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SOME OBSERVATIONS ON FOREIGN GRASSLAND AND RELATED RESEARCH: APRIL - JULY 1970 VAN DYNE TRIP REPORT

George M. Van Dyne

Natural Resource Ecology Laboratory

Colorado State University

Fort Collins, Colorado, USA

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GRASSLANDS BIOME

U. S. International Biological Program

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INTRODUCTION

This report summarizes an overseas trip I took during the period of 12 April through 8 July 1970. I visited 25 research institutions and universities in eight different countries during this time including weekends; only a few days were taken for tourist activities. For brevity, only major items of importance and major visits are referred to in this report.

Support for this trip came from three sources: the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO), the Smithsonian Institution, and the grant from the National Science Foundation for US IBP Grassland Biome studies.

My major purposes on this trip were:

(*i*) To attend working meetings on IBP Grassland studies;

(*ii*) To visit centers of basic and applied grassland research in several countries;

(*iii*) To attend international scientific conferences; and

(*iv*) To meet with scientists working on and interested in research and training in systems analysis of ecological, natural resource, and agricultural problems.

This report gives brief consideration to visits in each country, some general impressions and comparisons, and has appended an itinerary and a prospectus developed during the trip.

AUSTRALIA

The greatest part of my time was spent in Australia at 10 research institutes and universities. Of special importance were the following:

XI International Grassland Congress

I attended the Grassland Congress and gave an invited paper in the last plenary symposia; my topic was "A Systems Approach to Grasslands." About 750 scientists registered at the Congress; about 65% of these were Australians. During most of the Congress there were three simultaneous sessions except for the last 1.5 hours each day when the total group met together for plenary symposia of which there were six. The Congress took place from 13 through 23 April. Most of the papers presented at the Congress were of agronomic nature rather than ecological, although there were some important sessions from a resource management and ecological standpoint.

The Congress provided an excellent opportunity to meet a number of scientists from around the world with whom I had corresponded previously. Representation was 93 from North America; 72 from Europe, including the USSR; 18 from Asia; 17 from Latin America; 16 from Africa; and the remaining number from Oceania, with Australia and New Zealand obviously the larger groups.

A draft copy of the proceedings, but without the plenary symposia papers, was distributed at the Congress. A full edited proceedings is to be published. Members of the Congress were also given a copy of a book, written especially for the Congress, on grasslands of Australia: Moore, R. M. [ed.] 1970. Australian grasslands. Australian National University Press, Canberra. 455 p.

Third IBP Grasslands Working Group Meeting

This group met on 18 and 19 April, a weekend in the middle of the Grassland Congress. Some 37 scientists attended one or more sessions. About half the participants were from Australia and also represented were the United States, New Zealand, India, Isreal, Iran, United Kingdom, and Canada. There were two United Nation agencies represented. This meeting initially focused on review of ongoing research in each country.

Important IBP or IBP-related work in Australia was described by Morley of the CSIRO Division of Plant Industry; Rixon of the CSIRO Deniliquin Laboratory; Bishop of the Victoria Department of Agriculture; Hoskins of the State Department of Agriculture; MacDonald from the Waite Institute; Willoughby, Hutchinson, and Davidson from the CSIRO group at Armidale; Williams from the CSIRO Animal Physiology Laboratory at Prospect; Specht from the University of Queensland; Coaldrake from the CSIRO Division of Trophical Pastures; and Perry and Ross from the CSIRO Rangelands Research Unit.

Great Britain's work at the Grassland Research Institute at Hurley was outlined as well as Nature Conservancy studies at Bangor, Moorhouse, and Merlewood. Of particular interest is the modelling work being done under Spedding's program at Hurley and Reading.

The New Zealand program was outlined by O'Conner, but the emphasis seemed to be on improved pastures and seemed partly disorganized. Their work is supported by the DSIR.

Pandea from India outlined the program there which is located in four centers. Pandea's work at Rajkot is in a very hot and desert-like type, but 30 to 40-inch precipitation belt grassland studies are being conducted at Ujain, Varanasi, and Pilani.

A United Nation's man from Iran described the work there which appears to be exploratory although there is some FAO range research being done. There is a cooperative scientific effort among Iran, Pakistan, and Turkey but not as part of the IBP. It may also be possible to initiate cooperative work with the FAO in Iran but in Pakistan and Syria there are proposals that uncertainty adds to their funding.

Katznelson described the work in Israel, particularly at the Negev Institute and at Rehovolt. Energy studies are being conducted, particularly concerning commercial use of solar energy, at Negev Institute. At Rehovolt soil-plant-water studies are being conducted especially following the traditions of Standhill.

Norris of the FAO program at Rome discussed their work as it related to IBP. Their work is entirely in a supporting, but not a funding, role. They are, however, interested in the data collection and information exchange problems; it appears that some of the large herbivore studies that they do might be most closely related to IBP. Kenya appears to be a project area with greatest potential with some 12 to 14 scientists working there.

Specht also outlined some of the work in New Guinea about water and plant nutrition.

The Canadian program was described by Coupland and the United States program by Van Dyne, Knight, and Risser.

A draft of a prospectus for international synthesis efforts in grasslands was developed at this meeting. I later reworked this in Canberra and it was discussed again at Broken Hill. I again reworked it in Canberra and mailed it to Coupland, Hadley, and others for distribution (see attached).

Arid Zone Research Conference

I attended the third 5-year Australian Arid Zone Research Conference at Broken Hill, New South Wales and environs. I presented an invited review paper on the last day. This was the last paper and was a summary and critique of the conference. Brief abstracts of most of the papers were prepared and distributed ahead of the meeting so that participants had an opportunity to become familiarized with the work (i.e., except for the last half-day in which critique and review papers were presented). There were also two major daylong field trips during the meeting. One to Fowler's Gap Station, now operated by the University of New South Wales, and one to Wilangee Station, a private operation. The formal papers covered a wide variety of topics ranging from plant pathology, hydrology, plant ecology, wildlife ecology, human sociology, and domestic animal physiology, nutrition, and breeding. There were also discussions of mineral survey and mining in the arid zone.

In the Broken Hill area I was able to see two of the four major vegetation types of the central arid part of Australia. In the field tours I was able to examine some of the communities including the Atriplex type, a Kochia type, Acacia stands, and some perennial grass communities. There were extensive areas of overuse of the vegetation by sheep and extensive soil erosion and drifting. The area is an important location for domestic animal grazing with emphasis given to sheep although some cattle were present. Kangaroos were common as were emus, lizards, and a variety of birds. Livestock operations and research programs were described on both the Fowler's Gap Station and the Wilangee Station.

CSIRO Research Units In and Near Canberra

While in Canberra I visited several research units including the Division of Wildlife Research, laboratories of the Division of Land Research, laboratories, field sites, and the phytrotron of the Division of Plant

Industry, and laboratories of the Rangelands Research Unit. Additionally, I had an opportunity to visit in the Australian National University (ANU), especially in the Forestry School.

In my opinion, research is well supported in the CSIRO and the ANU but less well supported in the other universities throughout Australia. Much of the work is well planned, there seems to be adequate help and equipment for conducting much of it, and the scientists seem relatively free from a great deal of administrative and budgetary problems. The scientists I visited were well aware of the world literature, but many of the CSIRO scientists did not seem particularly enthused about their work (this seems to be relatively characteristic of government workers I encountered in several nations).

I had good opportunity to study graduate programs and converse with graduate students. While I was in Canberra I stayed at University House of ANU. The typical graduate student is brought to ANU for a three-year program, takes little if any coursework, and does not at all seem to be "pushed" in his work. My impression is that they do not obtain as good and as broad a training in such doctorate programs as they would in North America.

Ecological Systems Analysis Workshop

While in Canberra I conducted an ecological systems analysis workshop with 38 scientists from nine divisions of the CSIRO, several state universities, and several state departments. Half of the participants were there for the first week, half for the second week, and all for the third week. We covered primarily concepts, methods, and theory, but during the last week we did some computing utilizing the CSIRO's CDC 3600. I had the assistance of Peter Benyon, an engineer, in the computing sessions to spell me on a few lectures. The procedure was to hold three 1.5 hour lecture sessions each day; last 1.5 hours each day was used for discussion, critique and evaluation of Australian studies. I believe most of the biologically and environmentally-oriented scientists in Australia with an inclination for systems analysis techniques participated in the workshop. This provided me an opportunity to evaluate techniques and methods used in that continent, to become personally acquainted with these scientists, and also to explore and test some ideas of my own.

As one of the laboratory exercises during the final week I set up a problem with the following characteristics. This was a resource management simulation and optimization problem based on improving use of the arid lands of central Australia for domestic animal grazing, wildlife, and recreation. The procedure involved defining stations (ranches) and "commons" (perhaps National Deserts?) which could be used by station operators under adverse weather conditions on the home stations. The problem essentially involved developing a set of 28 differential equations which simulated the vegetation and animal biomass changes during the year. The vegetation was "driven" by probabilistic rainfall and temperature generators. Then at one point during the year a decision was made to optimally reallocate animals by movement,

by sale, or by control. This reallocation was done in a linear programming framework and this changed the initial conditions for the next simulation period. This simulation-optimization system then runs in an iterative or recursive manner to simulate management of an arid land resource for a long period of time consistent with improvement of the resource. This was done as an illustration of a technique to combine results from basic research (i.e., in developing simulation models) and use them for making implications for resource management. A scheme was shown how long term optimal use of the arid lands could be made and protect them from degradation while "rolling with the punch" of the vagaries of climate. The problem was developed and got running, but for realistic evaluation it needs more attention and time.

One interesting spin-off from this workshop was that the group was going to organize informally, develop and distribute a newsletter on their activities, and attempt to meet for information exchange and "technique-updating" once a year.

Division of Animal Physiology - Prospect Laboratory

At Prospect I learned of ongoing work in animal physiology and nutrition, animal ecology, and wool production. Also I had an opportunity to see calorimetric equipment in use there for large mammals. During the same visit I had an opportunity to examine the Hawksbury sandstone formation in the Blue Mountains and the Eucalyptus communities developed upon it. Owen Williams and I had numerous discussions about ecology and ecologists in general, the role of long-term vegetation studies (particularly chart quadrat work), and the IBP in particular. Williams is one of the few "integrative type ecologists" I met in Australia.

Division of Fisheries and Oceanography Laboratory

I had the opportunity to visit at this laboratory near Cronulla, and several scientists from nearby universities (Sydney and New South Wales) and the Australian National Museum came in for a one day "colloquium" on system approaches and ecology. One problem we explored in particular was the crown-of-thorns starfish. I did a little advance reading but I was not posing as a marine ecologist; instead we tried to apply a systems framework to discuss this problem. It proved to be a very interesting day. We had about 25 or 30 scientists and graduate students developing a lot of diagrams, box and arrow charts, and arguing and discussing the system, and resolving differences of opinion. This session clearly emphasized the need of taking a systems approach to such a complex ecological problem as that of the star-fish.

Victoria Pastoral Research Laboratory, Hamilton

A visit was made at this state department laboratory to see the extensive experiments in progress. Pastoral research in Australia is done by

universities, by the CSIRO, and by the state departments with a great deal of overlap in objectives, techniques, and habitats. This laboratory had interesting studies going on the intensity-of-grazing with both cattle and sheep in a high rainfall and very productive area of Australia. Jeff Walker and I discussed the "philosophies" of the state department people and compared them to those of the CSIRO. Many of the CSIRO scientists seemed to place themselves high on a "pedestal," i.e., according to the scientific peck order. But, in fact, some very good work is being done in some of the state departments of agriculture or primary industries.

While in Victoria, I had the first of my three days on this trip as a tourist. I visited national parks and forests in the Grampion mountains. I enjoyed seeing the various Eucalyptus communities and the koala bears.

University of New England and CSIRO Armidale Group

I visited at the University of New England where I gave a series of five lectures concerning system approaches, IBP research, and natural resource ecology. There were 25 to 30 participants from departments of Animal Science, Agronomy, Rural Science, Agricultural Economics, Entomology, and Botany and Zoology. I was able to have discussions in laboratories, to see equipment being utilized, and to meet some of the scientists individually over drinks and dinners.

Of particular interest is that, in my opinion, there is more of a systems approach taken in this university than in any other place in Australia. An interdisciplinary group has been meeting for the past year having systems-oriented seminars covering such topics as sulphur cycling through a soil-plant-sheep-wool system, agricultural resource systems analysis, insect diversity and food web relationships, and so forth. There is a high "esprit de corps" among this group which includes both University of New England personnel and those from the CSIRO Pastoral Research Laboratory at Armidale. Much of the success of the group rests in a few individuals including J. B. Dent (Agricultural Economics), John LeGay Brereton (Zoology), Bill Willoughby, Keith Hutchinson, Phil May, and Rob Davidson (all of the CSIRO). There is also a good nutritional biochemistry group there under Leng using systems techniques as analysis tools in their tracer studies. Perhaps another reason for the success of this group is that they are relatively isolated. This is one of few inland scientific and academic centers and they band together for reciprocal scientific stimulation.

Rangelands Research Unit

I had opportunities to visit with CSIRO Rangelands Research Unit scientists in their Canberra national Center, as participants in the work-shop, and during a review of the overall research program (their first time) at their Alice Springs Field Research Center in the Northern Territory. Ray Perry, the leader of this group, was my major contact and organizer in Australia.

Several days were spent in the air, in the field, and in the conference room at Alice Springs. I had an opportunity to fly by light plane over the major vegetation formations, see the nature in extent of the station operations in the region, see the gross effects of grazing on each of the four major vegetation types in the arid zone, and also be impressed by the fantastic scenery and frightening distances of the area. Later we went back over many of the research locations by car and spent time discussing problems in the field. Later, two days were spent in reviewing each individual project with their research staff.

This interdisciplinary group was formed only a few years ago; it is small in size but high in spirit. Their work covers vegetation, both on a basic and applied standpoint, soil moisture dynamics, animal ecology (including livestock), and termite ecology. They have fantastic logistic problems because of the distances involved, lack of facilities, and the difficulties in making measurements over large areas. Senior scientists in the group include Perry, Winkworth, Lowe and Ross. These men are supported by other scientists including Millington, Lindon, Lowe's wife, and some very capable technicians and research assistants. Additionally, they are supporting one graduate student in Canberra under the direction of Slatyer, one in Melbourne under the direction of Calder, and one in Adelaide under Lange. Furthermore, one visiting research scientist position is covered to about $5,000 per year. At the time they had Gary Hulett of Fort Hays Kansas State College with them for a year. Last year they had Thad Box, now a Dean at Utah State University, with them. Their work also ties with that of Chapman of the CSIRO Division of Land Research providing maintenance of instruments and measurements for hydrological work, and with Mabutt of the University of New South Wales on instrument maintenance and readings in the Simpson Desert. Also this group provides logistic support for a number of visiting scientists when they are working in the Alice Springs region. There is also a close tie to the Northern Territory Administration unit at Alice Springs and the Wildlife Research Division group on a dingo biology project. This Rangeland Research Unit field work is of pertinence and interest to both the USA Grassland and Desert Biome programs.

THAILAND

I spent a brief time in Thailand visiting scientists at Kasetart University in Bankok. Dr. Somsak Sukwong was my main guide. I visited the university facility and was also taken to research locations in northern Thailand in the tropical forests. In that area they had a project which was a contribution to the International Biological Program. In my opinion, the scientific work suffered from lack of strong leadership, low budgets, organization, and insufficient equipment.

I spent my second day as a tourist on this trip in visiting temples, palaces, etc. in and around Bangkok.

INDIA

In India I visited at the University of Delhi and Banaras Hindu University at Varanasi. I also had an opportunity to visit with Dr. Donald Fuller, the Scientific Attache in the United States embassy in Delhi.

In Banaras (the old name), I was met by Dr. Misra and in one afternoon had a tour of the city and surrounding areas with three professors from the university. A two day special meeting was held in Banaras on plant productivity studies with special reference to the Grassland Biome. I gave three seminars concerned with US IBP studies, methods of measuring plant productivity in grasslands, and the ecosystem approach in grassland management, research, and training. We had about 30 scientists brought in from around India for these discussions. Most of these individuals had done their doctoral research work under Professor Misra, who seems to be the "Dean of Ecology" in all of India, at least for plant ecology. I was particularly interested in hearing the reports on their grassland and forest studies and having an opportunity to meet not only senior scientists but also junior scientists and graduate students. Of course, a large number of Indians are interested in doctoral and postdoctoral work in the United States. I had an opportunity to meet with some who would be excellent candidates should postdoctoral opportunities become available in our programs.

In Delhi I visited at the university with Professor Seshachar, their national chairman for IBP. I had an opportunity to see the facilities of the zoology department and Seshachar and I had several long conversations on population problems, Indian science in general and ecology in particular, and on potential cooperative studies including synthesis efforts.

AFGHANISTAN

I visited in Kabul primarily with a group from the US AID program, the Agricultural and Science faculties of the University, and the Ministry of Agriculture. This group is interested in initiating ecological research and there is a sufficient number of capable scientists from the faculties of Agriculture and Science and the Ministry of Agriculture to carry on such work. Many of these individuals obtained either master's or doctoral degrees in North American universities. All that limits good work from being done there, in my opinion, is a little organization and money. Costs are low, but incentive is low because of alleged graft among the scientists and administrators.

Of particular interest to me was discussion, and viewing of slides, of the major ecological zones of the country and particularly the areas covered by the nomadic people. The nomads now move about 400 miles per year in their transit throughout the country. They may also be seminomadic because they have small, scattered patches of planted grain and they come back to harvest them if conditions warrant. A family or group of families tend to move around together. A family may have from 50 to 500 sheep and goats as well

as some cattle and camels, and, for the northern tribes, some horses. There is one area in the country in which many of the nomads from the north and the south rendezvous each year. At that place and time there may be a concentration of two million animals. There has been a long history of intensive grazing both by the flocks from the local villages and from the nomadic herds. Expectedly, many areas show a great deal of overuse and erosion. (The visit in Afghanistan really brings to life the book entitled "Caravans" by Michner.) Of particular interest was the simultaneous scientific input in Afghanistan from the Soviet Union, from Germany, and from the United States.

USSR

I spent several days visiting four research institutes and universities in the Soviet Union. I had an opportunity to visit in not only Asiatic Russia, but also Siberia, and, on my way out, in Moscow.

Tashkent

I entered the Soviet Union through Tashkent from Kabul. I had an opportunity to visit in this city at some of the standard tourist stops, to visit in a flat (of my car driver's) in one of the large apartment houses, to visit in both small and large stores, and restaurants. Obviously, I gained a great number of lasting impressions.

I visited at a forestry institute in Tashkent which serves the several central Asian republics, including Uzbek, Turkmenian, Kazak, Tadzik, and Kirgiz. Their work is concerned with both natural and introduced forests including the stopping of drifting of sand, development of shelter-belts in irrigated areas, improving the quality of tree species, and revegetation within towns. They also have studies on insect pests of trees, mechanization of harvesting and processing of wood, and economic effects of forestry. This institute has about 295 workers including 62 senior scientists. The work is more of an applied nature than a basic research or ecological nature.

Tadzik Academy of Science

My major contact there was Dr. Yousufs Nasyrov, Director of the Institute of Plant Physiology and Biophysics. This was one of two very useful visits in the Soviet Union. The program at this institute includes studies on bio-chemistry and photosynthesis, transport of carbohydrates, amino acids and minerals in relation to leaf structure, physiological genetics, plant growth studies in general, and macrobioenergetics in the ecosystem. Nasyrov has about 115 workers in the institute including 32 scientists and 12 post-graduates. It was interesting to note that there was also one Indian graduate student, seconded from a university in Moscow, doing his PhD. work at the research institute in Dushanbe. We visited the research station in Dushanbe, a botanical institute in the foothills, and a high mountain research

site. Nasyrov speaks good English and is well acquainted with some of the work in his area of plant physiology in North American institutions, especially those in California. His work covers from Desert to Alpine Tundra Biomes.

The laboratory in Dushanbe was relatively well equipped with instruments of a variety of vintages. They had good electron microscope equipment, but on the other hand their analytical balances were of the chain type rather than being automatic. They were doing considerable chromatography, autoradiography, and radioisotope work. The library in the institute seemed to cover relatively well the world journals, but there were also a large number of political books. During my visit in Dushanbe I had a brief visit at the Academy building where two students were undergoing dissertation defense examinations for the "candidate" degree. Late that night I got to go to a banquet for these two successful candidates.

We drove for about 3 hours from Dushanbe up a mountain river valley to a high elevation research station. There were relatively few trees in these mountains, there was evidence of rill and stream erosion and overgrazing, but some areas at high elevation under protection had lush subalpine meadow communities. It was interesting to identify the plants; I was surprised I could recognize perhaps a majority of the genera of the dominant plants.

Nasyrov's scientific work seems to be relatively well supported. His budget was approximately 120,000 rubles in salaries, 150,000 rubles in equipment and capital items, plus another budget for expenses, travel, supplies, etc. He indicated salary rates were about 125 rubles per month for a technician, 175 rubles for an executive assistant, and 250 rubles per month for a beginning PhD. I believe an academician in the Soviet Union makes 450 to 500 rubles per month but also has some perquisites. His funds seemed to come relatively trouble-free and in healthily increasing amounts.

Nasyrov is highly interested in IBP research, he volunteered his data for intensive analytical studies, and he would like to visit in the United States. I was particularly interested in seeing the field sites at the high elevations where they were doing a variety of field studies on biomass dynamics, energetics, and micrometeorology in herbaceous plant communities. Unfortunately, the work in this institute seems restricted to botanical, edaphic, and meteorological phenomena and does not include insect, microbial, or large animal studies.

Visit at the University in Alma Ata

I made an impromptu visit at the university in Alma Ata. There are about 12,000 students there, but perhaps 40 to 50% of them are corresponding students. Most of the university is located in eight large buildings without any sort of campus atmosphere. I was able to encounter students in the botany and zoology areas with whom I could converse either directly or through an interpreter. I had an opportunity to see some of the facilities in the university and meet some faculty although it was final examination time

and people were very busy. The university was singularly non-impressive with respect to facilities and ideas, i.e., based on my brief visit. I was also able to see some of the plant communities in the lower mountains nearby.

Institute of Geography for Siberia and the Far East

This was a second highlight in my visit to the USSR. This institute is headed by Academician Victor Sotchava and is very extensive, perhaps to match the extent of Siberia! Their work is carried out at various locations in Siberia and is concerned both with steppe and taiga vegetation. I have in my copy of the 1964 Russian atlas mapped the location of several of their studies. Furthermore, Sotchava has sent me several Russian publications describing their research areas and their concept of "geosystems." The Institute of Geography has some 30 to 40 years of studies planned; they will have 15 locations in Siberia where long-term studies will be conducted with approximately 15 to 20 scientists and 20 to 30 students per location. They also have extensive building plans in progress and new buildings in construction. The institute has 10 laboratories including geochemistry, physical geography, geomorphology, geology, hydrology, population geography, industrial geography, regional geography, cartography, and medical geography. There are about 130 scientists in the institute and 130 support staff, but it was unclear exactly how many of the scientists are PhD. level.

While in Irkutsk I had an opportunity to take my third day as a "real" tourist and visit Lake Baykal. During this trip I had opportunity to make some side excursions into the meadowlands and forests. I also had an opportunity to visit impromptu in a small village near Lake Baykal.

I was able to visit Sotchava in his home where he has an extra-large flat (by their standards) in a large apartment near the institute in the city. He maintains two rooms as home office where he also has a large and considerable collection of books on geobotany, vegetation mapping, and related areas. Sotchava told me of their past work, of related work throughout the Soviet Union, of conferences they have planned, and of their publication procedures. I also had an opportunity to inquire into their systems analysis techniques and use of computers. Most of the scientists in the research institutes I visited were not conversant on such techniques, in my opinion. I did have an opportunity to visit (on an airflight to Novosibirsk) with an engineer who was well up-to-date on systems analysis and operations research techniques. From his descriptions, I would class their computers as somewhere between our "second generation and third generation" systems.

Sotchava told me also of the economic development plans for Siberia including plans for warming the Arctic, for oilfield development, for new cities and settlements, for use of natural hot water systems, and for land drainage. There are now about 25 million people in Siberia and their plans are to increase it to 100 million. Even with this increase there will also be large areas of natural parks left; about 60% of the area of Siberia will be left in forest reserves. Sotchava discussed problems of "reserves for

humanity" throughout the world and emphasized there are three remaining - desert, wet tropics, and the taiga. He indicated he feels the major problems of the first two have been solved but solutions are needed for the taiga.

It was particularly informative in discussing with Sotchava the steppe and grassland work throughout the Soviet Union. I had an opportunity to get Sotchava's ideas on international syntheses on grasslands. He thought (i) they must be done within the MAB context, (ii) many of the people involved should be government people operating in commissions, and (iii) there should be many committees and subcommittees such as one on typology of geosystems. Sotchava is a prolific author and his staff seemed to produce well; this might be a location of potential value for future visits. He also informed me of future plans for symposia on ecosystem topics. He is to notify me of details. I was invited to return and spend more time with them in the field and in symposia and to contribute scientific articles to their journals.

POLAND

I visited several locations in Poland and was impressed by the IBP ecological work in progress and already conducted. Major aspects are outlined below:

Warsaw, Institute of Ecology

I visited in the Institute of Ecology of the Academy of Sciences with Petrusewicz, Breymeyer, and others. It has about 220 workers including 72 scientists, 80 technicians, and the remainder are helpers. Their work includes grasslands, fields, forests, and aquatic sites, with both basic and applied aspects. They have increasing interest in systems approaches and biomathematical techniques. In the past their work in this area has been in routine statistical analysis as well as some population dynamics and sampling. However, they would like to have additional people study system approaches and apply them in Poland.

Research Institute at Turov

At Turov I visited with Rsyzkowski who explained the studies in agroecology. This location is unique as their headquarters is in a large old castle or mansion. This building, following the revolution, was converted into a field station and some of the scientists live in this building and all of them have laboratories there. The work at Turov was started in 1952 with preliminary emphasis on field and shelter-belts. They are studying primary productivity, both aboveground and belowground studies. Detailed discussions were held with various scientists working there; I also saw the field sites and discussed methods of sampling and analysis.

At Turov there are nine scientists representing such areas as mammalogy, climatology, bacteriology, entomology, soil zoology, general zoology, and botany. There are also four cooperators from other institutions doing work on nematodes, bacteria, plants, and soil. There were about 15 technicians, 10 seasonal helpers and 10 students spending one month each at that site. In addition to hearing formal discussions of their work I presented a seminar on North American IBP studies with emphasis on USA analysis of ecosystems and grassland studies. They seemed relatively well supported, but seemed to have the usual problems with arranging for budgets. They have a difficulty in obtaining foreign equipment, but this is due to the lack of dollars rather than the lack of funds.

Krakow

I met with a group of eight people at the university in Krakow to talk about their field studies, laboratory metabolism work, calorimetry studies, food habit and nutrition studies, and balance of energy flow in small mammals. Grodzinski is the scientist in charge there and is impressive. He is relatively young, enthusiastic, productive, and personable. He seems well trained and aware of the current literature. He shows a great deal of ingenuity in their bioenergetic work.

Grasslands Laboratory

Breymeyer is director of this laboratory which has about 17 scientists and 17 technicians. They work out of the Academy of Science, Institute of Ecology, at Warsaw but do a great deal of their field studies about 15 miles from there. The scientists include about three botanists, two microbiologists, two soil scientists, and 10 zoologists including the entomologists. They also have a soil chemist cooperating with them from the Agricultural Institute in Warsaw.

More than anywhere else in Poland, the work under Breymeyer's control seems to be organized on an ecosystem and energy flow basis. Perhaps their botanical work is weaker than the entomology and zoology work, but it is still adequate as support studies. Breymeyer is now developing a series of about 15 papers which summarize most of their recent work. She will be spending approximately six months in Panama (under Smithsonian Institution support) and may wish to do some spider studies on grasslands in North America. I had an opportunity to visit the meadowland where they are doing a great deal of their IBP grassland work. This cultivated meadow may have been seeded years ago, it is fertilized, and it was mowed for hay. There is also a native meadow adjacent which is studied for comparisons. The complexity of the food web is greater on the native meadow than on the cultivated meadow.

UNITED KINGDOM

I met for about a day and a half at the IBP headquarters in London. The only one present was Hadley who came over from his Paris office and I also talked by telephone with Tony Gore. I was singularly unimpressed by the IBP office in London; it seems entirely a paper operation, and perhaps a not very intensive one at that. During this time we had an opportunity to discuss the proposed prospectus for synthesis on grassland information on an international level. This prospectus had previously been evaluated by a United Kingdom committee. They do not understand that synthesis is more than comparative tabulation, evidently. Hadley is sympathetic to the proposed effort. He brought me up to date on some of the international aspects of PT in IBP and its possible merging into MAB.

ICELAND

The last stop on my trip was at Reykjavik, Iceland, where I visited with scientists in the Agricultural Research Institute. This was particularly interesting because I did some consulting in Iceland three years ago and had an opportunity to see the followup on some of the items discussed. I was particularly impressed by the work of Gunnar Olafson who was leaving shortly to complete his PhD. in Norway. Olafson will combine for a dissertation many of the ecological and nutritional studies they have been doing in the past years.

The botanical survey work on the highlands is progressing well, at least in the phase of data accumulation. There is going to be a wealth of information there available for analysis in the very near future, but I doubt if they will have the ideas, energy, or facilities to capitalize upon it. I also had an opportunity to visit an area near Mount Hekla where volcanic eruptions had taken place in early May. Lava was still flowing and the effect of ash fall on the surrounding rangeland was examined. I also had opportunity to spend a day with Thorsteinsson and Olafson working on a manuscript reviewing the ecology of Icelandic ranges.

GENERAL SUMMARY AND IMPRESSIONS

The above comments are only brief extractions from my notes. Of course, I have omitted most of the items concerned with the ideological differences in various countries, the social habits, standards of living, and so forth. I was impressed by the different ways Homo sapians exist and mechanize their societies (I can add elephant, camel, and water buffalo dung to the kinds I have had on my boots!). I was particularly impressed, however, by the role of the scientist in most of these countries vs. the USA.

It seemed to me as if their scientists had much more time to do science and much less time was required to obtain financial support. Larger numbers of support staff were available, especially in the Soviet Union, Poland,

and India. Scientists in all of the countries seemed eager for information about recent developments in North America. An exception possibly was many Afghanistan scientists were not really concerned, except those who had been in North America previously.

The scientist has a relatively higher position in the community in many of these countries than in North America. This is when you compare scientific salaries relative to those of tradesmen such as carpenters, bricklayers, etc. Even so, the standard of living in most of these countries but Australia leaves much to be desired (by our standards). One discouraging aspect about Australia was the relatively high amount of income tax paid by professional people. Yet they were able to maintain a relatively high standard of living on their salaries.

I was particularly impressed by the need for more international travel on a reciprocal basis. I had opportunity to visit with individual scientists in their work, in their homes, in pubs, and in restaurants. A great deal of personal philosophy was exchanged as well as specific technical information. Informal discussions over beer, vodka, or scotch and during rides in jeeps were probably more useful and open than formal meetings.

On a political and economic basis, I was appalled by conditions in India and somewhat frightened by the resources in the Soviet Union. Personally, I see no solution to the problem in India other than compulsory sterilization after two children; this would have to be imposed and enforced by the government. The poverty and population pressure in Banaras, a very old city, was appalling. I was told there are probably near 600 million people in India; some of the scientists reckoned the carrying capacity at near 300 million! Banaras Hindu University is the largest resident university in Asia (still only about 12,000 resident students) and about half of the faculty live on campus. But even so, and especially for the younger faculty in whose homes I visited, their lives are drab and hard. The Soviet Union impressed me in two main ways, i.e., the magnitude of the country and resources and the complete control by the government over almost all items. The people I saw had enough to eat (albeit no variety nor quality by my standards), adequate clothing, and limited space in which to live. However, everything else seemed to be going into development of the nation, its industrialization, mechanization of agriculture, and so forth. Their natural resources are fantastic, especially in Siberia. It will be extremely interesting to see what will happen to that country in another 25 to 50 years; they have taken tremendous strides in development since World War II from what I could tell. The major question I ponder is, "Is the initiative so inherent in North American capitalism a necessary ingredient for rapid development of a nation?" I saw many instances in the Soviet Union where there appeared to be a great deal of copying of things from other countries. This may help in raising their standard fairly rapidly under their system, but can they continue in this manner to make advances over other nations without extreme sacrifices, perhaps as has been done in the space effort?

The discouraging thing about the whole trip was the large amount of time spent in travel per se, in waiting in airports, in arrangements of

"getting from here to there," and in "breaking the ice" of formality. Perhaps this was inevitable considering the number of locations I visited. More advanced planning might have eased the pain somewhat. Because of lack of certainty of support, I did not make all arrangements in advance (e.g., I had only my Australian visa when I left the USA, the others I arranged en route!). I was fortunate not to have any health problems throughout the trip considering the questionable nature and origin of food I ate in south-east Asia, the dried fermented mare's milk in Afghanistan, borsch in Russian villages, and sheep's heads in Iceland!

All in all, it was a useful and enlightening experience even though an extremely busy and exhausting one.

APPENDIX A

TRIP ITINERARY

April	12-13	Fort Collins, USA to Surfer's Paradise, Queensland, Australia	Travel (including date change)
	14-23	Surfer's Paradise, Queensland, Australia	International Grassland Congress
	18-19	Surfer's Paradise, Queensland, Australia	3rd IBP Grasslands weekend Working Group Meeting
	24-30	Canberra, ACT, Australia	CSIRO and ANU laboratories
May	1- 8	Borken Hill, New South Wales, Australia	Arid Zone Research Conference
	9-31	Canberra, ACT, Australia	Ecological Systems Analysis Workshop
	16-17	Canberra region	CSIRO Wildlife Research weekend visit
	23-24	Hamilton, Victoria	Victoria Department of Agricultural Pastoral Research Laboratory weekend visit
	30-31	Sydney and Prospect, New South Wales, Australia	Wool Board and CSIRO Division of Animal Physiology, weekend visit
June	1- 2	Canberra, ACT, Australia	Division of Land Research and Division of Plant Industry
	3	Cronulla, New South Wales, Australia	CSIRO Fisheries and Oceanography Division and universities
	4- 6	Armidale, New South Wales, Australia	University of New England and CSIRO Laboratories
	7-11	Alice Springs, Northern Territory, Australia	CSIRO Rangelands Research Unit

APPENDIX A (Continued)

June	12-14	Bangkok and Northern Thailand	School of Forestry, Kasetart University
	15-19	Delhi and Varanarsi, India	University of Delhi and Banaras Hindu University
	20-21	Kabul, Afghanistan	US/AID, University of Afghanistan, and Ministry of Agriculture
	22-29	Tashkent, Dushanbe, Alma Ata, Irkutsk, and Moscow, USSR	Academy of Science, Research Institutes, and universities
	30- 2	Warsaw, Turov, Krakov, and Warsaw region	Institute of Ecology, Academy of Sciences, universities
July	3- 4	London, England	Central IBP Office
	5- 7	Reykjavik, Iceland	Agricultural Research Institute
	8	Reykjavik, Iceland to Fort Collins	Travel

APPENDIX B

TO: Interested Persons

FROM: International Coordinating Committee
IBP Grasslands Working Group

SUBJECT: Proposed international synthesis project

DATE: 12 May 1970

The attached document was developed as a draft for discussion about plans for cooperative synthesis and integration of information on grasslands on an international scale. Although the needs are obvious, we have enumerated some of the reasons for the proposed project in this document.

This document arose from discussions during the 3rd meeting of the IBP PT Grasslands Working Group. This meeting was held 18 and 19 April at the time of the XI International Grassland Congress in Surfer's Paradise, Queensland, Australia. A small group was named at that meeting to convert the discussion notes into a working draft to be discussed later by several of the participants. The second meeting was held 4 May at the time of the 3rd Australian Arid Zone Research Conference in Broken Hill, N.S.W., Australia. A small group at that meeting was named to revise the document into its present form.

This draft is being circulated for your information and consideration. Your comments and suggestions are solicited. Send them to Dr. R. T. Coupland, Chairman, International Coordinating Committee, Matador Project, University of Saskatchewan, Saskatoon, CANADA.

We expect this topic will be discussed more at the proposed 4th working meeting of the IBP PT Grasslands Working Group to be held at the time of the IV General Assembly for IBP in Rome in late September. At that time we would seek means of improving the proposal and consider sources of funding. To date, the main suggested means of funding include: (1) Direct governmental funding from several participating nations; (2) Support from an international organization such as UNESCO; (3) Support through a grant from a foundation such as Ford, Nuffield, or Rockefeller; and (4) Support as a terminal phase of IBP by one of the participating nations having a large grassland program.

PROSPECTUS

INTERNATIONAL SYNTHESIS OF INFORMATION ON GRASSLANDS

PREAMBLE

Immediate action is required to develop structures and secure staff whose role will be to conduct international syntheses. Without such early and definite planning the major investments by several nations in IBP grassland studies will not be capitalized upon. Examining data from many countries and environments, and testing broad theoretical and practical questions, will provide a major benefit to resource management for all nations in the future. The IBP PT Grasslands Working Group proposes early development of a small but active international grassland synthesis project.

INTRODUCTION

The Problem of Synthesis and Integration

Many of the basic objectives within IBP Grasslands studies will be obtainable only after the establishment of an international organization whose function is synthesis and integration. A world-wide structure must be developed through which data, ideas, and information can be exchanged and synthesis programs initiated and coordinated. The IBP offers a unique opportunity to demonstrate not only a whole new concept in international cooperative research, but also to provide solutions to problems which are on a world scale and require the input of many scientists working in a diverse set of environmental conditions.

Many countries have established ambitious internal IBP grassland studies and are obtaining useful information. Furthermore, there are many IBP-related grassland investigations in these and other countries that have been interrelated to varying degrees. At least $5 to 10 million per year will be spent in grassland research at peaks of the programs (30 national programs at $200,000 for example). However the ultimate success of the total program may well be measured by the degree of international synthesis of data and the ability to transcend traditional political boundaries in order to solve problems which are only artificially separated by these divisions.

Example Theoretical and Practical Implications

A priori it is not possible to predict all the kinds of findings to be expected from the proposed work. Science is replete with examples of findings and principles of unexpected importance arising in studies of this nature. Commonly, combining parts into a whole in a synthesis results in a new level of knowledge about the system which can not be predicted from the component segments alone. Although many presently unpredictable

ideas and concepts will arise once the truly international endeavor is operational, it is possible at the outset to define a number of fundamental concepts which could be evaluated profitably by a group of scientists charged with the responsibility of integrating and synthesizing the international effort (Figure 1). The clarification of these concepts is uniquely made possible by some of the basic precepts on which many IBP studies are founded: (1) the data will be available from many different environmental conditions across the earth and (2) in many cases the data will be taken within the framework of a systems approach.

Each of the examples of the relationships enumerated in the Appendix is of both theoretical interest and practical consequence and will eventually play a significant role in resource management. The required data, whether it originates from IBP-generated studies, is extracted from IBP-related studies, or is from previously published material, will come from grasslands throughout the world which occur over a wide range of temperatures, amounts and distribution of precipitation and edaphic conditions.

Because of the large number of nations involved, and because of the many different groups in some nations, no single national effort can effectively undertake by themselves the total synthesis effort. This diversity of involvement also precludes funding entirely within a single nation and, in a practical sense, perhaps eliminates the chance for effective shared funding. Therefore, funds will be sought from an international source or a foundation whose interests in grasslands transcend political boundaries.

OBJECTIVES

An international project is needed in which a central staff may be assembled to focus on analysis, integration, and synthesis of experimental data from IBP studies on grasslands and from related studies. This group and program should be initiated prior to the planned termination of field studies in the international program.

The tasks of the group should include at least the following efforts:

1. Serve as an international center to collect, organize, process and store data from IBP PT, PP, CT and other grassland researches and from related investigations.

2. To examine problems of theoretical and practical importance (e.g., see Appendix) concerning the implications of grassland structure and function on resource management and to publish this work in the scientific journals.

3. Assist in describing the program and its results to the international scientific community, international governmental groups, and national programs related to the effort.

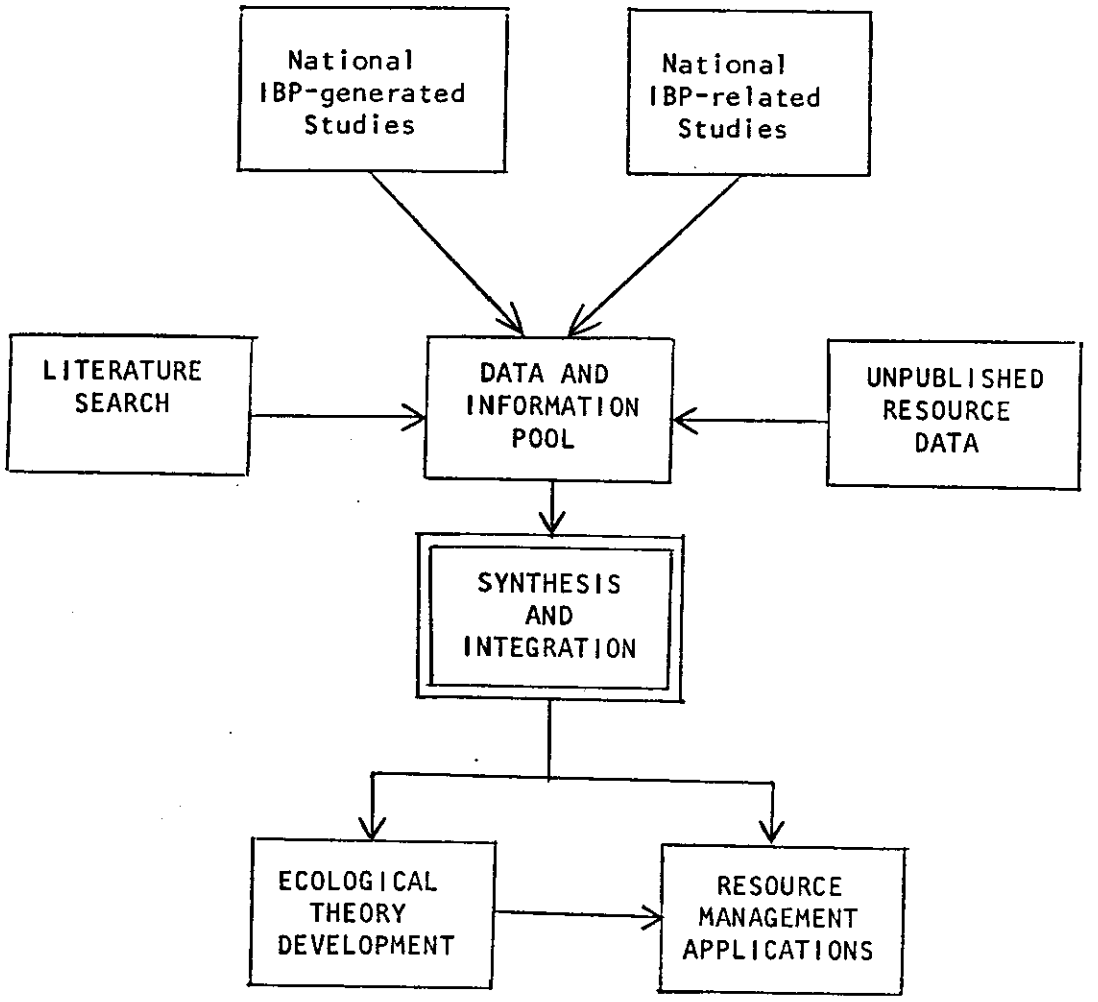

Figure 1. The general relationships between information available from various sources and eventual development of ecological theory and resource management applications.

The central staff could take over the responsibility of communications for IBP studies on grassland and produce and extend the current newsletter. This group naturally would participate actively in promoting international coordination through development of international working groups. The international synthesis group would also assist in and facilitate exchange of scientists in participating programs. The synthesis group will provide liaison with such agencies as FAO, UNESCO, WMO, and others having interest in grassland investigations.

ORGANIZATION STRUCTURE

The synthesis effort will operate under advice from the IBP PT International Coordinating Committee of the Grasslands Working Group. Continuity of the synthesis effort will be facilitated by the appointment of a permanent Coordinator, who will have direct responsibility for organizing the activities of the control team and of the support staff (Figure 2).

The core of the organization responsible for executing the tasks listed will consist of a group of capable, experienced scientists active and recognized in their respective fields (Figure 2). They will come together from their respective countries to work as members of an international team for a limited period. To this task they will bring their diverse experience in the field. At the end of their association with the central team they will return to their parent organization and countries with greatly enhanced experience and capabilities. It is envisaged that periods of service with this central team will range from 12 to 24 months, and that rosters will be so arranged as to permit adequate overlap, and hence continuity of effort (Figure 3). The team will be selected and rostered as far as possible to provide continuing representation of different regions and disciplines, and all members should have an interdisciplinary orientation and outlook.

The support staff would provide computer programming, bibliographic assistance, administrative assistance, and secretarial support to the scientific staff, both resident and visiting.

Many nations may wish to temporarily assign scientific staff to the international synthesis center to work with the central team on specific problems. Most of these assignments probably would be 6 to 12 months duration (Figure 3). During their tenure, they would receive technical support and assistance from the Coordinator.

The International Coordinating Committee will communicate directly with representatives of various national programs. This committee will be responsible for selecting the Coordinator, and will then collaborate with him, and with national and specialist committees, in selecting the members of the central team. For the period of their appointment, these members will give the whole of their time and attention to the work; in some cases this may be arranged by an ad hoc contract appointment, in other cases

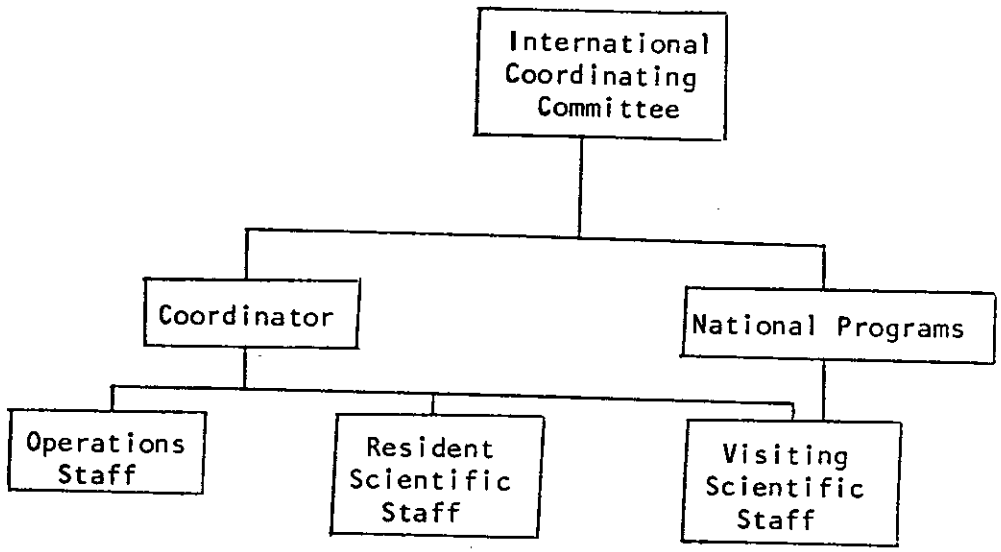

Figure 2. Organizational structure for an international synthesis center for IBP grassland studies.

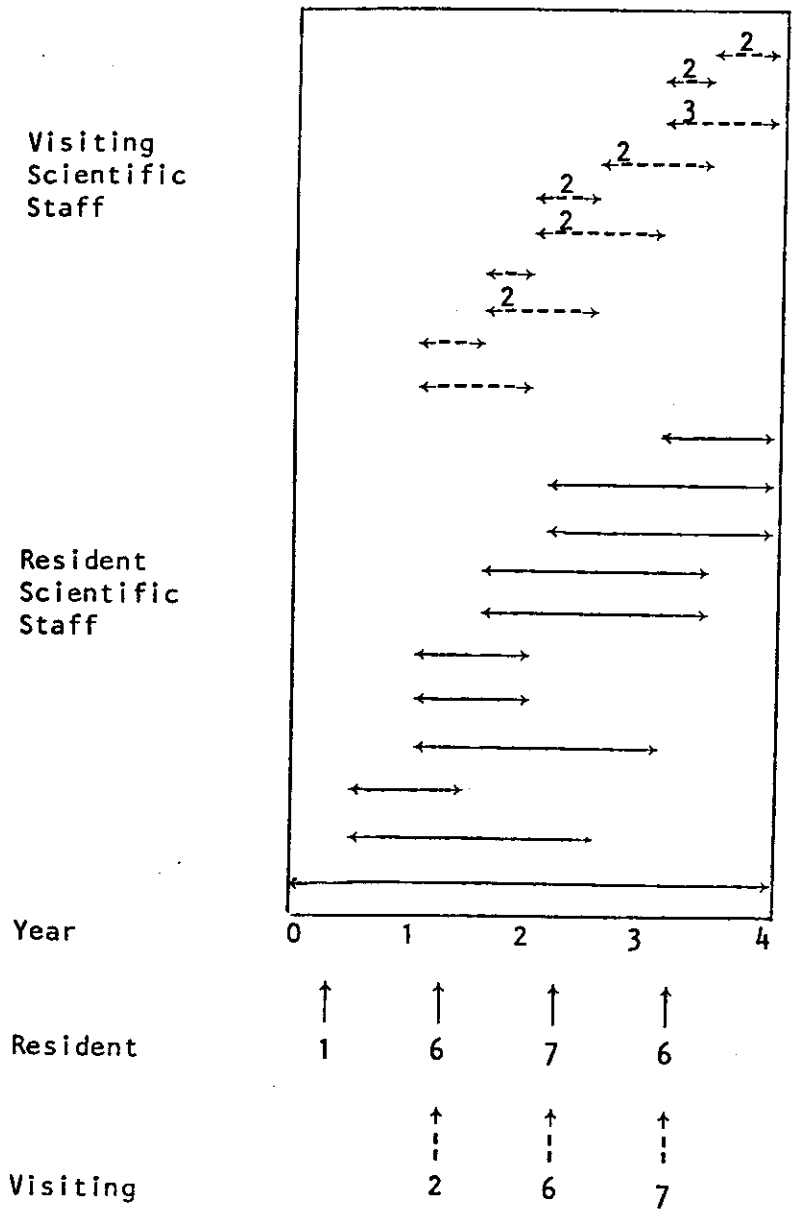

Figure 3. Example time phasing of resident and visiting scientific staff based on a 4-year project duration.

by secondment or leave from their continuing employment in their home countries.

The International Coordinating Committee and the synthesis groups both will be in active contact during the life of this project with related efforts in IBP, e.g., programs in the Tundra, Woodland, or Arid Land groups and related efforts in resource management agencies.

Approximate numbers in the groups in Figure 2 are: International Coordinating Committee, 6 to 9; Coordinator, 1; Operations Staff, 10; Resident Scientific Staff, 5 to 7; Visiting Scientific Staff, 4 to 8.

Facilities necessary would include office and data laboratory space, library collections and services, high-speed digital computer availability with remote processing capabilities, nearness to airport with adequate international connections, and adequate international communication facilities. Preferably, facilities for housing of short-term visitors should be available.

OPERATIONAL CONSIDERATIONS

This group should begin to function as soon as possible after 1 July 1971 and continue through the end of the formally defined IBP program (probably June 1972) and for three years thereafter. Initial activities would require that a coordinator be retained early and, preferably, for the duration of the program. He would be active in securing staff and developing facilities during the operation of the program. Early in the program several working meetings of short duration would be held with the purpose of seeking data from the national programs.

The program would require a budget for resident scientific staff and support staff, for arranging and conducting workshops, for travel of the staff, for computing costs, and for supplies, communication, publication, and various other operational costs. The expected cost of the program would be about $250,000 per year (plus indirect costs) at the peak phase. This level probably would not be reached until the third year and it would decrease in the last year. No major permanent facility would be required and relatively little investment would be made in equipment. Most of the cost would be in personnel, computer time rental, supplies, travel and meetings, etc. Note that at peak operation this cost would be perhaps 1 to 5% of the collective annual budget for field and laboratory grassland programs in the nations involved.

APPENDIX

Some examples of theoretical and practical problems to be examined in synthesis efforts utilizing results from grassland researches.

I. RELATIVE EFFICIENCIES OF MATERIAL AND ENERGY CYCLING

A. Energy Relations in Grassland Ecosystems.

1. Efficiency at each trophic level.
2. Efficiency of whole system.
3. Efficiency of primary producer to harvested crop.
4. Efficiency as related to system complexity as measured by network flow theory.
5. Comparative rates of seasonal biomass accumulation.

B. Water Relations in Grassland Ecosystems.

1. Efficiency of utilization of precipitation and soil moisture.
2. Comparative degree of response to supplemental moisture in single trophic levels and the whole system.
3. Rate and extent of water movement between trophic levels.
4. Relative effects of the amount and the distribution of precipitation.
5. Comparative effects of moisture on herbage palatability to various herbivores.

C. Nutrient Relations in Grassland Ecosystems.

1. Efficiency of nutrient uptake in various grasslands.
2. Comparative degree of response to supplemental nutrients in single trophic levels and the whole system.
3. Rate and degree of nutrient movement between trophic levels.
4. Nutrient inputs and outputs from the whole system.
5. Diagnostic values of specific nutrients in different trophic levels.

II. STRUCTURE-FUNCTION RELATIONSHIPS

A. Species Diversity and Productivity of each Trophic Level and in the Whole System.

B. Diversity and Response to Perturbations (e.g., Grazing, Precipitation) of the System

C. Concentration of Dominance as Related to Productivity, Turnover, and Stability.

D. Comparative Structure and Productivity of Crops, Native Grasslands, and Introduced Pastures.

E. Spatial Patterns of Species in Relation to Productivity and Stability.

III. OPTIMUM CONDITIONS FOR GRASSLAND MANAGEMENT

A. Comparison of Vegetational Structure as a Deterrent to Erosion.

B. Optimal Structure and Composition for Long Term Use versus Short Term Use.

C. Optimum Harvest Rates for Sustained Yield.

D. Evaluation of Introduced Species as Contributors to Rangeland Conservation.

IV. COMPARATIVE LAND USE SYSTEMS

A. Comparison of Native versus Introduced Grasslands.

B. Biologic and Economic Considerations for Crops (e.g., Small Grain, Sugar Cane, etc.).

C. Replacement Herbivores for Native Species.

D. Evolution of Multiple Crop Systems.

E. Inventory of Present Grasslands.

F. Continuous and Rotational Grazing Systems.