

# **Rethinking Ecosystem Services to Better Address and Navigate Cultural Values**

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13

## Abstract

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

30 **Keywords:** *environmental policy; environmental values and valuation; ecosystem-based*  
31 *management; incommensurability; non-use values; cultural ecosystem services*

32

## 1. Introduction

33 In recent decades, the concept of ecosystem services (ES) has gained widespread attention as  
34 one fruitful approach for integrating into decision-making ecosystem-related values often

35 heretofore dismissed as externalities. As the provision of direct and indirect benefits to people  
36 from ecosystems (building upon Daily, 1997; Millennium Ecosystem Assessment, 2005), ES as a  
37 framework has provided an approach to bridge the gap between ecology and economics, and  
38 thus the approach to date primarily represents these two perspectives. Specifically, economic  
39 valuation techniques are used to assign a value to ecosystem components and functions (see  
40 Fig. 1-3 in NRC 2005). By expressing ecosystem values in this manner, conservation scientists  
41 have added a compelling new tool for 'internalizing' the worth of ecosystems and conveying this  
42 to a broad audience, including many land managers and policymakers.

43 Integrating ecological and economic approaches has been an important area for advancement in  
44 ecosystem services research (Turner and Daily, 2008), and this integration has contributed to  
45 policy development, most notably with payment for ecosystem services programs (Eigenraam et  
46 al., 2007; Engel et al., 2008; Juniper, 2011; Muñoz-Piña et al., 2008; Turpie et al., 2008). But  
47 approaches of this kind cannot or have yet to encompass all dimensions of value, thus many  
48 important considerations remain marginalized within ecosystem services research and practice.  
49 To ecologists, economic valuation brought the ability to express some of the values of  
50 ecosystems in metrics (dollars) that have meaning to publics, policymakers and decision  
51 contexts. While this inclusion of economic values was likely fuelled by a desire to valorize  
52 ecosystems—a desire stemming from the perceived intrinsic values of nature (Satterfield and  
53 Kalof, 2005), one could argue that in their efforts to include economics, ecologists adopted an  
54 essentially economic worldview. In so doing, they may have simultaneously closed the door to  
55 other social perspectives—those more fully representative of the vicissitudes of human behavior  
56 and the less tangible social and ethical concerns to be outlined more fully below.

57 The objective of this paper is to better integrate a broader set of social perspectives and  
58 valuation techniques into the ecosystem services framework, to enable a fuller characterization

59 and representation of diverse ecosystem values in research and practice, while being mindful of  
60 the challenges of doing so. Some values do not fit naturally within an ES approach, and we do  
61 not seek such global inclusion; rather, we seek an ES approach that provides appropriate space  
62 for ill-fitting values such that important cultural and moral values are not dismissed as hidden  
63 externalities. Our hope is that such a broader consideration of cultural values will facilitate  
64 appropriate treatment of diverse stakeholders and perspectives, such that ES application avoids  
65 the claims of cultural insensitivity that have plagued biological conservation.

### 66 ***1.1 Treatment of Cultural and Non-Use Values***

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

77 In this paper, we argue that the effectiveness of the ES framework in decision-making is  
78 thwarted by (i) the conflation of services, values, and benefits, and (ii) the failure to recognize  
79 the importance of different kinds of values for valuation and decision-making, particularly with  
80 regard to cultural ES. We thus begin by reviewing and proposing a new definition for cultural ES.  
81 Our aim is to highlight in particular services said to be intangible and/or incommensurable and

82 as such sidelined by the ES framework. We then propose categories of relevant values, benefits,  
83 and services that clarify differences and connections between these conflated terms. We discuss  
84 the implications of these above clarifications for efforts to characterize and value ES.

85 Combined, our overarching goal is to enhance awareness of the diversity of values that are  
86 integral to the ES framework—and ecosystem-based decision-making generally—and so  
87 motivate meaningful change in the representation and analysis of how human well-being may  
88 change alongside ecological change.

89 ES have been defined in reference to their material or non-material values, with material values  
90 considered in relation to provisioning, regulating, and supporting services, whereas non-material  
91 values and/or benefits have been associated with cultural services. Costanza et al. (1997)  
92 defined cultural values-cum-services as “aesthetic, artistic, educational, spiritual and/or scientific  
93 values of ecosystems” (p. 254). The Millennium Ecosystem Assessment (2005, p.894) expanded  
94 this definition to include the “non-material benefits people obtain from ecosystems through  
95 spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience,  
96 including, e.g., knowledge systems, social relations, and aesthetic values”. Costanza et al.  
97 (1997) define cultural ES as values, while the MA (2005) defines services as benefits; similarly  
98 de Groot et al. (2005) include a diverse set of things in their list of categories of services:  
99 benefits, services, values, and activities. In the interest of conceptual clarity, we suggest  
100 distinguishing between these diverse things: services are the production of benefits (where  
101 benefits may take the form of activities), which are of value to people (see definitions for these  
102 terms below). Accordingly, we define cultural services inclusively as ecosystems’ contributions to  
103 the non-material benefits (e.g., capabilities and experiences) that arise from human-ecosystem  
104 relationships.

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

### 117 ***1.2 Why Intangible Services Matter and Why They Present Challenges***

118 As long as non-use, intangible, and cultural values are relegated to an after-thought or poorly  
119 represented by ill-suited value metrics, an ES approach will continue to be critiqued by many:  
120 ecologists and others perceiving intrinsic or other “higher” values in nature (e.g., Ludwig, 2000;  
121 McCauley, 2006; Redford and Adams, 2009; Rees, 1998); philosophers and others concerned  
122 with inappropriate assumptions of substitutability (e.g., Gowdy, 2001) and with diverse kinds of  
123 values (e.g., Norgaard, 2010; Norton and Noonan, 2007; Randall, 2002); and critical theorists  
124 concerned with the privatization and commodification of nature (Robertson, 2004). This rich  
125 ideological fodder fuels spirited discourse in academic and researcher communities and  
126 challenges decision-makers and practitioners to achieve an optimal balance of outcomes that  
127 may be at cross-purposes. As one example of striving for balance, Neil Hannahs is responsible  
128 for a 142,000-hectare endowment for a private school that strives to improve the capabilities

129 and well-being of people of Hawaiian ancestry. Conventional fiduciary principles support  
130 utilization of the endowment to generate financial resources to fund school operations, but land  
131 uses that develop desired cash flow may displace beneficiaries from traditional homelands,  
132 undermine sense of place, jeopardize cultural practices, or weaken worldview or spiritual  
133 foundations.

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

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

150 The first point is that some kinds of values are regarded as incommensurate because people  
151 reject outright the very possibility of tradeoffs—at least initially (‘protected’ or sacred values—

152 Baron and Spranca, 1997; Tetlock, 2003). In such cases, efforts to determine appropriate  
153 tradeoffs break down because the posed options trigger participants to believe they must  
154 sacrifice a deeply held principle in order to participate in any negotiation or decision process  
155 (Atran et al., 2007). That the value is 'incommensurate' with other values (a hallmark of  
156 protected values) is secondary; the central problem is that an act or management choice may  
157 be seen as violating an inviolable principle and thus any measurement or negotiation stalls.

158 A related point is that many values or properties of a material 'thing' can also have intangible  
159 qualities that are as or more important, and which are deemed central to identity to a self-  
160 defined population or recognized cultural group. In New Zealand, for example, the  
161 properties/values known as 'mauri' and 'whakapapa' fundamentally challenged that country's  
162 risk regulatory agency as both values were said to be transgressed by the creation of genetically  
163 modified organisms (GMOs) (Roberts et al., 2004; Satterfield and Roberts, 2008). Mauri is that  
164 which is said to endow things with their own special characters or natures, thus making it  
165 "possible for everything to move and live in accordance with the conditions and limits of its  
166 existence" (Barlow, 1991, p.83); whereas whakapapa is a principle/property of genealogy  
167 fundamental to conceptualizations of ancestry and identity. Whakapapa is the basis through  
168 which one locates oneself or other beings in the larger human and non-human world across  
169 time and space. Through that location one comes to know one's purpose (also inscribed by  
170 mauri), ontological history, and hence the place of oneself and all other entities (human and  
171 nonhuman) in the larger order of things, including ecosystem-like configurations of the natural  
172 and social world. Despite the fundamental meaning and importance of mauri and whakapapa,  
173 the regulator (The Environmental Risk Management Authority) expected these values to be  
174 weighed or converted to probabilities of material harm given their transgression. Few if any  
175 including many Maori scholars were willing to engage in this line of questioning, because a focus



176 on measurable effects fundamentally altered a metaphysical worldview about the potency and  
177 vitalism of all things (Henare, 2001), to a value measurement script of an untenable kind  
178 (Satterfield and Roberts, 2008). To fit economic assumptions, one might be tempted to ask—  
179 e.g., as in contingent valuation—what individuals are willing to pay to maintain mauri and  
180 whakapapa. But it is unlikely a person would put a monetary value on the very values through  
181 which the ontological importance of all things is understood.

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

189 The problem that some things are not amenable to valuation for tradeoffs has arisen most  
190 prominently in critiques of contingent valuation. Valuation studies of nonmarket goods through  
191 stated willingness-to-pay (e.g., improvement of the status of an environmental amenity) have  
192 revealed that, for example, assigned dollar values can be rooted in moral not monetary worth  
193 (Kahneman and Knetsch, 1992). As such, the problem of understanding the value at hand may  
194 be better served by democratically debating what “we” as a society want (i.e., the social good),  
195 in lieu of the aggregated personal (“I want”) preferences of individuals (Sagoff, 1998; Sagoff,  
196 2004). Paraphrasing and then citing, verbatim, Sagoff (2004, p.13-14): A democratic or political  
197 compromise ... responds to all manner of reasons; an economic tradeoff, in contrast, weighs  
198 preference or worth. “Political compromises may be said to be legitimate insofar as they emerge

199 from democratic processes structured to ensure that all sides get a fair hearing. Economic  
200 tradeoffs, in contrast, may take place between strangers who make exchanges in a market.”

201 Third, some kinds of values cannot be appreciated without being experienced. “You had to be  
202 there,” is a colloquial indication of such value, signaling that no available representation of an  
203 event could capture the way the event made a person feel. An obvious category of values here  
204 is transformative values, the value of a thing for the way it changes how we think (Norton,  
205 1987). A person cannot sum up the importance of a story to her with a number, and she often  
206 cannot relate the relevance of the story for a given problem without telling the story. This  
207 recognition of the importance of experience has motivated many scientists to turn to literature  
208 in their attempt to express the values they derive from nature (Satterfield and Slovic, 2004), and  
209 narration itself can help lay people articulate a broad range of environmental values (Satterfield,  
210 2001). If there are important transformative values associated with a site, associated narratives  
211 generally need to be told and heard in order for the values to be appreciated, as the  
212 transformation is personal.

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

223

## 224 **2. Dimensions of Values for Environmental Decision-Making**

225 The broad term 'value' can refer to both underlying ideals (held values, such as bravery,  
226 fairness, happiness) and also the relative importance of things (assigned values, such as  
227 monetary values of goods) (Brown, 1984). As others have argued persuasively, empirical  
228 valuations can only be explained by recognizing disjunctions between valuation methods  
229 employed and the respective kinds of value at play (Brown, 1984; Lockwood, 1998; Sagoff,  
230 1998). For example, longstanding debates about the validity of willingness to pay/accept  
231 (WTP/WTA) methods for environmental goods stem partly from a mixing of diverse kinds of  
232 values in a single valuation method. Whereas researchers must assume that an individual  
233 expresses such values based on the benefits (consequences) that the object of valuation has for  
234 her, social scientists have documented clearly that such responses also reflect a willingness to  
235 contribute to a moral cause (Kahneman and Knetsch, 1992)—and thus are measures not of  
236 individual preference but an index of support for a morally right or just society (Sagoff, 1998).  
237 The dollar metric 'index' can thus be insensitive to scale because survey participants find the  
238 question inappropriate, or they do not distinguish scope and so, for example, the dollar amount  
239 promised for one improvement is the same as that for five. The dollar amount provided is  
240 thereby a proxy for a donation to the social good and not an expression of market value per se.

241 In order to inform management and policy, we consider together all manner of personal and  
242 moral notions that contribute to a person's judgment of right and wrong, but we distinguish  
243 those dimensions especially pertinent for considering appropriate venues for value expression  
244 and decision-making. Not all values pertain to the importance of benefits from ES, but all are  
245 important to the broader context of environmental decision-making. Note that we consider

246 values to be one way to understand and represent what matters to people, and not a set of  
247 entities that exist 'out there'. Accordingly, while the typology below caricatures binaries (or  
248 triads) across the eight dimensions of value, we recognize that any instantiation of value—e.g.,  
249 a person's motivation for conservation—will be a complex mixture of value-types and not cleanly  
250 just one part of any binary (e.g., not just for oneself or others, but both intertwined). For  
251 philosophers, representing such disparate notions on the same spectrum risks conflating  
252 fundamentally unlike things, whereas for most people such distinctions are semantic  
253 constructions resulting from ad hoc dissection of a single set of judgments. Our pragmatic  
254 approach involves walking a purposeful middle road between these two perspectives in order to  
255 inform research for practice.

### 256 ***2.1 Preferences vs. principles vs. virtues***

257 One dimension of value follows a division of ethical theories between principle-based  
258 (deontological) and preference-based (teleological/consequentialist) (March, 1994; Sagoff, 1996,  
259 1998, 2000; Spash, 2000), to which we recognize a third category of virtue-based values (Dean  
260 Moore and Russell, 2009; O'Neill et al., 2007). Whereas principles generally pertain to  
261 characteristics of an action or decision (the means), preferences pertain to the consequences of  
262 an action (the ends), and virtues pertain to the actor(s).

263 Under some circumstances, a person's preferences may be affected by her principles or virtues  
264 (ideas of right actions or right people), and the principles a person adopts and maintains may  
265 stem partly from her virtues: the kind of person we believe we should be (e.g., honest) can  
266 inform the kinds of principles we uphold (e.g., truth-telling), which can affect how much we  
267 desire a thing (e.g., a product marketed dishonestly). This relationship between preferences and  
268 principles has implications for resulting valuations: one should expect frequent non-additivity,  
269 non-transitivity, and rapid changes in preferences including willingness to pay (WTP). For

270 example, if a conscientious consumer finds out that a “green” product contains a notorious  
271 persistent organic pollutant, her willingness to pay for the product may drop dramatically  
272 because of perceptions of false advertising and the virtues of honesty. Cialdini (2007)  
273 documents many instances in which consumers’ willingness to buy products is influenced in  
274 consistent ways by appealing inconspicuously to principles such as reciprocity via corporate  
275 charity donations.

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

## 281 ***2.2 Market-mediated vs. non-market-mediated***

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

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

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

305 The nature of a particular good or service can change fundamentally depending on whether it  
306 could be traded in markets—even if the particular item is not traded—as exemplified by West  
307 (2006) in her discussion of Papua New Guinean net-bags. These net-bags were once key objects  
308 of social exchange in the form of hand-made expressions of love, reciprocity, etc. When they  
309 instead became commodities for sale in markets, unexpected social consequences followed.  
310 Women (the producers) became viewed as labour inputs in production; this in turn triggered  
311 increases in bride prices and the expectation that net-bags could and should be produced more  
312 quickly. The value of both ('women' and 'bags') was thus altered greatly, with consequences for  
313 social interactions.

### 314 ***2.3 Self-oriented vs. other-oriented***

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

### 326 ***2.4 Individual vs. holistic / group***

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

### 337 **2.5 Experiential vs. metaphysical**

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

### 348 **2.6 Supporting vs. final (instrumental vs. inherent)**

349 Some values of things stem from the manner in which they help to produce other things; other  
350 values are inherent in that they are desired ends in themselves. The former are supporting or  
351 instrumental values, while the latter are final/terminal or inherent values (Brown, 1984). This  
352 distinction has been a prominent feature of ecosystem services categorizations (Boyd and  
353 Banzhaf, 2007; Daily, 1997; de Groot et al., 2002; MA, 2005), because it provides crucial  
354 information to characterize interactions between ecosystem components or functions, and  
355 resulting goods and services. Understanding such interactions is essential to avoid double-  
356 counting.

357 A special case of instrumental value is monetary value: the value of a thing to a person derived  
358 from the possibility of garnering money from the thing. Money is an instrument for achieving



359 other things; thus insofar as a thing yields money for people it provides instrumental value (but  
360 not necessarily only that).

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

### 367 ***2.7 Transformative vs. non-transformative***

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

## 380 **2.8 Anthropocentric vs. biocentric**

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

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

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

394 Many services produce many benefits, which may be important for many kinds of reasons.  
395 Virtually all services that have been considered material services suitable for purely monetary  
396 valuation (most provisioning, regulating, and supporting services) have crucial non-material  
397 dimensions. This may be for two reasons. First, a service may be intimately connected to a non-  
398 material benefit (e.g., because benefiting materially from a market good requires that someone  
399 obtain that good, which generally entails employment, physical activity, and/or other non-  
400 material benefits). Second, even material benefits may relate to various kinds of values (e.g.,  
401 produce from a farmers' market—a market good—may be connected to inspiration, social capital

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

402 and cohesion, and other categories of benefits, such that individual self-oriented monetary  
403 valuation may incompletely represent value to people) (Figure 1). This is in contrast to  
404 conventional economic approaches to ES, where it is often desirable to compartmentalize  
405 services such that each service only provides one kind of benefit (Kareiva et al., 2011)—a  
406 simplification that will be enlightening in some contexts and obfuscating in others.

### 407 ***3.1 The ubiquitous need to consider intangible dimensions***

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

416 The provision of fish for commercial harvest is simultaneously a provision of employment. Jobs  
417 play a central role in politics, above and beyond summary measures of economic output,  
418 suggesting strongly that the value of a job to a person transcends its contribution to the overall  
419 economy. This is especially true for the kinds of jobs that form the backbone of communities,  
420 which fishing does for many coastal communities. ITQs had the effect of consolidating  
421 ownership in Canada, which contributed to changes in the nature of employment (Davis, 1996;  
422 Pinkerton, 1989). Accordingly, what might appear to be simply a change in distribution of  
423 benefits in the form of market goods can be for some individuals and communities a devastating  
424 loss of many categories of benefits (virtually all those in Figure 1), which pertain to richly

425 diverse kinds of values. For instance, in some communities such as the Nuxalk First Nation of  
426 British Columbia (B.C.), the aforementioned shift in employment simultaneously triggered a loss  
427 of subsistence activities because the First Nation-allotted 'food' fishery depended critically on the  
428 commercial fishery for boats, gas, and cash (many fishermen previously caught their  
429 subsistence allotment, and that of friends and family, while catching their commercial quota)  
430 (Burke, 2010). And this loss of subsistence activities itself entailed a loss of benefits associated  
431 with appreciation of place (because many places are no longer visited), heritage, social capital  
432 and cohesion, and virtually every category of benefit in Figure 1. Common valuation practices  
433 relying heavily on market valuation might fail to identify any of these intangible values and  
434 suggest only benefits of ITQs, missing entirely the accompanying suite of social and cultural  
435 impacts.

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

448

#### 449                   **4. Non-Use and Cultural Values as Ecosystem Services**

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

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

467

#### 468                   **5. Implications for ES Research**

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

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

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

495 box' analysis with deeply-held values might incite constituents to reject the analysis, and along  
496 with it all the important research on ecological processes and functional relationships.

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

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

### 509 ***5.1 Conceptual (ES typologies and conceptual frameworks)***

510 The 'classes' of cultural values/benefits/services that have been grouped together under cultural  
511 services (de Groot et al., 2005) are perhaps best understood as those that do not fit well in  
512 other sectors of ES research. These values and benefits are so divergent from each other and so  
513 overlapping with the values associated with other 'master' categories of services (provisioning,  
514 regulating, supporting) (MA, 2005) that we can imagine no clean way to group these services  
515 without also including services that have been considered elsewhere.

516 Further, most of the cultural values/benefits/services that have been grouped together as  
517 cultural services are best understood not as services, we argue, but rather as benefits that are

518 produced not only through cultural services but also provisioning services, etc. For example,  
519 inspiration and identity benefits are commonly associated with fishing—a valued way of life and  
520 source of employment—but they are not fully reflected in monetary valuations of market goods  
521 associated with the provision of fish for harvest. Fishing is inextricably linked to the realization of  
522 fish harvests, so valuation frameworks are impoverished if they purport to represent the value  
523 of the provision of fish for harvest without accounting for these crucial but often intangible  
524 benefits associated with the process of fishing. The crux: monetary valuation is problematic or  
525 incomplete for a broad suite of ES.

526 The prevailing economic perspective on ecosystem services is represented in Figure 2. According  
527 to this perspective, the quantification of ecosystem services requires a metric of service  
528 provision that is the product of an ‘ecological production function’ and the input to an ‘economic  
529 valuation function’. For any intangible, non-market-mediated service or benefit (including  
530 recreation, subsistence, education & research, artistic, and ‘ceremonial’ services, and  
531 place/heritage, spiritual, inspiration, held, and identity value) it will be difficult to identify a priori  
532 metrics of service- or benefit provision. E.g., we can measure pollination as a service in the form  
533 of fruit set, and size and quality of fruit (Ricketts et al., 2004), but what metric could possibly  
534 represent the ecosystem provision of identity value? The problem is not that there can be no  
535 intermediary between ecosystems and the resulting values—there can. Rather, for benefits not  
536 mediated through markets, the characteristics that constitute the quantity and quality of benefit  
537 are not amenable to generalization and must be discovered on site. In contrast, for market-  
538 mediated goods one can appeal to characteristics of the global markets to identify appropriate  
539 metrics of service/benefit provision.

540 Ecosystems produce benefits through services, and those benefits matter to people and  
541 decision-making in many ways insufficiently represented by monetary valuation. Principles and



542 virtues, for example, pertain to many aspects of decision-making, in ways too important to be  
543 overlooked or distorted. The current popularity of the concept of sustainability is a prime  
544 example: that we should govern our resources in a manner that does not compromise “the  
545 ability of future generations to meet their own needs ... in particular the essential needs of the  
546 world's poor, to which overriding priority should be given” (WCED, 1987, p.43). Accordingly,  
547 sustainability is an idea steeped in principles of intergenerational equity and basic human needs.  
548 For ES research to ignore principles and virtues at the valuation stage would be to advance a  
549 dismembered concept of value lacking much of what matters to people.

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

## 557 ***5.2 Methodological (to assist decision-making)***

558 If, following the above, we accept that ecosystem services provide multiple benefits, valued for  
559 a range of reasons, then we must employ valuation methods that better match the diversity of  
560 values in question. An individual's values can be assessed using individual preference methods,  
561 but group/holistic methods are better assessed using group or deliberative approaches (e.g.,  
562 Gregory et al., 1993; Wilson and Howarth, 2002). Preferences (Lockwood's (1998) lexicographic  
563 or exchange preferences or Sagoff's consumer preferences (1998)) can be assessed using  
564 stated-values approaches (e.g., contingent valuation—Carson, 2000), but principle- and virtue-

565 based values are better assessed using inferred-values approaches like choice experiments or  
566 deliberative valuation (e.g., Howarth and Wilson, 2006; Spash, 2007, 2008a). What we term  
567 market-mediated values are generally conducive to monetary valuation, whereas non-market-  
568 mediated values are generally not. Bio- or eco-centric values and truly other-oriented values are  
569 excluded from consideration in economic valuation methods but amenable to consideration  
570 through deliberative, ethics-oriented approaches. Final values can be elicited through direct  
571 valuation, whereas supporting values should be valued through their contribution to final  
572 values (Boyd and Banzhaf, 2007). Non-transformative values present no special problems for  
573 valuation approaches, whereas transformative values cannot be related easily in any metric and  
574 require a richer form of communication (e.g., narration) combined with explicit consideration of  
575 societal goals and what should matter. This paragraph might seem to suggest a need for many  
576 incommensurate forms of valuation, but we can imagine a small set of kinds of valuation  
577 methods contributing information to a decision-making valuation workshop in which metrics are  
578 accompanied by narration and deliberation.

579  
580 Ultimately, much of the debate on methods for ES valuation is derivative of a larger debate  
581 between dollar metrics as expression of value and those who assert the necessity of multi-  
582 metric approaches (Chee, 2004; EPA, 2009; Fischhoff, 1991; Gatto and De Leo, 2000; Norton  
583 and Noonan, 2007; O'Neill et al., 2007; Satterfield and Kalof, 2005; Spash, 2008b). Further, the  
584 question of which metric and how to derive it can be addressed through individual, expert, or  
585 group-deliberative processes for deriving and assigning value (Keeney and Gregory, 2005).  
586 While too comprehensive a topic for full coverage in this paper, we generally advocate a multi-  
587 method and especially multi-metric approach. Likely key to this will be ability to either infer  
588 weights or preferences through choice surveys based on paired comparisons (Chuenpagdee et

589 al., 2001; Chuenpagdee et al., 2006; Hanley et al., 1998; Naidoo and Adamowicz, 2005), or the  
590 actual construction of metrics through the use of subjective scaling when necessary (i.e.,  
591 because no scale for that value exists) (Gregory et al 1993). Such scales enable the assigning of  
592 value, ordinal ranking, or numeric tag to what are in large part intangible properties (such as  
593 awe in reference to spiritual value). In choice experiments, we might know that (what we  
594 understand as) awe is more important than another value because the option that emphasizes  
595 protecting that kind of experience is preferred across many choices or paired comparisons.  
596 In the case of creating a metric for less tangible values using a multi-metric 'constructed'  
597 approach, the goal is best served by flexibility in the scales used (Keeney and Gregory, 2005).  
598 Following Keeney and Gregory {, 2005 #6179} and expanded for this context in Satterfield et al.  
599 (2011), a 'constructed' metric is a performance measure—perhaps a score and associated  
600 wording—developed to measure community support for a proposed management practice. If no  
601 a priori scale exists to measure support, an index (e.g., 1-5 or 1-10) might be created, with  
602 each rating denoting a different level of support. Many such constructed scales are in  
603 widespread use in society, e.g., the Apgar score used to track the health of newborn children.  
604 When thoughtfully designed, constructed indices can greatly facilitate a manager's decisions by  
605 defining precisely the focus of attention and by permitting tradeoffs across different levels of  
606 value and, equally important, rendering those tradeoffs visible (McShane et al., 2011). Scales  
607 translate qualitative information into quantitative scores, but without losing critical information:  
608 behind a summary rating of "2" can reside narratives, oral testimony, and scientific information  
609 relating to this anticipated level of impact. In general, scoring methods used to select scales  
610 should be accurate, understandable, and at an appropriate level of discrimination.  
611

612 Several particularly good examples can be found in the work of Gregory and colleagues, whose  
613 work is theoretically grounded in multi-attribute utility theory but who have advanced subjective  
614 scaling, whereby the language of local constituents is often the basis for 'constructing' scales  
615 that render otherwise excluded (often intangible) variables visible and commensurate (Gregory  
616 et al., 2011). Constructed scales or metrics of this kind are used when no suitable measures  
617 exist. An example might be a scale to measure the ES benefit that maintaining a species used  
618 only for local (e.g., indigenous or First Nation-to-First Nation) trading, such as dried edible  
619 seaweeds, a coveted food and widely used for ceremonial purposes across the BC coast (Turner  
620 and Loewen, 1998). Impact in the face of harm, may affect provisioning or market value, but  
621 also the cultural value placed on 'enduring trading relationships' or 'ceremonial or cultural' use.  
622 That is, a scale would then be developed for the value of relationships across communities that  
623 might be harmed if trading is not maintained. In a situation such as this, an index might be  
624 created spanning 1-5, with 1 = "complete loss of local trading partner/relations", ranging  
625 through 5 = "no loss of trading partner/relations", or similar for effect on ceremonial practices.  
626 Such a constructed index can focus a decision maker's attention on tradeoffs with other  
627 attributes and questions such as "is it worth protecting against potential impact on seaweed for  
628 x years in order to increase protection (e.g., of trading relations or networks) from level 2 to  
629 level 4 or 5?".

630 Some authors have argued that we should not preoccupy ourselves with eliciting values  
631 commensurate with values from welfare economics (Chee, 2004; Gatto and De Leo, 2000). They  
632 generally suggest instead that we should move straight to approaches like multi-criteria decision  
633 making or deliberative democratic approaches (Jacobs, 1997), which generally do not require  
634 value elicitation separate from the determination of a mutually agreeable decision. We prefer  
635 not to see ES characterization and deliberative decision-making as an either/or proposition: ES

636 characterization—with or without valuation—can contribute a clearer understanding of the many  
637 ways in which outcomes that matter to people are associated with ecological structures and  
638 functions; deliberation contributes one powerful forum for weighing various considerations and  
639 diverse perspectives. Both have likely side-benefits: e.g., valuation and their multi-metric  
640 expressions can help raise the prominence of certain under-appreciated benefits; and  
641 deliberation can lead citizens to a better appreciation of positions at apparent odds. Both also  
642 have limitations: ES valuation is impeded by several methodological and philosophical limitations  
643 as discussed above; and full realization of the potential of deliberative decision-making requires  
644 a rare set of circumstances (e.g., a wise, beneficent decision maker; a political context that  
645 provides a viable opportunity for decision-making outside the predominant neoliberal economic  
646 framework; all relevant stakeholders possessing a meaningful say at a table where they can  
647 communicate their concerns and needs effectively in a political process; etc.). Despite these  
648 limitations, we see a tremendous opportunity for ES characterization and deliberative decision-  
649 making to co-produce decision-making that reflects a richer understanding of the myriad ways  
650 that ecosystem change matters to people. Similar developments in the health risk literature also  
651 offer a case in point from which ES scholars might draw (Renn, 1999).

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

658

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

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

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

676 At the heart of this new program is a set of research questions: to what degree and in what  
677 manner can researchers elucidate the diversity of values at play in the minds of stakeholders,  
678 pertaining to ecosystems? If a decision-making framework involves having stakeholders choose  
679 between alternative scenarios, under which circumstances will it be helpful to characterize ES  
680 consequences in biophysical terms or, more prosaically, in terms signifying value? Concurrently,  
681 under what circumstances should consequences be represented in terms commensurate with

682 dollars to facilitate decision-making; under what circumstances should consequences be  
683 represented in some other terms, and how should a decision-making process reconcile these  
684 terms (building upon extant methods in decision analysis)? When transformative values of a site  
685 call for stories to be told in the decision-making process, how can these critically important  
686 narratives and value expressions be brought forth, and for whom? To the extent that ES  
687 decision-making may require input from group valuation workshops, what are the ramifications  
688 of differences in group composition, and how should groups be chosen for participation?  
689 Addressing each of these research frontiers will require collaborations involving a diverse range  
690 of natural and social scientists, practitioners, policy makers, and other stakeholders. We hope  
691 that this paper will start a conversation about how to do so most appropriately.

692

693

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## Figure Captions

910 **Figure 1.** The suggested use of the typologies of ecosystem services and values (reprinted with  
911 modifications from Chan et al., 2011): identify the relevant categories of ecosystem-derived benefits and  
912 services; connect the services and benefits, based on local expertise and/or participation; connect the  
913 benefits to kinds of values; use the kinds of values at stake to inform choice and application of valuation  
914 and decision-making methods—to ensure appropriate representation of the full range of relevant values  
915 and to avoid double-counting. The particular categories of services and benefits are only one example  
916 (categories are context-dependent—see text), and the arrows linking subsistence to categories of values  
917 are just one example of a mapping of one service onto benefits (other mappings are certainly possible).



918 Note that the service names are shorthand (e.g., it should be "provision of market-mediated goods"), and  
919 that individual services like 'subsistence' do not fit cleanly within a single master category.

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