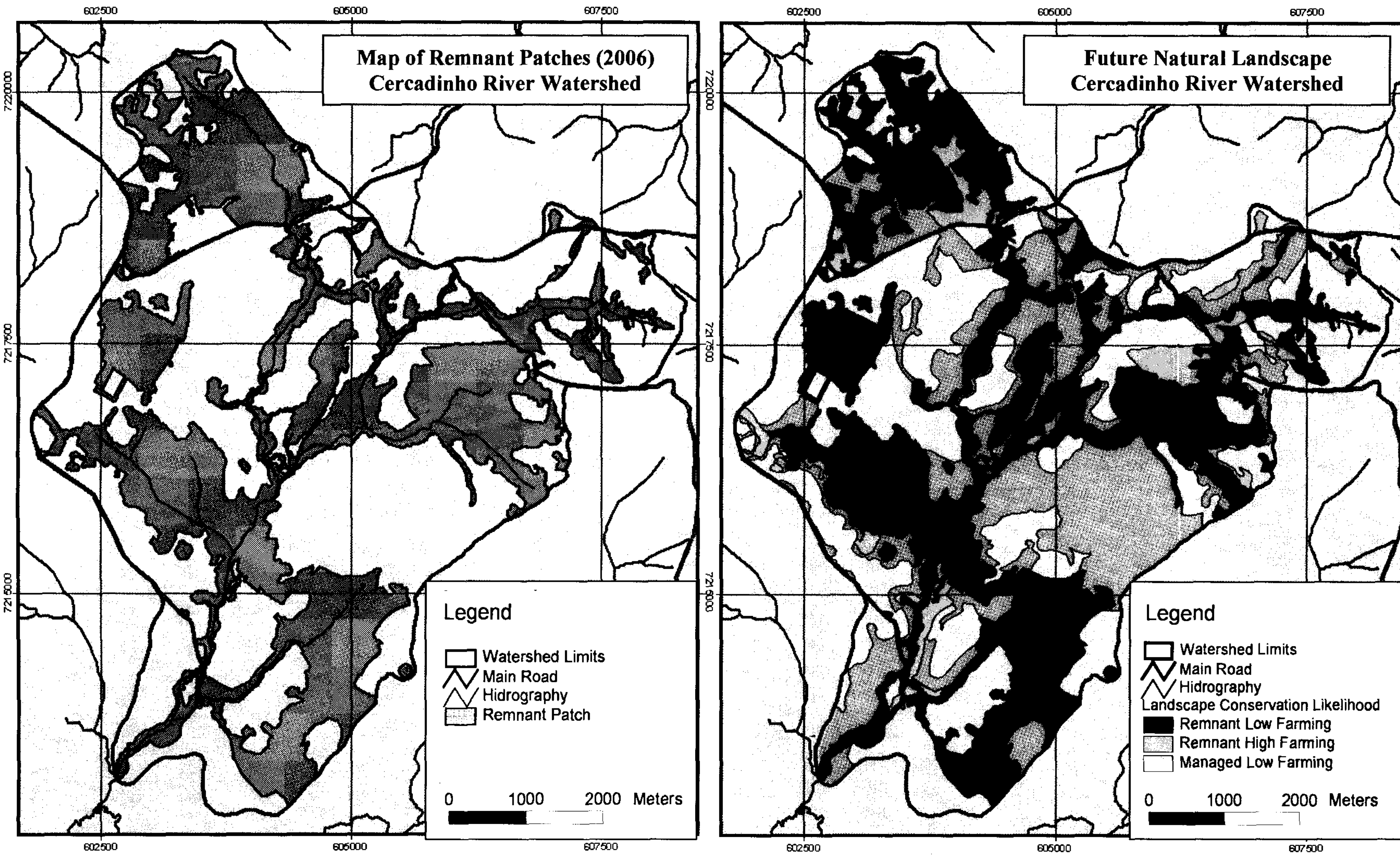

Figure 8.2: Spatial distribution of remnant patches (left) and how the compromise-negotiation model applied to the land units (see Figure 8.1) could affect a future natural landscape within a small (2.500 ha) watershed (right). Otherwise, if land use intensifies, Remnant High and Low Farming capacity land units are likely to be converted to more economically productive land use system.

Table 8.2: Potential for Conservation Tools to Achieve Specific Landscape Conservation Goals

Landscape Conservation Goals[1]	**Land Unit Farming Capacity**[2]	**Landscape Conservation Tools**[3]				
		Forest Code	**RPPN**	**Extension Service**	**Easements & TDRs**	**Land Purchase**
To halt further landscape fragmentation and habitat destruction	None to Low	***	***	**	***	***
	Medium to High	*	*	*	**	***
To effectively conserve and enhance the quality of existing habitats	None to Low	***	***	**	***	***
	Medium to High	**	**	**	***	***
To recover and expand the area of protected habitats	Low	*	-	*	***	***
	Medium to High	-	-	*	**	***
To improve structural and functional connectivity among remnant patches	None to Low	**	**	**	***	***
	Medium to High	*	-	*	***	***
To minimize ecological impacts from surrounding land uses	Low	*	-	**	***	***
	Medium to High	-	-	**	**	***
Landscape Conservation Likelihood Potentially ranging from:		Easier to implement .... to Complex to implement Lower investment .... to Higher investment Consensus .... to Compromises .... to Conflict				

Key: *** = high potential; ** = moderate potential; * = lower potential; - = potential. The weightings of the relevance among conservation tools, which are in agreement with land unit's farming capacity, are indicative of the potential of each conservation tool to achieve specific conservation goals. Such classification was also mapped across the Conservation Priority Landscapes (See Figure 8.1), and could be applied to each rural property. Hence, the relevance of each tool for the achieving specific landscape conservation goals could also be related to individual farms, reflecting distinct values, attitudes, and meanings that individuals attach to the landscapes where they farm and live.

[1] See also discussion on Section 3.3.4 - Defining Landscape Conservation Goals
[2] See also discussion on Section 5.2.2 - Mapping Land Units at Farm Level
[3] See also discussion on Section 6.2 - The Legal Framework and Incentives for Conservation in Brazil and Paraná

as well as anticipates which remnant land units are more likely to be conserved. Similarly, Table 8.3 summarizes the potential of the conservation tools to achieve specific goals on different types of farms and ranches having distinct social groups values, attitudes, and assigned meanings for the landscapes they live on and manage.

The land management restrictions and potential incentives provided by the Forest Code can be considered the most useful tool available to trigger habitat conservation planning and management. The conservation potential of the RPPNs, easements and TDRs-like incentives are still modest, but are likely to increase by the potential tradability of excess Legal Reserve units as compensation in the near future and, as such, are considered important instruments to direct conservation incentives.

Long-term conservation of the regional biodiversity requires the establishment of large core areas, which in the regional context will require land scattered across a great number of large, medium, and small rural properties. These include intensively managed highly valued lands, requiring acquisition (by negotiations) or land expropriation (by eminent domain), both considered indispensable landscape conservation tools. Despite opposition, the designation of the Campos Gerais National Park by Federal Decree (not numbered), on March 22nd, 2006, creates the potential for using acquisition mechanisms.

Findings indicate that the acquisition of land with lower farming capacity, within an integrated landscape conservation approach using a "Habermasian" collaborative planning, is likely to produce landowners who are willing to negotiate the sale or protection of certain parcels. Our analysis found that low capacity croplands are generally located adjacent to valuable conservation patches; negotiations and conservation agreements under these circumstances are expected to be more easily agreed upon.

Table 8.3: Potential of the Landscape Conservation Tools to achieve specific Conservation Goals on different types of farms and ranches

Landscape Conservation Goals[1]	Land Use System (LUS)[2]	Landscape Conservation Tools[3]				
		Forest Code	RPPN	Extension Service	Easements & TDRs	Land Purchase
To halt further landscape fragmentation and habitat destruction;	Ranching	***	**	**	***	***
	Family Farming with Remnants	***	*	**	***	***
	Family Farming	***	-	*	**	***
	Intensive Forestry	***	*	*	**	***
	Intensive Farming with Remnants	**	**	**	**	***
	Intensive Farming	***	*	*	*	***
To effectively conserve and enhance the quality of existing habitats	Ranching	**	**	**	***	***
	Family Farming with Remnants	**	*	**	***	***
	Family Farming	*	-	*	**	***
	Intensive Forestry	**	**	*	*	***
	Intensive Farming with Remnants	**	**	**	**	***
	Intensive Farming	*	*	*	*	***
To recover and expand the area of protected habitats	Ranching	**	*	**	***	***
	Family Farming with Remnants	*	-	*	***	**
	Family Farming	-	-	-	**	**
	Intensive Forestry	-	-	-	**	***
	Intensive Farming with Remnants	*	*	-	***	***
	Intensive Farming	-	-	-	**	***

Table 8.3 (cont.): Potential of the Landscape Conservation Tools to achieve specific Conservation Goals on different types of farms and ranches

To improve structural and functional connectivity among remnant patches	Ranching	**	*	**	***	***
	Family Farming with Remnants	**	-	**	***	*
	Family Farming	*	-	*	**	*
	Intensive Forestry	**	**	*	**	**
	Intensive Farming with Remnants	**	**	**	***	**
	Intensive Farming	*	*	*	**	**
To minimize ecological impacts from surrounding land uses	Ranching	***	*	**	***	***
	Family Farming with Remnants	*	-	**	***	*
	Family Farming	*	-	*	**	*
	Intensive Forestry	**	*	*	**	**
	Intensive Farming with Remnants	*	*	*	***	**
	Intensive Farming	*	-	*	***	**
Landscape Conservation Likelihood Potentially ranging from:		Easier to Implement .... to Complex to Implement Lower investment .... to Higher investment Consensus .... to Compromises .... to Conflict				

Key: *** = high potential; ** = moderate potential; * = lower potential; - = no potential. The weightings of the landscape conservation tools are indicative of the relevance of each tool for achieving specific conservation goals accordingly to each class of land use system (LUS). LUS reflects the values, attitudes, and meanings social groups attach to the lands they farm and live.

[1] See also discussion on Section 3.3.4 - Defining Landscape Conservation Goals

[2] See also discussion on Section 3.3.3 - Land Use Systems and Remnant Patches; Table 3.4: Area Metrics and Main Agronomic Characteristics of Land Use Systems in the Regional Matrix; and Figure 3.9 - Map of Land Use Systems

[3] See also discussion on Section 6.2 - The Legal Framework and Incentives for Conservation in Brazil and Paraná

Expropriation of high-valued farmed land, however, is likely to be confronted by strong opposition, particularly by the members of the rural elite and by the most influential stakeholders. Considering the existing social conflict provoked by the Campos Gerais National Park designation, the potential for conflict (last line on Table 8.2) is high.

Therefore, conservation alternatives for the majority of the medium to high farming capacity cropland patches must assess two options: a) the judicial expropriation of the land as allowed by the SNUC, and the inevitable confrontation with landowners and its negative consequences for the establishment of conservation partnerships; or, b) the negotiation of changes in the current forms of land use to other, more conservation-compatible systems, associated with complementary financial incentives. These conservation tools are expressed in the Table 8.2 in the columns labeled "Extension Service" and the "Easement and TDRS-like incentives".

As put by van den Hove (2006), "the acknowledgment of conflict potential does not force us to abandon the communicative rationality framework; the framework provides guidelines for the practical organization of participatory processes. In particular, it allows for the design of procedural rules which clearly emphasize freedom of speech, fairness, consistency, accountability and transparency, therefore offering an explicit framing of negotiation processes".

The guiding principle being that if consensus is achieved on matters that are likely to be unproblematic (e.g., the APP requirement in the Forest Code), then it will presumably be somewhat easier to reach agreement on issues that are conflictive (e.g., conservation of high valued farming land). In fact, even during the discussion of land acquisition and land expropriation, it was possible to establish a dialogue with landowners and to define places, land units, and situations where consensus could be reached.

While tables 8.1 – 8.3 provide a generalized evaluation of conservation tools, the dialectical approach as a research strategy allowed the construction of feasible conservation alternatives on a real landscape. To do this requires that we look at each specific land unit on each farm, and for each specific context, and anticipate which tools might work and where the participatory process is located along the "cooperation-conflict" continuum. The practical challenge in designing a participatory process for landscape conservation approach lies in knowing when to use consensus-oriented cooperation or compromise-oriented negotiation aspects.

8.7 Towards a Landscape Conservation Praxis - Conclusions

Although the number and scale of conservation initiatives have grown considerably in Brazil during the last few decades, they are still insufficient to guarantee the conservation of Brazil's biodiversity (Tabarelli et al 2005). An array of regionally and locally based, innovative initiatives is required, and both public and private protected areas (PAs) are the key elements of a network system for conserving what remains. The existing public PAs in the country, created to strictly protect biodiversity, must transform what are usually unmanaged lands into well-managed entities that effectively conserve biodiversity (Rylands & Brandon 2005).

The effectiveness of protected area systems as a whole depends on how well PAs can meet their mission at any given site, and how well they collectively represent and safeguard biodiversity within a given biome, ecoregion, or landscape. Yet, protected area systems must function amid competing governmental institutions. The broader policies of environment and economic development are, perhaps, the greatest challenges (Tabarelli & Gascon 2005, Rylands & Brandon 2005). In regions with intensively managed land systems and where strictly protected PAs are small, addressing land use management in buffer zones (as endorsed by the SNUC) is also considered fundamental.

Human-dominated landscapes tend to retain an impoverished and biased sample of original biota, simplified and homogeneous in both taxonomic and functional terms, i.e., dominated by matrix-tolerant generalists, disturbance-adapted opportunists, species with small area requirements, fire-tolerant species, and those without commercial value (Szaro 1996, Tabarelli & Gascon 2005). The magnitude of biodiversity loss and biotic simplification will depend largely on the efforts to avoid the extinction of species by adequately managing both the rehabilitation of remnant habitat patches and the matrix surrounding them (Tabarelli & Gascon 2005).

Effective law enforcement is also needed as a basic foundation of any conservation strategy. Particularly important is compliance with the Forest Code, requiring protection and/or the restoration of Legal Reserves and Areas of Permanent Protection on all proprieties (Alger & Lima 2005). This would significantly increase the amount of grasslands and riparian Araucaria forest habitat under protection and ensure that rural properties comply with social and environmental goals set forward in the Federal Constitution.

In the conservation scenario of the study area, the two public protected areas – the long established (1953), small (3,200 ha) Vila Velha State Park, and the newly decreed (2006), larger (22,000 ha) Campos Gerais National Park, so far (2008) a "paper park"

(See Figure 3.6 – New Federal Protected Areas) – are of fundamental importance. Additionally, regional and landscape conservation priority remnant patches[13] are the most valuable landscape units for the core areas for of a reserve network system[14].

These core reserves and the corridor network, however, will be only a small portion of the overall landscape and will remain too small to meet the requirements of very large areas necessary for the maintenance of grasslands ecosystems and for the long term conservation of several key species, such as top carnivores. Economic growth and the global demand for farm commodities have been the major forces driving industrial farming practices and other forms of land use that encroach on remnant patches and impoverish ecosystems. Consequently, it was necessary to define broad and complementary conservation strategies.

Avoiding further fragmentation in the regional matrix as well as reversing the current levels of habitat loss will require a "softening of the matrix" with innovative incentive mechanisms, including those aimed at improving the way land is managed. The adoption of more ecologically sound farming and land use practices must simultaneously promote economic development and social justice. Full collaboration between public agencies and other partners is vital for the design and implementation of sustainable landscapes.

As pointed out by Tabarelli et al (2005), "the challenge is how to integrate the diverse regulations and public policies, new opportunities and incentive mechanisms for ecosystem protection and restoration, and various independent projects and programs carried out by governments and NGOs into a single and comprehensive strategy for

[13] See discussion on Section 4.4.1: Conservation Priority Patches
[14] See discussion on Section 4.4.3 The Regional Network of Nature Reserves.

establishing networks of sustainable landscapes throughout a region". Economic development, resource protection, and conservation incentives should be seen as regionally complimentary strategies, locally adapted to the realities of farmers and communities.

We explored an array of different opportunities with stakeholders to integrate conservation and sustainable development alternatives as complementary strategies in the buffer zones of Vila Velha State and Campos Gerais National Parks. Our results suggest how sustainable development projects could be integrated with landscape conservation practices. Our conceptual framework, a landscape-based action research grounded in the meanings assigned by landowners, the realities of each farmstead, and on the contextual landscapes where they are located, could be employed by others hoping to increase land conservation and improve the way land is managed.

The full compliance with the existing environmental laws, in particular the requirements of the Forest Code and its associated incentives, is an essential step for the building of conservation-oriented landscapes. Focusing conservation efforts on priority areas and then monitoring key species "can tell us where we are, and where we need to go" (Lee 1993). There is a need to encourage and reward landholders for achieving conservation outcomes, including the modification of farming and rangeland practices and the development of ecotourism ventures.

Accordingly, in Chapter 6 we addressed consensus and negotiation-based alternatives for the conservation of remnant patches and improved connectivity in different types of landscapes with varying levels of productive potential. In Chapter 7, alternatives for increasing the economic potential of extensive rangelands were highlighted as a cornerstone strategy for the development of a landscape conservation program, centered on the building of partnerships with landowners, i.e. on the negotiated dimension of participatory approaches.

Three additional conservation alternatives were also explored with stakeholders: organic and agro-ecological farming systems as an alternative for both intensive and small family farming systems; and ecotourism as economic alternative based on the amenity and cultural values of the regional landscape. A rich compilation of opinions, points of view, and ideas, which are related to distinct farming systems, was gathered from the discussions on these topics, some of which were brought up as complementary conservation strategies within Chapters 6 and 7.

A conservation-friendly land management program will require an extension service which includes biodiversity protection among their goals and employs practices akin to communicative rationality (Habermas 1987). Extension efforts could provide the facilitation processes necessary to trigger local-scale implementation of landscape conservation practices conceived on the larger regional scale (See last column on Table 8.1). The primary role of rural extension services has long been to induce positive change of behavior among farmers and to build on existing practices of land management adopted by farmers (Koelle et al 2003). An effective landscape conservation action research framework, therefore, will also require improved communication (Freire 1974) among systems-oriented researchers, innovative farmers, private sector, farm advisers, and government extension specialists.

Within a landscape conservation framework, researchers, extension agents, and farmers must be considered just three actors in a nonlinear, dynamic system, which contrasts with linear models that separate research, extension, and land management. Researchers can no longer stay "outside" expecting to investigate objective, transparent, and predictable elements of a system. The role of the researcher is now one of "reflective practitioner"[15]. As put by Hagmann et al (2002) "researchers need to understand themselves as part of an actor system that is not controllable and predictable, and where innovation, motivation and inspiration are generated within a transactive research process".

Researchers need to bring pragmatism and empathy, common sense, and understanding fof the farmer's situation, knowledge, values and needs to the process (Hagmann et al 2002, Koelle et al 2003). If this is done, the overall quality and effectiveness of a conservation participatory process are likely to improve, in terms of creatively addressing and resolving landscape conservation issues, ensuring (some degree of) fairness, handling pre-existing or emerging conflicts, and avoiding manipulation (van den Hove 2006).

A major purpose of a landscape conservation approach is likely, therefore, to be the pursuit of the "future natural" rather than the "past nostalgic" (Selman 2002). The maps of Conservation Priority Patches and Major Conservation Landscapes (Figures 4.1 and 5.2) would be a guide to define where the most important "future natural" conservation lands are located. The biophysical attributes associated with remnant patches, land units and land use systems, can be linked with landowner attitudes and opinions that emerged during interviews. Such information will help to define places where consensus is most likely to succeed and where negotiations and compromises must

[15] See also discussion on Section 2.3.3 – The Researchers' Role

take place. The combination of ecological and social data is key for conservation planning and action.

Scientific abstraction tends to fragment knowledge along disciplinary and theoretical lines (Williams & Paterson 1999). Focusing on the land unit and landowners, integrates theory and is a form of epistemological integration that overcomes scientific abstraction and the fragmentation of knowledge. The existence of a tangible subject, the land unit, that can be interpreted, discussed, refined, walked upon and checked in the field, and redefined in the conversations with farmers, mediated the construction of landscape conservation strategies. Desirable management could be dialectically discussed, constructed, and negotiated with landowners in a "shoulder to shoulder" manner with mutual interest in a tangible object.

Conceiving of landscape conservation as located somewhere on a continuum between consensus-oriented processes in the pursuit of a common interest and compromise-oriented negotiation processes aiming at the adjustment of particular interests (van den Hove 2006), has important consequences for the practice of a landscape conservation planning. The limitation of the study was that our dialogues were largely hypothetical, i.e., we were not in a realistic setting, able to negotiate real conservation decisions, we were only able to explore and map landscape conservation prospects with stakeholders.

In practice, the negotiation dimension becomes more pregnant during real processes that must produce some sort of collectively agreed output/outcome (van den Hove 2006), e.g., a decision on setting land units as RPPN, or on widening the distance from crop to riparian areas to define corridors across the landscape, conclusions on conservation agreements (and disagreements) on TDRs or conservation easements, or any other form of ''collective'' output. Integration is often more evident in the field - in the way life is lived - than it is in a boardroom, classroom or office of an organization. The practical challenge in designing a participatory process for a landscape conservation approach lies in the combination of consensus-oriented cooperative aspects of participation with compromise-oriented negotiated aspects (see Figure 8.3 - Towards a Landscape Conservation Praxis).

Based on the "ideal speech situation" within a communicative action approach (represented in Figure 8.3 by the communicative action oval), individual differences (represented in Figure 8.3 by the faded cognitive hierarchy) are likely to be reduced in the search for a rational consensus about how to conduct conservation affairs. The site-in-context approach of landscape ecology, based on land units mapped at large scales, is proposed as an appropriate conceptual framework to match the scale and pattern of landscape change with appropriately defined and scaled multiple-farm management agreements.

On the agrolandscapes of study, changes towards conservation-friendly landscapes could stem if the direction of those changes is derived from the meanings assigned by landowners. Using a landscape conservation approach could allow us to design and implement new conservation practices (the goal of a participatory action research) in the real farming landscapes of the Campos Gerais ecoregion, and to achieve practical outcomes that have long-term benefits for species and biological communities.

Although it was not our initial research goal, we can consider the first loop of the "look, think, act" routine framework concluded, as discussed by Stringer (1999) to develop action research[16]. We gathered relevant socio-ecological, spatial information, constructed and described a broad regional picture (look); we have explored and analyzed what is happening in the landscapes of study, from geological information to global soybean markets, explained how landscapes have changed and theorized on how conservation initiatives could be developed (think); we mapped and evaluated

alternatives with stakeholders and designed landscape conservation plans, models, maps, and so on - that provide the basis for reformulating practices, policies, programs, and services for enhancing landscape conservation opportunities (act); and by reporting the results through this dissertation, we completed the first cycle of the routine. The cycle must be continued to strengthen partnerships and deliver conservation achievements in the real Campos Gerais' landscapes.

[16] See discussion on Chapter 2.4.6 A Critical Postmodern Landscape Research Approach.

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