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Where are 'Cultural' and 'Social' in Ecosystem Services? A Framework for Constructive Engagement

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Where are 'Cultural' and 'Social' in Ecosystem Services?

A Framework for Constructive Engagement

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Abstract

Focusing on ecosystem services (ES) is seen as a means for improving decision-making. Research to-date has emphasized valuation of material contributions of ecosystems to human well-being, with less attention to important cultural ES and non-material values. This gap persists because there is no commonly accepted framework for eliciting less tangible values, characterizing their changes and including them alongside other services in decision-making. Here we develop such a framework for ES research and practice, addressing three challenges: i) non-material values are ill-suited to characterization using monetary methods, ii) it is difficult to unequivocally link particular changes in social-ecological systems to particular changes in cultural benefits; and iii) cultural benefits are associated with *many services*, not just cultural ES. There is no magic bullet, but our framework may facilitate fuller and more socially acceptable integrations of ES information into planning and management.

Keywords: ecosystem-based management; resource management; marine spatial planning; participatory processes; economic valuation

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Introduction

In response to increasing pressures on ecosystems and the need for sustained flow of benefits to human societies (MA 2005, Halpern et al. 2008), communities and governments are directing their attention to ecosystem-based management (EBM) (McLeod and Leslie 2009) and spatial planning (UNECE 2008, Lubchenco and Sutley 2010). In these and other contexts, the ecosystem services (ES) concept has been advanced and widely adopted as a framework for identifying and weighting the social and ecological values at stake in comprehensive management schemes (Daily 1997, MA 2005, TEEB 2009, Kareiva et al. 2011).

ES are broadly defined as the conditions and processes through which ecosystems sustain and enrich human life (Daily 1997); they are ecological processes or functions that have value for people. The ecologists and economists working in this field have primarily focused on provisioning and regulating services—particularly understanding their ecological underpinnings (Kremen and Ostfeld 2005); projecting services based on such correlations (e.g., Díaz et al. 2007); and measuring, mapping, and valuing ES (MA 2005, Kareiva et al. 2011). Although informing decision-making is one of the major motivations for ES as a research program (Daily et al. 2009), little of the ES research characterizes ES in a manner intended to explicitly assist decision-making—making explicit both how potential decisions might impact things that matter through changes in ecosystems, and how much such changes matter (Daily et al. 2009). For example, most conservation assessments that mention ES actually assess ecological processes that are

not directly linked to human well-being (Egoh et al. 2007), which does not fulfill the potential of ES to inform decision-making. Furthermore, throughout this research, cultural services are regularly mentioned as a category of ES and thus recognized as important, but the incorporation of such services into decision-making remains far behind that associated with more tangible services (de Groot et al. 2002, MA 2005, Daniel et al. submitted).

The Millennium Ecosystem Assessment defines cultural ecosystem services as "the non-material benefits people obtain from ecosystems through spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience, including, e.g., knowledge systems, social relations, and aesthetic values" (see also de Groot et al. 2005, MA 2005). Phrased alternately to distinguish explicitly between services, benefits, and values, cultural ecosystem services are "ecosystems' contribution to the non-material benefits (e.g., experiences, capabilities) that people derive from human-ecological relations" (Chan et al. 2011). The MA connected ES to human well-being in a coarse way, but most work under the MA fell short of characterizing ES contributions to human well-being in ways that could assist decision-making. That is, studies under the MA frequently pointed to the fact that ecosystem good/condition X was important to human well-being for reason Y, but they did not generally characterize how a given decision might result in changes in Y in terms comparable with other things that matter.

One of the most powerful aspects of an ES approach is that it focuses decision-making and research specifically on what people care about. And while they are unquestionably difficult to measure, ecosystem-based cultural benefits are clearly valuable to people. For example, in the Puget Sound region of Washington State, a broad stakeholder

survey found that recreation, tourism, and ethical and existence values were consistently among the five ecosystem services reported as most important (Iceland et al. 2008). Omitting such ubiquitously shared cultural benefits from explicit consideration risks decision-making and planning that is not connected to what matters to many people.

Neglecting cultural values and services in the design of interventions can produce dire unintended consequences and impede the achievement of program goals. For example, West (2006) documents how marketing cultural forest-goods in Papua New Guinea, an economic development strategy to offset consequences of conservation interventions, overlooked the numerous ways that local peoples use the land, and how wildlife contributed to their socio-cultural system. These blind spots resulted in systemic changes to marital relations and the division of labor associated with producing such goods, and to the cultural values attached to them. Both the biodiversity objectives and the well-being of local people were undermined (West 2006).

A systematic consideration of cultural values associated with ecosystems could therefore benefit many kinds of initiatives, including spatial planning, ecosystem-based management, integrated conservation and development schemes, as well as payments for ES (PES). Whereas one might think that PES schemes require only the assessment of the target ES, any scheme that seeks to change human influences on ecosystems will simultaneously influence multiple ES and affect multiple values. Thus, whether to set up a PES scheme, how to design it, how extensively to fund it, and how to monitor its success, are all decisions that might benefit from a comprehensive assessment of ES, social context, and cultural values.

In this paper, we point out that many cultural ES are overlooked in much ES research, diminishing its applicability for decision-making, and we sketch an approach to ameliorate this deficiency by providing a conceptual framework for the role of ES research in decision-making, in particular research that articulates cultural ES and values. In so doing, we aim to (i) provide decision-makers with an understanding of how ES research might elucidate how socio-cultural and economic benefits may vary across scenarios, resulting in previously invisible tradeoffs; (ii) empower practitioners and stakeholders to effectively communicate how issues important to them might be affected by management options and associated ecosystem change; and (iii) clarify for researchers how ecological and ES research could contribute to improved management and policy.

The place of 'cultural' in ES to date: everywhere and nowhere

In practice, the ES concept has become widely associated with monetary valuation of ecosystems—an association that elicits enthusiasm from some (e.g., Economist 2005) and contestation from others (Nature 1998, Fairbank and Public Opinion Strategies 2010). This association with monetary valuation is understandable given that prominent ES research has characterized ES in dollar values using a variety of market and non-market valuation methods (Costanza et al. 1997, EPA 2009, Nelson et al. 2009, Kareiva et al. 2011). In a decision-making context, monetary valuation can be designed to contribute the marginal values needed for cost-benefit analyses (e.g., Naidoo and Ricketts 2006), which could potentially inform many policy decisions (Arrow et al. 1996).

Partly because of the focus on economic valuation, many cultural ES remain conspicuously absent from efforts to characterize ES. There are many studies of

ecosystem-based recreation (e.g., Cisneros-Montemayor and Sumaila 2010) and landscape scenic beauty (e.g., Grêt-Regamey et al. 2008), but other cultural services generally have not been characterized in this manner—for instance, those associated with spiritual values, cultural identity, social cohesion and heritage values. These cultural ES are especially difficult and contentious to value in monetary terms, and have consequently been rendered invisible in most ES planning and management. Even though decisions are seldom based exclusively on economic value (Ariely 2008, Stiglitz et al. 2010), this exclusion often relegates cultural ES to implicit components of decision-making frameworks.

Most ES, 'cultural' and otherwise, have non-material or intangible dimensions. In some cases, these intangible dimensions (changes of a principally psychological nature) can matter more to people than affiliated material benefits (money and desirable physical changes such as sustenance or shelter). For example, fishing provides food but may also be a way of life with ethical, political or spiritual aspects. An ES framework should explicitly include ecosystems' contribution to valued ways of life through fishing, and also recognize the concurrent food provisioning service.

Reformulating the problem(s): valuation, causation, and identification

This prevalence of 'cultural' dimensions across ES highlights a great gap in methods for valuing ES. Most frameworks for ES research have implicitly defended the primacy of market-oriented valuation by restricting their application to more navigable domains of provisioning, regulating, and supporting services, while recognizing that many cultural services could likely never be appropriately represented by such monetary valuation. If

intangible benefits are generated by all kinds of services, ES valuation cannot sidestep the challenges of intangibility and incommensurability (Chan et al. 2012). Borrowing from the example above on fish and fishing, one cannot make decisions about fisheries based solely on monetary values without inviting uproar, because such decisions affect other social values, not all of which are well represented by monetary valuations. Accordingly, the lack of a defensible framework for cultural ES could undermine the whole framework for ES.

An additional gap in ES research becomes especially obvious as we characterize cultural dimensions—the problem of attributing causation to ES change. In a social-ecological context, it is always difficult to distinguish ecological vs. social causes of ES change. But ES research has emphasized the former by identifying the social and economic gains and losses associated with ecological change, even though social and ecological changes may be fundamentally interlinked. For example, in B.C., Canada, one cannot engage fishermen about losses due to degrading fish stocks without also discussing losses and shocks to coastal communities associated with changes in licensing practices (Burke 2010). In this case the losses to fishermen with diminished access cannot be attributed completely or separately to the ecological change, but also the licensing changes that were triggered in part by perceptions of a declining resource. Once we recognize the crucial importance of intangible benefits (e.g., the emotional attachment to coastal areas or the identity and sense of purpose and belonging one derives from ownership of boat and license), and the implications for local ways of life, it becomes clear that social, economic, and political arrangements play critical roles in shaping the benefits people experience from their interactions with ecosystems.

A third gap in ES research, which also becomes apparent when considering intangible dimensions, is the dearth of participatory methods for identifying priority ES. Much ES assessment and research seems to assume that the priority ES in a region are self-evident, despite the intangible nature of much associated value. Accordingly, there has been little attention to methods for cataloging or identifying priority ES based on stakeholder input (for exceptions see Shelton et al. 2001, Iceland et al. 2008).

In brief, the central problem is as follows: ES decision-making tools are being and will be employed in many places, but the intangible dimensions of ES values—and cultural ES in general—are little considered despite widespread recognition of their importance (MA 2005). These values are crucial for ecosystem and resource management, but they are not adequately reflected by monetary values. How then to characterize ES values to enable their more appropriate representation in decision-making? In this paper we start filling this gap by providing a framework for ES research that is defensible in light of prevalent 'cultural' dimensions. We do so by (i) integrating research and concepts from the study of social-ecological systems (Berkes et al. 2003, Ostrom 2009), which aims to address the problem of multiple social and ecological causality, and (ii) drawing upon concepts and methods from anthropology, sociology, risk perception, applied ethics, ecosystem management and other disciplines.

A New Framework for ES Research to Support Decision-Making

As illustrated above, because of the pervasiveness of intangible values across services, an inclusion of cultural ES must go far beyond an addition to a framework for ES research designed for material values. Instead, inclusion of cultural values involves a re-envisioning of ES as a whole, with accompanying changes in research and decision-

making processes. Because of the complexity and difficulty of this task, it is helpful to proceed in three stages. First, we identify and explicitly state the core challenges posed by cultural ES and intangible values. Second, we set out a series of stages of work (a 'framework') that might enable the better reflection of cultural ES in the broader ES context. Third, we explicitly address possible approaches to (i) identify values associated with intangible cultural services; (ii) assign metrics to better enable the use of such values in contexts that include discussions of comparability and tradeoffs; and (iii) characterize the dependence of benefits on social and ecological components and processes.

Core Challenges and Strategies:

Characteristics of some of the values that people associate with ecosystems impede the straightforward integration of ES research and valuations into decision-making. These characteristics can be distinguished, and each is associated with one or more proposed strategies for addressing the associated challenge (Box 1). These strategies are by no means a checklist of necessary tasks, but rather a set of possible approaches to motivate the proposed framework below.

While explicitly characterizing complex webs of values and ES may help researchers and ultimately stakeholders, this requires intimate knowledge of the system. As above, appropriate characterization of a service/value (including valuation) is dependent on appropriate methods, and no method is universally applicable. Accordingly, researchers are unlikely to be able to identify a subset of especially important services, values, or methods without first engaging stakeholders in identifying those crucial services and values—and such *value identification* requires its own methods. Accordingly, we

recommend an approach of iteratively involving local experts and then other stakeholders while gradually defining the study based on researcher and stakeholder needs/limitations. The value-identification process blends into a value-characterization process, which can inform decision-making at several stages (including after initial steps that are practical, quick, and informative—e.g., Iceland et al. 2008).

Proposed Framework:

This suggested framework is intended to facilitate the characterization of diverse values associated with ecological and social-ecological change through a series of steps, with identified possibilities for greater iteration and sophistication (Figure 1). As noted above, because of the pervasiveness of non-material values across ES and the interrelated nature of services and benefits, this is a framework for *general* ES research and practice, but one attentive to the complications stemming from cultural benefits and values. It is not intended to supplant or compete with frameworks for management or decision-making (e.g., adaptive management—Walters 1986), but rather to facilitate inclusion of research about ES and values within any such framework. As such, the steps below are not comprehensive but rather are those we deemed necessary to explicitly integrate ES into decision-making. We developed this framework based on our insights from the literature on intangible values as distilled in the 'core challenges and strategies', from our experiences with social-ecological research, and from the pilot application of our interview protocol as part of the framework in three locations (Klain 2010, Gould 2011, Satterfield et al. 2011).

The framework addresses the core challenges (Box 1) by disentangling social, biophysical, and social-ecological contexts and interactions; by employing methods to explicitly identify relevant benefits, services, values, and their relationships; and by

eliciting valuations through diverse approaches. In order to roughly illustrate this framework in a real place, we incorporate some details from one of the pilot projects by some of the authors (SK, KC, TS) in the Regional District of Mount Waddington (RDMW), British Columbia, Canada (Figure 2). For each component of the framework below, we provide coarse explanations of the kind of information needed and examples of information pertinent for decision-making contexts. The framework is designed both for researchers—who might focus on particular steps with an awareness of the whole—and for practitioners—who might address all components of the framework at least in simplified fashion, possibly with minimal investment.

In each of the subsections below, the italics express our recommended actions. They are followed by explanations and illustrations from the pilot study.

0. Consent

Before beginning a project, and at various stages throughout, it is crucial for the research team to obtain and maintain consent to engage (Berg 2001). Identifying and measuring intangible values can only be successful when those with stakes in the decision context participate as collaborators throughout. Researchers involved in such endeavors can co-produce relevant knowledge only when invited. Good research practice goes beyond standards of informed consent (see e.g., AAA 2009) to respect the diversity and variability in local context and culture. Although developing local partnerships may create challenges to scientific objectivity or researcher legitimacy (see 2.2 Social context), good research practice requires a multi-party partnership with local institutions/organizations, which may include formal memoranda of understanding with indigenous groups/governments, local government and key stakeholder groups.

1. Decision Context

Define the relevant decision context(s). What is the nature of the decision being made—who is or will be making the decision, why, what is the range of possible alternatives (and what is 'off the table'), and what decision-making processes does this entail? Furthermore, what is the opportunity that motivates identifying and measuring values, and what is the role of the researcher in the decision context? Such explicit consideration of decision context is critical for ES characterization and valuation to contribute to policy and management change.

In-depth elucidation of decision context involves consultation with decision-makers. For example, in RDMW, the regional government is deciding which types of marine-related investments to support to boost employment in the area. Alternatives include facilitating growth of open net-pen salmon aquaculture (a currently profitable industry with controversial environmental impacts), or investing in closed-containment salmon aquaculture (an unproven but promising industry that would have little to no marine ecosystem impacts). An alternative that currently appears to be 'off the table' is removing fish farms: although environmentalists argue for this, RDMW does not appear ready to consider this option.

The researchers (authors SK, KC, TS) were invited to conduct an analysis of the benefits of marine activities in the region by the Living Oceans Society (LOS), which had recently formed a formal partnership with the RDMW government.

2. Social-Ecological Context

Roughly characterize the relevant components of the social-ecological system to provide context for the decision. This step includes setting boundaries of all kinds, and characterizing several dimensions of the context: biophysical (e.g. abiotic conditions, characteristics of the biota, interactions among them), social (e.g. social, economic, political, cultural), and interactions among them (e.g. decision-making context for ecosystem management). To connect to Ostrom's (2009) terminology for social-ecological systems, our 'biophysical' is Ostrom's resource systems and their units, and our 'social' is Ostrom's governance systems and users.

Whereas many frameworks for research and decision-making take as implicit the need for understanding the local context, we have elucidated particular elements of context that are critical for value identification, valuation, understanding causation, and connecting these to decisions.

2.0. Boundaries

Based on the decision to be made and initial understanding of the biophysical, social, and political context, define limits of the study area and system—spatially and temporally (Stanford and Poole 1996). This step in particular relies on iteration with steps 2.1-3 below. Because different processes have different boundaries, this task of setting boundaries for a study system is a challenging one, and one that has received considerable treatment elsewhere (Norton and Ulanowicz 1992, Chester 2006).

In our example in British Columbia, the physical boundaries of the study area are the waters of the RDMW—recognizing also that fish stocks important to First Nations and commercial fisheries, including wild salmon, migrate through this region. The limited boundary of the region of interest was driven by recognition that while many marine

resource decisions are made at the provincial or federal level, the regional government is instrumental in choosing which development projects to support. We constrain our time horizons to match those of local planning processes: changes that might happen in the near future (months to <3 years) with implications both immediate and for the medium-term future (up to 10 years).

2.1. Biophysical context

Characterize the current state of the most critical biophysical conditions, and past trends of these. Identify the components of the ecosystem and the ecological processes that are key to the provision of ecosystem services and those that are at stake in the decision-making process (Maass et al. 2005, Balvanera et al. 2011).

Historically, the RDMW region supported numerous large runs of salmon, eulachon and herring. Many of these runs have declined dramatically, and salmon stocks have fluctuated substantially. After a 15-year decline, the sockeye salmon population that migrates through this area crashed in 2009 (Angelo et al. 2010) and came back at remarkably high numbers in 2010 (Pacific Salmon Commission 2011). With its protected inlets and substantial tidal flow, an archipelago within the region is well suited for salmon aquaculture and has one of the highest densities of salmon aquaculture farms in BC. Open net-pen salmon aquaculture is suspected to have numerous negative impacts on marine ecosystems through diseases and parasites (Krkošek et al. 2007), although this issue is subject to considerable controversy.

2.2. Social context

Assess the social (inclusive of social, political, and cultural) context first by identifying the range of players—the people that are likely to be directly or indirectly involved with the decision making process and/or that are likely to be positively or negatively affected by it (Chan et al. accepted). This includes stakeholders (i.e., those with interests at stake) (Grimble and Wellard 1997) and researchers, who will generally not be seen as disinterested parties despite efforts to promote this view. This process should involve identifying the most relevant players at several administrative (i.e., town, county, etc.), social (i.e., individual, family, ethnic group, etc…), and temporal/generational scales.

Identify key relationships among the players, with special emphasis on power relations, and distinguish as necessary parties whose status is codified by institutional or legal arrangements (including rights) (Ostrom and Nagendra 2006), e.g., Treaty obligations with indigenous parties (Boyd 2003). Identify any key historical legacies (e.g., histories of colonization) and their effects on social and political dynamics (Castillo et al. 2005, Smith 2005, Timko and Satterfield 2008).

Finally, identify key demographic, economic, social, legal, and technological drivers underlying the decision making-process and key phenomena like migrations, recessions, and major shifts in industry (e.g., Sundberg 1998).

We briefly summarize information in this category to illustrate the type of information useful for this step. Major political players in RDMW include the regional district local government, town council members, 17 First Nation Band Councils, aquaculture companies, resource-extraction industries, and federal agencies. RDMW has an aging and shrinking population; as in many rural areas across the world, many young people move to urban areas for employment. Traditional sources of revenue and jobs from

forestry, fishing and mining have declined while open net-pen salmon aquaculture has grown substantially. Among both First Nations and non-aboriginal groups, some contingents adamantly oppose any type of ocean net-pen salmon aquaculture while others welcome associated employment opportunities. Over the past five decades, there has been a general consolidation of processing (lumber and pulp mills, fish canneries) and ownership (Ecotrust 2001): whereas fifty years ago many community members participated in fisheries and fish-processing, and many owner-operators lived in coastal communities, now few people are employed in fisheries and fish-processing and most fish quota-owners are wealthy urbanites living outside the region (Edwards et al. 2005). The research team also investigated the historical and legal context in the region, especially First Nations and the legislation governing their relationship with natural resources.

In the RDMW study, the research team faced several related complications, largely due to its strongly enabling partnership with the NGO: claims of biased study design, refusal of participation, and an attempt to dissociate the governmental entity from the study (which failed). Though the team ultimately overcame these hurdles, they exemplify the complexity and sensitivity of investigations of values.

2.3. Social-ecological interactions

Roughly characterize the integrated social-ecological context and interactions that result in the decision-making processes (Ostrom 2009). This involves identifying the resource units (e.g., wild salmon and farmed salmon) *and resource states at stake* (e.g., wild salmon runs—some healthy and some dwindling; seascapes free of salmon farms)*, how the governance system links the aforementioned players* (e.g. the tax revenue that the

regional government obtains from salmon aquaculture vs. revenue from wild fisheries)*, and the resulting interactions between these various components* (e.g., possible—and competing notions of—impacts of salmon aquaculture and oil and gas development on wild fisheries; competition between farmed and wild salmon in seafood marketplaces; shared reliance of aquaculture and wild fisheries on fish-processing plants; shifts toward the less-labor intensive salmon farming mean fewer people living in, knowing deeply, and directly relying upon these ecosystems).

3. Ecosystem services, benefits, and values

Brainstorm and explore broadly the range of ES and associated benefits and values that may be subject to change in scenarios under consideration—ideally with local experts and stakeholders (Klain 2010). Cultural ecosystem services fall into several categories (e.g., subsistence, outdoor recreation, education & research, artistic) (Chan et al. 2011). Each of these provides a broad range of benefits (e.g., material, heritage, aesthetic, spiritual, inspirational, knowledge) (Chan et al. 2011); these benefits can be of value to people for various kinds of reasons (e.g., self-/other-oriented, individual/group, physical/metaphysical) (Chan et al. 2012). The point here is not a comprehensive mapping for all beneficiaries of ES to all benefits and all kinds of values, but rather to facilitate later stages through an exploration of the prominent ES and benefits, key connections between them, and the kinds of values at stake.

After the priority ES and benefits have been identified, the crucial next steps are to characterize more rigorously (i) the implications of possible actions for social-ecological change, (ii) the impacts of social-ecological change on ES, and (iii) the importance of those possible changes, using appropriate metrics. It is at this stage 3 that our

framework directly employs most of the core strategies described above (Box 1), addressing challenges (b) – (f).

The U.S. Environmental Protection Agency (EPA) Science Advisory Board (2009) has extensively presented many available methods for steps i, ii, and iv, but here we note several methods especially pertinent for our effort. In particular, we emphasize the utility of qualitative methods for the step of identifying priority benefits, ES, and their associated values, as these may have several important advantages (see Box 2). In Table 1, we also document methods to address the following steps: disentangling multiple causality; valuation of non-material benefits; and evaluation of scenarios (in stage 4). Some of these valuation methods are appropriate for representing the value of individual goods or services (green circles in Fig. 3); others are parallel to decision-making exercises in representing the relative desirability of whole scenarios (blue dotted ellipse in Fig. 3). As suggested in the proposed strategies of Box 1, holistic valuation/decision-making approaches (blue dotted and dashed ellipses in Fig. 3) are especially helpful under the following conditions: interdependence/bundling of benefits (Klain 2010); intangibility and cultural sensitivity of the values at stake; values that do not conform to assumptions of economic valuation (e.g., individual, preference-based, self-oriented, market-mediated, anthropocentric, and non-transformative values).

Note that our dual purposes are to enrich research thereby facilitating decision-making, not to 'mine' local social data or to appropriate the intellectual property and knowledge held by local people. In some cases, decision-making might be best facilitated by compiling and analyzing available social data, and eliciting valuations from stakeholders. In other cases, it might be facilitated best by researchers engaging local researchers to

conduct the data gathering/valuation processes, and obtaining from local research assistants only summary data that leaves sensitive cultural information and values in the hands of locals. In many cases, local cultural practitioners do not need researchers to represent them, but simply to facilitate their voices being heard.

In RDMW, several of the authors pioneered an interview protocol whose purpose was to elicit perceptions from a range of stakeholders of the kinds of benefits people experience associated with ecosystems and the ways that people experience them (Klain 2010, Satterfield et al. 2011). Our 30 interviewees frequently mentioned the ES provision of fisheries in general, and wild salmon harvests in particular. People associated fisheries with a wide range of services, benefits and values. Fisheries continue to be important for subsistence and commercial purposes. Wild salmon was a staple food historically and is still nutritionally important for much of the local population. A majority of the interviewees value fishing for a plethora of benefits, many non-monetary. Most consume the fish or shellfish. Some use them as part of their art or ceremonies. Many derive pleasure from the act of fishing (including aesthetic, activity, and spiritual benefits). Fisheries are associated with a sense of place and heritage.

These various services and benefits are strongly linked to important values. In terms of rights-based values, First Nations are working toward increasing their authority over local fisheries management and fisheries resources. Collective values are associated with food, social and ceremonial fisheries catches—harvests allocated to First Nation communities—which are important for social cohesion. In contrast, salmon farming is a new industry associated with a limited range of services, benefits and values. This industry is important for producing a marketed commodity with material benefits. It has

also provided year-round employment opportunities while access to wild commercial fisheries has declined for most locals.

4. Influence diagrams and scenarios

Synthesize the above information in preliminary diagram(s) to highlight connections between the decision-making process, the key components/constituents/processes of the social-ecological system, ES provision, and the wide range of intangible values potentially associated with such services. Building upon other influence diagrams (e.g., Waltner-Toews et al. 2003), we focus on ecosystem services and their benefits. In any such diagram, large numbers of bubbles can render the diagram unwieldy, so priority should be given to those benefits (i) most likely to change with the decision in question, and (ii) of greatest importance to stakeholders (including benefits recognized and unrecognized). Such influence diagrams, constructed with or based on stakeholder perception, are critical for characterizing what matters to different groups, and how such things might be affected by decisions and the resulting direct and indirect changes in ecosystems. A highly simplified influence diagram of some key ES and benefits from the illustrative example in RDMW is shown in Figure 3.

Using the influence diagram(s), highlight potential trade-offs among services and among players associated with the decision under consideration. The diagram(s) can also be used to represent variation between stakeholder groups in conceptions of the system and kinds of values at stake. In RDMW, stakeholders largely group themselves into those associated with the fish-farming industry and those who are not. Our interview respondents employed by the fish-farming industry did not see salmon farming as a threat to ecosystems (as represented by the wide red arrow from farmed salmon to

social-ecological change); those respondents not associated with this industry almost invariably listed salmon farming as a threat (Klain 2010). Developing the influence diagram based on this information can help identify these differences in perception within the community. Such differences can lead to several next steps. First, if differences in perception are based on lack of awareness of scientific information, improved education and outreach can foster shared understanding. Alternatively, such differences may be due to lack of knowledge and thus can point to areas of critical scientific uncertainty for further research. Second, there may be ways to reduce conflicts among stakeholders by employing fish-farming practices or siting rules that ameliorate negative impacts on ecosystems. Finally, divergent stakeholder views or risk tolerances can be included explicitly in decision-making (e.g., by illustrating trade-offs in what different people care most about).

To illustrate the changes that might be anticipated to accompany the decision in question, these 'influences' can also be depicted through contrasting scenarios. Such scenarios can be incorporated in decision-support tools for characterizing ecosystem change and its consequences, such as the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) tool (Nelson et al. 2009, Kareiva et al. 2011).

Such influence diagrams should be interpreted cautiously in their limited ability to represent ever-present complex dynamics (Norgaard 2010) and to project consequences over medium- or long time periods. The simplified functional forms of stock-flow relationships between entities and ES are useful for heuristic projections of short-term consequences but not accurate predictions of long-term consequences, thresholds of system stability and resilience.

5. Iterative process

This framework is intended to be iterative, allowing a progressive deepening of understanding of key components/constituents/processes, key services/benefits/activities and their tangible and intangible values, and the decision-making processes at hand. We imagine iterations of the steps above—not in consecutive order but rather as determined by unfolding needs for information. Insights derived at any step above might inspire and enable efforts to deepen understanding at another step. Alternatively, the first pass might reveal that—although substantial scientific uncertainties remain—existing understanding is so hotly contested that further scientific understanding is unlikely to lead to meaningful progress (Pielke 2007). The latter may be the case in RDMW in the short term, given the fundamental disagreement among stakeholders regarding the threat posed by salmon farms (Klain 2010).

In decision-making contexts, however, time and resources will be limited, and a first iteration will provide information that can assist decision-making without great time or resources.

Once researchers have coarse or rudimentary understandings of the decision context from the first iteration, subsequent iterations might be designed to provide deeper understanding of the nature of the decisions at hand, who might make them, underlying/hidden drivers of change, and the complex interactions among these drivers. Examples of activities that could be appropriate in subsequent iterations of the framework include (organized by elements of the framework):

Biophysical context: In a second iteration, key biophysical conditions at stake could be qualitatively characterized and mapped, and the magnitude and direction of the

consequences of the decision-making processes on key ecosystem components and processes could be qualitatively assessed. Quantitative assessments, if needed and possible, might take place in a third iteration.

Social context: Understanding of key players and the relationships among them can be deepened in the second iteration. Deeper analyses of some of these players and relationships could take place in a third iteration. The same deepening understanding can take place for the underlying drivers.

Social-ecological interactions: Specific components of the resource units, resource states, governance system, and interactions can then be further analyzed in a second iteration and further dissected in a third.

Benefits, ES, and values: Key benefits, their links to ES, and reasons for their perceived importance can be assessed in a second iteration. Their contributions to the decision-making processes and the complex interactions among them and among the players could be assessed in a third iteration.

Influence diagrams and scenarios: More specific and clearer versions of the influence diagrams will be obtained from second and third iterations. The spatial context of key components/constituents and processes and their connections to non-tangible values of ES can be drawn in a second iteration and further refined in a third one. Trade-offs among services, players and their corresponding values could be further elicited in second and third iterations.

Research can inform decision-making at any point, and in a variety of ways (Figure 3). For example, an understanding of the consequences of social-ecological change for ES

and benefits might inform a multi-criteria decision-making exercise even without valuation (blue dotted ellipse). In contrast, researchers might use only value metrics in a cost-benefit analysis (green dotted ellipse). Alternatively, all available information might contribute to a deliberative approach such as participatory structured decision-making (blue dashed ellipse).

Discussion

Recently, significant effort and resources have been aimed at better understanding the biophysical processes underlying ecosystem change and implications of these changes for ES with material benefits. The characterization of these material benefits through economic valuation is gaining increasing recognition for its importance. But it is the intangible values that so often drive the success or failure of management, so the time is right to characterize their roles in ES valuation and natural resource decision-making by following and revising frameworks and methods like the ones we propose here.

The conceptual framework we propose here is intended to help researchers, decision-makers, practitioners and stakeholders direct and use research to make or affect decisions. It complements existing management frameworks by elucidating specifically the points of intersection with ES research, particularly the many ES associated with benefits of an intangible nature. It differs from the status quo for ES research in five principle ways: (1) it addresses the sensitive nature of intangible values (Consent); (2) it explicitly addresses the reality that ES change is a complex product of ecological and social changes (Context; Influence Diagrams); (3) it emphasizes the critical step of the participatory identification of priority ES and benefits, and their connection to diverse

values (ES, Benefits, Values); (4) it explicitly represents a diversity of perspectives (Influence Diagrams); (5) it proposes a suite of valuation approaches intended to address the multiplicity of values, and presents a suite of options for valuation and decision-making at different scales (individual benefits or ES ranging to whole scenarios)(ES, Benefits, Values).

Our framework embodies a significant step towards increased cultural sensitivity using deliberative methods in conjunction with analytic ones. That is, we propose gathering stakeholders together to discuss decision options in light of ES and benefits at stake. Such a move toward deliberation addresses several of the core challenges (Box 1) and also the critical issue of earned legitimacy. Few decisions are true win-wins, and those who feel losses deserve the opportunity to accept them as viable both because the decision-making process has been a legitimate one and because the tradeoffs they suffer are explicitly available and ideally tolerable for as many as possible. While there are valuation methods that employ deliberation (e.g., deliberative pricing and WTP studies), another worthy possibility is proceeding directly to deliberative decision-making—where many benefits are quantified in appropriate, meaningful terms (Satterfield et al. 2011, Chan et al. 2012). Embracing such decision-making methods might free ES research from the persistent and pervasive perception of being "all about pricing nature".

Applying our proposed framework in its entirety is likely to require considerable resources. With limited time and resources, researchers and practitioners can use this framework as a heuristic to guide scientific inquiry and engagement in natural resource decision processes that explicitly include cultural ES. Our main point is that conceptual

models and qualitative and quantitative methodologies exist to characterize the socio-cultural values associated with ecosystems, and that employing such methods in real decision contexts will improve our understanding of ES and associated decision-making.

A critical question in applying our framework is, "What is the bare minimum for stakeholder participation and elicitation?" We can offer no single answer to this question, as the desire and expectation for stakeholder involvement differ greatly across cultures, regions, and particular decision contexts. In keeping with the iterative nature of the framework, we propose that researchers/practitioners start with what seems immediately feasible, and only thereafter judge the necessity and appetite for further participation.

Applying this framework to ES research and practice will benefit from several key conditions. On the research side, its full application requires an engaged interdisciplinary research team interested in an applied context. On the practice side, it requires interested decision-makers or NGO practitioners with resources for research partnerships and a long-term planning/campaign horizon. Full realization of our framework and real policy/management change will also require a substantial collaboration between researchers and practitioners, which itself involves additional challenges and opportunities. Perhaps most limiting, the ideal framework we have proposed is explicitly inclusive of diverse stakeholders and values, such that the process requires insulation from or mitigation of pressures exerted by any particular stakeholders. That said, we have discussed some promising potential uses of the outputs of this framework with ecosystem-based management efforts being carried out in the RDMW (Klain 2010), the West Coast Aquatic management board of Vancouver Island (Guerry et al. 2012), the

Puget Sound Partnership in Washington State (Puget Sound Partnership 2009) and Kamehameha Schools in Hawai'i (Gould 2011). And even without the integrated partnership of researchers and decision-makers, there is very real value in assisting stakeholders to express their concerns about elusive or intangible ES values so that—to paraphrase an interviewee (Gould 2011)—"decision-makers can't say they didn't know".

There is no easy way to deal with cultural values, pertaining to ecosystems or otherwise. This is sensitive territory, which is in part why it has been neglected in ES research for so long. But it is not uncharted territory and it is not a total quagmire: we can represent these values more fully and in so doing greatly improve the validity and legitimacy of ES research and decision-making.

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Figures, Tables and Boxes

Figure 1. The proposed framework for characterizing ecosystem services that might be affected by management or planning. Note that although arrows depict possible routes by which understanding of the system might be deepened, such 'iterations' might proceed in any way (e.g., understanding of benefits, ES, and values might call for a deeper characterization of the social-ecological context; or it might call immediately for further elucidation of benefits, ES, and values). Like Haines-Young and Potschin (2010), we distinguish between benefits, ES, and values: "services are the production of benefits (which may take the form of activities), which are of value to people" (Chan et al. 2012). See text for more details on the framework.

Figure 2. Location of the illustration-study region, Regional District of Mount Waddington (RDMW), in British Columbia, Canada. PNCIMA is the Pacific North Coast Integrated Management Area.

Figure 3. An example conceptual diagram of impending social-ecological changes and their implications, as might be provided by a value identification process. The one depicted is a highly simplified, unsystematic diagram for the RDMW case study. The changes (red ellipse) are expected to have a variety of impacts (wide red arrows) on the 'things' that matter to people in/associated with ecosystems (blue circles—these can be decomposed into ecosystem-service

and other benefits); these benefits and service-providers may support other benefits through supporting relationships/services (blue arrows), and they may be of direct value to people (green arrows), as might be measured by a variety of metrics (green circles). Quantitative characterization of any arrow would take place in later iterations. Valuation methods include market and non-market monetary valuation, analyses of jobs expected, preference surveys, etc. Valuation or decision-making exercises might focus solely on measures of benefit quantity (blue dotted ellipse—e.g., multi-criteria decision-making), they might focus only on value metrics derived separately (green dotted ellipse—e.g., cost-benefit analysis), or they might include all manner of information and kinds of values (blue dashed ellipse—e.g., structured decision-making). The 'social-ecological change' bubble in particular could be fleshed considerably based on details such as those provided in the framework step descriptions.

Box 1. Characteristics of Services and Strategies for Addressing Challenges Posed

We identify a set of characteristics of cultural and other ES, their benefits, and associated values (especially non-material ones), and proposed strategies for addressing the challenges posed to valuation and expression of these values for decision-making. Many strategies address several challenges, and not all challenges will pertain to any particular context.

Multiple causality: changes in benefits and services result from many processes operating simultaneously—some social, some biophysical, and some social-ecological. ***Strategy:*** characterize social, biophysical, and social-ecological contexts and interactions. See Proposed Framework.

Interdependence: many different kinds of benefits and services are inextricably linked in their contribution to value to humans; e.g., all contribute to place value (the value people derive from their sense of place), heritage value, and cultural identity in likely non-additive, non-linear ways (Chan et al. 2011, Chan et al. 2012).
Strategy: employ (i) open-ended or semi-structured stakeholder interviews to identify key benefits, services, and values and their relationships; (ii) conceptual diagrams depicting these relationships; (iii) valuation of 'bundles' of services and benefits—as 'bundled' by stakeholders.

Values pertain to distribution and process: not all important values at stake are products of ES—some rights and moral principles pertain to the distribution of benefits and the process of management (e.g., equitable distribution of resources, restitution for past 'wrongs', or the right to sovereignty over traditional territories).
Strategy: (i) include stakeholders in various stages of planning and decision-making; (ii) perform scenario-based valuation (not just valuations of isolated benefits); (iii) use different valuation approaches to capture the different types of principles involved.

Plural values: most ES are valued for many kinds of reasons (this follows partly from both (a) and (b)).

Strategy: employ a diversity of valuation approaches (Table 1): represent values in multiple formats, including influence diagrams, stories, and other visual and verbal summaries.

Incommensurable values: some ES values are not appropriately judged by the same standard (e.g., cultural identity, market values).
Strategy: employ deliberative approaches (requiring contemplation and usually discussion) to decide on appropriate tradeoffs.

Values held for or by collectives: some values pertain to what an individual considers to be appropriate for a group, not necessarily better for him/herself (e.g., an individual can prefer publicly funded health care for a national policy without gaining from these at an individual level); such values can often be said to be characteristic of groups although they are generally not shared equally by all individuals.
Strategy: include group valuation and deliberative decision-making forums to decide on and express group values (see Table 1).

Values embedded within worldviews at odds with 'nature as a service-provider': especially in indigenous or 'traditional' communities, some values may be linked fundamentally to systems of practice and knowledge (e.g., traditional ecological knowledge) that conflict with a conception of nature as a provider of services for people.
Strategy: (i) avoid terms, phrases, and diagrams that may trigger reactions to this anthropocentric perspective; (ii) in interviews, focus on the benefits that people derive from nature, rather than the ecosystem processes that give rise to them (which are often invisible to people or thought of differently).

Values defy monetary valuation: some values trigger considerable discomfort with expression in dollar terms (e.g., some principle- and virtue-based values, sacred values).
Strategy: apply non-monetary valuation and decision-making forums to express values in non-monetary terms; see also strategy for (d) Plural values and (e) Incommensurable values**.**

Box 2: **The advantages of explicit use of qualitative methods for identifying priority benefits, ES, and associated values.** Such methods might include value-identification interviews and/or surveys, and site/stakeholder observation; all will often benefit from extensive partner involvement in design. Much research on ecosystem services assumes that the important benefits and values at stake can be identified by researchers, without extensive contact with stakeholders (but see Shelton et al. 2001, Iceland et al. 2008). Accordingly, the qualitative methods of engaging stakeholders to identify such benefits and values have been neglected within ecosystem service research, which frequently advances immediately to quantitative valuation.

- ***Prioritization of what matters***: by engaging relevant stakeholders to identify what matters locally, value-identification avoids unsubstantiated assumptions about priority services/values/benefits (quantitative valuation is generally restricted to a small set).
- ***Richness, with sensitivity****:* the narrative approach (letting people tell their own story—Table 3) helps people express much more, especially about sensitive or controversial topics.
- ***Understanding of influences****:* answers to well-crafted open-ended questions may illuminate not just what matters (the key benefits at stake), but why it matters, and how respondents perceive these benefits to be produced or at risk (quantitative valuation frequently assumes researchers have a priori understanding of these aspects).
- ***Interactions between services/activities/benefits****:* respondents' answers to semi-structured questions may signal perceived interactions between services, activities, and benefits; such interactions generally cannot be teased apart with quantitative valuation (except with a priori information, high sample sizes, and intricate survey design).
- ***Incommensurabilities****:* narrative approaches allow researchers to more directly discern key sources of incomparability between risks and benefits.
- ***Less dependent on framing****:* the discursive exchange between interviewer and interviewee lessens the problem of framing (by which the format of a question may dramatically alter answers). Framing effects are less of a concern with qualitative methods because of the flexibility to tailor questions to interviewees

and because interviewees' richer answers provide much more context about how the question framing directs their answers (quantitative valuation such as CV or choice experiments have a single rigid framing and allow only one-dimensional or yes/no answers). Accordingly, there is less of a need to constrain qualitative questions to particular kinds of interventions or to particular implied causality of changes.

- ***Kinds of values at stake**:* narrative approaches to value-identification can also elicit the nature of the value (whether something matters for reasons of principle vs. preference, for oneself vs. others, at the level of the individual vs. group, etc.), which informs appropriate kinds of valuation and also gives insight into stability of the values (most quantitative valuation methods are blind to such differences).
- ***Social and political dynamics**:* such interviews help researchers understand relationships among key players/engaged stakeholders that are not evident from published information. Such social dynamics can be critical for framing valuation studies that will be appropriate for the research question and that will not inadvertently trigger distracting reactions to local events in responses. (Quantitative valuation thus generally benefits from such understanding, but it generally does not contribute to it.)
- ***Rapport and local understanding of the research**:* in the process of effective narrative interviews, interviewees may gain understanding and appreciation of the research, which can remove many impediments and enable important further progress (quantitative valuation generally involves giving limited context for the research and the less conversational format maintains separation between researchers and interviewees).

Table 1. Methods from values literature to aid stages 3 and 4 of the proposed framework. The particular step for which each method is most relevant is provided under 'Purpose'. See supplementary online materials for an expanded version of this table.

	Purpose	Scale	Pros	Cons
Narrative Methods	Eliciting less tangible B/V/S (values, benefits, and services, e.g., spiritual values)	Coarse—near scale of constituency	Best when value categories uncertain & articulation difficult	Conversion of narratives to metrics difficult
Mental/ Cultural Models	Use for social-ecological/cause-effect logics, including ES 'production functions'	Fine, possibly coarse	Best when local worldviews, hence relations of B/V/S unknown	Values often implicit across cause-effect outputs
Paired Comparisons	Elicit relative weights across benefits	Coarse (survey) and fine (interviews)	Good for ordinal rankings; provides, statistical power with surveys	Design intensive; limited variables (benefits /objects usually <10)
Norm-based preference surveys	Elicits broad values and principles or 'values held'	Both, usually coarse	Widely used protocols; available databases at national levels	Values usually spatially nonspecific

Discursive Approaches/ Citizen Juries	Best for collective choices (citizen juries or quasi legal fora)	Coarse/ local	Good for matters needing lengthy deliberation & high transparency	Labor intensive, expensive; achieving consensus expected/difficult
Structured Decision Making (SDM)	Identify values as statements of what matters/objectives	Fine/local small groups	Flexible (uses natural, proxy or subjective performance measures)	Labor intensive; might only be appropriate for valuation and tradeoffs, not entire decision if application context is ES

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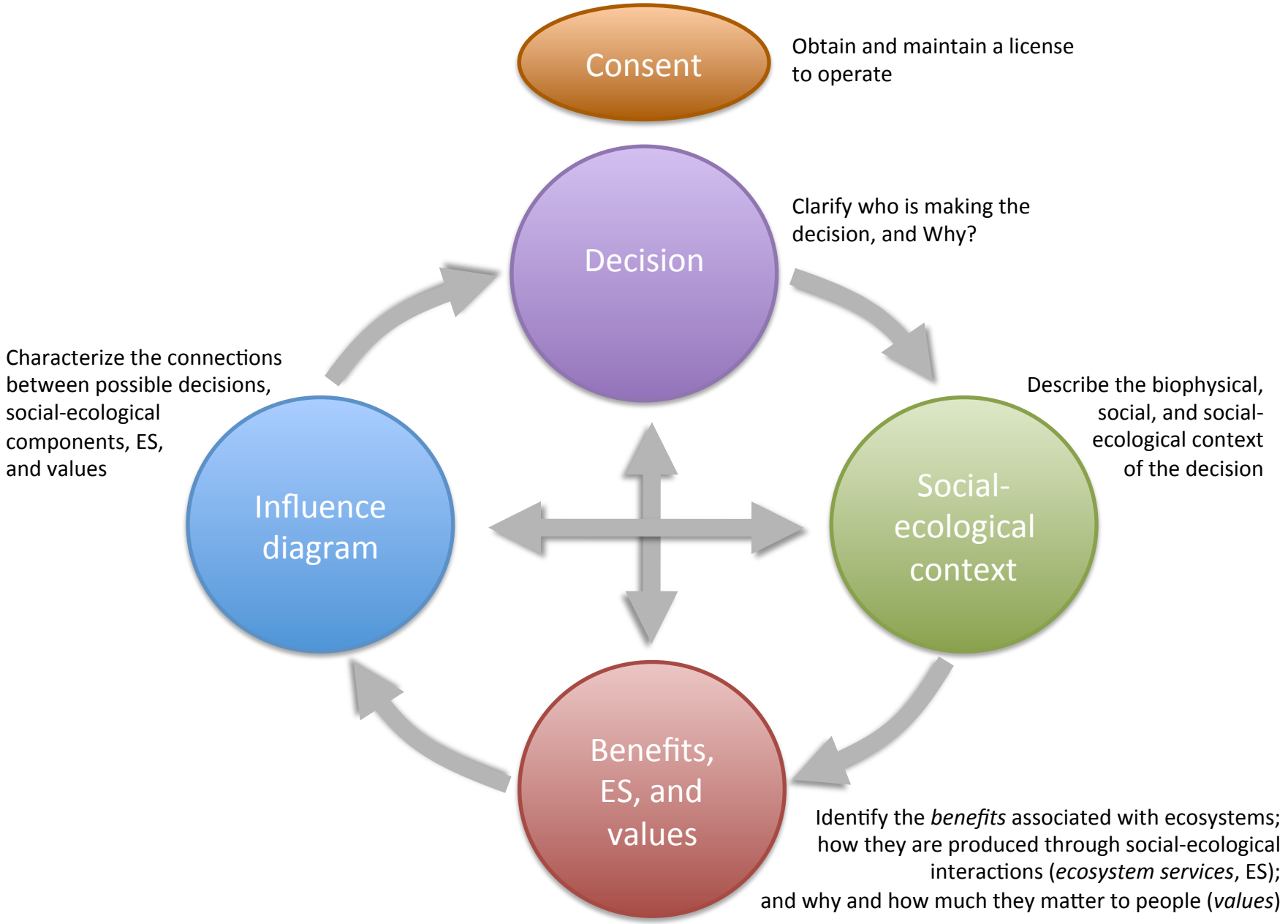
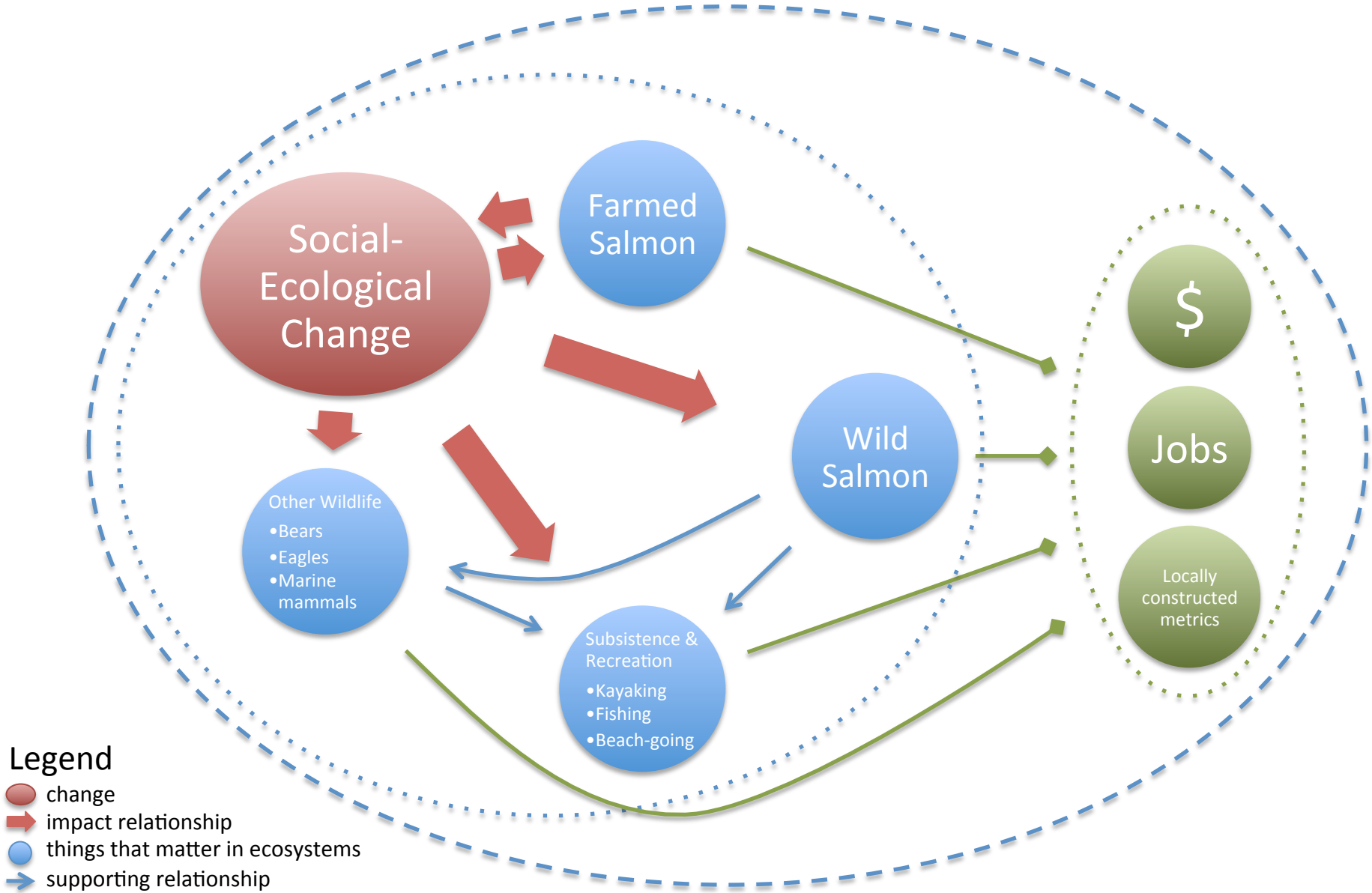

Consent
Obtain and maintain a license to operate
Decision
Clarify who is making the decision, and Why?
Social-ecological context
Describe the biophysical, social, and social-ecological context of the decision
Benefits, ES, and values
Identify the *benefits* associated with ecosystems; how they are produced through social-ecological interactions (*ecosystem services*, ES); and why and how much they matter to people (*values*)
Influence diagram
Characterize the connections between possible decisions, social-ecological components, ES, and values

Figure 2. Location of the illustration-study region, Regional District of Mount Waddington (RDMW), in British Columbia, Canada. PNCIMA is the Pacific North Coast Integrated Management Area. 178x253mm (300 x 300 DPI)


Social-Ecological Change
Farmed Salmon
Wild Salmon
Other Wildlife
•Bears
•Eagles
•Marine mammals
Subsistence & Recreation
•Kayaking
•Fishing
•Beach-going
$
Jobs
Locally constructed metrics
Legend
change
impact relationship
things that matter in ecosystems
supporting relationship
metrics of value
valuation process