



## Survey

## Rethinking ecosystem services to better address and navigate cultural values

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## ARTICLE INFO

## Article history:

Received 9 July 2011

Received in revised form 12 October 2011

Accepted 21 November 2011

Available online 20 December 2011

## Keywords:

Environmental policy

Environmental values and valuation

Ecosystem-based management

Incommensurability

Non-use values

Cultural ecosystem services

## ABSTRACT

Ecosystem service approaches have become a prominent basis for planning and management. Cultural services and non-use values are included in all major typologies and present some of the most compelling reasons for conserving ecosystems, though many barriers exist to their explicit characterization. The values that conform least well to economic assumptions—variously lumped together with/as cultural services—have proven elusive in part because valuation is complicated by the properties of intangibility and incommensurability, which has in turn led to their exclusion from economic valuation. We argue that the effectiveness of the ecosystem services framework in decision-making is thwarted by (i) conflation of services, values, and benefits, and (ii) failure to appropriately treat diverse *kinds* of values. We address this challenge by (1) distinguishing eight dimensions of values, which have implications for appropriate valuation and decision-making; (2) demonstrating the interconnected nature of benefits and services, and so the ubiquity of intangible values; (3) discussing the implications of these propositions for ecosystem-services research; and (4) outlining briefly a research agenda to enable decision-making that is ecologically appropriate and socially just. Because many ecosystem services (co-)produce 'cultural' benefits, full characterization of services must address non-material values through methods from diverse social sciences.

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## 1. Introduction

In recent decades, the concept of ecosystem services (ES) has gained widespread attention as one fruitful approach for integrating into decision-making ecosystem-related values often heretofore dismissed as externalities. As *the provision of direct and indirect benefits to people from ecosystems* (building upon Daily, 1997; Millennium Ecosystem Assessment, 2005), ES as a framework has provided an approach to bridge the gap between ecology and economics, and thus the approach to date primarily represents these two perspectives. Specifically, economic valuation techniques are used to assign a value to ecosystem components and functions (see Fig. 1.3 in National Research Council, U.S., 2005). By expressing ecosystem values in this manner, conservation scientists have added a compelling new tool for 'internalizing' the worth of ecosystems and conveying this to a broad audience, including many land managers and policymakers.

Integrating ecological and economic approaches has been an important area for advancement in ES research (Turner and Daily, 2008), and this integration has contributed to policy development, most notably with payment for ecosystem services programs (Eigenraam et al.,

2007; Engel et al., 2008; Juniper, 2011; Muñoz-Piña et al., 2008; Turpie et al., 2008). But approaches of this kind cannot or have yet to encompass all dimensions of value, thus many important considerations remain marginalized within ES research and practice. To ecologists, economic valuation brought the ability to express some of the values of ecosystems in metrics (dollars) that have meaning to publics, policymakers and decision contexts. While this inclusion of economic values was likely fuelled by a desire to valorize ecosystems—a desire stemming from the perceived intrinsic values of nature (Satterfield and Kalof, 2005), one could argue that in their efforts to include economics, ecologists adopted an essentially economic worldview. In so doing, they may have simultaneously closed the door to other social perspectives—those more fully representative of the vicissitudes of human behavior and the less tangible social and ethical concerns to be outlined more fully below.

The objective of this paper is to better integrate a broader set of social perspectives and valuation techniques into the ecosystem services framework, to enable a fuller characterization and representation of diverse ecosystem values in research and practice, while being mindful of the challenges of doing so. Some values do not fit naturally within an ES approach, and we do not seek such global inclusion; rather, we seek an ES approach that provides appropriate space for ill-fitting values such that important cultural and moral values are not dismissed as hidden externalities. Our hope is that such a broader consideration of cultural values will facilitate appropriate treatment of diverse stakeholders and perspectives, such that ES application avoids the claims of cultural insensitivity that have plagued biological conservation.

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### 1.1. Treatment of Cultural and Non-use Values

Cultural and 'non-use' values are included with ecosystem services in all prominent typologies (Costanza et al., 1997; Daily et al., 1997; de Groot et al., 2002; Millennium Ecosystem Assessment, 2005), but in practice they have received little attention in the growing body of empirical ecosystem services research. Insofar as they have been quantified, cultural ES have generally been valued in purely economic terms (e.g., Chiesura and de Groot, 2003; Martín-López et al., 2007, 2009), which cannot reflect the full extent of their differences from other ecosystem services. While these intangible values have been described elegantly through poetry and prose (e.g., Satterfield and Slovic, 2004), these descriptions are neither expressions of how these values are produced (as in an ecological production function), nor are they commensurate with an ES framework.

In this paper, we argue that the effectiveness of the ES framework in decision-making is thwarted by (i) the conflation of services, values, and benefits, and (ii) the failure to recognize the importance of different kinds of values for valuation and decision-making, particularly with regard to cultural ES. We thus begin by reviewing and proposing a new definition for cultural ES. Our aim is to highlight in particular services said to be intangible and/or incommensurable and as such sidelined by the ES framework. We then propose categories of relevant values, benefits, and services that clarify differences and connections between these conflated terms. We discuss the implications of these above clarifications for efforts to characterize and value ES. Combined, our overarching goal is to enhance awareness of the diversity of values that are integral to the ES framework—and ecosystem-based decision-making generally—and so motivate meaningful change in the representation and analysis of how human well-being may change alongside ecological change.

ES have been defined in reference to their material or non-material values, with material values considered in relation to provisioning, regulating, and supporting services, whereas non-material values and/or benefits have been associated with cultural services. Costanza et al. (1997) defined cultural values-cum-services as “aesthetic, artistic, educational, spiritual and/or scientific values of ecosystems” (p. 254). The Millennium Ecosystem Assessment (2005, p. 894) expanded this definition to include 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”. Costanza et al. (1997) define cultural ES as *values*, while the Millennium Ecosystem Assessment (2005) defines services as *benefits*; similarly de Groot et al. (2005) include a diverse set of things in their list of categories of services: benefits, services, values, and activities. In the interest of conceptual clarity, we suggest distinguishing between these diverse things: *services* are the production of *benefits* (where benefits may take the form of *activities*), which are of *value* to people (see definitions for these terms below). Accordingly, we define cultural services inclusively as *ecosystems' contributions to the non-material benefits (e.g., capabilities and experiences) that arise from human-ecosystem relationships*.

We recognize that such a broad definition might overlap with other categories of services (provisioning, supporting, regulating) (MA, 2005) and so lead to concerns of double-counting. But double-counting is only problematic if these four master categories are used for accounting purposes—i.e., to parcel independent services, whose values are then aggregated to obtain a total economic value. The summation of values across master categories is neither the only purpose for those categories nor good accounting in any case, given that supporting services provide value to people only through other (final) services. Accordingly, we distance ourselves in this paper from this accounting purpose for the master categories and argue for descriptive master categories, such that any service might be a constituent of multiple categories (e.g., both provisioning and cultural; see examples below). Our primary purpose here is to achieve more appropriate consideration of the

various relevant values associated with ecosystems and environmental management.

### 1.2. Why Intangible Services Matter and Why They Present Challenges

As long as non-use, intangible, and cultural values are relegated to an after-thought or poorly represented by ill-suited value metrics, an ES approach will continue to be critiqued by many: ecologists and others perceiving intrinsic or other “higher” values in nature (e.g., Ludwig, 2000; McCauley, 2006; Redford and Adams, 2009; Rees, 1998); philosophers and others concerned with inappropriate assumptions of substitutability (e.g., Gowdy, 2001) and with diverse kinds of values (e.g., Norgaard, 2010; Norton and Noonan, 2007; Randall, 2002); and critical theorists concerned with the privatization and commodification of nature (Robertson, 2004). This rich ideological fodder fuels spirited discourse in academic and researcher communities and challenges decision-makers and practitioners to achieve an optimal balance of outcomes that may be at cross-purposes. As one example of striving for balance, Neil Hannahs is responsible for a 142,000-hectare endowment for a private school that strives to improve the capabilities and well-being of people of Hawaiian ancestry. Conventional fiduciary principles support utilization of the endowment to generate financial resources to fund school operations, but land uses that develop desired cash flow may displace beneficiaries from traditional homelands, undermine sense of place, jeopardize cultural practices, or weaken worldview or spiritual foundations.

To some, these other values are “where we really get at well-being” (Neil Hannahs, personal communication), a stark contradiction to neoclassical assumptions that economic values appropriately represent preference and well-being (see also King and Roth, 2006).

The critique that important value content has been sidelined in ES research and practice pertains primarily to representation and the measurement of value. From an ES perspective, it appears that the desire to ‘solve’ these questions is a function of necessity—everything must somehow ‘fit’ into an ES framework so that all that matters can be treated equally, and thereafter be compared and traded off against one another as more or less important, more or less ‘valued’ or more or less subject to protection, loss, or gain. And yet, the notion that all values are or should be subject to these rules is contested. In particular, many have argued that some classes of value are incommensurate and not (by this logic) amenable to tradeoffs in analytical frameworks such as cost-benefit or risk assessment (e.g., Brosius, 2010; Satterfield and Roberts, 2008). This occurs for several (not mutually exclusive) reasons: e.g., because some values (a) are central elements of worldviews, and so to lose or ignore these is to risk all basis for meaning and value; (b) need to be examined discursively before they can be traded off; (c) are a function of experience and so difficult to articulate.

The first point is that some kinds of values are regarded as incommensurate because people reject outright the very possibility of tradeoffs—at least initially (‘protected’ or sacred values—Baron and Spranca, 1997; Tetlock, 2003). In such cases, efforts to determine appropriate tradeoffs break down because the posed options trigger participants to believe they must sacrifice a deeply held principle in order to participate in any negotiation or decision process (Atran et al., 2007). That the value is ‘incommensurate’ with other values (a hallmark of protected values) is secondary; the central problem is that an act or management choice may be seen as violating an inviolable principle and thus any measurement or negotiation stalls.

A related point is that many values or properties of a material ‘thing’ can also have intangible qualities that are as or more important, and which are deemed central to identity to a self-defined population or recognized cultural group. In New Zealand, for example, the properties/values known as ‘mauri’ and ‘whakapapa’ fundamentally challenged that country’s risk regulatory agency as both values were said to be transgressed by the creation of genetically modified organisms (GMOs) (Roberts et al., 2004; Satterfield and Roberts, 2008). Mauri is

that which is said to endow things with their own special characters or natures, thus making it “possible for everything to move and live in accordance with the conditions and limits of its existence” (Barlow, 1991, p. 83); whereas whakapapa is a principle/property of genealogy fundamental to conceptualizations of ancestry and identity. Whakapapa is the basis through which one locates oneself or other beings in the larger human and non-human world across time and space. Through that location one comes to know one’s purpose (also inscribed by mauri), ontological history, and hence the place of oneself and all other entities (human and nonhuman) in the larger order of things, including ecosystem-like configurations of the natural and social world. Despite the fundamental meaning and importance of mauri and whakapapa, the regulator (The Environmental Risk Management Authority) expected these values to be weighed or converted to probabilities of material harm given their transgression. Few if any including many Maori scholars were willing to engage in this line of questioning, because a focus on measurable effects fundamentally altered a meta-physical worldview about the potency and vitalism of all things (Henare, 2001), to a value measurement script of an untenable kind (Satterfield and Roberts, 2008). To fit economic assumptions, one might be tempted to ask—e.g., as in contingent valuation—what individuals are willing to pay to maintain mauri and whakapapa. But it is unlikely a person would put a monetary value on the very values through which the ontological importance of all things is understood.

The second point is that some kinds of values cannot be traded off without negotiation. Often this occurs when moral principles are involved, such as equity and sovereignty. In such cases, the person or persons affected may not hold the principle as sacrosanct, but they feel the need to be involved in the trading-off. Restitution is one example: one commonly accepted principle of fair compensation is that the affected party should be involved in determining the terms. This moral principle is reflected in legal requirements, e.g., those pertaining to First Nations treaty and title settlements in Canada (Chan and Satterfield, 2007; Gregory et al., 2008).

The problem that some things are not amenable to valuation for trade-offs has arisen most prominently in critiques of contingent valuation. Valuation studies of nonmarket goods through stated willingness-to-pay (e.g., improvement of the status of an environmental amenity) have revealed that, for example, assigned dollar values can be rooted in moral not monetary worth (Kahneman and Knetsch, 1992). As such, the problem of understanding the value at hand may be better served by democratically debating what “we” as a society want (i.e., the social good), in lieu of the aggregated personal (“I want”) preferences of individuals (Sagoff, 1998, 2004). Paraphrasing and then citing, verbatim, Sagoff (2004, p. 13–14): A democratic or political compromise ... responds to all manner of reasons; an economic tradeoff, in contrast, weighs preference or worth. “Political compromises may be said to be legitimate insofar as they emerge from democratic processes structured to ensure that all sides get a fair hearing. Economic tradeoffs, in contrast, may take place between strangers who make exchanges in a market.”

Third, some kinds of values cannot be appreciated without being experienced. “You had to be there,” is a colloquial indication of such value, signaling that no available representation of an event could capture the way the event made a person feel. An obvious category of values here is transformative values, the value of a thing for the way it changes how we think (Norton, 1987). A person cannot sum up the importance of a story to her with a number, and she often cannot relate the relevance of the story for a given problem without telling the story. This recognition of the importance of experience has motivated many scientists to turn to literature in their attempt to express the values they derive from nature (Satterfield and Slovic, 2004), and narration itself can help lay people articulate a broad range of environmental values (Satterfield, 2001). If there are important transformative values associated with a site, associated narratives generally need to be told and heard in order for the values to be appreciated, as the transformation is personal.

In addition to the problems posed by the above three kinds of incommensurability, the incorporation of cultural services into an ES framework is confounded by the frequent conflation of values, benefits, and services—which in this context must be distinguished for two reasons (discussed in Chan et al., 2011). *Benefits*, as valued goods and experiences, are the level at which people can most easily relate ecosystems to themselves. *Services*, as the ecosystem processes underpinning benefits, are the level at which ecosystem properties and dynamics might be considered in planning and management. *Values* are the preferences, principles and virtues that we (up)hold as individuals or groups. Unlike the categorization of services and benefits (see Supporting Online Information for a description of nine prominent categories of cultural benefits), values can differ in kind across any of eight (or more) dimensions, with ramifications for appropriate valuation.

## 2. Dimensions of Values for Environmental Decision-making

The broad term ‘value’ can refer to both underlying ideals (held values, such as bravery, fairness, happiness) and also the relative importance of things (assigned values, such as monetary values of goods) (Brown, 1984). As others have argued persuasively, empirical valuations can only be explained by recognizing disjunctions between valuation methods employed and the respective kinds of value at play (Brown, 1984; Lockwood, 1998; Sagoff, 1998). For example, longstanding debates about the validity of willingness to pay/accept (WTP/WTA) methods for environmental goods stem partly from a mixing of diverse kinds of values in a single valuation method. Whereas researchers must assume that an individual expresses such values based on the benefits (consequences) that the object of valuation has for her, social scientists have documented clearly that such responses also reflect a willingness to contribute to a moral cause (Kahneman and Knetsch, 1992)—and thus are measures not of individual preference but an index of support for a morally right or just society (Sagoff, 1998). The dollar metric ‘index’ can thus be insensitive to scale because survey participants find the question inappropriate, or they do not distinguish scope and so, for example, the dollar amount promised for one improvement is the same as that for five. The dollar amount provided is thereby a proxy for a donation to the social good and not an expression of market value per se.

In order to inform management and policy, we consider together all manner of personal and moral notions that contribute to a person’s judgment of right and wrong, but we distinguish those dimensions especially pertinent for considering appropriate venues for value expression and decision-making. Not all values pertain to the importance of benefits from ES, but all are important to the broader context of environmental decision-making. Note that we consider values to be one way to understand and represent what matters to people, and not a set of entities that exist ‘out there’. Accordingly, while the typology below caricatures binaries (or triads) across the eight dimensions of value, we recognize that any instantiation of value—e.g., a person’s motivation for conservation—will be a complex mixture of value-types and not cleanly just one part of any binary (e.g., not just for oneself or others, but both intertwined). For philosophers, representing such disparate notions on the same spectrum risks conflating fundamentally unlike things, whereas for most people such distinctions are semantic constructions resulting from ad hoc dissection of a single set of judgments. Our pragmatic approach involves walking a purposeful middle road between these two perspectives in order to inform research for practice.

### 2.1. Preferences vs. Principles vs. Virtues

One dimension of value follows a division of ethical theories between principle-based (deontological) and preference-based (teleological/consequentialist) (March, 1994; Sagoff, 1996, 1998, 2000; Spash, 2000), to which we recognize a third category of virtue-based values (Dean Moore and Russell, 2009; O’Neill et al., 2007). Whereas

principles generally pertain to characteristics of an action or decision (the means), preferences pertain to the consequences of an action (the ends), and virtues pertain to the actor(s).

Under some circumstances, a person's preferences may be affected by her principles or virtues (ideas of right actions or right people), and the principles a person adopts and maintains may stem partly from her virtues: the kind of person we believe we should be (e.g., honest) can inform the kinds of principles we uphold (e.g., truth-telling), which can affect how much we desire a thing (e.g., a product marketed dishonestly). This relationship between preferences and principles has implications for resulting valuations: one should expect frequent non-additivity, non-transitivity, and rapid changes in preferences including willingness to pay (WTP). For example, if a conscientious consumer finds out that a "green" product contains a notorious persistent organic pollutant, her willingness to pay for the product may drop dramatically because of perceptions of false advertising and the virtues of honesty. Cialdini (2007) documents many instances in which consumers' willingness to buy products is influenced in consistent ways by appealing inconspicuously to principles such as reciprocity via corporate charity donations.

Furthermore, although principles and virtues generally do not pertain directly to the products of ecosystem services (rather, indirectly through preferences), they may be critical to the success or failure of plans or projects. For example, principle- and virtue-based values may be at the heart of many of the problematic kinds of incommensurability discussed above. Accordingly, environmental researchers and decision-makers ignore principles and virtues at their peril.

## 2.2. Market-mediated vs. Non-market-mediated

Another fundamental distinction is between values mediated through the market (in most cases, through money) and those that are independent of markets. Our market/non-market *value* dichotomy differs from the market/non-market *valuation* dichotomy of economics. In economics, valuation of a good/service is 'non-market' if the good/service is not directly transacted in markets, even if valuation relies upon the thing's contributions to market-transacted goods/services; all revealed-preference methods operate this way (e.g., hedonic valuation, travel-cost method). By our terminology, such revealed-preference 'non-market' valuation would provide measures of supporting/instrumental market-mediated value: at stake, but indirectly, is a gain/loss of money (see Section 2.6). Money has a particular kind of meaning because its value is independent of the things bought/sold.

The market-mediation of value has two other implications for valuation. First, if the final benefits in question are mediated through markets, people have experience expressing willingness to pay/accept; this experience neutralizes one of the fundamental critiques of WTP/WTA as a measure of value.

Second, benefits mediated through markets with middle-men are almost certain to be thought of—and valued—in largely instrumental terms. As a thing becomes such a commodity, the special (sometimes unique) value of the thing based on its embodied labor and meaning, meaning associated with the transaction itself, etc., may be lost. Consider the kinds of values that tend to accompany things made and gifted by the producer at one extreme, through things sold by the producer (e.g., at a farmers' or craft market), to those sold in major retail chains. The value of the latter market-mediated things is more likely to be represented well by monetary values alone (monetary values are more likely to be an appropriate estimate of a thing's true value to a person).

The nature of a particular good or service can change fundamentally depending on whether it could be traded in markets—even if the particular item is not traded—as exemplified by West (2006) in her discussion of Papua New Guinean net-bags. These net-bags were once key objects of social exchange in the form of hand-made expressions of love, reciprocity, etc. When they instead became commodities for sale in markets, unexpected social consequences followed. Women (the

producers) became viewed as labor inputs in production; this in turn triggered increases in bride prices and the expectation that net-bags could and should be produced more quickly. The value of both ('women' and 'bags') were thus altered greatly, with consequences for social interactions.

## 2.3. Self-oriented vs. Other-oriented

It is important to distinguish between concern for oneself vs. for others, as this raises an important question of constituency ("the individual or group that the valuator is representing when making the valuation"). Valuation should represent all who have a legitimate stake in the resulting decision; and economists generally prefer self-oriented valuation by each legitimate stakeholder to other-oriented valuation. The unfortunate byproduct of such practice is that the perspectives of some who cannot express valuations are largely ignored (including future people and non-human organisms). Future people generally are assumed to have the same preferences as existing people: although important differences are likely, they cannot easily be anticipated. In contrast, non-human organisms frequently are assumed to be of no intrinsic moral worth (so not deserving consideration), an assumption that many—including Chan (2011)—have challenged.

## 2.4. Individual vs. Holistic/group

Values can be held at the level of individuals or groups, and most valuation methods are clearly oriented towards one kind such that the other kind is suppressed (Brown, 1984; Wilson and Howarth, 2002). For example, Sagoff's (1998) 'citizen preferences' are determined largely by an individual's idea of what constitutes a good *society*, which might explain Sagoff's preference for deliberative and discursive group approaches: we infer that he considers such ideas to be group values in that they are formed and articulated most appropriately in groups. While group values are often conflated with principles/deontological values, we postulate that both principles and preferences can pertain to both individuals and groups. Cultural integrity and continuity are examples of values whose importance is determined largely at the level of groups (as in the Maori example above); for such values, valuation exclusively by individuals seems inappropriate.

## 2.5. Experiential vs. Metaphysical

Objects can be valued not only for contributions to valued experiences, but also—simultaneously and sometimes inseparably—for their existence, independent of experience (Krutilla, 1967). The classic existence value is the expressed preference of donors to conservation organizations, who seek to protect wildlife or patches of wilderness without any expectation of future experience (Krutilla, 1967). Such metaphysical values can be self-oriented (existence value) or other-oriented (e.g., bequest value), and they can be based in virtues, principles, or preferences. Attention to this dimension of value can help resolve appropriate constituencies of valuation: because of the experience requirement, experiential values generally incur much narrower constituencies than metaphysical ones (only people who visit a park will benefit from experiential enjoyment, but many might benefit metaphysically).

## 2.6. Supporting vs. Final (Instrumental vs. Inherent)

Some values of things stem from the manner in which they help to produce other things; other values are inherent in that they are desired ends in themselves. The former are supporting or instrumental values, while the latter are final/terminal or inherent values (Brown, 1984). This distinction has a prominent feature of ecosystem services categorizations (Boyd and Banzhaf, 2007; Daily, 1997; de Groot et al., 2002; MA, 2005), because it provides crucial information to

characterize interactions between ecosystem components or functions, and resulting goods and services. Understanding such interactions is essential to avoid double-counting.

A special case of instrumental value is monetary value: the value of a thing to a person derived from the possibility of garnering money from the thing. Money is an instrument for achieving other things; thus insofar as a thing yields money for people it provides instrumental value (but not necessarily only that).

An implication of this distinction is that instrumental values are frequently fungible (substitutable), in the sense that other things may also help people achieve the desired end. The substitutability of a thing to a person is a function of his/her capabilities, access to other resources and other forms of capital, etc. If ES research intends to contribute to an understanding of well-being through monetary values, it must account for this heterogeneous value of a dollar (Chan et al., 2011).

### 2.7. Transformative vs. Non-transformative

A thing or process can be valuable for its contribution to a transformation in values and perspectives (Norton, 1987), or it can be valuable in reference to unchanging values and perspectives. A thing or experience seen to have high transformative value might be seen as worthless under the prevailing value set; this poses considerable problems for economic valuation methods, which assume that values are pre-existing and unchanging. Considerable evidence suggests that most people do not have pre-existing preferences (e.g., that might be represented by monetary valuations), particularly for 'environmental amenities' such as clean air or water (Gregory et al., 1993). To the extent that powerful experiences can change the way we view the world and designate importance (many environmental leaders cite the power of such pivotal experiences in motivating their own paths—Mowat, 1990), valuation methods that assume constancy of preferences will be inappropriate in cases where decisions at hand may impact opportunities for such experiences.

### 2.8. Anthropocentric vs. Biocentric

Values may be held by human beings (anthropocentric) or—arguably—by non-human organisms (biocentric, 'intrinsic').<sup>1</sup> Ecosystem services are defined as the provision of things/conditions of anthropocentric value, but it is crucial to recognize that biocentric values such as the perceived intrinsic value of biodiversity may underlie many efforts to value ecosystem services (Chan et al., 2007) as well as resistance to such efforts (e.g., McCauley, 2006; Rees, 1998). Only the metaphorical shadow of these biocentric values can be captured as ecosystem services, e.g., in the form of existence and bequest values.

These eight dimensions of values—and their implications for valuation practice—have special significance in light of the deep, pervasive, and variable connections between diverse services, benefits and values. Because there are few cases in which a given service provides a single kind of benefit, of value for only one kind of reason, there are few contexts in which services can be valued comprehensively using just one method.

## 3. The Interconnected Nature of Services, Benefits, and Values

Many services produce many benefits, which may be important for many kinds of reasons. Virtually all services that have been considered material services suitable for purely monetary valuation (most provisioning, regulating, and supporting services) have crucial non-material dimensions. This may be for two reasons. First, a service may be intimately connected to a non-material benefit (e.g., because

benefiting materially from a market good requires that someone obtain that good, which generally entails employment, physical activity, and/or other non-material benefits). Second, even material benefits may relate to various kinds of values (e.g., produce from a farmers' market—a market good—may be connected to inspiration, social capital and cohesion, and other categories of benefits, such that individual self-oriented monetary valuation may incompletely represent value to people) (Fig. 1). This is in contrast to conventional economic approaches to ES, where it is often desirable to compartmentalize services such that each service only provides one kind of benefit (Kareiva et al., 2011)—a simplification that will be enlightening in some contexts and obfuscating in others.

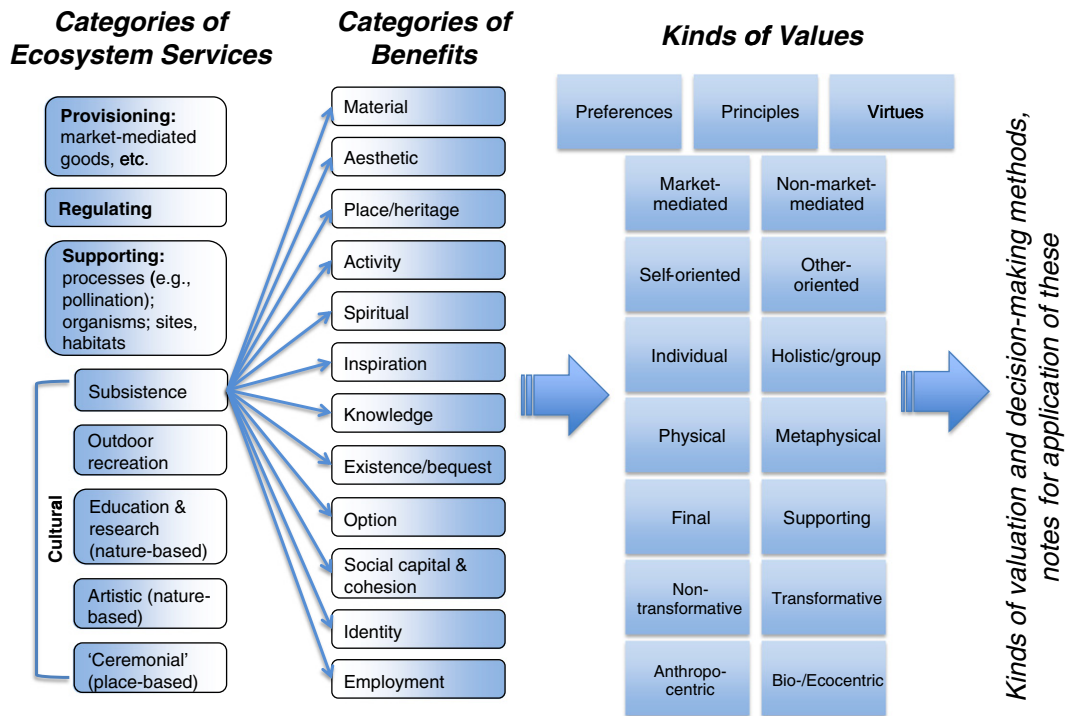
### 3.1. The Ubiquitous Need to Consider Intangible Dimensions

Without considering intangible dimensions, management or policy actions that might seem highly desirable for a natural resource may actually hide aspects that suggest a more complicated situation. Consider the example of fisheries management, by which a switch to individual tradable quotas (ITQs) is advocated as providing an improved strategy for protecting the resource base and enabling a sustainable high catch (Ostrom, 2009). By the logic of disaggregate services, this might seem entirely positive (and indeed, there are many positive aspects to ITQs; our discussion here is intended solely to highlight the interconnectedness of services and benefits).

The provision of fish for commercial harvest is simultaneously a provision of employment. Jobs play a central role in politics, above and beyond summary measures of economic output, suggesting strongly that the value of a job to a person transcends its contribution to the overall economy. This is especially true for the kinds of jobs that form the backbone of communities, which fishing does for many coastal communities. ITQs had the effect of consolidating ownership in Canada, which contributed to changes in the nature of employment (Davis, 1996; Pinkerton, 1989). Accordingly, what might appear to be simply a change in distribution of benefits in the form of market goods can be for some individuals and communities a devastating loss of many categories of benefits (virtually all those in Fig. 1), which pertain to richly diverse kinds of values. For instance, in some communities such as the Nuxalk First Nation of British Columbia (B.C.), the aforementioned shift in employment simultaneously triggered a loss of subsistence activities because the First Nation-allotted 'food' fishery depended critically on the commercial fishery for boats, gas, and cash (many fishermen previously caught their subsistence allotment, and that of friends and family, while catching their commercial quota) (Burke, 2010). And this loss of subsistence activities itself entailed a loss of benefits associated with appreciation of place (because many places are no longer visited), heritage, social capital and cohesion, and virtually every category of benefit in Fig. 1 (and Supporting Online Information). Common valuation practices relying heavily on market valuation might fail to identify any of these intangible values and suggest only benefits of ITQs, missing entirely the accompanying suite of social and cultural impacts.

To some lay people, these connections between various services, benefits, and values are obvious. A Kyuquot-Checleset elder (of the northwest coast of Vancouver Island, B.C.), described to one of the authors (pers. comm.) the loss of fishing opportunities as causing a loss of knowledge and cultural identity in the community's youth, which she seemed to attribute to a lack of transformative experiences, all of which were entangled with both self- and other-oriented, group and individual values. Moreover, people may intentionally make use of service-benefit-value connections to achieve desired ends. For example, a Kyuquot-Checleset fisherman (pers. comm.) suggested the decline of local Chinook salmon (*Oncorhynchus tshawytscha*) as triggering loss of inspiration and spiritual benefits because fishing less animat-ed and abundant species no longer captured boys' interest. They (fishermen) had begun to rely on black bass (*Sebastes melanops*) fishing to provide the transformative experiences to get boys hooked on

<sup>1</sup> Values may even represent other entities, such as mountains, but here we consider only living beings.



**Fig. 1.** The suggested use of the typologies of ecosystem services and values (reprinted with modifications from Chan et al., 2011): identify the relevant categories of ecosystem-derived benefits and services; connect the services and benefits, based on local expertise and/or participation; connect the benefits to kinds of values; use the kinds of values at stake to inform choice and application of valuation and decision-making methods—to ensure appropriate representation of the full range of relevant values and to avoid double-counting. The particular categories of services and benefits are only one example (categories are context-dependent—see text), and the arrows linking subsistence to categories of values are just one example of a mapping of one service onto benefits (other mappings are certainly possible). Note that the service names are shorthand (e.g., it should be “provision of market-mediated goods”), and that individual services like ‘subsistence’ do not fit cleanly within a single master category.

fishing, because black bass is one of very few species sufficient to provide the necessary thrill.

#### 4. Non-use and Cultural Values as Ecosystem Services

In our proposed typology, many services produce multiple benefits, and the value of a service depends on the marginal value of changes in the various benefits it provides. Each of the associated benefits might simultaneously change through various other processes, which renders the independent valuation of several services problematic.

It may seem counterproductive to define services in such a way, but the interdependency of benefits is a reality (Klain, 2010), so defining services differently (e.g., as what we term benefits) will not solve the problem for valuation. Accordingly, comprehensive valuation of changes to ecosystems will rarely be easy or straightforward. Our explicit recognition of this interdependency is intended to foster understanding and appropriate treatment (see also an associated chapter with greater detail on methods and spatial modeling—Chan et al., 2011). Spiritual, inspiration, and place values are not products of single kinds of experiences; rather these values are products of all manner of experiences associated with ecosystems (including metaphysical contemplation of organisms, processes, and sites). Valuation exercises must account for these multiple benefits and their interdependencies, in part by avoiding double-counting. We and colleagues discuss these issues at length, including the implications for valuation, which will generally be more successful if more inclusive (i.e., of a range of services simultaneously) (Chan et al., 2011).

#### 5. Implications for ES Research

If ES researchers hope to foster ecosystem decision-making that appropriately addresses all manner of important values, they must employ a broader range of social-science tools and methods than the

current economic ones. In the pursuit of analytical tractability, economics researchers have focused principally on measurement and modeling, making assumptions that enable real-world application and generality (such as substitutability of resources). Such an approach is both defensible and of fundamental importance to improved environmental decision-making. The problem arises when a decision-making framework from economics is touted as complete, because values that fit poorly get left out or distorted. To represent ill-fitting values in economic terms produces numerous undesirable risks, including suggesting that all such values—including the sacred—are for sale (Spash, 2008b). Anthropologists, sociologists, ethicists, etc., endeavor to represent a fuller set of values, even if that representation is a site-specific description that cannot be generalized. Although adopting approaches from these other schools will make analysis ‘messier’ and less generalizable, it is a necessary route to a decision-making framework comprehensive in values (Fig. 2).

Of course an ES analysis will rarely if ever determine any particular decision alone, so a worthy question is whether ES researchers should bother seeking a comprehensive analytical framework that includes ill-fitting values. One might instead assume that political processes will ensure that such values will be properly considered in decision-making, as through a systematic democratic process or small-‘p’ politics (the ubiquitous jockeying to achieve goals through social power and influence). While understandable, we posit that such an approach yields four risks: (1) the attractiveness of a pre-packaged (e.g., cost-benefit) analysis might lead to important values being left out entirely; (2) although such values might be reflected in decision-making, political processes may be too blunt an instrument to represent the role of social and ecological dynamics in these co-produced benefits of cultural ES; (3) the *ad hoc* political process might privilege the interests of those who are empowered politically, socially, and economically, at the expense of the interests of the disempowered; (4) the inability to reconcile a technical ‘black-box’ analysis with deeply-held values might incite

constituents to reject the analysis, and along with it all the important research on ecological processes and functional relationships.

We do not intend that ES research should disentangle all possible service–benefit–value connections and employ a valuation exercise suited for each. Such reductionism would be impossibly and unnecessarily complicated. Rather, the conceptual mapping of services to benefits to values is helpful for researchers to identify interdependencies between services, potential double-counting, and broad valuation strategies that can appropriately account for the relevant diversity of values.

What matters most are the following key points: (1) ecosystems provide a variety of benefits through services, which are subject to management; (2) many services provide several benefits, such that interdependencies between services should be expected and accounted for; (3) people are likely to have a variety of preferences, principles, and virtues that pertain to ES, benefits, and their management—and these values are likely to be complex and diverse across several dimensions that have ramifications for valuation.

5.1. Conceptual (ES Typologies and Conceptual Frameworks)

The ‘classes’ of cultural values/benefits/services that have been grouped together under cultural services (de Groot et al., 2005) are perhaps best understood as those that do not fit well in other sectors

of ES research. These values and benefits are so divergent from each other and so overlapping with the values associated with other ‘master’ categories of services (provisioning, regulating, supporting) (MA, 2005) that we can imagine no clean way to group these services without also including services that have been considered elsewhere.

Further, most of the cultural values/benefits/services that have been grouped together as cultural services are best understood not as services, we argue, but rather as benefits that are produced not only through cultural services but also provisioning services, etc. For example, inspiration and identity benefits are commonly associated with fishing—a valued way of life and source of employment—but they are not fully reflected in monetary valuations of market goods associated with the provision of fish for harvest. Fishing is inextricably linked to the realization of fish harvests, so valuation frameworks are impoverished if they purport to represent the value of the provision of fish for harvest without accounting for these crucial but often intangible benefits associated with the process of fishing. The crux: monetary valuation is problematic or incomplete for a broad suite of ES.

The prevailing economic perspective on ecosystem services is represented in Fig. 2. According to this perspective, the quantification of ecosystem services requires a metric of service provision that is the product of an ‘ecological production function’ and the input to an ‘economic valuation function’. For any intangible, non-market-mediated

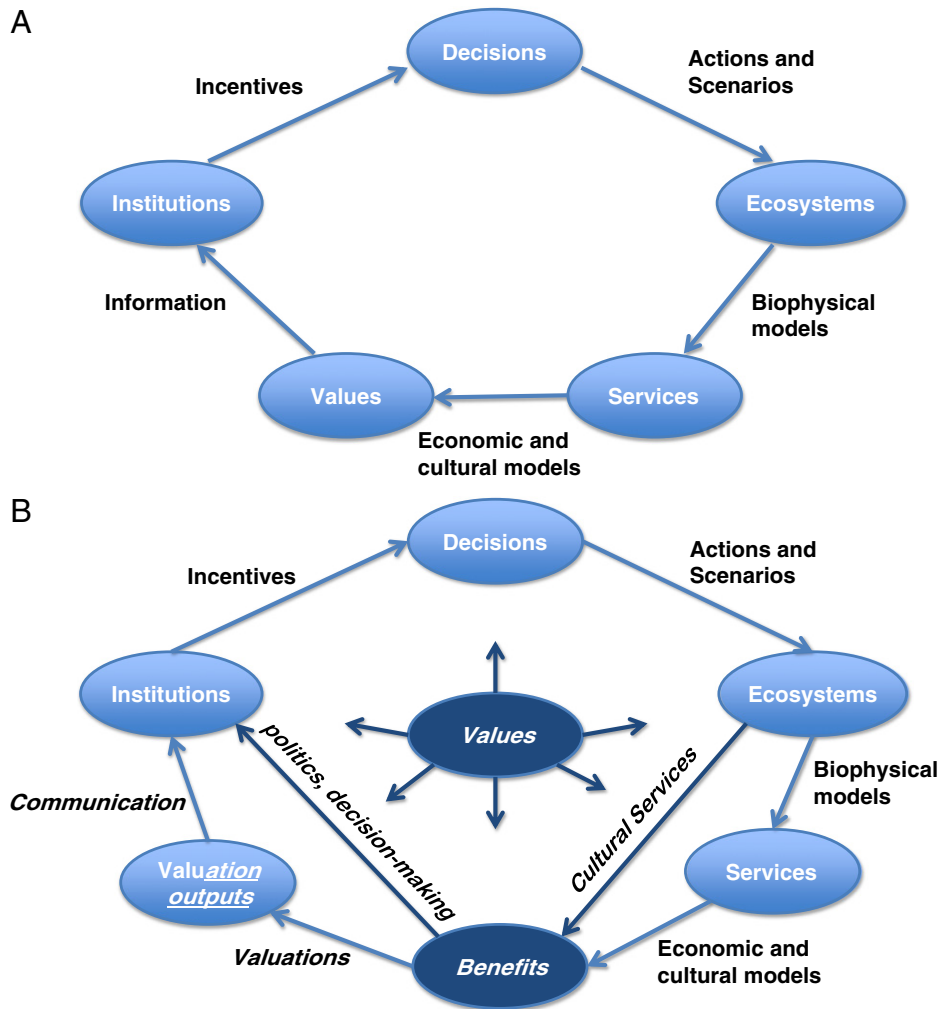


Fig. 2. The prevailing perspective on the roles of valuation (“economic and cultural models”) and ecosystem services in decision making (A) (redrawn from Daily et al., 2009), and the same graphic with suggested changes following the nature of values at play and discussion herein (B). Any bubble can be connected to any other bubble, but principal ES research connections are displayed. Italics and dark fill and line color indicate added/changed text, links, and bubbles. Changes: (1) cultural services are represented as a link without a bubble (because cultural services generally defy identification of a metric representing the service); (2) services produce benefits, not values; (3) benefits can be reflected in changes to institutions or decisions through politics (power and influence) and various forms of decision-making, or through valuations, which produce valuation outputs that must then be communicated; (4) values are pervasive and pertain to human preferences, principles, and virtues for and about all bubbles (and all arrows).

service or benefit (including recreation, subsistence, education and research, artistic, and 'ceremonial' services, and place/heritage, spiritual, inspiration, held, and identity value) it will be difficult to identify *a priori* metrics of service- or benefit provision. E.g., we can measure pollination as a service in the form of fruit set, and size and quality of fruit (Ricketts et al., 2004), but what metric could possibly represent the ecosystem provision of identity value? The problem is not that there can be no intermediary between ecosystems and the resulting values—there can. Rather, for benefits not mediated through markets, the characteristics that constitute the quantity and quality of benefit are not amenable to generalization and must be discovered on site. In contrast, for market-mediated goods one can appeal to characteristics of the global markets to identify appropriate metrics of service/benefit provision.

Ecosystems produce benefits through services, and those benefits matter to people and decision-making in many ways insufficiently represented by monetary valuation. Principles and virtues, for example, pertain to many aspects of decision-making, in ways too important to be overlooked or distorted. The current popularity of the concept of sustainability is a prime example: that we should govern our resources in a manner that does not compromise “the ability of future generations to meet their own needs ... in particular the essential needs of the world's poor, to which overriding priority should be given” (World Commission on Environment and Development, 1987, p. 43). Accordingly, sustainability is an idea steeped in principles of intergenerational equity and basic human needs. For ES research to ignore principles and virtues at the valuation stage would be to advance a dismembered concept of value lacking much of what matters to people.

Finally, even though biocentric values are not considered to be measures of benefits for people, it is crucial that ES valuation provide space for their expression in a manner commensurate with anthropocentric values. Some argue persuasively that it is unjustifiably speciesist for our duties to non-human organisms to be represented only through the extent to which people feel better or worse (Singer, 1993). Moreover, it will often be difficult to elicit from people only the parts of their values that correspond to their personal satisfaction, without the parts that stem from the moral commitments underlying or paralleling that satisfaction.

## 5.2. Methodological (to Assist Decision-making)

If, following the above, we accept that ecosystem services provide multiple benefits, valued for a range of reasons, then we must employ valuation methods that better match the diversity of values in question. An individual's values can be assessed using individual preference methods, but group/holistic methods are better assessed using group or deliberative approaches (e.g., Gregory et al., 1993; Wilson and Howarth, 2002). Preferences (Lockwood's (1998) lexicographic or exchange preferences or Sagoff's consumer preferences (1998)) can be assessed using stated-values approaches (e.g., contingent valuation—Carson, 2000), but principle- and virtue-based values are better assessed using inferred-values approaches like choice experiments or deliberative valuation (e.g., Howarth and Wilson, 2006; Spash, 2007, 2008a). What we term market-mediated values are generally conducive to monetary valuation, whereas non-market-mediated values are generally not. Bio- or eco-centric values and truly other-oriented values are excluded from consideration in economic valuation methods but amenable to consideration through deliberative, ethics-oriented approaches. Final values can be elicited through direct valuation, whereas supporting values should be valued through their contribution to final values (Boyd and Banzhaf, 2007). Non-transformative values present no special problems for valuation approaches, whereas transformative values cannot be related easily in any metric and require a richer form of communication (e.g., narration) combined with explicit consideration of societal goals and what *should* matter. This paragraph might seem to suggest a need for many incommensurate forms of valuation, but we can imagine a small set of kinds of valuation methods

contributing information to a decision-making valuation workshop in which metrics are accompanied by narration and deliberation.

Ultimately, much of the debate on methods for ES valuation is derivative of a larger debate between dollar metrics as expression of value and those who assert the necessity of multi-metric approaches (Chee, 2004; EPA (U.S. Environmental Protection Agency Science Advisory Board), 2009; Fischhoff, 1991; Gatto and De Leo, 2000; Norton and Noonan, 2007; O'Neill et al., 2007; Satterfield and Kalof, 2005; Spash, 2008b). Further, the question of which metric and how to derive it can be addressed through individual, expert, or group-deliberative processes for deriving and assigning value (Keeney and Gregory, 2005). While too comprehensive a topic for full coverage in this paper, we generally advocate a multi-method and especially multi-metric approach. Likely key to this will be ability to either infer weights or preferences through choice surveys based on paired comparisons (Chuenpagdee et al., 2001, 2006; Hanley et al., 1998; Naidoo and Adamowicz, 2005), or the actual construction of metrics through the use of subjective scaling when necessary (i.e., because no scale for that value exists) (Gregory et al., 1993). Such scales enable the assigning of value, ordinal ranking, or numeric tag to what are in large part intangible properties (such as awe in reference to spiritual value). In choice experiments, we might know that (what we understand as) awe is more important than another value because the option that emphasizes protecting that kind of experience is preferred across many choices or paired comparisons.

In the case of creating a metric for less tangible values using a multi-metric 'constructed' approach, the goal is best served by flexibility in the scales used (Keeney and Gregory, 2005). Following Keeney and Gregory (2005) and expanded for this context in Satterfield et al. (2011), a 'constructed' metric is a performance measure—perhaps a score and associated wording—developed to measure community support for a proposed management practice. If no *a priori* scale exists to measure support, an index (e.g., 1–5 or 1–10) might be created, with each rating denoting a different level of support. Many such constructed scales are in widespread use in society, e.g., the Apgar score used to track the health of newborn children. When thoughtfully designed, constructed indices can greatly facilitate a manager's decisions by defining precisely the focus of attention and by permitting tradeoffs across different levels of value and, equally important, rendering those tradeoffs visible (McShane et al., 2011). Scales translate qualitative information into quantitative scores, but without losing critical information: behind a summary rating of “2” can reside narratives, oral testimony, and scientific information relating to this anticipated level of impact. In general, scoring methods used to select scales should be accurate, understandable, and at an appropriate level of discrimination.

Several particularly good examples can be found in the work of Gregory and colleagues, whose work is theoretically grounded in multi-attribute utility theory but who have advanced subjective scaling, whereby the language of local constituents is often the basis for 'constructing' scales that render otherwise excluded (often intangible) variables visible and commensurate (Gregory et al., 2011). Constructed scales or metrics of this kind are used when no suitable measures exist. An example might be a scale to measure the ES benefit that maintaining a species used only for local (e.g., indigenous or First Nation-to-First Nation) trading, such as dried edible seaweeds, a coveted food and widely used for ceremonial purposes across the BC coast (Turner and Loewen, 1998). Impact in the face of harm, may affect provisioning or market value, but also the cultural value placed on 'enduring trading relationships' or 'ceremonial or cultural' use. That is, a scale would then be developed for the value of relationships across communities that might be harmed if trading is not maintained. In a situation such as this, an index might be created spanning 1–5, with 1 = “complete loss of local trading partner/relations”, ranging through 5 = “no loss of trading partner/relations”, or similar for effect on ceremonial practices. Such a constructed index can focus a decision maker's attention on tradeoffs with other attributes and questions such as “is it worth protecting



against potential impact on seaweed for  $x$  years in order to increase protection (e.g., of trading relations or networks) from level 2 to level 4 or 5?”

Some authors have argued that we should not preoccupy ourselves with eliciting values commensurate with values from welfare economics (Chee, 2004; Gatto and De Leo, 2000). They generally suggest instead that we should move straight to approaches like multi-criteria decision making or deliberative democratic approaches (Jacobs, 1997), which generally do not require value elicitation separate from the determination of a mutually agreeable decision. We prefer not to see ES characterization and deliberative decision-making as an either/or proposition: ES characterization—with or without valuation—can contribute a clearer understanding of the many ways in which outcomes that matter to people are associated with ecological structures and functions; deliberation contributes one powerful forum for weighing various considerations and diverse perspectives. Both have likely side-benefits: e.g., valuation and their multi-metric expressions can help raise the prominence of certain under-appreciated benefits; and deliberation can lead citizens to a better appreciation of positions at apparent odds. Both also have limitations: ES valuation is impeded by several methodological and philosophical limitations as discussed above; and full realization of the potential of deliberative decision-making requires a rare set of circumstances (e.g., a wise, beneficent decision maker; a political context that provides a viable opportunity for decision-making outside the predominant neoliberal economic framework; all relevant stakeholders possessing a meaningful say at a table where they can communicate their concerns and needs effectively in a political process; etc.). Despite these limitations, we see a tremendous opportunity for ES characterization and deliberative decision-making to co-produce decision-making that reflects a richer understanding of the myriad ways that ecosystem change matters to people. Similar developments in the health risk literature also offer a case in point from which ES scholars might draw (Renn, 1999).

A critical point in this context is that the expression of such intangible values can inform decision-making not only through civic-oriented decision-makers, but also by providing those who are struggling to find their voice with another means to communicate the importance and nature of their relationships with ecosystems (Chan et al., in review). Accordingly, researchers might well consider as their audience not only researchers, managers and policymakers, but also practitioners and stakeholders.

## 6. A Research Agenda for Cultural Values and Ecosystem Services

We have argued for an approach to ES research that will involve broadening beyond the economic framework of early ES research, with the loss of generality and added ‘messiness’ that might entail. While a daunting prospect, its upsides might include (i) a turning of corners away from the erroneous assumption that ES approaches necessarily or solely involve ‘putting a dollar value on nature,’ (ii) better inclusion of insights from those who have long studied environmental values and ethics, and (iii) better ES practices overall. Such a proposal involves a new research community and program at the nexus of ecological–economic analysis and the social sciences of decision-making, a program dramatically different from the existing ES research program, although we still see a strong role for economic valuation within this.

Our proposed new research community must directly confront the issue of political opportunity. It is no accident that the prevailing ES research program conforms closely to prevailing political norms: there is an appetite for economic decision-making frameworks that does not apply equally to the alternative approaches. Accordingly, bringing into practice an ES research agenda inclusive of diverse values, and of economic and other social science approaches, may require that researchers don their advocate hats—in support not of particular outcomes, but of just and inclusive processes.

At the heart of this new program is a set of research questions: to what degree and in what manner can researchers elucidate the diversity of values at play in the minds of stakeholders, pertaining to ecosystems? If a decision-making framework involves having stakeholders choose between alternative scenarios, under which circumstances will it be helpful to characterize ES consequences in biophysical terms or, more prosaically, in terms signifying value? Concurrently, under what circumstances should consequences be represented in terms commensurate with dollars to facilitate decision-making; under what circumstances should consequences be represented in some other terms, and how should a decision-making process reconcile these terms (building upon extant methods in decision analysis)? When transformative values of a site call for stories to be told in the decision-making process, how can these critically important narratives and value expressions be brought forth, and for whom? To the extent that ES decision-making may require input from group valuation workshops, what are the ramifications of differences in group composition, and how should groups be chosen for participation? Addressing each of these research frontiers will require collaborations involving a diverse range of natural and social scientists, practitioners, policy makers, and other stakeholders. We hope that this paper will start a conversation about how to do so most appropriately.

## Acknowledgments

This paper has benefited greatly from the input of many, including the National Center for Ecological Analysis and Synthesis (NCEAS) Cultural ES working group (especially Neil Hannahs and Ulalia Woodside), Terry Daniels and others at the Austria cultural ES meeting, the Chan lab group (especially Jordan Levine, Sarah Klain, and Jordan Tam; [www.conciseresearch.net](http://www.conciseresearch.net)), Stanford Norms and Institutions workshop (especially Debra Satz, Rachelle Gould, Amanda Cravens, Ken Arrow, Hal Mooney, Paul Ehrlich, and Steve Schneider), and Maria Lavis. Funding was provided by the Canada Research Chairs Program, the Canadian Foundation for Innovation, the B.C. Knowledge Development Fund, and the Social Sciences and Humanities Research Council of Canada.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at [doi:10.1016/j.ecolecon.2011.11.011](https://doi.org/10.1016/j.ecolecon.2011.11.011).

## References

- Atran, S., Axelrod, R., Davis, R., 2007. Sacred barriers to conflict resolution. *Science* 317, 1039–1040.
- Barlow, C., 1991. *Tikanga Whakaaro: Key Concepts in Māori Culture*. Oxford University Press, Auckland, New Zealand.
- Baron, J., Spranca, M., 1997. Protected values. *Organizational Behavior and Human Decision Processes* 70, 1–16.
- Boyd, J., Banzhaf, S., 2007. What are ecosystem services? The need for standardized environmental accounting units. *Ecological Economics* 63, 616–626.
- Brosius, J.P., 2010. Conservation tradeoffs and the politics of knowledge. In: Leader-Williams, N., Adams, W.M., Smith, R.J. (Eds.), *Trade-offs in Conservation: Deciding What to Save*. Wiley-Blackwell, Oxford, UK, pp. 311–328.
- Brown, T.C., 1984. The concept of value in resource allocation. *Land Economics* 60, 231–246.
- Burke, C.L., 2010. *When the Fishing's Gone: Understanding How Fisheries Management Affects the Informal Economy and Social Capital in the Nuxalk Nation*. Resource Management and Environmental Studies. University of British Columbia, Vancouver.
- Carson, R.T., 2000. Contingent valuation: a user's guide. *Environmental Science and Technology* 34, 1413–1418.
- Chan, K.M.A., 2011. Ethical extensionism under uncertainty of sentence: duties to non-human organisms without drawing a line. *Environmental Values* 20, 323–346.
- Chan, K.M.A., Satterfield, T., 2007. Land-for-land is Central to a Just Musqueam Settlement. Vancouver Sun, Vancouver, p. 11.
- Chan, K.M.A., Pringle, R.M., Ranganathan, J., Boggs, C.L., Chan, Y.L., Ehrlich, P.R., Haff, P.K., Heller, N.E., Al-Khafaji, K., Macmynowski, D.P., 2007. When agendas collide: human welfare and biological conservation. *Conservation Biology* 21, 59–68.
- Chan, K.M.A., Goldstein, J., Satterfield, T., Hannahs, N., Kikiloi, K., Naidoo, R., Vadeboncoeur, N., Woodside, U., 2011. Cultural services and non-use values. In: Kareiva, P., Tallis, H.,

- Ricketts, T.H., Daily, G.C., Polasky, S. (Eds.), *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. Oxford University Press, Oxford, UK, pp. 206–228.
- Chan, K.M.A., Guerry, A., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B.S., Hannahs, N., Levine, J., Norton, B., Ruckelshaus, M., Russell, R., Tam, J., Woodside, U., in review. Where are 'cultural' and 'social' in ecosystem services: a framework for constructive engagement. *Bioscience*.
- Chee, Y.E., 2004. An ecological perspective on the valuation of ecosystem services. *Biological Conservation* 120, 549–565.
- Chiesura, A., de Groot, R., 2003. Critical natural capital: a socio-cultural perspective. *Ecological Economics* 44, 219–231.
- Chuenpagdee, R., Knetsch, J.L., Brown, T.C., 2001. Coastal management using public judgments, importance scales, and predetermined schedule. *Coastal Management* 29, 253–270.
- Chuenpagdee, R., Liguori, L., Preikshot, D., Pauly, D., 2006. A public sentiment index for ecosystem management. *Ecosystems* 9, 463–473.
- Cialdini, R.B., 2007. *Influence: The Psychology of Persuasion*. Harper Paperbacks, New York, NY.
- Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., van den Belt, M., 1997. The value of the world's ecosystem services and natural capital. *Nature* 387, 253–260.
- Daily, G.C., 1997. *Nature's Services: Societal Dependence on Natural Ecosystems*. Island Press, Washington, DC, p. 392.
- Daily, G.C., Alexander, S., Ehrlich, P.R., Goulder, L., Lubchenco, J., Matson, P.A., Mooney, H.A., Postel, S., Schneider, S.H., Tilman, D., Woodwell, G.M., 1997. Ecosystem services: benefits supplied to human societies by natural ecosystems. In: *Ecological Society of America (Ed.), Issues in Ecology*, Washington, DC, pp. 1–18.
- Daily, G.C., Polasky, S., Goldstein, J., Kareiva, P.M., Mooney, H.A., Pejchar, L., Ricketts, T.H., Salzman, J., Shallenberger, R., 2009. Ecosystem services in decision making: time to deliver. *Frontiers in Ecology and the Environment* 7, 21–28.
- Davis, A., 1996. Barbed wire and bandwagons: a comment on IQ fisheries management. *Reviews in Fish Biology and Fisheries* 6, 97–107.
- de Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecological Economics* 41, 393–408.
- de Groot, R., Ramakrishnan, P.S., Berg, A.v.d., Kulenthiran, T., Muller, S., Pitt, D., Wascher, D., Wijesuriya, G., Amelung, B., Eliezer, N., Gopal, A.R., Rössler, M., 2005. Cultural and amenity services. In: *Millennium Ecosystem Assessment (Ed.), Ecosystems and Human Well-being: Current Status and Trends*. Island Press, Washington, DC, pp. 455–476.
- Dean Moore, K., Russell, R., 2009. Toward a new ethic for the oceans. In: McLeod, K., Leslie, H. (Eds.), *Ecosystem-based Management for the Oceans*. Island Press, Washington, D.C., pp. 324–340.
- Eigenraam, M., Strappazzon, L., Lansdell, N., Beverly, C., Stoneham, G., 2007. Designing frameworks to deliver unknown information to support market-based instruments. *Agricultural Economics* 37, 261–269.
- Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. *Ecological Economics* 65, 663–674.
- EPA (U.S. Environmental Protection Agency Science Advisory Board), 2009. *Valuing the Protection of Ecological Systems and Services*, Washington, D.C., p. 121.
- Fischhoff, B., 1991. Value elicitation: is there anything in there? *American Psychologist* 46, 835–847.
- Gatto, M., De Leo, G.A., 2000. Pricing biodiversity and ecosystem services: the never-ending story. *Bioscience* 50, 347–355.
- Gowdy, J.M., 2001. The monetary valuation of biodiversity: promises, pitfalls, and rays of hope. In: Hollowell, V.C. (Ed.), *Managing Human-dominated Ecosystems: Proceedings of the Symposium at the Missouri Botanical Garden, St. Louis, Missouri, 26–29 March 1998*. Missouri Botanical Garden Press, St. Louis, MO, pp. 141–149.
- Gregory, R., Lichtenstein, S., Slovic, P., 1993. Valuing environmental resources: a constructive approach. *Journal of Risk and Uncertainty* 7, 177–197.
- Gregory, R., Failing, L., Harstone, M., 2008. Meaningful resource consultations with first peoples: notes from British Columbia. *Environment* 50, 34–45.
- Gregory, R., Failing, L., Harstone, M., Long, G., McDaniels, T., 2011. *Structured Decision Making: A Practical Guide to Environmental Management Choices*. John Wiley & Sons, Incorporated, Hoboken, NJ.
- Hanley, N., Wright, R., Adamowicz, V., 1998. Using choice experiments to value the environment. *Environmental and Resource Economics* 11, 413–428.
- Henare, M., 2001. Tapu, Mana, Mauri, Hau, Wairua: a Māori philosophy of vitalism and cosmos. In: Grim, J. (Ed.), *Indigenous Traditions and Ecology: The Interbeing of Cosmology and Community*. Harvard University Press, Cambridge, MA, pp. 197–221.
- Howarth, R.B., Wilson, M.A., 2006. A theoretical approach to deliberative valuation: aggregation by mutual consent. *Land Economics* 82, 1–16.
- Jacobs, M., 1997. Environmental valuation, deliberative democracy and public decision-making institutions. In: Foster, J.M. (Ed.), *Valuing Nature? Ethics, Economics and the Environment*, Routledge, New York, pp. 211–231.
- Juniper, T., 2011. A Historic Move in the Battle to Save Tropical Rainforests. *The Guardian*, London, UK, p. A1.
- Kahneman, D., Knetsch, J.L., 1992. Valuing public goods: the purchase of moral satisfaction. *Journal of Environmental Economics and Management* 22, 57–70.
- Kareiva, P., Tallis, H., Ricketts, T.H., Daily, G.C., Polasky, S., 2011. *Natural Capital: Theory & Practice of Mapping Ecosystem Services*. Oxford University Press, Oxford, UK.
- Keeney, R.L., Gregory, R.S., 2005. Selecting attributes to measure the achievement of objectives. *Operations Research* 53, 1–11.
- King, S.P., Roth, R.W., 2006. Broken Trust: Greed, Mismanagement & Political Manipulation at America's Largest Charitable Trust. University of Hawaii Press, Honolulu.
- Klain, S., 2010. Navigating marine ecosystem services and values. RMES. Vancouver, BC, University of British Columbia. M.Sc <http://hdl.handle.net/2429/29396>.
- Krutilla, J.V., 1967. Conservation reconsidered. *The American Economic Review* 57, 777–786.
- Lockwood, M., 1998. Integrated value assessment using paired comparisons. *Ecological Economics* 25, 73–87.
- Ludwig, D., 2000. Limitations of economic valuation of ecosystems. *Ecosystems* 3, 31–35.
- March, J.G., 1994. *A Primer on Decision Making: How Decisions Happen*. Free Press, New York.
- Martín-López, B., Montes, C., Benayas, J., 2007. The non-economic motives behind the willingness to pay for biodiversity conservation. *Biological Conservation* 139, 67–82.
- Martín-López, B., Gómez-Baggethun, E., Lomas, P.L., Montes, C., 2009. Effects of spatial and temporal scales on cultural services valuation. *Journal of Environmental Management* 90, 1050–1059.
- McCauley, D.J., 2006. Selling out on nature. *Nature* 443, 27–28.
- McShane, T.O., Hirsch, P.D., Trung, T.C., Songorwa, A.N., Kinzig, A., Monteferrri, B., Mutekanga, D., Thang, H.V., Dammert, J.L., Pulgar-Vidal, M., Welch-Devine, M., Peter Brosius, J., Coppolillo, P., O'ÁConnor, S., 2011. Hard choices: making trade-offs between biodiversity conservation and human well-being. *Biological Conservation* 144, 966–972.
- Millennium Ecosystem Assessment, 2005. *Ecosystems and Human Well-being: Synthesis*. Island Press, Washington, DC.
- Mowat, F., 1990. *Rescue the Earth! Conversations with the Green Crusaders*. McClelland & Stewart Inc., Toronto, Canada.
- Muñoz-Piña, C., Guevara, A., Torres, J.M., Braña, J., 2008. Paying for the hydrological services of Mexico's forests: analysis, negotiations and results. *Ecological Economics* 65, 725–736.
- Naidoo, R., Adamowicz, W.L., 2005. Biodiversity and nature-based tourism at forest reserves in Uganda. *Environment and Development Economics* 10, 159–178.
- National Research Council (U.S.), 2005. Committee on assessing and valuing the services of aquatic and related terrestrial ecosystems. *Valuing Ecosystem Services: Toward Better Environmental Decision-making*. National Research Council, Washington, DC, p. 277.
- Norgaard, R.B., 2010. Ecosystem services: from eye-opening metaphor to complexity blinder. *Ecological Economics* 69, 1219–1227.
- Norton, B.G., 1987. *Why Preserve Natural Variety?* Princeton University Press, Princeton, NJ.
- Norton, B.G., Noonan, D., 2007. Ecology and valuation: big changes needed. *Ecological Economics* 63, 664–675.
- O'Neill, J., Holland, A., Light, A., 2007. *Environmental Values*. Routledge, New York.
- Ostrom, E., 2009. A general framework for analyzing sustainability of social-ecological systems. *Science* 325, 419–422.
- Pinkerton, E., 1989. *Co-operative Management of Local Fisheries: New Directions for Improved Management and Community Development*. UBC Press, Vancouver.
- Randall, A., 2002. Benefit-cost considerations should be decisive when there is nothing more important at stake. In: Bromley, D., Paaola, J. (Eds.), *Economics*. Blackwell Publishers, Oxford, Ethics and Environmental Policy, pp. 53–68.
- Redford, K.H., Adams, W.M., 2009. Payment for ecosystem services and the challenge of saving nature. *Conservation Biology* 23, 785–787.
- Rees, W.E., 1998. How should a parasite value its host? *Ecological Economics* 25, 49–52.
- Renn, O., 1999. A model for an analytic-deliberative process in risk management. *Environmental Science and Technology* 33, 3049–3055.
- Ricketts, T.H., Daily, G.C., Ehrlich, P.R., Michener, C.D., 2004. Economic value of tropical forest to coffee production. *Proc. Natl. Acad. Sci. U. S. A.* 101, 12579–12582.
- Roberts, M., Haami, B., Benton, R., Satterfield, T., Finucane, M.L., Henare, M., 2004. Whakapapa as a Māori mental construct: some implications for the debate over genetic modification of organisms. *The Contemporary Pacific* 16, 1–28.
- Robertson, M.M., 2004. The neoliberalization of ecosystem services: wetland mitigation banking and problems in environmental governance. *Geoforum* 35, 361–373.
- Sagoff, M., 1996. On the value of endangered and other species. *Environmental Management* 20, 897–911.
- Sagoff, M., 1998. Aggregation and deliberation in valuing environmental public goods: a look beyond contingent pricing. *Ecological Economics* 24, 213–230.
- Sagoff, M., 2000. Environmental economics and the conflation of value and benefit. *Environmental Science and Technology* 34, 1426–1432.
- Sagoff, M., 2004. *Price, Principle, and the Environment*. Cambridge University Press, Cambridge, UK.
- Satterfield, T., 2001. In search of value literacy: suggestions for the elicitation of environmental values. *Environmental Values* 10, 331–359.
- Satterfield, T., Kalof, L., 2005. Environmental values: an introduction. In: Kalof, L., Satterfield, T. (Eds.), *The Earthscan Reader in Environmental Values*. Earthscan, Sterling, VA, pp. xxi–xxxiii.
- Satterfield, T., Roberts, M., 2008. Incommensurate risks and the regulator's dilemma: considering culture in the governance of genetically modified organisms. *New Genetics and Society* 27, 201–216.
- Satterfield, T., Slovic, S., 2004. What's nature worth? Narrative Expressions of Environmental Values. University of Utah Press, Salt Lake City, UT, p. 310.
- Satterfield, T., Klain, S., Gregory, R., Chan, K., 2011. Intangibles, measurement and tradeoffs across cultures of environmental management. In: Satz, D. (Ed.), *Environmental Norms, Institutions, and Policy*. Stanford University.
- Singer, P., 1993. *Practical Ethics*. Cambridge University Press, Cambridge, UK.
- Spash, C.L., 2000. Multiple value expression in contingent valuation: economics and ethics. *Environmental Science and Technology* 34, 1433–1438.
- Spash, C.L., 2007. Deliberative monetary valuation (DMV): issues in combining economic and political processes to value environmental change. *Ecological Economics* 63, 690–699.
- Spash, C.L., 2008a. Deliberative monetary valuation and the evidence for a new value theory. *Land Economics* 84, 469–488.
- Spash, C.L., 2008b. How much is that ecosystem in the window? The one with the bio-diverse trail. *Environmental Values* 17, 259–284.
- Tetlock, P.E., 2003. Thinking the unthinkable: sacred values and taboo cognitions. *Trends in Cognitive Sciences* 7, 320–324.

- Turner, R.K., Daily, G.C., 2008. The ecosystem services framework and natural capital conservation. *Environmental and Resource Economics* 39, 25–35.
- Turner, N.J., Loewen, D.C., 1998. The original “free trade”: exchange of botanical products and associated plant knowledge in northwestern North America. *Anthropologica* 49–70.
- Turpie, J.K., Marais, C., Blignaut, J.N., 2008. The working for water programme: evolution of a payments for ecosystem services mechanism that addresses both poverty and ecosystem service delivery in South Africa. *Ecological Economics* 65, 788–798.
- West, P., 2006. *Conservation is Our Government Now: The Politics of Ecology in Papua New Guinea*. Duke University Press, Durham, NC.
- Wilson, M.A., Howarth, R.B., 2002. Discourse-based valuation of ecosystem services: establishing fair outcomes through group deliberation. *Ecological Economics* 41, 431–443.
- World Commission on Environment and Development, 1987. *Our Common Future*. Oxford University Press, Oxford, UK.