DISSERTATION

TOWARDS VALUE PLURALISM, KNOWLEDGE PLURALISM, AND RECOGNITIONAL

JUSTICE: IMPROVING INTEGRATION OF CULTURAL BENEFITS OF ECOSYSTEM

SERVICES IN ENVIRONMENTAL DECISION-MAKING

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ABSTRACT

TOWARDS VALUE PLURALISM, KNOWLEDGE PLURALISM, AND RECOGNITIONAL JUSTICE: IMPROVING INTEGRATION OF CULTURAL BENEFITS OF ECOSYSTEM SERVICES IN ENVIRONMENTAL DECISION-MAKING

This mainstreaming of the ecosystem services (ES) concept and approach is reflected in its adoption by governments and non-governmental organizations around the world, including in the United States: in 2015, a U.S. Federal Memorandum directed all Federal agencies to integrate ES information in their decision-making processes. In principle this momentum represents an opportunity for improved consideration of the cultural benefits of ES in decision-making, as part of the improved consideration of ES as a whole. However, there is concern that cultural benefits – and the plural values and multiple knowledge systems they reveal – are being left behind in processes of standardization in ES theory and practice. Cultural benefits challenge the emphasis on instrumental values common in the ES field. Further, in revealing the culturally contextual and situated character of all ES, cultural benefits challenge the universalizing and generalizing tendencies common in this field.

More meaningful consideration of the cultural benefits of ES, as one strand of a larger movement toward value pluralism and knowledge pluralism, is a question of both equity and ecological outcomes. On-going conversations and critiques in the ES field around how to create space for multiple worldviews, including multiple human-nature relationships and well-beings, are critical to bringing environmental management into alignment with environmental justice, including distributional, procedural, and recognitional justice for current and future generations.

In addition, ensuring a place for currently marginalized knowledge systems in ES theory and practice, including place-based and Indigenous ways of knowing, brings new solutions to the table and increases the adaptive capacity of managers and decision-makers at local and global scales as they face into growing global environmental challenges.

To support movement toward knowledge pluralism in ES theory and practice, the three manuscripts presented in this dissertation offer: 1) a conceptual framework that reveals ES-knowledge as a system, seeking to support personal and collective reflexivity around the role of worldviews embedded in our institutions and the implications of this (Manuscript 1); 2) a theoretical model of learning opportunities for integration of a diverse forms of knowledge, and explores how some cultural-benefits-knowledge-forms are more likely to convey non-instrumental, relational value aspects or holistic value perspectives, and more likely to be effectively considered at particular stages of decision-making (Manuscript 2); and 3) an Opportunities Framework that can be used to systematically identify available forms of cultural-benefits-knowledge, and the opportunities that exist to integrate these knowledge forms in a particular decision context (Manuscript 3). This final manuscript both introduces the framework and illustrates its potential by applying it to a past decision process: Elwha River dam removal and restoration in Washington State, U.S.A. Next steps for research and application of a knowledge-pluralist ES approach are discussed in the dissertation's conclusion.

ACKNOWLEDGEMENTS

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1. INTRODUCTION

The overarching goal of this dissertation is to support movement toward value pluralism and knowledge pluralism in environmental valuation and ecosystem management. I seek to demonstrate how improving consideration of the cultural benefits of ecosystem services (ES) is an opportunity to bring pluralism into ES theory and practice, and that this represents one important strand of the larger movement toward pluralism in environmental management. The ES approach is a particularly important arena in which to engage questions of pluralism: there is growing global interest from governments, the NGO community, and the private sector around the potential of the ES framework to integrate ecosystem values in decision-making (Adams & Morse, 2019; Cox et al., 2013; PCAST, 2011; Schaefer et al., 2015; Schleyer et al., 2015). This mainstreaming of the concept of ES is reflected in a recent Federal memorandum in the United States directing all Federal agencies to integrate ES information in their decision-making processes (White House, 2015). In response, prominent research teams are working to produce guidelines and best practices for integration of ES into United States Federal decision-making (e.g., Olander et al., 2015).

In principle this momentum represents an opportunity for improved consideration of cultural benefits alongside improved consideration of ES as a whole. However, there is concern that cultural benefits – and the plural values and multiple knowledge systems they reveal – are being left behind in this process (Gould et al., 2020a; Hirons et al., 2016; Steger et al. 2018). The cultural benefits of ES, also often referred to as cultural ecosystem services, have been defined as "ecosystems' contributions to human well-being in terms of the identities they help frame, the experiences they help enable, and the capabilities they help equip" (Fish et al., 2016, p. 212).

Despite their diverse contributions to human well-being (Chan et al., 2012; Martín-López et al., 2014; MEA, 2005), cultural benefits are consistently under-represented in research products intended to inform environmental decision-making (Adams & Morse, 2019; Gould et al., 2019; Milcu et al., 2013; Satterfield et al., 2013; Satz et al., 2013). This marginalization – particularly of categories such as cultural identity and knowledge systems which are less amenable to quantification and monetization (Manuscript 2, this dissertation) – can be linked to both the intangible, non-instrumental character of many cultural benefits of ES, and the fact that they arise through context-specific processes of co-production between humans and ecosystems (Fish et al., 2016).

Accurate understanding and meaningful integration of cultural benefits requires attention to value pluralism. Cultural benefits are increasingly associated with relational aspects of value or holistic value perspectives (Chan et al., 2016; Fish et al., 2016; Gould et al., 2019a, 2020a; Raymond et al., 2018), and as such they challenge the emphasis on instrumental values common in the ES field (Breslow, 2015; Raymond et al., 2013). And at a deeper level, understanding and integration of cultural benefits require attention to knowledge pluralism, i.e., the diversity of cultural contexts and knowledge systems from and within which cultural benefits arise and are experienced (Díaz et al., 2015a; Hirons et al., 2016). These concepts are essential to understand opportunities from improved consideration of cultural benefits of ES, but may not be familiar to all readers. Concepts related to value pluralism and knowledge pluralism, as well as new terms introduced in relation to *ES-knowledge* and *cultural-benefits-knowledge*, are defined throughout this dissertation in text boxes and are also included in a glossary at the end of this document.

Recognizing the cultural context and situatedness of ecosystem services and benefits challenges the universalizing and generalizing tendencies common in the ES field (Ainscough et

al., 2019; Díaz et al., 2018; Gould et al., 2020b; Steger et al., 2018). And more foundationally, the diverse human-nature relationships and well-beings associated with cultural benefits require that ES practitioners and decision-makers think beyond the utilitarian understandings of nature-as-object and reductionist notions of separation between nature and culture that pervade existing natural resource management institutions (Castree, 2003; Dongoske et al., 2010, 2015; Pierotti & Wildcat, 2000).

Standard application of the ES framework has been highlighted as an example of economic and scientific imperialism, in which only those knowledge products which can be validated by Western[1] science are able to inform environmental management (Persson et al., 2018; Thorén & Stålhammer, 2018). This represents a unificationist approach to knowledge integration, in which the suppression of ontological difference is admissible, and indeed required, to enable universal and generalizable discovery (Persson et al., 2018). In the context of ES, this has meant reducing conversations about ecosystems' value to only those benefits that are comprehensible when nature is believed to be an object, and when human relationship to nature is understood with respect to how nature-as-object can be alternately used, stewarded, or ignored by human agents (Muradian & Pascual, 2018). In turn, this implies the erasure of benefits arising within understandings of nature-as-subject, and human relationships to nature grounded on respect and reciprocity between human and non-human subjects.

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[1] I use the term "Western" throughout this dissertation, e.g., Western science, Western scholarship, and Western natural resource management, to refer to foundational philosophical assumptions arising from the Enlightenment period in European thought. These include elements of a naturalistic ontology such as a division between nature and culture and between subject and object. These dichotomies are enabled by the Cartesian notion of an atomistic self whose essence is not affected by relations, and the idea that humans are the only subjects possessing agency (Descola, 2005). These assumptions provide the ontological and epistemological terms of engagement for environmental management in societies colonized by Western Europeans (Howitt & Suchet-Pearson, 2006; Muller, 2012; Muller, 2014; Muller et al., 2019), and yet they are linked to only a fraction of possible human-nature relationships (Descola, 2005; Muradian & Pascual, 2018).

Increasingly, Western scholarship recognizes the need for ontological and epistemological pluralism (e.g., Barad, 2003). In the context of ecosystem valuation, knowledge pluralism is now viewed as a missing piece that confounds integration of plural values (Bremer et al., 2018; Diaz et al., 2015; Kenter, 2018; Raymond et al., 2018; Muradian & Pascual, 2018), and in environmental management more broadly (Howitt & Suchet-Pearson, 2006; Muller et al., 2019; Nadasdy, 2003; Vaughan, 2018). This body of literature calls attention to recognition of and respect for multiple human-nature relationships and ways of knowing as a foundation for equitable and meaningful integration of diverse understandings of well-being – and associated values and benefits – in decision-making (Bremer et al., 2018; Diaz et al., 2015; Muradian & Pascual, 2018; Pascual, 2021; Vaughan, 2018). The marginalization of cultural benefits in ecosystem assessment is intertwined with the marginalization of diverse human-nature relationships and understandings of well-being.

More meaningful consideration of cultural benefits, as one strand of a larger movement toward value pluralism and knowledge pluralism, is a question of equity and justice. Failure to create space for multiple ways of knowing ecosystems and well-being represents recognitional (epistemic) injustice (Lau et al., 2021; Martin et al., 2016). An ES approach characterized by economic and scientific imperialism can thus be understood to be out of alignment with environmental justice, with the active potential to cause harm by erasing the diversity of well-beings linked to diverse human-nature relationships. And in addition to considerations of equity and justice, the need for knowledge pluralism has been linked to improving ecological outcomes. For example, it is increasingly accepted that Indigenous knowledge systems and traditional management practices support biodiversity conservation (CBD, 2010; Fernández-Llamazares et al., 2020; Garnett et al., 2018; Ogar et al., 2020). Traditional Indigenous Territories make up

only 22% of the world's land surface, but host 80% of the planet's biodiversity (Sobrevila, 2008). Even if the objective of Indigenous-controlled areas is not biodiversity conservation, the outcome of Indigenous stewardship often achieves this goal (Jonas et al., 2017). In addition, these place-based knowledges bring additional potential solutions to the table, which can increase the adaptive capacity of conservation approaches and increase the potential for success in the face of management challenges (David-Chavez, 2018; David-Chavez & Gavin, 2018; Gavin et al., 2018; Nakashima et al., 2012).

This body of work lays foundations for a knowledge-pluralist ES approach, in which the legitimacy and validity of multiple knowledge systems, and the knowledge forms that arise within them, are recognized and respected (Tengö et al., 2012, 2014). Further, this dissertation explores whether and how broadened conceptualizations of ES-knowledge and ES-knowledge-use can enable more adequate understanding and meaningful consideration of the full spectrum of cultural benefits, and their associated plural values arising from diverse human-nature relationships and well-beings. This is accomplished through both theory-building and development of a decision-support framework for systematic identification of diverse cultural-benefits-knowledge-forms and opportunities to integrate them in environmental decision-making.

1.1 Research Gaps Filled by Manuscripts

Knowledge of ES benefit, i.e., *benefits-knowledge*, has to our knowledge never been explicitly conceptualized or defined. The forms in which ES-benefits-knowledge-claims are made available to decision-makers, and the aspects of value they most successfully convey, is a missing puzzle piece in research and theory around integration of cultural benefits in environmental decision-making. Fig. 1.1 lays out four interrelated areas of research that can

support more comprehensive understanding of the dynamics of knowledge of cultural benefits of ES, i.e., *cultural-benefits-knowledge*, and how this knowledge can be meaningfully considered in environmental decision-making.

Research into cultural ecosystem services (CES) has long focused on identifying and categorizing the cultural benefits of ES (Fig. 1.1A), and more recent effort has focused on understanding the plural values that characterize these benefits (Fig. 1.1B). Emerging conversations around CES theory (Chan et al., 2012; Fish et al., 2016), relational values (Chan et al., 2016, 2018; Himes & Muraca, 2018; Muraca, 2011; Muraca et al., 2016), and pluralist approaches to knowledge integration (Díaz et al., 2015a, 2015b; Tengö et al., 2012, 2014, 2017; Pascual et al., 2017) emphasize the need to move beyond these established research areas, and to focus more attention on the ways cultural-benefits-knowledge can inform decision-making. I assert that, in addition to research on ES-knowledge use and integration (Fig. 1.1C), researchers must also attend to an intermediary area of inquiry that has received little to no attention in ES theory and practice: the diversity of forms in which cultural benefits are known, and this knowledge made available to inform decision-making (Fig. 1.1C).

An emerging literature on ES-knowledge-use (Fig. 1.1D) has made important contributions to understanding the dynamics of ES knowledge at the science-policy interface (e.g., McKenzie et al., 2014; Posner et al., 2016; Ruckelshaus et al., 2015). Building on the work of Carol Weiss (Weiss, 1977, 1979, 1999; Weiss & Bucuvalas, 1977, 1979), this literature highlights modes of knowledge use that extend beyond instrumental uses, in which information is produced that directly satisfies a knowledge gap to provide a straightforward, technical solution, to include conceptual and strategic uses of knowledge (McKenzie et al., 2014; Owens, 2015). However, the ES-knowledge-use literature has thus far failed to critically engage with the

very definition of knowledge that underpins its inquiry. The term *ES-knowledge* tends to conflate

scientific information and knowledge, treating *knowledge* as "a body of information [tangible,

factual outputs of scientific research] learned and conveyed through scientific and policy

processes" (Posner et al., 2016, p. 1760).[2]
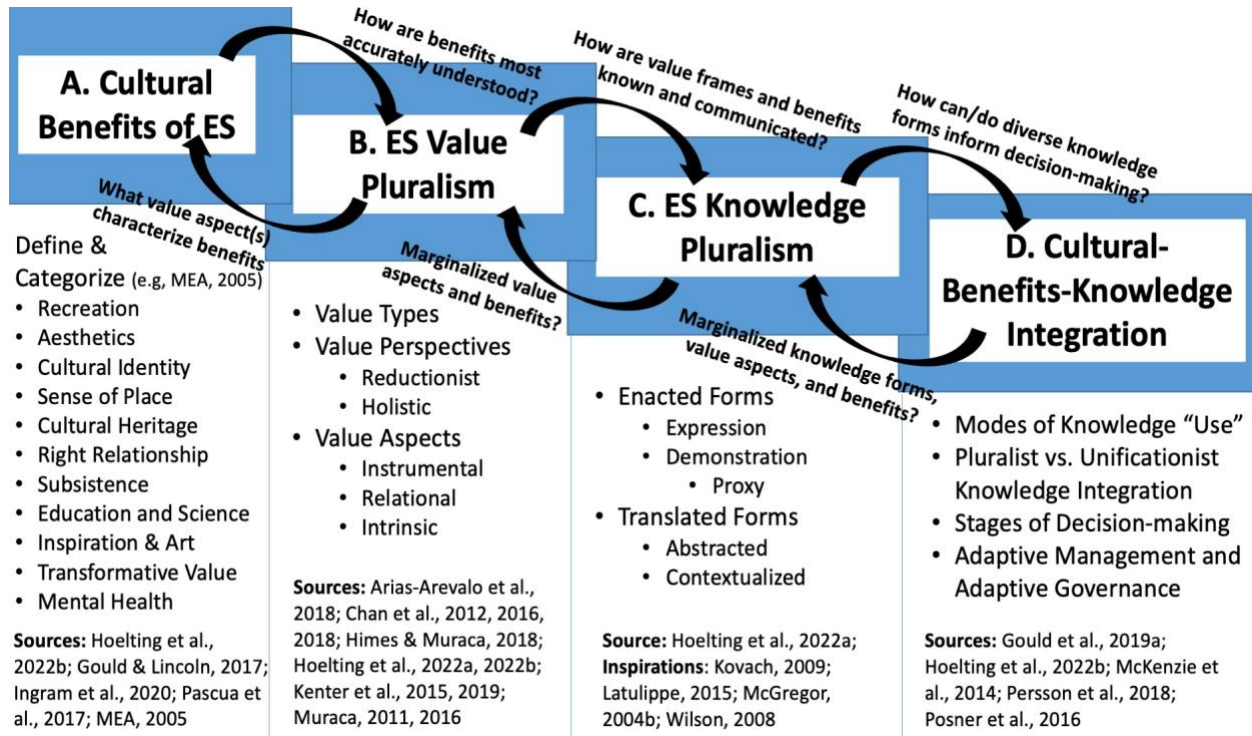
Figure 1.1: Intersecting areas of research – and research questions – to support a cohesive theory of ES cultural-benefits-knowledge, including how cultural benefits arise in association with diverse value aspects and value perspectives, and the knowledge forms through which they are conveyed to inform environmental decision-making.

Although ecosystem valuations are increasingly produced through participatory and

transdisciplinary processes that involve Indigenous and local knowledge (ILK) holders, a

common characteristic is that decision-relevant forms of ES knowledge must be validated in

accordance with Western scientific ways of knowing (i.e., McKenzie et al., 2014; Posner et al.,

2016; Ruckelshaus et al., 2015). Further, the decision relevance of a given ES-knowledge-

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[2] This definition is sometimes adopted only in an operational sense. For example, while Posner et al. (2016) specifically seek to understand how uptake of ES-knowledge-*as-scientific-information* can be improved, they also acknowledge that "knowledge itself" is best understood as an entire knowledge system.

product is often judged on its alignment with the heavily technocratic and economic rationalities of natural resource management institutions that privilege empirical measurement and quantification of value (Ascher et al., 2010; Gould et al., 2019a; Fish et al., 2016; Milcu et al., 2013).

The conceptualization of ES-knowledge-as-scientific-product, whether implicit or explicit, hampers our ability to recognize the culturally-embedded character of all ES-knowledge-forms. Further, it prevents us from exploring whether and how particular ES-knowledge-forms may succeed or fail to adequately convey plural values linked to the cultural benefits of ES. This body of work lays foundations for a knowledge-pluralist ES approach, in which the legitimacy and validity of multiple knowledge systems, and the knowledge forms that arise from them, are recognized and respected (Tengö et al., 2012, 2014).

1.1.2 Manuscript 1: Advancing Knowledge Pluralism and Cultural Benefits in Ecosystem Services Theory and Application

In this conceptual contribution, we (re)imagine ES-knowledge not solely as information but as a larger system. We demonstrate how this shift reveals and allows for the questioning of culturally-contextual assumptions about both ecosystems, well-being, and knowledge. Although there has been some acknowledgement of the larger knowledge systems that enable the production of Western scientific ES-knowledge-products (e.g., Posner et al., 2016), the term *knowledge system* has rarely been explicitly defined or conceptualized in the context of ES theory and practice. We assert that such a conceptualization is essential to enable space for knowledge pluralism, and by association value pluralism, in the ES approach and its contributions to environmental decision-making.

1.1.2 Manuscript 2: Opportunities for Improved Consideration of Cultural Benefits in Environmental Decision-Making

In this manuscript, we lay a theoretical foundation for inquiry into diverse cultural-benefits-knowledge-forms. Using a Critical Interpretive Synthesis of environmental management literature, we build a knowledge-pluralist theory of cultural-benefits-knowledge. This includes both development of a Typology of Cultural-Benefits-Knowledge-Forms and an Opportunity Map to support understanding of a broader suite of opportunities to learn from these diverse knowledge forms in the context of environmental decision-making. In addition, this manuscript presents empirical findings from this systematic literature review around both a) the likelihood that a particular form of cultural-benefits-knowledge will successfully convey a given category of cultural benefit and associated plural values. categories and value frames, and b) barriers and enabling factors that influence whether a particular form of knowledge will be meaningfully considered in decision-making.

1.1.3 Manuscript 3: An Opportunities Framework for Improved Integration of Cultural-Benefits-Knowledge in Environmental Decision-making

Decision-makers and researchers need tools to support implementation of value pluralism and knowledge pluralism in both ecosystem valuation research and practices of environmental management (Hoelting & Gould, 2021, 2022). Building on the conceptual and theoretical contributions of the first two manuscripts, this manuscript outlines a decision-support Framework for systematic identification of diverse cultural-benefits-knowledge-forms and opportunities to integrate them in environmental decision-making. The Framework can alternately be applied retrospectively to examine past examples of integration of cultural-benefits-knowledge in decision-making, and applied to assess opportunities for improved integration of cultural-benefits-knowledge in on-going decision processes. In this manuscript, we

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demonstrate the retrospective function of the Framework through application to a case study of Elwha River dam removal and ecosystem restoration.

1.2 Positionality

I (Kristin Hoelting), the primary author of this dissertation, am a member of the white settler community in the United States. I grew up between a Southeast Alaskan fishing community and an island in the Salish Sea, in Washington State. I came to this research out of a deep connection to place in the coastal temperate rainforest of the Western United States and awareness of diverse human-nature relationships and understandings of well-being.

I recognize that my cultural and academic conditioning reflect many elements of Western scientific philosophical assumptions that this dissertation seeks to decenter, including Judeo-Christian ontological assumptions about nature/culture and subject/object divides (Dongoske et al., 2015; Hoelting et al., 2022a). I have approached this work as an opportunity to learn beyond my initial assumptions, and have appreciated the support of members of my review team, dissertation Committee, and other reviewers who have challenged my tendency, for example, toward binary thinking. This work arises from and contributes to Western academic scholarship, but I hope it can contribute to conversations around cross-cultural (epistemological/ontological) spaces in both research and decision-making (Held, 2019; Kovach, 2009; Latulippe, 2015; McGregor, 2004, 2009, 2012; Reddekop, 2014; Wilson, 2008; Zanotti & Palomino-Schalscha, 2016).

1.3 Research Ethics

Qualitative data collection for the Elwha River dam removal and ecosystem restoration case study was approved in August 2016 under Colorado State University Institutional Review Board (CSU IRB) Approval #16-6728HH, and renewed in 2019 as Approval #19-8962H. I

contacted potential participants by email and telephone and provided them with an IRB-approved letter describing the research, its purpose, and that participation was voluntary and confidential. Consent was granted first in writing and confirmed verbally prior to the start of interviews. I stored interview data, including audio files and transcriptions, on my password protected computer. In addition, prior to initiating interview research, I shared my research interest with relevant contacts at Olympic National Park and with Tribal leaders from the Lower Elwha Klallam Tribe and received their approval to move forward with the case study.

1.4 Lead Author and Collaborator Contributions:

As lead on all three manuscripts, I (Kristin Hoelting) was responsible for the conceptualization, data collection, analysis, and writing for this body of work. The quality and potential impact of these contributions have been strengthened through brainstorming sessions and feedback from chapter co-authors, including members of a review team convened for the Critical Interpretive Synthesis (Manuscript 2) and members of my Ph.D. committee. Co-authors on each chapter advised on conceptualization and analysis, and contributed to writing in an editing role.

2. MANUSCRIPT 1: ADVANCING KNOWLEDGE PLURALISM AND CULTURAL BENEFITS IN ECOSYSTEM SERVICES THEORY AND APPLICATION[3]

2.1 Introduction

The ecosystem services (ES) metaphor has given rise to powerful tools and approaches for identification and measurement of a wide range of human benefits arising from the natural world (Kumar, 2010; MEA, 2005). However, many cultural benefits of ES,[4] defined as "contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable, and the capabilities they help equip" (Fish et al., 2016, p. 212), are consistently under-represented in ES assessments provided to environmental decision-makers (Bremer et al., 2015; Gould et al., 2019a). Categories of cultural benefit most marginalized in assessments include knowledge systems and cultural identity (Gould et al., 2019a; Hoelting et al., 2022b; Milcu et al., 2013), highlighting issues of recognitional injustice that remain to be addressed to bring an ES approach into alignment with environmental justice (Lau et al., 2021; Martin et al., 2016); the movement toward more meaningful integration of cultural benefits of ES in decision-making is intertwined with improved recognition and legitimization of multiple human-nature relationships, understandings of well-being, and knowledge systems more broadly.

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[3] Co-authors on this dissertation chapter include Dr. Doreen E. Martinez, Dr. Rudy M. Schuster, and Dr. Michael C. Gavin. This manuscript passed through U.S. Geological Survey internal review and has been preprinted in the repository SocArXiv at https://osf.io/preprints/socarxiv/p4wts/.

[4] Following Scholte et al. (2015), we adopt the term "cultural benefits of ES" as our primary terminology, rather than the term "cultural ecosystem services," (CES) to acknowledge the fact that cultural benefits are bundled with a variety of different ES categories, and to follow the evolution of the International Panel on Biodiversity and Ecosystem Services (IPBES) framework which removes the category CES and instead highlights the cultural context within which all ES arise. Categories of CES included in past CES typologies align with the categories of cultural benefits informing our thinking. See appendices to Manuscript 2 (Chapter 3) for a full list of cultural benefit categories and discussion of how they overlap with past typologies of CES.

The past decade has seen an explosion of scholarship around the challenges limiting meaningful inclusion of cultural benefits in both ES theory and practice (Chan et al., 2012; Daniel et al., 2012; Fish et al., 2016; Hirons et al., 2016; Milcu et al., 2013), along with associated challenges around their meaningful consideration in decision-making (Gould et al., 2019a; Satterfield et al., 2013; Satz et al., 2013). Much of this discussion has centered around the need to better address *value pluralism* (Arias-Arévalo et al., 2018; Jax et al., 2013). Scholars have emphasized that cultural benefits defy the classic utilitarian (instrumental) understandings of value, i.e., instrumental value aspects, that characterized the origins of the ES framework (Chan et al., 2016; Norgaard, 2010; Raymond et al., 2013). They have highlighted the need to look beyond instrumental value aspects to more adequately include both non-instrumental (relational) and intrinsic value aspects (e.g., Chan et al., 2016, 2018; Himes & Muraca, 2018; Muraca, 2011, 2016) and the shared/social benefits that extend beyond individual preference satisfaction (e.g., Gould et al., 2019b; Kenter et al., 2015; Ravenscroft, 2019). These conversations echo Indigenous voices and scholarship that have long articulated a more holistic value perspective, in which utilitarian (instrumental / substitutable) and relational (non-instrumental / non-substitutable) value aspects are mutually dependent and inseparable (LaDuke, 1993; Martinez, 2016; McGregor, 2004a, 2004b; Pierotti & Wildcat, 2000; Watson, 2018; Whyte et al., 2016; Wildcat, 2013).

However, to truly enable more meaningful consideration of the plural values linked to cultural benefits of ES, we must also attend to the larger question of *knowledge pluralism*, in the sense of diverse worldviews and valid forms of knowledge. Value pluralism and knowledge pluralism are intertwined; the plural values associated with cultural benefits arise from diverse worldviews, including diverse assumptions about human-nature relationship (ontology) and well-

being (axiology). Knowledge pluralism further implies diverse ways of knowing (epistemology) and generating valid claims about reality and well-being (methodology). Advances in theory around the plural values of cultural benefits have highlighted this inter-relationship, and catalyzed a growing movement to better understand and create space for multiple worldviews and valid cultural-benefits-knowledges, i.e., ways of knowing and providing evidence of cultural benefit, in the context of ecosystem valuation and decision-making.

In this paper, we elaborate two key concepts linked to knowledge pluralism that have received insufficient attention in evolving conversations around ES, and which act as barriers to meaningful consideration of diverse cultural benefits in decision-making. First, we call attention to *ES-knowledge-as-a-system*. The dominant conceptualization of ES-knowledge tends to conflate "knowledge" with "scientific information" (Posner et al., 2016), obscuring the overarching role of worldview in our assumptions about valid ES information. Improving awareness of the relationship between worldviews, ways of knowing, and valid forms of knowledge can support improved consideration of diverse cultural benefits and understandings of well-being that arise from multiple worldviews and cultural contexts. Second, we highlight *benefits-knowledge* as an undertheorized aspect of ES-knowledge and explore its dynamics at all levels of the ES-knowledge-system, from the *worldviews* that give rise to particular understandings and experiences of benefit, to the diverse *knowledge forms,* i.e. knowledge products and practices, that serve to convey socially legitimized – and hence validated – *knowledge claims* (Tengö et al., 2012, 2014) about benefit and well-being.

With this foundation, we are better positioned to examine knowledge claims specifically about cultural benefits of ES. A central question is whether cultural benefits of ES can be adequately recognized, comprehended, and considered when technical, utilitarian knowledge

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products are viewed by decision-makers as the primary decision-relevant forms of ES-knowledge (Hoelting et al., 2022b; Raymond et al., 2018). More explicit conceptualization of the ES-knowledge-system, and the diverse ways humans know and convey evidence of well-being, are critical starting points to enable movement toward knowledge pluralism in the context of ecosystem valuation and decision-making. They can support personal and collective reflexivity around the role of personal and institutionally-embedded worldviews (Gorddard et al., 2016). And they can help illuminate what is at stake when assumptions about human-nature relationship and well-being remain hidden, limiting decision-makers' ability to recognize and comprehend a full spectrum of valid benefits-knowledge-claims.

In **Section 2.2** we introduce key concepts that serve as building blocks for a shift toward knowledge pluralism in ES theory and practice, including a value-pluralist definition of ES benefits, a knowledge-pluralist definition to ES-knowledge, and the interrelationship between how humans know ecosystem functions (services-knowledge; ecosystem knowledge) and how humans know benefit and well-being (benefits-knowledge). In **Section 2.3** we bring these concepts together to conceptualize and illustrate the overarching ES-knowledge-system. In **Section 2.4** we use this conceptual model to explore how the particular worldview(s) embedded in decision contexts impact decision-makers' capacity to understand and equitably prioritize cultural benefits linked to marginalized cultural groups. **Section 2.5** provides concluding remarks, including discussion of how scholars, decision-makers, and cultural-benefits-knowledge-holders can move these concepts forward to support knowledge pluralism in ES theory and practice, as well as ecosystem valuation and environmental decision-making more broadly.

2.1.1 A Note on Evolving Terminology in Ecosystem Valuation

This paper explores how attention to the larger ES-knowledge-system can support movement toward knowledge pluralism in the context of research and policy efforts branded as "ecosystem services." We adopt this ES terminology in the midst of on-going debates around the potential of the ES concept to accommodate plural values and human-nature relationships (e.g., Barnaud & Antona, 2014; Borie & Hulme, 2015; Braat, 2018; de Groot et al., 2018; Díaz et al., 2015a, 2015b; Kenter, 2018; Maes et al., 2018; Peterson et al., 2018; Raymond et al., 2013). The International Panel on Biodiversity and Ecosystem Services (IPBES) recently introduced the Nature's Contributions to People (NCP) framework as an alternative to ES. Whereas the ES concept originated as a decidedly utilitarian view of human-nature relationship, the NCP framework was created with recognition of the culturally-contextual character of all benefits arising from ecosystems (Díaz et al., 2015a). It acknowledges the importance of context-specific perspectives alongside a universalizing perspective (Díaz et al., 2018), and builds in flexibility for different knowledge holders to name and define framework elements according to their own language, categories, and human-nature relationships (Díaz et al., 2015b).

Based on these features, the authors of the NCP argue their new framework offers a paradigm shift away from ES (Díaz et al., 2018). However, many ES scholars feel this distinction dismisses the rich evolution of ES theory and topics of research (Braat, 2018; Droste et al., 2018). Kadykalo et al. (2018) suggest that the emergence of the NCP framework can be understood not as a departure from ES theory and practice, but as part of the ongoing evolution of research topics in ES, in that "the NCP framework formalizes some recent conceptual and methodological frontiers in ES research, rather than perhaps introducing them" (p. 281).

The terminology we privilege is of critical importance. Dominant concepts and metaphors frame how we think, mirroring and reproducing the assumptions embedded in the dominant worldview (Avila, 2011; Freyfogle, 1994; Kenter, 2018; Lakoff, 2010; Stevenson, 2012). There are particular challenges around including Indigenous understandings in a framework such as ES, which originated with and remains grounded in Western assumptions (Norgaard, 2010; Raymond et al., 2013). And yet, simply shifting surface language may not dislodge deeper philosophical assumptions. For example, neither the ES nor the NCP framework attempt to transcend anthropocentric objectives around environmental "management," e.g., the assumption that humans can control non-human nature, and their emphasis on "human" well-being. Both of these concepts are based on culturally-biased nature-culture and subject-object dualisms that restrict possibilities for human-nature relationship (Barad, 2003; Caillon et al., 2017; Descola, 2005; Himes & Muraca, 2018; Howitt & Suchet-Pearson, 2006; Latour, 1993; Pierotti & Wildcat, 2000; Santas, 1999). These dualisms are also firmly entrenched in Western natural resource management institutions (Berkes, 2018; Castree, 2003; Dongoske et al., 2010, 2015; Pierotti & Wildcat, 2000). We argue, in line with Kenter (2018), that debate over ES versus NCP terminology should not stand in the way of opportunities to provide inroads for knowledge pluralism in the practice of ecosystem valuation and environmental decision-making. It is clear that ES terminology is conceptually limited. And yet the current momentum of the ES approach across diverse decision contexts (Cox et al., 2013; PCAST, 2011; Schaefer et al., 2015; Schleyer et al., 2015; UKNEA, 2011), particularly in the Western world (Borie & Hulme, 2015), also presents unique opportunities. Movement toward knowledge pluralism in the context of ES research has great potential to challenge culturally biased assumptions and facilitate more equitable consideration of the plural values and human-nature relationships associated with

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cultural benefits of ES. This paper specifically seeks to contribute to a conceptual toolkit for implementation of knowledge pluralism in ES theory and practice, as one strand of a broader movement toward pluralism in ecosystem valuation and environmental decision-making.

2.2 Key Concepts for ES-Knowledge Pluralism

To set the stage for value and knowledge pluralism in ES theory and practice, we must first clarify some key components of ES-knowledge that have often been viewed from the universalizing perspective of a single worldview. In this section, we outline necessary shifts in thinking for a knowledge pluralist approach. First, we review the evolving conceptualizations of ES benefits, from solely instrumental to value plural (Section 2.2.1). Second, we argue for a shift in the dominant definition of ES-knowledge, from *knowledge-as-scientific-information* to *knowledge-as-system*, encompassing both worldview and the forms of knowledge that arise within and are valid within diverse ways of knowing (Section 2.2.2). Finally, we update the relationship between services and benefits, moving from linear and universalized to intertwined and socially constructed (Section 2.2.3). Understanding these aspects of ES-knowledge from a knowledge pluralist perspective can support us in conceptualizing the full ES-knowledge-system in Section 2.3.

2.2.1 ES Benefits: A Value Pluralist Perspective

ES benefits have been defined as "valued goods and experiences" arising from ecosystem processes (MEA, 2005; Chan et al., 2012, p. 9). This definition associates ES benefits with use value, i.e., *instrumental value aspects* (Fig. 2.1) in which well-being defined in terms of individual preference satisfaction, wherein ecosystems as viewed as substitutable means for satisfying those preferences. Some view the term "benefit" itself as a roadblock to improved consideration of plural values and knowledges, given its historical association with instrumental

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> We use **plural values,** or **value pluralism,** to refer to multiple, incommensurable value aspects and value perspectives.
>
> **Value aspects**: To achieve value pluralism, we must attend not only to *instrumental value aspects*, i.e., utilitarian and substitutable, but also *relational value aspects*, i.e., non-substitutable and arising from reciprocal human-nature relationship, and *intrinsic value aspects*, i.e., ecosystems, or components of ecosystems, are understood to possess their own value, independent of human use or other benefit.
>
> **Value perspectives**: The separation of value aspects into distinct categories represents a *reductionist value perspective*. To achieve value pluralism, we must also create space for *holistic value perspectives*, in which instrumental, relational, and intrinsic aspects of value are understood to be inseparable and mutually reinforcing.
>
> **Anthropocentric values:** Focus on values experienced and received by humans, i.e., the emphasis is placed on achieving *human well-being* as opposed to well-being of the ecosystem as a whole.

Figure 2.1: Definition Box - ES Benefits and Value Pluralism

value and its connotation of being simply *extra* and *advantageous* rather than *requisite* and *foundational* for well-being (Jax et al., 2018; Muller et al., 2019). However, we assert that just like diverse "contributions" to human well-being in the NCP framework, benefits can be associated with multiple value aspects. More specifically, benefit remains a useful term for referencing the diversity of *anthropocentric* values arising from human-nature relationships, including but extending beyond individual, instrumental preference satisfaction.

A solely instrumental approach to understanding well-being and value presents particular challenges for integration of *ES cultural benefits* (henceforth *cultural benefits of ES*). This is because cultural benefits arise in the context of individual, collective, or ancestral relationship to ecosystems (Nakachi et al., 2022), in which particular places, resources, and ecosystem functions are often incapable of being experienced or understood as substitutable (Chan et al., 2016). Meaningful consideration of cultural benefits of ES thus requires attention to value pluralism. This includes benefits linked to relational aspects of value. It also includes benefits as understood from a holistic value perspective, in which instrumental, relational, and intrinsic aspects of value are mutually dependent and inseparable. Relational aspects of value, and holistic value perspectives, align more closely to human experience of cultural benefit and well-being compared to solely instrumental conceptualizations (Chan et al., 2016; Fish et al., 2016; Gould et

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al., 2019a; Raymond et al., 2018). We therefore follow Fish et al. (2016) and define ES benefits more broadly as "ecosystems' contributions to human well-being," reflecting the parallel between concepts of ES benefits and Nature's Contributions to People (Kenter et al., 2018). Cultural benefits of ES have more specifically been defined as "contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable, and the capabilities they help equip" (Fish et al., 2016, p. 212).[5]

 Relational aspects of value emphasize the well-being that arises from real or desired relationships with ecosystems (Chan et al., 2016; Himes & Muraca, 2018; Knippenberg et al., 2018), including the ability to meet reciprocal responsibilities or spiritual obligations to non-human nature (Basso, 1996; LaDuke, 1993, Martinez, 2016; Nakachi, 2022; Timoti et al., 2017; Vaughan, 2018). The value linked to these relationships is non-substitutable, in the sense that one cannot receive the same degree of benefit, e.g., contributions of place-relationship to identity, in locations where the same depth of relationship is not present. Relational values are conceptualized to extend beyond benefits themselves, i.e., contextual value,[6] to include axiological elements of worldview that define understandings of well-being and guide behavior, i.e., held or transcendental values (Brown, 1984; Chan et al., 2018; Gould et al., 2019b; Kenter et al., 2015). It makes sense to speak about "relational benefits," or "relational contextual values," in the sense of contributions to human well-being that arise from the ability to live in accordance with relational transcendental values.

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[5] Categories included in many past CES typologies align closely with the categories of cultural benefits informing our thinking. See appendices associated with Manuscript 2 (Chapter 3) for a full list of cultural benefits categories and discussion of how they overlap with past typologies of CES.

[6] Contextual value can be understood as the value we perceive in the context of our particular worldview and set of understandings (Kenter et al., 2015). Depending on an individual or group's worldview, including held or transcendental values, they are likely to perceive or embody distinct cultural benefits, i.e., to be aware of distinct aspects of value in their particular contexts.

For example, Inuit peoples link reciprocal obligations with wildlife to relational benefits: "Respectful behavior toward wildlife is seen as essential to leading a 'good life' for everyone, including non-Inuit. This responsibility includes being kind-hearted toward animals, an attitude that brings people together for the common good [36]" (Sheremata, 2018, p. 77). This example speaks to relational benefits arising from the ability to live in right relationship with the non-human (natural) world in accordance with one's moral principles and the foundations of sociocultural self-understanding (Himes & Muraca, 2018; Taylor, 1999). These relational contributions to well-being can be considered ES benefits even though – and perhaps more importantly because – their value extends beyond instrumental use; such relational benefits are central to cultural survival (Nadasdy, 2003), and there is no substitute that could provide the same level of well-being if these relational benefits are lost. Relational values are becoming increasingly mainstreamed in ES assessment (e.g., Jacobs et al., 2018), and were officially adopted as a new category of anthropocentric value in the NCP framework (Chan et al., 2018; Díaz et al., 2015a, 2015b).

There is concern about this reductionist approach to inclusion of relational values, in which scholars seek to isolate relational value from a holistic system of interrelated values and knowledges, resulting in a loss of meaning and inaccurate understanding of the interrelationship between these aspects of value (LaDuke, 1993; Martinez, 2016; Reddekop, 2014). Within a holistic value perspective, the reduction of value aspects into distinct categories of relational, instrumental, and intrinsic is artificial, as these aspects of value and meaning are mutually dependent and irreducible. Instrumental value is bounded and constrained by a view that well-being equates to maintaining balance in relationships between humans and non-human nature. Relational (non-substitutable) cultural benefits are reinforced by practices of instrumental use

that facilitate transmission of place-based understandings, skills and capabilities and maintenance/opportunities of reciprocity and balance in relationship with non-humans (Nadasdy, 2003). For example, although economic analyses often reduce subsistence practices to their instrumental value aspects (e.g., Adamowicz et al., 2004), for many place-based cultural groups subsistence cannot be separated from its relational context and meaning (e.g., Byers et al., 2001; Chanwai & Richardson, 1998; Dupont & Van Eetvelde, 2013; Garvie, 2009; Kenny & Hing, 2017; McCoy et al., 2018; Nadasdy, 2003; Norgaard & Reed, 2017; Zurba et al., 2012). Place-based cultural survival – including maintaining identity, traditional knowledge, and right relationship with the non-human world – depends on the continuity of knowledge-practice-belief systems (Berkes, 2018). In this way, the continuity of knowledge systems, subsistence practices, and cultural benefit and well-being are fundamentally intertwined.

These are critical gaps and errors that cannot be fully addressed by the work of reductionist Western academic traditions, and must be filled by Indigenous scholarship and direct engagement with ES-benefits-knowledge-holders in decision-making processes (Hill et al., 2012; Kovach, 2009).[7] However, we believe that increasing attention to both relational value aspects and holistic value perspectives in applied and critical Western scholarship – such as this article – serves an important role to amplify awareness of two key gaps in ecosystem valuation: 1) value pluralism broadly, i.e., the non-substitutable, relational aspects of well-being that have been marginalized in dominant instrumental approaches to ecosystem valuation, and 2)

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[7] Critical Western research traditions can act as allied tools for indigenous ways of knowing, in terms of making space for Indigenous methods informed by holistic understandings (Kovach, 2009, p. 86). Research based on affordance theory (Gibson, 1979; Raymond et al., 2018), assemblage theory (Delanda, 2016), new materialism and agential realism (Haraway, 1988; Barad, 2003), and posthumanism (Sundberg, 2014) are increasingly creating space for ontological pluralism within Western academic discourse (Muller et al., 2019; Saxena et al., 2018). However, it is dangerous to rely solely on Western academic traditions to achieve knowledge pluralism, given that "their emergence from Eurocentric scholarship creates a propensity to exclude the intellectual and political value of Indigenous knowledges" (Muller et al., 2019, p. 402).

knowledge pluralism broadly, and the question of what knowledge forms are required to adequately convey plural values.

2.2.2 ES-Knowledge: A Knowledge Pluralist Perspective

Operational understandings of the term "ES-knowledge" tend to conflate scientific information and knowledge, casting knowledge as "a body of information [tangible, factual outputs of scientific research] learned and conveyed through scientific and policy processes" (Posner et al., 2016, p. 1760). [8] In other words, the term ES-knowledge has primarily been used to refer to scientific ES-knowledge-*products*, i.e., qualitative or quantitative documentation resulting from Western scientific research approaches.

Similarly, the emerging literature on "ES-knowledge-use" remains rooted in a view of ES-knowledge-as-scientific-product. Building on the work of Carol Weiss (Weiss, 1977, 1979, 1999; Weiss & Bucuvalas, 1977, 1979), this literature highlights diverse modes of ES-knowledge-use, including technical, instrumental uses, conceptual uses, and strategic uses of ES-knowledge (McKenzie et al., 2014; Owens, 2015). This literature has made important contributions to understanding the dynamics of ES-knowledge at the knowledge-policy interface (e.g., McKenzie et al., 2014; Posner et al., 2016; Ruckelshaus et al., 2015), but important opportunities remain to more directly question the very definition of "knowledge" that underpins this inquiry. With respect to cultural benefits of ES specifically, this means researching forms of knowledge beyond scientific products that convey cultural-benefits-knowledge.

We suggest that research into ES-knowledge-use be recalibrated based on a more expansive understanding of knowledge. To set the stage for broadened inquiry we offer the

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[8] This definition is sometimes adopted only in an operational sense. For example, while Posner et al. (2016) specifically seek to understand how uptake of ES-knowledge-*as-scientific-information* can be improved, they also acknowledge that "knowledge itself" is best understood as an entire knowledge system.

following definitions from a knowledge-pluralist perspective: **ES-knowledge** can be understood as, "the assumptions that guide our ways of knowing both ecosystems and well-being," **ES-knowledge-claims** are "understandings of ecosystems and well-being validated within their epistemology of origin," and **ES-knowledge-forms** are "means of conveying ES-knowledge-claims that can be mobilized and/or translated to inform environmental decision-making." ES-knowledge can be conveyed in the form of scientific products, i.e., *knowledge-as-product*, and it can also be conveyed through embodied or encoded forms of ES-knowledge, i.e., *knowledge-as-practice.*

In discussions of ES-knowledge, the concept of knowledge-as-product is often presented as universal, reinforcing a view that scientific products such as ecological research and economic valuation studies are the sole source of valid ES-knowledge-claims. In this way, the role of the culturally contextual assumptions underlying that concept are obscured and taken for granted. Muller (2014) discusses how "the assumed neutrality and universalism of [Western] science acts to dismiss understandings of the world that cannot be made sense of within its own parameters" (p. 139). Western scientific knowledge products reflect a specific, Cartesian worldview grounded on assumptions about human-nature relationship that include subject-object and nature-culture dualisms (Barad, 2003; Descola, 2005; Himes & Muraca, 2018). These assumptions act as "background understandings" (Taylor, 1999), or "integrating schemas" (Descola, 2005), that define possibilities for what humans can know about (reality, ontology), how humans understand value and well-being (axiology), and how humans develop knowledge (epistemology, methodology) (Held, 2019).

Sole emphasis on knowledge products produced within Western scientific epistemological traditions may fail to readily incorporate relational value aspects or holistic

perspectives commonly associated with the cultural benefits of ES (Chan et al., 2016; Fish et al., 2016; Gould et al., 2019a; Raymond et al., 2018). One reason for this is that Western scientific methods are well-suited to documenting and measuring the values of *nature-as-object*, but poorly-suited to recognizing and comprehending the values of *nature-as-subject,* or *nature-as-relations*. Human-nature relationships based on reciprocity or responsibility or as kinship between human and non-human subjects give rise to distinct ways of knowing both ecosystems and well-being, and distinct forms of ES-knowledge capable of conveying valid ES-knowledge-claims.

Relational and holistic understandings of benefits and well-being may be more fully and accurately conveyed through embodied or encoded knowledge practices. Hoelting et al. (2022b) refer to the concept of knowledge-as-practice as *enacted knowledge forms,* which embody, reproduce, and bring ES-knowledge into action. Examples of enacted *benefits*-knowledge-forms include expression (verbally) and/or demonstration of the linkages between well-being and land-based practices and through, for example, subsistence practices, stewardship as a practice of reciprocal relationship, and/or actions geared toward defending and maintaining these practices and lifeways. These benefits-knowledge-forms may serve the interrelated purposes of guiding stewardship actions, building place-based knowledge and capabilities, reinforcing relationships with ecosystems, or providing direct evidence of the relational and holistic value of human-nature interactions.

In contrast, Hoelting et al. (2022b) discuss the concept of knowledge-as-product using the term *translated knowledge forms* (Fig. 2.2). Translated forms can be understood as a spectrum of approaches to documentation of ES-knowledge, ranging from highly abstracted representations of benefit to more contextualized forms that seek to retain the meanings and values embodied

Enacted knowledge forms: Forms of embodied cultural-benefits-knowledge, i.e., knowledge practices. These include **practices of knowledge sharing** that reproduce and convey truths, e.g., narrative, linguistic, performative, visual, or ceremonial forms. These also include the **enactment of these truths through action**, whether through articulation of principles for responsible engagement with ecosystems or demonstration through lived engagement with ecosystems.

Translated knowledge forms: Forms of documented cultural-benefits-knowledge, i.e., knowledge products, on a spectrum from more contextualized to more abstracted. *Contextualized Translations* attempt to stay as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. *Abstracted Translations* seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."

Figure 2.2: Definition Box – Cultural-benefits-knowledge-forms (Definitions from Hoelting et al., 2022b)

and enacted by knowledge holders. Examples of translated *benefits*-knowledge-forms include:

- Abstracted Translations that seek to answer, for example:

  o How much value do ecosystems elements or functions contribute?

  o What categories of benefit do ecosystems contribute?

  o Which elements or functions of an ecosystem are most valuable?

  o Where is value located in the landscape (spatial)?

- Contextualized Translations that seek to answer, for example:

  o Why is an ecosystem or ecosystem function valuable or meaningful?

  o How does an ecosystem or ecosystem function contribute to human well-being?

  o To whom is the ecosystem or ecosystem function valuable?

  o How do services and benefits vary across individuals and groups or over time?

These translated knowledge forms also serve a spectrum of purposes. Abstracted translations may be produced with the goal of controlling, monitoring, and managing nature, whereas contextualized translations may simply serve to provide cognitive knowledge – rather than experiential knowledge – about the linkages between ecosystems and well-being. When

translated knowledge forms are highly contextualized, e.g., ethnographic documentation, they can also serve to amplify and mobilize enacted knowledge forms (Hoelting et al., 2022b).

One knowledge form may not fall strictly into one category or another. For example, a particular enactment of knowledge, e.g., sharing an oral history within Indigenous traditions, may alternately be considered a knowledge practice or a source of data for contextualized translation. The distinction comes in how both the knowledge holder and the listener understand the sharing of that knowledge. For example, Indigenous oral histories often encode linkages between individual and collective well-being and ancestral and contemporary land-based practices that embed nationhood. For listeners who understand this sharing as an epistemological practice, the oral history offers lessons that reaffirm place-based relationships, ground those sharing and receiving the knowledge in their responsibilities, and guide stewardship actions for futures (Martinez, 2014, 2016, 2021). Listeners with other epistemological groundings may understand the sharing as simply a source of data for analysis. Even if the knowledge is offered as a practice, the purpose may be understood very differently depending on the listener.

The universalization of the concept of knowledge-as-product, i.e., translated knowledge forms, in ES theory and practice also serves to universalize and require a particular worldview and human-nature relationship. In contrast, a knowledge-pluralist approach to ES would begin with acknowledgement of diverse and equally insightful and legitimate worldviews that define distinct understandings of human-nature relationship, well-being, and valid ways of knowing (see Fig. 2.3). Recognitional (epistemic) justice, as a component of environmental justice, requires that knowledge arising from a particular knowledge system not be subject to validation outside the way of knowing from which it arises, i.e., its epistemology of origin. A knowledge-pluralist approach to ES would therefore create space for diverse ES-knowledge-forms –

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> **More equitable and inclusive consideration of ecosystems' diverse contributions to human well-being can be** achieved through a pluralist approach to knowledge integration (Persson et al., 2018), "in which two opposed patterns of ideas complement, interact and relate to one another, but never lose their distinctiveness as separate and opposed parts of one whole" (Yunupingu & Watson, 1986, cited in Muller, 2012, p. 61). Examples of cross-cultural frameworks that support this pluralist approach to knowledge integration include "Co-motion" and "Two Ways" (*Ganma*) (Muller, 2012, 2014), "Two-Eyed Seeing" (*Etuaptmumk*) (Bartlett et al., 2012; Reid et al., 2020), "Plural Coexistence" (Howitt & Suchet-Pearson, 2006), the "Double Canoe" and "Maori Guardianship" (*Kaitiakitanga*) (Maxwell et al., 2019), the Two-Row Wampum (*Kahswenhtha*) (McGregor, 2004b), and the Multiple Evidence Base (MEB) approach popularized by IPBES (Díaz et al., 2015a, 2015b; Pascual et al., 2017; Tengö et al., 2014, 2017). Implementation of any of these frameworks requires that we acknowledge and dismantle the power imbalances and systemic biases that have characterized modern Western resource management agencies (Turnhout et al., 2014).

Figure 2.3: Highlight Box – Pluralist Knowledge Integration

including enacted and translated forms – that communicate knowledge claims validated within their own epistemologies. This highlights the importance of involving representatives of diverse knowledge systems in both research and decision-making.

2.2.3 Benefits-Knowledge and Services-Knowledge

ES-knowledge encompasses both how we know ecosystems (services-knowledge; ecological-knowledge) and well-being (benefits-knowledge). Services-knowledge-claims and benefits-knowledge-claims differ in their foci, i.e., whether they present evidence and guidance around ecosystem function, or evidence and guidance about well-being. Because benefits-knowledge relates directly to the axiological question of what we mean by well-being, it is often dismissed as "merely values" and not "knowledge." When it is recognized as knowledge, it is often qualified as 'normative knowledge,' in contrast to a view of services-knowledge, or ecological-knowledge, as 'factual systems knowledge' (Abson et al., 2014). However, services-knowledge and benefits-knowledge are inherently intertwined, and are both subjective, socially constructed, and culturally contextual (Borie & Hulme, 2015; Haraway, 1988; Jax, 2016). Both depend at a foundational level on the presumed ontological character of human-nature relationship, which influences both what we seek knowledge about, i.e., nature-as-object vs. non-human nature-as-relations, and how we understand well-being (Descola, 2005).

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This interrelatedness of knowledge about ecosystem function (services) and knowledge

about well-being (benefit) requires us to reimagine the Cascade Model that was popularized in

early ES research (Haines-Young and Potschin, 2010). The Cascade Model was based on a linear

relationship between services and benefits (Fig. 2.4A), which depends on the belief that

ecosystem services exist as natural phenomena in a singular, universal reality, i.e., a realist

paradigm (Held, 2019). Belief in a singular reality further enables researchers to track and

measure universalized understandings of benefit, most commonly understood from an

instrumental value perspective, that are conceptualized to flow from nature-as-object. However,

these universalized views obscure multiple ways of knowing both ecosystems and well-being

linked to ecosystems. In contrast, critical, interpretivist, and Indigenous paradigms see

knowledge claims as culturally and historically situated and socially constructed (Borie &

Hulme, 2015; Fish et al., 2016; Haraway, 1988; Held, 2019; Jax, 2016; Raymond et al., 2018,

Turnbull, 2016). A situated or relativist view allows us to see that understandings of services and

benefits are equally dependent on worldview, and therefore interrelated (Fig. 2.4B).
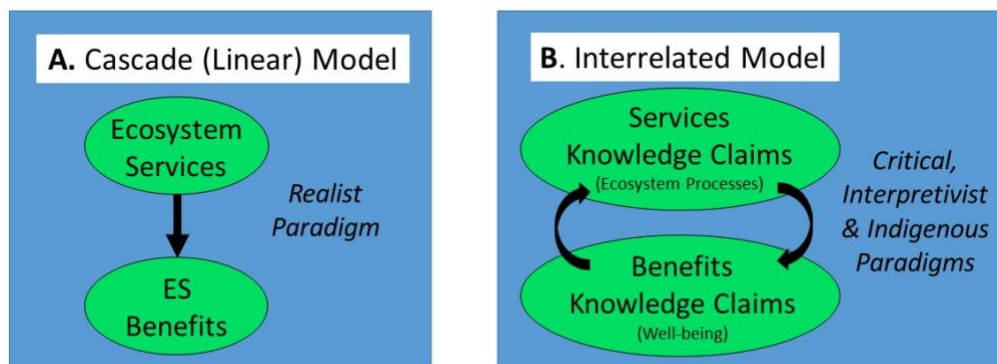
Figure 2.4: Comparing assumptions about services and benefits across paradigms. A realist paradigm (Box A) assumes that ES exist as facts of nature, and that benefits arising from these services can be tracked and measured. In contrast, Indigenous, interpretivist, and critical paradigms (Box B) recognize that how we see nature as being 'of service' is historically and culturally-contextual, and depends on the kinds of benefits we view as relevant to our well-being. To enable a knowledge pluralist approach, services and benefits are best understood as interrelated, and ES-knowledge-claims as situated (Borie & Hulme, 2015; Haraway, 1988) or constructed (Jax, 2016).

This can help us understand and anticipate that cross-cultural collaborations around natural resource management are likely to encounter conflicting ecological-knowledge-claims alongside and as a reflection of conflicting benefits-knowledge-claims (see Fig. 2.5).

For example, Paul Nadasdy details multiple ecological-knowledge-claims around the status of Dall sheep in Northern Yukon territory, how these knowledge claims were linked to distinct worldviews and distinct benefits-knowledge-claims. In 1995, following a decline of the Dall sheep population in the Ruby Range, the Ruby Range Sheep Steering Committee (RRSSC) was formed to make recommendations for management of the sheep population. The RRSSC was made up of biologists, members of the Kluane First Nation, and Dall sheep hunting outfitters. Although all three groups agreed that there had been a decline of the Dall sheep population in the Ruby Range, they vehemently disagreed about the severity and causes of the decline.

These differences can be attributed to their different ways of knowing sheep (epistemology, i.e., approach to valid knowledge), arising from distinct worldviews and lived experiences. Biologists and outfitters relied on abstracted knowledge in the form of annual aerial survey data beginning in 1974, reinforced by several years of personal experience and observation through the course of the research or hunting expeditions. They interpreted these data and experiences to suggest the population decline was a temporary blip. In contrast, First Nations hunters and trappers relied on intimate personal experiences and detailed observation of sheep behavior and movement gained over many years spent on the land throughout the year, hunting, trapping, fishing, guiding, and travelling. These personal experiences and recollections dated back as far as 1920.

The differing ecological-knowledge-claims can also be understood with respect to distinct understandings of well-being linked to divergent understandings of "nature," or the "non-human other." Nadasdy explains that "Kluane people conceive of animals as intelligent, social, and spiritually powerful other-than-human persons, and they see themselves as embedded in a complex web of reciprocal relations with animals. They see their relationships with animal persons as social in nature and vital to their physical and cultural survival" (p. 108). This First Nations understanding of Dall sheep as subjects with agency is in stark contrast to the dominant colonial Euro-American understanding of animals as objects to be managed and used by humans. Differences in our "benefits-knowledge" are necessarily intertwined with differences in our understanding of the character of the animals providing "services" to humans.

Figure 2.5: Highlight Box – Multiple Ways of Knowing Dall Sheep in the Ruby Range

2.3 Conceptualizing the ES-Knowledge-System

The knowledge-pluralist definitions of ES-knowledge, ES-knowledge-claims, and ES-knowledge-forms introduced in Section 2.2.2 encourage a shift from the view of ES-knowledge-*as-scientific-information* to ES-knowledge-*as-a-system*. This shift can support improved awareness of underlying, often hidden assumptions that are embedded in all ES-knowledge-claims. Transparency around assumptions about human-nature relationship, well-being, and valid knowledge is an enabling condition for recognition of diverse knowledge systems, and can help

bring ES theory and practice into alignment with environmental justice (Lau et al., 2021; Martin et al. 2016).

Although there has been some acknowledgement of the larger knowledge system that enables the production Western scientific ES-knowledge-products (e.g., Posner et al., 2016), the term "knowledge system" has rarely been explicitly defined in the context of ES theory and practice. The authors of the NCP framework define a knowledge system as, "a body of propositions that are adhered to, whether formally or informally, and are routinely used to claim truth" (Díaz et al., 2015a, p. 13). Held (2019) similarly define knowledge systems as "the sum of the principles, ethics, and values that determine how knowledge [claims are] generated, acquired, valued, shared, and used" (p. 11), and note overlap with concepts of worldview and paradigm. ES-knowledge, as a system, thus incorporates worldviews, i.e., our assumptions about humans, non-humans, and possibilities for human-nature relationship, as well as assumptions about well-being (Held, 2019) and the knowledge forms and knowledge claims that arise in the context of particular worldviews.

Our elaboration of the ES-knowledge-system draws from two well-established models: 1) knowledge-practice-belief complexes as applied in the context of natural resource management systems (Berkes, 2018), and 2) paradigms guiding scientific research (Held, 2019; Kuhn, 1962). Both of these models highlight that knowledge products and practices – whether conveying knowledge claims about ecosystem processes or well-being – are inherently guided and constrained by worldview. We conceptualize four nested layers in the ES-knowledge-system (Fig. 2.6): worldview, institutions, lived experience, and knowledge forms.
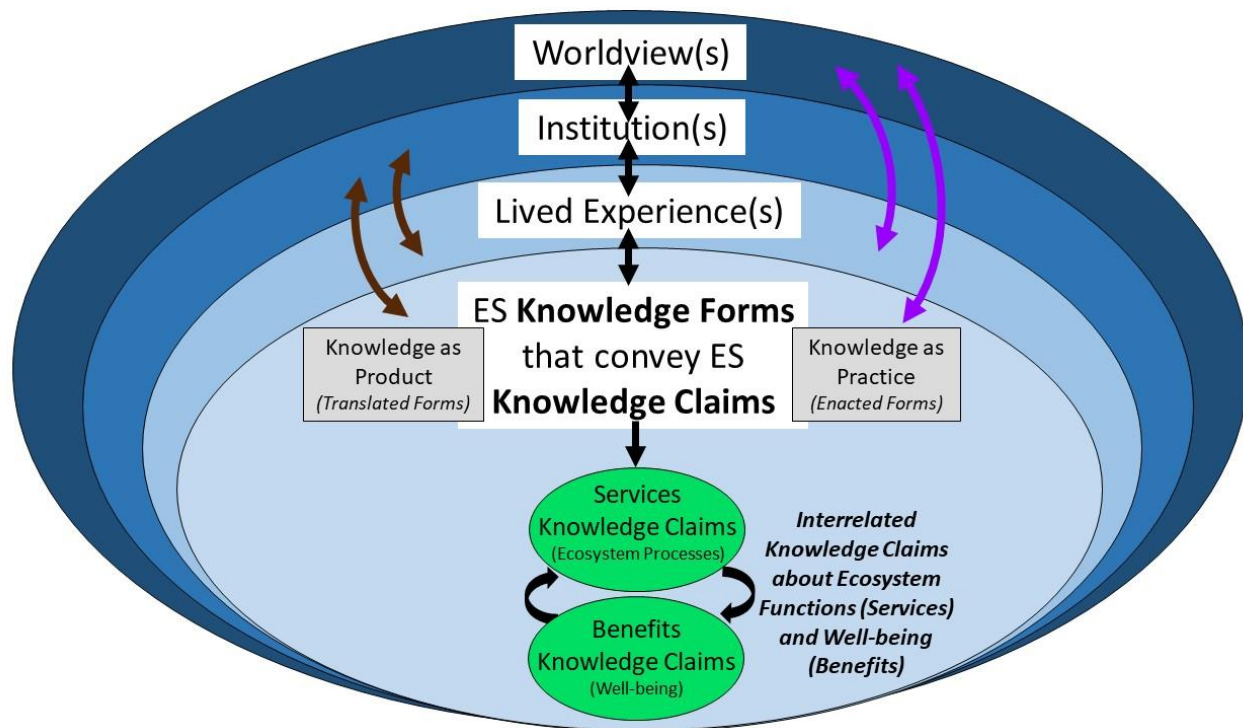
Figure 2.6: ES-Knowledge-System, with nested layers of Worldview(s), Institution(s), Lived Experience(s) and Knowledge Forms. ES-knowledge-forms include enacted forms (knowledge guiding action; knowledge as practice) and translated knowledge forms (knowledge as documentation of information; knowledge as product). Knowledge forms serve to convey knowledge claims about ecosystem processes (services) and well-being (benefits), including cultural benefits. All ES-knowledge-claims implicitly carry the assumptions of particular worldview(s) or paradigm(s). Worldviews can be alternately supported or undermined by dominant institutions that, for example, may restrict lived experiences that enable realization of ES benefits.

We begin with the same outer layer included in the Berkes (2018) model, **worldview**, which reflects "a set of metaphysical beliefs, assumptions, concepts, and values that informs [one's] view of reality, what counts as knowledge and ways of knowing" (Held, 2019, p. 1). The next layer is **institutions**, which guide and mediate our behavior and in turn our lived experience. This includes informal institutions such as social norms and formal institutions such as environmental regulations, as well as constitutive decision-making bodies that can change or create new rules. The next layer is **lived experience**, which is guided by our worldview and mediated by the formal and informal institutions that determine access and encourage or constrain behavior. Finally, **forms of ES-knowledge** arising within particular worldviews,

institutional contexts, and lived experiences are located at the center of the ES-knowledge-system. A spectrum of ES-knowledge-forms, from knowledge-as-product (translated forms) to knowledge-as-practice (enacted forms) (Hoelting et al., 2022b) serve to communicate diverse knowledge claims around both ecosystem processes, i.e., **services-knowledge-claims** and ecosystems' contributions of ecosystems to well-being, i.e., **benefits-knowledge-claims**.

The center of Fig. 2.6 reflects the interrelatedness of how we know services and how we know benefits, as initially described and depicted in Section 2.2.3, Fig. 2.4. These innermost components of the ES-knowledge-system can also be understood to influence outer layers. For example, how we understand ecosystems and well-being influences how we live, reinforcing or redirecting our lived experiences. Further, our understandings of ecosystems and well-being may align with outer layers of the knowledge system and reinforce dominant institutions and worldview, or they may be marginalized by existing institutions and conflict with the dominant societal worldview.

2.4 Implications for Meaningful Consideration of Cultural Benefits in Decision-making

The underrepresentation of cultural benefits in ES assessments (Gould et al., 2019a; Milcu et al., 2013; Satterfield et al., 2013; Satz et al., 2013) is in large part a function of the parameters we have set for producing and considering evidence in decision-making (Muller, 2014). If we take as a starting point that only Western scientific knowledge products provide valid, actionable ES-benefits-knowledge-claims, then only those benefits-knowledge-forms that fit within this predetermined mold will be recognized and legitimated. If we instead take as a starting point the need to explore diverse ES-knowledge-forms to help us more fully and accurately comprehend cultural benefits – as understood and experienced across cultural contexts

– then we must step back from the standardized menu of Western scientific methods and knowledge products to imagine a more complete range of possibilities.

In a Critical Interpretive Synthesis of environmental management literature, Hoelting et al. (2022b) found that more intangible cultural benefits are inadequately conveyed through highly abstracted knowledge forms commonly produced during ES-assessments. These knowledge products seek to translate cultural benefits into their instrumental aspects to answer questions such as "how much" value, or which benefits are "most valuable." This process of translation is based on the assumption that ES benefits are commensurable and substitutable (Trainor, 2006), and fails to account for inherently contextual value aspects arising from non-substitutable relationships of familiarity and intimacy (Chan et al., 2016). In contrast, Hoelting et al. (2022b) found that more intangible cultural benefits categories, such as knowledge systems and cultural identity, are more fully communicated through enacted forms of ES-knowledge that embody relational aspects of value or holistic value perspectives.

These findings support results of other systematic reviews on CES which demonstrate that cultural benefits categories most easily imagined as substitutable, i.e., emphasizing instrumental value aspects, are also most likely to be represented within dominant approaches to ES assessment and valuation. For example, Milcu et al. (2013), Gould et al. (2019a) and Hoelting et al. (2022b) each found that recreational value, aesthetic value, and educational and scientific values were among the most likely cultural benefit categories to be represented through highly abstracted forms of ES-knowledge common to ES assessment; and all three systematic reviews found that categories of knowledge systems, cultural diversity, identity, and sense of place were among those least likely to be adequately represented.

Enacted knowledge forms may include knowledge practices linked to maintaining and reproducing relationships with ecosystems through ceremony, traditional narrative, and stewardship action, as well as advocacy to protect the rights of cultural-benefits-knowledge-holders to engage in these actions. Some of the meaning and importance of these knowledge practices can be documented and amplified through translation into static knowledge products, but the act of documenting or extracting facts and numbers can also undermine the validity of the knowledge from the perspective of Indigenous or local knowledge systems (Kovach, 2009; Tengö et al., 2012, 2014). This highlights the importance of involving representatives from diverse knowledge systems in research and decision-making. In so doing, knowledge can be offered and interpreted with reference to cultural-benefits-knowledge-holders' understandings and practices of well-being (Gadamus et al., 2015; Hoelting et al., 2022b; Hill et al., 2012).

Involvement of knowledge holders in research and decision-making can also guide when it is appropriate to document cultural-benefits-knowledge, and when it is not desirable or may cause harm. For example, in the context of settler-colonial governance, knowledge holders' may perceive current risks or have had past negative consequences in making their cultural benefits knowable to those in power (e.g., Davies et al., 1999; Smith et al., 2003), or cultural protocols may restrict knowledge sharing (e.g., Sole & Woods, 1993). In such instances, cultural-benefits-knowledge can still be integrated into decision-making through the direct involvement of cultural-benefits-knowledge-holders in decision-making, enabling them to participate in the selection of management approaches that align with their understandings and practices of well-being without the need for explicit articulation of their cultural-benefits-knowledge (Hoelting et al., 2022b).

Our conceptual model of the ES-knowledge-system can help us think more deeply about processes of marginalization of particular cultural benefits categories, including the role of worldviews and privileged knowledge forms. In particular, it can help us visualize what is at stake when cultural benefits – as experienced and understood from the perspective of a given human-nature relationship – do not align with the worldview embedded in natural resource decision-making institutions. As depicted in Fig. 2.6, environmental management institutions arise from and within particular worldview(s). The rules of any decision context reflect a set of values and philosophical assumptions about humans, the natural world, and human-nature relationship (Gorddard et al., 2016). Western environmental decision contexts have traditionally embedded instrumental value aspects and utilitarian understandings of human-nature relationship, with decision rules geared toward efficiency and maximum utility (Anderson, 2018; Berkes et al., 2018; Bromley, 1990; Cooper et al., 2016; Dongoske et al., 2010, 2015; Howitt & Suchet-Pearson, 2006; Pierotti & Wildcat, 2000). In contrast, cultural benefits of ES are increasingly associated with relational value aspects or holistic value perspectives (Avila, 2011; Chan et al., 2016; Gould et al., 2019a; Hoelting et al., 2022b; Watson, 2018).

Fig. 2.7 offers an example, in which we consider the potential of ES-benefits-knowledge-claims arising from two distinct worldviews to inform existing resource management institutions. Worldview A represents a reciprocal human-nature relationship, i.e., non-human nature-as-relations, in which benefit and well-being are understood from a holistic value perspective. Worldview B represents a utilitarian perspective, i.e., nature-as-object, with well-being understood to relate primarily to instrumental aspects of value. Although this distinction overly simplifies the diversity of possible human-nature relationships that underpin knowledges of ES benefit (see for example Descola, 2005; Muradian & Pascual, 2018), it offers an illustration of

some foundational ontological challenges that can impede meaningful consideration of many cultural benefits of ES in environmental decision-making.
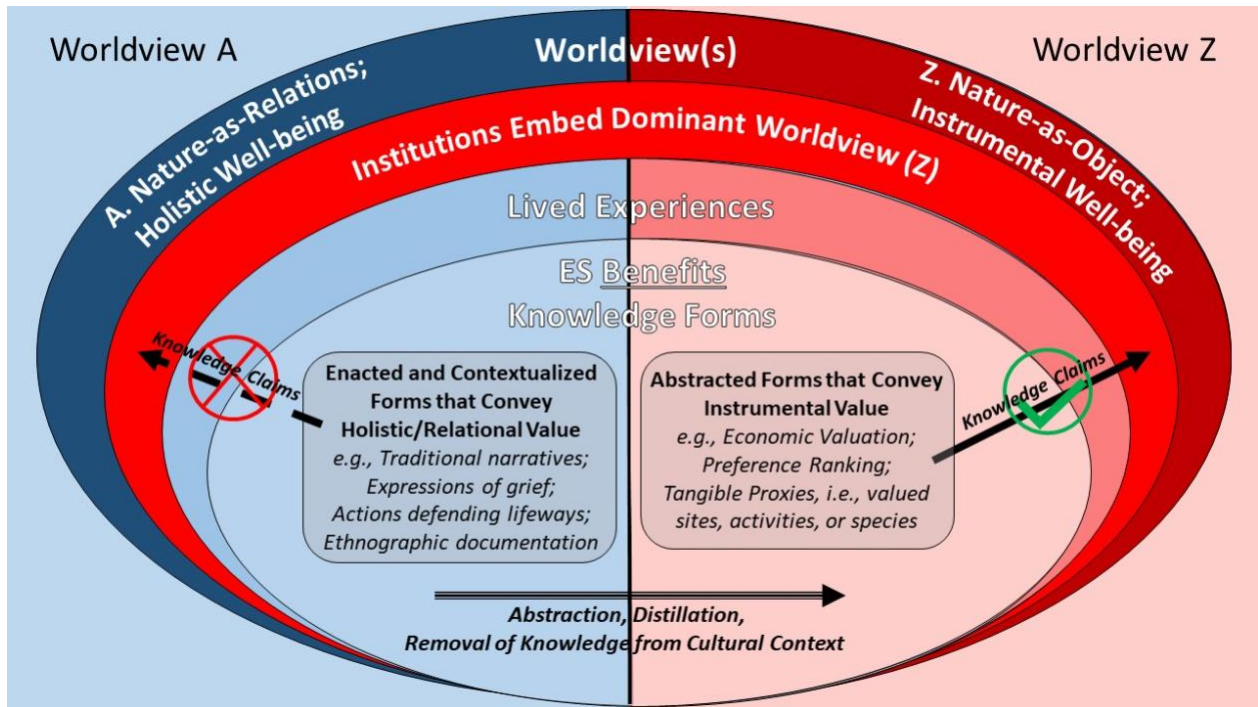
Figure 2.7: Implications of embedded worldview for meaningful consideration of cultural-benefits-knowledge in varied forms within institutions. When a single worldview becomes universalized and embedded in environmental decision-contexts, e.g., Worldview Z (Nature-as-object; Instrumental understanding of well-being), benefits-knowledge-claims arising from distinct worldviews, e.g., Worldview A, are often rendered incomprehensible and irrelevant for decision-making. The simplified utilitarian Worldview Z included in this example echoes the institutions arising within the paradigm of neoliberal environmental governance, for which utility maximization is a guiding decision rule based on the assumption of nature-as-object and the universalization of instrumental value aspects.

Knowledge forms that align with the values and assumed reality of the dominant worldview are privileged in a given decision context (Gorddard et al., 2016). As a result, those cultural benefits of ES that are most easily conveyed through privileged knowledge forms, and in alignment with privileged value aspects, are more likely to be meaningfully considered in existing environmental decision-making processes. In our example in Fig. 2.7, cultural benefits most easily framed as instrumentally valuable, typically using quantitative approaches that imply commensurability and substitutability, are most likely to be viewed as valid and decision-

relevant. Only those relational benefits and holistic value perspectives that can be re-imagined as substitutable and made comprehensible within instrumental understandings of nature-as-object are likely to be included in decision-making (Gould et al., 2019a; Hoelting et al., 2022b; Milcu et al., 2013; Nadasdy, 2003; Persson et al., 2018). It is possible to increase comprehension of diverse worldviews within such institutions, for example by ensuring that decision-makers are trained to recognize and engage with diverse forms of evidence (e.g., Makgill & Rennie, 2012), or by ensuring that decision-makers themselves represent diverse knowledge systems (e.g., Booth & Skelton, 2011). However, when decision-makers are directed to carry out processes and protocols grounded in a utilitarian worldview, they will have limited power to integrate knowledge forms that convey relational value aspects or holistic value perspectives.

Fig. 2.7 helps to frame the challenges for meaningful consideration of relational or holistic cultural benefits in existing environmental decision-making institutions, which may not be equipped to acknowledge forms of evidence that best communicate non-substitutable value, or to comprehend the weight of relational and holistic benefits as contributions to well-being and cultural survival for place-based peoples. When a utilitarian worldview dominates our decision contexts, simply providing a more complete description of the plural values of human-nature relationship, i.e., through enacted expression or ethnographic documentation, is not enough to enable equitable consideration of diverse cultural benefits. Such information comes up against hidden ontological assumptions that limit its comprehensibility. Latulippe (2015) notes, for example, that when all knowledge is required to be "integrated within conventional, dualistic environmental and resource management regimes… [it] reinforces the ontological dissonance that renders Indigenous knowledge systems unintelligible and conceals mechanisms that maintain dominant resource governance" (p. 2).

Improving consideration of marginalized cultural benefits of ES requires value pluralism, in that we must recognize the plural values linked to cultural benefits. And more foundationally, it requires knowledge pluralism. This means recognizing the diverse ES-knowledge-forms that convey valid and decision-relevant benefits-knowledge-claims; it means acknowledging the worldview(s) embedded in our institutions; and it means addressing the ways they can limit our capacity to access, comprehend, and meaningfully consider benefits-knowledge-claims arising from diverse human-nature relationships and understandings of well-being.

2.5 Conclusion

Andreotti et al. (2011) share a Maori metaphor for gaining knowledge: "ontologies are fishing grounds, epistemologies are fishing nets and the fish is the appropriate knowledge that will serve as nourishment for one's community. In order to weave an effective net one needs to have appropriate knowledge of the different fishing grounds, of different weaving patterns, floaters and weights, and of the weather, currents and tides" (p. 47). This metaphor highlights the need for multiple ontologies (fishing grounds) to enable access to knowledge forms (fish), "rather than the projection or universalization of one fishing ground representing the whole sea of possibilities" (p. 47).

It is clear we cannot fully account for the plural values of cultural benefits using conventional ES-assessment methodologies and forms of knowledge alone (Fish et al., 2016; Hoelting et al., 2022b; Raymond et al., 2018); meaningful consideration of the full spectrum of cultural benefits requires us to reimagine valid, decision-relevant ES-knowledge from the perspective of knowledge pluralism. Factors that undermine meaningful consideration of the cultural benefits of ES are present at all levels of the ES-knowledge-system: in the worldviews enshrined in our institutions, in the shifting ways of life and access to lands and resources that

impact our lived experiences and human-nature interactions, and in the forms of ES-benefits-knowledge that are considered 'decision-relevant' and 'actionable'.

At the level of worldview, we are challenged to step back from the idea that Western scientific ways of knowing are objective and value-neutral; we must explicitly acknowledge that dominant Western science and resource management traditions – like all knowledge systems – rest on culturally biased philosophical assumptions that influence the types of cultural benefits that are rendered comprehensible[1] (Dongoske et al. 2010, 2015; Held, 2019; Ludwig & Poliseli, 2018; Muller, 2014; Pierotti & Wildcat, 2000; Turnbull, 2016). At the level of knowledge forms and knowledge claims, we must grapple with the fact that the full spectrum of cultural benefits cannot be adequately recognized, comprehended, and considered when technical, utilitarian knowledge products serve as the primary decision-relevant forms of ES-knowledge (Hoelting et al., 2022b; Raymond et al., 2018).

Western academic research can support movement toward knowledge pluralism in ES theory and practice. Critical, qualitative, participatory, and Indigenous research approaches offer important allied tools to bring multiple ways of knowing and valuing the natural world into academic spaces (Kovach, 2009; Muller et al., 2019; Saxena et al., 2018). Specifically in the context of ES theory and practice, Barnaud and Antona (2014) argue that critical and participatory social science methods can support movement toward improved reflexivity and knowledge pluralism. More broadly, critical Western disciplines such as political ecology, political ontology, and feminist and post-colonial studies, in conversation and alliance with Indigenous methodologies, can help us expose and combat universalizing approaches that obscure the politics and power dynamics surrounding knowledge production and integration for environmental decision-making (Blaser, 2014; Muller et al., 2019).

This paper takes a critical approach to the dominant conceptualization of ES-knowledge-as-scientific-product. We suggest that current investigations around modes of ES-knowledge-use (McKenzie et al., 2014; Posner et al., 2016a, 2016b; Ruckelshaus et al., 2015; Weiss, 1979) can be usefully redirected toward a broader understanding of ES-knowledge-as-system, by defining ES-knowledge as "the assumptions that guide our ways of knowing both ecosystems and well-being" (Section 2.2.2). This includes recognition of differing assumptions around the validity of research methods and ES-knowledge-claims. In order to create space for benefits-knowledge-claims arising from diverse understandings of well-being, there is a need to recognize a more complete spectrum of ES-knowledge-forms and explore their dynamics within the knowledge-policy interface. More specifically, theoretical and empirical inquiry around the diversity of ES-benefits-knowledge-forms, and their role in mediating the benefits categories and value aspects that are made available to decision-makers, can support more meaningful inclusion of diverse cultural benefits in environmental decision-making (e.g., Hoelting et al., 2022b).

Our approach to advancing knowledge pluralism is reformist, in the sense that we seek to facilitate shifts within institutions as they currently exist. Castree (2003) recalls Robert Handler's saying that "to be effective critics we must 'speak the language that power understands'" (cited on p. 206). The nature/culture dualism is firmly entrenched in existing decision-making institutions (Berkes, 2018; Castree, 2003), as evidenced by the anthropocentrism of both the NCP and ES frameworks. Given this, many advocate a more revolutionary approach to advancing knowledge pluralism, desiring to create new institutions that are not constrained by anthropocentrism and other ethnocentric beliefs. We support such efforts, but also see value in incremental improvements that can be achieved within existing decision contexts by challenging culturally biased assumptions around knowledge and value. Within dominant institutions and

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frameworks we may find opportunities to disrupt the subject-object dualism that underpins the

instrumental value perspective in many of our decision contexts, and to create space for multiple

understandings of human-nature relationship to be highlighted and valued. This can be

understood as a middle ground approach. It is at once pragmatic in its potential to resonate

within existing Western institutions, and subversive in its potential to challenge some of the most

ethnocentric assumptions about human-nature relationship that currently pervade these

institutions (Howitt & Suchet-Pearson, 2006; Muller et al., 2019).

Explicitly acknowledging the role of worldviews in ES-knowledge is a foundational first

step to achieve meaningful consideration of the plural values of cultural benefits. Diverse

authors, and particularly Indigenous voices, call for cross-cultural spaces in research and

decision-making (Bartlett et al., 2012; Davidson-Hunt, 2006; Denny & Fanning, 2016;

Kneebone, 1993; Reddekop, 2014; Watson, 2018). Emerging cross-cultural research

frameworks, such as the Multiple Evidence Base (MEB) approach (Díaz et al., 2015a; Tengö et

al., 2014, 2017), Two-Eyed Seeing (Bartlett et al., 2012) and many others (Muller, 2012, 2014;

Reid et al., 2020), echo the need for validity to be determined within the knowledge system from

which knowledge claims originate. These cross-cultural research frameworks encourage and

invite the ES community of practice to move away from the perceived need to unify all ES-

knowledge under one privileged worldview.

In this paper, we contribute to a conceptual toolkit for implementation of knowledge

pluralism in ES theory and practice by reconceptualizing ES-knowledge-as-*knowledge-system*

and more explicitly outlining the role of *benefits-knowledge* in the larger system.

Conceptualizing the full ES-knowledge-system can support increased awareness on the part of

decision-makers of the different ways individuals and cultural groups know benefit and well-

being, which mirror the different ways they know ecosystems; it can support imagination of a greater range of possible benefits-knowledge-forms with potential to convey plural values; it can facilitate personal and collective reflexivity around the role of worldviews embedded in our institutions that limit recognition of diverse knowledge forms; and it can illuminate what is at stake for value pluralism in decision-making when assumptions about human-nature relationship and well-being remain hidden. Further Western academic inquiry around knowledge pluralism in ES theory and practice – alongside direct involvement of benefits-knowledge-holders themselves in environmental decision-making – can improve our ability to comprehend, convey, and meaningfully integrate the plural values of cultural benefits of ES as they arise across cultural contexts and worldviews.

3. MANUSRIPT 2: OPPORTUNITIES FOR IMPROVED CONSIDERATION OF CULTURAL BENEFITS IN ENVIRONMENTAL DECISION-MAKING[9]

3.1 Introduction

Understanding and protecting ecosystems' contributions to well-being are central to environmental management efforts (e.g., Martín-López et al., 2014; MEA, 2005; White House, 2015). The cultural benefits of ecosystem services (ES), often referred to as cultural ecosystem services, make essential contributions to human well-being, but they have consistently been under-represented in research and decision-making (Ascher et al., 2010; Gould et al., 2019; Milcu et al., 2013). The ES framework is increasingly mainstreamed at national and international scales (Cox et al., 2013; PCAST, 2011; Schaefer et al., 2015; Schleyer et al., 2015; White House, 2015). In accompanying processes of standardization and institutionalization of an ES approach, the cultural benefits of ES are at risk of being left behind (Steger et al., 2018). And yet, they also hold potential to fundamentally transform conversations about ES and ecosystem valuation (Ainscough et al., 2019; Fish et al., 2016; Gould et al., 2020; Hirons et al., 2016).

The cultural benefits of ES have been defined as, "the contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable and the capabilities they help equip" (Fish et al., 2016, p. 212). This includes, for example, contributions to identity formation, spiritual and religious value, recreation and ecotourism, aesthetic values, the maintenance of knowledge systems. The ES Framework has traditionally emphasized instrumental, i.e., substitutable, aspects of ecosystems' value, in the sense of

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individual preference satisfaction (Norgaard, 2010; Raymond et al. 2013). And yet many cultural benefits categories are linked to fundamental and non-substitutable aspects of human well-being (Jax et al., 2013). Some, such as identity and spiritual and religious values, are non-substitutable in that they are constitutive of human ability to life a good life (James, 2015), for example through maintaining responsible relations to non-humans and other generations (Necefer, 2016; Robinson et al., 2012; Sheremata, 2018). Others, such as knowledge systems, have fundamental value in that they provide the very foundation of socio-cultural self-understanding, i.e., they are essential for cultural survival (Berkes, 2018; Himes & Muraca, 2018; Nadasdy, 2003). In this paper, we explore how attention to multiple knowledge systems is essential for meaningful consideration of cultural benefits of ES. In turn, we highlight the ways improved attention to the cultural benefits of ES can enhance equity and environmental justice through recognition and legitimization of multiple human-nature relationships, understandings of well-being, and knowledge systems in environmental decision-making.

Both the challenges and the potential around meaningful consideration of cultural benefits in environmental decision-making have sparked substantial scholarship. A central research question has been how to move beyond the utilitarian origins of the ES framework to more fully and accurately characterize the plural values linked to cultural benefits. Environmental ethicists and philosophers have elaborated on this question of *value pluralism* (Fig. 3.1), in the sense of diverse *aspects of value* and distinct *value perspectives* through which humans recognize contributions of ecosystems to their well-being (Chan et al., 2012, 2016, 2018; Jacobs et al., 2016, 2018; Jax et al., 2013; Kenter et al., 2015, 2019; Himes & Muraca, 2018; Neuteleers & Hugé, 2020). As a second area of advancing scholarship, researchers increasingly investigate *ES-knowledge-use*, or how ES-knowledge informs decision-making. As one example,

scholars have explored the dynamics of ES-knowledge in the science-policy interface, including conceptual, strategic, and instrumental modes of ES-knowledge-use for decision-making (e.g., McKenzie et al., 2014; Posner et al., 2016; Prewitt et al., 2012; Ruckelshaus et al., 2015; Weiss, 1999; Weiss & Bucuvalas, 1977).

However, both areas of research have failed to attend to *knowledge pluralism* (Fig. 3.1). Dominant approaches to research on both value pluralism and ES-knowledge-use rest on the assumption that ES-knowledge is only made available to decision-makers through scientific documentation. As a result, we fail to recognize the role of knowledge pluralism as an enabling

We use **knowledge pluralism** to refer to multiple ways of knowing, including distinct worldviews and diverse knowledge forms understood to convey valid knowledge claims (Hoelting et al., 2022a).

We use **plural values**, or **value pluralism**, to refer to multiple, incommensurable value aspects and value perspectives (Hoelting et al., 2022a).

Value aspects: To achieve value pluralism, we must attend not only to instrumental value aspects, i.e., utilitarian and substitutable, but also relational aspects, i.e., non-substitutable and arising from reciprocal human-nature relationship, and intrinsic value aspects, i.e., ecosystems, or components of ecosystems, are understood to possess their own value, independent of human use or other benefit (Hoelting et al., 2022a).

Value perspectives: The separation of value aspects into distinct categories represents a reductionist value perspective. To achieve value pluralism, we must also create space for holistic value perspectives, in which instrumental, relational, and intrinsic aspects of value are understood to be inseparable and mutually reinforcing (Hoelting et al., 2022a).

Figure 3.1: Definition Box – Knowledge Pluralism and Value Pluralism

factor for meaningful consideration of the plural values linked to the cultural benefits of ES (Hoelting et al., 2022a). Western scholars and decision-makers are beginning to acknowledge that attention to knowledge pluralism is a requirement to achieve value pluralism in ES research and in decision-making more broadly (Díaz et al., 2015a, 2015b; Hoelting et al., 2022a; Pascual et al., 2021; Tengo et al., 2014, 2017; Turnhout et al., 2014; Turnhout, 2018). This emerging awareness echoes persistent frustrations among Indigenous peoples, who have long faced challenges in explaining the value of the land to non-Native decision-makers (e.g., Bates & Winter, 1993; Lewis & Sheppard, 2005; Mowaljarlai, 1993). A central obstacle is a limited

concept of valid, decision-relevant "knowledge," with bias toward written and quantitative

knowledge forms (e.g., Kovach, 2009; Martinez, 2014, 2021; Smith, 2007; Wilson, 2008).

The ES-knowledge-use literature often conflates the term ES-knowledge with technical,

quantitative information documented through Western scientific research methods (Fig. 3.2). The

forms of knowledge associated with formal ES assessment can generally be described as

abstracted, i.e., characterized by universalized understandings of well-being and loss of cultural

context. Examples include economic valuations, non-monetary preference ranking, use of

universalized categories, or spatially locating universalized value aspects through mapping.

However, emerging insights from research on value pluralism highlight the fact that many

cultural benefits of ES – particularly those grounded in relational value aspects or holistic value

perspectives – are often best communicated and comprehended through direct, embodied

engagement with ecosystems or context-specific narrative or ceremonial knowledge forms,

rather than through abstracted, universalized scientific documentation (e.g., Chan et al., 2012;

Fish et al., 2016; Martinez, 2016, 2021; Raymond et al., 2018; Wilson, 2008). In turn, many

cultural benefits categories have been consistently underrepresented through the over-reliance on

ES-knowledge, *a.k.a. the ES-knowledge-system***:** From a knowledge pluralist perspective, ES-knowledge is best conceptualized as a system, encompassing the "assumptions that guide how we claim knowledge of both ecosystems and well-being" (Hoelting et al., 2022a). These assumptions include often hidden beliefs about ontology (reality), axiology (ethics and value), and epistemology (how humans develop knowledge).

Cultural-benefits-knowledge: ES-knowledge encompasses both how we know ecosystems (services-knowledge) and well-being linked to ecosystems (benefits-knowledge) (Hoelting et al., 2022a). As one element of ES-knowledge, cultural-benefits-knowledge is how we know the cultural benefits of ecosystems.

Cultural benefits of ecosystems, *a.k.a. cultural benefits of ES or cultural ecosystem services*: "the contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable and the capabilities they help equip" (Fish et al., 2016, p. 212).

ES-knowledge-forms: "Means of conveying ES-knowledge-claims that can be mobilized or translated to inform decision-making" (Hoelting et al., 2022a). These can include knowledge in the form of products, and knowledge in the form of practice (see Section 3.3.1.1).

ES-knowledge-claims: "Understandings of ecosystems and well-being validated within their epistemology of origin" (Hoelting et al., 2022a). All ES-knowledge-claims, whether about well-being (benefits-knowledge-claims) or ecosystem processes (services-knowledge-claims), embed the assumptions present in the larger ES-knowledge-system (Hoelting et al., 2022a).

Figure 3.2: Definition Box – ES-knowledge

Western scientific knowledge forms, with particular marginalization of benefits categories described as intangible, non-material, or non-instrumental (Chan et al., 2012; Gould et al., 2019; Milcu et al., 2013).

Knowledge pluralism implies attention to multiple knowledge forms that have the potential to communicate cultural-benefits-knowledge-claims (Fig. 3.2), beyond a sole focus on Western scientific documentation. But more foundationally, knowledge pluralism requires awareness that every knowledge claim embeds and reproduces a particular worldview. Worldviews guide beliefs about reality (ontology, e.g., what is the relationship between humans and non-humans?), ethics and value (axiology, e.g., what is well-being?), and how humans develop knowledge (epistemology, including valid methodologies and knowledge forms) (Berkes et al., 2018; Gould et al., 2020a; Held, 2019; Hoelting et al., 2022a; Kovach, 2009; Martinez, 2014, 2016; Wilson, 2008).

In practice, diverse systems of validation present challenges for cross-cultural knowledge integration. When discussing efforts to integrate Indigenous and local knowledge for environmental management, one of the greatest validity concerns raised by knowledge holders is that data points will be extracted from their knowledge systems and interpreted out of context in ways that are not robust within their own worldviews (Berkes, 2018; Díaz et al., 2015a). Indigenous and local knowledge systems have their own protocols to determine empirical and social legitimacy of knowledge, i.e., its validation (Tengö et al., 2012, 2014). Recognizing that assumptions about validity are intertwined with other elements of worldview, including assumptions about human-nature relationship and well-being, is an important point of departure for implementing knowledge pluralism in ecosystem valuation and decision-making.

The dominant concept of ES-knowledge, as encompassing scientifically validated documentation, is a barrier to recognition and exploration of diverse cultural-benefits-knowledge-forms that may arise in association with diverse human-nature relationships (ontology), understandings of well-being (axiology), and understandings of legitimate, valid knowledge (epistemology and methodology). The resulting inattention to the full spectrum of cultural-benefits-knowledge-forms prevents decision-makers from identifying and exploring opportunities for meaningful inclusion of the plural values linked to cultural benefits. There is thus a need for an expanded theory of cultural-benefits-knowledge, and ES-benefits-knowledge more broadly (Hoelting et al., 2022a), that facilitates improved knowledge pluralism in environmental decision-making. Such a theory can serve as a basis for continued research and advocacy around opportunities for meaningful consideration of cultural-benefits-knowledge-claims conveyed through diverse knowledge forms.

Building theory around the diverse ways people know and convey understandings of benefit and well-being is an essential starting point to enable movement toward knowledge pluralism – and by extension value pluralism and environmental justice – in ecosystem valuation and decision-environmental decision-making. In order to improve integration of plural values of cultural benefits, we must first understand the forms in which those plural values have the potential to be conveyed. This paper presents the results of a Critical Interpretive Synthesis (Dixon-Woods et al., 2006; Depraetere et al., 2020) of environmental management literature. We anchor our synthesis with the following broad research questions: 1) in what forms is cultural-benefits-knowledge conveyed to inform environmental decision-making, i.e., articulated, demonstrated, identified, measured, or represented; and 2) how can these knowledge forms meaningfully inform decision-making processes? We begin with a description of the Critical

Interpretive Synthesis method (Section 3.2). Our results (Section 3.3) detail the synthetic

constructs that emerged in response to these two research questions (Sections 3.3.1 and 3.3.2),

and integrate these constructs in an overarching synthesizing argument, or theoretical

framework, to enhance our understanding of opportunities for improved consideration of cultural

benefits (Section 3.4).

3.2 Methods

Literature relevant to the cultural importance of the natural world is a complex body of

evidence, characterized by varied terminologies, epistemologies, and ontological understandings.

Given this, we required a systematic review methodology (Gough et al., 2017) that would enable

synthesis of concepts across diverse literatures, and would facilitate development of an

encompassing theoretical model. Critical Interpretive Synthesis provides a robust path for

synthesizing large bodies of heterogenous evidence through a multi-phase purposive and

theoretical sampling process (Dixon-Woods et al., 2006; Moat et al., 2013). Further, Critical

Interpretive Synthesis is appropriate for theory building through the generation of synthetic

constructs and a synthesizing argument (Booth, 2016; Boyko et al., 2012; Dixon-Woods et al.,

2006; Gough et al., 2012; Gough & Thomas, 2017). Synthetic constructs are a transformation of

underlying evidence, including existing concepts and constructs, into new conceptual forms; a

synthesizing argument integrates existing concepts and emergent synthetic constructs into a

coherent theoretical framework, rooted in overall critique of the evidence (Dixon-Woods et al.,

2006). Critical Interpretive Synthesis is a configurative systematic review method that makes the

literature itself the object of scrutiny at the level of concepts (Dixon-Woods et al., 2006). In

contrast to aggregative systematic review methods characterized by representative sampling and

statistical aggregation of findings, configurative reviews are intended to interpret and understand, i.e., configure, information (Gough et al., 2012; Gough & Thomas, 2017).

Drawing from the primary research methods of Grounded Theory (Corbin & Strauss, 2015; Creswell, 2007), searching, screening, analysis, and synthesis take place concurrently and iteratively in Critical Interpretive Synthesis (Dixon-Woods et al., 2006; Moat et al., 2013). Configurative reviews involve iterative construction of the "field to be known," and as such the boundaries of the sampling frame are more diffuse (Dixon-Woods et al., 2006; Gough et al., 2012; Gough & Thomas, 2017). Our review team developed initial inclusion and exclusion criteria with the understanding that these criteria would be adjusted based on analysis of early search results. Similarly, we began with a set of open-ended research questions that guided early stages of our review, with the understanding that these questions could be focused or updated through the course of research (Boyko et al., 2012; Corbin & Strauss, 2015; Creswell, 2007; Dixon-Woods et al., 2006; Moat et al., 2013). We used the principle of constant comparison to continually reference new information against our emerging theoretical framework.

Sampling took place in four stages, and synthesis took place across five stages of analysis. Analysis Phase 1 took place alongside article screening and purposive sampling, and Analysis Phases 2-5 built iteratively and successively from the initial analysis. Synthetic constructs emerging during earlier phases provided a foundation for subsequent phases of analysis. Sampling and analysis methods across these distinct stages are provided in a primary appendix: **Appendix A –** Stages of Sampling and Analysis. In this appendix, Table A1 details stages of sampling, and how the literature sample informed distinct stages of analysis. This primary methods appendix is supplemented by **Appendix B**: Database of Potentially Relevant Articles and **Appendix C**: Screening Criteria for Record Inclusion. The final literature sample

used in this synthesis is presented in **Appendix D**: Final Literature Sample, and definitions of
synthetic constructs that emerged throughout the analysis are included in **Appendix E**:
Codebooks. For reference, Table 3.1 details which appendices are relevant to each stage of
sampling and analysis.

Table 3.1: Guide to Appendices, and Their Relevance to Stage(s) of Sampling and Analysis

Appendix Name	Relevant Sampling Stage(s)	Relevant Analysis Stage(s)
Appendix A – Stages of Sampling and Analysis	All – Primary methods appendix	All – Primary methods appendix
Appendix B – Database of Potentially Relevant Articles	Stage 1 – Database of Potentially Relevant Articles	None
Appendix C – Screening Criteria for Record Inclusion	Stage 2 – Article Screening	Stage 1 – Text Extraction
Appendix D – Final Literature Sample	Stage 2 – Article Screening	Stage 1 – Text Extraction
Appendix E – Codebooks	None	Stage 2 – Knowledge Forms (Main Text Section 3.3.1.1); Stage 3 – Cultural Benefits Categories (Section 3.3.1.2); Stage 4 – Intersections with Decision-making (Section 3.3.2); and Stage 5 – Synthesizing Argument (Section 3.4)

In addition to facilitating theory building, we feel that Critical Interpretive Synthesis is
well-suited to engagement with multiple knowledge systems. In this work we adopt a critical
research paradigm, and seek further to engage with Indigenous paradigms (Held, 2019).
Although this work arises from and contributes to Western academic scholarship, we hope to
participate in and inform conversations around cross-cultural (epistemological/ontological)
spaces in both research and decision-making (Held, 2019; Kovach, 2009; Latulippe, 2015;
Martinez, 2016; McGregor, 2004, 2009, 2012; Reddekop, 2014; Wilson, 2008; Zanotti &
Palomino-Schalscha, 2016). Critical Western research paradigms, although still grounded in
many assumptions associated with Western ways of knowing (Held, 2019; Muller et al., 2019),

can serve as allied tools that support cross-cultural inquiry (Kovach, 2009, p 86). However, there is no substitute for direct engagement with individuals and communities who embody diverse knowledge systems. It follows that we offer this work as only a starting point for conversation; the theoretical contributions presented here should be refined through further engagement with and critique by those familiar with and embodying non-Western ways of knowing.

3.2.1 – Study Limitations

Two caveats underscore the need for refinement of these ideas through future research and application in collaboration with diverse cultural-benefits-knowledge-holders. First, this synthesis relies on written articles that either document and describe environmental decision-making processes, or explicitly offer information intended to inform such processes. Therefore, our exposure to diverse knowledge forms was primarily mediated through textual descriptions. While we uncovered important patterns around the cultural benefits categories most commonly conveyed by diverse knowledge forms, we did not have direct access to oral, visual and embodied knowledge forms that would convey more nuance and meaning than is possible to translate into written text form (Kovach, 2009; Martinez, 2021; Wilson, 2008). However, it is of note that during the Critical Interpretive Synthesis process, the lead author was concurrently engaged in case study data collection about how cultural-benefits-knowledge informed decision-making associated with the Elwha River dam removal and ecosystem restoration process. Many examples of knowledge forms encountered in the literature review found parallels in the Elwha case study, and this more direct, on-the-ground exposure brought added dimension and color to interpretation of textual examples. Future case study research can allow for continued and deepened constant comparison (Corbin & Strauss, 2015; Creswell, 2007) of empirical evidence against the original conceptual models arising from this Critical Interpretive Synthesis.

Second, this effort was originally inspired by a 2015 United States Federal Memorandum directing Federal agencies to improve consideration of cultural benefits in decision-making, alongside all ecosystem services and benefits (White House, 2015). We therefore targeted our article selection and analysis toward examples of how cultural-benefits-knowledge can intersect with environmental decision-making in the context of formal institutions that often hold authority over management of land, water, and natural resources in modern nation states. Our focus on existing institutions may exclude knowledge forms and possibilities for their consideration that currently exist or could exist in other governance arrangements. In spite of this, we are confident that our results offer insight into a more complete spectrum of cultural-benefits-knowledge-forms; examples in the literature we synthesized highlight the limitations of privileged knowledge forms for adequate comprehension and consideration of diverse knowledges and understandings of cultural benefit and well-being, and raise additional possibilities and pathways. This synthesis can therefore serve as one useful starting point for a pluralist theory of cultural-benefits-knowledge, particularly in the context of settler-colonial societies.

3.3 Results and Discussion

Through the iterative phases of analysis described in Appendix A, we developed a series of synthetic constructs and integrated them into an overarching synthesizing argument, or theoretical framework. In response to the question, "in what forms is cultural-benefits-knowledge conveyed to inform environmental decision-making, i.e., articulated, demonstrated, identified, measured, or represented?" we developed a typology of cultural-benefits-knowledge-forms encountered in our literature sample (Section 3.3.1.1). Building from this typology, we explored the cultural benefits categories most commonly associated with these distinct

knowledge forms (Section 3.3.1.2). Second, responding to the question, "how can these knowledge forms meaningfully inform decision-making processes?" we identified knowledge pathways related to translation, mobilization, and integration of cultural-benefits-knowledge across phases of decision-making (Section 3.3.2.1), and variables influencing meaningful consideration of cultural-benefits-knowledge (Section 3.3.2.2). Our synthesizing argument (Section 3.4) integrates these findings and offers a theoretical framework of unique but intersecting Areas of Learning Opportunity through which diverse cultural-benefits-knowledge-forms have potential to meaningfully inform environmental decision-making.

3.3.1 Conveying Cultural Benefits Through Diverse Knowledge Forms

The first research question anchoring this synthesis was, "In what forms is cultural-benefits-knowledge conveyed to inform environmental decision-making, i.e., articulated, demonstrated, identified, measured, or represented?" As a foundation for a knowledge-plural theory of cultural benefits, we explored both the diverse forms in which cultural-benefits-knowledge-claims were conveyed within our literature sample (Section 3.3.1.1) and the specific cultural benefits categories that were conveyed by these distinct knowledge forms (3.3.1.2).

3.3.1.1 Typology of Cultural-Benefits-Knowledge-Forms

During Phase 2 Analysis we coded each article or book in our Final Literature Sample (Appendix A, Table A1) for examples of how cultural-benefits-knowledge was conveyed. The purpose of this exercise was to develop a set of clear categories of distinct forms of cultural-benefits-knowledge. Development of this typology allowed us to then explore whether and how distinct knowledge forms succeed in conveying particular cultural benefits categories, value aspects, and value perspectives.

At the outset of this study, we initially conceptualized the question of cultural-benefits-knowledge-*forms* as a question about the diversity of knowledge *products*, i.e., forms of documentation or externalized knowledge, that have potential to convey cultural-benefits-knowledge-claims in the context of environmental decision-making. However, as we explored examples of cultural-benefits-knowledge in our literature sample we recognized the need to think beyond *knowledge-as-product*. Using a second cycle coding method known as Theoretical Coding (Saldaña, 2009), we identified the core category of *Knowledge Concept* from among our first-cycle codes (Appendix E1.1). This category highlights that in addition to conceptualizing knowledge in terms of products, we must also create space for understandings of *knowledge-as-practice*. The Knowledge Concept category is central to our theory because it serves to link and organize additional first-cycle codes related to cultural-benefits-knowledge-forms. These additional codes are present in our final Typology of Cultural-Benefits-Knowledge-Forms (Fig. 3.3; Table 3.2) as common characteristics of overarching knowledge forms.

We came to refer to examples of knowledge-as-practice as *Enacted knowledge forms* (upper portion of Fig. 3.3; Table 3.2), in that they represent cultural-benefits-knowledge-holders putting their experience and understandings of cultural benefit/well-being – whether explicit or tacit – into practice through expression or action. We came to refer to knowledge-as-product, i.e., static forms of written or quantitative documentation, as *Translated knowledge forms* (lower portion of Fig. 3.3; Table 3.2). All Translated knowledge forms involve the separation of cultural-benefits-knowledge from the original knowledge holder, and the production of knowledge forms that can be used and interpreted across cultural contexts, with varying degrees of loss of meaning and context.

Enacted knowledge forms can be understood as the embodiment of cultural-benefits-knowledge through knowledge practices, including practices that seek to gain knowledge and practices that put that knowledge into action. Putting cultural-benefits-knowledge into action may involve, for example, verbal expressions of why or how a specific site or species is linked to well-being, or demonstration of this knowledge through engagement in land-based traditions and lifeways, e.g., subsistence practices and ecosystem stewardship. Western scholars and decision-makers typically view these knowledge forms as sources of data from which information can be derived. However, from the perspective of Indigenous epistemology, they stand alone as valid, decision-relevant knowledge gained through "internal" methods of coming to know (Wilson, 2008) that is then put into practice as a sacred responsibility (e.g., Privott, 2019).

For example, Kovach (2009) discusses story not as a narrative data source to mine for facts, but as an embodied Indigenous research method. "The knowledges that we gather in the ephemeral moment of oral story, as told by a teller, as we sit in a specific spiritual, physical, and emotional place, are of a different sort. The immediacy of the relational stands outside the research, and at best we can only reflect upon it. To make visible the holistic, relational meaning requires a reflexive narrative by the researcher" (p. 102). The purpose of story as a knowledge practice is not solely for the listener to gain understanding through internal methods, but to equip them to act on those truths to "enhance the well-being of earth's inhabitants" (Kovach, 2009, p. 102). Thus, story as an Indigenous research method incorporates both reflexive learning and responsibility to act.
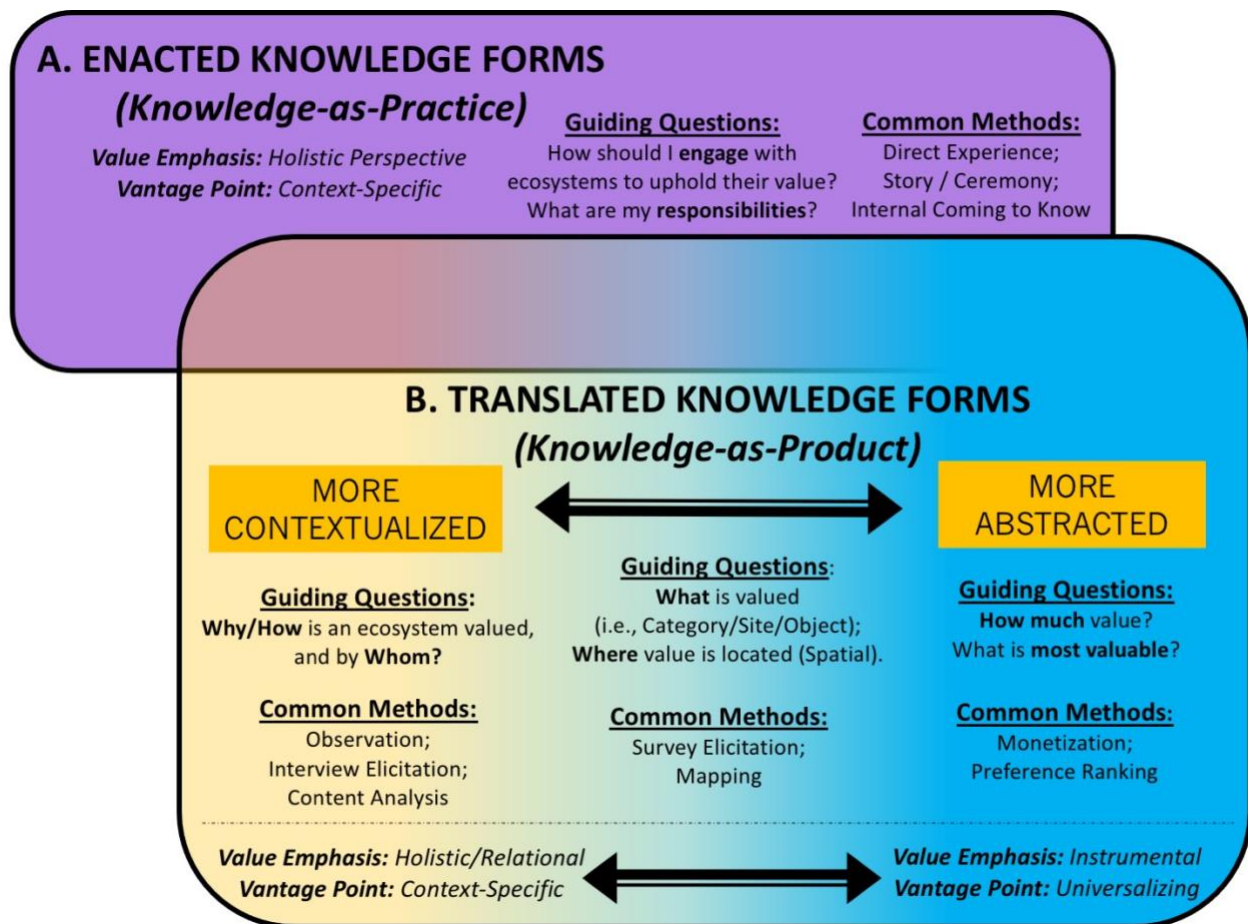
Figure 3.3: Typology of Cultural-Benefits-Knowledge-Forms. The code *Knowledge Concept* serves as the organizing theoretical concept for this typology, distinguishing between A. Enacted knowledge forms (*knowledge-as-practice*) and B. Translated knowledge forms (*knowledge-as-product*). Additional codes populate characteristics of each knowledge form, including *Guiding Questions*, *Common Methods*, *Epistemology*, *Value Emphasis*, and *Vantage Point*. Enacted knowledge forms are inherently context-specific, as they consist of lived experience conveyed through direct expression or demonstration. Enacted forms generally convey holistic understandings of value and well-being, in the sense that relational and instrumental value aspects are mutually dependent (Hoelting et al., 2022a). Translated knowledge forms can be understood as a spectrum of approaches to documentation of value, from more context-specific to more abstracted. Overlap between A. Enacted and B. Translated knowledge forms occurs when community-led translation or co-research enables Enacted Knowledge to inform Translated Knowledge products, or when Translated Knowledge products support cultural-benefits-knowledge-holders to enact their cultural-benefits-knowledge through articulation or demonstration.

We conceptualize Translated knowledge forms as a spectrum of documentation approaches ranging from more contextualized to more abstracted. Translations utilize Enacted knowledge as data sources from which to extract useful facts and understandings (Kovach, 2009). On one end of the spectrum, *Abstracted Translations* separate knowledge from context in the interest of documenting universalized understandings of well-being. Examples of Abstracted

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Translations include quantitative metrics such as monetary valuation or non-monetary preference ranking. On the other end of the spectrum, *Contextualized Translations* are characterized by an effort to retain context and meaning as expressed or demonstrated by cultural-benefits-knowledge-holders. Examples of Contextualized Translations include ethnographic reports and other qualitative, rich descriptions of the meanings and value of human-nature relationship. Although the purpose of Contextualized Translations differs from that of Enacted knowledge forms, they can serve to protect and amplify traditional knowledge in some cases (e.g., Kaufman, 2013; Muzzin, 2010; Shepherd, 2008).

Translated knowledge forms can fall mid-way between Contextualized and Abstracted on this spectrum. For example, knowledge can become partially separated from its full meaning and context through use of simplified categories and definitions of benefit or value (e.g., Carroll et al. 2003). Depending on how they are created, these intermediary Translated knowledge forms can retain partial context or become more abstracted. For example, when mapping efforts use locally-meaningful spatial units and definitions of cultural value, or if categories of cultural benefits have been defined locally, the resulting knowledge forms are more likely to retain cultural context (e.g., Pascua et al., 2017; Rawluk et al., 2019). However, if they rely on universalized categories or definitions of space and value, they begin to merge with fully abstracted forms of documentation.

Fig. 3.3 and Table 3.2 also depict and describe overlap between Enacted and Translated knowledge forms. Cultural-benefits-knowledge-holders enact their knowledge through embodied practices of well-being. This embodiment can involve their participation in production of Translated knowledge forms. This may take the form of community-led or co-research that results in more accurate and culturally appropriate translations (David-Chavez & Gavin, 2018;

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Ford et al., 2014; Gadamus et al., 2015). Translated knowledge forms may be examples of Enacted knowledge when, for example, cultural-benefits-knowledge-holders develop research questions that resonate with their understanding of well-being, identify decision-relevant indicators or categories, and/or when they participate in the production of maps or qualitative written documentation. These processes can help ensure that the resulting knowledge falls further toward context on the spectrum from Contextualized to Abstracted Translations. When decision processes require that value be distilled to its instrumental aspects, opportunities for overlap between Enacted Knowledge and Translated knowledge forms are constrained, as this requires that cultural-benefits-knowledge-holders distill their understandings of well-being into universalized and substitutable terms. However, in the context of institutional arrangements that can facilitate learning across scales, e.g., co-management or other collaborative or polycentric decision contexts (Armitage et al., 2011; Heikkila & Gerlak, 2019), and interaction among distinct actors over longer time periods, e.g., adaptive management (Heikkila & Gerlak, 2019; Williams & Brown, 2018), there may be greater opportunity for localized categories and understandings of well-being to be mainstreamed in decision-making.

Table 3.2: Cultural-Benefits-Knowledge-Form Categories

Grayed portions of the Table represent areas of overlap between categories (see Fig. 3.3 for a visual depiction of these relationships).

KNOWLEDGE CONCEPT	KNOWLEDGE FORM	CATEGORY DEFINITION	COMMON CHARACTERISTICS	EXAMPLES
Knowledge-as-Practice	**Enacted knowledge forms**	Include: • **Practices of knowledge sharing** that reproduce and convey truths (e.g., narrative, linguistic, performative, visual, or ceremonial forms). • **Enactment of these truths** through articulation of principles for responsible engagement with ecosystems, or demonstration through lived engagement with ecosystems (e.g., engaging in traditional place-based practices, and defending ecosystems and lifeways tied to those ecosystems).	**Guiding Questions**: How should we engage with ecosystems to uphold their value and maintain balance in relationships? What are our obligations and responsibilities? **Common Methods**: Direct experience; story / ceremony; internal coming to know. **Epistemology**: Experiential and intersubjectivist (Held, 2019). **Value Emphasis**: Holistic value perspective. **Vantage Point**: Context-specific (Díaz et al., 2018).	Enacted forms of knowledge-as-*practice* include expression or demonstration, including to protect cultural benefits or to embody and reproduce them. For example: • Direct involvement in management, i.e., "Management Proxies," in which cultural-benefits-knowledge-holders identify management approaches that will maintain cultural benefits, and • Protest or advocacy to promote institutional changes, i.e., "Institutional Proxies," in which cultural-benefits-knowledge-holders identify institutional arrangements that would enable them to achieve management that aligns with their well-being. • Maintaining engagement in traditional practices and ecosystem stewardship to reproduce and maintain knowledge systems and lifeways.
Intersection between Practice and Product	*Enacted Products*	*As a sub-set of both Knowledge-as-Practice and Knowledge-as-Product, cultural-benefits-knowledge can be enacted when knowledge holders guide or participate in processes of translation.*	*Where cultural-benefits-knowledge holders guide or participate in translation, including through involvement in documentation or interpretation, there can be a blending of characteristics from both Enacted and Translated categories. For example, common characteristics of Enacted Knowledge, such as*	*Translated knowledge forms may be examples of Enacted knowledge, i.e., Enacted Products, when for example, cultural-benefits-knowledge-holders lead or collaborate in research (Collaborative Research Pathway). This may include, for example, when cultural-benefits-knowledge-holders develop research questions, identify decision-relevant indicators or categories, and/or when they participate in the production of maps or qualitative written documentation.*

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			obligation/responsibility, holistic value perspective, and context-specific vantage point may provide a backdrop for how and why translated products are created and used to inform decision-making (e.g., Raymond-Yakoubian & Daniel, 2018).	
Knowledge-as-Product	**Contextualized Translation**	Knowledge products that attempt to translate meaning and benefit, staying as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. There is always a loss of meaning in translation, but there is an effort to retain original meanings and understandings.	**Guiding Questions**: Why and how is an ecosystem important? For whom is it important? **Common Methods**: Observation; Interview Elicitation; Content Analysis. **Epistemology**: Experiential, subjectivist, or intersubjectivist (Held, 2019). **Value Emphasis**: Holistic value perspective or Relational value aspects **Vantage Point**: Context-specific (Díaz et al., 2018).	Examples of Contextualized Translations include: • Ethnographic reports and other qualitative, rich descriptions of the meanings and value of human-nature relationship. • Written documentation of cultural benefits, including oral contributions to a written record, e.g., public comment.
	Intermediary Translation	*Forms of documented knowledge (knowledge products) that seek to convey what is important, i.e., categories, or where value is located, i.e., spatial locations. The degree to which these knowledge forms are removed from the original context and value perspective of the cultural-benefits-knowledge-holders, i.e.,*	*Guiding Questions: What is valued, i.e., categories, sites, objects? Where is value located, i.e., spatial?* *Common Methods: Survey elicitation; Mapping.* *Epistemology: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.* *Value Emphasis: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.*	*Depending on how they are created, knowledge forms can fall at an intermediary location between contextualized and abstracted. For example, when mapping efforts utilize locally-meaningful spatial units and definitions of cultural value, or if categories of cultural benefits have been defined locally, the resulting knowledge forms are more likely to retain some cultural context (e.g., Pascua et al., 2017; Rawluk et al., 2019). However, if they rely on universalized categories or definitions of space and value, they begin to merge with fully abstracted forms of documentation.*

		abstracted, depends on the level of involvement of knowledge holders in defining terms and categories, etc.	*Vantage Point: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.*	
	Abstracted Translation	Forms of documented knowledge, i.e., knowledge products, that seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."	**Guiding Questions**: How much value does an ecosystem provide? What elements or functions of an ecosystem are most valuable? **Common Methods**: Survey elicitation; Monetization; Preference ranking; Mapping. **Epistemology**: Objectivist, empirical (Held, 2019). **Value Emphasis**: Instrumental value aspects. **Vantage Point**: Universalizing (Díaz et al., 2018).	Examples of Abstracted Translations include: • Quantitative value metrics such as monetary valuation or non-monetary preference ranking. • Documentation of tangible variables, such as locations (mapping), which can be inventoried without reference to cultural context and meaning, i.e., relevant value aspects or perspectives • Presence/absence of "categories" of cultural benefit which can be inventoried without reference to cultural context and meaning, i.e., relevant value aspects or perspectives.

In addition to the core category of Knowledge Concept, five additional organizing themes were identified during second-cycle coding: Guiding Questions, Common Methods, Epistemology, Value Emphasis, and Vantage Point. These themes can be understood as common characteristics of the overarching knowledge forms, and help to distinguish between categories in the typology. First, *Guiding Questions* highlights the goal or purpose inherent to the knowledge form. Enacted forms of cultural-benefits-knowledge, as embodied and lived, are geared toward guiding human actions. In many cultures this entails guidance around how to fulfill reciprocal responsibilities in relationship to non-human nature. In contrast, Translated knowledge forms serve a range of purposes linked to measuring, describing, or understanding value. Where Enacted and Translated forms overlap, they may achieve both. Guiding Questions are listed in Fig. 3.3 and Table 3.2 for each knowledge form category.

Second, two themes – *Common Methods* and *Epistemology* – are linked to validity. Enacted forms of cultural-benefits-knowledge tend to view personal and collective experience as valid knowledge sources, reflecting an experiential and intersubjectivist epistemology (Held, 2019). They make use of direct experience, learning and mentorship, and "internal" methods such as story and ceremony (Kovach, 2009; Martinez, 2021; Wilson, 2008). Contextualized Translations have similar epistemological foundations around the value of subjective experience. However, given that researchers are often not the primary holders of the cultural-benefits-knowledge being documented, Contextualized Translations typically do not engage "internal" methods, and instead rely on elicitation of benefits-knowledge from knowledge holders which can then be interpreted through qualitative analysis.[10] In contrast, Abstracted Translations are

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[10] It is of note that many Indigenous researchers are finding ways to bridge enacted knowledge and Western qualitative research methods, for example through integration of narrative/story in written products, and through treating research itself as ceremony in service of coming to know on the part of the researcher (Barber & Jackson, 2011; Kovach, 2009; Martinez, 2016, 2021; Wilson, 2008).

based on objectivist and empirical epistemologies (Held, 2019), typically utilizing quantitative, positivist methods, and viewing expert scientific knowledge based on aggregated, statistically representative understandings as valid. Common Methods for each knowledge form are listed in Fig. 3.3 and Table 3.2.

The final two themes – *Value Emphasis* and *Vantage Point* – relate to the value perspective or value aspects that can be conveyed through each type of knowledge form. These themes are distinct and yet highly interrelated. The concept of a "value perspective" highlights not only the aspects of value communicated, but whether value can be reduced to separate aspects, i.e., holistic or reductionist value perspectives, and ontological assumptions about human-nature relationship that accompany this perspective. The "vantage point" from which value is understood, i.e., context-specific or universalizing (Díaz et al., 2015a), has implications for value perspective. Benefits understood from a context-specific view of well-being and human-nature relationship are more difficult to convey through Abstracted knowledge forms, which tend to rely on universalized metrics expressing instrumental or unspecified aspects of value. In contrast, Enacted knowledge forms and Contextualized Translations are most likely to engage context-specific vantage points, and to convey holistic value perspectives or relational aspects of value.

The value perspective characterizing Enacted knowledge forms is typically holistic because embodied experience of human-nature relationship contributes both instrumental (substitutable) and non-instrumental relational (non-substitutable) value aspects, and alongside the intrinsic value of non-human nature these values are often experienced as inseparable and mutually reinforcing. The relational value aspect is non-substitutable in that it is *constitutive* of human flourishing, i.e., the possibility of living a good life, and is of *fundamental* value because

it acts as the "foundations of our socio-cultural self-understanding" (Himes & Muraca, 2018, p. 3, see also Jax et al., 2013). The ability to live in right relationship with non-human nature, i.e., to fulfill moral responsibilities and reciprocal obligations, are directly linked to our ability to live a good life (flourishing) and maintain socio-cultural self-understanding (cultural survival) (Sheremata, 2018; Vaughan, 2018). In many place-based cultures, instrumental uses of ecosystems such as subsistence harvesting (instrumental value) are essential for maintaining respectful reciprocal relationships (relational value), and relational value in turn guide action and place limits on the extent of instrumental use. Contextualized Translations may seek to retain and amplify this holistic value perspective, or may seek to reduce holistic value to its non-instrumental aspects for the purpose of understanding and describing relational values.

3.3.1.2 Cultural Benefits Conveyed through Knowledge Forms

During Phase 2 Analysis we also explored the relationship between knowledge forms and categories of cultural benefit. We coded each knowledge form record for relevant cultural benefits categories, which allowed us to identify which knowledge forms in our sample were most likely to convey a particular cultural benefit (Fig. 3.4). Our results align closely with past research into the cultural benefits categories most included and most marginalized in common approaches to ES assessment. Like Milcu et al. (2013) and Gould et al. (2019), we find that that educational and scientific value, recreational value, and aesthetic value are the cultural benefits categories most commonly conveyed through Abstracted Translations, reflecting the relative ease with which they can be quantified and universalized. In contrast, categories of benefit most commonly associated with relational value aspects or holistic value perspectives, such as knowledge systems and cultural identity, were the least frequently conveyed through Abstracted knowledge forms.
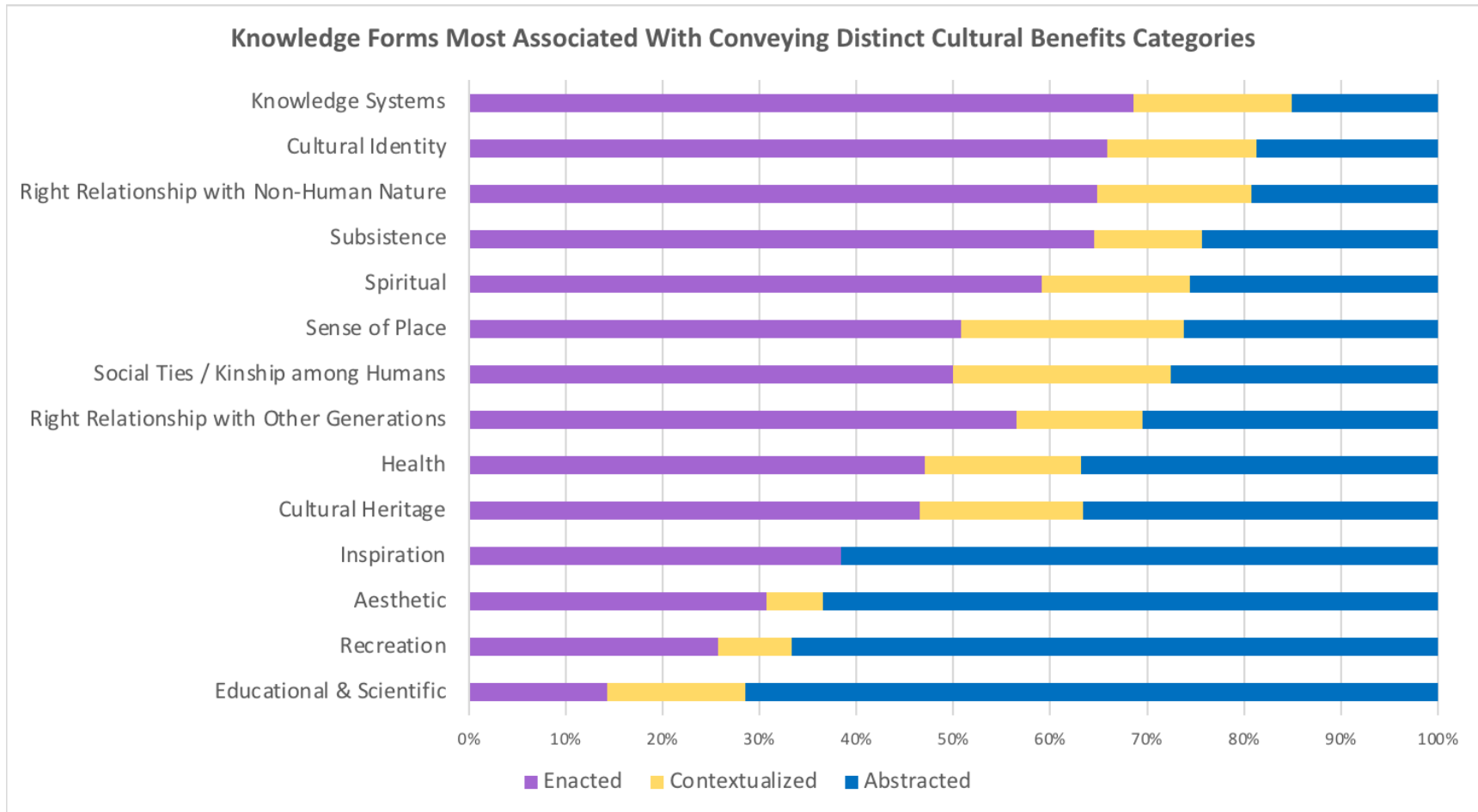
Figure 3.4: Likelihood that cultural benefits categories are conveyed through distinct knowledge forms. Based on cases in our literature sample, we find that some cultural-benefits-knowledge-forms are more likely to convey particular cultural benefits categories than others. The bars reflect the proportions of different knowledge forms that were associated with each cultural benefits category.

Beyond confirming past findings, Fig. 3.4 tells a nuanced story about the potential for marginalized cultural benefits categories, such as Knowledge Systems and Cultural Identity, to be more meaningfully considered in decision-making. The fact that all cultural benefits categories were conveyed to some degree through Abstracted knowledge forms suggests there are ways to include these highly intangible cultural benefits through traditional approaches to ES assessment. On the other hand, the small proportion of Abstracted knowledge forms used to convey many of the categories in our sample raises questions about what may be lost in translation when we seek to represent these benefits in more Abstracted forms that emphasize instrumental value aspects or fail to specify meanings. This question is further explored in Section 3.3.2.1.

Appendix E2, Table E2.1 provides a detailed description of the final cultural benefits categories represented in Fig. 3.4, including definitions and how they overlap with past cultural-ecosystem-services typologies. It is of note that we introduce several new cultural benefits categories to account for examples in our literature sample. Frequent expressions of obligation to non-human nature and to other generations (past and future) – the costs of not being able to fulfill these obligations and the benefits of fulfilling them – did not fit within past categories. We therefore developed two new categories through our coding process: 1) *Right Relationship with Non-Human Nature*[11] and 2) *Right Relationship with Other Generations*.[12] In addition, we felt

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[11] We incorporate existence value within this category as an instrumental expression of the value of meeting our obligations to non-human others. However, a majority of the instances of discussion of obligations to non-human nature were characterized as non-substitutable, and best expressed within a holistic value perspective or a focus on relational aspects of value.

[12] We incorporate bequest value within this category as an instrumental expression of the value of meeting our obligations to future generations. However, a majority of the instances of discussion of obligations to other generations were characterized as non-substitutable, and best expressed within a holistic value perspective or a focus on relational aspects of value. As a further point of departure from the concept of bequest value, this category explicitly includes fulfilling obligations to both past and future generations. Our sample suggests that some cultural-benefits-knowledge-holders have obligations to ancestors as well as future generations, and that the opportunity to

that past descriptions of the CES category *Knowledge Systems* did not adequately capture the depth of importance ascribed to maintenance of knowledge systems as a foundation for cultural survival, and we provide a more detailed definition based on the cases in our sample. Our identified need for these new and expanded categories mirrors the development of the relational value concept in the wider literature, which seeks to include aspects of nature's value that are not explained by a strictly instrumental cultural-ecosystem-services framework (Chan et al., 2016, 2018; Himes & Muraca, 2018).

3.3.2 Intersections with Decision-making

In Section 3.3.1 we reimagined the meaning of "knowledge," enabling us to recognize multiple forms of knowledge that convey understandings and practices of ecosystems' cultural benefits. Our second guiding research question, "How do diverse cultural-benefits-knowledge-forms intersect with decision-making processes?" raises a parallel need to explore a fuller spectrum of opportunities for cultural-benefits-knowledge to inform decision-making.

To do so requires that we reexamine what we mean by "decision-making," as well as what we mean by "inform." Recent research on ES-knowledge-use has begun to reexamine these concepts, exploring uses of ES-knowledge that move beyond technical needs, e.g., optimization and cost-benefit analysis, to also explore conceptual and strategic modes of knowledge use (e.g., McKenzie et al., 2014; Posner et al., 2016; Prewitt et al., 2012; Ruckelshaus et al., 2015). Conceptual use occurs when knowledge helps to expand understanding or shift the framing of policy problems and solutions, and strategic use occurs when decision-makers holding pre-existing policy positions use new knowledge to validate their positions or attempt to undermine knowledge that contradicts those positions (Dunlop et al., 2014; McKenzie et al., 2014; Weiss,

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fulfill these obligations contributes to their well-being (Barber & Jackson, 2011; Byers et al., 2001; Muzzin, 2010; Smith et al., 2003; Sole & Woods, 1993).

1979, 1999). However, these explorations around how ES-knowledge can inform decision-making are based on the concept of knowledge-as-product, i.e. emphasis is placed on knowledge in the form of Abstracted Translation. This limited concept of decision-relevant ES-knowledge is likely to result in a limited understanding of opportunities for meaningful consideration of cultural-benefits-knowledge as a whole.

To uncover a more complete spectrum of opportunities, based on an expanded view of knowledge, we carried out in-depth analysis of two underrepresented cultural benefits categories: 1) Knowledge Systems and 2) Cultural Identity. Earlier, we found these categories of cultural benefit were much more likely to be conveyed through Enacted or Contextualized knowledge forms (Fig. 3.4, Section 3.3.1.2). In other words, these categories of benefit are more likely to be made evident through direct embodiment and enactment of responsibilities, or attempts to document this embodiment or enactment while staying true to the original meaning and value perspective. In this section we explore points of intersection between knowledge forms and decision-making. First, we identify pathways through which knowledge of Cultural Identity and Knowledge Systems benefits may travel, and stages of decision-making this knowledge is likely to inform (Section 3.3.2.1). Second, we present findings around variables that can act as barriers to or enabling factors for consideration of these two cultural benefits categories (Section 3.3.2.2).

3.3.2.1 Knowledge Pathways across Phases of Decision-Making

Our analysis revealed two distinct yet overlapping types of pathways through which cultural-benefits-knowledge can inform decision-making. These two pathway types align with the overarching distinction of Knowledge Concepts represented in our Typology of Knowledge Forms (Fig. 3.3 and Table 3.2, Section 3.3.1.1): understandings of knowledge-as-product and knowledge-as-practice. When knowledge is viewed as a product, there is a need to translate

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contextualized understandings into more decontextualized knowledge forms. In this *Knowledge Product Pathway*, Enacted knowledge and Contextualized Translations are generally viewed as sources of data to be converted into final Abstracted knowledge forms. However, cultural-benefits-knowledge can also be meaningfully integrated into decision-making through *Knowledge Practice Pathways* that involve knowledge holders directly, traversing around the need for translation or documentation of their knowledge. This is particularly important with regard to meaningful integration of Indigenous perspectives on well-being and human-nature relationship, as discussed further below. In turn, meaningful inclusion of cultural-benefits-knowledge-holders – and enacted knowledge - exists at the overlap between Product and Practice pathways. Examples of these distinct yet overlapping pathways are discussed sequentially in the following paragraphs.

Knowledge Product Pathways

Knowledge Product Pathways have thus far received most attention in the context of ES theory and application. These pathways involve translation of more contextualized knowledge forms, i.e., Enacted and Contextualized forms, into more universalized and transferrable forms, i.e., Abstracted knowledge products. We found that this pathway involves two overarching types of proxies that serve to "make cultural values tangible" for decision-making (Lewis and Sheppard, 2005). These include: *Use Proxies*, i.e., when the value of a cultural benefit category is reduced to its use value, i.e., instrumental value aspects; and *Benefit Proxies*, i.e., when a more measurable cultural benefit or ecological indicator is substituted as an indicator for less tangible categories of cultural benefit.

Use Proxies serve to distill a cultural benefit's value to its instrumental (utilitarian) aspects. Whereas this may facilitate inclusion of that value in technical decision-making, it also

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sidelines the more complete spectrum of value aspects associated with that benefit. For example, the value of subsistence activities could be characterized as the quantity of protein harvested (focus on instrumental value aspects) (e.g., Adamowicz et al., 2004; Boyd et al., 2010; Luizza et al., 2016; Maclean et al., 2011; Nordlund et al., 2018; Norgaard, 2005; Schreiber, 2013; Walsh, 1993). Alternatively, subsistence can be understood as the embodiment of a way of life and knowledge system in which instrumental and relational value aspects cannot be separated (holistic value perspective) (e.g., Boyd et al., 2010; Craig et al., 2012; McCormick, 2006; McKinney et al., 2016; Russell et al., 2020; Turner & Bitonti, 2011; Walsh, 1993; Yazzie, 2006). This richer meaning and value are lost when Use Proxies are the dominant approach to representing and integrating cultural benefits in decision-making (Edwards et al., 2018; Kenny & Chan, 2017, Lewis & Sheppard, 2005).

Benefit Proxies also often emphasize instrumental value aspects, given that instrumental value is more easily converted into metrics. For example, in our sample Recreational value is often conceptualized as instrumental and represented using quantifiable landscape characteristics or features, such as specific species or habitats (Nordlund et al., 2018), in-stream water flow (Burmil et al., 1999), or the presence of preferred scenery elements (Brady et al., 2012; Casado-arzuaga et al., 2014; Trainor, 2006; van Zanten et al., 2016). However, Benefit Proxies can also be linked to policy priorities grounded in diverse aspects of value. For example, cultural heritage protections may align more readily with relational value aspects or holistic value perspectives. In our sample, the number of protected cultural heritage sites was used as a Benefit Proxy for less tangible cultural benefits categories such as Knowledge Systems, Cultural Identity, and Right Relationship with other Generations (e.g., Boyd et al., 2010; Kaufman, 2013; Wang, 2018).

Use and Benefit Proxy metrics are generally envisioned to inform technical phases of decision-making, such as estimating outcomes, assessing impacts, and optimizing according to established interests and objectives (Brest & Krieger, 2010). This function of knowledge can be equated with *single-loop learning*, defined as slight adjustments to technical understandings and approaches that do not challenge accepted ways of framing the problem or objectives (Pahl-Wostl, 2009). Both easily fit within established problem framings, whether related to maximizing utility (instrumental value) or tracking and reporting on existing policy priorities.

This pathway also involves an inherent shift in the value aspects or perspective likely to be conveyed: whereas Enacted and Contextualized forms of knowledge tend to convey relational value aspects or holistic value perspectives, proxy metrics tend to convey instrumental value aspects or generic "unspecified" value that is indirectly linked to policy objectives. It is therefore important to interpret Fig. 3.4 (Section 3.3.1.2) with the understanding that, even if a cultural benefits category has been "represented" via an Abstracted knowledge form, *aspects of value and meaning are almost certainly lost in these processes of translation*. Even as researchers look for new and improved ways to make cultural benefits tangible, decision-makers should be wary of relying solely on this Knowledge Product Pathway for meaningful consideration and protection of the plural values linked to cultural benefits of ES (Kenny & Chan, 2017, Lewis & Sheppard, 2005; Sheremata, 2018).

Knowledge Practice Pathways

Another important way to minimize the inevitable losses of meaning that occur in translation is the direct inclusion of diverse cultural-benefits-knowledge-holders in both research and decision-making. Approaches that include cultural-benefits-knowledge-holders as decision-makers, whether through community-led management or co-management, can be referred to as

Knowledge Practice Pathways. In contrast to the Knowledge Product Pathways detailed above, Knowledge Practice Pathways have received limited attention in the context of ES theory and application. Two primary Knowledge Practice Pathways involve the enactment of cultural-benefits-knowledge through practices linked to 1) ecosystem management and 2) institutional arrangements. First, the *Management Practice Pathway* refers to direct involvement of cultural-benefits-knowledge-holders in ecosystem management, e.g., through identification of preferred ecological management approaches, ecological thresholds, or other ecological objectives that support well-being. Second, the *Institutional Practice Pathway* refers to advocacy by cultural-benefits-knowledge-holders for institutional arrangements which afford resource tenure and shared decision authority, e.g., co-management or Indigenous-led management.

Through the Management Practice Pathway, cultural-benefits-knowledge-holders can ensure that management approaches align with cultural values and protect their understandings and practices of well-being. They may identify ecological thresholds or site protections that maintain their cultural benefits, for example, by enabling fulfillment of reciprocal or respectful responsibilities and the reproduction of knowledge systems (e.g., Booth & Skelton, 2011; Chanwai & Richardson; 1998; Garvie, 2009; Martinez, 2006; McNee et al., 1993; Lewis & Sheppard, 2005; Robinson et al., 2012; Sheremata, 2018; Sletto, 2002; Stevenson & Webb, 2003). These actions can be taken whether or not the cultural group explicitly articulates or documents the particular cultural benefits they will protect. For example, an Indigenous group may identify a "cultural flow" of water (ecological threshold) that will protect their cultural well-being, but they may not provide detail about the cultural benefits or aspects of value they seek to protect (e.g., Barber & Jackson, 2011; Morgan et al., 2004); and "culturally valuable" locations (sites requiring protection) may be identified on a map without description of the cultural

benefits or value perspectives linked to the sites (e.g., Schreiber, 2013; Smith et al., 2003; Witiw & Wiersma, 2015).

The Management Practice Pathway can be understood to inform deliberative phases of decision-making, including problem definition, prioritization of values, interests, objectives, and identifying potential alternative actions (Brest & Krieger, 2010). These functions of cultural-benefits-knowledge can be equated with *double-loop learning*, defined as reflecting on whether goals and objectives need to be adjusted to better account for diverse values and knowledges (Pahl-Wostl, 2009). In the context of settler-colonial governance, this Knowledge Practice Pathway is essential for meaningful inclusion of Indigenous groups' cultural benefits: the protection of particular ecological states, sites, or activities can also protect understandings and practices of well-being that Western decision-makers may fail to comprehend (e.g., Bates & Winter, 1993; Lewis & Sheppard, 2005; Mowaljarlai, 1993), and whose meanings and value perspectives can only be partially conveyed through the Knowledge Product Pathway (Kovach, 2009; Martinez, 2016; Smith, 2007; Wilson, 2008). In addition, it offers alternatives to explicit documentation in instances when knowledge holders' cultural protocols restrict sharing of cultural-benefits-knowledge (e.g., Sole & Woods, 1993), or when knowledge holders perceive potential for negative consequences or have experienced past negative consequences in making their cultural benefits knowable to those in power (e.g., Davies et al., 1999; Smith et al., 2003).

In turn, the Institutional Practice Pathway involves the creation of institutions that facilitate inclusion of knowledge through the Management Practice Pathway. This can be understood as a form of institutional work, defined as "the purposive action of individual or organizations aimed at creating, maintaining, and disrupting institutions" (Lawrence & Suddaby, 2006, p. 215). In decision contexts in which their involvement in management is limited or

absent, cultural-benefits-knowledge-holders may advocate – through policy proposals or other

forms of protest and resistance – for new institutional arrangements (e.g., Martinez, 2006;

McMillan, 2012, Norgaard & Reed, 2018; Peace, 1999; Privott, 2019; Shepherd, 2008; Shirley &

Word, 2018; Smith, 2007; Wang, 2018). In this sense, cultural-benefits-knowledge-holders seek

decision-making structures that align management practice with their understandings and

practices of well-being. This function of knowledge can be equated with *triple-loop learning*,

defined as adjustment of the governance paradigm, including definition of valid, legitimate

knowledge and decisions around who should be involved in decision-making, i.e., information

and boundary rules (Ostrom, 2005, 2011; Pahl-Wostl, 2009).

Overlapping Pathways: Product through Practice

Additional Knowledge Pathways exist at the overlap between Product and Practice

Pathways: 1) Collaborative Research and 2) Amplification. The *Collaborative Research*

Pathway refers to the direct involvement of knowledge-holders in processes of cultural-benefits-

knowledge translation. This pathway is active when cultural-benefits-knowledge-holders are

involved in identifying relevant well-being indicators, defining well-being, defining categories of

cultural benefit, or documenting their own cultural benefits, understandings, and practices of

well-being. Like Management Practice, the Collaborative Research Pathway may alleviate some

concern around losses of meaning that inevitably occur during processes of translation by

remaining at least partially grounded in context; this Knowledge Pathway can enable the

production of indicators and metrics more reflective of cultural-benefits-knowledge-holders'

understandings and practices of well-being, such as indicators of the continuity of place-based

knowledge systems and traditions (e.g., Ford et al., 2014; Gadamus et al., 2015; Johnston et al.,

2013; Sheremata, 2018).

The *Amplification Pathway* refers to the use of Translated knowledge forms to support and amplify the voices of cultural-benefits-knowledge-holders as they seek to inform environmental management. In particular, Contextualized Translations can explicitly amplify the experiences and understandings of knowledge-holders (e.g., Barber & Jackson, 2011; Clemmer, 2004; Lepofsky & Lertzman 2018; McCormick, 2006; Sullivan, 1993; Sillitoe, 2006), but Abstracted Translations can also be used to support advocacy for cultural-benefits-knowledge-holders' desired management approaches.

Practice Pathways, including the overlapping Practice-Product Pathways of Collaborative Research and Amplification, highlight the potential for cultural-benefits-knowledge-holders to bring their understandings of well-being in at the ground level of both research and decision-making. They further highlight the diversity of opportunities that emerge when we look beyond single-loop learning to consider how cultural-benefits-knowledge can inform us across both deliberative and technical phases of decision-making, and in the creation of institutions themselves.

3.3.2.2 Barriers and Enabling Factors for Consideration of Cultural-Benefits-Knowledge

The notion of "opportunities" for improved consideration of cultural-benefits-knowledge implies either removing barriers or reinforcing enabling factors. Table 3.3 presents four themes associated with barriers and enabling factors that emerged during Stage 4 analysis: A. Structural Factors, B. Political Will, C. Mobilizing Knowledge, and D. Integrating Knowledge. Definitions, specific examples, and relevant citations from our literature sample are provided in Appendix E, Table E4.1. A variable that serves as a barrier in one situation may act as an enabling factor in another, so our themes emphasize variables that influence consideration more generally. The

themes represent emergent "areas of opportunity" for improved consideration of cultural-

benefits-knowledge in decision-making.

Table 3.3: Factors Influencing Consideration of Cultural-Benefits-Knowledge in Environmental
Decision-Making

THEME	SUMMARY	EXAMPLES OF FACTORS
◊ Structural Factors	The rules of a decision context often privilege certain values and knowledge forms over others. Legal and legislative systems can perpetuate inequality or open possibilities for new social relations.	This theme encompasses factors such as the worldview and values embedded within institutions, knowledge forms that are required by or permitted to inform decision processes, degree of policy adaptiveness and institutional flexibility, and structures for participation by or shared authority of cultural-benefits-knowledge-holders throughout phases of decision-making.
◊ Political Will	Whether or not knowledge pluralism is implemented in practice depends on political will at the scale of both institutions and individual decision-makers.	Political will was evident as important variable for implementing knowledge co-production, upholding treaty rights and engaging in meaningful Tribal consultation, and pursuing new legal channels and governance arrangements to share decision authority.
◊ Mobilizing Knowledge	Mobilizing cultural-benefits-knowledge means making it available to inform decision-making, whether in the form of a knowledge product or the direct involvement of knowledge holders in decision-making.	This theme encompasses factors that impact successful mobilization, such as united voice and shared vision on the part of cultural groups, capacity, time, and funding for knowledge co-production processes, the sensitive or protected character of knowledge, and alliances with researchers, non-profits, or governments to amplify knowledge.
◊ Integrating Knowledge	Once cultural-benefits-knowledge has been mobilized, whether as product or in practice, many factors influence whether and how it informs decision-making.	This theme encompasses factors that impact successful integration, including openness of institutions and individual decision-makers to multiple knowledge systems and associated valid forms of knowledge, how readily cultural-benefits-knowledge can be conveyed through privileged knowledge forms, e.g., quantitative metrics, and the degree to which cultural-benefits-knowledge-holders are actively involved in ecosystem management and institutional design.

First, the rules of a decision context (A. Structural Factors) specify avenues for and

limitations on the participation of stakeholders and rights-holders, the knowledge forms that are

required or permissible, and the degree of policy adaptiveness and flexibility afforded to decision-makers. Ultimately, all of these aspects reflect the worldview of those who designed the institution, and determine the values that become embedded in decisions (Gorddard et al., 2016). Many resource management institutions in the United States are bound by requirements for quantitative knowledge forms that consider instrumental aspects of value, for example in terms of cost-benefit or cost-effectiveness (Ascher et al., 2010). Abstracted knowledge forms that emphasize instrumental aspects of cultural benefits are thus less likely to encounter barriers to integration in decision-making compared to knowledge forms that convey relational value aspects or holistic value perspectives. These plural values are more likely to be conveyed through Enacted forms and Contextualized Translations that are less likely to be viewed as legitimate within existing decision contexts.

Second, issues of political will at multiple scales (B. Political Will) interact with structural factors to enhance or limit opportunities for consideration of cultural-benefits-knowledge within a given decision context. Individual leaders play an outsized role in creating and sustaining – or limiting – opportunities for collaboration and innovation in environmental management (Steelman, 2010). In addition, agency missions can constrain or encourage individual environmental managers to pursue creative approaches (e.g., Brugnach & Ingram, 2012; Garvie, 2009). We identified several specific issues of political will in our literature synthesis that impact opportunities for meaningful consideration of cultural-benefits-knowledge, including the will to share decision authority, promote knowledge co-production, uphold Treaty rights and other legally binding agreements, and engage in meaningful Tribal consultation.

Finally, there were linked themes around both *whether cultural-benefits-knowledge can be mobilized* to inform decision-making (C. Mobilizing Knowledge) and *how successfully*

cultural-benefits-knowledge is integrated within decision contexts (D. Integrating Knowledge).

Both Knowledge Practice and Product Pathways (Section 3.3.2.1) are relevant to mobilization

and integration of cultural-benefits-knowledge: knowledge can be mobilized and integrated

through documentation and also through direct involvement of cultural-benefits-knowledge-

holders in the practice of ecosystem management. With mobilization of cultural-benefits-

knowledge, variables include the sensitive or protected status of knowledge, the degree of intra-

community cohesiveness or conflict around this knowledge, and effort barriers inherent to

collaborative knowledge processes, such as capacity, time and funding limitations. Financial and

technical support from NGOs and government agencies can support capacity-building and

development of a shared vision within and across cultural groups. The quality of relationship and

level of trust between cultural-benefits-knowledge-holders and authorities is also an important

enabling factor for both mobilization of cultural-benefits-knowledge.

It is important to note that barriers related to mobilizing and integrating knowledge are

nested within power dynamics established by the structure of decision contexts (A. Structural

Factors) and the will of actors empowered within those structures (B. Political Will). Institutional

rules[13] determine who can participate in decision-making and how, the types of knowledge that

are permitted to inform decision-making, permitted actions, the scope of outcomes that can be

affected by a decision, and the benefits or consequences for decision-makers associated with

particular actions and outcomes (Ostrom, 2005, 2011). When considering opportunities for

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[13] Ostrom (2005, 2011) outline seven working rules of institutions that affect the structure of action situations. These include: **boundary rules** affecting the attributes decision-making participants, including rules for entering or leaving; **position rules** determining what roles can be filled by participants; **choice rules** determining actions that actors may, must or must not take; **scope rules** determining the outcomes that can be affected by a decision and the actions that are linked to that outcome; **aggregation rules** determining how decisions are made, including with respect to who must be involved in particular actions; **information rules** affecting the forms of knowledge that are available to actors; and **payoff rules** affecting the benefits and costs associated with particular actions and outcomes, including can incentivize or deter particular actions.

meaningful consideration of cultural benefits, particularly consequential factors include whether diverse cultural-benefits-knowledge-holders can participate in decision-making, i.e., whether boundary rules are inclusive, and whether cultural-benefits-knowledge is available in a form that fits within dominant paradigms of knowledge legitimacy, i.e., whether it fits within existing information rules.

With integration of cultural-benefits-knowledge, a consequential factor is whether the knowledge is available in a form that fits within dominant paradigms of knowledge legitimacy. On the one hand, cultural-benefits-knowledge is more readily integrated in technical decision-making when it is translated into Abstracted knowledge forms, i.e., quantified and universalizable. On the other hand, this translation process marginalizes non-instrumental value aspects and perspectives. Openness of decision-makers to a wider variety of knowledge forms can enable more comprehensive and thorough communication of value, including relational aspects and holistic perspectives. Co-research or community-led research can better reflect community values, but the evidence produced is not always deemed decision-relevant or politically feasible to integrate. As with mobilization of cultural-benefits-knowledge, the level of trust and strength of relationships between decision-makers and knowledge-holders is an important enabling factor for integration of cultural-benefits-knowledge.

Building from these barriers and enabling factors, a cross-cutting area of opportunity emerged: Cultural Comprehension. Many of the studies in our sample detailed challenges of inadequate cultural comprehension on the part of decision-makers, falling along a spectrum from lack of awareness of Indigenous axiologies and epistemologies (Clemmer, 2004; Mowaljarlai, 1993; Norgaard, 2005; Sillitoe, 2006; Smith, 2007; Watson, 2018) to active indifference or hostility to other worldviews and ways of knowing (McCormick, 2006; Shirley & Word, 2018;

Sillitoe, 2006; Sole & Woods, 1993). Our analysis highlights the need and opportunity for

improved cultural comprehension both at the level of individual decision-makers and researchers

(Booth & Skelton, 2011; Makgill & Rennie, 2012), and in terms of acknowledging and

dismantling systemic biases within our institutional and legal structures (Lawson, 1993;

Martinez, 2006; McMillan, 2012; Watson, 2018). Table 3.4 provides a list of opportunities for

improved Cultural Comprehension that were highlighted in our literature sample, at both

individual and institutional scales.

Table 3.4: Cultural Comprehension as a Cross-Cutting Area of Opportunity

◊ Cultural Comprehension	Individual Scale Building respectful relationships between Indigenous groups and decision-makers, and/or bringing Indigenous people into positions of decision-making authority; - Availability of educational opportunities that support decision-makers to recognize their own embedded knowledge systems and comprehend the knowledge systems of others; - Level of decision-maker willingness to comprehend diverse ways of knowing, including forms of knowledge understood as valid across knowledge systems. Institutional Scale - Degree to which institutions create space for multiple knowledge systems in terms of embedded definitions, categories, decision rules, and requirements for admissible knowledge; - Degree to which institutions recognize and prioritize plural values and plural human-nature relationships; - Degree to which institutions enable direct involvement of cultural-benefits-knowledge-holders throughout phases of decision-making.

3.4 Synthesizing Argument and Discussion: From Knowledge Use to Learning Opportunities

During our final, synthesizing phase of analysis, we came to understand *meaningful consideration* of cultural benefits as diverse *opportunities for learning*. Attention to double- and triple-loop learning enhanced our understanding of how, where, and when diverse cultural-benefits-knowledge-forms have the potential to intersect with and inform decision-making in practice. As a synthesizing argument for this Critical Interpretive Synthesis, we therefore propose a shift from the concept of "ES-knowledge-use" to "ES-learning-opportunities."

Dominant conceptualizations of ES-knowledge-use as technical are still relevant in the context of single-loop learning, but by broadening the view to include double- and triple-loop processes the dynamics of cultural-benefits-knowledge at the knowledge-policy interface become more understandable. Further, this enables identification of a more complete spectrum of opportunities for meaningful consideration of cultural-benefits-knowledge.

Our final model of Areas of Learning Opportunity (Fig. 3.5) includes three primary areas of opportunity that exist across single-, double-, and triple-loop processes: A. Translation to Product, B. Management and Institutional Practice, and C. Cultural Comprehension. First, *A. Translation to Product* encompasses opportunities to better represent cultural-benefits-knowledge in static informational products. When produced by or in collaboration with cultural-benefits-knowledge-holders, knowledge products are most likely to align with knowledge holders' understandings of well-being and benefit. However, knowledge products always have the potential to be (mis)interpreted and used by decision-makers without attention to the original cultural context. The Translation to Product area of learning opportunity mirrors the Product Pathway described in Section 3.3.2.1.

B1. Management Practice encompasses opportunities for direct involvement of cultural-benefits-knowledge-holders in interpretation of translated cultural-benefits-knowledge, and more broadly in establishing appropriate interaction with ecosystems as part of management. This may include involvement in setting ecological management goals and objectives, or identification of relevant indicators and thresholds. *B2. Institutional Practice* involves opportunities for cultural-benefits-knowledge-holders to participate in institutional design, including decisions about what constitutes valid, decision-relevant knowledge and who should participate in interpretation and decision-making. This may include forms of action such as advocacy, protest, lawsuits, or other

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Figure 3.5: Areas of Learning Opportunity. Opportunities to learn from cultural-benefits-knowledge can be mapped within these areas. These include single- and double-loop learning opportunities within existing agency processes (inside dotted line), and triple-loop learning opportunities that involve transformation of institutional structures (outside dotted line).

forms of resistance as knowledge practice. The Management Practice and Institutional Practice areas of learning opportunity mirror the Practice Pathways described in Section 3.3.2.1.

Finally, the *C. Cultural Comprehension* area of learning opportunity encompasses opportunities to support awareness and legitimation of multiple knowledge systems, including distinct foundational realities (ontology) and moral/ethical systems (axiology) that give rise to diverse ways of knowing cultural benefit and well-being. This third area emerged as a cross-cutting theme during our analysis of barriers and enabling factors (Section 3.3.2.2, Table 3.4). It

is situated at the bottom of the opportunity map to symbolize its foundational role: improved Cultural Comprehension can equip decision-makers to recognize and act on opportunities emerging in the other two areas of opportunity, and lack of adequate Cultural Comprehension can limit recognition of other opportunities.

Structural Factors serve to define the decision context, including the rules, embedded values, and understandings of valid knowledge that guide a particular agency decision process (Gorddard et al., 2016). This is represented in our model as the dark blue outer circle in Fig. 3.5, titled "Institutional and Legal Structures," which serve to define "Existing Agency Decision Processes" inside the dotted line at center of the figure. Some learning opportunities exist within existing government agency processes, while others may not be viable within the particular decision context. All single- and double-loop learning opportunities can be understood as "nested" within the outer, constitutive structures; they depend on processes of triple-loop learning to create the necessary conditions for particular forms of knowledge to be considered legitimate and relevant to ordinary decision-making.

For example, a single- or double-loop learning opportunity within Translation to Product (Fig. 3.5, A.) is community-led or co-research. Using terminology from our typology of knowledge forms (Fig. 3.3 and Table 3.2, Section 3.3.1.1), this can be characterized as the (co)production of more culturally appropriate and accurate Abstracted Translations using contextualized categories or understandings of well-being (e.g., Garvie, 2009; Ford et al., 2014; Johnston et al., 2013; Pascua, 2017; McCormick, 2006; Rawluk, 2019; Raymond-Yakoubian & Daniel, 2018; Robinson et al., 2012; Sletto, 2002; Stevenson & Webb, 2003; Swensen & Sætren, 2014). However, such knowledge products may not be deemed "relevant" or "actionable" in decision contexts that privilege universalized categories or monetary metrics, i.e., institutions

with narrow information rules (Ostrom, 2005; Ostrom, 2011). Similarly, an opportunity within Management Practice (Fig. 3.5, B1) is the involvement of cultural-benefits-knowledge-holders in skilled interpretation of knowledge products (Marek-Martinez, 2016; Martinez, 2006), and in processes of decision-making more broadly (Chanwai & Richardson, 1998; Craig, 1999; Lawler & Bullock, 2017; McNee et al., 1993; Necefer, 2016). However, these opportunities may not be feasible in decisions contexts with narrow boundary rules that restrict the participation of diverse cultural-benefits-knowledge-holders, for example in top-down governance arrangements. In turn, more expansive boundary rules which may be encountered in, for example, co-management, polycentric, or Indigenous-led governance arrangements (Heikkila & Gerlak, 2019), may have greater potential to involve knowledge-holders directly in knowledge translation and interpretation. Similarly, opportunities for improved Cultural Comprehension (Fig. 3.5, C.) depend on levels of participation and shared authority afforded to stakeholders and rights-holders.

In cases in which institutional and legal structures constrain opportunities for single- or double-loop learning within agency decision processes, triple-loop learning may be required to better enable consideration of cultural-benefits-knowledge. Institutional Practice (Fig. 3.5, B2) is an area of triple-loop learning opportunity in which, for example, cultural-benefits-knowledge-holders may enact their benefits-knowledge by engaging in advocacy to bring institutions more in alignment with their understandings of cultural benefit and well-being, i.e., a form of institutional work (Lawrence & Suddaby, 2006). Such institutional reforms have the potential to open new opportunities for single- and double-loop learning in all Areas of Learning Opportunity depicted in Fig. 3.5. This could include opportunities around the forms of knowledge deemed valid and decision-relevant (A. Translation to Product), who is able to guide

and participate in management actions (B1. Management Practice), and prioritization of cross-cultural understanding within agency decision-making processes (C. Cultural Comprehension).

These three Areas of Learning Opportunity – Translation to Product, Practice (Management and Institutional), and Cultural Comprehension – resonate with previous research by Gadamus et al. (2015, p. 117) which points to three approaches for improving inclusiveness of Indigenous knowledge and values in Federal fisheries policy in the United States: 1) acceptance of very different approaches to knowledge (e.g., legitimating Enacted knowledge forms and considering how they can intersect with and inform single-loop learning; supporting opportunities for Cultural Comprehension in research and decision-making); 2) document traditional ecological knowledge within scientific frameworks on terms acceptable to Tribes (e.g., co-research and community-led Translation to Product); and 3) directly address issues of power and the role scientific research has played in colonialism (e.g., who is involved in the practice of institutional design, including in determining what knowledge forms are valid and actionable). Our synthesis echoes this need to recognize dynamics of power, particularly in settler-colonial societies, that privilege certain knowledge systems – and knowledge forms and epistemologies – over others.

Within ES research and practice, translation of cultural-benefits-knowledge into forms already deemed valid and decision-relevant is often viewed as the primary Area of Opportunity for "learning" from ES-knowledge. Quantification, i.e., production of Abstracted Translations, is framed as the primary enabling factor for ES-knowledge to inform decision-making (Bernués et al., 2014; Carrihlo & de Almeida Sinisgalli, 2018; Kermagoret & Dupras, 2018; Kumar, 2010; Stosh et al., 2017). For example, the director of a Health and Ecosystems initiative articulates the view that management of both ecosystems and human health requires quantitative indicators, for

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"if it cannot be measured, it cannot be managed" (Quoted in Holzman, 2012, p. A157). However, when quantification becomes the primary requirement, it also acts as a barrier for consideration of those cultural benefits not adequately conveyed through highly Abstracted knowledge forms (Raymond et al., 2018; Tsosie, 2007).

Several authors in our literature sample directly spoke to the importance of developing quantitative indicators while simultaneously highlighting the dangers of sole reliance on this form of cultural-benefits-knowledge (e.g., Edwards et al., 2018; Kenny & Chan, 2017; Lewis & Sheppard, 2005; Sheremata, 2018). Kenny and Chan (2017) state particularly clearly that measurable indicators do not stand alone in providing a complete picture. They echo our synthesizing argument around the need to engage multiple areas of learning opportunity to achieve meaningful consideration of cultural-benefits-knowledge: we must involve cultural-benefits-knowledge-holders in research (Fig. 3.5, Translation to Product) to improve the way cultural benefits and understandings of well-being are represented, and in interpretation of resulting Translations to ensure they are applied in alignment with their original cultural context, values, and meanings (Fig. 3.5, Skilled Interpretation; Management Practice). Both of these learning opportunities contribute to and are enabled by efforts to increase Cultural Comprehension (Fig. 3.5) at individual and institutional scales.

3.5 Conclusion

The Critical Interpretive Synthesis method supports generation of new theory through the development of synthetic constructs and an overarching synthesizing argument (Booth, 2016; Boyko et al., 2012; Dixon-Woods et al., 2006; Gough et al., 2012; Gough & Thomas, 2017). The synthesizing argument arising from this Critical Interpretive Synthesis process is rooted in a critique of past characterization of "ES-knowledge" and "ES-knowledge-use," which have failed

to acknowledge a greater diversity of knowledge forms and learning opportunities through which cultural-benefits-knowledge can meaningfully inform environmental decision-making. Through the various phases of this synthesis, we found that attention to a greater diversity of knowledge forms (knowledge pluralism) may support consideration of plural values associated with diverse cultural benefits categories (value pluralism).

Past conceptualizations of ES-knowledge-use are still present in our model of learning opportunities in the form of single-loop learning. However, by broadening the view to include double- and triple-loop processes, decision-makers can begin to see a greater range of possibilities for how plural values and diverse cultural benefits can intersect with and inform environmental decision-making. By expanding the forms of cultural-benefits-knowledge included under the umbrella of legitimate ES-knowledge, new opportunities for meaningful consideration of marginalized cultural benefits categories become apparent. Not all of these opportunities will be immediately accessible within existing decision-contexts, but seeing a more complete range of opportunities is an essential first step in understanding the constraints present within existing institutions. When the constraints and opportunities are clearly visible, opportunities can be harnessed and institutions can be (re)imagined to be more inclusive of knowledge and value pluralism.

Our Typology of Cultural-Benefits-Knowledge-Forms (Fig. 3.3 and Table 3.2, Section 3.3.1) and culminating model of Areas of Learning Opportunity (Fig. 3.5, Section 3.4) can inform on-going development of a knowledge pluralist theory of the cultural benefits of ES. However, given important limitations of a literature-based approach (Section 3.2.1), next steps toward robust theoretical development should involve refinement of these ideas in direct collaboration with cultural-benefits-knowledge-holders representing diverse worldviews. This

can be accomplished in part through case study research to engage in in-depth observation and explore cultural-benefits-knowledge in practice, as well as targeted workshops to explore the application of these concepts in on-going decision-making processes. This may include discussions around how these ideas can best inform existing decision contexts, as well as the need for legislative and legal reforms.

4. MANUSCRIPT 3: AN OPPORTUNITIES FRAMEWORK FOR IMPROVED

INTEGRATION OF CULTURAL-BENEFITS-KNOWLEDGE IN ENVIRONMENTAL

DECISION-MAKING[14]

4.1 Introduction

The cultural benefits of ecosystem services (ES), often referred to as cultural ecosystem services, have been defined as "the contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable and the capabilities they help equip" (Fish et al., 2016, p. 212). Cultural benefits make ubiquitous and foundational contributions to human well-being (Chan et al., 2012a, 2012b), and yet they are consistently under- and misrepresented in decision-making processes (Gould et al., 2019; Satterfield et al., 2013; Satz et al., 2013). In this paper, we outline a Framework that can support improved integration of cultural benefits in environmental decision-making.

Challenges associated with improving accurate consideration of cultural benefits have been widely discussed in the literature (Chan et al., 2012, 2016, 2018; Daniel et al., 2012; Fish et al., 2016; Hirons et al., 2016; Milcu et al., 2013; Satterfield et al., 2013; Satz et al., 2013). A core challenge has been the emphasis placed on *instrumental aspects of value*, i.e., value conceptualized as substitutable and oriented toward maximizing human utility (Fig. 4.1), when many cultural benefits are inadequately understood through this instrumental lens. Instead, cultural benefits are better understood as arising in the context of valued relationships between

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[14] Co-authors on this dissertation chapter include Dr. Doreen E. Martinez, Lucas S. Bair, Dr. Rudy M. Schuster, and Dr. Michael C. Gavin. This manuscript is currently passing through USGS internal review and has not yet been preprinted.

humans and nature (Fish et al. 2016), and as such are linked to *relational (non-instrumental)*

aspects of value (Fig. 4.1, and see Chan et al., 2016).

We use **plural values,** or **value pluralism,** to refer to multiple, incommensurable value aspects and value perspectives.

Value aspects: To achieve value pluralism, we must attend not only to instrumental value aspects, i.e., utilitarian and substitutable, but also relational aspects, i.e., non-substitutable and arising from reciprocal human-nature relationship, and intrinsic value aspects, i.e., ecosystems, or components of ecosystems, are understood to possess their own value, independent of human use or other benefit.

Value perspectives: The separation of value aspects into distinct categories represents a reductionist value perspective. To achieve value pluralism, we must also create space for holistic value perspectives, in which instrumental, relational, and intrinsic aspects of value are understood to be inseparable and mutually reinforcing.

Figure 4.1: Definition Box – Value Pluralism

Categories of cultural benefits include, for example, spiritual and religious value, cultural

heritage, cultural identity, sense of place, recreation, aesthetic value, educational and scientific

value, inspiration, mental health, social or kinship ties, the ability to maintain knowledge systems

and cultural diversity, and the ability to seek to live in responsible relationship with nature (for

full definitions of cultural benefits categories used in this study, see Table F1, Appendix F). The

cultural benefits categories most linked to relational value aspects and *holistic value perspectives*

(Fig. 4.1), such as knowledge systems and cultural identity (Hoelting et al. 2022b), have been

particularly marginalized in ES assessment. Multiple systematic reviews have found that the

cultural benefits that are most easily imagined as substitutable, i.e., emphasizing instrumental

value aspects, are also most likely to be included in dominant approaches to ES assessment and

valuation. Milcu et al. (2013), Gould et al. (2019) and Hoelting et al. (2022b) each found that

recreational value, aesthetic value, and educational and scientific values were most likely to be

quantified for trade-off analysis, i.e., weighing of the costs and benefits of decision alternatives.

In contrast, benefits associated with maintenance of knowledge systems, cultural diversity,

identity, and sense of place were among those least amenable to trade-offs, and less likely to be

included in technical valuation studies. There is increasing recognition of the need for pluralistic

ecosystem valuation that takes account of the *plural values* of nature (Fig. 4.1, and see Díaz et

al., 2015a, 2015b; Gould et al., 2020a; Pascual et al., 2017, 2021). In recent years, various

frameworks and value typologies have been developed to carve out space for value pluralism in

theory (Arias-Arévalo et al., 2018; Chan et al., 2012a; Fish et al., 2016; Kenter et al., 2015, 2019;

Rawluk et al. 2019), and research methods of integrative and deliberative valuation have

received increasing attention as a path to value pluralism (Jacobs et al., 2016, 2018; Martín-

López et al., 2014; Raymond et al., 2014).

However, meaningful integration of plural values in decision-making requires more than

integrated or deliberative valuation research. Scholars and decision-makers increasingly

acknowledge what Indigenous peoples and place-based communities have long voiced (e.g.,

Bates & Winter, 1993; Kovach, 2009; Lewis & Sheppard, 2005; Martinez, 2014; Mowaljarlai,

1993; Smith, 2007; Wilson, 2008): to achieve value pluralism in decision-making, we must

attend to knowledge pluralism (Fig. 4.2). This means recognizing that when decision-relevant

knowledge is limited to the products of reductionist Western scientific epistemologies and

methodologies, bounds are also placed on what cultural benefits and associated value aspects are

comprehensible, i.e., possible to comprehend within the paradigm (Hoelting et al. 2022a; Muller,

2014; Howitt & Suchett Pearson, 2006). In other words, we must create space in decision-

making processes for the diverse *ways of knowing,* i.e., epistemologies (Fig. 4.2) that are linked

to diverse understandings of well-being (axiologies) and human-nature relationships

(ontologies).

The term **knowledge system** has been defined as "the sum of the principles, ethics, and values that determine how knowledge [claims are] generated, acquired, valued, shared, and used" (Held, 2019, p. 11). This includes one's beliefs about reality (ontology, e.g., what is the relationship between humans and non-humans?), value (axiology, e.g., what is well-being?), and how humans develop knowledge (epistemology, including valid methodologies and knowledge forms) (Berkes et al., 2018; Gould et al., 2020a; Held et al., 2019; Hoelting et al., 2022a; Kovach, 2009; Wilson, 2008).

We use **knowledge pluralism** to refer to variation in knowledge systems, including what humans can know about (reality, ontology), how humans understand value and well-being (axiology), and how humans come to know (epistemology, methodology).

Ways of knowing is a term largely synonymous with ideas of epistemology and methodology, in terms of approaches and methods for learning and teaching, i.e., coming to know and sharing knowledge.

Cultural-benefits-knowledge: "The <u>knowledge system</u> that guides our ways of knowing ecosystems (non-human nature) and cultural benefits arising from human relationship to those ecosystems" (Hoelting et al., 2022a).

Cultural-benefits-knowledge-claims: "<u>Understandings</u> of ecosystems (non-human nature) and cultural benefits arising from human relationship to those ecosystems, as validated within their epistemology of origin" (Hoelting et al., 2022a).

Cultural-benefits-knowledge-forms: "<u>Knowledge products and knowledge practices that provide means for conveying</u> cultural-benefits-knowledge-claims and can be mobilized and/or translated to inform environmental decision-making" (Hoelting et al., 2022a).

Figure 4.2: Definition Box – Cultural-Benefits-Knowledge and Knowledge Pluralism

Attention to knowledge pluralism must include awareness of the diverse forms of knowledge through which understandings of cultural benefits may be conveyed, i.e., *cultural-benefits-knowledge-forms* (Fig. 4.2, and see Hoelting et al., 2022b; Tengö et al., 2014, 2017; White House, 2021). When the concept of knowledge is restricted to products, e.g., quantitative information or written documentation, important aspects of cultural benefit and well-being linked to non-Western knowledge systems become marginalized. In contrast, when we pay attention to knowledge-as-practice in addition to knowledge-as-product, we become aware of a more complete and multi-cultural suite of opportunities for meaningful consideration of diverse cultural benefits and well-beings in decision-making. As a starting point, we must address the epistemic hierarchies and power imbalances built into existing natural resource management institutions, in which dominant worldviews and understandings of well-being have been treated

as universal (Dongoske et al. 2010, 2015; Hoelting et al., 2022a; Muller 2014; Pierotti & Wildcat, 2000).

Although there is a growing clarity around the *need* to implement knowledge pluralism in decision-making, there is less clarity around *how* to accomplish this in practice. For example, during the Cultural Ecosystem Services session at the "A Community on Ecosystem Services" (ACES) Roundtable in 2021, the question raised by ecosystem services practitioners, academics, and U.S. Federal decision-makers was not whether to move toward knowledge pluralism, but how to do so (Hoelting & Gould, 2021). There is a broad need for guidance to support implementation of knowledge pluralism in practice (Hoelting & Gould, 2022). As a core element of this, there is a need for examples that make this guidance tangible and feasible.

The framework presented in this paper can support improved integration of the cultural benefits of ES through implementation of knowledge pluralism in ES theory and application. Our Opportunities Framework for Improved Integration of Cultural Benefits (Opportunities Framework, or Framework) calls attention to diverse forms in which cultural-benefits-knowledge is made available, and diverse pathways through which that knowledge can inform environmental decision-making. The Framework builds on the work of Hoelting et al. (2022a, 2022b), and is envisioned as a systematic approach to make knowledge pluralism explicit in how we identify decision-relevant ES-knowledge and seek to integrate it with decision-making. Through recognition of diverse knowledge forms and pathways, more comprehensive assessment of opportunities becomes possible.

The Opportunities Framework can be used alternately as a tool for retrospective analysis or to systematically identify opportunities for improved consideration of cultural-benefits-knowledge in on-going decision-making processes. These applications are stand-alone and yet

complementary. Retrospective analysis enables continued theoretical refinement of the Framework, and can support implementation of knowledge pluralism in ES theory and practice by providing tangible examples as a form of guidance. In turn, application of the Framework to an on-going decision process enables systematic identification of available cultural-benefits-knowledge-forms and opportunities for their meaningful consideration. In addition, assessment of a current decision can serve as a form of cultural sensitivity training, supporting decision-makers' recognition of the multiple knowledge systems linked to an ecosystem. We envision the Framework as a tool both for natural resource management agency staff, as well as ecosystem stakeholders and rights-holders who seek to advocate for improved consideration of cultural-benefits-knowledge in decision-making. Implementing this framework is a critical step to avoid under- and misrepresentation of cultural benefits in decision-making processes.

The dual purposes of this article are to demonstrate the retrospective function of the Opportunities Framework, and to set the stage for its application to opportunities assessment in on-going decision-making contexts. The paper is divided into two parts. First, Section 4.2 introduces the Framework, including: methods used in its development (Section 4.2.1); conceptual models upon which it draws (Section 4.2.2); and a step-by-step guide to Framework implementation for either current decision assessment or retrospective case analysis (Section 4.2.3). Second, Section 4.3 demonstrates the retrospective function of the Framework through in-depth analysis of a past decision-making process: Elwha River dam removal and ecosystem restoration in Northwest Washington State. The Elwha River case study offers powerful examples of how inclusion of diverse knowledge holders can create space for formerly marginalized knowledge systems and cultural benefits in decision-making, but sometimes at the risk of marginalizing other cultural benefits and associated knowledge systems.

4.2 Outlining an Opportunities Framework

We propose a step-by-step Opportunities Framework to identify opportunities for improved integration of cultural-benefits-knowledge with decision-making processes. The Framework can be alternately applied for: 1) retrospective assessment of how cultural-benefits-knowledge informed a past decision; or 2) use in a current decision process to identify opportunities for improved integration of cultural-benefits-knowledge. The Opportunities Framework does not set out to resolve conflicts between multiple cultural-benefits-knowledges linked to a particular ecosystem (Fig. 4.2). Instead, it functions to a) ensure that all forms of cultural-benefits-knowledge relevant to the focal ecosystem are recognized, i.e., recognitional justice (Martin et al., 2016; Gould et al. 2020), and b) shed light on opportunities – including existing barriers and enabling factors that could be addressed or harnessed, respectively – to improve integration of diverse cultural-benefits-knowledge-forms (Fig. 4.2) in the focal decision-context (Hoelting et al. 2022b).

Importantly, opportunities may exist to integrate cultural-benefits-knowledge at multiple stages of decision-making, facilitated by distinct types of learning (Hiekkila & Gerlak, 2019; Hoelting & Gould, 2022). *Single-loop learning* is defined as slight adjustments to technical understandings and approaches that do not challenge accepted ways of framing the problem or objectives (Pahl-Wostl, 2009). This can be generally equated with technical stages of decision-making, including actions such as estimating outcomes, assessing impacts, and decision optimization (Brest & Krieger, 2010). *Double-loop learning* involves reflecting on whether goals and objectives need to be adjusted to better account for diverse values and knowledges (Pahl-Wostl, 2009). This can take place at early stages of decision-making (Brest & Krieger, 2010), but can also occur iteratively as in the case of adaptive management (Williams & Brown, 2018).

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In addition to opportunities within established institutional structures, actions to improve consideration of cultural-benefits-knowledge include adjusting decision contexts to engage a greater diversity of cultural-benefits-knowledge-holders and forms of knowledge arising from multiple epistemological traditions (Heikkila & Gerlak, 2019; Martinez, 2021; Tengö et al., 2012, 2014). For example, boundary rules or aggregation rules may be adjusted to encourage or require greater diversity among decision-makers; scope rules may be adjusted to allow for longer decision timelines, enabling more extended engagement among diverse actors; and information rules may be updated to recognize the legitimacy and decision-relevance of a greater diversity of knowledge forms (Heikkila & Gerlak, 2019; Ostrom, 2011). These kinds of adjustments to institutional rules can be equated with *triple-loop learning*, i.e., adjustments to the decision context itself (Pahl-Wostl, 2009) and linked to the concept of institutional work, defined as "the purposive action of individual or organizations aimed at creating, maintaining, and disrupting institutions" (Lawrence & Suddaby, 2006, p. 215).

When those involved in decision-making possess more complete awareness of and respect for available knowledge forms and opportunities for their meaningful consideration, across stages of decision-making, they will be better equipped to engage in pluralistic valuation of ecosystems' contributions to people (Pascual et al., 2017), grounded in awareness of diverse knowledge systems and human-nature relationships (Himes & Muraca, 2018; Tengö et al., 2014).

4.2.1 Methods used to Develop the Framework

This Framework applies a theory of cultural-benefits-knowledge to support implementation of knowledge pluralism – and value pluralism – in practice. The underlying theoretical contributions emerged from a Critical Interpretive Synthesis (Dixon-Woods et al.,

2006) of environmental management literature documenting examples of environmental management from around the world (Hoelting et al., 2022b).[15] The literature synthesis process involved the constant comparison method common to a Grounded Theory approach, in which new information is continually referenced against the emerging theoretical framework (Corbin & Strauss, 2015; Creswell, 2007). The resulting conceptual models are summarized in Section 4.2.3 and are incorporated in the Framework. These conceptual models are critical when identifying and articulating cultural benefits and recognizing space within decision-making process for their consideration.

Moving forward, the Framework and underpinning conceptual models should be understood as open to evolution based on both: 1) continued constant comparison with in-depth decision case studies, both retrospective and on-going, such as the one presented in this article; and 2) collaborative refinement workshops involving decision-makers and cultural-benefits-knowledge-holders representing diverse knowledge systems and human-nature relationships.

Given that the Framework is intended to support knowledge pluralism in ES theory and application, the development of the Framework itself should also involve holders of multiple knowledge systems. We therefore introduce this Framework in the spirit of continued conversation about how and when it can appropriately and equitably support movement toward knowledge pluralism and value pluralism in practice; it can be considered a starting point, with

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[15] It is of note that the lead author was concurrently engaged in data collection for the Elwha case study (Manuscript 3, this dissertation) and the Critical Interpretive Synthesis of environmental management literature discussed here. Given the lead author's in-depth knowledge of the Elwha case, some of the insights arising from this case study have already been integrated in the conceptual models underpinning the Framework, i.e., the Typology of Cultural-Benefits-Knowledge Forms and the Opportunity Map introduced in Section 3.3.2.2, and summarized again in Section 4.2.3. Nevertheless, the retrospective case analysis presented in this article, derived from closer analysis of interviews and documents associated with Elwha dam removal and ecosystem restoration decision processes, provides an opportunity for continued and deepened constant comparison (Corbin & Strauss, 2015; Creswell, 2007) of empirical evidence from the Elwha case study against the original conceptual models presented here.

the expectation that it will be refined through future workshops and case study application in collaboration with diverse knowledge holders.

4.2.2 Outlining the Opportunities Framework

The Opportunities Framework consists of four overarching steps that can be adapted for either retrospective case analysis or current decision assessment: 1) Clarify Context; 2) Knowledge Systems; 3) Cultural-Benefits-Knowledge-Forms; and 4) Opportunities in Context. Table 4.1 outlines objectives at each phase of the Framework, depending on the desired application. Framework phases are detailed further in subsequent text, including explanation of the conceptual models upon which the Framework draws. Whether engaging in current decision assessment or retrospective case analysis, the Typology of Cultural-Benefits-Knowledge-Forms facilitates comprehensive identification and articulation of forms of cultural-benefits-knowledge that are a) linked to the focal ecosystem, and b) made available to inform a particular decision process. Following identification and articulation of knowledge forms, they can be mapped within theorized Areas of Opportunity. These conceptual models were derived from a Critical Interpretive Synthesis of environmental management literature (Hoelting et al., 2022b).

Table 4.1: *Opportunities Framework for Improved Integration of Cultural Benefits, with goals and* objectives linked to two distinct Framework Applications (Current vs. Retrospective)

This Table is intended to guide application of the Framework, beginning with clarifying whether the case is current or retrospective, and continuing with c objectives at each Phase and identification of desired outputs and outcomes. **Note**: Most Phases have objectives linked to each of the goals identified for th relevant application (first row of the Table). However, Retrospective Case Analysis Phases 1 and 2 are primarily descriptive actions, and no Theoretical Refinement objectives are listed. Further, Retrospective Phase 1 does not include Guidance Objectives. Similarly, Current Decision Assessment Phase 1 is primarily descriptive, and no Foundational Objectives are listed.

FRAMEWORK PHASES	*Distinct Goals and Objectives for Each Framework Application*	
Determine Relevant Framework Application and Goals	CURRENT DECISION ASSESSMENT: *Goal 1 – Foundations*: Build a foundation of reflexivity and cultural comprehension among decision-makers, cultural-benefits-knowledge-holders linked to the focal ecosystem and decision process. *Goal 2 – Current Case Assessment:* Build a comprehensive list of available cultural-benefits-knowledge-forms and opportunities to improve their integration in the focal decision context.	RETROSPECTIVE CASE ANALYSIS: *Goal 1 – Descriptive Analysis:* Describe whether and how cultural-benefits-knowledge informed a past decision, and identify missed opportunities. *Goal 2 – Guidance for future Implementation of Knowledge Pluralism:* Highlight tangible examples that can offer guidance to support implementation of knowledge pluralism in practice. *Note*: application of the Framework to current decision contexts is envisioned as a way to implement knowledge pluralism. *Goal 3 – Theoretical Refinement:* Identify needed theoretical refinements to the framework.
PHASE 1 – Clarify Context	*Phase 1 Case Assessment Objectives:* • *Define the ecosystem* about which decision-making is taking place. • *Identify cultural-benefits-knowledge-holders* linked to the focal ecosystem. • *Describe the current decision context*, including guiding statutes and legal requirements, and a description of distinct stages of decision-making. This includes identifying the role of cultural-benefits-knowledge-holders within the existing decision context.	*Phase 1 Descriptive Analysis Objectives:* • *Define the ecosystem* about which decision-making took place. • *Identify cultural-benefits-knowledge-holders* linked to the focal ecosystem. • *Describe the retrospective decision context(s)*, including guiding statutes and legal requirements, and a description of distinct stages of decision-making, and the role of cultural-benefits-knowledge-holders in the process.
PHASE 2 – Knowledge	*Phase 2 Foundational Objectives*:	*Phase 2 Descriptive Analysis Objectives:*

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Systems	• *Cultivate Reflexivity*: All parties, including decision-makers and cultural-benefits-knowledge-holders, establish a foundation of reflexivity and awareness of positionality (e.g., understanding of one's own knowledge system and the assumptions that underlie it). • *Cultivate Awareness of Systemic Biases and Historical Recognitional Injustices*: All parties understand the ways a particular knowledge system may be embedded in the focal institution, and how this has historically obscured and may continue to marginalize other ways of knowing and valuing non-human nature. • *Cultivate Commitment*: Decision-makers cultivate commitment to addressing systemic biases within institutions. • *Build Respectful Relationships* between decision-makers and groups of cultural-benefits-knowledge-holders as a foundation for mutual understanding and pluralistic knowledge integration. ***Phase 2 Case Assessment Objectives***: • *Building cultural comprehension*: Stakeholders and rightsholders consider how and what to share with decision-makers about their ways of knowing the focal ecosystem; Decision-makers seek to comprehend and legitimize the knowledge systems of all parties.	• *Gather evidence of cultural comprehension*: Explore interview-based evidence and/or historical documentation around a) whether and how cultural-benefits-knowledge-holders articulated or demonstrated their knowledge systems to inform the focal decision process and b) whether and how decision-makers displayed awareness of these multiple ways of knowing the focal ecosystem. ***Phase 2 Guidance Objectives:*** • Highlight examples of successes and failures around cultural comprehension of the diverse knowledge systems and human-nature relationships linked to the focal ecosystem.
PHASE 3 – Cultural-Benefits-Knowledge-Forms	***Phase 3 Foundational Objectives:*** • *Understand and develop respect for diverse forms of cultural-benefits-knowledge*, including concepts of knowledge-as-product and knowledge-as-practice. • *Understand diverse criteria and approaches to validation* of cultural-benefits-knowledge, i.e., achieving its social legitimacy (Tengö et al., 2012). ***Phase 3 Case Assessment Objectives***:	***Phase 3 Descriptive Analysis Objectives***: • *Identify forms of cultural-benefits-knowledge* that were, or could have been, available to decision-makers, as well as forms of knowledge noted to have been missing. • *Cultural Benefits and Plural Values*: Where possible, identify the cultural benefits categories, value aspects, and value perspectives communicated through each knowledge form, or which could have been communicated through missing knowledge forms. ***Phase 3 Guidance Objectives:***

	• *Identify forms of cultural-benefits-knowledge* that are, or could be, available for consideration within the focal decision-making process. • *Cultural Benefits and Plural Values:* Where possible, identify the cultural benefits categories, and associated value aspects and value perspectives, communicated through each knowledge form.	• Highlight clear examples of knowledge forms that communicate diverse cultural benefits categories. ***Phase 3 Theoretical Refinement Objectives:*** • Identify any examples that do not fit within the existing Typology of Cultural-Benefits-Knowledge-Forms.
PHASE 4 – Opportunities in Context	***Phase 4 Foundational Objectives:*** • *Understand multiple Areas of Opportunity* for meaningful inclusion of cultural-benefits-knowledge in decision-making, and how the contours of these Areas of Opportunity may vary depending on decision context and across stages of decision-making. ***Phase 4 Case Assessment Objectives:*** • *Identify Action Opportunities* that could enable meaningful inclusion of available knowledge forms. Populate opportunity lists by: a) locating opportunities in one of the three Areas of Opportunity; and b) determining whether each opportunity is accessible within the existing decision context or if conditions for action require institutional adjustments. • *Return to the description of the (current) decision context from Phase 1*, and consider how existing directives guided or constrained consideration of identified cultural-benefits-knowledge-forms. These may include, for example: 1) what forms of knowledge are defined as admissible and decision-relevant; 2) who is considered a cultural-benefits-knowledge-holder; and 3) how and at what stages of decision-making are cultural-benefits-knowledge-holders able to participate in decision-making? • *Describe additional barriers and enabling factors* that may influence whether and how these knowledge forms can successfully be incorporated in decision-making.	***Phase 4 Descriptive Analysis Objectives:*** • *Identify demonstrated or potential Opportunities* associated with meaningful inclusion of each identified knowledge form. These include missed opportunities. • *Return to the description of the (retrospective) decision context from Phase 1*, and consider how existing directives guided or constrained consideration of identified cultural-benefits-knowledge-forms. These may include, for example: 1) what forms of knowledge were defined as admissible and decision-relevant; 2) who was considered a stakeholder or rightsholder; and 3) how and at what stages of decision-making were cultural-benefits-knowledge-holders able to participate in decision-making? • *Describe additional barriers and enabling factors* that influenced whether and how each knowledge form was incorporated in decision-making. ***Phase 4 Guidance Objectives:*** • Highlight clear examples of knowledge forms intersecting with decision-making within the distinct Areas of Opportunity. ***Phase 4 Theoretical Refinement Objectives:*** • Identify examples of knowledge forms that do intersect with decision-making through Areas of Opportunity in the current Opportunity Map.
Framework	***Outputs and Outcomes of Current Decision Assessment:***	***Outputs of Retrospective Case Analysis:***

Outputs and Outcomes	1) <u>List of Current Action Opportunities</u>: Using the Opportunity Map, identify specific opportunities linked to each available knowledge form. The final Opportunities List will include both a) actions that are achievable within the existing decision-context, and b) actions that would be enabled by changes to the decision context. 2) <u>Reflect on Foundations:</u> Circle back to the Foundational Objectives of Phase 1, including recognizing the systemic biases within our institutions, i.e., how the rules and structures of the decision context determine what kind of values are comprehensible, actionable, and decision-relevant. Describe what can be done now – with the existing decision context – to improve consideration of diverse cultural benefits, and identify desirable institutional shifts that would enable further improvement.	1) <u>Descriptive Analysis, with Examples for Guidance Support</u>: Summarize whether and how particular cultural benefits categories were conveyed and integrated, including the knowledge forms through which they were conveyed, barriers and enabling factors, and the Areas of Opportunity that best describe their intersections with decision-making. Illustrate this summary with tangible, clear examples from Phases 2, 3, and 4 that demonstrate how knowledge pluralism has been and can be implemented in ES theory and practice. This can offer guidance support for implementation of knowledge pluralism in practice, including applications of this Framework to current decision contexts. *Note*: application of the Framework to current decision contexts is envisioned as a way to implement knowledge pluralism. 2) <u>Theoretical Fit Summary</u>: Summarize how well examples identified in the analysis fit within the existing conceptual models, including the Typology of Cultural-Benefits-Knowledge-Forms and the Areas of Opportunity map. Identify any areas in which empirical evidence seemed a poor fit with the existing conceptual models.

4.2.3 Detailed Description of Framework Phases and Conceptual Underpinnings

The Framework begins with two foundational elements: Clarifying Context (Phase 1) and understanding Knowledge Systems (Phase 2). As a first step, Phase 1 involves both identifying cultural-benefits-knowledge-holders linked to the focal ecosystem and defining the decision context. This includes identifying guiding statutes and legal requirements, describing how the ecosystem was defined, and outlining distinct stages of decision-making. Identifying the role cultural-benefits-knowledge-holders within the existing decision context is also a fundamental step. Second, Phase 2 focuses on understanding the distinct knowledge systems of stakeholders, rightsholders, and decision-makers. This is important because an individual or cultural group's foundational understandings about non-human nature, and the relationship between humans and nature, underpin the types of cultural benefits that are possible to comprehend or to experience. Further, knowledge systems underpin why an individual or group – and environmental management institutions – may view a particular form of knowledge as legitimate and decision-relevant. Meaningful consideration of cultural benefits depends on the foundational willingness to comprehend and take seriously the multiple knowledge systems linked to an ecosystem. This process sets the stage for comprehension of the plural values linked to cultural benefits, as well as awareness and openness to diverse forms in which these cultural benefits may be conveyed to inform decision-making.

Phase 2 retrospective case analysis may draw on interview data collection and/or historical documentation to explore evidence of whether and how diverse knowledge systems were communicated to decision-makers. Interview data may also offer evidence of decision-maker awareness and openness to those knowledge systems. In contrast, when applied to a current decision context, Phase 2 can be used to actively support all parties – including cultural-

benefits-knowledge-holders and decision-makers – to cultivate awareness of their varied

knowledge systems, as well as to recognize the knowledge system(s) that are currently privileged

in the focal decision context. This includes exploring what all parties mean by "cultural benefits"

and "well-being," as well as their understandings of valid and decision-relevant knowledge.

Phases 3 and 4 of the Framework build upon this foundational willingness to engage with

multiple ways of knowing ecosystems by exploring diverse forms of cultural-benefits-knowledge

and how these forms can intersect with decision-making. Phase 3 draws on the Typology of

Cultural-Benefits-Knowledge-Forms introduced by Hoelting et al. (2022b). The Typology is

based around a core distinction between *knowledge-as-practice* and *knowledge-as-product*.

Together, Fig. 4.3 and detailed descriptions in Table F1 (Appendix F) introduce the distinct but

overlapping knowledge form concepts in the Typology. This Typology serves as a template for

identification of available knowledge forms, whether in a current decision context or through

retrospective analysis of interview data and documents associated with a past decision process.

Identification of available cultural-benefits-knowledge-forms across these concepts is central to

the application of the Opportunities Framework.
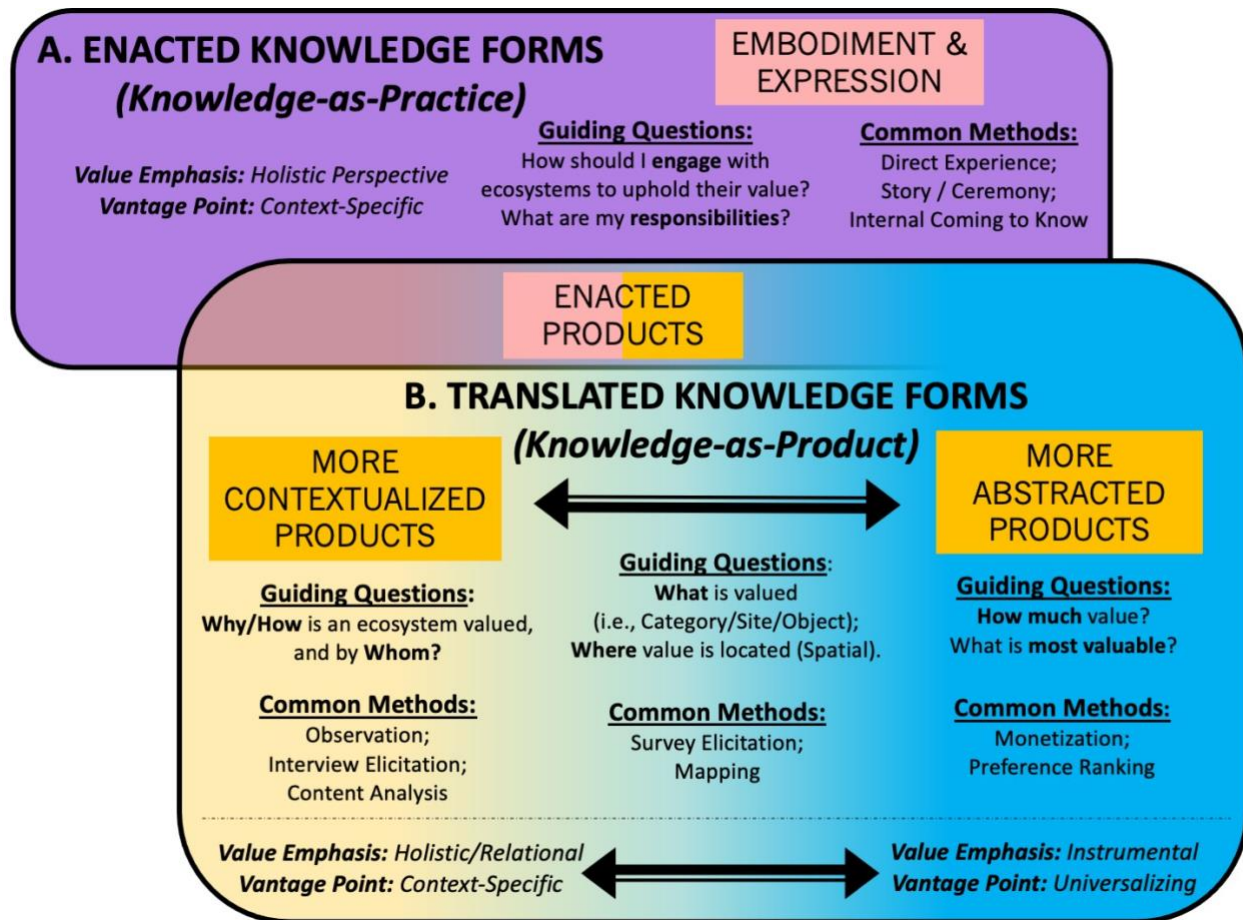
Figure 4.3: Typology of Cultural-Benefits-Knowledge-Forms. The code Knowledge Concept serves as the organizing theoretical concept for this typology, distinguishing between A. Enacted knowledge forms (*knowledge-as-practice*) and B. Translated knowledge forms (*knowledge-as-product*). Additional codes populate characteristics of each knowledge form, including *Guiding Questions*, *Common Methods*, *Epistemology*, *Value Emphasis*, and *Vantage Point*. **Enacted knowledge forms** are inherently context-specific, as they are grounded in intimate lived experience of cultural benefit. As knowledge practices, they can serve to protect or embody and reproduce cultural benefits. Enacted Forms generally convey holistic understandings of value and well-being, in the sense that relational and instrumental benefits are mutually dependent (Hoelting et al., 2022a). **Translated knowledge forms** can be understood as a spectrum of approaches to documentation of value, from more context-specific to more abstracted. Overlap between A. Enacted and B. Translated knowledge forms occurs when community-led translation or co-research enables Enacted knowledge to inform Translated knowledge products, and/or when Translated knowledge products support cultural-benefits-knowledge-holders to enact their cultural-benefits-knowledge through articulation or demonstration. The term Enacted Products encapsulates these aspects of overlap. (Reproduced from Manuscript 2, Chapter 3 this dissertation).

During Framework Phase 4, the Opportunity Map (Fig. 4.4) can be used to locate specific

action opportunities for integration of cultural-benefits-knowledge-forms. Locating action

opportunities involves two steps. First, it is necessary to identify the relevant action area(s) of the

map, i.e., Procedural Inclusion, Translation to Product, and/or Cultural Comprehension (Fig.

4.4). Second, the map must be cross-referenced with the specific decision context being analyzed

or assessed to determine whether each opportunity is actionable within the existing agency

process (inner circle of Fig. 4.4) or if the action would require adjustments to institutional or

legal structures (outer circle of Fig. 4.4). These action areas facilitate identification and

articulation of knowledge forms, and operationalize the inclusion of cultural benefits across all

levels of decision-making.
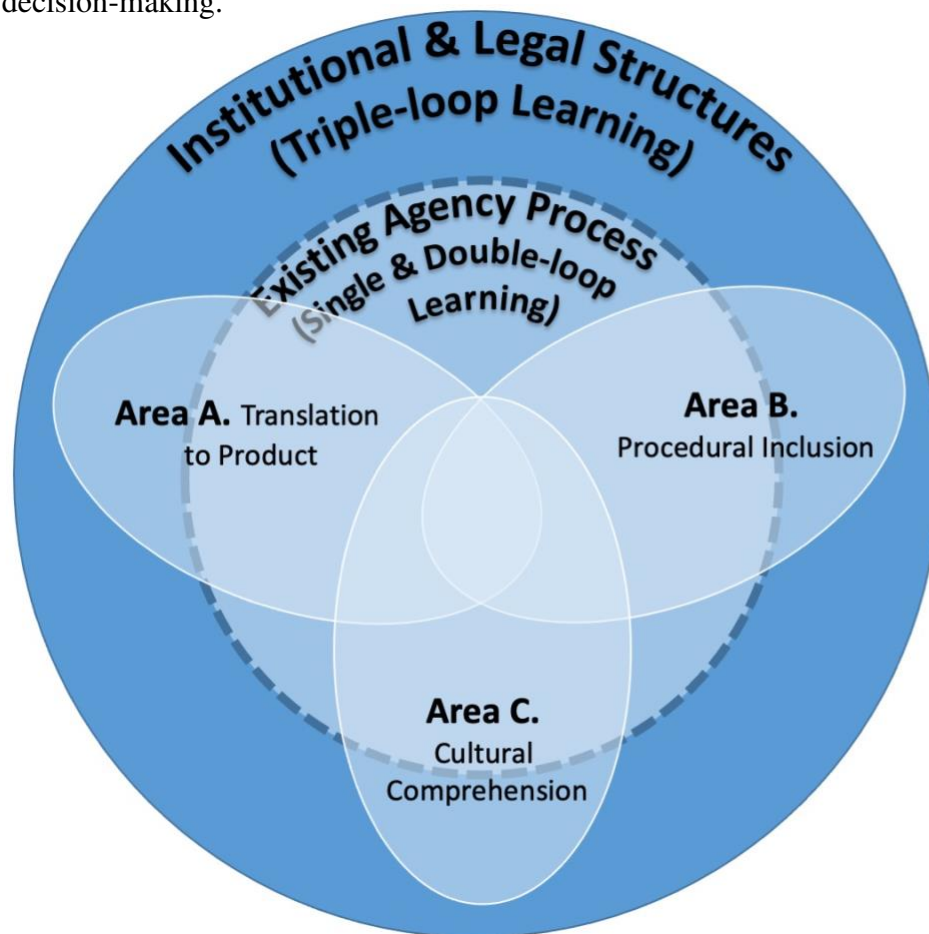
Figure 4.4: Opportunity Map for locating integration opportunities for distinct cultural-benefits-knowledge-forms. Opportunities, i.e., action to improve integration of cultural-benefits-knowledge, are located in one or overlapping areas of opportunity: Translation to Product, Procedural Inclusion, and Cultural Comprehension. In addition, depending on the decision context being analyzed or assessed, a particular opportunity may be available within the constraints of the existing agency process (within the inner circle), or it may require changes to institutional or legal structures (outer circle). Opportunities within the inner circle can be understood as single- and double-loop learning opportunities. Single-loop learning involves slight adjustments to technical understandings and approaches that do not challenge accepted ways of framing the problem or objectives, while double-loop learning involves reflecting on whether goals and objectives need to be adjusted to better account for diverse values and knowledges (Pahl-Wostl, 2009). Opportunities in the outer circle constitute triple-loop learning opportunities, involving transformation of institutional structures (Pahl-Wostl, 2009). In many cases, double-loop learning opportunities are constrained or enabled by triple-loop learning. (Reproduced from Manuscript 2, Chapter 3 this dissertation.)

Locating knowledge forms involves determining: 1) whether each knowledge form was –

or could be – considered via one or multiple Area(s) of Opportunity, including Translation to

Product, Procedural Inclusion, and/or Cultural Comprehension; and 2) whether the knowledge

form could be integrated within the existing decision context, i.e., in the inner circle of the

Opportunity Map, or would require adjustments to the institution, i.e., outer circle of the

Opportunity Map. The structures of a decision context determine, for example, what forms of

knowledge are defined as admissible and decision-relevant, i.e., information rules, who is

considered a cultural-benefits-knowledge-holder, and how and at what stages of decision-making

cultural-benefits-knowledge-holders are able to participate in decision-making, i.e., boundary

rules and aggregation rules (Gorddard et al., 2016; Ostrom, 2005, 2011). In addition, there are

many factors that influence how a particular set of rules, definitions, and regulations is

implemented in practice, including the motivations – including payoff rules (Ostrom, 2005,

2011) – and leadership capacity of individual decision-makers (Steelman, 2010), the quality and

strength of relationship between decision-makers and cultural-benefits-knowledge-holders, and

myriad logistical and equity-based issues linked to communities' resources and capacity for

engagement in governance processes (Hoelting et al. 2022b).

According to Brest & Krieger (2010), any decision is grounded in both deliberative and

technical stages of decision-making. These stages are depicted in Fig. 4.5. Deliberative stages

include problem definition, prioritization of values, interests, and objectives, and identification of

potential alternative actions. Technical phases include estimating outcomes associated with

decision alternatives, assessing impacts, and optimizing based on established interests and

objectives. These technical phases support decision-makers to arrive at a final decision, e.g.,

selecting a preferred alternative. As depicted in Fig. 4.4, opportunities for improved

consideration of cultural-benefits-knowledge exist in all Areas of Opportunity at all stages of decision-making. This may include high level problem definition in the deliberative phase, framing of conceptual and mathematical models in the technical phases, and the assessment of management actions and outcomes in the adaptive phase. However, the Opportunity Map is likely to look different at distinct stages of decision-making, e.g., increased opportunities in translation to product (Area A.) in the center of the figure, i.e., during single-loop learning processes most associated with technical stages of decision-making.
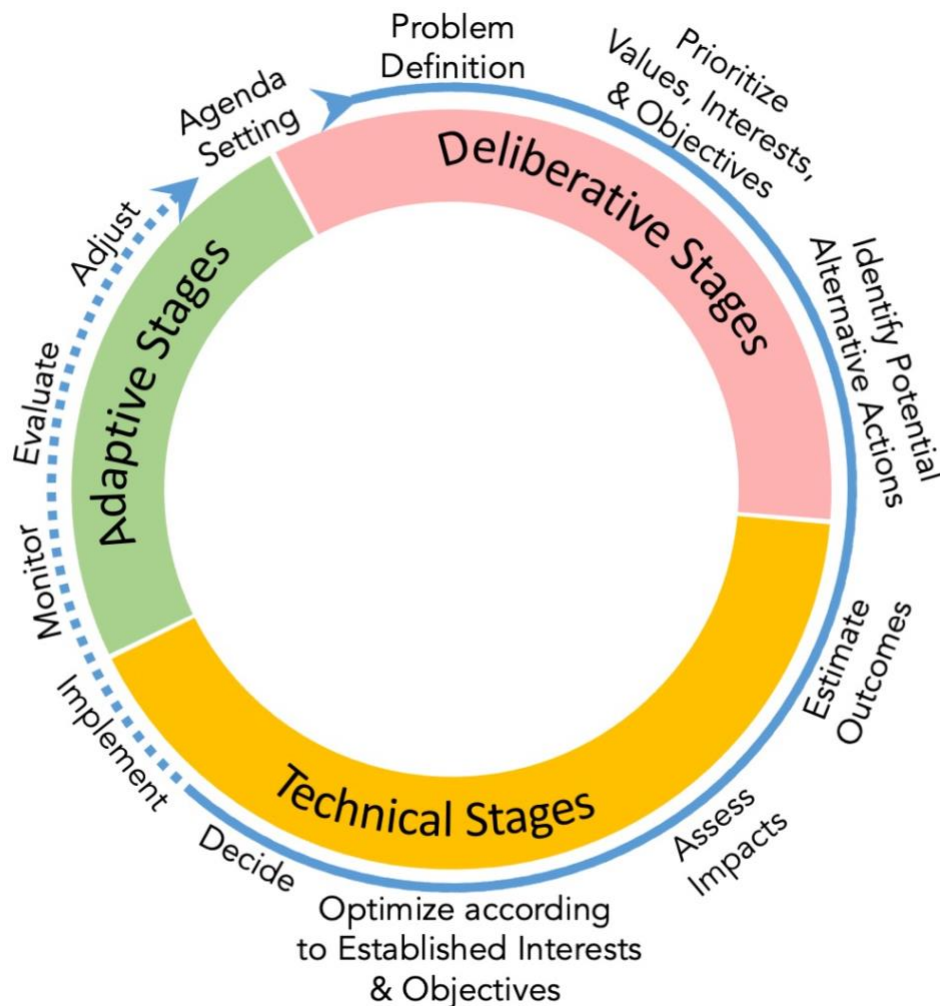
Figure 4.5: Stages of Decision-making conceptualized in this study. Building on the work of Brest & Krieger (2010) and Allen et al. (2011), we conceptualize deliberative, technical, and adaptive stages of decision-making. Cultural-benefits-knowledge has the potential to inform decision-making in different ways throughout the cycle of decision-making.

Fig. 4.5 also highlights the cyclical and iterative character of decision-making. Drawing on the adaptive management literature (e.g., Allen et al., 2011; Williams & Brown, 2018), our conceptual model of decision-making includes adaptive phases. After a decision has been made there may be continued opportunities for learning and adjusting that could lead to new understandings of problems and potential solutions. In some cases, these adjusted understandings may usher in new phases of agenda setting and problem definition.

Depending on the constraints of the focal decision context, the same opportunity may be available within the existing agency process, i.e., located within the inner circle of the Opportunity Map (Fig. 4.4), or may require changes to institutional or legal structures, i.e., located in the outer portion of the Opportunity Map (Fig. 4.4). For example, in the case of Elwha River hydropower relicensing presented in Section 4.3, opportunities to integrate cultural-benefits-knowledge at phases of agenda setting and problem definition involved foundational changes to the existing decision context. In contrast, in multi-stakeholder adaptive management governance arrangements, opportunities to revise the problem definition may be available within the established decision context.

4.2.4 Framework Outputs

Finally, for both Framework applications (retrospective and current), desired outputs and outcomes listed at the end of Table 4.1 link back to the goals outlined at the top of Table 4.1. When applying the Framework to current decision assessment, the primary envisioned output is a comprehensive list of action opportunities, i.e., actions that can be taken to improve integration of cultural-benefits-knowledge, with reference to the barriers and enabling factors present in the focal decision context. In this process, two aspects of opportunity are highlighted: 1) actions that can be implemented within the existing decision context; and 2) opportunities that are not

currently available, but could be actualized with institutional change, e.g., shifts toward more adaptive or integrated management approaches.

The goal of Opportunities List 1 is to identify actions that can be taken now, in the decision context as it currently exists. Knowledge forms for which there are fewer barriers to integration in the existing decision context will be associated with actions placed in Opportunities List 1. In contrast, knowledge forms for which many barriers exist in the decision context will be listed in Opportunities List 2. The goal of Opportunities List 2 is to explicitly recognize the power structures built into the existing decision context, i.e., the embedding of a particular worldview (Gorddard et al., 2016; Hoelting et al., 2022a). This includes: a) privileged values and understandings of well-being (axiology); b) privileged beliefs about nature and human-nature relationship, e.g., is nature an object for human use, or a subject with whom humans have relations (ontology); and c) embedded assumptions about what constitutes valid knowledge and forms in which that knowledge can be shared (epistemology). Both lists are important, as they allow agency staff or others applying the Framework to both identify actions that can be taken right now, and at the same time to directly acknowledge the areas where institutional structures currently inhibit improved consideration of particular cultural-benefits-knowledges.

A second, related desired outcome of current decision assessment is deepened reflection about knowledge systems on the part of those carrying out the assessment, whether they be government agency staff or advocates for cultural-benefits-knowledge-holders. This includes reflection on the knowledge systems of all parties, the systemic biases within the existing decision context, and the impacts of these on the potential for meaningful consideration of diverse cultural benefits of ecosystems. This "Reflections on Foundations" outcome can be

related to the Cultural Comprehension Area of Opportunity, which supports and enhances the likelihood that opportunities in the other two areas (Translation to Product and Enacted Practice) will be recognized and acted upon.

For Framework applications involving retrospective analyses of case studies, the envisioned outputs include: 1) Summary Analysis: Summarize how cultural-benefits-knowledge informed, or failed to inform, decision-making; 2) Tangible Examples: Highlight particularly accessible examples of cultural comprehension (Phase 2), knowledge forms (Phase 3), and intersections with decision-making (Phase 4). These examples can be integrated into guidance for implementation of knowledge pluralism in ES theory and practice, including to support Framework application in current decision contexts; and 3) Theoretical Refinement: Constant comparison with evidence from the retrospective case study to identify elements of the analysis for which the current conceptual models, i.e., Typology of Cultural-Benefits-Knowledge-Forms and Areas of Opportunity, do not provide a good fit and may call for further refinement.

4.3 Retrospective Case Analysis using Elwha River Dam Removal and Ecosystem Restoration

This section presents a historical case study of cultural-benefits-knowledge and decision-making related to Elwha River dam removal and ecosystem restoration. We use this case study to demonstrate the retrospective functions of the Opportunities Framework described in Section 4.2, with case study methods outlined in Section 4.3.1, Retrospective Framework Output 1 (Descriptive Case Analysis) presented in Section 4.3.2, and Retrospective Framework Output 2 (Theoretical Fit Summary) in Section 4.3.3.

The Elwha River ecosystem and fisheries restoration decision process is a story of alliance-building and collaboration between the Lower Elwha Klallam Tribe (LEKT),

environmental NGOs, and Federal agencies. These stakeholders and rights-holders were united around the need to restore the Elwha River ecosystem and fisheries. Together they expanded the values that must be considered in the relicensing of hydroelectric dams (Ulibarri, 2015). They lobbied for an Act of Congress that would broaden the problem from the narrow need for energy generation to also include the need for "full restoration of the Elwha River ecosystem and native anadromous fisheries" (PL 102-495, Section 3(c)). This decision process is an example of integration of a place-based cultural-benefits-knowledge arising from an Indigenous group's understanding of well-being grounded in reciprocal human-nature relationship. As such, the case offers an example of value pluralism and knowledge pluralism in practice through the comprehension and prioritization of relational value aspects and holistic value perspectives (Fig. 4.1, Section 4.1) in an environmental decision-making process.

The Elwha River dam removal process is also the story of the shifting societal value of rivers, and conflict between differing environmental discourses and cultural-benefits-knowledges within a local community. Dam removal and ecosystem restoration represented a departure from a largely utilitarian worldview that dominated the community of Port Angeles in the early 20th Century. Thomas Aldwell was viewed by many as a hero when he constructed the Elwha Dam (1913) and Glines Canyon Dam (1926) on the Elwha River to "conquer the last frontier" by bringing electrical power to the wilderness (Aldwell, 1950). These dams, and the two reservoirs formed by the dams – Lake Mills behind the upper Glines Canyon Dam and Lake Aldwell behind the lower Elwha Dam – afforded diverse recreational benefits. The dams also served as a form of cultural heritage, representing the pioneering spirit of Port Angeles's founders. While these cultural benefits arose from a Euro-centric, utilitarian understanding of well-being and

human-nature relationship, the dams and reservoirs offered both instrumental and relational value to many community members.

The Elwha decision process illustrates processes of value negotiation as they unfolded over the course of decades, and through multiple distinct decision contexts: Federal Energy Regulatory Commission Relicensing, an Act of Congress, a National Environmental Policy Act (NEPA) process, and Senate Appropriations Committee deliberations. Our analysis reveals the power of deep cultural ties to place and historical grievances as motivating factors for persistence toward a policy goal. And it reveals how values articulated and enshrined at the earliest stages of decision-making, such as problem definition and objective setting, can act as enabling factors for meaningful consideration of some cultural-benefits-knowledges through later stages of decision-making, while simultaneously acting as barriers to the cultural-benefits-knowledge of others. Whether and how cultural benefits are recognized and integrated with decision-making is colored and influenced by processes of value negotiation at early stages of decision-making. In other words, "valuation" should be envisioned not solely as a technical exercise, but as a process that unfolds across all decision stages (Hoelting & Gould 2022).

To be clear, we do not suggest that integration of the Tribe's cultural-benefits-knowledge in decision-making was the only driving factor toward Elwha River dam removal. There are many factors that enabled dam removal to occur in that place at that time. These included Tribal Treaty rights to salmon, Washington State mandates for fish passage, concerns about dam safety, and the ready availability of alternate power sources (Appendix C). But the clear interest within Congress to right the wrongs inflicted upon the Lower Elwha Klallam Tribe by dam construction and forcible removal from their lands had much to do with recognition of their cultural-benefits-knowledge; it recognized the fundamental importance of the Elwha River and its salmon for the

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Tribe's cultural survival. For example, during celebrations following the start of dam demolition in September, 2011, Senator Bill Bradley spoke about his personal motivations to work for dam removal:

> As Chair of the Senate Water and Power Subcommittee, I saw my position as an opportunity to use the resources of the Senate to begin undoing some of the unnecessary damage inflicted on communities and the environment in the early years of water and power development. I had a particular drive also to bend the arc of history to bring justice to Indian people whose lives were so frequently and unhappily interwoven with the rivers that the United States chose to develop for water supply and power (Bradley, 2011).

As stated by a Tribal staff member and echoed by many other interview participants, "the Elwha restoration wouldn't have happened if it weren't for the fact that there's a Tribe at the mouth of the river that had its ancestral grounds throughout the watershed. It wouldn't have even come close" [P24].

4.3.1 Methods for Retrospective Case Analysis

As outlined in Table 4.1, retrospective case analysis using the Opportunities Framework can draw upon interview-based evidence and/or historical documentation of the focal decision-making process. The analysis of the Elwha River dam removal and restoration case study presented here relies primarily on interview analysis, with supporting reference to historical documents. Qualitative data collection for this case study was approved under Colorado State University IRB Approval #19-8962H. Potential participants were contacted by email and telephone, and provided with an IRB-approved letter describing the research, its purpose, and that participation was voluntary and confidential. The following sub-sections provide detail around case selection and approval (Section 4.3.1.1), case study location (Section 4.3.1.2), qualitative data collection methods (Section 4.3.1.3), and qualitative data analysis methods (Section 4.3.1.4).

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4.3.1.1 Elwha River Case Selection and Approval

We selected the Elwha River fisheries and ecosystem restoration decision process as a case study based on a pre-determined set of relevance and feasibility criteria: 1) presence of individuals holding cultural-benefits-knowledge, or having sustained interactions with the study ecosystem over time; 2) decision process concluded within the last 10 years to ensure cultural-benefits-knowledge holders and decision-makers are still available for consultation; 3) written documentation of decision processes is readily available to support retrospective case analysis; and 4) key government and community entities welcome and approve the planned research. The lead author (K. Hoelting) was familiar with the Elwha dam removal decision process and its potential to meet these criteria, given her upbringing in Washington State and former work in communities on the Olympic Peninsula as a social science researcher with the National Oceanographic and Atmospheric Administration (NOAA)'s Northwest Fisheries Science Center.

We made the decision to move forward with the Elwha River dam removal case study following telephone and in-person scoping consultations with eight individuals who were involved throughout the decision-making process. These included three individuals at Olympic National Park (ONP), three from the Lower Elwha Klallam Tribe (LEKT, or the Tribe), one from the conservation community, and one involved with the former Elwha Citizens Advisory Committee (ECAC, 1996). All of these individuals felt the case study met criteria 1-3 above. In addition, we shared our research interest and received approval from ONP and the Tribe to move forward with the case study.

4.3.1.2 Case Study Location and Overview

The Elwha River is located in Northwestern Washington State (Fig. 4.6). The river originates within what is today Olympic National Park, and passes through private land,

including the Lower Elwha Klallam Tribe's reservation lands, before entering the Strait of Juan de Fuca. Two dams were built on the Elwha in the early 1900s to power a nascent industrial sector in Port Angeles, WA. The Elwha Dam became operational in 1913 at river mile 5, and the Glines Canyon Dam began its operation in 1926 at river mile 13. The lower dam was constructed without fish passage, cutting off salmon migration to 70 miles of the upper river. Further, the flooding of reservoirs behind each dam removed "access to culturally sensitive sites that are vital to the spiritual well-being of the Elwha Klallam people" (Valadez, 2002, p. 30). This included the Tribe's origin site (DOI, 1994a, 1994b).

Figure 4.6: Map of Elwha River, with sites of dams. (Source: Duda et al., 2011).

In 1940 the site of the Glines Canyon dam was incorporated into the area of Olympic National Park. The dams initially served as the sole source of power for industry in Port Angeles,

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but in 1949 this area of the Olympic Peninsula was connected to the larger power grid managed

by the Bonneville Power Administration (Clallam County PUD, 2020). Following nearly a

century in operation, and the persistence of Lower Elwha Klallam Tribe and their allies, the

dams were removed between 2011 and 2014. See Appendix G for a timeline and further

description of historical events.

4.3.1.3 Qualitative Data Collection

The retrospective case analysis offered in this article is derived from 47 interviews about

the Elwha River dam removal and ecosystem restoration decision-making process (Table 4.2).

We targeted interview participants who could speak to: a) their relationship with the study

ecosystem and the value associated with that relationship; and/or b) their involvement in one or

more stages of decision-making. We built a sampling frame through a scoping process involving

both snowball sampling and historical document review to identify leaders and participants in

Elwha River dam removal decision-making processes. During scoping conversations with

individuals at ONP, the Tribe, and others (Section 4.3.1.1), we requested relevant documentation

and names of individuals who either a) played an important role in decision-making, and/or b)

were notable for their connection to the Elwha River as an ecosystem.

We expanded our document review through archival research in the Port Angeles Public

Library's newspaper microfiche and local history collections, and the North Olympic History

Center of the Clallam County Historical Society. Our final sampling frame included participants

in the Elwha Citizen's Advisory Committee process, authors and interested parties listed in the

two Environmental Impact Statements linked to Elwha River ecosystem and fisheries restoration

(DOI, 1995, 1996, 2005), and authors of Letters to the Editor retrieved from microfiche at the

Port Angeles public library.

Drawing from this sampling frame, we prioritized interviews using a stratified purposive sampling approach (Ritchie et al., 2013; Tashakkori & Teddlie, 2003). As displayed in Table 4.2, we emphasized interviews with three key groups: employees of the National Park Service (NPS), employees and Tribal members of the LEKT, and members of the Elwha Citizen's Advisory Committee. We contacted and successfully interviewed all five members of this Committee who were still in the Port Angeles area (see the Timeline in Appendix G for more information about the Elwha Citizens Advisory Committee, and its role in diffusing local controversy around dam removal). In addition, we sought to include a diversity of "other" perspectives from the larger Port Angeles community, ranging from ecological researchers not affiliated with the NPS or the Tribe, members of artist, recreation, and conservation communities interested in dam removal, elected representatives, and individuals with intimate knowledge of the operation of the former dams or meaningful connection to the reservoirs.

Table 4.2: Breakdown of Affiliations of Interview Participants

Affiliation	Interviews
National Park Service	14
- *Olympic National Park*	*- 13*
Lower Elwha Klallam Tribe Employee and/or Tribal Member	13
Elwha Citizen's Advisory Committee Members	5
Other, including Ecological researchers (4), Local and Federal elected representatives (3), Artists/Conservationists (3), Environmental Educators (1), Outdoor recreation (1), Workers at former Elwha dam (1), and other citizens with connection to the Elwha River and/or former Reservoirs (2).	15
TOTAL	**47**

4.3.1.4 Qualitative Data Analysis

Retrospective Output 1 (Descriptive Analysis, Section 4.3.2) seeks to respond to the first two goals of retrospective case analysis: descriptive analysis and identification of tangible examples for guidance. To accomplish this, we used existing coding structures to analyze interviews. The coding scheme is based on the theoretical elements underpinning the proposed

Opportunities Framework for Improved Integration of Cultural Benefits, taken from Hoelting et al. (2022b), as well as theory around stages of decision-making taken from Brest & Krieger (2010) and Allen et al. (2011). These theoretical elements were outlined in Section 4.2.3. First, we coded for forms of cultural-benefits-knowledge, based on the Typology of Cultural-Benefits-Knowledge-Forms (Fig. 4.3, Section 4.2.3 and Table F1, Appendix F). For each knowledge form we made note of the relevant cultural-benefits-knowledge-holder (individual or group), the stage of decision-making (Fig. 4.5, Section 4.2.3) where the knowledge form was made available, and barriers and enabling factors that influenced its use. Finally, based on the stage of decision-making, the form of the knowledge, i.e., enacted and/or translated, more contextualized or more abstracted, and evidence around how it was integrated, we then located, i.e., coded, each example in the Opportunity Map (Fig. 4.4, Section 4.2.3).

The Framework is intended to support improved integration of a full spectrum of knowledge forms that can more fully and accurately convey the plural values associated with cultural benefits of ecosystems. Therefore, in selecting examples to illustrate the Descriptive Analysis we did not carry out frequency analysis related to the forms most commonly mentioned in interviews or encountered in historical documents. A frequency-based approach would fail to ensure equal attention to all forms of cultural-benefits-knowledge, and particularly those which are less recognized or understood; a frequency approach would risk over-emphasizing forms of knowledge and aspects of value already viewed as legitimate and decision-relevant by Western institutions built on notions of 'knowledge-as-product' and 'nature-as-object' (Muradian & Pascual, 2018; Pierotti & Wildcat, 2000). Instead, we selected examples to illustrate a full spectrum of knowledge forms and pathways, from abstracted and contextualized knowledge products to enacted knowledge practices (Box 4.3). Given space constraints, we elected to focus

our analysis on the cultural-benefits-knowledge-forms that sought to convey relational values or holistic value perspectives (Box 4.1, p. 92).

Enacted knowledge forms: Forms of embodied cultural-benefits-knowledge, i.e., knowledge practices. These include **practices of knowledge sharing** that reproduce and convey truths, e.g., narrative, linguistic, performative, visual, or ceremonial forms. These also include the **enactment of these truths through action**, whether through articulation of principles for responsible engagement with ecosystems or demonstration through lived engagement with ecosystems.

Translated knowledge forms: Forms of documented cultural-benefits-knowledge, i.e., knowledge products, on a spectrum from more contextualized to more abstracted. *Contextualized Translations* attempt to stay as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. *Abstracted Translations* seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."

Enacted Products are an area of overlap between Enacted and Translated forms, where cultural-benefits-knowledge-holders enact their knowledge through leading or participating in processes of translation or interpretation of knowledge products.

Figure 4.7: Definition Box – Cultural-benefits-knowledge-forms (from Hoelting et al., 2022a)

Retrospective Output 2, Theoretical Fit Summary (Section 4.3.3), responds to the third goal of retrospective analysis: theoretical refinement. During coding and analysis, we paid attention to instances when our conceptual models were difficult to apply to the Elwha decision process, e.g., where categories were difficult to distinguish. Some issues of fit may be inherent; for example, a particular knowledge form may possess elements of more than one category in the Typology of Cultural-Benefits-Knowledge-Forms. However, we elaborate on issues that may be important to address in future refinement of the Framework.

4.3.2 Retrospective Output 1: Descriptive Case Analysis

In the following sub-sections, we offer analysis of the Elwha River decision process as a template for retrospective case analysis using the Opportunities Framework for Improved Integration of Cultural Benefits. First, in Section 4.3.2.1 we clarify context by defining the focal ecosystem, identifying groups of cultural-benefits-knowledge-holders connected to the

ecosystem, and describing the decision context, including laying out distinct stages of decision-making. Second, in Section 4.3.2.2 we explore evidence from interviews and historical documents of whether and how decision-makers possessed cultural comprehension of varied knowledge systems across groups of cultural-benefits-knowledge-holders (Framework Phase 2).

Third, in Section 4.3.2.3, we identify forms of knowledge through which cultural-benefits-knowledge was conveyed at each stage of decision-making (Framework Phase 3). Given space constraints, and given interest in improved consideration of value aspects and value perspectives that are commonly marginalized in environmental decision-making, we chose to focus this analysis on two groups of cultural-benefits-knowledge-holders who sought to convey non-instrumental value aspects or perspectives: 1) the Lower Elwha Klallam Tribe, who sought to convey a holistic value perspective in which the Elwha River, Elwha Valley, and its non-human inhabitants – including salmon – contributed to Tribal well-being economically, culturally, and spiritually in ways that cannot be separated; and 2) Local Port Angeles Recreationists who opposed dam removal for reasons that included non-instrumental, relational values arising from multi-generational relationships to the Elwha Valley. These examples may be particularly useful for understanding and providing guidance for implementation of value pluralism and knowledge pluralism in practice.

Fourth, in Section 4.3.2.4 we summarize how identified knowledge forms intersected with decision-making, using the Opportunity Map (Fig. 4.4, Section 4.2.3) to locate each example (Framework Phase 4). The process of locating knowledge forms involves cross-referencing against the constraints of the decision context, as outlined during Framework Phase 1, to determine whether an opportunity is available within the existing decision context, i.e., located in the inner circle of Opportunity Map, or requires changes to the decision context, i.e.,

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located in the outer circle of the Opportunity Map. We also make note of forms of cultural-benefits-knowledge that most fully conveyed plural values, and discuss barriers and enabling factors for particular knowledge forms to influence the decision outcome. Finally, in Section 4.3.2.5 we summarize lessons learned from retrospective analysis of the Elwha River dam removal and ecosystem restoration decision-making process.

4.3.2.1 Phase 1 – Clarifying Context

Phase 1 of the Opportunities Framework for Improved Integration of Cultural Benefits is to clarify contextual aspects of the case, including the distinct individuals and groups holding cultural-benefits-knowledge related to the ecosystem, and the decision context(s) structuring decision-making related to that ecosystem. This includes describing how the ecosystem is or was defined, identifying guiding statutes and legal requirements, and outlining distinct stages of decision-making.

Cultural-benefits-knowledge-holders

There is never complete agreement within any community around specific beliefs, including understandings of well-being and relevant cultural benefits linked to an ecosystem. In addition to interviews with individuals to understand their nuanced perspectives. it can also be helpful to identify cultural groups that may share general aspects of cultural-benefits-knowledge, and who may seek to convey this knowledge to inform decision-making. This can be understood as an element of stakeholder analysis, specifically targeted at identifying groups of stakeholders and rights-holders for whom the ecosystem provides cultural ecosystem services, i.e., makes contributions to their well-being in terms of identities, experiences, or capabilities (Fish et al., 2016). In retrospective case analysis, distinct groups can be identified through interview-based recollections and historical documentation of cultural-benefits-knowledge offered to inform

decision-making. When applying this Framework to current decision assessment, identification of distinct groups of cultural-benefits-knowledge-holders could be supported by research methods such as Q-methodology that reveal groups with shared perspectives on ecosystems' values (Armatas et al., 2014, 2019).

Through our analysis of data related to the Elwha decision process, we identified five primary groups of cultural-benefits-knowledge-holders connected to the Elwha River ecosystem. Table 4.3 describes each group and the core cultural benefits that members of the group articulated during interviews, or as encountered in historical documentation of their expression or action.

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Table 4.3: *Cultural-benefits-knowledge-holders linked to the Elwha River ecosystem*

Group	Description	Core Cultural Benefits Articulated	Relevant Value Aspects or Perspective *(Hoelting et al., 2022a, 2022b)*
The Lower Elwha Klallam Tribe (pro-dam-removal)	The ancestral homeland of the Lower Elwha Klallam Tribe includes the Elwha Valley, and their current reservation is located at the mouth of the Elwha River. For the Lower Elwha, "the river was the heart of … ceremonial, cultural, and spiritual existence [and] provided the resources necessary for sustenance of lifeways" (DOI, 1994b, p. 205).	Core Cultural Benefits Articulated: • Knowledge System (arising from and reproduced through place-based lifeway) • Ability to Live in Responsible Relationship with Non-Human Nature • Cultural Identity	Holistic Value Perspective, i.e., relational, instrumental, and intrinsic value aspects cannot be disentangled; relational and intrinsic values constrain and guide instrumental uses.
Environmentalists (pro-dam-removal)	Regional and national environmental entities, along with many local Port Angeles community members, saw intrinsic and recreational values in a free-flowing river. Several environmental groups intervened in the FERC relicensing process: Friends of the Earth; Seattle Audubon; Sierra Club, and Olympic Park Associates.	Core Cultural Benefits Articulated: • Recreational Value • Identity and Sense of Place • Ability to live in Responsible Relationship with Nature • Existence Value	Relevant Value Aspects: • Intrinsic (non-anthropocentric), i.e., the inherent value of wilderness, a free-flowing Elwha River, and the diverse species it supports. • Instrumental, i.e., the free-flowing Elwha provides value to humans through both instrumental uses (substitutable) such as recreation and fisheries, and relational (non-substitutable, constitutive) contributions to well-being such as place-based identity, sense of place, and the ability to live in responsible relationship with non-human nature.
Port Angeles Pioneer Community (anti-dam-removal)	Local Port Angeles Pioneer descendants and others connected to pioneer industries. For these community members, some of whom worked in the mills powered by the dams, the dams represented cultural heritage and enabled a way of life; many had arrived on the Olympic Peninsula to participate in, as Thomas	Core Cultural Benefits Articulated: • The dams as an object of Cultural Heritage, representing the Pioneer History of Port Angeles.	Relevant Value Aspects: • Instrumental, i.e., river is conceptualized as an object to be harnessed for power generation.

	Aldwell phrased it, "Conquering the last frontier" (Aldwell, 1950) by building civilization out of the wilderness.		
Sport Fishers (pro-dam-removal)	Although there were some sport fishers who feared the loss of a world-class trout fishery above the Glines Canyon Dam, many local, regional, and national fishers saw overall recreational value in the restoration of salmon fisheries on the Elwha River. Sport fishing NGOs providing public comment in support of dam removal during the NEPA process included American Fisheries Society, Friends Insisting on Salmon Habitat, and Trout Unlimited (DOI, 1995).	Core Cultural Benefits Articulated: • Recreational Value	Relevant Value Aspects: Instrumental, i.e., the ability to catch salmon in the Elwha River.
Local Recreationists Opposed to Dam Removal (anti-dam-removal)	Although many local Port Angeles recreationists were supportive of dam removal, a distinct and vocal group of recreationists had lifelong or multi-generational connection to the reservoirs (Lake Mills behind the Glines Canyon Dam and Lake Aldwell behind the Elwha Dam), associated campgrounds and amenities in the Elwha Valley, and to the ease of access to Olympic National Park via the Elwha Valley. These areas held memories and provided recreation, shared experiences, and sense of place.	Core Cultural Benefits Articulated: • Recreational value of Elwha Valley campgrounds and reservoirs; • Aesthetic value of the reservoirs and the wildlife, including swans. • Multi-generational access afforded social ties, sense of place, mental health, and inspiration.	Relevant Value Aspects: • Instrumental, i.e., the closest place to Port Angeles for recreation. • Relational, i.e., relationship with the Elwha valley campgrounds and reservoirs was constitutive of well-being for some individuals in the Port Angeles community, for example if their childhood or shared memories were located there.

Defining the Ecosystem and Stages of Decision-making

Distinct individuals or groups of cultural-benefits-knowledge-holders are likely to understand and define the ecosystem differently, and to understand the problem and objectives of management differently as well. For the purposes of retrospective case analysis, it is necessary to both note these differences and identify central definitions of both the ecosystem and the problem to which management ultimately sought to respond. With the passage of the Elwha River Ecosystem and Fisheries Restoration Act (Elwha Act) of 1992, the problem definition at the center of the focal decision context became the need for: "full restoration of the Elwha River ecosystem and native anadromous fisheries" (PL 102-495, Section 3(c)). Both the Elwha Report provided to Congress in 1994 and the multiple NEPA environmental impact statement (EIS) documents prepared in subsequent years defined the ecosystem, i.e., affected environment, as the "river-based ecosystem": the 45-mile-long Elwha River, with its drainage basin of 321 square miles (DOI, 1994a, 1994b, 1995, 1996). This definition of the ecosystem included riverine and estuarine habitats, with primary concern for improving salmon spawning and rearing potential on the Elwha River.

Placing the need for full restoration, as mandated by the Elwha Act of 1992, at the center of our story, five distinct stages of decision-making become evident in one overarching decision process. Table 4.4 provides an overview of these stages through which the cultural-benefits-knowledge-holders identified in Table 4.3 attempted to convey their knowledge to inform decision-making. Federal Energy Regulatory Commission (FERC) relicensing was a period of agenda setting, in which values and interests previously deemed irrelevant were brought to the table. The passage of the Elwha Act formally defined 'the problem' and set objectives around how to solve it, and removed the projects from FERC's purview. Two distinct NEPA EIS

processes explored 1) alternatives for implementation of restoration in accordance with the

Elwha Act, with the resulting preferred alternative of full removal of both dams on the Elwha

River (DOI, 1995); and 2) alternatives for implementation of dam removal (DOI, 1996). Next, an

almost two-decade-long delay in funding for dam removal can be understood as an attempt to

adjust the problem definition yet again. Finally, the implementation stage of decision-making

began in 2011 with the start of dam demolition and continues to the present with on-going

revegetation and fisheries restoration efforts. For a more detailed account of events throughout

these stages of decision-making, see Appendix G.

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Table 4.4: *Stages of Decision-making – Elwha River Dam Removal and Ecosystem Restoration*

When carrying out retrospective case analysis or current decision assessment, this table may not include all decision stages as outlined in Fig. 4.5. Instead, it should include all decision stages found to be relevant to the focal decision context.

	Decision Stage	Description	Relevant Statutes, Court Cases, and Procedural Rules around Public Participation	Cultural-Benefits-Knowledge-Holders engaged at this Stage

Deliberative Stages	**1. Agenda Setting:** Federal Energy Regulatory Commission (FERC) Licensing of Hydropower Dams, and the need for a Negotiated Settlement.	The original 50-year hydropower operating license for the Glines Canyon Dam expired in 1976. The legality of relicensing was in question, given that the site of the dam was now located within Olympic National Park. The dams' owner, James River Corporation, stalled for several years by applying for yearly operating licenses rather than a new long-term license. In 1984 the Supreme Court ruled that relicensing was equivalent to issuing a new license and must consider issues such as fish passage and multiple values of the river. In this context, in 1986 **Tribes and environmental NGOs petitioned as intervenors in the Glines Canyon Dam relicensing process and brought new values and interests to the table, <u>i.e., they set a new agenda</u>** that extended beyond the need for hydropower for Port Angeles's industrial sector. The Tribes and Environmental NGOs were later joined by Federal and State government agencies mandated to provide for fish passage, protect the wilderness character of National Parks, and other directives. This group was known as the Joint Fish and Wildlife Agencies (JFWA).	**Relevant Statutes or Court Cases**
			• <u>Federal Power Act (FPA) of 1920, as amended</u>: grants FERC authority to issue hydropower licenses.
			   Relevant amendments:
			    • <u>1921 amendments to the FPA</u>: Prohibits licensing of hydropower dams in National Parks and National Monuments.
			    • <u>1986 amendments within the Electric Consumers Protection Act</u>: Required that FERC licensing consider multiple values of rivers, including recreation, wildlife protections, and other environmental considerations.
			• <u>Rock Island Decision of 1984</u>: The Supreme Court found that FERC relicensing counts as issuing a new license.
			Public Participation Rules:
			• Procedural rule that only those materially affected can become intervenors in a FERC relicensing process (18 CFR 385.214).
				• <u>The Tribe</u> intervened and made motions in the Glines Canyon Dam FERC proceedings.
				• <u>Environmentalists</u> intervened and made motions in the Glines Canyon Dam FERC proceedings.

		Collectively, the FERC intervenors and JFWA held significant leverage over the relicensing process, through both threat of lawsuit from the	**Relevant Statutes or Court Cases**	• 1) <u>The Tribe</u>, 2) <u>Environmentalists</u>, and 3) <u>Sport</u>

Deliberative Stages	**2. Problem Definition and Objective Setting:** Passage of the Elwha Act	Tribe, and concerns about multiple use of rivers, dam safety, and fish passage raised by environmental groups and agencies. Through this process, industrial interests in Port Angeles realized power was available from other sources, and the owner of the dams agreed to negotiate. The negotiation culminated in passage of Public Law 102-495, the Elwha River Ecosystem and Fisheries Restoration Act (Elwha Act) in 1992, which formally **established the 'problem' that needed to be solved**: "full restoration of the Elwha River ecosystem and native anadromous fisheries" (PL 102-495, Section 3(c)), **and set the objective to conduct research** around how restoration could be accomplished.	• <u>Boldt Decision of 1974</u>, which protected Northwest Treaty Tribes' Treaty rights to salmon. • <u>Wild and Scenic Rivers Act of 1968,</u> enacted "to preserve certain rivers with outstanding natural, cultural, and recreational values in a free-flowing condition for the enjoyment of present and future generations" (PL 90-542; 16 U.S.C. 1271 et seq.) • <u>Electric Consumers Protection Act of 1986</u>: Required that FERC licensing consider multiple values of rivers, including recreation, wildlife protections, and other environmental considerations. **Public Participation Rules**: • In order to offer testimony during a congressional hearing, one must be invited by a member of Congress. Anyone can offer to appear, but congressional committees have the power to decide whom to invite.	<u>fishers</u> lobbied congressional representatives and testified at congressional hearings for the Elwha Act.
Deliberative & Technical Stages	**3. Identifying Alternatives, Estimating Costs and Benefits, and Selecting Preferred Alternatives:** NEPA Process	The Elwha Act required the Secretary of the Interior to develop a report documenting whether dam removal was necessary to achieve full ecosystem and fisheries restoration. An initial report, The Elwha Report, was submitted to Congress in 1994 detailing investigations into several restoration alternatives, including both dam removal and leaving the dams in place. The Elwha Report was followed by two Environmental Impact Statements (EISs), for which the National Park Service served as Lead Entity. First, the Elwha Restoration EIS (DOI,	**Relevant Statutes and Court Cases** • <u>The Elwha Act of 1992</u>: The Elwha Act provided a clear directive, including defining the problem, i.e., need for full restoration of the Elwha ecosystem and anadromous fisheries, and setting objectives, e.g., determining how restoration could best be achieved. **Public Participation Rules**: • The National Environmental Policy Act (NEPA) provides opportunities for public comment during preparation of	• <u>The Tribe</u> cooperated in preparation of NEPA documents and consultation with the National Park Service. • <u>Port Angeles Pioneers, Local Recreationists, The Tribe, Environmentalist</u>

		1995) outlined and assessed alternatives for achieving restoration, resulting in selection of the preferred alternative of dam removal. Second, the Elwha Restoration Implementation EIS (DOI, 1996) outlined and assessed alternatives to implement dam removal. The preferred alternative was to allow sediments to run downstream rather than try to dredge behind the dams prior to their demolition.	Environmental Impact Statements (EISs).	s, and Sport Fishers, all lobbied representatives and provided NEPA public comment.
(Adaptive Stages)	(*4. Attempt to Prevent Implementation and Adjust the Problem Definition:* *Appropriations Battle)*	In the years immediately following passage of the Elwha Act, anti-dam removal interests attempted to prevent implementation by holding up congressional appropriations for the purchase of the dams. Local interests opposed to dam removal found a champion in Congress, Senator Slade Gorton, who was the Chairman of the Department of the Interior's Appropriations Committee. The Elwha Citizen's Advisory Committee (ECAC) was convened by the owners of the dams and others to provide a "local consensus" around the best way forward. The ECAC's recommendation, released in 1996, was to begin by removing one dam. This was sufficient to convince Slade Gorton to appropriate funds for the purchase of the dams. But he would not appropriate funds for removal. Ultimately this caused a delay but did not prevent dam removal. As a result, it took almost 20 years to set aside funding from disparate sources, including some allocated from DOI and a portion taken from the National Park Service's own budget.	• The U.S. Constitution requires appropriations made by law prior to the release of funds from the Federal Treasury. Both the Senate and House Appropriations Committees have the power to determine what legislative mandates will be prioritized through funding. Up until 2000, Washington Senator Slade Gorton was the Chair of the Senate Appropriations Committee. Although he initially sponsored the Elwha Act of 1992, he later opposed dam removal and held up appropriation of Federal funds to acquire and remove the dams. In 1999 he finally released funds to acquire the dams from their owner, James River Corporation, but he never appropriated the remaining funds for dam removal. Senator Gorton was voted out of office in 2000. The full necessary funds for dam removal were finally pieced together from diverse sources by the year 2009.	• Port Angeles Pioneers and Local Recreationists lobbied congressional representatives. • All interests presented to the Elwha Citizens Advisory Committee.
		Dams were removed: Elwha Dam between 2011-2012, and Glines Canyon Dam between 2011-2014. Scientists monitored the movement of sediments.	**Relevant Statutes and Court Cases** • The Elwha Act of 1992: The Elwha Act provided a clear directive to carry out restoration.	• The Tribe's direct Involvement in restoration is an

Technical Stages				
	5. **Implementation:** Restoration Planning and Action	Following release of sediments, collaborating agencies began implementing detailed restoration plans for fisheries (Ward et al., 2008) and revegetation of the former reservoirs (Chenoweth et al., 2011).	**Public Participation** • The implementation of ecological and fisheries restoration were guided by ecological constraints rather than public preferences. For example, choices around revegetation were constrained by ecological variables rather aimed toward culturally valued plant species. And as multiple interview respondents pointed out, restoration efforts – including revegetation – were 'all about the fish' [P101].	enacted form of cultural-benefits-knowledge. • The National Park Service consulted with the Tribe and worked with non-Tribal community interests to protect and/or document cultural sites.

4.3.2.2 Phase 2 – Knowledge Systems

When applying the Framework to current decision analysis, Phase 2 provides an opportunity to build mutual understanding and respect across the distinct knowledge systems of stakeholders, rightsholders, and decision-makers as a form of cultural sensitivity training. This means seeking to comprehend the cultural-benefits-knowledge of distinct stakeholders and rightsholders linked to a focal ecosystem, including how they understand human-nature relationship (ontology, see Himes & Muraca, 2018; Hoelting et al., 2022a), the values and ethics linked to ecosystems and human-nature relationship (axiology, see Chan et al., 2016, 2019; Jax et al., 2013; Pascual et al., 2017) as well as how they understand "knowledge" (epistemology, see Held, 2019; Hoelting et al., 2022a, 2022b). This may be accomplished through, for example, development of a Record of Engagement (RoE), i.e., "a description of the participatory processes, stakeholder perspectives offered, lines of argumentation, group dynamics, emotions expressed, and all other "engagement" aspects that together combine into decisions made to manage [ecosystems]" (Glynn et al., 2018, p. 1, see also Cockerill et al., 2019). The RoE process is intended to make transparent the role of biases, beliefs, heuristics, and values in decision-making, i.e., ontological, axiological, and epistemological foundations. This or a similar approach could support mutual understanding across the knowledge systems of stakeholders and rightsholders during current decision assessment.

In retrospective case analysis, Framework Phase 2 is primarily targeted toward uncovering the degree to which decision-makers in the focal decision context possessed a foundation of cultural comprehension toward distinct groups of cultural-benefits-knowledge-holders. Interviews and historical documentation can offer insight into whether and how decision-makers understood the cultural importance of the focal ecosystem to distinct actors.

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Ideally, retrospective analysis could also involve characterizing the knowledge systems of identified groups of cultural-benefits-knowledge-holders. However, without the ability to engage all actors in development of an RoE, such attempts to characterize ontological, axiological, and epistemological groundings are likely to be speculative. This challenge is discussed further in in Section 4.3.3 on future framework refinement needs.

In our analysis of the Elwha River dam removal and ecosystem restoration decision process, Phase 2 revealed one of the most important lessons: that when Federal agency staff possess a high level of cultural comprehension at the outset of a decision process, this can act as an enabling factor both a) for recognition of the validity of diverse cultural-benefits-knowledge-forms and b) to motivate action to integrate that knowledge within the constraints of the decision context. This section provides some evidence from interviews around how this cultural comprehension developed among staff at Olympic National Park. Later, in Section 4.3.2.3 (Phase 3), we offer specific examples of how Tribal cultural-benefits-knowledge was able to inform decision-making in large part because of the ability of Olympic National Park staff to comprehend the cultural importance of the Elwha River to the Tribe, and their willingness to work with the Tribe to integrate their knowledge – including through direct involvement of the Tribe in preparation of NEPA documents and co-management of restoration actions.

Interview respondents spoke about multiple interrelated factors that contributed to a high level of pre-existing cultural comprehension among Olympic National Park staff. First, Olympic National Park is located in geographic proximity to the LEKT reservation. Park staff live in the same community as Tribal members, and there is less turnover at ONP compared to other Federal offices. In addition, multiple staff members at ONP had formerly worked for the Tribe, or had spouses that were Tribal members or worked for the Tribe. A former Tribal employee

noted that the Tribe did a good job of building a relationship with Olympic National Park through hiring individuals with personal ties to ONP staff [P33]. One Park staff member noted that "we knew a lot of those people [from the Lower Elwha Klallam Tribe] personally" [P2]. Another Park staff member described how they came to understand the importance of the Elwha River to the Tribe:

> After working on the peninsula for 27 years, I mean, tribal culture there is huge… and how is that communicated? It's communicated as it is with any of your neighbors. You know, you come to know them, you understand their history. [P115]

Second, the Lower Elwha Klallam Tribe worked over many decades to build capacity and skill for engagement with non-Tribal communities and governments. As part of this, they cultivated a patient, respectful, and persistent approach to educating non-Tribal communities and agencies about their culture and needs. As a Tribal leader explained:

> You have your own beliefs. And having you believe those beliefs, [educating about our culture is] not something that is productive in one day. You have a whole process of educating and doing that outreach, because you can't make them truly understand it unless they have gone through it themselves. [P5]

They also acknowledged that, "with agencies, it's easier to work with those that are on the ground with you, than those that are sitting behind a desk and they're only looking at the piece of paper. They have no bearings, no feelings to it" [P5].

A third, related factor was the sustained interaction between Olympic National Park staff and the Lower Elwha Klallam Tribe over many years, through which they built a foundation of respect, communication, and collaboration. One former Tribal employee described how early interactions during the FERC relicensing process enabled mutual understanding and set the stage for continued collaboration throughout the NEPA process and beyond:

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We met so frequently and certainly formed good relations within [the Olympic National Park] team. We were all there for the same purpose, to figure out the… terms and conditions that we would recommend to FERC if the dams were relicensed, or licensed, as the case for the Elwha [Dam]. So we were all there to figure out how is there a way to recommend to FERC any way to get fish restored back up river. And I think just the process of working together for so long, thinking about those terms and conditions and understanding each other's perspectives and the leverage that each party brought. [P116]

This final quote also highlights the limitations of cultural comprehension, on its own, as an enabling factor for cultural-benefits-knowledge to influence decision-making. This Tribal employee, along with many other interview respondents, pointed to the importance of alignment of interests among Federal agencies and multiple stakeholders and rightsholders as a core enabling factor for dam removal. The Elwha River and its fisheries are holistically and fundamentally important to the Lower Elwha Klallam Tribe – for their combined cultural, spiritual, ceremonial, and economic survival as a people (DOI, 1994a, 1994b, 1995). But regardless of whether individuals working for the National Park Service and other Federal agencies comprehended this importance, they also had to consider whether it aligned with their directive. In this case, fisheries restoration was a shared objective that facilitated this alliance among multiple parties, and in this context the restoration of cultural benefits to the Lower Elwha Klallam Tribe became an important facet of the collective argument for dam removal.

In contrast, the cultural-benefits-knowledge of anti-dam-removal interests in Port Angeles did not align with the established problem of full ecosystem and fisheries restoration. Individuals working for Olympic National Park also described their comprehension of the cultural importance of the dams, reservoirs, and associated recreational opportunities for many local Port Angeles community members. National Park staff also understood that the dams were a symbol of cultural heritage, as they represented the Pioneer history of the community, and they understood that the reservoirs and campgrounds in the Elwha Valley were a source of recreation,

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mental health, sense of place, and social ties across multiple generations. One Olympic National

Park staff member explained that:

> There's also cultural significance for non-Indians… Just for an example is in the Elwha
> [Valley] we have a campground. In the campground there is a community kitchen. We
> have people, non-Indians, who grew up here, who said, 'Dad worked on that… it's my
> history.' [P4]

Both dams were listed on the National Register of Historic Places in 1988 (DOI, 1988a, 1988b),

and in 2007 the Elwha Campground community kitchen was nominated (DOI, 2007).

Issues of alliance-building and conflict between cultural-benefits-knowledge-holders and

government agencies is not unique to the Elwha decision process. What is unique is that this

particular alignment of interests – between environmental NGOs, sport fishing interests, the

Lower Elwha Klallam Tribe, and Federal agencies – created opportunities for the early and

sustained involvement of the Lower Elwha Klallam Tribe in all aspects of decision-making. As a

result, the holistic value perspective of the Lower Elwha Klallam Tribe, as conveyed through

diverse knowledge forms, was meaningfully integrated across stages of decision-making.

4.3.2.3 Phase 3 – Cultural-Benefits-Knowledge Forms

Phase 3 of the Framework involves identification of diverse knowledge forms through

which the plural values linked to cultural benefits of ecosystems were conveyed to inform

decision-making (retrospective case analysis) or are available to inform decision-making (current

decision assessment). This is important because distinct knowledge forms have varying potential

to communicate different value aspects and value perspectives (Hoelting et al., 2022b).

In this section, we offer a template for summarizing identified knowledge forms in a

retrospective case analysis. Given space constraints, we cannot include all identified knowledge

forms for all groups of cultural-benefits-knowledge-holders connected to the Elwha River. For

the purposes of illustrating the Framework we focus analysis on two groups of cultural-benefits-knowledge-holders: 1) the Lower Elwha Klallam Tribe who favored dam removal; and 2) local recreational interests opposed to dam removal. A focus on these two groups provides insight into knowledge forms and pathways through which relational value aspects and holistic value perspectives have potential to be integrated. This is important because non-instrumental values have been marginalized in standard approaches to ecosystem valuation (Hoelting et al., 2022b; Gould et al., 2020; Milcu et al., 2013).

As outlined in Table 4.4 (Section 4.3.2.1), interviews and historical documents reveal that the Tribe sought to convey cultural benefits linked to a holistic value perspective, including knowledge system, cultural identity, and ability to live in responsible relationship to non-human nature (for full definitions of these cultural benefits categories please see Table E2.1, Appendix E). Our interviews also suggest that Local Recreationists received both instrumental and relational values through cultural benefits including recreation, aesthetic value, sense of place, social ties, and inspiration. In some ways these two groups conveyed their cultural-benefits-knowledge using similar approaches, although there were important differences that likely arose from distinct epistemological groundings (see discussion of epistemology in Section 4.3.3).

Table 4.5 presents a sample of knowledge forms through which the Tribe sought to convey and integrate their cultural-benefits-knowledge. They accomplished this using a variety of both Enacted and Translated knowledge forms, including both Abstracted and Contextualized Translations (Fig 4.1, Section 4.2.3; Table F1, Appendix F). They used all avenues to communicate, even though some knowledge forms – particularly Abstracted forms – failed to convey the Tribe's full holistic understanding of the value of the Elwha. They did so because

they knew the full importance, as they understood it, would not be comprehensible within

Federal institutions or to individual decision-makers. As a Tribal leader explained:

> They didn't understand it, so we didn't have to, but we changed the perspective of it to go back to [Washington D.C., to how they] would comprehend it, and what would they understand through that process. Because they didn't understand our cultures. They didn't understand the sensitivity values of our smoke houses or the concerns or the interests we had on the species that we had for the tables to feed our families, and what those were utilized for spiritually or culturally… We knew we couldn't have them understand it. [P5]

A Tribal staff member noted that the Tribe worked hard to "anglicize and Federalize" the

language they used to communicate information to decision-makers [P24]. In particular, this

meant emphasis on instrumental value through economic valuation, i.e., "use proxies" (Table F1,

Appendix F). A Tribal leader explained that, "for instance, with dam removal, we had to put a

value on things to get others to start agreeing with dam removal. We had to use the economy"

[P6]. For example, during the Senate Joint Hearing for the Elwha Act, on July 9, 1992, Tribal

economists submitted an economic valuation of the fishing-related benefits that would come

from dam removal (Table 4.5, Knowledge Form 2c). They did this knowing that it only

communicated instrumental value aspects, and included the caveat that "dollar estimates of value

comprise only part, and likely not the greatest part, of the importance of salmon to Tribal

peoples" (Meyer Resources, 1992, p. 123).

The Tribe also found ways to convey the holistic value of the Elwha through consistent,

respectful efforts to "educate" decision-makers as a form of Enacted knowledge. As a Tribal

leader explained, "our traditional values was never hidden or pushed aside. We always had it on

the table knowing they wouldn't understand it, but we put it there" [P6]. For example, the late

Tribal elder, Beatrice Charles, testified before a Senate Hearing on the Elwha Act on June 4,

1992, describing the importance of the salmon for Lower Elwha Klallam culture and heritage

(Knowledge Form 2b, Table 4.5). By all accounts her testimony was very impactful. A representative of the James River Corporation, which owned the dams at that time, spoke of the Senate Hearings in Washington D.C., saying, "[The Tribe] brought their elders, and when they spoke it was a very emotional moment, and convinced a pretty hard-hearted person that there's got to be something here" [P1]. Similarly, a National Park Service representative noted that "it seemed to be really important to the congressional folks when the elders testified" [P4].

This process of education unfolded over many years. After the passage of the Elwha Act, but before Congress had appropriated funds to remove the dams, the Tribe continued educating and demonstrating the importance of dam removal, as in the example of Knowledge Form 4a (Table 5), in which Tribal members gathered in front of Olympic National Park headquarters to demonstrate and articulate the importance of dam removal for cultural survival. And the process of educating was often very personal. For example, the Tribe has brought congressional and Federal agency representatives and their staff, as well as local actors, to cultural events:

> We have brought some of the dignitaries. We have brought some of the locals. We have brought some of the individual agencies, so that they were able to witness our process and our protocol… I think it may have [made a difference] in some ways, because they didn't understand the process of that salmon, what it meant, because it wasn't just the fish itself but the whole process that was taking place. And not recognizing to the fact of how spiritually some of the cooks would go down to the river and feed the river and feed the salmon people and feed the ones that got lost at sea, you know, kind of stuff. So it kind of hit a few. I mean, we have brought different agencies to, when we've done ceremonial burnings, and they don't understand it. And we don't expect them to understand, but we let them ask the questions and explain to them what we were doing and why we're doing it, whether they believe or not. I mean, that's their choice. That's their open mind. [P5]

The Tribe pursued multiple avenues to convey the importance of dam removal and ecosystem restoration on the Elwha River. Often, these approaches seemed to buoy one another. For example, efforts to support cultural comprehension were strengthened by the Tribe's clear articulation of a management objective, i.e., dam removal, and their ability to describe the value

of this management choice both through Abstracted Translation, i.e., economic valuation

(Knowledge Form 2c, Table 4.5), Contextualized Translation, i.e., describing the value of the

Elwha to the Tribe in "anglicized language" (Knowledge Form 3b, Table 4.5), in addition to the

ways they were able to Enact this cultural-benefits-knowledge through their direct involvement

at all stages of decision-making (Knowledge Forms 1b, 2a, 3b, 5a, Table 4.5). The Tribe

continues to convey the cultural importance of the Elwha River today through knowledge

practices that renew and strengthen the Tribe's respectful, reciprocal relationship to salmon and

the Elwha River ecosystem more broadly (Knowledge Forms 5a and 5b, Table 4.5).

Table 4.5: *Knowledge Forms through which the Lower Elwha Klallam Tribe communicated its Cultural-Benefits-Knowledge at distinct stages of decision-making.*

- Core cultural benefits that the Tribe sought to convey through these identified knowledge forms included knowledge system, responsible relationship with non-human nature, and place-based cultural identity (Table 4.3, Section 4.3.2.1). These cultural benefits are linked together within a holistic value perspective, in which relational, instrumental, and intrinsic value aspects cannot be disentangled, and relational and intrinsic values constrain and guide instrumental uses.
- Information in Area(s) of Opportunity column (furthest right) is visually represented in Fig. 4.8, Section 4.3.2.4.

Stage of Decision-making	Knowledge Forms Identified (*Source*)	Knowledge Pathways	Values Conveyed	Area(s) of Opportunity
1. Agenda Setting: FERC Relicensing and Negotiated Settlement	**1a. Enacted:** Persistent advocacy for fisheries restoration, Elwha dam removal, and protection of cultural heritage. Quote: Dam removal "was our top priority for 20 years" [P105] **Note**: This knowledge form is relevant throughout all stages of decision-making. (*Interviews and historical documentation*)	These are both examples of "management proxies," in which cultural-benefits-knowledge-holders identify management approaches that would protect or restore cultural benefits and associated well-being. The Tribe's intervention in the FERC process can also be viewed as an "institutional proxy" because it called attention to the need for reform of FERC participatory processes (Ulibarri, 2015).	Holistic value perspective not explicitly articulated, but indirectly integrated by virtue of cultural-benefits-knowledge-holders' involvement in management or institutional reform.	**1a. Procedural Inclusion (Management Practice)** *Inform management approach.*
	1b. Enacted: Intervention in FERC process, with a motion to remove the dams. (*Interviews and historical documentation*)			***1b. Procedural Inclusion (Management & Institutional Practice)*** *Inform management approach and call for institutional reforms.*
	1c. Abstracted Translation: The LEKT's comments on FERC's Draft EIS included a request that cultural resources, and in particular the importance of traditional cultural	This is an example of a "benefit proxy," in which protection of a proxy cultural benefit will achieve some protection of core cultural benefits. In this case, cultural	Value is reduced to "unspecified," in that tangible objects and sites are identified as	**1c. Translation to Product** *Requesting further documentation of cultural sites.*

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	properties, be more adequately described. *(Historical documentation)*	heritage protections under the NHPA and AIRFA offer proxy protection for other cultural benefits valued within the Tribe's holistic value perspective.	"valued" and eligible for protection but their specific values are not elaborated.	
2. Problem Definition and Objective Setting: **Passage of the Elwha Act**	**2a. Enacted:** Tribal leaders and elders testified before Congress about the fundamental importance of the Elwha River and salmon to the Lower Elwha Klallam People. This included Ms. Carla Elofson's testimony around cultural sites inundated by the reservoirs, including the Tribe's creation site and former village site, and Mrs. Beatrice Charles' description of salmon as "a gift from our creator. It was our culture and our heritage" (Senate Hearing on the Elwha Act, June 4, 1992). *(Interviews and historical documentation)*	This is an example of "enacted expression," in which cultural-benefits-knowledge is *practiced* in the articulation of linkages between an ecosystem and well-being. Tribal members articulated the value of the Elwha River, Elwha Valley, and salmon to the Tribe, expressing holistic value in the interconnections between economic, cultural, and spiritual contributions to the well-being of the Lower Elwha Klallam Tribe.	Holistic value perspective and depth of importance is clear in the articulation, with potential to educate receptive listeners.	**2a. Cultural Comprehension** *Helping congressional leaders gain insight into holistic value perspective and depth of importance.*
	2b. Enacted: During Ms. Carla Elofson's testimony to Congress (June 4, 1992), she advocated for the U.S. government to keep its promises and uphold the Treaty of Point No Point that it signed in 1855. This requires that fish and other treaty resources be protected for Tribes to continue practicing their way of life, and the holistic value that affords. *(Interviews and historical documentation)*	This is an example of an "institutional proxy," in which cultural-benefits-knowledge-holders identify institutional or higher-level policy changes that would protect or restore cultural benefits and associated well-being.	Holistic value perspective not explicitly articulated, but indirectly integrated by virtue of cultural-benefits-knowledge-holders' involvement.	**2b. Procedural Inclusion (Institutional Practice)** *Need to uphold Institutional Structures that will better enable consideration of cultural-benefits-knowledge.*

	2c. Abstracted Translation: Tribal economists submitted an economic analysis during the Senate Joint Hearing on the Elwha Act, July 9, 1992. This included economic benefits of restoration for Treaty Tribes, and non-market values for sport fishers and other recreators. *(Interviews and historical documentation)*	This is an example of a "use proxy," in which instrumental value aspects are offered as a partial proxy for non-instrumental value aspects or holistic value perspectives. In this document, Tribal economists acknowledged that "dollar estimates of value comprise only part, and likely not the greatest part, of the importance of salmon to Tribal peoples" (Meyer Resources, Inc., 1992, p. 123).	Value is reduced to instrumental aspects.	**2c. Translation to Product** *Seeking to convey cultural-benefits-knowledge within the constraints that are required and comprehensible to decision-makers.*
3. Identifying Alternatives, Estimating Costs and Benefits, and Selecting Preferred Alternatives: NEPA Process	**3a. Abstracted Translation:** During cultural resource assessment under the National Historic Preservation Act, the NPS created maps of cultural sites. In consultation with the Tribe, the maps were created using "general" locations rather than specific coordinates to protect culturally sensitive locations. *(Interviews)* It is also an example of a "collaborative research," in which a translated knowledge form is produced by or in collaboration with cultural-benefits-knowledge-holders to bring it in alignment – as much a possible – with their understandings of well-being.	This is an example of a "benefit proxy," in which cultural heritage as protected by statutes, e.g., the National Historic Preservation Act and American Indian Religious Freedom Act, serves as a proxy for multiple cultural benefits and the Tribe's holistic value perspective.	Value is reduced to "unspecified," in that tangible objects and sites are identified as "valued" and eligible for protection but their specific values are not elaborated. Involvement of cultural-benefits-knowledge-holders minimizes harm related to culturally sensitive locations and knowledge.	**3a. Translation to Product** *Seeking to convey cultural-benefits-knowledge within the constraints that are required and comprehensible to decision-makers.*
	3b. Contextualized Translation: Socio-cultural portions of the Elwha Report and Elwha EISs are produced by Tribal staff. *(Historical documentation).*	This is an example of "collaborative research," in which a translated knowledge form is produced by or in collaboration with cultural-benefits-knowledge-holders to	Holistic value perspective is conveyed as well as possible in words, with potential to	**3b. Translation to Product & Cultural Comprehension**

	ensure that it is most in alignment with their well-being.	educate receptive readers; Full understanding would require direct experience in context.	*Seeking to convey holistic value in written form; Reading this offers insight into holistic value.*
	3c. Enacted: During government-to-government consultation under Section 106 of the National Historic Preservation Act, LEKT informs the National Park Service's approach to dam removal, including hillsides to avoid disrupting and the need to minimize potential impacts to the Tribe's creation site during removal of the lower dam.	This is an example of a "management proxy," in which cultural-benefits-knowledge-holders identify a management approach that would protect or restore cultural benefits and associated well-being.	Holistic value perspective not explicitly articulated, but indirectly integrated by virtue of cultural-benefits-knowledge-holders' involvement.	**3c. Procedural Inclusion (Management Practice)** *Informing Management Approach*
(4. Attempt to Prevent Implementation and Adjust the Problem Definition: Appropriations Battle)*	**4a. Enacted:** Example of the Tribe's persistent advocacy (expression and demonstration) around the need for fisheries restoration and dam removal on the Elwha: In late Autumn, 2000, "men, women and children from the Lower Elwha Klallam community gathered for a cultural encounter at the NPS headquarters in Port Angeles, Washington… Many of the older youth were dressed in contemporary Coast Salish regalia and carried brightly painted skin-covered hand drums. Tribal chairman Russell Hepfer opened with a brief statement welcoming the crowd. He discussed the significance of dam removal for environmental restoration and the importance of tribal involvement in all levels of this action	This is an example of "enacted demonstration" and "enacted expression" to advocate for a particular "management proxy," i.e., dam removal and fisheries restoration. In this case, cultural-benefits-knowledge is *practiced* through demonstrating and articulating the depth of importance of the removal of dams and restoration of fisheries.	Holistic value perspective is clear in this articulation and demonstration as a cultural-benefits-knowledge practice, with potential to educate receptive observers and listeners.	**4a. Procedural Inclusion (Management Practice) & Cultural Comprehension** *Informing Management Approach; Helping National Park Service staff gain insight into holistic value perspective and depth of importance.*

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	stating that without the salmon we 'we are all gone.'" (Boyd, 2001, pp. 1-2). *(Interviews and Historical Documentation)*			
5. Implementation: Restoration Planning and Action	**5a. Enacted:** In the Elwha Act, the Lower Elwha Klallam Tribe negotiated that their natural resource staff would receive funding through Programmatic Agreements to lead restoration actions on their reservation, including fisheries restoration and revegetation efforts.	This is an example of both "management proxy" (see above) and "enacted demonstration," in which cultural-benefits-knowledge is *practiced* when Tribal members embody and reproduce the holistic value of the Elwha River, Elwha Valley, and salmon by engaging in stewardship practices.	Holistic value perspective is clear in the depth of commitment around this engagement in restoration actions.	**5a. Procedural Inclusion (Management Practice)** *Direct engagement in ecosystem management is necessary to maintain the Tribe's cultural benefits.*
	5b. Enacted: The Lower Elwha Klallam Tribe is actively renewing and reproducing ceremonial engagements with the Elwha River and its salmon, including reinstituting the First Salmon Ceremony. As former LEKT Fishery Manager, Rachel Hagaman, explained: "It was taught to me by my Grandmother, Laverne Ulmer Hepfer, that the ceremonies were important to the people, for through these acts of thanks to the Creator, the Tribe was assured of continued success and survival from one season to the next. My grandmother also shared with me that the ceremonies were also the means by which the hunting and fishing villages came together to celebrate, share and give thanks" (LEKT, no date).	This is an example of "enacted demonstration," in which cultural-benefits-knowledge is *practiced* when Tribal members embody and reproduce the holistic value of the Elwha River and salmon by restoring ceremonial practices associated with respectful, reciprocal relationship to salmon.	Holistic value perspective is clear in the Tribe's respectful, reciprocal engagement with salmon, including cultural, spiritual, ceremonial, and economic facets.	**5b. Cultural Comprehension** *Aspects of this and other ceremonies that the LEKT chooses to share can help educate Federal agency staff and other non-Tribal community members about interconnection between cultural renewal and ecosystem restoration.*

Table 4.6 presents a sample of knowledge forms through which Local Recreationists opposed to dam removal sought to convey and integrate their cultural-benefits-knowledge in the decision-making process. Based on evidence from our interviews and review of available historical documents, it appears they primarily communicated their cultural-benefits-knowledge through Contextualized Translation and Enacted knowledge forms. They provided public comments during both the FERC relicensing and Elwha NEPA processes (Knowledge Forms 1a and 3d, Table 4.6) which contributed context to the record of public opinion. The advocacy group Rescue Elwha Area Lakes (REAL) produced a documentary that sought to convey the importance of the reservoirs for recreation and aesthetic value, including for the protection of swan habitat (Knowledge Form 3c, Table 4.6). Further, they enacted their cultural-benefits-knowledge through their acts of organizing and advocating for the protection of the dams and reservoirs (Knowledge Forms 3a and 4a, Table 4.6).

In their public comments, letters to the editor, and in documentaries, Local Recreationists emphasized instrumentally-valuable cultural benefits, such as recreation and aesthetic value, and it is clear from interviews that they did not see an obvious role for expression of relational values in the decision-making process. For example, an individual for whom the reservoirs provided cultural benefits including sense of place, social ties, and inspiration stated that it made no sense to voice such feelings: "It's not like you're going to go to City Hall and say that this place is special to you. It wasn't our land; it belongs to the Elwha Tribe. We didn't make any effort to voice that" [P144]. Given this, it is unclear the degree to which articulation of instrumentally-valuable cultural benefits may have acted as "use proxies" or "benefit proxies" (Table F1, Appendix F).

Interviews and historical documents also suggest that Local Recreationists used Enacted knowledge forms to convey relational value aspects. Enacted knowledge forms offer ways to convey relational values without always explicitly articulating them. For example, their advocacy for particular management approaches or outcomes was a way they sought to protect both the instrumental and relational value they received from the Elwha. Beyond simply advocating for retention of the dams and reservoirs (Knowledge Form 3a, Table 4.6), Local Recreationists were engaged in efforts to protect a specific species. The organization REAL helped to fund a study into the impact of dam removal on swans that used Lake Aldwell (Knowledge Form 3b, Table 4.6). As a National Park Employee recounted, "swans became an issue in the EIS, in part because of aesthetics. And there were also some swan advocates who were afraid that the swans would be harmed by the loss of the lake" [P116].

Multiple interview respondents spoke about the lack of local opposition to dam removal at early stages of the decision process [P8, others]. It seems people didn't take the threat of dam removal seriously. Dam removal was largely unprecedented, and early promoters of Elwha River dam removal, such as environmentalist Rick Rutz, were told, "You're insane. You don't take out working dams that don't have something wrong with them" (Simson, 2014). It was only after the passage of the Elwha Act in 1992 that local opposition to dam removal began to organize. Had Local Recreationists organized earlier, they may have found other ways to convey their cultural-benefits-knowledge to inform decision-making. If invited, they could have testified before the Senate Hearings for the Elwha Act and offered Abstracted and Contextualized Translations as part of the record (Missing Knowledge Form 2a, Table 4.6). And because they were not "at the Table" as intervenors in FERC relicensing, they missed the opportunity to bring the relational values tied to the dams and reservoirs into negotiations (Missing Knowledge Form 1b, Table

4.6). In contrast, recreational benefits associated with dam removal were articulated by environmental NGOs at this early stage of decision-making, given that they successfully intervened in the FERC relicensing process.

Table 4.6: *Knowledge Forms through which Local Recreationists Opposed to Dam Removal Communicated Cultural-Benefits-Knowledge at distinct stages of decision-making.*

- Core cultural benefits that Local Recreationists sought to convey included recreation, aesthetic value, sense of place, social ties, mental health, and inspiration (Table 4.3, Section 4.3.2.1). These benefits can all be conceptualized as instrumentally valuable, and recreational and aesthetic values are particularly amenable to inclusion in utilitarian cost-benefit approaches. However, benefits such as sense of place and social ties are more adequately understood when we also consider relational value aspects (Chan et al., 2016).
- Information in Area(s) of Opportunity column (furthest right) is visually represented in Fig. 4.9, Section 4.3.2.4.

Stage of Decision-making	Knowledge Forms Identified *(Source)*	Knowledge Pathways	Values Conveyed	Area(s) of Opportunity for Integration
1. Agenda Setting: FERC Relicensing and Negotiated Settlement	**1a. Contextualized Translation:** In 1991, individual community members testified at public hearings and submitted public comment on FERC's draft EIS. Most comments centered on economic concerns, but a small number described the recreational and aesthetic values of the dams and associated reservoirs. *(Historical documentation)*	This is an example of individual community members contributing to a documented record of public opinion. They described the loss of instrumentally valuable cultural benefits – aesthetic and recreational values – that they felt would accompany dam removal. It is possible that, in some cases, these recreational and aesthetic benefits may have served as "benefit proxies" for non-instrumental cultural benefits valued by the authors, but not believed to be relevant to the FERC decision process.	Instrumental value aspects are clear in these articulations of cultural benefits; uncertain of the degree to which instrumentally-valued benefits served as benefit proxies for relationally-valued benefits.	**1a. Translation to Product & Cultural Comprehension** *Documented record of public opinion; Reading these letters offers insight into their values.*
	1b. Missed Opportunity to Enact cultural-benefits-knowledge by gaining a seat at the Table. **Note**: In the quasi-judicial context of FERC relicensing, entities had to prove they were materially affected to intervene. This would not have been feasible for individual community members. *(Interviews and Historical Documentation)*	*Missed Opportunity* to enact cultural-benefits-knowledge through "management proxy" by identifying dam retention as a management approach that would protect their cultural benefits.	--	***Missed Opportunity* 1b. Procedural Inclusion (Management Practice)** *Local cultural benefits linked to the dams and reservoirs were not "at the Table."*

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2. Problem Definition and Objective Setting: Passage of the Elwha Act	*2a. Missed Opportunity for Abstracted and Contextualized Translation*: Local concerns about loss of cultural benefits are not reflected in congressional testimony or material submitted for the record, whether in Abstracted or Contextualized form. (**Note**: Senate hearings included testimony from those who had gained standing in the FERC process and had collectively negotiated an agreement). *(Historical Documentation)*	*Missed Opportunity* to make local Port Angeles cultural benefits linked to the dams and reservoirs part of the formal record and influence whether or not the Elwha Act was passed by Congress.	--	*Missed Opportunity* **2a. Translation to Product** *Contributing to documented record through submitting Translated knowledge.*
3. Identifying Alternatives, Estimating Costs and Benefits, and Selecting Preferred Alternatives: NEPA Process	**3a. Enacted:** Local community interests opposed to dam removal organized to amplify their concerns. This included formation of the advocacy group, Rescue Elwha Area Lakes (REAL). The leader of REAL, Marvin Chastain, and other community members opposed to dam removal, wrote letters to the editor, met with Park Service staff, and lobbied congressional representatives. *(Interviews and Historical documentation)*	These are examples of knowledge practices, including "enacted demonstration" and "enacted expression," intended to convey to the National Park Service the importance of a "management proxy," retaining the dams and reservoirs, that would protect cultural benefits.	Instrumental value aspects linked to recreational and aesthetic value most clearly articulated by REAL and other community members, but relational values likely also motivated this effort, as evidenced by interviews with local recreationists for this study.	**3a. Procedural Inclusion (Management Practice) & Cultural Comprehension** *Promoting a specific management action; Helping National Park Service and congressional representatives understand local values linked to the dams and reservoirs.*

3b. Enacted: REAL supported research into the impact of dam removal on swans that used Lake Aldwell for habitat and were beloved for their aesthetic value. The leader of REAL "really wanted the swans to be that piece of wildlife, or that species, that was going to help him stop the dam removal" [P142].	This is an example of a "management proxy," in which cultural-benefits-knowledge-holders advocate for a specific management action or approach that would protect their cultural benefits.	Instrumental value aspects linked to recreational and aesthetic value most clearly articulated by REAL and other community members, but relational values likely also motivated this effort, as evidenced by interviews with local recreationists for this study.	**3b. Procedural Inclusion (Management Practice)** *Promoting a management objective.*
3c. Contextualized Translation: REAL puts out a documentary with footage of swans on the reservoirs and interviews with long-time residents of Port Angeles opposed to dam removal. The video paints environmentalists as highly radicalized, calling them "Virgin Earth Cultists." *(Historical Documentation)*	This is a knowledge product that provides context around how and why the dams and reservoirs are important to local community members.	Instrumental value aspects linked to recreational and aesthetic value were most clearly articulated, but relational value aspects also conveyed through emotion.	**3c. Translation to Product & Cultural Comprehension** *Video intended to highlight values linked to the reservoirs and call into question opposing values.*
3d. Contextualized Translation: Between 1994 and 1996, individual community members testified at public hearings and submitted public comment on the two Elwha EISs. Again, most comments centered on recreational and aesthetic values of the dams and associated reservoirs, but some	This is an example of individual community members contributing to a documented record of public opinion. They primarily described the loss of instrumentally valuable cultural benefits – aesthetic and recreational values – that they felt would accompany dam removal. It is possible that, in some cases, these recreational and aesthetic benefits may have served	Emphasis heaviest on instrumentally-valuable benefits, with some explicit mention of relationally-valuable benefits*;* uncertain of the degree to which instrumental values	**3d. Translation to Product & Cultural Comprehension** *Documented record of public perception; Reading these letters offers insight into their values.*

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	explicitly discussed more relational cultural benefits such as sense of place and social ties. (Historical documentation)	as "benefit proxies" for non-instrumental cultural benefits valued by the authors, but not believed to be relevant to the FERC decision process.	served as benefit proxies for relational values.	
(4. Attempt to adjust the Problem Definition: Appropriations Battle)	**4a. Enacted:** REAL and other local individuals and groups opposed to dam removal lobbied congressional representatives such as Senator Slade Gorton and Representative Al Swift to ask them to prevent dam removal.	This is an example of advocacy for a "management proxy" that would protect cultural benefits, i.e., retaining the dams and reservoirs.	Emphasis heaviest on instrumentally-valuable benefits, with some mention of relationally valuable benefits*;* uncertain of the degree to which instrumental values were benefit proxies for relational values.	**4a. Procedural Inclusion (Management Practice)** *Identifying a need to shift the decision context to better align with cultural-benefits-knowledge.*
5. Implementation: Restoration Planning and Action	**5a. Contextualized Translation**: Comments on the Elwha Implementation EIS (DOI, 1996) and later public meetings urging restoration actions to be carried out in ways that would minimize loss of recreational benefits, e.g., maintain recreational access roads.	This is an example of individual community members contributing to a documented record of public opinion. They primarily emphasized the need to protect recreational values, a cultural benefit that is readily incorporated in economic cost-benefit analyses. It is possible that, in some cases, highlighting of recreational benefits may have served as "benefit proxies" for non-instrumental cultural benefits bundled with recreational access and valued by commentors.	Explicit emphasis on instrumental values; Possibility that discussion of recreational value also implicitly sought to protect relationally-valuable cultural benefits.	**5a. Translation to Product & Cultural Comprehension** *Documented record of public perception; Reading these public comments offers insight into commentors' values.*
	5b. Enacted: Effort to protect the Elwha Campground community kitchen, a site of cultural significance to many	This is an example of "enacted demonstration" to advocate for a particular "management proxy" i.e., the protection of a valued cultural	The cultural heritage significance of this site can be understood as a	**5b. Procedural Inclusion (Management Practice)**

| | local community members, through listing on the National Register of Historic Places. | heritage site. Further, designation as cultural heritage can be understood as a "benefit proxy" for various relationally-valuable cultural benefits arising from sustained interaction with the site. These included social ties, shared experiences, and sense of place. | benefit proxy for relational values. | *Identifying a management action that would help protect – or at least document – a tangible object linked to relationally-valuable cultural benefits.* |

4.3.2.4 Phase 4 – Opportunities in Context

As a concluding step in the Cultural Benefits Action Opportunities Framework, Phase 4 involves locating each knowledge form within the Opportunity Map (Fig. 4.4, Section 4.2.3). By locating knowledge forms we illustrate the Area(s) of Opportunity through which each informed – or could have informed – decision-making. Locating knowledge forms involves determining whether it was – or could be – considered within one or multiple Area(s) of Opportunity, including Translation to Product, Procedural Inclusion, and/or Cultural Comprehension. In addition, it requires determining whether the knowledge form could be integrated within the existing decision context, i.e., in the inner circle of the Opportunity Map, or would require adjustments to the institution, i.e., outer circle of the Opportunity Map. Determining whether the knowledge form is in the inner or outer circle requires cross-referencing against the description of decision context completed during Framework Phase 1, including guiding statues, rules for public participation or Tribal involvement, etc. Discussion of these and other barriers and enabling factors affecting meaningful consideration of each knowledge form can accompany Figures 4.5 and 4.6.

As in Section 4.3.2.3, we focus this retrospective analysis on two groups of cultural-benefits-knowledge-holders: The Lower Elwha Klallam Tribe, which supported dam removal, and the group of Local Recreationists in Port Angeles that organized in opposition to dam removal. Both of these groups spoke in interviews about non-instrumental value associated with the Elwha River, and although linked to different ecosystem elements. And yet only some of the knowledge forms offered by these groups fully conveyed relational value aspects, in the case of Local Recreationists, and holistic value, in the case of the Tribe. In the Opportunity Maps, we distinguish between knowledge forms we identified to have conveyed more complete

understandings of value (shapes with solid fill) and those we identified as conveying only partial meaning (shapes with checkered fill). Examples of partial meaning include use proxies that emphasize instrumental value aspects, e.g., economic valuation (Knowledge Form 2c, Table 4.5) and benefit proxies that rely on protection of more tangible and well-defined cultural benefits as proxy protection for other cultural benefits, e.g., cultural heritage (Knowledge Forms 1c and 3a, Table 4.5) and recreation and aesthetic value (Knowledge Forms 1a and 3d, Table 4.6).

The Tribe conveyed the holistic meaning of the Elwha River, in the sense of the inseparability of the ceremonial, cultural, spiritual, and economic importance of the river as a foundation for their lifeways (DOI, 1994b, p. 205), through diverse forms of Enacted knowledge (Circle shapes in Fig. 4.8) and Contextualized Translations (Square shapes in Fig. 4.8). Enacted knowledge forms are primarily located in the Procedural Inclusion and Cultural Comprehension Areas of Opportunity. Enacted forms involving articulation of the holistic value of the Elwha River and salmon are represented as solid, while Enacted forms involving management or institutional proxies are represented as hollow. This is because proxy pathways allow for integration of cultural-benefits-knowledge without the explicit articulation of those benefits (Table F1, Appendix F). We identified one Contextualized Translation that we deemed largely successful in conveying this holistic value: Knowledge Form 3b (Table 4.5), in which Tribal staff authored the socio-economic content in the Elwha Report (DOI, 1994a, 1994b) and the two Elwha EISs (DOI, 1995, 1996). We found no Abstracted knowledge forms (Triangles in Fig. 4.8) that conveyed the Tribe's full holistic value perspective; instead, the Abstracted knowledge forms offered by the Tribe conveyed solely instrumental value. For example, the Tribe offered a monetary valuation study with the clarification that "dollar estimates of value comprise only part, and likely not the greatest part, of the importance of salmon to Tribal peoples" (Meyer

Resources, Inc., 1992, p. 123). Since instrumental value is only part of the value to the Tribe, these Abstracted Translations are represented with checkered (partial) fill.

Local Recreationists offered similar knowledge forms to convey the value they associated with the reservoirs and recreation in the Elwha Valley. However, the knowledge forms were much more likely to convey solely, or primarily, instrumental value aspects. Through our interviews, we learned that many local community members had lifelong or multi-generational connections to campgrounds and other recreational opportunities on and near the reservoirs: Lake Mills and Lake Aldwell. Some of the cultural benefits associated with these connections clearly offered relational value, including social ties, i.e., the way the Elwha Valley enabled shared experiences and memories with loved ones, and a sense of place that people characterized as core to their well-being. And yet, most of the examples of cultural-benefits-knowledge offered to inform decision-making emphasized instrumentally-valuable cultural benefits such as recreation and aesthetic value. It is unclear the degree to which Local Recreationists' articulation of recreation and aesthetic value may have served as benefit proxies for the relational value they spoke of in interviews; while this proxy function was explicitly described by Tribal respondents, it was never explicitly mentioned by Local Recreationists in interviews.

We identified two examples of Enacted knowledge through which we judged that Local Recreationists sought to bring the full meaning of the Elwha River from their perspective – which included instrumental and relational values – into decision-making. First, they engaged in advocacy to promote retaining the dams as a management outcome (Knowledge Form 3a, Table 4.6). Second, they commissioned research to understand impacts on swans from dam removal (Knowledge Form 3b, Table 4.6). In both of these instances the circles in Fig. 4.9 are represented as hollow, given that the cultural-benefits-knowledge was offered via management proxies, and

the cultural benefits were not explicitly articulated. We also identified a Contextualized

Translation that we deemed largely successful at conveying this group's relational values in

addition to instrumental value: a documentary produced by the organization REAL that included

footage of swans on the reservoirs and interviews with individuals who cared about the

reservoirs (Knowledge Form 3c, Table 4.6). Instrumentally-valuable cultural benefits were

explicitly discussed in this documentary, and relational value aspects were also demonstrated

through emotion. As in the Tribal Opportunity Map, these Enacted knowledge forms were

located within Procedural Inclusion and Cultural Comprehension Areas of Opportunity. Based

on evidence from interviews and historical documents, we failed to identify examples of

Abstracted Translations offered by Local Recreationists to inform decision-making.

Figure 4.8: Locating cultural-benefits-knowledge-forms offered by the Lower Elwha Klallam Tribe within the Opportunity Map. Knowledge forms are in separate maps based on the Stage of Decision-making (Fig. 4.5, Table 4.4) for which they were identified. Full explanation of each knowledge form is provided in Table 4.5. Core cultural benefits the Tribe sought to convey and/or protect included 1) maintenance of their knowledge system, 2) cultural identity, and 3) ability to live in responsible relationship to nature. Shapes with solid fill represent knowledge forms that conveyed the Tribe's holistic value perspective with minimal loss of meaning. In contrast, checkered shapes are knowledge forms that conveyed partial understandings of value, e.g., value was "unspecified" or reduced to its instrumental aspects. Green represents knowledge that was reflected in the decision outcome, orange represent knowledge not reflected in the decision outcome, and red are "missed opportunities" where knowledge could have been, but was not, conveyed. △ = Abstracted Translation □ = Contextualized Translation ○ = Enacted Knowledge

1. Agenda Setting & Negotiated Settlement: FERC Relicensing

2. Problem Definition & Objective Setting: Elwha Act

3. Identifying Alternatives, Estimating Costs and Benefits, Selecting Preferred Alternative: NEPA
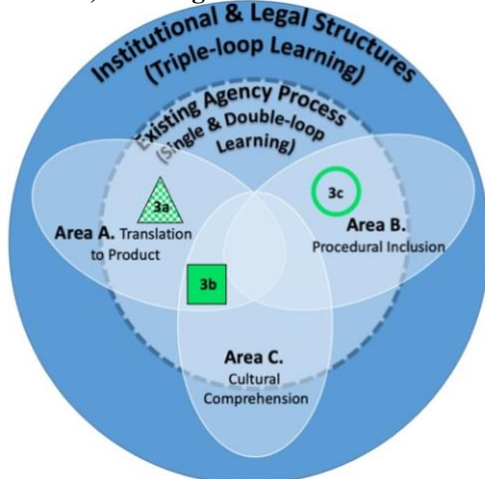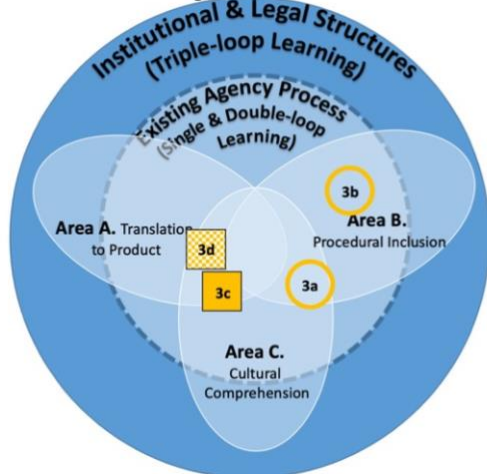
4. *(Appropriations Battle, attempt to Adjust Problem Definition)*

5. *Implementation*

Figure 4.9: Locating cultural-benefits-knowledge-forms offered by Local Recreationists in Port Angeles who opposed dam removal within the Opportunity Map. Knowledge forms are located within a separate map based on the Stage of Decision-making (Fig. 4.5, Table 4.4) for which they were identified. Full explanation of each knowledge form is provided in Table 4.6. Interviews suggest local recreationists received instrumentally-valuable benefits including recreation and aesthetic value, and relationally-valued benefits including sense of place, social ties, and inspiration from the reservoirs behind the dams. Shapes with solid fill represent knowledge forms that conveyed relational value aspects in addition to instrumental. In contrast, checkered shapes represent knowledge forms that conveyed partial understandings of value, e.g., value was "unspecified" or reduced to its instrumental aspects. Green circles represent knowledge that was reflected in the decision outcome, orange circles represent knowledge not reflected in the decision outcome, and red circles represent "missed opportunities" where knowledge forms could have been, but were not, offered to inform decision-making. △ = Abstracted Translation □ = Contextualized Translation ○ = Enacted Knowledge

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A focus on these two groups also allows us to compare barriers and enabling factors that led to the cultural-benefits-knowledge of the Tribe being reflected in the decision outcome, while the cultural-benefits-knowledge of Local Recreationists was not. Color is indicative of whether the knowledge was ultimately reflected in the decision outcome, with green shapes indicating knowledge that was reflected in the outcome, orange indicating knowledge not reflected in the outcome – though it may have been received and considered by decision-makers, and red indicating examples of "missed opportunities" for cultural-benefits-knowledge to be conveyed to inform decision-making, i.e., knowledge forms 1b and 2a in Table 4.6 (Section 4.3.2.3).

Enabling factors for inclusion of the Tribe's cultural-benefits-knowledge in this decision-making process were many. As a starting point, the Tribe's high level of motivation and persistence to advocate for salmon recovery was a foundational enabling variable. One Tribal leader noted that Tribal members had resisted the dams from the moment land was being cleared to build them:

> [We] had a couple of [elders] that had tried to stand against the companies that were tearing down the trees and tearing down their fishing holes and their land bases of it, for the impacts that it was having on building, not only the Lower dam but the Glines dam just as much, and where we've had one of the elders that really stood out against it being developed and let alone the land being taken away from them in any concepts. Because we didn't have any rights. We weren't considered citizens at those times. [P5]

Another Tribal leader stated that "as soon as we found out [dam removal] might be possible… the [Tribal Council] made it the Tribe's top priority. And from then on, it was until it was accomplished" [P105].

Building from this foundational motivation, many other variables began to line up in support of the Tribe's goal. The Boldt decision of 1974 upheld Tribal Treaty rights to salmon in their Usual and Accustomed fishing areas (*United States v. Washington*, 1974). Society was beginning to recognize that rivers were valuable for much more than energy production, as

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reflected in passage of the Wild and Scenic Rivers Act of 1968 and the Electric Consumers

Protection Act of 1986, which required FERC to consider other uses and values of rivers. The

Tribe found strong allies in both environmental and sport fishing interests. These groups had

differing strengths and resources that could support each other to advance their mutual interests.

Many Federal and State agencies also had interests that aligned with Tribes, environmental

groups, and sport fishing interests, including mandates to protect fish passage.

Over time, the Tribe built significant capacity within their natural resource, economics,

and legal staff. This positioned them to successfully engage at high levels with State and Federal

agencies. In collaboration with environmental NGOs, the Tribe successfully intervene in the

FERC relicensing process, setting the stage for ongoing collaboration with NGOs and

government agencies throughout the Elwha River dam removal and ecosystem restoration

decision-making process. As one National Park Service employee noted, "I think that because

the Tribe figured so prominently in the Elwha Act and was one of the key interveners in the

FERC case, that that just sort of carried over. And the tribe inserted itself into [the NEPA]

process, too. [The Tribe was] actually tasked with writing some of the report" [P116] (see

Knowledge Form 3b, Table 4.5, Fig. 4.8). These formal collaborations between the Tribe and

Federal agencies, in particular Olympic National Park, also created a unique opportunity for

cultural comprehension on the part of National Park Service staff, as discussed in Section

4.3.2.2.

There were multiple arguments for dam removal that complemented and provided proxy

approaches to protection of the cultural importance of the ecosystem. There were issues with

dam safety and overall fisheries decline in the region. These issues gave the Tribe and its allies a

number of legal mechanisms to promote their desired outcome. One National Park Service

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employee spoke about his involvement in getting the Elwha Dam elevated to #5 on the list of unsafe dams in the United States [P94]. And numerous interview respondents talked about how Elwha River dam removal and restoration was "all about the fish" [P101]. As one local environmentalist noted, "You have the way you feel about it, and then you need some other ammunition on your side… Objective expertise… it could be science or it could be economic" [P247].

In addition to factors lining up in support of dam removal, during early stages of decision-making there was a surprising lack of barriers. For example, the owners of the dams, James River Corporation, and the mill operators, Daishowa America, were primarily concerned with securing replacement power. This was easily accomplished with power from the Bonneville Power Administration. The City of Port Angeles was concerned about safeguarding its water supply, and there were other issues related to the Tribal fish hatchery. These were solved with promises of Federal funding built into the Elwha Act.

It was not until after the passage of the Elwha Act that controversy around dam removal began to build at a local level. Because local interests, such as the example of Local Recreationists, had not been involved at earlier stages of decision-making, there were common feelings that dam removal was a pre-determined conclusion, and that there was no room for public input to make any difference in the eventual outcome. Many local residents saw dam removal as just another example of Federal overreach on the Olympic Peninsula, in the wake of the spotted owl controversy. A public comment on the original FERC EIS from a Local Recreationists highlighted that, although local interests were not yet organized, it did not mean they did not feel strongly:

The mood of the country seems bent on environmental escapades such as this one, particularly in areas where the outcry of the inhabitants is weak. Consider a loud outcry from Port Angeles citizens against the well-financed and skillfully organized national environmental lobby. The outcome of such a confrontation is predictable. (DOI, 1993)

Local opposition to dam removal became more organized following the Elwha Act, but by this time many opportunities for integration of their cultural-benefits-knowledge in decision-making had already passed (see "Missing Knowledge Forms 1b and 2a, Table 4.6, Fig. 4.9). Indeed, the problem definition – a need for full ecosystem restoration – had already been set with passage of the Elwha Act. A National Park Service representative noted that it was the "Elwha Act which gave us [our] marching orders" [P4].

During the NEPA process, those opposing dam removal attempted to identify legal hooks, similar to issues of fish and dam safety, that would create momentum to halt dam removal. The organization REAL supported an ecological research study on the impact of dam removal on swans who used the reservoirs. A wildlife biologist interviewed for this study shared that the leader of REAL "really wanted the swans to be that piece of wildlife, or that species, that was going to help him stop the dam removal" [P142]. However, a study concluded that the swans had alternate habitats and would not be significantly impacted by dam removal. Although local opposition gained allies in Congress, including Senator Slade Gorton who singlehandedly held up appropriations for dam removal for many years, in the end they were not able to shift the problem definition of the need for full restoration, as established by an Act of Congress.

4.3.2.5 Retrospective Output 1 Summary and Conclusions

As a former Tribal employee stated, the Elwha decision process is not an example of "things that went wrong" with representation of Tribal values or "missed opportunities to include [Tribal] socio-cultural information" [P33]. Instead, this is a story of the involvement of the Lower Elwha Klallam Tribe (LEKT) at early stages of decision-making, including agenda setting

and problem definition. This early involvement enabled the Tribe's knowledge system to be

reflected in the negotiation of the Elwha Act, and for their holistic value perspective to be

reflected in the outcome of the decision-making process. One Klallam Tribal leader explained

the role of cultural-benefits-knowledge in value negotiation at these early stages of decision-

making:

> Yeah, I think [conveying cultural importance helps inform decision making] in the sense
> that you do have to reformulate how do you see the problem and what kinds of things are
> going to be involved in crafting the solution, and becoming very strategic in doing that.
> So that all the values are heard, and implemented. And that's a big way for everyone to
> have a voice. The larger the group, the harder it is to get something done, right? But it has
> to happen. And so that's why in the, in that sense, you send your key people, you know,
> your leadership or others they may designate and make sure that you're heard. [P95]

Possibilities for learning from cultural-benefits-knowledge are bounded by institutional

working rules (Heikkila & Gerlak, 2019; Ostrom 2005, 2011). In general, decision-processes

under both FERC and NEPA have been criticized as bureaucratic and technocratic, emphasizing

abstracted knowledge products and limiting possibilities for meaningful participation (Ulibarri,

2015; Ulibarri et al., 2022). However, institutional working rules may play out differently in a

particular context due to history and local logics of practice (Arts et al., 2014). The common

institutional working rules of both FERC and NEPA were stretched during the Elwha decision

process. Boundary rules were stretched in the FERC process when environmental groups and the

LEKT realized they could intervene in the relicensing processes for the Glines Canyon and

Elwha dams, bringing new actors into the process who sought to expand the scope of the

problem definition to include values beyond hydroelectric power generation (Simson, 2014;

Ulibarri, 2015). In the NEPA process, scope rules were stretched. In general under NEPA,

environmental impact statements (EISs) must be prepared within a short timeframe (Ulibarri et

al., 2022), limiting potential for extended engagement and mutual learning among actors

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(Heikkila & Gerlak, 2019). However, in the Elwha case the NEPA process took place following many years of collaboration between the LEKT and Federal and state agencies interested – for multiple reasons – in Elwha ecosystem and fisheries restoration. As a result, the timeframe scope of this NEPA process was – not formally, but in effect – considerably expanded. This, in addition to the proximity of Olympic National Park headquarters to the LEKT, allowed for deeper mutual learning between these entities. This in turn led to stretching of boundary rules in the Elwha NEPA process, with the LEKT helping to draft portions of the initial Elwha Report to Congress (DOI, 1994a, 1994b) and the ensuing EISs (DOI, 1995, 1996).

Although the Elwha dam removal and ecosystem restoration story is largely hailed as a success for inclusion of cultural-benefits-knowledge from the perspective of Tribes and environmental groups, many local community members in the Port Angeles area perceived that their cultural benefits, and interests more broadly, were not integrated in decision-making. Although they called attention to recreation and aesthetic value, these issues were sidelined by the Congressional mandate for full ecosystem restoration. In the NEPA context, the decision-relevance of knowledge is determined by the purpose and needs statement that defines the scope of alternatives analysis (Mandelker, 2010). As a representative from James River Corporation, the owner of the dams prior to Federal acquisition, noted:

> the issue of the future of the Elwha dams was clearly established by the Elwha Act. So the Elwha Act was the decision that settled virtually everything except the implementation. So it was only those forces and arguments out there that were made before the Elwha Act, before the Congress decided to take action [that influenced the final outcome]. [P1]

A comparison of these two groups of cultural-benefits-knowledge-holders offers two core insights. First, the process of "valuation" is taking place at all stages of decision-making, and perhaps most importantly at the earliest stages of agenda setting, problem definition, and

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objective setting (Hoelting & Gould, 2022). When a particular cultural-benefits-knowledge is not present at these early stages, it can be more easily sidelined during the more technical and implementation stages. Second, for both groups, Enacted knowledge forms and Contextualized Translations succeeded in conveying aspects of value beyond instrumental. Opportunities for these knowledge forms to influence decision-making were primarily located in the Procedural Inclusion and Cultural Comprehension Areas of Opportunity. Overall, this highlights the importance of direct involvement of cultural-benefits-knowledge-holders in decision-making processes, as well as the need for decision-makers to cultivate awareness of and respect for multiple knowledge systems.

These findings underscore that Translation to Product does not stand alone as an Area of Opportunity for integration of plural values in decision-making. Although translation of cultural-benefits-knowledge to qualitative or quantitative products can be advantageous in decision contexts that privilege the idea of knowledge-as-product, the conditions for a knowledge product to be deemed decision-relevant are set in earlier stages of decision-making. This echoes multiple authors who have noted that, even as researchers look for new and improved ways to make cultural benefits tangible, decision-makers should be wary of relying solely on this Knowledge Product Pathway for meaningful consideration and protection of the plural values linked to cultural benefits of ES (Hoelting et al., 2022b; Kenny & Chan, 2017, Lewis & Sheppard, 2005; Sheremata, 2018).

4.3.3 Retrospective Output 2: Theoretical Fit Summary

The theoretical refinement goal of retrospective case analysis highlights the fact that the Opportunity Framework for Improved Integration of Cultural Benefits, as outlined in Table 4.2 (Section 4.2.3), is intended to be a starting point for conversation and continued theory-building.

We demonstrate here how in-depth analysis of a single case study, such as Elwha River dam removal and ecosystem restoration decision process, can call attention to aspects of the conceptual models that may benefit from further refinement or clarification. It is of note that no case study will be a perfect match for the proposed framework; different elements of the framework will be most relevant to a given decision-making process in an applied setting.

Our application of the Framework to the Elwha River decision process revealed theoretical and applied questions around the concept of Enacted knowledge, and in particular how the epistemology of a group of cultural-benefits-knowledge-holders may impact the relevance of this concept. As described in Section 4.2.3, Enacted knowledge forms bring cultural-benefits-knowledge into practice through expression or demonstration. These knowledge practices may serve to protect cultural benefits, as in the case of advocacy for management approaches that align with well-being, e.g., seeking dam removal and fisheries restoration. Or they may embody and reproduce cultural benefits, e.g., maintaining engagement in traditional practices and ecosystem stewardship can reproduce and maintain knowledge systems and lifeways.

Two related issues arose during our application of the Framework. First, although interviews afforded some insight into respondents' perspectives on valid knowledge, we did not gather sufficient evidence to characterize the epistemologies of each group of cultural-benefits-knowledge-holders. However, to illustrate the importance of epistemology for application of the concept of Enacted knowledge, we can consider the evidence we did gather regarding the epistemologies of the two groups for whom we explored examples of cultural-benefits-knowledge-forms: The Lower Elwha Klallam Tribe and the group of Local Recreationists who opposed dam removal.

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The addition of the concept of Enacted knowledge forms is particularly important to create space for knowledge arising within Indigenous epistemologies. In Indigenous epistemologies, knowledge is linked both to learning and to responsibility to act (Kovach, 2009; Martinez, 2016). The Tribe's cultural identity, knowledge system, and ability to seek to live in responsible relationship with nature were negatively and profoundly impacted by the presence of the dams. Lower Elwha Klallam Tribal leaders interviewed for this study discussed how their engagements at all stages of decision-making were grounded in the teachings of their elders, educating them about the linkages between the ecosystem, salmon, and cultural survival. One Tribal leader described how the teachings of her elders came back to her while she testified in Washington D.C., and allowed her to give voice to the values that had been excluded in previous decision processes:

> The Tribe has a tradition of oral history and sharing, [and] that's important because for me personally, when I was growing up… my grandmother from the time that I was like three or four would tell me stories only and she would tell them over and over again. And that was her way to ensure that the cultural knowledge was retained and kept in my mind and that I would know what happened... But the key here is that when I was a Fisheries Director for the Tribe and I was going to D.C. and talking with the Congressman and other key people, the key was is that when I needed to talk about the Elwha – even though I was really angry, really upset because the only value [they seemed to acknowledge was electric] power – and everything that she taught me started coming out … and it was part of me telling that … these are values that you haven't included that have to be included. Because it's not just about the [hydroelectric] power. That watershed sustained our Tribe and our people for thousands of years, as well as all the key species in the watershed. And you have to have that value in there even though those values weren't part of your original decision. We're here now and you have to. [P95]

This and other sharings during interviews suggest that Klallam Tribal leaders found grounding in an Indigenous epistemology, which includes enactment of knowledge gained through such teachings. And the ways the Tribe engaged around Elwha decision-making and processes of ecosystem restoration can be understood as the enactment of their knowledge, including knowledge of their well-being, i.e., the practice of their cultural-benefits-knowledge.

It is more challenging to know when and how to apply the concept of Enacted knowledge outside of Indigenous epistemologies. The evidence available from our interviews suggests that Local Recreationists may have understood the validity of knowledge from a Positivist epistemological stance, in which the validity of knowledge is derived from objectivity, i.e., the removal of values or subjective or emotional experiences. For example, one member of the Elwha Citizen's Advisory Committee was an avid hiker, and was concerned that dam removal would negatively impact access to Olympic National Park via the Elwha Valley. When asked about how cultural benefits were communicated by interest groups to the Committee, he noted that arguments on both sides of the debate were "emotional," i.e., not objective and therefore less compelling than economic or ecological evidence. For example, comments made by representatives of the group Rescue Elwha Area Lakes "were general and they were presented by people that didn't have the academic background to do a thorough presentation and so they were emotional arguments." Similarly, in a presentation by the Lower Elwha Klallam Tribe on the cultural importance of the river, "they didn't present a good argument, they just said 'it's a cultural thing for us to have the free-flowing river'" [P12]. Local Recreationists felt personally connected to the reservoirs and campgrounds that would be lost when the dams were removed. But even those who in interviews articulated relational values arising from their connection to these places, they tended to discount emotion or descriptions of intimacy with place as valid evidence of cultural importance.

In the Elwha decision process, both groups we describe articulated their cultural-benefits-knowledge at public meetings and demonstrated these values through organization, alliance-building, and advocacy. Although non-Tribal community members may also have felt the "responsibility to act" to protect their own cultural benefits, the epistemological grounding for

these efforts was almost certainly not equivalent. Questions arise around which epistemological groundings should allow for consideration of the Enacted knowledge concept? Can the Enacted knowledge concept be applied in the same way across groups with differing epistemologies? And in terms of feasibility of Framework application, what evidence would be required to have confidence to characterize the epistemology of a group of cultural-benefits-knowledge-holders in order to draw these distinctions. Past work has shown that (re)conceptualizing ES-knowledge to include knowledge practices in addition to knowledge products opens new possibilities to recognize, respect, and integrate forms of cultural-benefits-knowledge that convey plural values arising from diverse human-nature relationships and well-beings (Hoelting et al., 2022a, 2022b). But as we begin to apply the idea in practice, we must determine when the concept of Enacted knowledge is correct and helpful, rather than misplaced and potentially harmful.

In this paper, we settled on a middle ground: we included examples of Enacted knowledge for both the Tribe and Local Recreationists; however, where a knowledge form possessed characteristics of both Enacted knowledge and Contextualized Translation, such as testimony at Senate hearings or public comment during a NEPA process, we considered how the individuals offering those statements might have thought about the knowledge. For Tribal leaders and elders, we characterized congressional testimony as Enacted knowledge, in that they were putting their cultural-benefits-knowledge into practice. In contrast, for Local Recreationists who provided public comment during the NEPA hearings, we characterized it as a Contextualized Translation, in the sense that they were "contributing to a documented record of public opinion." This may prove to be a useful strategy in the future, but further refinement, in collaboration with knowledge holders representing multiple knowledge systems, may lead to better approaches.

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4.4 Conclusion

To improve consideration of a full spectrum of cultural benefits, as they arise from multiple understandings of well-being and human-nature relationship, requires "decision-support" at multiple levels. In addition to standard approaches to ecosystem valuation that take place during technical stages of decision-making, there is also a need to recognize processes of valuation taking place at earlier, deliberative stages of decision-making. Valuation can be understood to begin with the very establishment of the decision context, for example through agenda setting and problem definition. The assumptions embedded at these earliest stages of decision-making constrain the types of cultural benefits and understandings of well-being that will be comprehensible (Dongoske et al., 2010, 2015; Hoelting et al., 2022a; Muller, 2014), and the forms of knowledge that will be considered decision-relevant and actionable, at later, more technical stages of decision-making (Hoelting & Gould, 2022).

The Opportunities Framework for Improved Integration of Cultural Benefits can be understood to offer decision-support through improved awareness of pathways and enabling factors for meaningful integration of a wider range of cultural benefits – and plural values – at all stages of decision-making. Specifically, this Framework can support systematic identification of available knowledge forms, the cultural benefits and value perspectives the knowledge forms seek to convey, and multi-faceted opportunities for their integration in decision-making, from problem definition to optimization. In current decision analysis, recognition of this full spectrum of opportunities is reinforced through improved cultural comprehension on the part of decision-makers, including increased understanding of diverse knowledge forms that have potential to communicate distinct value aspects and value perspectives. As a complementary function, retrospective case analysis can provide examples that offer roadmaps for improved consideration

of cultural-benefits-knowledge and support recognition of biases and power dynamics in existing decision contexts.

The Elwha River decision process offers an example of the incorporation of Tribal cultural-benefits-knowledge in decision-making. This was simultaneously enabled by a suite of factors, but central among them was the early and sustained involvement of the Lower Elwha Klallam Tribe in decision-making. The relative lack of barriers to meaningful consideration of Tribal cultural-benefits-knowledge offers a unique opportunity to explore a more complete set of opportunities for integration of plural values and a place-based, Indigenous knowledge system in Federal decision-making. At the same time, it is a clear example of exclusion of relational values held by another group of cultural-benefits-knowledge-holders.

This Framework does not help to resolve such conflicts between competing cultural-benefits-knowledges, or to determine who should be involved to inform decisions at each stage of decision-making. Instead, it highlights that valuation is taking place at all stages of decision-making – perhaps most importantly at the earliest stages. It raises concerns around the characterization of valuation as a technical endeavor. Such a characterization is harmful because it obscures processes revealed in the Elwha River dam removal and ecosystem restoration decision process: that problem definition sets parameters around whose cultural-benefits-knowledge will be decision-relevant at later stages of decision-making.

Future research can explore how these dynamics play out across distinct decision-contexts. The Elwha River decision process is unique in that the problem definition was clearly established by an Act of Congress. There was little room for negotiation of values at later stages of decision-making in large part because of the lack of flexibility in the resulting decision context. There may be more opportunities for meaningful consideration of diverse cultural-

benefits-knowledges at later stages of decision-making in, for example, an adaptive management context.

5. CONCLUSION

There is growing global interest around knowledge pluralism in environmental decision-making. This is linked to increasing awareness of the role of multiple knowledge systems for equity and environmental justice (Martin et al, 2016; Pascual et al., 2021), as well as for achieving successful outcomes in conservation of biodiversity and resource management (Fernández-Llamazarez et al., 2020; Garnett et al., 2018; Ogar et al., 2020; Sobrevila, 2008). In the context of ecosystem valuation specifically, scholars and decision-makers are beginning to connect the dots between knowledge pluralism, the recognition and integration of plural values of ecosystems, and the distributive, procedural, and recognitional justice of environmental management processes and actions (Díaz et al., 2015a, 2015b, 2018; Pascual et al., 2017, 2021; Tengo et al., 2014, 2017; Turnhout et al., 2014; Turnhout, 2018).

In the United States, equity and environmental justice are active policy priorities. Executive Order 14008, signed in January, 2021, gave rise to several directives linked to equity and environmental justice, including the America the Beautiful Initiative. Principle 2 of the America the Beautiful Initiative directs Federal agencies to Conserve America's Lands and Waters for the Benefit of All People, stating that "conservation and restoration of natural places should yield meaningful benefits in the lives of all Americans, and these benefits should be equitably distributed" (NCTF, 2021, p. 14). The acknowledgement that "meaningful benefits" mean different things to different Americans is a call not only for value pluralism, but for recognitional justice through knowledge pluralism. In November, 2021 a U.S. Federal Memorandum directed U.S. Federal agencies to "recognize Indigenous Traditional Ecological Knowledge (ITEK)—a form of Indigenous Knowledge—as one of the many important bodies of

knowledge that contributes to the scientific, technical, social, and economic advancements of the United States and to our collective understanding of the natural world" (White House, 2021, p 1). This Memo highlights both recognitional and procedural elements of equity in its emphasis on direct inclusion of Indigenous peoples in environmental decision-making.

However, there is a lack of clarity among decision-makers and researchers about what knowledge pluralism means in practice, and how to accomplish it. This lack of clarity is epitomized by ongoing conversations regarding the marginalization of cultural ecosystem services (CES), a.k.a. cultural benefits of ES, in decision-making. In the United States there is interest at high levels of government in improved integration of the cultural benefits of ES, as evidenced by the Federal Memorandum on Incorporating Ecosystem Services into Federal Decision Making, issued in 2015 (White House, 2015) and for which implementation guidance is still being prepared. Improving integration of CES was a core theme for the 2021 ACES (A Community on Ecosystem Services) Virtual Roundtable, a biannual gathering of policy-makers, ES scholars, and practitioners. During the Roundtable participants expressed the need for guidelines and examples of effective actions to support meaningful integration of cultural ES in decision-making, and more broadly to move toward implementation of value pluralism and knowledge pluralism in practice (Hoelting & Gould, 2021, 2022).

The organizer of the CES session at the ACES Virtual Roundtable was Kristin Hoelting, the author of this dissertation, and the conceptualization and content of the session drew heavily from this dissertation work. A Federal Policy Brief based on the CES session, prepared by Kristin Hoelting and Dr. Rachelle Gould with input from all session panelists, begins to offer guidelines and examples that can fill the need expressed by participants (Hoelting & Gould,

2022). The Policy Brief outlines the following Principles for improved integration of cultural

benefits of ES:

1. Many cultural ES are embedded in the context of valued relationships between humans and ecosystems. Cultural ES are increasingly linked to the concept of relational value(s), which are associated with meaningful relationships. Cultural ES cannot exist without communities, individuals, and the continuation of their chosen or obliged relationships with the ecosystem (these relationships can take countless forms, e.g., recreation-based, care-based, use-based, etc.).

2. A focus on plural values (i.e., multiple forms of value) can allow for fuller treatment of cultural ES in valuation. To better integrate cultural ES in valuation, we must look beyond monetary value and Western biophysical representations of value (e.g., carbon sequestered or water quantity). Other forms of value include relational value(s) and shared and social value(s). One implication of attending to multiple forms of value is improved ability to address aspects of traditional values that are currently marginalized.

3. Understanding multiple knowledge systems improves incorporation of diverse forms of value. Reductionist approaches that privilege Western science currently dominate the ES field. Incorporation of a broader array of approaches to knowledge development and integration will allow adequate treatment and incorporation of a full suite of cultural ES, and thus make space for the full meaning of the profound concept of valuation. This principle relates closely to ideas of legitimacy – i.e., what forms of data and knowledge are considered legitimate?

4. Comprehensive valuation of cultural ES must consider process (i.e., how valuation occurs). Valuation is taking place throughout decision-making, including during early, foundational phases. Valuation is, like decision-making, often iterative. Each round of valuation begins with determination of the rules or structures that will guide the exercise (e.g., defining terms and setting objectives) and continues with steps such as assigning weights or characterizing value. Decisions about these features of valuation determine what kinds of value can be expressed.

5. Comprehensive valuation of cultural ES must consider who is involved (i.e., who holds authority and/or participates) at each step. Robust engagement throughout the phases of decision-making described in Principle 4, with communities representing diverse knowledge systems, enables more accurate, comprehensive valuation. This can manifest in many ways, including providing footing for multiple knowledge systems within the structures of decision-making.

The body of work laid out in this dissertation can support application of these Principles.

It does so first in Manuscript 1 by exposing the need for this shift, e.g., what is at stake when one

knowledge system – the utilitarian and objectivist tendencies of Western science and natural

resource management – is universalized and used to validate all ES knowledge. This first piece

makes conceptual contributions by illustrating the need to (re)imagine ES-knowledge as a system

rather than solely as information, and offering more targeted terminology to clarify the

difference. Manuscript 2 makes conceptual contributions through theory-building that recognizes

a broader suite of forms of knowledge and a broader spectrum of opportunities to learn from

those knowledge forms. Further, it provides empirical evidence that knowledge pluralism is

linked to successful integration of plural values. Finally, Manuscript 3 contributes to application

by outlining and testing a Framework for systematic identification of learning opportunities and

actions to improve integration of cultural-benefits-knowledge in decision-making. These

conceptual models and the decision-support framework presented here can begin to attend to

recognitional justice needs through offering language and structure for inquiry into these

expanded possibilities.

5.1 Key Contributions and Findings:

This dissertation provides conceptual, empirical, and applied contributions to the

literature on ES-knowledge. Here we summarize core conceptual contributions and empirical

findings arising from these three Manuscripts, discuss limitations of this work and next steps for

future research, and offer some final concluding remarks.

5.1.1 Conceptual Contributions:

1. Clarifying the terminology around ES-knowledge, and conceptualizing cultural-benefits-
   knowledge: The term ES-knowledge has been used informally to refer to written or

   quantitative documentation of ES-knowledge-claims arising from Western scientific

   research approaches. This conflation of information and knowledge has functioned to

constrain our collective imagination around possibilities for ES-knowledge that may take on varied forms. To break open additional imaginative space, in Manuscript 1 we clarify that **ES-knowledge** can more accurately be defined as "the assumptions that guide how we claim knowledge of both ecosystems and well-being." In turn, **ES-knowledge-claims** can be defined as "Understandings of ecosystems and well-being validated within their epistemology of origin." Finally, **ES-knowledge-forms** can be defined as "Means of conveying ES-knowledge-claims that can be mobilized or translated to inform decision-making." These definitions are inclusive of but not restricted to knowledge conveyed in the form of scientific knowledge products.

ES-knowledge encompasses both how we know ecosystems (services-knowledge) and well-being linked to ecosystems (benefits-knowledge). As one element of ES-knowledge, **cultural-benefits-knowledge** is how we know the cultural benefits of ecosystems, which can further be specified as "ecosystems' contributions to human well-being in terms of the identities they help frame, the experiences they help enable, and the capabilities they help equip" (Fish et al., 2016, p. 212).

2. The importance of conceptualizing knowledge-as-practice alongside the concept of knowledge-as-product: A core insight arising from the Critical Interpretive Synthesis of environmental management literature described in Manuscript 2 was the importance of paying attention to knowledge practices as means of conveying cultural-benefits-knowledge. Many cultural benefits of ES – particularly those grounded in relational value aspects or holistic value perspectives – are often best communicated and comprehended through direct, embodied engagement with ecosystems or context-specific narrative or

ceremonial knowledge forms, rather than through abstracted, universalized scientific documentation (e.g., Chan et al., 2012; Fish et al., 2016; Martinez, 2016, 2021; Raymond et al., 2018; Wilson, 2008).

3. <u>Recognizing a more complete suite of opportunities for integration of ES-knowledge</u>: Recent literature on ES-knowledge-use has been based on the concept of ES-knowledge as a scientific product (Posner et al., 2016; McKenzie et al., 2014; Posner et al., 2016; Weiss 1977, 1979, 1999). When investigations into the knowledge-policy interface depart from a limited concept of available knowledge forms, they may similarly result in limited understanding of opportunities for meaningful integration of cultural-benefits-knowledge. The Opportunity Map presented in Manuscript 2, building from our synthesis of environmental management literature, considers areas of opportunity for integration of all forms of cultural-benefits-knowledge described in the Typology of Cultural-Benefits-Knowledge-Forms. Representing and documenting cultural-benefits-knowledge through scientific research is only one Area of Opportunity to learn from cultural-benefits-knowledge, which we term Translation to Product. In addition, we describe two additional Areas of Opportunity: the direct involvement of cultural-benefits-knowledge holders in management and governance (Procedural Inclusion) and supporting decision-makers' recognition, comprehension, and respect for multiple human-nature relationships and well-beings (Cultural Comprehension).

5.1.2 *Empirical Findings*

1. <u>Enacted and contextualized knowledge forms were more likely to convey relational values or holistic value perspectives:</u> An important finding that emerged from the Critical Interpretive Synthesis of environmental management literature presented in Manuscript 2

is that relationally-valuable, non-instrumental categories of cultural benefit were more likely to be conveyed through Enacted knowledge and Contextualized Translations, rather than through Abstracted Translations. This finding aligns with past systematic reviews that have found only those cultural benefits categories most easily imagined as instrumentally-valuable, such as recreational and aesthetic value, to be commonly included in Abstracted approaches to ES assessment (Gould et al., 2019a; Milcu et al., 2013). This is particularly problematic when such Abstracted Translations are envisioned as the primary pathway for integration of ES-knowledge in decision-making.

The Elwha River dam removal and ecosystem restoration decision process analyzed in Manuscript 3 further strengthens this finding. We selected two groups of cultural-benefits-knowledge-holders for detailed analysis who articulated relationally-valuable cultural benefits (Recreationists Opposed to Dam Removal) or who held a holistic value perspective regarding the interconnected instrumental, relational, and intrinsic values of the Elwha River (the Lower Elwha Klallam Tribe). In both cases, our analysis offers evidence that holistic value perspectives and relational value aspects are best conveyed through Enacted knowledge forms and Contextualized Translations. We did not identify any examples of Abstracted Translations offered by Local Recreationists to convey their relational values to decision-making. The few examples of Abstracted Translations submitted to decision-makers by the Tribe were offered with clear caveats about their inability to convey the full value of the Elwha River.

In our literature review, we found that some authors did attempt to include non-instrumental cultural benefits such as knowledge systems and cultural identity in Abstracted Translations, for example by suggesting that rates of subsistence harvest can serve as a proxy for maintenance of knowledge systems. However, reliance on indicators more easily treated as instrumentally-valuable obscures the richer meaning of subsistence lifeways and associated knowledge systems (Kenny & Chan, 2017). In this sense, Abstracted Translation of cultural-benefits-knowledge is concerning in the same way that efforts to integrate traditional ecological knowledge in natural resource management have been critiqued as extractive: managers and decision-makers are interested in data points but tend to ignore the larger cultural context in which those data are embedded, and which should guide appropriate interpretation and use of those data (Nadasdy, 2003; Salomon et al., 2018).

2. <u>Enacted knowledge forms and Contextualized Translations can be Integrated through Procedural Inclusion and Cultural Comprehension Areas of Opportunity</u>: In the analysis of Elwha River decision process presented in Manuscript 3, we found that the Tribe conveyed the holistic meaning of the Elwha River, in the sense of the inseparability of the ceremonial, cultural, spiritual, and economic importance of the river as a foundation for their lifeways (DOI, 1994b, p. 205), through diverse forms of Enacted knowledge and Contextualized Translations. Similarly, the relational values articulated by Recreationists Opposed to Dam Removal were communicated through Enacted and Contextualized forms. In both cases, Contextualized Translations commonly informed the Cultural Comprehension Area of Opportunity, and Enacted knowledge forms were integrated

through both the Procedural Inclusion and Cultural Comprehension Areas of

Opportunity.

3. <u>Relational Value Aspects and Holistic Value Perspectives, as Communicated via Enacted</u>

<u>Knowledge and Contextualized Translation, are Important at all Stages of Decision-</u>

<u>making but May be Most Influential at Early Stages</u>**:** In the Elwha River analysis

(Manuscript 3) we found that, although examples of all forms of cultural-benefits-

knowledge were offered throughout stages of decision-making, they were most

influential at early stages of decision-making. Foundational processes of valuation, in

terms of embedding priorities and understandings of well-being in problem definition and

objectives for management, set the parameters for meaningful inclusion of cultural-

benefits-knowledge at later stages. This finding echoes other authors and principles of

engagement that call for early involvement of multiple knowledge systems in decision-

making processes (e.g., Chief et al., 2016; Garvie, 2009; Hill et al., 2012; Richardson,

2016; Vaughan, 2018).

5.2 Limitations of this Work

As described in Manuscript 2, two important limitations of this work must be mentioned.

First, the Critical Interpretive Synthesis process through which we built our conceptual models

relied on written articles that either document and describe environmental decision-making

processes, or explicitly offer information intended to inform such processes. Therefore, our

exposure to diverse knowledge forms was primarily mediated through textual descriptions.

While we uncovered important patterns around the cultural benefits categories most commonly

conveyed by diverse knowledge forms, we did not have direct access to oral, visual and

embodied knowledge forms that would convey more nuance and meaning than is possible to

translate into written text form (Kovach, 2009; Martinez, 2021; Wilson, 2008). However, it is of note that during the Critical Interpretive Synthesis process, the lead author was concurrently engaged in case study data collection about how cultural-benefits-knowledge informed decision-making associated with Elwha River dam removal and ecosystem restoration. Many examples of knowledge forms encountered in the literature review found parallels in the Elwha decision process, and this more direct, on-the-ground exposure brought added dimension and color to interpretation of textual examples. Future case study research can allow for continued and deepened constant comparison (Corbin & Strauss, 2015; Creswell, 2007) of empirical evidence against the original conceptual models arising from this Critical Interpretive Synthesis.

Second, this body of work was originally inspired by the 2015 United States Federal Memorandum on ES (White House, 2015). For the literature review (Manuscript 2) we therefore targeted our article selection and analysis toward examples of how cultural-benefits-knowledge can intersect with environmental decision-making in the context of formal institutions that often hold authority over management of land, water, and natural resources in modern nation states. Our focus on existing institutions may exclude knowledge forms and possibilities for their consideration that currently exist or could exist in other governance arrangements.

These limitations underscore the importance of future refinement of these conceptual models and proposed Framework in collaboration with cultural-benefits-knowledge-holders representing diverse worldviews. We envision that this can be accomplished through additional case study research, allowing in-depth engagement and observation of cultural-benefits-knowledge across varied decision contexts, and workshop application of the Opportunities Framework with decision-makers and knowledge holders to refine concepts and approaches.

5.3 Next Steps for Research and Application

A primary goal of this dissertation has been to crack open new lines of inquiry surrounding ES-knowledge that have previously been closed off due to lack of necessary conceptual foundations. Therefore, in addition to offering unique contributions to the field of ES and ecosystem valuation, this research raises many new questions that provide fertile ground for future research. Equitable and beneficial application of the Framework presented in this dissertation will require answers to these questions.

1. Improving Integration of Knowledge Pluralism in Existing Tools and Frameworks: In highlighting past inattention to knowledge forms in ES theory, this body of work raises the need for updates to other conceptual frameworks such as Fish et al. (2016)'s CES Framework for Research and Critical Engagement, and the Nature's Contributions to People (NCP) Framework. Fish et al. (2016) advance CES theory by highlighting the co-production of cultural benefits in the context of relationships between humans and ecosystems. They briefly acknowledge linkages to questions of ontology, and note that cultural benefits require new epistemologies. However, their Framework remains confined to consideration of ES-knowledge-products, rather than imagining a greater range of possibilities through which cultural-benefits-knowledge can inform decision-making, including through direct involvement of knowledge holders in ecosystem management and related processes of institutional work to create rules that allow for this engagement.

    Similarly, the NCP Framework acknowledges the importance of multiple knowledge systems, but in many ways this acknowledgement feels limited to surface terminology.

For example, Díaz et al. assert that the diversity of human-nature relationships and well-beings can be recognized in the NCP Framework through the naming of Framework components, for example by exchanging "ecosystem services" for "nature's gifts," "ecosystems" for "Mother Nature," or "well-being" for "Living in harmony with nature / Living-well in balance and harmony" (Díaz et al., 2015a, 2015b). And yet, merely renaming Framework components fails to meaningfully shift conceptualizations of knowledge-as-product toward the inclusion of knowledge-as-practice, or to dislodge anthropocentric emphasis on human well-being (Borie & Hulme, 2015; Kenter, 2018). Future research can explore how these models could more directly incorporate knowledge pluralism, including acknowledging diverse forms of knowledge and varied opportunities for knowledge to inform decision-making. A core challenge is to establish a more meaningful role for knowledges that resist separation of human well-being from the well-being of nature.

2. <u>Conceptual Refinements around Enacted Knowledge:</u> Further research is needed to clarify theory and application of the concept of Enacted knowledge. The Critical Interpretive Synthesis presented in Manuscript 2 calls attention to knowledge-as-practice as an important addition to theories of ES-knowledge. We demonstrated that, in the environmental management literature reviewed, Enacted forms of cultural-benefits-knowledge were more likely to convey intangible and relationally-valued cultural benefits such as cultural identity, knowledge systems, and the ability to seek to live in responsible relationship to nature. Enacted knowledge forms are also linked to broadened possibilities for integration of cultural-benefits-knowledge.

Whereas Translated knowledge is about documentation of benefits, Enacted knowledge forms such as Management Proxies and Institutional Proxies enable groups of cultural-benefits-knowledge-holders to identify management and governance approaches that align with their well-being, without the need to always characterize their well-being. This is particularly important in settler-colonial societies in which decision-makers may fail to recognize and comprehend the cultural benefits of non-dominant communities, when the full meaning of cultural benefits and well-being resists written or quantitative documentation, or when knowledge holders perceive potential for negative consequences or have experienced past negative consequences in making their cultural benefits knowable to those in power (e.g., Davies et al., 1999; Smith et al., 2003).

And yet, the concept of Enacted knowledge has the potential to be misapplied and to cause further marginalization of the knowledge systems it seeks to recognize and integrate. Questions arise around when Enacted knowledge is relevant. Can it be applied equally across all groups of cultural-benefits-knowledge-holders, even to those groups who do not understand knowledge as a practice of responsibilities? For example, in the Elwha River dam removal decision-process, members of the Lower Elwha Klallam Tribe spoke about ceremonial and everyday practices core to their identity and cultural survival that were no longer possible to practice because of the dams. Individuals from the non-tribal community in Port Angeles both dismissed these knowledge offerings as emotional and subjective and strategically emulated this language, arguing that their experiences at the reservoirs and adjacent campgrounds were central to their culture. In general, cultural benefits arise through creative, ceremonial, celebratory and everyday practices (Fish et

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al., 2016). But is it appropriate to understand all practice as legitimate expression of Enacted knowledge, regardless of whether an individual or group's epistemological tradition includes or recognizes knowledge-as-practice? And if not, what standards could be used to determine who should be represented using this approach?

3. Improving Integration of Knowledge Pluralism in Existing Tools and Frameworks: In highlighting past inattention to knowledge forms in ES theory, this body of work raises the need for updates to other conceptual frameworks such as Fish et al. (2016)'s CES Framework for Research and Critical Engagement, and the Nature's Contributions to People (NCP) Framework. Fish et al. (2016) advance CES theory by highlighting the co-production of cultural benefits in the context of relationships between humans and ecosystems. They briefly acknowledge linkages to questions of ontology, and note that cultural benefits require new epistemologies. However, their Framework remains confined to consideration of ES-knowledge-products, rather than imagining a greater range of possibilities through which cultural-benefits-knowledge can inform decision-making.

Similarly, the NCP Framework acknowledges the importance of multiple knowledge systems, but in many ways this acknowledgement feels limited to surface terminology. For example, Díaz et al. assert that the diversity of human-nature relationships and well-beings can be recognized in the NCP Framework through the naming of Framework components, for example by exchanging "ecosystem services" for "nature's gifts," "ecosystems" for "Mother Nature," or "well-being" for "Living in harmony with nature / Living-well in balance and harmony" (Díaz et al., 2015a, 2015b). And yet, merely

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renaming Framework components fails to meaningfully shift conceptualizations of knowledge-as-product, or to dislodge anthropocentric emphasis on human well-being (Borie & Hulme, 2015; Kenter, 2018). Future research can explore how these models could more directly incorporate knowledge pluralism, including acknowledging diverse forms of knowledge and varied opportunities for knowledge to inform decision-making. A core challenge is to establish a more meaningful role for knowledges that resist separation of human well-being from the well-being of nature.

4. <u>The Challenge of Making Knowledge Systems "Knowable":</u> Questions about the Enacted Knowledge concept are intertwined with questions about how to assess the epistemological grounding of an individual or group in practice. In the Elwha case study described in Manuscript 3, data collection was geared toward understanding the ways in which the Elwha was linked to respondents' well-being, with particular interest in cultural benefits. A limitation of our data collection was that we did not explicitly seek to uncover information about respondents' epistemologies, though interviews did provide some clues regarding their perspectives on knowledge. This included their evidence of forms of knowledge they deemed valid, and whether knowledge is held and offered individually or collectively. However, this evidence was insufficient to definitively characterize the epistemologies of the groups of cultural-benefits-knowledge-holders we encountered. Future case study data collection should focus more on understanding the variation in epistemological groundings across relevant parties. For example, this could be accomplished in current decision assessment using an approach such as the Record of Engagement (RoE) described by Glynn et al. (2018). However, the process may be more

difficult in retrospective analyses that rely on interviews and review of historical

documentation.

Stepping back from Framework application, the very need to assess and characterize

epistemological groundings raises concerns around who or what is served by making

one's epistemology "knowable" to those in power. The same question arises around when

cultural-benefits-knowledge-holders may choose to make their ontological and

axiological groundings knowable, in the sense of detailing their understandings of nature,

human-nature relationships, and well-being. In principle, making knowledge systems

more knowable can improve equity when decision-makers recognize and respect diverse

knowledge systems and respectfully engage with the forms of valid knowledge arising

from those systems. And yet there are many reasons why individuals or groups may

choose not to reveal the inner workings of their knowledge systems. The double-edged

character of increased transparency of knowledge systems is articulated well by Glynn et

al. (2018) in their discussion of the RoE approach:

> Given all the possible conflicting interests, there are many reasons why
> individuals or the constituencies that they represent would be unwilling or
> reluctant to have transparency on their negotiating positions. Additionally,
> transparency is often prized in science, but it is difficult to ask people to be
> transparent about their beliefs, their emotions, or more generally to be willing to
> reveal [them]. And there are many good reasons (in addition to costs) not to have
> transparency that could violate rights of privacy, proprietary information,
> community or individual security, or that could be deleterious to the "sacred
> values" of individuals or constituencies. (p. 3)

These concerns call for development of Principles around application of a Framework

such as the one outlined in this dissertation that ensure prior and informed consent and proper

protection measures for holders of traditional knowledge. Principles could follow the example of

efforts such as the Akwé: Kon Voluntary Guidelines for the Conduct of Cultural, Environmental, and Social Impact Assessments developed by the parties to the Convention on Biological Diversity (Secretariat, 2004), including the need for consideration of whether Framework application may have impacts on (a) continued customary use of biological resources; (b) the respect, preservation, protection and maintenance of traditional knowledge, innovations and practices; (c) Protocols; (d) Sacred sites and associated ritual or ceremonial activities; (e) Respect for the need for cultural privacy; and (f) the exercise of customary laws (p. 14). As articulated by a Tribal leader who offered comments on a draft of the Framework presented in this dissertation, robust relationship between decision-makers and knowledge holders should be a prerequisite for its application, including ensuring that application of the Framework is desired by groups of cultural-benefits-knowledge-holders.

5.4 Parting thoughts

Decision-makers need tools and approaches to both understand what knowledge pluralism can mean in environmental research and management, and to move toward implementation. In this dissertation, I seek to lay foundations for implementation of knowledge pluralism, specifically in the context of ES theory and practice. My work culminates in the Opportunities Framework for Improved Integration of Cultural Benefits, which offers a systematic approach for recognizing: a) the diverse forms of cultural-benefits-knowledge; b) the multiple knowledge systems from and within which they arise; and c) opportunities for learning from those knowledge forms, at the level of both individual decision-makers and institutions.

This type of Framework may serve as a bridge for natural resource managers and decision-makers who see the need for knowledge pluralism but feel constrained by existing agency processes. Having taken the first step of explicitly recognizing the forms of cultural-

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benefits-knowledge that are available to inform decision-making, the Framework enables identification of two separate Opportunity Lists. Opportunity List 1 is made up of actions that can be taken now, within the existing decision contexts. At the same time, Opportunity List 2 details actions that would improve integration of marginalized cultural-benefits-knowledge, but to do so would require institutional adjustments, e.g., the ability to revisit core definitions. This process reveals and underscores how valuation exercises carried out at technical phases of decision-making are incomplete, in that they fail to account for processes of valuation at earlier stages of decision-making that set parameters for engagement at later stages (Hoelting & Gould, 2022; Muller, 2014).

As a whole, this body of work seeks to move toward guidance for real-world application of knowledge pluralism in decision-making. It makes important contributions to application by proposing a template for understanding opportunities to integrate cultural-benefits-knowledge. The conceptual models and decision-support Framework presented in this dissertation will need to be refined in collaboration with representatives of multiple knowledge systems. As part of this process, principles will need to be developed to guide Framework application to ensure that it succeeds in moving toward recognitional justice and does not cause unintended harm. This work is offered with awareness of the challenges and potential pitfalls in using a framework built on Western philosophical assumptions as a platform for inclusion of knowledge forms and plural values arising across diverse knowledge systems. And it is offered in the spirit of creating cross-cultural space in both the ES approach and in the decision-making processes it seeks to inform (e.g., White House, 2015, 2021).

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Appendix A: Stages of Sampling and Analysis

Sampling and analysis take place concurrently and iteratively in Critical Interpretive Synthesis, drawing from the methods of Grounded Theory (Creswell, 2007; Corbin & Strauss, 2015). This section details the relationship between stages of sampling, article screening, and stages of analysis. Table A1 traces the distinct samples we developed and utilized at different stages of analysis. For a full description of sampling stages see Appendix A1. For a full description of analysis stages (coding and synthesis) see Appendix A2.

Table A1: Evolution of Article / Knowledge Form Samples Informing Stages of Analysis

Sampling Stage	Sample Developed	Unique Articles or Books	Unique Knowledge Forms	Analysis Stage(s)
Stage 1	**Full Sampling Frame**, i.e., Database of Potentially Relevant Articles	5,083	n/a	n/a
Stages 2 & 3	**All Included Articles & Books** (174 from Original Database + 8 Records from Theoretical Sampling)	182	n/a	**Stage 1** (Text Extraction) and **Stage 2** (Knowledge Forms)
Stage 4	**Knowledge Form Sample**	180	495	**Stage 3** (Cultural Benefits Categories)
Stage 5	**Knowledge Form Sub-Sample**	85	179	**Stage 4** (Intersections with Decision-making)

A1 Sampling Stages

We followed a five-stage sampling approach to identify the purposive sample(s) that informed distinct stages of analysis and the final synthesis. As detailed in Table A1, the process

included development of a sampling frame, i.e., a database of potentially relevant articles (Sampling Stage 1), a screening process to generate a smaller purposive sample of relevant articles and a supplemental theoretical sampling process (Sampling Stages 2 and 3), and finally development of a database of distinct knowledge forms derived from the included articles and books (Sampling Stages 4 and 5).

A1.1 Stage 1 Sampling – Database of Potentially Relevant Articles

As a starting point (**Stage 1 Sampling**), we built a database of potentially relevant articles – including several books – to serve as an initial sampling frame. This involved development of two keywords lists and consultation with Colorado State University reference librarians to identify relevant databases and design our search strategy (Appendix B). The resulting database contained 5,083 distinct search results.

A1.2 Stage 2 Sampling – Article Screening

Stage 2 Sampling involved screening of articles for inclusion or exclusion, and overlapped with Analysis Stage 1 (Appendix A2). We began our article screening process with an interrater reliability exercise, in which two of us (K.R. Hoelting and J.M. Morse) independently screened and rated a random selection of 250 search results from the database of potentially relevant articles. As a starting point, our primary screening criteria were that a search result must a) discuss one or more cultural benefits arising from human relationship to the natural world, and b) elucidate how knowledge of this cultural benefit has – or could – inform environmental decision-making. The two of us then came together to discuss discrepancies in our assessment of relevance. We presented questions and proposed resolutions to the full review team, and together the group outlined final inclusion criteria (see Appendix C for a full list of final screening criteria). Based on this guidance, the lead author (K.R. Hoelting) proceeded alone

with the remainder of the screening process. We proceeded with screening and extraction of relevant text until we had reached saturation of key themes, at which point we stopped reviewing additional articles. This occurred after we had screened a randomly selected 925 records from the original database, of which we included 174 articles and books.

A1.3 Stage 3 Sampling – Supplemental Theoretical Sampling

The originators of the Critical Interpretive Synthesis method, Dixon-Woods et al. (2006), describe the need for theoretical sampling as a supplement to screening of articles identified through the database of potentially relevant articles described in Sampling Stages 1 and 2. This is important given that the purpose of Critical Interpretive Synthesis is "the development of concepts and theory rather than on exhaustive summary of all data" (p. 3).

In our case, we required theoretical sampling to support our understanding of Indigenous epistemologies. Although there were many examples of Indigenous knowledge in the environmental management case studies within the original database, we encountered relatively little discussion of Indigenous epistemologies: only three out of 174 included search results spoke directly to Indigenous research methods and knowledge forms. Therefore in **Stage 3** of our sampling process we drew on these three articles – Denny & Fanning (2016), Latulippe (2015), and McGregor (2004) – as a point of departure for theoretical sampling. Through review of the citations in these three articles we added eight additional books and articles explicitly focused on Indigenous epistemologies. This theoretical sampling improved our capacity to comprehend and recognize a more complete spectrum of knowledge forms during coding (Stage 2 Analysis, Appendix A2.2), and informed the development of our Typology of Cultural-Benefits-Knowledge-Forms (Main Text, Section 3.3.1.1; See also Appendix E1). With the addition of

these eight records through theoretical sampling, our final sample of Included Articles and Books amounted to 182 (Table A1; see also Appendix D for full citations).

A1.4 Stage 4 Sampling – Knowledge Forms

Once we had identified the final sample of included articles and books as a basis for synthesis, during **Stage 4 Sampling** our attention turned toward knowledge forms as the primary unit of analysis for the Critical Interpretive Synthesis. During coding, a single article/book from the sample of Included Articles & Books (Table A1) yielded, on average, 2 or 3 distinct knowledge forms. We created a separate record for each individual knowledge form identified through review of all included articles and books, resulting in a total of 495 knowledge form records for further analysis (Knowledge Form Sample, Table A1).

A1.5 Stage 5 Sampling – Sub-Sample of Underrepresented Cultural Benefits

Beginning with the full Knowledge Form Sample (Stage 4 Sampling; Table A1), **Stage 5 Sampling** involved the identification of a targeted sub-sample of 179 distinct knowledge form records (Knowledge Form Sub-Sample, Table A1). This sub-sample isolated knowledge forms that conveyed two underrepresented cultural benefits categories: Knowledge Systems and Cultural Identity. In later stages of analysis, we carried out targeted analysis of this sub-sample with the goal of understanding opportunities for more meaningful consideration of these marginalized cultural benefits in decision-making. This process is further described in Stage 4 Analysis (Appendix A2).

A1.6 Appendix A1 References

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  Nova Scotia, Canada: Setting the stage for collaborative co-existence. Int. Indig. Policy J.
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Dixon-Woods, M., Cavers, D., Agarwal, S., Annandale, E., Arthur, A., Harvey, J., Hsu, R., Katbamna, S., Olsen, R., Smith, L., Riley, R., Sutton, A.J., 2006. Conducting a critical interpretive synthesis of the literature on access to healthcare by vulnerable groups. BMC Med. Res. Methodol. 6, 35.

Latulippe, N., 2015. Bridging parallel rows: Epistemic difference and relational accountability in cross-cultural research. Int. Indig. Policy J. 6, 7.

McGregor, D., 2004. Coming full circle: Indigenous knowledge, environment, and our future. Am. Indian Q. 28, 385-410.

Moat, K.A., Lavis, J.N., Abelson, J., 2013. How contexts and issues influence the use of policy-relevant research synthesis: A critical interpretive synthesis. Milbank Quarterly 91, 604-648.

A2 Analysis Stages

Analysis (coding and synthesis) took place in five iterative and successive stages. The synthetic constructs that emerged during earlier stages of analysis provided a foundation for subsequent stages. All final codebooks can be viewed in Supplemental Materials, Appendix E.

A2.1 Stage 1 Analysis – Text Extraction

Stage 1 Analysis took place concurrently with the screening process, as described in Appendix A1. We built an excel database to track inclusion and exclusion decisions. As part of this process, we summarized each article and developed a set of categories, i.e., Provisional Codes (Saldaña, 2009), to focus extraction of potentially relevant textual data from included articles (Boyko et al., 2012; Contandriopoulos et al., 2010). We included one column in the database for each exploratory category. Throughout the screening process, new columns were added as we identified additional concepts we felt may be relevant to later stages of analysis.

Some categories were related to development of new synthetic constructs, such as "knowledge forms," "knowledge pathways," and "barriers and enabling factors" for meaningful consideration of cultural benefits knowledge. Other columns were intended to capture text relevant to constructs drawn from past theory, such as "modes of knowledge use" (McKenzie et al., 2014) and "phases of decision-making" (Brest & Krieger, 2010).

A2.2 Stage 2 Analysis – Knowledge Forms

Stage 2 Analysis was initially focused on our first guiding research question, "In what forms is cultural-benefits-knowledge conveyed to inform environmental decision-making, i.e., articulated, demonstrated, identified, measured, and/or represented?" We sought to understand the diversity of cultural-benefits-knowledge-forms present in the full Knowledge Form Sample (Table A1) and how these knowledge forms may be linked to communication of particular cultural benefits categories. As a first cycle coding method, we used Holistic Coding (Saldaña, 2009) to identify potentially relevant characteristics of knowledge forms. This took place concurrently with the process of dataset transformation described in Appendix A1.4, Sampling Stage 4. We then used Theoretical Coding as a second-cycle coding method, which involves identifying a core category that serves as "an umbrella that covers and accounts for all other codes and categories formulated thus far in grounded theory analysis" (Saldaña, 2009, p. 163). This enabled development of synthetic constructs supporting a draft Typology of Cultural-Benefits-Knowledge-Forms.

Finally, we re-coded our dataset to link each knowledge form record to knowledge forms in our typology. Through this process of constant comparison, we refined our knowledge form categories to better account for all cases in our dataset. Our final Typology of Cultural-Benefits-

Knowledge-Forms (Main Text, Section 3.3.1.1; see also Appendix E1) served as a basis for Stages 3 and 4 of Analysis.

Also during Stage 2 Analysis, an additional set of synthetic constructs emerged that addressed our second guiding research question, "How can these knowledge forms meaningfully inform decision-making processes?" We came to refer to these emergent constructs as "Knowledge Pathways." During re-coding of the full Knowledge Form Sample, we made note of instances when a particular knowledge form involved one of the pathway types we identified, including Knowledge Product Pathways and Knowledge Practice Pathways (Main Text, Section 3.3.2.1; see also Appendix E3). These synthetic constructs allowed us to explore a greater diversity of avenues through which cultural-benefits-knowledge can meaningfully inform environmental decision-making.

A2.3 Stage 3 Analysis – Cultural Benefits Categories

During **Stage 3 Analysis** we drew on textual data extracted during Stage 1 Analysis to refine definitions for cultural benefits categories. Our analysis of textual excerpts led to 15 final categories of cultural benefits (Appendix E2). Using these revised cultural benefits code categories, we re-coded the full Knowledge Form Sample (Table A1; see also Appendix A1.4). Linking cultural benefits categories to each knowledge form in our sample allowed us to explore which knowledge forms were most likely to convey particular cultural benefits categories (Main Text, Section 3.3.1.2). As elaborated in Appendix B1, we designed the keyword sets for our database search based on review of numerous past typologies of cultural services and benefits, including conversations about the Nature's Contributions to People (NCP) framework and the mediating role of cultural context and practice in the production and perception of ecosystem services (Díaz et al., 2018; Fish et al., 2016; UKNEA, 2014). We included keywords related to

all cultural benefits categories encountered in past typologies, in addition to keywords that triggered discussion of value pluralism and knowledge pluralism, including relational value, holistic value, and multiple knowledge systems or ways of knowing (see Appendix B1, Keyword Set 2).

A2.4 Stage 4 Analysis – Intersections with Decision-making

During **Stage 4 Analysis** we drew on textual excerpts (Stage 1 Analysis) relevant to how underrepresented cultural benefits categories were envisioned or demonstrated to intersect with decision-making. By underrepresented, we mean those categories of cultural benefit identified in Section 3.3.1.2 as *least likely, by proportion* to be effectively conveyed through commonly accepted Western scientific ES knowledge products, i.e., Abstracted Translations. We selected two cultural benefits categories – Knowledge Systems and Cultural Identity – for analysis in this stage because a) they were the categories least likely to be conveyed through Abstracted knowledge forms in our sample and b) they are among the categories most consistently linked to value pluralism, i.e., relational value aspects and holistic value perspectives.

Using the Knowledge Form Sub-Sample (Table A1, Appendix A), which reduced the full Knowledge Form Sample to only those 179 knowledge form records that we identified as conveying Knowledge Systems or Cultural Identity benefits, we explored: 1) phases of decision-making where these underrepresented cultural benefits categories intersected (Main Text, Section 3.3.2.1); and 2) barriers and enabling factors for their meaningful consideration (Main Text, Section 3.3.2.2).

For exploration of barriers and enabling factors we utilized Open Coding as a first-cycle coding method and Axial Coding as a second-cycle method (Saldaña, 2009). Resulting themes

are presented in the Main Text, Section 3.3.2.2, Tables 2 and 3, as well as the Final Codebook (Appendix E4).

As a coding structure to explore phases of decision-making, we looked to existing frameworks. We initially conceptualized decision-making according to the phases of structured decision-making, including problem definition, objective setting, development of evaluation criteria, estimation of outcomes, and evaluation of trade-offs (e.g., Allen et al., 2011). However, given the diversity of decision-making contexts included in our literature sample, there were many instances in which decisions were not geared toward trade-off analysis. For example, cultural-benefits-knowledge was also used to meet evidence requirements for designation of Traditional Cultural Properties (Boggs, 2002; Brown, 2016), support Aboriginal land claims (Blowes, 1991; Schreiber, 2013; Shepherd, 2008), understand the likelihood of public support for particular decision alternatives (Falk-Andersson et al., 2015; Vucetich et al., 2012), or to decide how to interpret archaeological evidence or National Park history (Almlie, 2011; Marek-Martinez, 2016; Martinez, 2006). Through our coding process, we therefore found that a more comprehensive and consistent distinction could be made using concepts of single-, double-, and triple-loop learning (Pahl-Wostl, 2009). *Single-loop learning* is defined as slight adjustments to technical understandings and approaches that do not challenge accepted ways of framing the problem or objectives; *Double-loop learning* involves reflecting on whether goals and objectives need to be adjusted to better account for diverse values and knowledges; *Triple-loop learning* involves adjustment of the very structures that guide decision-making. We used these categories (Appendix E3) to code all records in our Knowledge Form Sub-sample (Table A1; see also Appendix A1.5). This allowed us to explore points of intersection between diverse cultural-

benefits-knowledge forms and environmental decision-making across phases of decision-making (Main Text, Section 3.3.2.1).

A2.5 Stage 5 Analysis – Synthesizing Argument

Finally, during Stage 5 analysis we considered the themes and constructs that emerged from Analysis Stages 1-4 (Main Text, Sections 3.3.1-3.3.2) to derive a map of Areas of Learning Opportunity (Main Text, Section 3.4, Fig. 3.5).

A2.6 Appendix A2 References

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Appendix B: Database of Potentially Relevant Articles

This Appendix describes the development of the Keyword Sets we used in our database search (Appendix B1), as well as a list of the databases searched (Appendix B2).

B1 Keyword Sets

We built our database search around two keyword lists. Keyword Set 1 includes terms associated with environmental decision-making and ecosystem management, and Keyword Set 2 is comprised of terms related to the cultural importance of the natural world. The goal of combining these two keyword sets was to identify documents that both: 1) address aspects of the cultural value of ecosystems and/or the cultural knowledge influencing awareness/perception of this value, and 2) relate this information to environmental decision-making.

The ecosystem management keyword list (Set 1) includes terms related to the management, policy, planning, decision-making, or governance of a diverse range of ecosystems. The list begins with general concepts, such as environmental, natural resource, ecosystem, land, and water management, and goes on to list more specific ecosystem or landscape types, such as river or riverine, estuary or estuarine, ocean, coastal, or marine, and farmland, rangeland, or agricultural lands. We felt this was important to capture papers focused on more specific ecosystems or resource types, given that their text may not include general terms in spite of their relevance. We also included terms to capture documents discussing biodiversity policy, ecosystem conservation and restoration, and management of a variety of protected area designations.

We designed the cultural importance keyword list (Set 2) to reflect evolving discussions around categories of cultural ecosystem services (CES) (Gould & Lincoln, 2017), including conversations about the Nature's Contributions to People (NCP) framework and the mediating

role of cultural context in the production and perception of ecosystem services (Díaz et al., 2018). We conceptualize cultural benefits knowledge as an intersection between the assigned or contextual value associated with valuation activities, and our cultural knowledge, including worldviews and transcendental/moral/held values (Kenter et al., 2015; Chan et al., 2018). It is critical to integrate these elements under the umbrella of cultural benefits knowledge, given that one's cultural knowledge determines their understanding of human-nature relationship and their perceptions – and assignment – of value and benefit (Díaz et al., 2018; Gavin et al., 2018; Jax, 2016).

We began compiling Keyword Set 2 by reviewing published typologies of CES categories. Gould and Lincoln (2017) reviewed and consolidated 12 different CES typologies and suggested several additional CES categories based on emergent themes in their research. Our keywords operationalize their final list, which includes the following categories: spiritual, recreation, aesthetic, artistic, cultural heritage, education, social capital/relations, sense of place, existence, knowledge systems, cultural diversity, identity, bequest, ingenuity, life teaching, and perspective values. In addition, we included keywords related to subsistence, health/healing, and intrinsic value. Milcu et al. (2013) and Raymond et al. (2009) both include intrinsic value within the umbrella of CES. In addition, growing attention to plural human-nature relationships link intrinsic value to human-nature relational models that include moral responsibilities toward nature (Arias-Arévalo et al., 2018; Díaz et al., 2018; Pascual et al., 2017; Muradian & Pascual, 2018). Chan et al. (2012) clearly identify subsistence as a CES category, and the NCP framework acknowledges the non-material contributions arising from use of ecosystems for subsistence or livelihood purposes (Díaz et al. 2018, supplemental materials). Health and healing are included

as non-material benefits/contributions by Fish et al. (2016), the UKNEA (2014), and Díaz et al. (2018, supplemental materials).

Beyond keywords associated with published CES categories, we included terms relevant to plural human-nature relationships and cultural knowledges. We sought to capture discussions of relational value (Chan et al., 2018; Jackson & Palmer, 2015), including reciprocal and kincentric relations (Kimmerer, 2011), meaningful relations (Basso, 1996) and spiritual relations (Cooper et al., 2016), as well as constitutive and eudaimonistic value (Fish et al., 2016; Jax et al., 2013; Muraca, 2016), and terms referencing non-instrumental, or "non-capitalocentric" forms of human-nature relationship (Gibson-Graham, 2006; Jackson & Palmer, 2015). For example, we included the relational concepts of "living in harmony" (Díaz et al., 2018, supplemental materials), "caring for country," and "landed citizenship" (Jackson & Palmer, 2015; Palmer, 2006). We included a selection of terms for non-Western worldviews (e.g., Inuit Qaujimajatuqangit) and holistic understandings of wellness (e.g., the Navajo concept of Hozho), and more general terminology related to: moral/ethical norms or codes (Basso, 1996); transcendental, held, and moral values (Kenter et al., 2015; Chan et al., 2018); plural knowledges and values (Lo & Spash, 2013; Tengö et al., 2014; Thorén & Stålhammer, 2018); shared, group, and social values (Kenter et al., 2015); and terms that may help capture discussion of value from the perspective of indigenous peoples. For example, we included iterations of the terms, "Tribal value*" OR "valued by the Tribe*" OR "valued by Tribes" OR "valuable to the Tribe*" OR "valuable to Tribes" OR "Tribal importance" OR "importance to Tribes" OR "importance to the Tribe," etc. Finally, we included biocentric ideas related to intrinsic or inherent value, such as the "rights of nature" (Caillon et al. 2017; Jax et al. 2013), which are important in relational models

that include moral duties or obligations toward the natural world (Arias-Arévalo et al. 2018; Muradian & Pascual, 2018).

Some keywords were much more prevalent in the literature compared to others. During a pilot search, common terms such as 'cultural value/importance', 'recreational value', and 'aesthetic value' were found to dominate search results. Therefore, in keeping with our purposive sampling approach, we divided Keyword Set 2 into 17 sub-groupings to ensure conceptual and terminological diversity in our database of potentially relevant articles. This approach also enabled us to conduct our searching iteratively and leave space to add additional keywords later in our process. This iterative search approach is in keeping with the Critical Interpretive Synthesis review method. Whereas aggregative literature reviews begin with clear sampling frames built around pre-defined concepts and research traditions, configurative reviews involve iterative construction of the "field to be known," and as such, the boundaries of the sampling frame are more diffuse (Dixon-Woods et al. 2006).

The sub-groupings are broken into two categories, divided according to the value concept most relevant to each keyword group: transcendental or contextual. Transcendental values are one key element of cultural knowledge (Bailey & Peoples, 2002), and are often tacitly held. Contextual values are explicit expressions of the worth or importance of an object perceived by individuals (Kenter et al., 2015). Transcendental values act in the background to inform our relational models of human-nature interaction and associated perception and assignment of contextual values. While some keywords may be used in the literature to refer to both transcendental and contextual value concepts, such as general terms like "cultural value" and "traditional value" that can be used to refer to either principles/virtues or worth/importance, the

sub-groupings were categorized based on their overall relevance to one value concept or the other.

Sub-groupings 1-5 relate most to transcendental value, and fall under the larger category of Cultural Knowledge and Human-Nature Relational Models. Searches using these keyword lists target papers discussing diverse human-nature relational models and associated transcendental values and worldviews, and how these knowledges can be integrated in environmental decision-making. It is of note that keywords in these categories are also designed to capture documents related to the CES categories, "cultural diversity" and "intrinsic value." The cultural diversity category is particularly relevant to the shift within IPBES toward recognize the mediating role of culture in the co-production of ES, or NCP (Díaz et al., 2018, supplemental materials). Intrinsic value was included as a CES category by both Milcu et al. (2013) and Raymond et al. (2009). However, it is distinct from the anthropocentric concepts that make up the rest of the CES categories, and was excluded from Gould and Lincoln (2017)'s final list. Intrinsic value has been linked to relational models / metaphors of human-nature relations that involve moral responsibilities toward the natural world (Arias-Arévalo et al., 2018; Muradian & Pascual, 2018). As such, we included intrinsic / inherent value as keywords in sub-grouping 3: Non-Instrumental Relational Models.

Sub-groupings 6-17 contain keywords most related to contextual/assigned values, and have been placed under a larger category titled Cultural Benefits; Contributions of Ecosystems to Human Identity, Experiences, and Capabilities. This category is further divided into two sets: 1) general categories of benefit (Sub-groupings 6-9); and 2) specific categories of benefit (Sub-groupings 10-17).

General terms used to speak about cultural benefit include overarching concepts of cultural and socio-cultural value (Sub-grouping 6) and intangible/non-material/non-consumptive value (Sub-grouping 7), as well as terminology associated with heritage/traditional value (Sub-grouping 8) and shared/social/group value (Sub-grouping 9). Sub-grouping 7 captures the heavy association between intangible value and the concept of CES (Chan et al., 2012). This grouping includes several CES categories associated with economic non-use values: existence and bequest values (Milcu et al., 2013). Sub-grouping 8 captures the CES category of "heritage," and following Gould and Lincoln (2017) links this to concepts of traditional and customary value. Finally, Sub-grouping 8 targets discussion of what Kenter et al. (2015) term shared and social values, or shared social values, which constitute a diverse set of "non-mutually exclusive types of shared values: transcendental, cultural/societal, communal, group, deliberated and other-regarding values, and value to society" (p. 86). Emerging work on shared/social values highlights the fact that the same value terms can be used to mean very different things, and as such, these terms overlap in meaning with many of our other keyword sub-groupings.

Finally, sub-groupings 10-17 include keyword lists designed to capture the rest of the CES categories outlined above. Rationales for combinations of CES categories in groupings 10-17 are as follows:

- **Sub-grouping 10:** Spiritual values were grouped with symbolic value following Haines-Young and Potschin (2013). We also included ceremonial and ritual values in this set. In addition, we added terms related to the concept of wisdom in an effort to capture documents with a non-Western perspective. We included the terms "place wisdom" and "place-based wisdom," as the word "wisdom" by itself returned too many irrelevant results. We also included the term "humility," which is linked to awareness of responsibilities within a moral/ethical framework of human-nature relations (Timoti et al., 2017; Basso, 1996). Related concepts of judgment, perspective, and insight also returned too many irrelevant search results.
- **Sub-grouping 11:** Identity and sense of place terms were grouped together, given the strong links between place and identity formation (Sampson & Goodrich, 2009). We

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included the concept of dwelling (Basso, 1996) and drew additional terms from the NCP framework such as belonging, rootedness, connectedness (Díaz et al., 2018, supplemental materials).

- **Sub-grouping 12:** Education and knowledge terms were grouped together, following the UKNEA (2014) and de Groot et al. (2002). This included terms related to contributions of ecosystems to science and research.

- **Sub-grouping 13:** Social ties and shared experience terms attempt to capture the CES category of social relations (Chan et al. 2012, MEA 2005), which highlights the important role that ecosystems play in facilitating social capital. Shared experiences in nature can create or strengthen bonds between people.

- **Sub-grouping 14:** Recreational and Aesthetic value terms were grouped together, following CICES (Haines-Young & Potschin, 2013) and the NCP framework (Díaz et al., 2018, supplemental materials). This includes recreational/tourism/lifestyle benefits, as well as aesthetic.

- **Sub-grouping 15:** Inspirational and Artistic value terms were grouped together, following Milcu et al. (2013), along with terms related to transformative experiences and transformative learning. It is of note that other CES typologies have associated inspiration with other CES, such as inspiration for ingenuity and problem solving and design in environmental management (i.e., biomimicry) (Gould & Lincoln, 2017). As such, Díaz et al. (2018, supplemental materials) grouped inspiration with education.

- **Sub-grouping 16:** Subsistence was included as a separate search sub-grouping to ensure that this review captures discussion of this culturally important lifeway. Following Fish et al. (2016)'s definition of CES as "the contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable, and the capabilities they help equip" (p. 212), we acknowledge the ways in which cultural benefits have a material cultural dimension. Subsistence is a key example of the interwoven character of material and non-material benefits. It was included as a CES category by Chan et al. (2012), and the NCP framework acknowledges overlap between material and non-material categories of value (Díaz et al., 2018, supplemental materials). In addition to subsistence, we include several keywords in other sub-groupings that address the material dimension of cultural benefits, such as "cultural use*" in sub-grouping 6 and spiritual, religious, ceremonial and ritual use in Sub-grouping 10.

- **Sub-grouping 17:** Healing and Health benefits were included as CES categories by Haines-Young and Potschin (2013), Fish et al. (2016), and Díaz et al. (2018, supplemental materials). Although health, like the idea of well-being, is often conceptualized as a dependent variable toward which CES benefits contribute, health benefits are also often themselves conceptualized as CES benefits. We therefore elected to include them in our exploration of the literature.

B1.1 Keyword Set 1: Ecosystem Management

- "environmental decision-making" OR "environmental planning" OR "environmental management" OR "environmental regulation" OR "environmental polic*" OR "environmental governance" OR "environmental conservation" OR
- "natural resource decision-making" OR "natural resource planning" OR "natural resource management" OR "natural resource regulation" OR "natural resource polic*" OR "natural resource governance" OR "natural resource conservation" OR
- "ecosystem management" OR "ecosystem planning" OR "ecosystem polic*" OR "ecosystem decision-making" OR "ecosystem governance" OR
- "land management" OR "land polic*" OR "land planning" OR "land governance" OR "land decision-making" OR "land use management" OR "land use planning" OR "land use polic*" OR "land use governance" OR "land use decision-making" OR "landscape management" OR "landscape planning" OR "landscape polic*" OR "landscape decision-making" OR "landscape governance" OR
- "water management" OR "water planning" OR "water polic*" OR "water decision-making" OR "water governance" OR "watershed management" OR "watershed planning" OR "watershed polic*" OR "watershed decision-making" OR "watershed governance" OR
- "estuary management" OR "estuary planning" OR "estuary polic*" OR "estuary decision-making" OR "estuary governance" OR "estuarine management" OR "estuarine planning" OR "estuarine polic*" OR "estuarine decision-making" OR "estuarine governance" OR
- "river* management" OR "river* planning" OR "river* polic*" OR "river* decision-making" OR "river* governance" OR "riparian management" OR "riparian planning" OR "riparian polic*" OR "riparian decision-making" OR "riparian governance" OR
- "floodplain management" OR "floodplain planning" OR "floodplain polic*" OR "floodplain decision-making" OR "floodplain governance" OR "fluvial management" OR "fluvial planning" OR "fluvial polic*" OR "fluvial decision-making" OR "fluvial governance" OR
- "lake management" OR "lake planning" OR "lake polic*" OR "lake decision-making" OR "lake governance" OR "lacustrine management" OR
- "littoral management" OR "littoral planning" OR "littoral polic*" OR "littoral governance" OR "coastal management" OR "coastal planning" OR "coastal polic*" OR "coastal governance" OR "coastal decision-making" OR "shoreline management" OR "shoreline planning" OR "shoreline polic*" OR "shoreline governance" OR "shoreline decision-making" OR "nearshore management" OR "nearshore planning" OR "nearshore polic*" OR "nearshore governance" OR
- "ocean management" OR "ocean planning" OR "ocean polic*" OR "ocean governance" OR "ocean decision-making" OR "marine management" OR "marine planning" OR "marine polic*" OR "marine governance" OR "marine decision-making" OR "sea management" OR "sea planning" OR "sea governance" OR
- "wetland management" OR "wetland planning" OR "wetland polic*" OR "wetland governance" OR "wetland decision-making" OR

- "fisheries management" OR "fisheries planning" OR "fisheries polic*" OR "fisheries governance" OR "fisheries decision-making" OR "fisheries conservation" OR
- "wildlife management" OR "wildlife planning" OR "wildlife polic*" OR "wildlife governance" OR "wildlife decision-making" OR "wildlife conservation" OR
- "forest management" OR "forest planning" OR "forest polic*" OR "forest governance" OR "forestry management" OR "forestry planning" OR "forestry polic*" OR "forestry governance" OR
- "grassland management" OR "grassland planning" OR "grassland polic*" OR "grassland governance" OR
- "range* management" OR "range* planning" OR "range* polic*" OR "range* governance" OR "range* decision-making" OR
- "farm* management" OR "farm* planning" OR "farm* polic*" OR "farm* governance" OR "agricultur* management" OR "agricultur* planning" OR "agricultur* polic*" OR "agricultur* governance" OR "agricultur* decision-making" OR
- "park management" OR "park planning" OR "park polic*" OR "park governance" OR "park decision-making" OR "protected area management" OR "protected area planning" OR "protected area polic*" OR "protected area governance" OR "protected area decision-making" OR "reserve polic*" OR "reserve management" OR "reserve planning" OR "reserve governance" OR "reserve decision-making" OR "national monument planning" OR "national monument management" OR "national monument polic*" OR "national monument governance" OR "national monument decision-making" OR "preserve planning" OR "preserve management" OR "preserve polic*" OR "preserve governance" OR "preserve decision-making" OR "conservation area planning" OR "conservation area polic*" OR "conservation area management" OR "conservation area governance" OR "conservation area decision-making" OR "ICCA planning" OR "ICCA polic*" OR "ICCA management" OR "ICCA governance" OR "ICCA decision-making" OR "IPA management" OR "IPA planning" OR "IPA polic*" OR "IPA governance" OR
- "wilderness management" OR "wilderness planning" OR "wilderness polic*" OR "wilderness governance" OR "wilderness decision-making" OR
- "biodiversity management" OR "biodiversity planning" OR "biodiversity polic*" OR "biodiversity governance" OR "biodiversity decision-making" OR "biodiversity conservation" OR "biodiversity restoration" OR "biological diversity management" OR "biological diversity planning" OR "biological diversity polic*" OR "biological diversity governance" OR "biological diversity decision-making" OR "biological diversity conservation" OR "biological diversity restoration" OR
- "conservation polic*" OR "conservation planning" OR "conservation management" OR "conservation governance" OR "conservation decision-making" OR
- "restoration polic*" OR "restoration planning" OR "restoration management" OR "restoration governance" OR "restoration decision-making"

Cultural Knowledge and Human-Nature Relational Models

1. **Transcendental Value:** "transcendental value*" OR "held value*" OR "moral value*" OR "moral importance" OR "moral significance" OR "moral code*" OR "moral norm*" OR "moral worldview*" OR "ethical value*" OR "ethical importance" OR "ethical significance" OR "ethical code*" OR "ethical norm*" OR "ethical worldview*" OR "cultural protocol*" OR "cultural norm*" OR "cultural worldview*" OR "cultural knowledge*" OR "construction* of meaning" OR "construction* of purpose" OR "construction* of wellbeing" OR "construction* of well-being" OR

2. **Relational Value:** "relational value*" OR "relational importance" OR "relational meaning*" OR "relational significance" OR "relationship value*" OR "constitutive value*" OR "constitutive importance" OR "constitutive relation*" OR "constitutive relatedness" OR "non-substitutable value*" OR "non-substitutable importance" OR "eudaimonistic value*" OR "eudaemonistic value*" OR "eudemonistic value*" OR "meaningful relation*" OR "valu* relation*" OR

3. **Non-Instrumental Relational Models:** "reciprocity" OR "nature's gifts" OR "reciprocal relation*" OR "respectful relation*" OR "worldview of relatedness" OR "kincentric relation*" OR "kinship relation*" OR "spiritual relation*" OR "ethic* of care" OR "ritualized exchange*" OR "devotion" OR "responsible stewardship" OR "car* for country" OR "landed citizen*" OR "land as citizen" OR "dwelling perspective" OR "all are related" OR "community of beings" OR "oneness" OR "liv* in balance" OR "liv* in harmony" OR "everything is connected" OR "interconnected*" OR "holism" OR "hozho" OR "ohana" OR "lokahi" OR "Mitakuye" OR "buen vivir" OR "kawsay" OR "suma quamaña" OR "mauri ora" OR "aat ya ayunei" OR "qaujimajatuqangit" OR "geomentality" OR "relational thinking" OR "relational ontolog*" OR "indigenous cosmo*" OR "aboriginal cosmo*" OR "indigenous ontolog*" OR "aboriginal ontolog*" OR "indigenous epistemolog*" OR "aboriginal epistemolog*" OR "indigenous worldview*" OR "aboriginal worldview*" OR "intrinsic value*" OR "inherent value*" OR "rights of nature" OR

4. **Indigenous Value/Meaning:** "Tribal value*" OR "valu* by the Tribe*" OR "valu* by Tribe*" OR "valu* to the Tribe*" OR "valu* to Tribe*" OR "Tribal importance" OR "importance to Tribes" OR "importance to the Tribe*" OR "Tribal meaning*" OR "meaningful to Tribes" OR "meaningful to the Tribe*" OR "meaning* for the Tribe*" OR "meaning* for Tribe*" OR "Tribal significance" OR "significan* to Tribes" OR "significan* to the Tribe*" OR "significan* for Tribes" OR "significan* for the Tribe*" OR "Native American value*" OR "valu* by Native Americans" OR "valu* to Native Americans" OR "importan* for Native Americans" OR "importan* to Native Americans" OR "Native American meaning*" OR "meaningful to Native Americans" OR "meaning* for Native Americans" OR "Native American significance" OR "significan* to Native Americans" OR "significan* for Native Americans" OR "First Nations value*" OR "valu* by First Nations" OR "valu* by

First Nations" OR "valu* to First Nations" OR "importan* for First Nations" OR "importan* to First Nations" OR "First Nations meaning*" OR "meaningful to First Nations" OR "meaning* for First Nations" OR "significan* to First Nations" OR "significan* for First Nations" OR "indigenous value*" OR "valu* by indigenous" OR "valu* to indigenous" OR "valu* for indigenous" OR "importan* for indigenous" OR "importan* to indigenous" OR "indigenous meaning*" OR "meaning* for indigenous" OR "meaning* to indigenous" OR "Aboriginal value*" OR "valu* by aboriginal" OR "valu* to aborigin*" OR "valu* for aborigin*" OR "Aboriginal importance" OR "importance to aborigin*" OR "importance for aborigin*" OR "Aboriginal meaning*" OR "meaning* for aborigin*" OR "meaning* to aborigin*" OR "Aboriginal significance" OR "significan* to aborigin*" OR "significan* for aborigin*" OR

5. **Knowledge and Value Pluralism:** "comprehensive value*" OR "holistic value*" OR "plural value*" OR "plural meaning*" OR "value pluralism" OR "multiple value*" OR "plural valuation" OR "plural knowledge*" OR "knowledge pluralism" OR "multiple knowledge*" OR "ontological pluralism" OR "plural ontolog*" OR "epistemological pluralism" OR "plural epistemolog*" OR "axiological pluralism" OR "plural axiolog*" OR "multiple ways of knowing" OR "plural ways of knowing"

Cultural Benefits; Contributions of Ecosystems to Human Identity, Experiences, and Capabilities
General Categories:

6. **Socio-Cultural Value/Importance** (note, Social Value* was moved to Sub-grouping 9, Shared and Social Value): "cultural value*" OR "cultural importance" OR "cultural meaning" OR "cultural significance" OR "cultural benefit*" OR "cultural use*" OR "socio-cultural value*" OR "socio-cultural importance" OR "socio-cultural meaning*" OR "socio-cultural significance" OR "socio-cultural benefit*" OR

7. **Intangible and Non-Consumptive Values:** "intangible value*" OR "intangible importance" OR "intangible meaning*" OR "intangible significance" OR "intangible benefit*" OR "non-material value*" OR "non-material importance" OR "non-material meaning*" OR "non-material significance" OR "non-material benefit*" OR "non-monetary value*" OR "non-monetary importance" OR "non-monetary meaning*" OR "non-monetary significance" OR "non-monetary benefit*" OR "non-instrumental value*" OR "non-instrumental importance" OR "non-use benefit*" OR "non-consumptive value*" OR "non-consumptive benefit*" OR "existence value*" OR "bequest value*" OR "non-use value*" OR

8. **Traditional and Heritage Value:** "traditional value*" OR "traditional importance" OR "traditional meaning*" OR "traditional significance" OR "customary value*" OR "customary importance" OR "customary significance" OR "heritage value*" OR "heritage importance" OR "heritage meaning*" OR "heritage significance" OR

9. **Shared and Social Value:** "shared value*" OR "shared meaning*" OR "shared importance" OR "shared significance" OR "social value*" OR "social benefit*" OR "social importance" OR "social meaning*" OR "social significance" OR "community

value*" OR "communal value*" OR "collective value*" OR "group value*" OR "public value*"

Specific Categories:

10. **Spiritual Value**: "spiritual value*" OR "spiritual importance" OR "spiritual meaning*" OR "spiritual significance" OR "spiritual benefit*" OR "spiritual use*" OR "religious value*" OR "religious importance" OR "religious meaning*" OR "religious significance" OR "religious benefit*" OR "religious use*" OR "symbolic value*" OR "symbolic importance" OR "symbolic meaning*" OR "symbolic significance" OR "ceremonial value*" OR "ceremonial importance" OR "ceremonial meaning*" OR "ceremonial significance" OR "ceremonial use*" OR "ritual value*" OR "ritual importance" OR "ritual meaning*" OR "ritual significance" OR "ritual use*" OR "humility" OR "place wisdom" OR "place-based wisdom" OR

11. **Identity and Sense of Place Value**: "identity value*" OR "importance to identit*" OR "importance for identit*" OR "identity meaning*" OR "meaning* for identit*" OR "meaning* to identit*" OR "identity significance" OR "significance to identit*" OR "significance for identit*" OR "impact* to identit*" OR "benefit* to identit*" OR "identity formation" OR "place identit*" OR "place-based identit*" OR "sense of place" OR "place-connectedness" OR "connection to place" OR "place-rootedness" OR "rooted* in place" OR "place-belonging" OR "belonging in place" OR "dwell* in place" OR "place attachment" OR "place-based value*" OR "place-based meaning*" OR "place-based significance" OR "place-based importance" OR "place-making" OR

12. **Education and Knowledge Value**: "education value*" OR "education benefit*" OR "valu* for education*" OR "benefit* for education*" OR "benefit* to education*" OR "educational value*" OR "educational importance" OR "educational significance" OR "educational benefit*" OR "learning value*" OR "learning benefit*" OR "valu* for learning" OR "benefi* for learning" OR "scientific value*" OR "ecosystem* value* for science" OR "ecosystem* value* for scientific" OR "ecosystem* value* for research" OR "knowledge value*" OR "knowledge benefit*" OR "valu* for knowledge*" OR "benefit* to knowledge*" OR "benefit* for knowledge*" OR "knowledge system* value*" OR "knowledge system* benefit*" OR "knowledge transmission" OR "transmission of knowledge" OR "knowledge acquisition" OR "acquisition of knowledge" OR "experiential knowledge" OR "place-based knowledge*" OR

13. **Social Ties and Shared Experience**: "valu* social relation*" OR "important social relation*" OR "valu* social tie*" OR "important social ties" OR "valu* social interaction*" OR "important social interaction*" OR "valu* interpersonal relation*" OR "important interpersonal relation*" OR "valu* social network*" OR "important social network*" OR "shared experiences" OR "shared activities" OR "shared memories" OR

14. **Recreational and Aesthetic Value**: "recreational value*" OR "recreational importance" OR "recreational significance" OR "recreational benefit*" OR "benefit* for recreation*" OR "benefit* to recreation" OR "recreational impact*" OR "impact* for recreation*" OR "impact* to recreation*" OR "leisure value*" OR "leisure

benefit*" OR "tourism value*" OR "tourism benefit*" OR "lifestyle value*" OR "lifestyle benefit*" OR "benefit* for lifestyle*" OR "benefit* to lifestyle*" OR "aesthetic value*" OR "aesthetic importance" OR "aesthetic meaning*" OR "aesthetic significance" OR "aesthetic benefit*" OR "aesthetic impact*" OR "esthetic value*" OR "esthetic importance" OR "esthetic meaning*" OR "esthetic significance" OR "esthetic benefit*" OR "esthetic impact*" OR

15. **Inspirational and Transformative Value**: "transformative value*" OR "transformative meaning*" OR "transformative benefit*" OR "transformative learning" OR "transformative experience*" OR "artistic value*" OR "artistic benefit*" OR "inspirational value*" OR "inspirational importance" OR "inspirational significance" OR "inspirational benefit*" OR "inspiration value*" OR "inspiration benefit*"   OR "inspiration value*" OR "inspiration benefit*" OR

16. **Subsistence**: "subsistence practice*" OR "subsistence lifeway*" OR "subsistence cultur*" OR "subsistence tradition*" OR "subsistence way*" OR "subsistence use*" OR

17. **Health and Healing**: "therapeutic value*" OR "therapeutic benefit*" OR "health value*" OR "health impact*" OR "health benefit*" OR "healing value*" OR "healing benefit*"

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B2 Databases Searched

The objectives of database selection were to: 1) ensure coverage of diverse disciplinary perspectives; 2) include diverse cultural perspectives where possible in the context of written documentation; and 3) limit the number of databases to approximately 10 given time and resource constraints. In consultation with reference librarians at Colorado State University, we identified a large number of EBSCO and ProQuest databases that contained material relevant to our research question. We carried out a pilot test of content overlap, examining the top 200 relevant hits across databases for four different cultural importance keyword sub-groupings, to ensure that our final selection of databases provided adequate coverage of the material contained in excluded databases. We found that three large academic databases (Web of Science, EBSCO's Academic Search Premier, and ProQuest's Agricultural and Environmental Science Collection) provided between 85% and 100% coverage of results from other EBSCO and ProQuest databases containing ecological and/or economic literature.

In addition, in order to ensure inclusion of minority viewpoints and contributions from diverse disciplinary perspectives, we also carried out the search in four smaller ProQuest databases (Ethnic NewsWatch, ERIC, Public Affairs Information Service (PAIS) Index, and Sociological Abstracts), and two other EBSCO databases (Anthropology Plus and Philosopher's Index). We initially included ProQuest's Linguistics and Language Behavior Abstracts in the search as well. However, we found that almost no relevant results were returned across the entire keyword list, and we ultimately decided to exclude those results from our list for screening.

Although EBSCO and ProQuest databases provide some coverage of law journals and gray literature, non-legal academic journals make up the bulk of their content. In order to increase coverage of law journals, we also carried out our search in Hein Online, a legal

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database. Further, we felt it would be important to include Science.gov, a database of Federal research.

The following is the final list of databases included in our search:

1) Web of Science, Core Collection

2) EBSCO

    a. Academic Search Premier

    b. Anthropology Plus

    c. Philosopher's Index

3) ProQuest

    a. Agricultural and Environmental Science Database

    b. Education Resources Information Center (ERIC)

    c. Ethnic NewsWatch

    d. Public Affairs Information Service (PAIS) Index

    e. Sociological Abstracts

4) Hein Online

Appendix C – Final Screening Criteria for Record Inclusion/Exclusion

Final Guide for Inclusion-Exclusion Decisions

Finalized May 14, 2019

1. *Basic inclusion/exclusion criteria*

    o (1) Article must include discussion of cultural value/importance; and

    o (2) Article must provide insight as to how this information can be considered/integrated/used to inform environmental decision-making.

2. *Defining scope of "environmental decision-making"*

    o Agriculture? **Decision**: Narrow it down to ag. policy as it relates to human experiences of culturally important landscapes, practices, and traditions. Combine with food security / nutrition examples under a heading of "food systems."

    o Wildlife as an object of CES knowledge? **Decision**: Yes, information about the CES benefits arising from wildlife could inform habitat protections.

    o How CES knowledge informs wildlife management, as opposed to land/water management decision-making? **Decision**: Yes, insofar as wildlife management = natural resource management.

    o Recreation and Aesthetic values? **Decision**: Include, but limit the influence of these keywords by conducting sub-searches of groups of keywords.

    o Urban Ecosystem Services: **Decision**: Yes, include, because it could help get at environmental justice issues / include issues relevant to more diverse stakeholders.

o <u>Food security and Nutrition</u>: **Decision**: Include as an aspect of culturally important interactions with food systems; combine with agriculture category.

o <u>Include discussion of CES benefits/impacts as outcomes of policy</u>? When to include in our model of CES knowledge, and how this influences policy? **Decision**: Include when benefit/impact information is clearly intended to circle back and inform policy.

3. *Geographical scope*

o **Decision**: Include all regions of the world. But, if we need to limit scope, limit geography first before limiting to only Federal scale of decision-making.

4. *Scale of governance*

o **Decision**: Include all scales of governance, i.e., local, regional, national, international.

5. *Defining relevant expressions/forms of knowledge*

o <u>Include both Contextual and Transcendental forms of CES knowledge</u>? **Decision:** Yes, both are important aspects of CES knowledge. Remains to be seen how Transcendental values emerge as knowledge products and/or are used in applied examples.

o <u>Include economic valuation</u>? Or should we explicitly focus on non-monetary methods as a way to reduce the scope of the review? **Decision**: Yes, insofar as economic methods are used to examine intangible/non-monetary/non-consumptive/non-use values.

o <u>Use value as a proxy for cultural value</u>? **Decision**: Yes in instances when use is explicitly intended to convey ES bundles (i.e., recreation, cultural importance

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index that explicitly relies on use to represent importance). Note: Discussion of livelihood use, such as agriculture, timber, or fisheries, does not warrant inclusion unless cultural relevance is specifically noted.

- Instances where "use" concepts were included in the final keyword list:
  - Subsistence sub-grouping: One keyword sub-grouping was built around the idea of subsistence lifeways, which is a key example of the interrelatedness of material and non-material dimensions.
  - The Socio-cultural value/importance Sub-grouping includes the keyword, "cultural use*."
  - The Spiritual Value sub-grouping includes the keywords, "spiritual use*," "ceremonial use*," and "ritual use*."

- The manner in which knowledge is represented – are we interested only in forms of knowledge that can be distilled and conveyed independent from the knowledge holder? **Decision**: No, we are also interested in forms of knowledge that require direct interaction between knowledge holder and decision-maker.

6. *Defining Relevant Pathways*

- Agency Control vs. Broader? Are we interested in only pathways over which agency decision-makers have some control? Or pathways that affect the system more broadly as well (i.e., processes outside of agency decision-making, that affect societal and legal context within which agencies operate)? **Decision**: All Pathways are relevant, including those over which agencies have control and those over which they do not, such as the legal landscape, political climate, shifts in societal values/paradigms that lead to acts of Congress, etc.

7. *Relevance of examples of Representation and/or Use*

<u>Clear case study</u>? Include only if a paper clearly demonstrates how information is considered? **Decision**: No, this would be too strict of a criterion for inclusion since many papers will not clearly demonstrate use of particular information.

- Questions:
  - What about representation of CES knowledge that presume use as a logical outcome of providing data (most ES work). **Decision**: Yes, include papers that provide information with implicit belief that the production of the information is warranted because it should be "used."
  - What about discussions of "use of plural knowledge" that focus more on processes through which knowledges are integrated, and for which we may have to presume content? (Since such work may not explicitly discuss whether socio-cultural value is part of the "plural knowledges" or not…) **Decision**: Yes, include references to plural knowledges even if they don't specify content. This gets at contextual vs. transcendental knowledge, and the fact that including plural transcendental values is assumed to bring plural contextual valuations.
- <u>Include papers focused on methods</u>? Describes a method that has promise for integration of socio-cultural value information through one or multiple pathways… **Decision:** No, I think there will be enough methods papers that do focus on socio-cultural value. But we should track other papers as possible

background, and review them to see if those methods were captured within the database of included papers.

- o Include papers focused on Barriers to use? If yes, should a paper be included if non-use or barriers is the only information included, or should barriers be assessed once we have our database and select our purposive sample? **Decision**: If a paper discusses attempts to use socio-cultural value, and only barriers are encountered, it should be included. If a barrier is discussed in passing in a paper not focused on socio-cultural value, exclude.

- o Include papers focused on Vulnerability/Impacts? As opposed to focus on CES benefits? (Seems like vulnerability and impacts are the other side of the same coin?) **Decision**: Similar to the question of cultural impacts/benefits, if a paper is focused on socio-cultural vulnerabilities or socio-cultural resilience, consider whether that information is being compiled to inform decision-making in some way. If yes, include.

8. *How much detail required for inclusion?*

- o Only papers about which socio-cultural value is the focus of the work? Or at least a key variable? **Decision**: Limit database to papers for which representation or use of socio-cultural value (including knowledge integration papers) is focus.

- o Argument without application? There are some papers that make general statements about the importance of including plural knowledges or mixed methods, etc., but don't actually provide examples about how this has been or could be done. Should they be included? (e.g., papers on research ethics, calling for improved integration of plural knowledge as an ethical issue). **Decision**: No,

exclude papers that make general statements without further research or

application supporting those statements. However, keep track of these as

background papers and consider citing them in a contextual portion of the lit

review for the paper.

Appendix D – Final Literature Sample

Table D1 provides database reference information for all articles and books that were included in our Full Article Sample (Table A1). The "Knowledge Form Sub-Sample" column indicates whether or not the record was linked to the Knowledge Form Sub-Sample that was used to explore barriers and enabling factors for inclusion of Cultural Identity and Knowledge Systems benefits (Main Text, Section 3.3.2.2). The "Theoretical Sampling" column indicates whether the article or book was retrieved from the Database of Potentially Relevant Articles (174 records), or through subsequent theoretical sampling (12 additional records).

Table D1: Full Sample of Included Articles and Books that Contributed to this Critical Interpretive Synthesis.

AUTHOR(S)	YEAR	TITLE	JOURNAL OR BOOK PUBLISHER	KNOWLEDGE FORM SUB-SAMPLE (Y/N)	THEORETICAL SAMPLING (Y/N)
(No Author)	2016	Existence-Value Standing Notes.	Harvard Law Review. 129: 775.	N	N
Adamowicz, W; Boxall, P; Haener, M; Zhang, YQ; Dosman, D; Marois, J,	2004	An assessment of the impacts of forest management on Aboriginal hunters: Evidence from stated and revealed preference data.	FOREST SCIENCE. 50(2): 139.	N	N
Allen, Maggie, Bird, Stoney, Breslow, Sara, Dolsak, Nives,	2017	Stronger together: Strategies to protect local sovereignty, ecosystems, and place-based communities from the global fossil fuel trade.	Marine Policy. 80: 168.	N	Y
Almlie, Elizabeth J.,	2011	A Place of Nature and Culture: The Founding of Congaree National Park, South Carolina.	Federal History. 3: 1.	N	N

Amiraslani, F.; Dragovich, D.; Caiserman, A.,	2018	A long-term cost-benefit analysis of national anti-desertification plans in Iran.	Desert. 23(1): 141.	N	N
Anderson, Kai S. Paulus-Jagric, Deborah,	2008	A New Land Initiative in Nevada Breaking the Logjam: Environmental Reform for the New Congress and Administration: Panel IV - Protecting Ecosystems on Land.	New York University Environmental Law Journal. 17: 398.	N	N
Avila, Rosemary,	2011	Sacred sites and the perpetuation of religious beliefs: Indigenous understandings and Western perspectives within legal frameworks.	Masters Thesis, The University of Arizona, Tucson, Arizona, USA.	N	N
Baing, Andreas Schulze,	2015	Land Policy: Planning and the Spatial Consequences of Property.	The Town Planning Review. 86(4): 485.	N	N
Barber, M; Jackson, S,	2011	Aboriginal water values and resource development pressures in the Pilbara region of north-west Australia.	AUSTRALIAN ABORIGINAL STUDIES. 2011(2): 32.	Y	N
Bartlett, Cheryl, Marshall, Murdena, Marshall, Albert,	2012	Two-Eyed Seeing and other lessons learned within a co-learning journey of bringing together indigenous and mainstream knowledges and ways of knowing.	J. Environ Stud Sci. 2: 331.	N	Y

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Bates, Badger; Witter, Dan,	1993 Reprint (first publish ed in 1992)	Cultural tourism at Mutawintji - and beyond.	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 215-220.	Y	N
Battiste, M. and Henderson, J.,	2000	Protecting Indigenous Knowledge and Heritage: A Global Challenge.	Purich Publishing, Saskatoon, Saskatchewan, Canada.	N	Y
Beitl, CM,	2011	Cockles in custody: the role of common property arrangements in the ecological sustainability of mangrove fisheries on the Ecuadorian coast.	INTERNATIO NAL JOURNAL OF THE COMMONS. 5(2): 485.	N	N
Bengston, David N; Webb, Trevor J; Fan, David P,	2004	Shifting Forest Value Orientations in the United States, 1980-2001: A Computer Content Analysis.	Environmental Values. 13(3): 373.	N	N
Bernstein, Jacob,	1996	Maya Traditional Knowledge: Preserving Forests in Guatemala.	Native Americas. March 31, 1996: 30.	N	N
Bernues, A; Tello-Garcia, E; Rodriguez-Ortega, T; Ripoll-Bosch, R; Casasus, I,	2016	Agricultural practices, ecosystem services and sustainability in High Nature Value farmland: Unraveling the perceptions of farmers and nonfarmers	LAND USE POLICY. 59: 130.	Y	N
Birckhead, Jim,	1993 Reprint (first publish	Traditional Aboriginal Land Management Practices' at Charles Sturt	Aboriginal Involvement in Parks and Protected Areas, (eds)	Y	N

	ed in 1992)	University - The cultural politics of a curriculum innovation.	Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 297-306.		
Birol, E; Koundouri, P; Kountouris, Y,	2008	Integrating wetland management into sustainable water resources allocation: The case of Akrotiri wetland in Cyprus.	JOURNAL OF ENVIRONME NTAL PLANNING AND MANAGEME NT. 51(1): 37.	N	N
Bischoff-mattson, Zachary; Lynch, Amanda H,	2016	Adaptive governance in water reform discourses of the Murray-Darling Basin, Australia.	Policy Sciences. 49(3): 281.	N	N
Black, Kerry; McBean, Edward,	2016	Increased Indigenous Participation in Environmental Decision-Making: A Policy Analysis for the Improvement of Indigenous Health.	International Indigenous Policy Journal. 7(4).	N	N
BLAIR, MARY E.; LE, MINH D.; SETHI, GAUTAM; THACH, HOANG M.; NGUYEN, VAN T. H.; AMATO, GEORGE; BIRCHETTE, MARK; STERLING, ELEANOR J.,	2017	The Importance of an Interdisciplinary Research Approach to Inform Wildlife Trade Management in Southeast Asia.	BioScience. 67(11): 995.	Y	N
Blakney, Sherrie,	2003	Aboriginal forestry in New Brunswick: conflicting paradigms.	Environments. 31(1): 61.	Y	N
Bledsoe, Adam,	2016	Defender Nosso Pedaço de Chão: Quilombola	Dissertation, University of North Carolina, Chapel Hill,	Y	N

		Struggles in Bahia.	North Carolina, USA.		
Blowes, Robert,	1991	From Terra Nullius To Every Person's Land: Legal Bases for Aboriginal involvement in National Parks - Precedents from the Northern Territory.	Aboriginal Law Bulletin. 2(52): 4.	N	N
Bluemel, Erik B. ,	2005	Accommodating Native American Cultural Activities on Federal Public Lands .	Idaho Law Review. 41: 475.	Y	N
Bode, Thomas G. ,	2017	A Modern Treaty for the Columbia River.	Environmental Law. 47: 81.	Y	N
Boggs, James P,	2002	Anthropological knowledge and Native American cultural practice in the liberal polity.	American Anthropologist. 104(2): 599.	Y	N
Bolund, P; Hunhammar, S,	1999	Ecosystem services in urban areas.	ECOLOGICAL ECONOMICS. 29(2): 293.	N	N
Booth, Annie L; Skelton, Norman W,	2011	"There's a Conflict Right There": Integrating Indigenous Community Values into Commercial Forestry in the Tl'azt'en First Nation.	Society & Natural Resources. 24(4): 368.	Y	N
Boyd, Amanda D; Jardine, Cynthia G; Furgal, Christopher M,	2010	A SOCIAL AND CULTURAL CAPITAL APPROACH TO UNDERSTANDING TRADITIONAL ACTIVITIES ON THE LAND IN TWO NORTHERN DENE COMMUNITIES.	The Canadian Journal of Native Studies. 30(2): 267.	Y	N

Bradshaw, Richard, Collett, Andrew,	1991	Aboriginal Land Rights in South Australia (Issue 52, pp. 20-21).	Aboriginal Law Bulletin. 2(52): 20.	N	N
Brady, Mark; Sahrbacher, Christoph; Kellermann, Konrad; Happe, Kathrin,	2012	An agent-based approach to modeling impacts of agricultural policy on land use, biodiversity and ecosystem services.	Landscape Ecology. 27(9): 1363.	N	N
Breedlove, Joseph, Resources, Science, and Industry Division Intern,	1999	NATURAL RESOURCES: ASSESSING NONMARKET VALUES THROUGH CONTINGENT VALUATION.	CRS Report for Congress.	N	N
Brown, Christine Sue,	2016	Dark legacies: Tracing roots of U.S. settler colonialism in contemporary tribal issues.	Dissertation, Washington State University, Pullman, WA, USA.	N	N
Brownlee, Diane K. ,	2002	The Public Vote in the Game of Water Wars: An Unquenchable Thirst to Define and Implement Public Values in Western Water Laws Comment.	UMKC Law Review. 70(3): 647.	Y	N
Brugnach, M; Ingram, H,	2012	Ambiguity: the challenge of knowing and deciding together.	ENVIRONMENTAL SCIENCE & POLICY. 15(1): 60.	Y	N
Burmil, S; Daniel, TC; Hetherington, JD,	1999	Human values and perceptions of water in arid landscapes.	LANDSCAPE AND URBAN PLANNING. 44: 99.	N	N
Byczek, Coline; Longaretti, Pierre-Yves; Renaud, Julien; Lavorel, Sandra,	2018	Benefits of crowd-sourced GPS information for modelling the recreation ecosystem service.	PLoS ONE. 13(10): 1.	N	N
Byers, Bruce A; Cunliffe, Robert	2001	Linking the conservation of culture and nature:	Human Ecology. 29(2): 187.	N	N

N; Hudak, Andrew T,		A case study of sacred forests in Zimbabwe.			
Cajete, Gregory,	2000	Native Science: Natural Laws of Interdependence.	Clear Light, Santa Fe, NM, USA.	N	Y
Carroll, Matthew S; Blatner, Keith A; Cohn, Patricia J,	2003	Somewhere between: Social embeddedness and the spectrum of wild edible huckleberry harvest and use.	Rural Sociology. 68(3): 319.	Y	N
Casado-arzuaga, Izaskun; Onaindia, Miren; Madariaga, Iosu; Verburg, Peter H,	2014	Mapping recreation and aesthetic value of ecosystems in the Bilbao Metropolitan Greenbelt (northern Spain) to support landscape planning.	Landscape Ecology. 29(8): 1393.	N	N
Chalk, Andrew,	1991	Land Rights Under New South Wales Legislation.	Aboriginal Law Bulletin. 2(52): 22.	N	N
Chambers, Catherine M; Whitehead, John C,	2003	A Contingent Valuation Estimate of the Benefits of Wolves in Minnesota.	Environmental and Resource Economics. 26(2): 249.	N	N
Chanwai, Kiri Richardson, Benjamin ,	1998	Re-working Indigenous Customary Rights - The Case of Introduced Species .	New Zealand Journal of Environmental Law. 2: 157.	Y	N
Chen, Si; Shahi, Chander; Chen, Han Y.H.,	2016	Economic and ecological trade-off analysis of forest ecosystems: options for boreal forests.	Environmental Reviews. 24(3): 348.	N	N
Clemmer, Richard O,	2004	"The Legal Effect of the Judgment": Indian Land Claims, Ecological Anthropology, Social Impact Assessment, and	Human Organization. 63(3): 334.	Y	N

		the Public Domain.			
Colorado, Pamela,	1988	Bridging Native and Western Science.	Convergence 21(2 & 3): 49.	N	Y
Craig, David; Yung, Laurie; Borrie, William,	2012	"Blackfeet Belong to the Mountains": Hope, Loss, and Blackfeet Claims to Glacier National Park, Montana.	Conservation and Society. 10(3): 232.	Y	N
Craig, Donna,	1999	Indigenous Joint Management of National Parks.	Australian Indigenous Law Reporter. 4: 73.	Y	N
Crossman, Neville D.; Pollino, Carmel A.,	2018	An ecosystem services and Bayesian modelling approach to assess the utility of water resource development in rangelands of north Australia.	Journal of Arid Environments. 159: 34.	Y	N
Dana, DA,	2004	Existence value and federal preservation regulation.	HARVARD ENVIRONME NTAL LAW REVIEW. 28(2): 343.	N	N
Davies, Jocelyn, Higginbottom, Karen, Noack, Denise, Ross, Helen, and Young, Elspeth,	1999	Sustaining Eden: Indigenous community wildlife management in Australia.	Australian Indigenous Law Reporter. 4: 115.	N	N
Denny, Shelley K; Fanning, Lucia M,	2016	A Mi'kmaw Perspective on Advancing Salmon Governance in Nova Scotia, Canada: Setting the Stage for Collaborative Co-Existence.	International Indigenous Policy Journal. 7(3).	Y	N
Dhiksawan, F.S., Hadi, S.P., Samekto, A., Sasongko, D.P.,	2018	Indigenous Peoples Involment At The Environmental Impact Assessment (EIA)	The 2nd International Conference on Energy, Environmental and	Y	N

		Process in Tabi Mamta Area Of Papua Province.	Information System (ICENIS 2017), E3S Web Conf. 31, Article 08017.		
Diamant, Rolf,	2003	Reflections on environmental history with a human face: Experiences from a new national park.	Environmental History. 8(4): 628.	N	N
Diduck, Alan Paul; Pratap, Dinesh; Sinclair, A John; Deane, Sarra,	2013	Perceptions of impacts, public participation, and learning in the planning, assessment and mitigation of two hydroelectric projects in Uttarakhand, India.	Land Use Policy. 33: 170.	Y	N
Dupont, L; Van Eetvelde, V,	2013	Assessing the potential impacts of climate change on traditional landscapes and their heritage values on the local level: Case studies in the Dender basin in Flanders, Belgium.	LAND USE POLICY. 35: 179.	N	N
DuPraw, Marcelle Elise,	2018	Defining Landscape-Scale Collaboration as Used to Restore Forests and Reduce Catastrophic Wildfires.	The Qualitative Report. 23(11): 2774.	Y	N
Edwards, D; Jensen, FS; Marzano, M; Mason, B; Pizzirani, S; Schelhaas, MJ,	2011	A theoretical framework to assess the impacts of forest management on the recreational value of European forests.	ECOLOGICAL INDICATORS. 11(1): 81.	N	N

Edwards, DM; Collins, TM; Goto, R,	2016	An arts-led dialogue to elicit shared, plural and cultural values of ecosystems.	ECOSYSTEM SERVICES. 21: 319.	N	N
Edwards, Eric C; Cristi, Oscar; Edwards, Gonzalo; Libecap, Gary D,	2018	An illiquid market in the desert: estimating the cost of water trade restrictions in northern Chile.	Environment and Development Economics. 23(6): 615.	N	N
Egoz, S,	1996	Israel's citrus grove landscape - An opportunity to balance urbanization with cultural values.	LANDSCAPE AND URBAN PLANNING. 36(3): 183.	Y	N
Falk-andersson, Jannike; Foley, Naomi S; Armstrong, Claire W; van den Hove, Sybille; van Rensburg, Thomas M;Tinch, Rob,	2015	A deliberative approach to valuation and precautionary management of cold water corals in Norway.	Maritime Studies. 14(1): 1.	N	N
Farley, Kathleen A.,	2018	Manager Perceptions of Goals and Outcomes of Public Rangeland Management in San Diego County.	California Geographer. 57: 49.	N	N
FIELKE, SIMON J; BARDSLEY, DOUGLAS K,	2015	A Brief Political History of South Australian Agriculture.	Rural History. 26(1): 101.	N	N
Ford, James D; Willox, Ashlee Cunsolo; Chatwood, Susan; Furgal, Christopher; Harper, Sherilee; Mauro, Ian; Pearce, Tristan,	2014	Adapting to the Effects of Climate Change on Inuit Health.	American Journal of Public Health. 104(S3): E9.	Y	N
Frank, S; Furst, C; Koschke, L; Makeschin, F,	2012	A contribution towards a transfer of the ecosystem service concept to landscape	ECOLOGICA L INDICATORS. 21: 30.	N	N

		planning using landscape metrics.			
Freyfogle, Eric T. ,	1994	The Ethical Strands of Environmental Law .	University of Illinois Law Review. 1994: 819.	N	N
Garvie, Kathryn Henderson,	2013	Beyond Consultation: First Nations and the Governance of Shale Gas in British Columbia.	Masters Thesis, University of Victoria, British Columbia, Canada.	Y	N
Gonçalves, Vasco Barroso,	2013	The precautionary principle and environmental risk management: contributions and limitations of economic models.	Ambiente & Sociedade. 16(4).	N	N
Grant, Evadne,	2018	Indigeneity, Human Rights and the Environment Editorial.	Journal of Human Rights and the Environment. 9: 113.	Y	N
Groenfeldt, David,	2004	Indigenous Perspectives on Water and Development (Issue 29, pp. 26 - 27).	Indigenous Law Bulletin. (5): 1.	Y	N
Gunton, Thomas; Joseph, Chris,	2010	Economic and Environmental Values in Marine Planning: A Case Study of Canada's West Coast.	Environments. 37(3): 111.	N	N
Hoefman, Kevin; Bramson, Aaron; Schoors, Koen; Ryckebusch, Jan,	2018	The impact of functional and social value on the price of goods.	PLoS ONE. 13(11): 1.	N	N
Holzman, David C,	2012	Accounting for Nature's Benefits: The Dollar Value of Ecosystem Services.	Environmental Health Perspectives. 120(4): A153.	N	N
Hung-Hao, Chang; Boisvert, Richard N,	2010	Accounting for the market and non-market values of multifunctional outputs in evaluating water transfers to non-agricultural uses:	Water Policy. 12(4): 528.	N	N

		empirical evidence from Taiwanese rice production.			
Hynes, S; Campbell, D; Howley, P,	2011	A Holistic vs. an Attribute-based Approach to Agri-Environmental Policy Valuation: Do Welfare Estimates Differ?	JOURNAL OF AGRICULTU RAL ECONOMICS. 62(2): 305.	N	N
Jankie, Dudu,	2011	"Tell me who you are": Problematizing the construction and positionalities of "insider"/"outside r" of a "Native" ethnographer in a postcolonial context. In Decolonizing Reseach in Cross-Cultural Contexts: Critical Personal Narratives, (Eds.) K. Mutua, & B.B. Swadener.	State University of New York Press, New York, NY, USA	N	Y
Johnston, Leah; Doyle, Joyce; Morgan, Bec; Atkinson-Briggs, Sharon; Firebrace, Bradley; Marika, Mayatili; Reilly, Rachel; Cargo, Margaret; Riley, Therese; Rowley, Kevin,	2013	A Review of Programs That Targeted Environmental Determinants of Aboriginal and Torres Strait Islander Health.	International Journal of Environmental Research and Public Health. 10(8): 3518.	Y	N
Kaufman, N,	2013	Putting Intangible Heritage in its Place(s): Proposals for Policy and Practice.	INTERNATIO NAL JOURNAL OF INTANGIBLE HERITAGE. 8: 19.	N	N
Keely, Annie,	1992	Two Laws Meet: The Significance of Junction Waterhold.	Aboriginal Law Bulletin. 56: 14.	N	N

Kelly, C,	2018	I Need the Sea and the Sea Needs Me': Symbiotic coastal policy narratives for human wellbeing and sustainability in the UK.	MARINE POLICY. 97: 223.	N	N
Kenny, Tiff-Annie; Hing Man Chan,	2017	Estimating Wildlife Harvest Based on Reported Consumption by Inuit in the Canadian Arctic.	Arctic. 70(1): 1.	Y	N
Kovach, Margaret,	2009	Indigenous Methodologies: Characteristics, Conversations, and Contexts.	University of Toronto Press, Toronto, Canada. (): .	N	Y
Kuper, Richard,	2003	Conferderation paysanne: French farmers fight back.	Social Policy. 33(2): 23.	N	N
LAH, Ljubo; AŽMAN MOMIRSKI, Lucija,	2018	AN OUTSTANDING CULTURAL KARST LANDSCAPE: TERRACED LANDSCAPE FEATURES AND STRENGTHENING THE NATURAL AND CULTURAL VALUES OF THE KARST PLATEAU.	Annales: Series Historia et Sociologia. 28(4): 741.	Y	N
Lamarque, Pénélope; Tappeiner, Ulrike; Turner, Catherine; Steinbacher, Melanie; Bardgett, Richard D; Szukics, Ute; Schermer, Markus; Lavorel, Sandra,	2011	Stakeholder perceptions of grassland ecosystem services in relation to knowledge on soil fertility and biodiversity.	Regional Environmental Change. 11(4): 791.	N	N
Lambert, David K,	1995	Grazing on public rangelands: An	Contemporary Economic	N	N

		evolving problem of property rights.	Policy. 13(2): 119.		
Larsen, Frank Wugt; Petersen, Anders Højgård; Strange, Niels; Lund, Mette Palitzsch; Rahbek, Carsten,	2008	A Quantitative Analysis of Biodiversity and the Recreational Value of Potential National Parks in Denmark.	Environmental Management. 41(5): 685.	N	N
Larson, Rhett B.,	2018	Colorado River Lessons for International Water Law.	Jurimetrics. 59: 83.	N	N
Latulippe, Nicole,	2015	Bridging Parallel Rows: Epistemic Difference and Relational Accountability in Cross-Cultural Research.	International Indigenous Policy Journal. 6(2).	N	N
Lawler, Julia H; Bullock, Ryan C L,	2017	A Case for Indigenous Community Forestry.	Journal of Forestry. 115(2): 117.	Y	N
Lefevre, Jessica S,	2013	A Pioneering Effort in the Design of Process and Law Supporting Integrated Arctic Ocean Management.	Environmental Law Reporter News & Analysis. 43(10).	Y	N
LEPOFSKY, DANA; LERTZMAN, KEN,	2018	Through the Lens of the Land: Reflections from Archaeology, Ethnoecology, and Environmental Science on Collaborations with First Nations, 1970s to the Present.	BC Studies. 200.	Y	N
Lewis, JL; Sheppard, SRJ,	2005	Ancient values, new challenges: Indigenous spiritual perceptions of landscapes and forest management.	SOCIETY & NATURAL RESOURCES. 18(10): 907.	Y	N

Long Island Sound Regional Study (LISSR), New England River Basins Commission,	1973	Outdoor Recreation: An interim report	Long Island Sound Regoinal Study (LISSR), New England River Basins Commission, U.S. Congressional Serial Set. (13072-3).	N	N
Long Island Sound Regional Study (LISSR), New England River Basins Commission,	1974	Scenic and cultural resources: An Interim Report.	Long Island Sound Regoinal Study (LISSR), New England River Basins Commission, U.S. Congressional Serial Set. (13072-3).	N	N
Lopes, Rita; Videira, Nuno,	2016	A Collaborative Approach for Scoping Ecosystem Services with Stakeholders: The Case of Arrábida Natural Park.	Environmental Management. 58(2): 323.	Y	N
Luizza, MW; Evangelista, PH; Jarnevich, CS; West, A; Stewart, H,	2016	Integrating subsistence practice and species distribution modeling: assessing invasive elodea's potential impact on Native Alaskan subsistence of Chinook salmon and whitefish.	ENVIRONME NTAL MANAGEME NT. 58(1): 144.	N	N
Lynch, Michael J; Stretesky, Paul B,	2012	Native Americans and Social and Environmental Justice: Implications for Criminology.	Social Justice. 38(3): 104.	N	N
Maclean, Ilya M; D; Boar, Rosalind R; Lugo, Charles,	2011	A Review of the Relative Merits of Conserving,	Environmental Management. 47(2): 218.	N	N

		Using, or Draining Papyrus Swamps.			
Makgill, Robert A. Rennie, Hamish G. ,	2012	A Model for Integrated Coastal Management Legislation: A Principled Analysis of New Zealand Resource Management Act 1991.	International Journal of Marine and Coastal Law. 27: 135.	Y	N
Manuera, Eru; Tumu, Te Heuheu, Tumu; Prime, Kevin,	1993 Reprint (first published in 1992)	The conservation estate, the Tangata Whenua.	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 327-338.	N	N
Marek-Martinez, Ora Viola,	2016	Archaeology For, By, and With the Navajo People- the <i> Nihookáá Dine'é' Bila' Ashdla'ii </i> Way.	Dissertation, University of California, Berkeley.	Y	N
Marshall, Murdena,	2008	Cultural Senstitivity and Cultural Humility Module - Health and healing - death and dying: women's roles within. Workshop training materials for "cultural sensitivity and cultural humility"; for health organization.	http://www.integrativescience.ca/uploads/articles/2008-Marshall-cultural-sensitivity-humility-module-aboriginal-health.pdf	N	Y
Martinez, Desireé Reneé,	2006	Overcoming Hindrances to Our Enduring Responsibility to the Ancestors: Protecting Traditional Cultural Places.	American Indian Quarterly. 30(3/4): 486.	Y	N
Martins, Bruno; Pereira, Andreia,	2018	Residents' Perception and	Geosciences. 8(10).	N	N

		Assessment of Geomorphosites of the Alvão—Chaves Region.			
Mathe, Syndhia;Rey-Valette, Helene,	2015	Local Knowledge of Pond Fish-Farming Ecosystem Services: Management Implications of Stakeholders' Perceptions in Three Different Contexts (Brazil, France and Indonesia).	Sustainability. 7(6): 7644.	N	N
McCormick, Sabrina,	2006	THE BRAZILIAN ANTI-DAM MOVEMENT: Knowledge Contestation as Communicative Action.	Organization & Environment. 19(3): 321.	Y	N
McGregor, Deborah,	2004	Coming Full Circle: Indigenous Knowledge, Environment, and Our Future.	American Indian Quarterly. 28(3/4): 385.	Y	N
McIntyre, N; Moore, J; Yuan, M,	2008	A place-based, values-centered approach to managing recreation on Canadian Crown lands.	SOCIETY & NATURAL RESOURCES. 21(8): 657.	N	N
McKinney, Matthew L. Paisley, Richard Kyle Stenovec, Molly Smith,	2016	A Sacred Responsibility: Governing the Use of Water and Related Resources in the International Columbia Basin through the Prism of Tribes and First Nations Report.	Public Land & Resources Law Review. 37: 157.	Y	N
Mclain, Rebecca; Poe, Melissa; Biedenweg, Kelly; Cerveny, Lee; Besser,	2013	Making Sense of Human Ecology Mapping: An Overview of Approaches to	Human Ecology. 41(5): 651.	Y	N

Diane; Blahna, Dale,		Integrating Socio-Spatial Data into Environmental Planning.			
McLain, RJ; Lee, RG,	1996	Adaptive management: Promises and pitfalls.	ENVIRONME NTAL MANAGEME NT. 20(4): 437.	N	N
McMillan, L Jane, PhD,	2012	"MU KISI MAQUMAWKIK PASIK KATAQ - WE CAN'T ONLY EAT EELS:" MI'KMAQ CONTESTED HISTORIES AND UNCONTESTED SILENCES.	The Canadian Journal of Native Studies. 32(1): 119.	Y	N
McNee, Andrew, Turner, Rose, Sherwin, Alistair, Liddle, Lynette,	1993 Reprint (first publish ed in 1992)	Land management and use: sustainability and Aboriginal people.	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 99-116.	Y	N
Meutia, Z.D., Akbar, R., Zulkaidi, D.,	2018	Heritage planning and rethinking the meaning and values of designating heritage sites in a post-disaster context: The case of Aceh, Indonesia.	IOP Conference Series: Earth and Environmental Science. 158: 012039.	N	N
Morgan, Monica; Stelein, Lisa; Weir, Jessica,	2004	Indigenous Water Rights Within the Murray Darling Basin.	Indigenous Law Bulletin. 5(29): 17.	Y	N
MORRISON, SCOTT A.; SILLETT, T. SCOTT; FUNK, W. CHRIS; GHALAMBOR, CAMERON K.; RICK, TORBEN C.,	2018	California Island Rediscovery: building an archive to improve conservation today and equip the historical	Western North American Naturalist. 78(4): 837.	N	N

		ecologist of tomorrow.			
Mowaljarlai, David,	1993 Reprint (first published in 1992)	WAYRRULL - Aboriginal traditional responsibility in cultural resource management in the northwest Kimberleyes of Western Australia.	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 179-190.	Y	N
Mullett, Albert,	1993 Reprint (first published in 1992)	No people, no spirit, no land.	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 45-46.	Y	N
Musacchio, LR; Grant, WE,	2002	Agricultural production and wetland habitat quality in a coastal prairie ecosystem: simulated effects of alternative resource policies on land-use decisions.	ECOLOGICAL MODELLING. 150: 23.	N	N
Muzzin, Ruth Stoner,	2010	Seeing the Free Exercise Forest for the Trees: NEPA, RFRA and Navajo Nation .	Hastings West-Northwest Journal of Environmental Law and Policy. 16: 277.	Y	N
Natarajan, Lucy; Lock, Simon J; Rydin, Yvonne; Lee, Maria,	2019	Participatory planning and major infrastructure: experiences in REI NSIP regulation.	The Town Planning Review. 90(2): 117.	N	N
Native American Rights Fund,	1979	"We Also Have A Religion": The American Indian Religious Freedom Act and the Religious	NARF Legal Review. 5: 1.	Y	N

		Freedom Project of the Native American Rights Fund.			
Necefer, Len Edward,	2016	Development of a decision aid for energy resource management for the Navajo Nation incorporating environmental cultural values.	Dissertation, Carnegie Mellon University, Pittsburgh, PA, USA.	Y	N
Nesbitt, Bradley,	1993 Reprint (first published in 1992)	Aboriginal 'joint' management of northwest Kimberly conservation reserves: achievable under existing legislation but is there the political will?	Aboriginal Involvement in Parks and Protected Areas, (eds) Birckhead, Jim, De Lacy, Terry, and Smith, Laurajane, pp. 251-262.	Y	N
Nielsen, AB; Olsen, SB; Lundhede, T,	2007	An economic valuation of the recreational benefits associated with nature-based forest management practices.	LANDSCAPE AND URBAN PLANNING. 80(1-2): 63.	N	N
Nordlund, Lina M.; Unsworth, Richard K. F.; Gullström, Martin; Cullen-Unsworth, Leanne C.,	2018	Global significance of seagrass fishery activity.	Fish & Fisheries. 19(3): 399.	Y	N
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Appendix E – Definitions and Codebooks

This appendix presents final definitions and codebooks for synthetic constructs developed throughout the analysis and synthesis, including development of the Typology of Cultural-Benefits-Knowledge-Forms (Appendix E1), categories of cultural benefits used in our analysis (Appendix E2), intersections with decision-making, including Knowledge Pathways and Phases of decision-making (Appendix E3), variables that influence success around mobilization and integration of cultural-benefits-knowledge in decision-making (Appendix E4), and definitions of areas in our final Map of Areas of Learning Opportunity (Appendix E5).

E1 Knowledge Forms

During Stage 2 Analysis we utilized Holistic (first-cycle) and Theoretical (second-cycle) coding (Saldaña, 2009) to build a Typology of Cultural-Benefits-Knowledge-Forms encountered in our literature sample (Main Text, Section 3.3.1.1). This Stage 2 Analysis was based on the final Knowledge Form Sample, including 495 distinct knowledge forms derived from 180 original source articles (Table A1, Appendix A).

Table E1.1 provides definitions of our final list of first-cycle Holistic Codes (Saldaña, 2009). During Holistic Coding, we described each knowledge form. As we proceeded, we made note of characteristics that seemed to vary across our sample and may constitute meaningful differences. Our goal was to identify characteristics that could serve as the basis for development of unique categories of knowledge forms.

Table E1.2 provides the results of second-cycle Theoretical Coding (Saldaña, 2009), in which we organized first-cycle codes into a meaningful structure. We discovered that the code *Knowledge Concept* acted as a core, overarching category that could serve as "an umbrella that covers and accounts for all other codes and categories formulated thus far in grounded theory

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analysis" (Saldaña, 2009, p. 163). Our other Holistic Codes fell into place as descriptive

characteristics of two overarching Knowledge Concept categories: 1) Enacted knowledge forms

and 2) Translated knowledge forms. The variation of these descriptive characteristics across

Translated knowledge forms led to our conceptualization of a spectrum within the Translated

category, from more Contextualized to more Abstracted knowledge forms.

Table E1.3 provides final definitions of the four emergent Cultural-Benefits-Knowledge-

Form categories: 1) Enacted knowledge forms; 2) Contextualized Translations; 3) Intermediary

Translations; and 4) Abstracted Translations.

Table E1.1: First Cycle Coding: Holistic Coding for Knowledge Forms

CODE NAME	Description
Knowledge Concept	How knowledge is conceptualized, i.e., knowledge-as-product or knowledge-as-practice.
Guiding Questions	What questions does a particular form of cultural-benefits-knowledge have the potential to answer?
Common Methods	What methods are linked to the production or practice of the knowledge form?
Epistemology	What beliefs about truth and validity are associated with the production or practice of the knowledge form?
Value Emphasis	What aspects of or perspectives on value are conveyed by knowledge in this form? I.e., does this knowledge form convey instrumental, relational, intrinsic – or unspecified – aspects of value; is the knowledge form associated with a reductionist value perspective, i.e., value aspects can be distinguished, or a holistic value perspective, i.e., relational, instrumental, and intrinsic value aspects are intertwined and mutually reinforcing and cannot be meaningfully separated.
Vantage Point	Does the knowledge form arise from and relate to a context-specific view of value and benefit, or a universalizing view (e.g., Díaz et al., 2015a).

Table E1.2: Theoretical Coding for Knowledge Form Categories

KNOWLEDGE CONCEPT	KNOWLEDGE FORM	CHARACTERISTICS
Knowledge-as-Practice	**Enacted knowledge forms**	**Guiding Questions**: How should I engage with ecosystems to uphold their value and maintain balance in relationships? What are my responsibilities?
		Common Methods: Direct experience; story / ceremony; internal coming to know.
		Epistemology: Experiential and intersubjectivist (Held, 2019).
		Value Emphasis: Holistic value perspective.
		Vantage Point: Context-specific (Díaz et al., 2015).
Knowledge-as-Product	**Contextualized Translation**	**Guiding Questions**: Why and how is an ecosystem important? For whom is it important?
		Common Methods: Observation; Interview Elicitation; Content Analysis.
		Epistemology: Experiential, subjectivist, or intersubjectivist (Held, 2019).
		Value Emphasis: Holistic value perspective or Relational value aspects
		Vantage Point: Context-specific (Díaz et al., 2015).
	Intermediary Translation	**Guiding Questions**: What is valued, i.e., categories, sites, objects? Where is value located, i.e., spatial?
		Common Methods: Survey elicitation; Mapping.
		Epistemology: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.
		Value Emphasis: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.
		Vantage Point: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.
	Abstracted Translation	**Guiding Questions**: How much value does an ecosystem provide? What elements or functions of an ecosystem are most valuable?
		Common Methods: Survey elicitation; Monetization; Preference ranking.
		Epistemology: Objectivist, empirical (Held, 2019).
		Value Emphasis: Instrumental value aspects.
		Vantage Point: Universalizing (Díaz et al., 2015).

Table E1.3: Final Definitions of Cultural-Benefits-Knowledge-Form Categories

KNOWLEDGE CONCEPT	KNOWLEDGE FORM CATEGORY	CATEGORY DEFINITION
Knowledge-as-Practice	**ENACTED FORMS**	Forms of embodied cultural-benefits-knowledge, i.e., knowledge practices. These include **practices of knowledge sharing** that reproduce and convey truths, e.g., narrative, linguistic, performative, visual, or ceremonial forms. These also include the **enactment of these truths through action**, whether through articulation of principles for responsible engagement with ecosystems or demonstration through lived engagement with ecosystems. Lived practices may include engaging in traditional place-based practices and defending a way of life, e.g., seeking rights to occupy, use, and steward the ecosystems of traditional homelands and other efforts toward cultural survival.
Knowledge-as-Product	**CONTEXTUALIZED TRANSLATION**	Forms of documented knowledge, i.e. knowledge products, that attempt to translate meaning and benefit, staying as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. There is always a loss of meaning in translation, but there is an effort to retain original meanings and understandings.
	INTERMEDIARY TRANSLATION	Forms of documented knowledge (knowledge products) that seek to convey *what* is important, i.e., categories, or *where* value is located, i.e., spatial locations. The degree to which these knowledge forms are removed from the original context and value perspective of the cultural-benefits-knowledge-holders, i.e., abstracted, depends on the level of involvement of knowledge holders in defining terms and categories, etc.
	ABSTRACTED TRANSLATION	Forms of documented knowledge, i.e., knowledge products, that seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."

E1.1 Appendix E1 References

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E2 Final Definitions of Cultural Benefits Categories

During Stage 3 Analysis we drew on textual data extracted during Stage 1 Analysis to refine definitions for cultural benefits categories. These categories overlap with but did not align completely with any one of the multiple typologies of Cultural Ecosystem Services or Nature's Contributions to People that have been proposed in the past (e.g., Boyd, 2006; Chan et al., 2012; Costanza et al., 1997; de Groot et al., 2002, 2010; Diaz et al., 2018; Gould & Lincoln, 2017; Ingram et al., 2020; MEA, 2005; Milcu et al., 2013; Raymond et al., 2009; UKNEA, 2011, 2014). This reflects an emerging reality that relevant cultural benefits categories will differ according to the populations whose cultural-benefits-knowledges are being assessed. For example, Pert et al. (2015) add "Governance" as a core Cultural Ecosystem Service, with respect to the foundational contribution to well-being that Aboriginal groups Australia attributed to their involvement as stewards of their ancestral lands. This echoes Ingram et al. (2020)'s newly proposed CES category of "Fulfilling Stewardship," as well as a new category we propose in our final list: "Right Relationship with Non-Human Nature."

Table E2.1: Cultural Benefits Categories Used in This Analysis

CULTURAL BENEFIT CATEGORY	DEFINITION	LINKAGES TO SPECIFIC PAST TYPOLOGIES	REVISIONS TO PAST CATEGORIES AND OTHER NOTES
Aesthetic Value	The contributions ecosystems make to human well-being through appreciation of beauty or other sensory or visual experiences of an ecosystem.	Following Gould & Lincoln (2017) and Ingram et al. (2020).	
Cultural Heritage Value	The contributions that ecosystems make to human well-being in terms of linkages to history through culturally important landscapes, sites, or objects (*heritage as historic*), or providing opportunities to continue practices that engage with heritage landscapes, sites, or objects		Although some past typologies combine Cultural Identity, Cultural Heritage, and/or Sense of Place (e.g., de Groot et al., 2010; Gee & Burkhard, 2010; Gould & Lincoln, 2017), we encountered distinct articulations of these benefits and elected to keep them as three separate categories.

	as part of current identity, meaning, and knowledge (*heritage as lived*).		
Cultural Identity Value	The contributions ecosystems make to human well-being in terms of collective (community or communal) identity.		Although some past typologies combine Cultural Identity, Cultural Heritage, and/or Sense of Place (e.g., de Groot et al., 2010; Gee & Burkhard, 2010; Gould & Lincoln, 2017), we encountered distinct articulations of these benefits and elected to keep them as three separate categories.
Educational and Scientific Value	The contributions ecosystems make in terms of opportunities to gain information, skills, and/or carry out scientific research. Note: There are clear linkages between maintenance of knowledge systems and educational value. However, we seek to clearly distinguish between the fundamental value of knowledge systems as a foundation for socio-cultural understanding, and the use of ecosystems for pedagogical purposes.	Following de Groot et al. (2002, 2010).	We follow de Groot et al. (2002, 2010) by combining Educational and Scientific Value, given their commonality around use of ecosystems for purposes of learning and gaining information.
Health	The contributions ecosystems make to health and healing, whether through opportunities for physical movement and material sustenance, or psychologically or spiritually beneficial engagement	Health is included in several past typologies of cultural benefit (e.g., Diaz et al., 2018; Fish et al., 2016; UKNEA, 2014).	We coded separately for Physical Health and Mental Health, but given strong overlap in results for these categories, and general interrelationship between physical and mental health, we elected to combine them into one category in our list.
Inspiration Value	The contributions ecosystems make to human well-being through inspiration for creative expression or architectural or technological design.	Following de Groot et al. (2010) and Díaz et al. (2018).	While some past typologies distinguish between inspiration for art and inspiration for ingenuity in design or technology (e.g., Gould & Lincoln, 2017), we follow de Groot et al. (2010) and Díaz et al. (2018) by subsuming both *Artistic Value* and Gould & Lincoln (2017)'s category of *Ingenuity* under the larger category of Inspiration Value.
Knowledge Systems	The contributions ecosystems make to sustaining knowledge systems that serve as foundations for socio-cultural self-understanding. Cultural survival is often tied to maintenance of place-based knowledge systems and associated ways of life, in		We propose that the original MEA (2005) category of "Cultural Diversity" can be subsumed under the larger category of Knowledge Systems, given that diverse knowledge systems provide the basis for cultural diversity. We also seek to clearly distinguish between the contributions ecosystems make to

	which knowledge and practice are intertwined.		maintaining Knowledge Systems as a foundation for socio-cultural understanding and cultural survival, and the contributions they make to education in the sense of using ecosystems for pedagogical purposes; although there are clear linkages between the two, they differ in the depth of their importance.
Recreational Value	The contributions ecosystems make to well-being through opportunities for physically and psychologically beneficial activities, which in turn offer healing, relaxation, and aesthetic enjoyment, and can provide a foundation for sense of place, etc.		
Right Relationship with Non-Human Nature	The contributions ecosystems make to human well-being by enabling us to live in accordance with moral obligations to non-human others, a.k.a. the natural world.		This category subsumes both the utilitarian concept of "Existence Value," which seeks to capture human awareness of the intrinsic value of non-human value through an instrumental value frame, as well as concepts of care, reciprocity, and obligation to the non-human nature that are best understood through relational or holistic value frames.
Right Relationship with Other Generations	The contributions ecosystems make to our relationships with past and future generations, including the ancestors, our descendants, and future generations of humans more broadly.		This category subsumes both the utilitarian concept of "Bequest Value," which seeks to capture human awareness of the intrinsic value of future generations through an instrumental value frame, as well as kinship obligations to ancestors and future generations that are best understood through relational or holistic value frames.
Sense of Place	The contributions ecosystems make to human well-being in terms of place identity, including sense of belonging, rootedness, or connectedness to different aspects of the natural world and one's interactions with it.	Following de Groot et al. (2010); Díaz et al. (2018); Ingram et al. (2020).	Although some past typologies combine Cultural Identity, Cultural Heritage, and/or Sense of Place (e.g., de Groot et al., 2010; Gee & Burkhard, 2010; Gould & Lincoln, 2017), we encountered distinct articulations of these benefits and elected to keep them as three separate categories.
Social Ties or Kinship among Humans	The contributions ecosystems make to strengthening of social ties and maintenance of kinship bonds among humans. This category is also commonly referenced as social capital, social cohesion, community cohesion, etc.		For social ties or kinship bonds between humans and non-humans, see the category *Right Relationship with Non-Humans Nature*. For social ties or kinship bonds with past or future generations, see the category *Right Relationship with Other Generations*.

Spiritual Value	The contributions ecosystems make to human well-being in terms of offering sacred locations or inspiring landscapes that support and enable spiritual connection and experience.		Although some typologies distinguish between spiritual and ceremonial value (e.g., Gould & Lincoln, 2017; Ingram et al., 2020), we included all discussion of sacred sites, ceremonial use and value, and spiritual & religious values under our Spiritual Value category
Subsistence Value	The contributions ecosystems make to human well-being through providing opportunity for subsistence harvesting activities, which in turn provide material, cultural, and spiritual sustenance and in many cases enable cultural survival through maintenance of the knowledge system and fulfillment of reciprocal obligations to non-humans.	Chan et al. (2012) offers precedent for inclusion of Subsistence as a category of cultural benefit.	Although many typologies of cultural benefits have excluded Subsistence, we elected to include it. This enabled us to explore the role that subsistence plays as a Benefit Proxy for a wider array of intangible cultural benefits categories, etc. (Main Text, Section 3.3.2.1).
Transformative Value	The contributions ecosystems make to changing the way we perceive and think, including through gaining perspective or life lessons.	Transformative Value has appeared occasionally as a separate category of cultural benefit linked to memorable experiences that change us in lasting ways (e.g., Bryce et al., 2016; Chan et al., 2012).	For our purposes, we include Gould & Lincoln (2017)'s suggested categories of "Life Teacher" and "Perspective" under this larger category of Transformative Value. **Note**: This category is not included in Figure 2 (Main Text, Section 3.3.1.2) given that we only encountered one clear example of in our synthesis.

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E3 Intersections with Decision-making

Table E3.1 provides final definitions for Knowledge Pathways described in the main text,

Section 3.3.2.1.

Table E3.1: Knowledge Pathway Definitions

PATHWAY CATEGORY	PATHWAY SUB-CATEGORY	DEFINITION
Knowledge Product Pathway	Use Proxy	The value of a cultural benefit category is reduced to its use value, i.e., instrumental value aspects.
	Benefit Proxy	When a more measurable cultural benefit or ecological indicator is substituted as an indicator for less tangible categories of cultural benefit.
Knowledge Practice Pathway	Management Practice	Direct involvement of cultural-benefits-knowledge-holders in ecosystem management, e.g., through identification of preferred ecological management approaches, ecological thresholds, or other ecological objectives that support well-being.
	Institutional Practice	Advocacy by cultural-benefits-knowledge-holders for institutional arrangements which afford resource tenure and shared decision authority, e.g., co-management or Indigenous-led management.
Overlapping Product-Practice Pathways	Co-Research	Direct involvement of knowledge-holders in processes of cultural-benefits-knowledge translation.
	Amplification	Use of Translated knowledge forms to support and amplify the voices of cultural-benefits-knowledge-holders as they seek to inform environmental management.

E4 Barriers and Enabling Factors for Consideration of Cultural-Benefits-Knowledge

This section provides information about the specific articles and books that informed each of our barriers and enabling factor themes (Table E4.1), as well as records linked to the cross-cutting theme of Cultural Comprehension (Table E4.2). Full citations for these records can also be found in Table D1 in Appendix D: Final Literature Sample. Note that the article and book records that contributed to this analysis of barriers and enabling factors were only those included in the Knowledge Form Sub-Sample (Table A1), which means that they provided information about knowledge forms that conveyed either Cultural Identity or Knowledge Systems benefits.

Table E4.1: Opportunities for Improved Consideration of Cultural-Benefits-Knowledge in Environmental Decision-Making

THEME	EXAMPLES	CITATIONS
◊ Structural Factors: *The rules of a decision context that privilege certain values and knowledge forms.*	- Worldview(s) and values embedded within institutions, including legislative and legal structures;	Brugnach & Ingram, 2012; Davies et al., 1999; Lawson, 1993; Lewis & Sheppard, 2005; McMillan, 2012; Pollino et al., 2007
	- Knowledge forms required by or permitted to inform the decision context;	Brugnach & Ingram, 2012; Davidson & McKendrick, 2007, Makgill & Rennie, 2012; Pollino et al., 2007; Raymond-Yakoubian & Daniel, 2018; Stocker et al., 2016
	- Degree of policy adaptiveness and institutional flexibility, e.g., integrated or adaptive management;	Johnston et al., 2013; Martinez, 2006; McKinney et al., 2016; Sheremata, 2018; Turner & Bitonti, 2017
	- Degree of participatory process and shared authority throughout phases of decision-making.	Bode, 2017; Chanwai & Richardson, 1998; Clemmer, 2004; Craig et al., 2012; Dhiksawan et al., 2018; Craig, 1999; Diduck et al., 2013; Geering & Roberts, 1993; McKinney et al., 2016; Morgan et al., 2004; O'Neill, 2018; Pollino et al., 2008; Sullivan, 1993
◊ Political Will: *Whether or not knowledge pluralism is implemented in practice depends on political will at the scale of both institutions and individual decision-makers.*	- Level of political will to share authority throughout phases of decision-making;	Bluemel, 2005; Bode, 2017; Brugnach & Ingram, 2012; Chanwai & Richardson, 1998; Craig et al., 2012; Denny & Fanning, 2016; Lawler & Bullock, 2017; Trainor, 2006; Tsoukala et al., 2018
	- Level of political will to implement knowledge co-production;	Blakney, 2003; Craig et al., 2012; Davies et al., 1999; Kenny & Chan, 2017; Lawler & Bullock, 2017; Lefevre, 2013
	- Level of political will to recognize treaty rights and engage in meaningful Tribal consultation;	Chanwai & Richardson, 1998; Clemmer, 2004; Garvie, 2009; Lefevre, 2013; Marek-Martinez, 2016; McMillan, 2012; Naylor, 1993; Nesbitt, 1993; O'Neill, 2018; Raymond-Yakoubian & Daniel, 2018; Sillitoe, 2006; Smith, 2007; Sole & Woods, 1993; Zurba et al., 2012
	- Level of political will to implement legally binding agreements or pursue new legal channels.	Groenfeldt, 2004; Lefevre, 2013; Watson, 2018
◊ Mobilizing Knowledge: *Mobilizing cultural-benefits-knowledge means making it*	- Strength of relationship and trust between authorities and cultural-benefits-knowledge holders;	Booth & Skelton, 2011; Davies et al., 1999; Garvie, 2009; Lawson, 1993; Lewis & Sheppard, 2005; Martinez, 2006; Yazzie, 2006; Zurba et al., 2012
	- Degree to which cultural-benefits-knowledge is sensitive or protected;	Lepofsky & Lertzman, 2018; Sole & Woods, 1993
	- Degree to which cultural groups have a united voice and shared goals and vision;	Blakney, 2003; Lawler & Bullock, 2017; Martinez, 2006; Morgan et al., 2004; O'Neill, 2018; Raymond-Yakoubian & Daniel, 2018; Wang, 2018

available to inform decision-making, whether in the form of a knowledge product or the direct involvement of knowledge holders in decision-making.	- Degree of capacity and funding to engage in social movements, collaborative data collection and documentation, or land acquisition to protect cultural benefits;	Birckhead, 1993; Clemmer, 2004; Garvie, 2009; Lawler & Bullock, 2017; Lawson, 1993; O'Neill, 2018; Yazzie, 2006; Zurba et al., 2012
	- Degree of financial and technical resources to support capacity development and facilitate shared visions within and across stakeholder and rights-holder groups;	Lawler & Bullock, 2017; McCormick, 2006; Morgan et al., 2004; O'Neill, 2018; Raymond-Yakoubian & Daniel, 2018; Sullivan, 1993; Wang, 2018
	- Social movements, including acts of resistance and advocacy for institutional change, i.e., institutional practice as enactment of cultural-benefits-knowledge;	Blakney, 2003; Bode, 2017; Diduck et al., 2013; Lah & Azman Momirski, 2018; Lawler & Bullock, 2017; Lepofsky & Lertzman, 2018; Martinez, 2006; McKinney et al., 2016; McMillan, 2012; Morgan et al., 2004; Nesbitt, 1993; Norgaard & Reed, 2017; Peace, 1999; Pollino et al., 2007; Privott, 2019; Raymond-Yakoubian & Daniel, 2018; Scott-Enns, 2015; Shepherd, 2008; Shirley & Word, 2018; Smith, 2007; Sole & Woods, 1993; Stocker et al., 2016; Turner & Bitonti, 2017; Walsh, 1993; Wang, 2018; Zurba et al., 2012
	- Alliances with researchers, non-profits, or governments to amplify cultural-benefits-knowledge.	Lefevre, 2013; Robinson et al., 2012
◊ Integrating Knowledge: *Once cultural-benefits-knowledge has been mobilized, whether as product or in practice, there are many barriers and enabling factors that influence whether and how it informs decision-making.*	- Strength of relationship and level of trust between authorities and cultural-benefits-knowledge holders;	Booth & Skelton, 2011; Davies et al., 1999; Garvie, 2009; Lawson, 1993; Lewis & Sheppard, 2005; Martinez, 2006; Yazzie, 2006; Zurba et al., 2012
	- Degree of openness – of both individual decision-makers and institutions – to diverse forms of cultural-benefits-knowledge, beyond quantitative and written documentation;	Makgill & Rennie, 2012; McKinney et al., 2016; Pollino et al., 2007; Richardson, 2018; Richardson, 2016; Watson, 2018; Yazzie, 2006
	- Degree to which cultural-benefits-knowledge can be meaningfully conveyed via privileged knowledge forms, e.g., quantitative metrics;	Crossman & Pollino, 2018; Dhiksawan et al., 2018; Kenny & Chan, 2017; Lewis & Sheppard, 2005
	- Degree to which cultural benefits can be protected through strategic framing of ecosystem value in ecological or utilitarian terms, or in alliance with other policy priorities;	Johnston et al., 2013; Lepofsky & Lertzman, 2018; Shirley & Word, 2018; Sletto, 2002
	- Degree to which cultural-benefits-knowledge holders participate in research, i.e. co-research or community-led research;	Ford et al., 2014; Garvie, 2009; McCormick, 2006; Pollino et al., 2007; Raymond-Yakoubian & Daniel, 2018; Sheremata, 2018; Tsoukala et al., 2018; Yazzie, 2006
	- Degree to which cultural-benefits-knowledge holders participate in ecosystem management, i.e., management practice as enactment of cultural benefits knowledge.	Blakney, 2003; Craig et al., 2012; Davies et al., 1999; Denny & Fanning, 2016; Kenny & Chan, 2017; Lawler & Bullock, 2017; Lefevre, 2013; Pollino et al., 2007; Raymond-Yakoubian & Daniel, 2018

Table E4.2: Cultural Comprehension as a Cross-Cutting Barrier or Enabling Factor

THEME	EXAMPLES	CITATIONS
◊ Cultural Comprehension *The degree to which decision-makers are aware of their own knowledge systems and those of others influences their willingness and ability to pursue opportunities to integrate plural values and knowledge forms.*	Individual Scale - Building respectful relationships and mutual understanding between cultural groups, e.g., Tribes, and decision-makers, or bringing individuals from diverse worldviews into positions of decision-making authority;	Birckhead, 1993; Booth & Skelton, 2011; Garvie, 2009; Lawson, 1993; Lepofsky & Lertzman, 2018; Marek-Martinez, 2016; Martinez, 2006; Muzzin, 2010; Sullivan, 1993; Watson, 2018; Yazzie, 2006; Zurba et al., 2012
	- Availability of educational opportunities that support decision-makers to recognize their own embedded knowledge systems and comprehend the knowledge systems of others;	Booth & Skelton, 2011; Dhiksawan et al., 2018; Lepofsky & Lertzman, 2018; Lewis & Sheppard, 2005; Makgill & Rennie, 2012; Marek-Martinez, 2003; Pollino et al., 2007; Sillitoe, 2006; Walsh, 1993; Watson, 2018
	- Level of decision-maker ability or willingness to comprehend and integrate diverse ways of knowing, including forms of knowledge understood as valid across knowledge systems.	Brownlee, 2002; Clemmer, 2004; Denny & Fanning, 2016; Mowaljarlai, 1993; Native American Rights Fund, 1979; Norgaard & Reed, 2017; Richardson, 2016; Sillitoe, 2006; Smith, 2007; Sole & Woods, 1993; Sullivan, 1993; Watson, 2018
The degree to which multiple knowledge systems are legitimated within institutions influences the available opportunities for meaningful engagement with plural values and knowledge forms.	Institutional Scale - Degree to which institutions create space for multiple knowledge systems in terms of embedded definitions, terminology, categories, decision rules, and requirements for admissible knowledge;	Brugnach & Ingram, 2012; Makgill & Rennie, 2012; Martinez, 2006; McCormick, 2006; Muzzin, 2010; Pollino et al. 2017; Norgaard & Reed, 2018; Scott-Enns, 2015; Watson, 2018
	- Degree to which institutions recognize and prioritize plural values and plural human-nature relationships;	Booth & Skelton, 2011; Diduck et al., 2013; Lewis & Sheppard, 2005; Native American Rights Fund, 1979; Pollino et al. 2007; Shirley & Word, 2018; Watson, 2018
	- Degree to which institutions enable direct involvement of cultural-benefits-knowledge-holders throughout phases of decision-making.	Garvie, 2009; McCormick, 2006; Shirley & Word, 2018

E5 Areas of Opportunity

Table E5.1 presents definitions of the areas of learning opportunity. The Map of Areas of

Learning Opportunity (Main Text, Fig. 3.5, Section 3.4) is at the core of our synthesizing

argument around the need to shift from a focus on "ES-knowledge-use" to "ES-learning-

opportunities."

Table E5.1: Definitions of Areas of Learning Opportunity

AREA OF LEARNING OPPORTUNITY	SUB-AREA	DEFINITION
A. Translation to Product	n/a	Opportunities to better represent cultural-benefits-knowledge in static informational products. When produced by or in collaboration with cultural-benefits-knowledge-holders, knowledge products are most likely to align with knowledge holders' understandings of well-being and benefit. However, knowledge products always have the potential to be (mis)interpreted and used by decision-makers without attention to the original cultural context. The Translation to Product area of learning opportunity mirrors the Product Pathway described in Appendix E3 and Main Text, Section 3.3.2.1.
B. Practice	B1. Management practice	Opportunities for direct involvement of cultural-benefits-knowledge-holders in interpretation of translated cultural-benefits-knowledge, and more broadly in establishing appropriate interaction with ecosystems as part of management. This may include involvement in setting ecological management goals and objectives, or identification of relevant indicators and thresholds. The Management Practice area of learning opportunity mirrors the Practice Pathway described in Appendix E3 and in Main Text Section 3.3.2.1.
	B2. Institutional Practice	Opportunities for cultural-benefits-knowledge-holders to participate in institutional design, including decisions about what constitutes valid, decision-relevant knowledge and who should participate in interpretation and decision-making. This may include forms of action such as advocacy, protest, lawsuits, or other forms of resistance as knowledge practice. The Institutional Practice area of learning opportunity mirrors the Practice Pathway described in Appendix E3 and in Main Text Section 3.3.2.1.
C. Cultural Comprehension	n/a	Opportunities to support awareness and legitimation of multiple knowledge systems, including distinct foundational realities (ontology) and moral/ethical systems (axiology) that give rise to diverse ways of knowing cultural benefit and well-being. This includes opportunities at the level of individual decision-makers as well as at the level of institutional design. The Cultural Comprehension area of learning opportunity mirrors the cross-cutting theme that emerged from analysis of barriers and enabling factors (Table E4.2, see also Main Text Section 3.3.2.2).

Appendix F: Typology of Cultural-Benefits-Knowledge-Forms

Table F1: Cultural-Benefits-Knowledge-Form Categories
Grayed portions of the Table represent areas of overlap between categories (see Main Text Fig. 4.3, Section 4.2.3, for a visual depiction of these relationships).

KNOWLEDGE CONCEPT	KNOWLEDGE FORM	CATEGORY DEFINITION	COMMON CHARACTERISTICS	EXAMPLES
Knowledge-as-Practice	**Enacted knowledge forms**	Include: • **Practices of knowledge sharing** that reproduce and convey truths (e.g., narrative, linguistic, performative, visual, or ceremonial forms). • **Enactment of these truths** through articulation of principles for responsible engagement with ecosystems, or demonstration through lived engagement with ecosystems (e.g., engaging in traditional place-based practices, and defending ecosystems and lifeways tied to those ecosystems).	**Guiding Questions**: How should we engage with ecosystems to uphold their value and maintain balance in relationships? What are our obligations and responsibilities? **Common Methods**: Direct experience; story / ceremony; internal coming to know. **Epistemology**: Experiential and intersubjectivist (Held, 2019). **Value Emphasis**: Holistic value perspective. **Vantage Point**: Context-specific (Díaz et al., 2018).	Enacted forms of knowledge-as-*practice* include expression or demonstration, including to protect cultural benefits or to embody and reproduce them. For example: • Direct involvement in management, i.e., "Management Proxies," in which cultural-benefits-knowledge-holders identify management approaches that will maintain cultural benefits, and • Protest or advocacy to promote institutional changes, i.e., "Institutional Proxies," in which cultural-benefits-knowledge-holders identify institutional arrangements that would enable them to achieve management that aligns with their well-being. • Maintaining engagement in traditional practices and ecosystem stewardship to reproduce and maintain knowledge systems and lifeways.
Intersection between Practice and Product	*Enacted Products*	*As a sub-set of both Knowledge-as-Practice and Knowledge-as-Product, cultural-benefits-knowledge can be enacted when knowledge holders guide or participate in processes of translation.*	*Where cultural-benefits-knowledge holders guide or participate in translation, including through involvement in documentation or interpretation, there can be a blending of characteristics from both Enacted and Translated categories. For*	*Translated knowledge forms may be examples of Enacted knowledge, i.e., Enacted Products, when for example, cultural-benefits-knowledge-holders lead or collaborate in research (Collaborative Research Pathway). This may include, for example, when cultural-benefits-knowledge-holders develop research questions, identify decision-relevant indicators or categories,*

			example, common characteristics of Enacted Knowledge, such as obligation/responsibility, holistic value perspective, and context-specific vantage point may provide a backdrop for how and why translated products are created and used to inform decision-making (e.g., Hoelting et al. 2022; Raymond-Yakoubian & Daniel, 2018).	*and/or when they participate in the production of maps or qualitative written documentation.*
Knowledge-as-Product	**Contextualized Translation**	Knowledge products that attempt to translate meaning and benefit, staying as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. There is always a loss of meaning in translation, but there is an effort to retain original meanings and understandings.	**Guiding Questions**: Why and how is an ecosystem important? For whom is it important? **Common Methods**: Observation; Interview Elicitation; Content Analysis. **Epistemology**: Experiential, subjectivist, or intersubjectivist (Held, 2019). **Value Emphasis**: Holistic value perspective or Relational value aspects **Vantage Point**: Context-specific (Díaz et al., 2018).	Examples of Contextualized Translations include: • Ethnographic reports and other qualitative, rich descriptions of the meanings and value of human-nature relationship. • Written documentation of cultural benefits, including oral contributions to a written record, e.g., public comment.
	Intermediary Translation	*Forms of documented knowledge (knowledge products) that seek to convey what is important, i.e., categories, or where value is located, i.e., spatial locations. The degree to which these knowledge forms are removed from the original*	*Guiding Questions: What is valued, i.e., categories, sites, objects? Where is value located, i.e., spatial?* *Common Methods: Survey elicitation; Mapping.* *Epistemology: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.*	*Depending on how they are created, knowledge forms can fall at an intermediary location between contextualized and abstracted. For example, when mapping efforts utilize locally-meaningful spatial units and definitions of cultural value, or if categories of cultural benefits have been defined locally, the resulting knowledge forms are more likely to retain some cultural context (e.g., Pascua et al., 2017;*

		context and value perspective of the cultural-benefits-knowledge-holders, i.e., abstracted, depends on the level of involvement of knowledge holders in defining terms and categories, etc.	***Value Emphasis****: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.* ***Vantage Point****: Varied, depending on level of involvement of cultural-benefits-knowledge-holders.*	*Rawluk et al., 2019). However, if they rely on universalized categories or definitions of space and value, they begin to merge with fully abstracted forms of documentation.*
	Abstracted Translation	Forms of documented knowledge, i.e., knowledge products, that seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."	**Guiding Questions**: How much value does an ecosystem provide? What elements or functions of an ecosystem are most valuable? **Common Methods**: Survey elicitation; Monetization; Preference ranking; Mapping. **Epistemology**: Objectivist, empirical (Held, 2019). **Value Emphasis**: Instrumental value aspects. **Vantage Point**: Universalizing (Díaz et al., 2018).	Examples of Abstracted Translations include: • Quantitative value metrics such as monetary valuation or non-monetary preference ranking. • Documentation of tangible variables, such as locations (mapping), which can be inventoried without reference to cultural context and meaning, i.e., relevant value aspects or perspectives • Presence/absence of "categories" of cultural benefit which can be inventoried without reference to cultural context and meaning, i.e., relevant value aspects or perspectives.

F1 Appendix F References

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Appendix G – Timeline and Description of Events Related to Elwha River Dam Removal and Ecosystem Restoration Decision-making

G1 Year-by-Year Timeline of Events

1790	Spanish explorer Manuel Quimper anchors in Freshwater Bay near the Elwha River and interacts with the local people.
1854	Treaty of Medicine Creek (ratified 1855).
1855	Treaty of Neah Bay and Treaty of Point No Point (ratified 1859).
1855	Many Lower Elwha Klallam refused to move to the Skokomish Reservation on Hood Canal. Some tried to gain ownership of ancestral lands but found they could not gain title since they lacked U.S Citizenship (Valadez, 2002).
1855-56	Quinault River Treaty, or Treaty of Olympia (ratified 1859).
1860	Settlers begin arriving in the Elwha Valley.
1884-94	Following the Indian Homestead Act of 1884, 10 Klallam families became landowners in the Elwha Valley by 1894. Other Klallam families lived at Pysht Village and Ediz Hook (Valadez, 2002).
1909	Olympus National Monument is established by Theodore Roosevelt.
1910	Seattle Audubon began running trips out on the Olympic Peninsula. (This is important as a justification for the standing of environmental groups to intervene in the FERC relicensing process in the 1980s).
1911	Elwha Dam initial completion.
1912	Elwha Dam blows out.
1913	Elwha Dam resumes operation following repair.
1914	Olympic Power and Development Company, later Northwest Power and Manufacturing Co., later Northwestern Power and Manufacturing Company, and later Northwestern Power and Light Company, begins electricity transmission to the community of Port Angeles in January 1914.
1918	First pulp and paper mill in Port Angeles, Crescent Boxboard Company, began operations.
1919	Crown Zellerbach purchases the Elwha power plant to run a new mill in Port Angeles.
1920	Washington Pulp and Paper mill begins production on Ediz Hook, the site of a former Klallam village and burial site.
1920	The Federal Water Power Act (FWPA) established the Federal Power Commission (FPC) to regulate entities producing Hydropower , which later became the Federal Energy Regulatory Commission (FERC) in 1977.
1921	FWPA's 1921 amendments exclude National Parks and Monuments from hydropower licensing. This would become an important legal issue in conversations around relicensing of the Glines Canyon Dam in the 1970s and 1980s.
1924	The Snyder Act, or Indian Citizenship Act, is signed by President Calvin Coolidge, granting Native Americans U.S. citizenship and the right to vote.
1925	Construction begins on the Glines Canyon Dam.
1926	The FPC grants a permit for construction of the Glines Canyon Dam, and construction of the dam begins.

1927	Glines Canyon Dam construction completed.
1930	FWPA updated to become the Federal Power Act (FPA).
1930	Olympic Forest Products (subsequently Rayonier) opens a mill in Port Angeles.
1935	Updates to the FPA, in the form of the Public Utility Holding Company Act, include regulation of electric utilities.
1937	Crown Zellerbach purchases the Elwha and Glines Canyon Dams.
1938	Olympic National Park is established by Franklin D. Roosevelt.
1940	An expansion of Olympic National Park adds the Glines Canyon Dam site and the Olympic Hot Springs area to the Park.
1949	Port Angeles, including the Crown Zellerbach mill, are connected to Bonneville Power Administration grid.
1966	Olympic Hot Springs Resort is closed.
1968	Crown Zellerbach files a license application to the FPC for the Elwha Dam.
1968	The Lower Elwha Klallam Tribe gains Federal recognition and establishes their reservation at the mouth of the Elwha River.
1968	Congress passes the Wild and Scenic Rivers.
1973	Crown Zellerbach files an application to the FPC to relicense the Glines Canyon Dam.
1974	*U.S. v. Washington* (The Boldt Decision): Judge Boldt reaffirms the treaty fishing rights of western Washington Tribes.
1977	Most of the responsibilities of the FPC are transferred to a new entity, the Federal Energy Regulatory Commission (FERC).
1978	The Public Utility Regulatory Policies Act (PURPA) encouraged licensing of small hydropower projects and required that small electricity producers be paid a fair price for their electricity. This raised interest among environmental groups around how to mitigate impacts of small hydropower projects (Simson, 2014).
1982	*Mountain in the Clouds*, a book featuring the Elwha River, is published by Bruce Brown, drawing popular attention to the issue.
1984	In *Tulalip Tribes and others vs. F.E.R.C.* the U.S. Ninth Circuit Court of Appeals determines that small hydropower projects cannot be exempted from Federal licensing.
1984	In *Confederated Tribes v. F.E.R.C.* (the Rock Island Decision), the U.S. Ninth Circuit Court of Appeals determines that relicensing applications must be treated the same as new license applications.
1985	Crown Zellerbach sells the Port Angeles mill and two Elwha dams to James River Corporation.
1986	Congress passes the Electric Consumers Protection Act, requiring FERC to consider other uses of rivers in addition to electricity production.
1986	The Lower Elwha Klallam Tribe files a petition for intervenor status in the FERC relicensing process for the Elwha and Glines Canyon Dams.
1986	Seattle Audubon Society, Friends of the Earth, Olympic Park Associates, and Sierra Club file a petition for intervenor status in the FERC relicensing process for the Elwha and Glines Canyon Dams.
1988	Daishowa purchases the Port Angeles mill from James River Company Dams.
1988	Congress designates 95 percent of Olympic National Park acreage as wilderness.

1991	FERC releases a Draft Environmental Impact Statement concluding that dam removal is feasible.
1992	President George G.W. Bush signs PL 102-495, the Elwha River Ecosystem and Fisheries Restoration Act (Elwha Act) into law, mandating "full restoration of the Elwha River ecosystem and native anadromous fisheries" (Section 3(c)).
1992	FERC updates its relicensing process to increase potential for collaboration in the pre-application stages (Ulibarri, 2015).
1994	The Elwha Report is submitted to Congress by the deadline specified in the Elwha Act (PL 102-495), presenting initial research into restoration options.
1994	In the face of growing local controversy, the Elwha Citizen's Advisory Committee is formed by Bart Phillips, a Clallam County economic development official, and Joe Mentor, a Seattle lawyer and board member of Olympic Park Associates. This ad hoc group was intended "to study and offer recommendations to resolve the controversy surrounding restoration of the Elwha River" (ECAC, 1996). The Committee wrote to the Secretary of the Interior and the Washington Congressional Delegation to ask if they would be open to receiving local input on a way forward that would be acceptable to the local community.
1995	Building on the Elwha Report, Olympic National Park issues a final EIS for Elwha River Ecosystem Restoration, including exploration of alternatives to dam removal.
1996	Olympic National Park issues a final Implementation EIS for Elwha River Ecosystem Restoration, exploring alternative approaches to implementation of dam removal.
1996	The Elwha Citizens Advisory Committee produces a report to Congress entitled, "The Elwha River and Our Community's Future: Recommendations of the Elwha Citizens' Advisory Committee." This report recommends step-wise removal of the dams, beginning with removal of the lower (Elwha) dam and conducting research over time to determine whether removal of the upper (Glines Canyon) dam is necessary. The report helps diffuse some opposition.
1997	Funds for acquisition of the dams are appropriated. Given at least partial approval for dam removal from the Elwha Citizen's Advisory Committee, Senator Slade Gorton, chairman of the Senate Appropriations Committee, agreed to allocate funds from the Land and Water Conservation Fund for acquisition of the two dams, but said funds for demolition would need to come from other sources.
1999	Final deal for Federal acquisition of the two dams is negotiated between the National Park Service, James River Company, and Daishowa America.
2000	The Federal government completes acquisition of the Elwha and Glines Canyon hydroelectric projects.
2000	Slade Gorton, the chairman of the Senate Appropriations Committee who held up funding for dam removal, is voted out of office.
2003	FERC initiates an Integrated Licensing Process (ILP) that formally involves the licensee, resource agencies, Tribes, and NGOs working jointly through a 5-year relicensing process (Ulibarri, 2015).
2004	The National Park Service, City of Port Angeles, and Lower Elwha Klallam Tribe sign a Memorandum of Understanding that identifies dam removal mitigation measures and responsibilities.

2005	Olympic National Park issues a Record of Decision on a Final Supplemental Environmental Impact Statement on Elwha Ecosystem Restoration Implementation.
2009	The Federal Stimulus package provides the final $54 million needed to fund the $325 million dollar dam removal project, allowing dam removal plans to be set in motion.
2011	Demolition work begins on both the Glines Canyon Dam and Elwha Dam.
2012	Demolition of the Elwha Dam completed.
2014	Demolition of the Glines Canyon Dam completed.
Present	On-going revegetation and fisheries restoration activities

G2 Further Description of Events throughout Stages of Decision-making

Beginning in 1910, the Elwha Dam was constructed to solve a problem: the need for electricity to power industry in Port Angeles. This problem definition aligned with the worldview and well-being of the growing settler community of Port Angeles. But it was at odds with the worldview and well-being of the Lower Elwha Klallam people, who depended for the cultural, spiritual, ceremonial, and economic survival on the Elwha Valley and the anadromous salmon runs that returned to spawn in the Elwha River (DOI, 1994a, 1995). At that time, prior to the Indian Citizenship Act of 1924, the Klallam people were not eligible for U.S. citizenship (Valadez, 2002), and their protests against dam construction went largely unheeded. In the decades that followed Tribal elders continued to speak of the need to remove the dams. A Tribal leader shared how his mother always reminded him that "we have to take those dams out" [P6]. A former Port Angeles mill manager noted that the Tribes became increasingly vocal around dam removal in the early 1960s, expressing concern about both the safety of the dams and decline of the Elwha salmon runs [P1].

By the early 1980s, an opportunity emerged to shift the problem definition away from the need for electricity toward the need for restoration of the Elwha River and its fisheries. A combination of a 1984 court ruling that hydropower relicensing was equivalent to issuing an initial license (*Confederated Tribes v. F.E.R.C.*, 1984) and lesser-known 1921 amendments to

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The Federal Water Power Act of 1920 that prohibited licensing of hydropower dams in National Parks, signaled potential negotiating power for dam removal advocates (Simson, 2014).

At that time, the Federal Energy Regulatory Commission (FERC) was actively engaged in a (re)licensing process for both the Elwha Dam – which had never been licensed – and the Glines Canyon Dam, for which the original 50-year license was set to expire in 1977. In 1986 both the Lower Elwha Klallam Tribe and environmental NGOs successfully petitioned as formal intervenors to this FERC (re)licensing process (LEKT, 1986; Sierra Club et al., 1986). Environmental and Tribal interests were later joined by Federal and State government agencies responsible for ensuring fish passage and protecting wild and scenic rivers. This group was known as the Joint Fish and Wildlife Agencies (JFWA).

At the time, the FERC process was not designed to facilitate integration of diverse values and interests in rivers, beyond hydroelectric power generation. A Lower Elwha Klallam Tribal leader interviewed for this study likened the Tribe's successful intervenor petition to "kicking open the door" [P6] for their values and interests to be on the table. Another Tribal leader explained how the Tribe, with support from agencies and environmental groups, sought to make values beyond electric power generation pertinent to the relicensing process:

> When we introduced our cultural values into the FERC process, they didn't know how to respond. They couldn't respond because the values were so different and it was hard for them to relate to. Because up until then it had been a matter of "You get a few fish back, be happy." The Tribe said, "no, we're not happy. We want all of the fish back. And this is what you need to do to make that happen." And they didn't know how to … respond to that. We had some really smart people helping us [from NPS, NOAA, and environmental groups]. And we all started coming together to come up with strategy to circumvent the fact that the only value that they really wanted to hear about was the electricity... So when we introduced the arguments related to the environment and all the species, the salmon species and the ecosystem and all the species that thrive in that, they weren't quite sure… And it was one of my original arguments, is that if you try to put fish up against power they're always going to lose. No matter what happens, they're going to lose. And we needed to modify that, make an assertion that there's other values involved here. [P95]

With new values brought to the table, backed by legal challenges around treaty fishing rights and the legality of licensing a dam in a National Park, the FERC process floundered. A draft EIS on the two license applications was circulated for comment, but a final EIS was never published (DOI, 1991, 1993). Instead, the Tribe, environmental groups, and State and Federal agency staff enlisted congressional representatives and began to work toward a negotiated agreement. Through this process, the owner of the dams at the time, James River Corporation, realized it would be a financial burden to retain ownership dams that could not be licensed. Although the Elwha and Glines Canyon dams were originally the only source of power for the community and industry in Port Angeles, by the 1990s the 18.7 MegaWatts produced by the two dams was easily replaced by power from the Bonneville Power Grid. Further, because the upper dam was located within the boundaries of Olympic National Park, the Federal government was able to consider purchasing the dams. All parties therefore were open to a negotiated settlement that would be brokered by the Federal government.

This culminated in the passage of PL 102-495, the Elwha River Ecosystem and Fisheries Restoration Act (Elwha Act), which established a new 'problem' that needed to be solved: "full restoration of the Elwha River ecosystem and native anadromous fisheries" (PL 102-495, Section 3(c)). The Elwha Act stayed FERC's licensing process, provided for the government to purchase the dams from the current owner, and directed Federal and State agencies to begin researching alternatives for full ecosystem and fisheries restoration on the Elwha River. Following an initial report to Congress called the Elwha Report (DOI, 1994a, 1994b), a multi-pronged National Environmental Policy Act (NEPA) process began.

An initial Environmental Impact Statement (EIS) identified alternatives for how to achieve full restoration of the Elwha River ecosystem and native anadromous fisheries. The Final

EIS was published in 1995, based on the research summarized in the 1994 Elwha Report as well as subsequent studies. Through these investigations, the Secretary of the Interior determined that full removal of the dams was the only alternative that would achieve full ecosystem restoration. Following selection of the preferred alternative of dam removal, a subsequent EIS was issued in 1996 to assess alternatives for implementation of dam removal. For the implementation EIS, the preferred alternative allowed for sediment to flow downriver rather than dredging and transporting fine grain sediments prior to dam removal (DOI, 1996). Phased demolition to allow for multiple smaller periods of sediment loading was also rejected as an alternative (DOI, 1996). Both the Elwha Report provided to Congress in 1994 and the NEPA documents prepared in subsequent years defined the ecosystem, i.e., affected environment, as the "river-based ecosystem": the 45-mile-long Elwha River, with its drainage basin of 321 square miles (DOI, 1994a, 1994b, 1995, 1996). This definition of the ecosystem included riverine and estuarine habitats, with primary concern for improving salmon spawning and rearing potential on the Elwha River.

Following passage of the Elwha Act and the selection of dam removal as the proposed action in the first EIS, the prospect of dam removal became more of a reality for community members who had previously dismissed the possibility. Those opposed to dam removal became more organized. Newspaper articles from the Port Angeles Daily News highlight concerns about dam removal articulated by community members as EIS public comments or letters to the editor. These included fiscal irresponsibility in destroying working assets and a continuation of Federal overreach in the wake of spotted owl / forest management controversy; failure to consider climate impacts from loss of hydropower; lack of evidence that ecosystem and fisheries restoration could succeed on the Elwha River given failures of salmon stocks in other Olympic

Peninsula Rivers; and potential harm to the Trumpeter swans that used the reservoirs as habitat. Newspaper articles and EIS documents further detail Olympic National Park staff responses to these concerns, clarifying that the failure of salmon runs on other Olympic Peninsula rivers was linked to habitat disruptions, and that research into swans suggested they primarily used floodplain and wetland habitats, and did not depend on Lake Aldwell and Lake Mills (DOI, 1995, 1996).

Local opposition to dam removal caught the attention of Washington Senator Slade Gorton. At the time, Senator Gorton was Chairman of the Senate Appropriations Committee, and he single-handedly held up the appropriations of funds needed for the Federal government to acquire the dam and implement dam removal. The Senator was concerned that Elwha dam removal would set a precedent, and prior to funding the project sought guarantees against targeting the Snake River and Columbia River dams in the future. This left James River Corporation in a precarious situation: they still owned the dams but could not use them. It was not financially viable to maintain dams that were slated to be removed, and as years passed concern grew about the safety of the dams.

In response to a call from Senator Gorton and others from the Washington congressional delegation for local input on resolving the Elwha River controversy, a group of Clallam county residents convened an Elwha Citizen's Advisory Committee made up of individuals with "a wide range of views about the wisdom and feasibility of fisheries restoration and dam removal, [but] reasonable people that were open-minded about possible solutions to the Elwha controversy" (ECAC, 1996, pp. 3-4). The Committee invited presentations from the mill operator, Daishowa America, the dams' owner, James River, Inc., the Lower Elwha Klallam Tribe, the advocacy group Rescue Elwha Area Lakes (REA.L), conservation and sport fishing organizations, the

Bonneville Power Administration, and the National Park Service. The Committee also hosted a town meeting on March 7, 1996 (ECAC, 1996).

The Elwha Citizens' Advisory Committee concluded that dam removal was the only solution for full ecosystem and fisheries restoration, but recommended a phased approach to dam removal that would begin with removal of the lower Elwha Dam. As a starting point, they strongly supported acquisition of the two dams by the Federal government. With local support, in 1999 Senator Gorton appropriated just enough money for the Federal government to acquire the dams, but refused to appropriate funds for their demolition. Although this appropriations battle delayed dam removal, by 2009 the necessarily funding has been secured from piecemeal sources, including the National Park Service's own budget and the 2009 Federal Stimulus Package. Dam removal was initiated in 2011, the Elwha Dam fully removed by 2012, and the Glines Canyon Dam demolition completed by 2014.

Restoration efforts have proceeded in phases. Following release of sediments, collaborating agencies began implementing detailed restoration plans for fish habitat. Building on habitat restoration efforts initiated by the LEKT Fisheries Department in the 1990s, post-dam removal fisheries restoration efforts have included: side channel restoration, use of logjams, reforestation of the floodplain, removal or modification of floodplain dikes, acquisition and conservation of floodplain habitats, establishing instream flows that support fish recovery, and restoration of nearshore habitat (Ward et al., 2008). In addition, revegetation of the former reservoirs supports the betterment of fish habitat. Goals of revegetation include: minimizing invasive exotic species, stabilize ecosystem processes, and establish native forests (Chenoweth, et al., 2011). The approach to revegetation has been limited by the ecological realities of the presence and removal of the dams, in terms of trying to achieve successful planting in fine

sediments or cobble. According to one Olympic National Park staff member, a core strategy has been to seed riverbank Lupine, a short-lived perennial species that produces a lot of organic matter, acting as a kick starter for soil production [P117].

G3 Appendix G References

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Abstracted translations are translated knowledge forms, i.e., knowledge products, that seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses."

Anthropocentric values: Focus on values experienced and received by humans, i.e., the emphasis is placed on achieving human well-being as opposed to well-being of the ecosystem as a whole.

Axiology: As an element of human knowledge system, axiology is related to assumptions about ethics and value.

Contextualized translations are translated knowledge forms that attempt to stay as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders.

Cultural-benefits-knowledge: ES-knowledge encompasses both how we know ecosystems (services-knowledge) and well-being linked to ecosystems (benefits-knowledge). As one element of ES-knowledge, cultural-benefits-knowledge is how we know the cultural benefits of ecosystems.

Cultural-benefits-knowledge-holders: Individuals or groups whose well-being is linked in one or multiple ways to an ecosystem and who may seek to enact or document their cultural-benefits-knowledge to inform decision-making related to the ecosystem and their relationship(s) to it.

Cultural benefits of ecosystems: "the contributions ecosystems make to human well-being in terms of the identities they help frame, the experiences they help enable and the capabilities they help equip" (Fish et al., 2016, p. 212).

Cultural benefits of ES: See Cultural benefits of ecosystems.

Cultural ecosystem services: See Cultural benefits of ecosystems.

Ecosystem services (ES): Ecosystem processes and functions that are linked to human well-being.

ES-knowledge: The assumptions that guide our ways of knowing both ecosystems and well-being. From a knowledge pluralist perspective, ES-knowledge is best conceptualized as a system, encompassing the assumptions that guide how we claim knowledge of both ecosystems and well-being. These assumptions include often hidden beliefs about ontology (reality), axiology (ethics and value), and epistemology (how humans develop knowledge).

ES-knowledge-claims: Understandings of ecosystems and well-being validated within their epistemology of origin. All ES-knowledge-claims, whether about well-being (benefits-knowledge-claims) or ecosystem processes (services-knowledge-claims), embed the assumptions present in the larger ES-knowledge-system.

ES-knowledge-forms: Means of conveying ES-knowledge-claims that can be mobilized or translated to inform decision-making. These can include knowledge in the form of products, and knowledge in the form of practice.

ES-knowledge system: See ES-knowledge.

Enacted knowledge forms: Forms of embodied cultural-benefits-knowledge, i.e., knowledge practices. These include *practices of knowledge sharing* that reproduce and convey truths, e.g., narrative, linguistic, performative, visual, or ceremonial forms. These also include the *enactment of these truths through action*, whether through articulation of principles for responsible engagement with ecosystems or demonstration through lived engagement with ecosystems. See also Knowledge practice.

Epistemology: As an element of human knowledge systems, epistemology is related to assumptions about how humans develop knowledge, including validity of different methods and knowledge forms.

Translated knowledge forms: Forms of documented cultural-benefits-knowledge, i.e., knowledge products, on a spectrum from more contextualized to more abstracted.

Holistic value perspective: A holistic perspective on the value of ecosystems sees the reduction of value into discrete categories, such as relational, intrinsic, and instrumental, as artificial, given that these aspects of value and meaning are mutually dependent. For example, instrumental value is bounded and constrained by a view that well-being equates to maintaining balance in relationships between humans and non-human nature. Relational (non-substitutable) cultural benefits are reinforced by practices of instrumental use that facilitate transmission of place-based understandings, skills and capabilities and maintenance/opportunities of reciprocity and balance in relationship with non-humans.

Intrinsic value aspects: The inherent value of ecosystems and their components, that exists independent of human use or other engagements of meaning between humans and nature.

Instrumental value aspects: Substitutable aspects of an ecosystem's value linked to human utility gained through use of ecosystems or ecosystem components to satisfy preferences.

Knowledge pluralism: the diversity of cultural contexts and knowledge systems from and within which cultural benefits arise and are experienced. The term knowledge pluralism is used in this dissertation to refer to variation in knowledge systems, including what humans can know about (reality, ontology), how humans understand value and well-being (axiology), and how humans come to know (epistemology, methodology).

Knowledge practice: The enactment of knowledge through forms of knowledge sharing as epistemological practice, e.g., narrative, linguistic, performative, visual, or ceremonial forms, or through action, e.g., to articulate to reproduce or convey truths, or through actions to articulate or embody principles. See also Enacted knowledge forms.

Enacted knowledge forms: Forms of embodied cultural-benefits-knowledge, i.e., knowledge practices. These include *practices of knowledge sharing* that reproduce and convey truths, e.g., narrative, linguistic, performative, visual, or ceremonial forms. These also include the *enactment of these truths through action*, whether through articulation of principles for responsible engagement with ecosystems or demonstration through lived engagement with ecosystems.

Knowledge product: Knowledge conveyed through processes of translation, i.e., documentation, whether qualitative or quantitative. See also Abstracted translations, Contextualized translations, and Translated knowledge forms.

Ontology: As an element of human knowledge systems, ontology is related to assumptions about the nature of reality, including, for example, whether nature is an object or a subject.

Plural values: See Value pluralism.

Reductionist value perspective: A reductionist perspective on the value of ecosystems seeks to separate and categorize aspects of value, such as relational, instrumental, and intrinsic value aspects. This approach is contrasted against holistic value perspectives in which the reduction of these values aspects is artificial, as these aspects of value and meaning are mutually dependent.

Relational value aspects: Non-substitutable aspects of an ecosystem's value arising in the context of valued human-nature relationships.

Translated knowledge forms: Forms of documented cultural-benefits-knowledge, i.e., knowledge products, on a spectrum from more contextualized to more abstracted from context. *Contextualized Translations* attempt to stay as close as possible to the original value perspective and lived experience of cultural-benefits-knowledge-holders. *Abstracted Translations* seek to measure or track universalized understandings of well-being. This may be achieved through monetary metrics, non-monetary preference ranking, or tracking of indicators of other universalized policy goals, most often conceptualized instrumentally, such as protection of health, recreational, subsistence, or ceremonial "uses." See also Knowledge product.

Value aspects: To achieve value pluralism, we must attend not only to *instrumental value aspects*, i.e., utilitarian and substitutable, but also *relational value aspects*, i.e., non-substitutable and arising from reciprocal human-nature relationships, and *intrinsic value aspects*, i.e., ecosystems, or components of ecosystems, are understood to possess their own value, independent of human use or other benefit.

Value perspectives: The separation of value aspects into distinct categories represents a *reductionist value perspective*. To achieve value pluralism, we must also create space for *holistic*

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value perspectives, in which instrumental, relational, and intrinsic aspects of value are understood to be inseparable and mutually reinforcing.

Value pluralism: We use the term value pluralism to refer to multiple, incommensurable value aspects and value perspectives.

Ways of knowing is a term largely synonymous with ideas of epistemology and methodology, in terms of approaches and methods for learning and teaching, i.e., coming to know and sharing knowledge.

ABBREVIATIONS

ACES	A Community on Ecosystem Services
DOI	Department of the Interior
ECAC	Elwha Citizen's Advisory Committee
ES	Ecosystem services
CBD	Convention on Biological Diversity
CES	Cultural ecosystem services
CFR	Code of Federal Regulations
FERC	Federal Energy Regulatory Commission
FPC	Federal Power Commission
FWPA	Federal Water Power Act of 1920
ILK	Indigenous and local knowledge
ITEK	Indigenous traditional and ecological knowledge
IPBES	International Panel on Biodiversity and Ecosystem Services
IRB	Institutional Review Board
JFWA	Joint Fish and Wildlife Agencies
MEA	Millennium Ecosystem Assessment
MEB	Multiple Evidence Base
NCP	Nature's Contributions to People
NCTP	National Climate Task Force
NEPA	National Environmental Policy Act of 1969
NGO	Non-Governmental Organization

NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
ONP	Olympic National Park
PCAST	President's Council of Advisors on Science and Technology
PL	Public Law
PUD	Public Utility District
REAL	Rescue Elwha Area Lakes
RM-CESU	Rocky Mountain Cooperative Ecosystem Studies Unit
RoE	Record of Engagement
TEEB	The Economics of Ecosystems and Biodiversity
UKNEA	United Kingdom National Ecosystem Assessment
UNEP	United Nations Environment Program
USGS	U.S. Geological Survey