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Chapter 8

How ecosystem services research can advance ecological economics principles

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Abstract

Ecosystem services (ES) have been a part of the ecological economics (EE) toolkit for decades. Over that time, however, ES has grown into a field of its own, and some Ecological Economists have criticized it for diverging from several core tenets of EE. Here we highlight five frontier areas of ES research and practice that can reverse that trend. Each of these areas has seen important recent ES research that builds toward stronger alignment with EE. These areas of emphasis are: measure ES broadly, not just monetarily; focus on stocks in addition to flows; better consider distributional impacts; incorporate non-Western perspectives on the benefits from ecosystems; and account for social dynamics, particularly learning. For each of these research areas, we describe its overall importance and potential for alignment, and we highlight the growing body of recent research. We then suggest further research questions related to each idea. We hope that distilling this list can contribute to meaningful advancements in both fields and stronger synergies between them.

INTRODUCTION

Research in ecosystem services and ecological economics has developed in tandem in many ways. Ecosystem services grew in the 1970s from systems ecology (Westman, 1977), then simmered in the 1980s (e.g., Ehrlich and Mooney, 1983). Researchers published influential work

in ES in the late 1990s (Costanza et al., 1997b; Daily, 1997), and the concept solidly entered the international decision-making realm with the Millennium Ecosystem Assessment (2005). Ecological economics, in contrast, arose to study the ways in which economic activities drive ecological change, along with the role that biophysical systems play in supporting the economy and human well-being. From the outset, ecological economics emphasized issues of sustainability and justice, contrasting with the strong focus on economic efficiency that was central in (neo-classical) environmental economics.

Ecological economics (EE) centres around the idea that the human economy is a subsystem of the biosphere, and thus is governed by laws of physics, subject to biophysical constraints, and embedded within social systems (Daly and Farley, 2004). This basic framework has many implications, which is why ecological economics has become such a diverse and even fragmented transdiscipline (Baumgärtner et al., 2008; Funtowicz and Ravetz, 1994; Jahn et al., 2012). One clear implication of an economy subject to biophysical laws and constraints, however, is that the throughput of energy and materials that support the economy cannot expand indefinitely on a finite planet. Ecological economists understand that continued material growth cannot be sustained. The goals of economic activity should therefore aim to enhance multidimensional *human well-being* in a way that involves *just distribution* while remaining within the earth's *planetary boundaries* (Figure 8.1).

Ecosystem services (ES) conceptualize ecosystem functions that benefit humans as services provided by ecosystems to humans (Daily, 1997). A core tenet of ES is that human well-being is largely dependent on functioning ecosystems. This draws directly from the EE core tenet that the human economy is a subset of the planetary system. More generally, the ES field is based on the idea that better understanding these links between ecosystems and human well-being will allow us to make decisions that move us toward sustainability. *ES thus can be considered a conceptual and practical tool for operationalizing those EE principles of human well-being, justice, and planetary boundaries*.

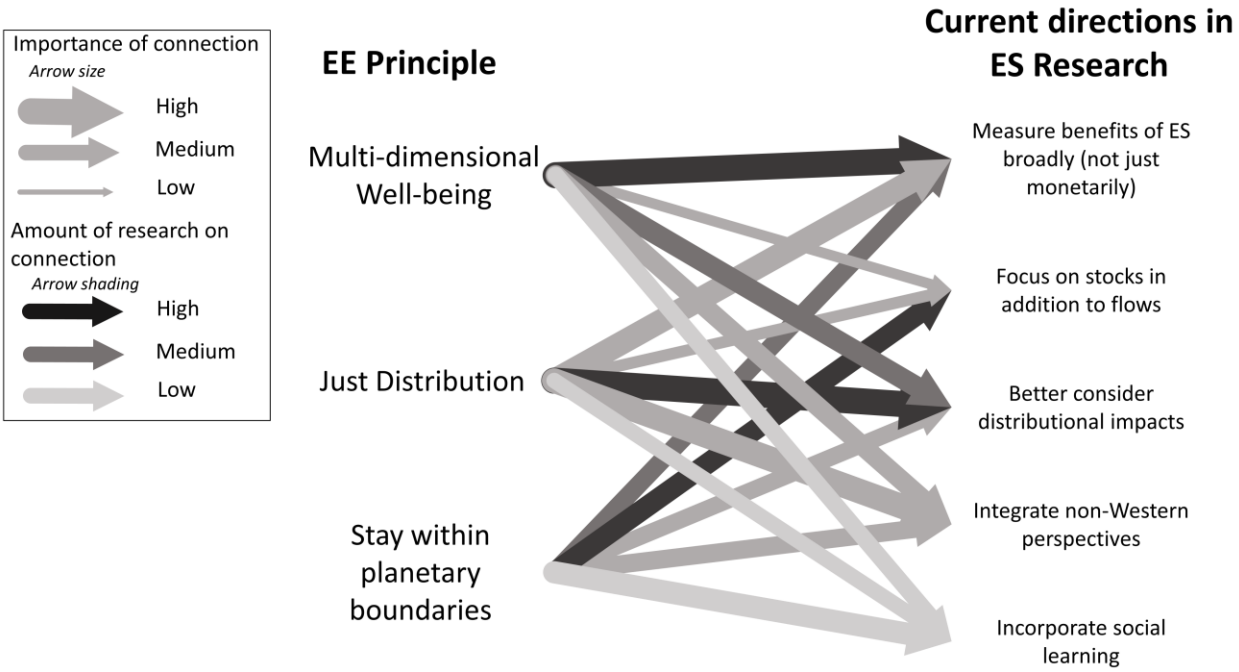
The ES framework has by many measures succeeded. It has been used in scores of policy initiatives at regional and national scales; these include planning decisions (e.g., Bai et al., 2018), policy strategy documents (Apitz, 2013; Donovan et al., 2015; European Commission, 2019; Maes et al., 2012; Robinne et al., 2019), and Payments for Ecosystem Services (PES) schemes (e.g., Goldman-Benner et al., 2012). It has also gained acceptance in multiple international bodies such as the UN-sponsored Intergovernmental Platform on Biodiversity and Ecosystem Services (though IPBES has also suggested a re-branding of ES to "Nature's Contributions to People" (Díaz et al., 2018), the core concept remains). This may be because it is a concrete way to operationalize principles of EE. Another reason for the success of the concept is that it is intuitive, even to non-experts. To some audiences, in fact, ES and EE are used almost interchangeably, with people using EE to essentially mean ES.

Yet some ecological economists believe that ES has become its own world, and no longer reinforces the principles of EE. Critiques of the ES concept (from both within and beyond ecological economics) are broad and diverse. Some argue that ES is "shallow EE," inserting nature into our existing system rather than fundamentally reforming that system; these conversations intertwine with those about whether EE is achieving its revolutionary goals (Kirchhoff, 2019; Spash, 2008, 2013; Gowdy and Erickson, 2005; Erickson, 2015; Nadeau,

2015; Røpke, 2005). Relatedly, others worry that valuing ES plays to market forces and can lead to commodifying nature (Farley et al., 2015; Kosoy and Corbera, 2010; McCauley, 2006; Muradian et al., 2013; Spash, 2008). Still others argue that the very language of "services" is deeply problematic because it does not accurately represent many humans' relationships with ecosystems (e.g., non-human entities are not humanity's "servants") (Kirchhoff, 2019; Pascual et al., 2017). Some even see the concept as blasphemous, because sacred entities like ecosystems should be revered, not counted and monetized (Brown, 2004; Schweitzer, 1933). These critiques are important, raise valid concerns, and are closely connected to significant and ongoing debates within EE (and also in adjacent fields). Responding to each critique in detail is the purview of a different paper. Instead, in this chapter we consider recent developments that both address some of these critiques and may strengthen the role that ES can play in advancing the core ideas of EE and, more importantly, moving our society toward sustainability. We highlight the current directions in ES research that reinforce three core principles of EE: focusing on broad human well-being; ensuring a just distribution of benefits; and keeping the economy within planetary boundaries. We identify five avenues of research with most promise. For each avenue, we identify the links with EE principles, highlight work underway in that area, and suggest research questions to inspire work that can further align ES and EE. We do not systematically review the ES literature, nor do we claim an exhaustive review of ES work that aligns with the five trends we describe. We simply aim to distil promising research directions and offer examples of them.

We hope that these ideas can inform not only ES research, but may also serve as reminders of how ES can help to operationalize core tenets of EE in general. The descriptions that follow suggest that ES can remain a vital contributor to the EE research agenda in the short, medium, and long term. In the short term, ES demonstrates and socializes the idea that nature underpins our economies and livelihoods. In the medium term, ES can incentivize investment in public goods from the biosphere. In the long term, ES can set the stage for more fundamental reforms to our economic system. To strengthen these contributions, however, ES research needs to remain aligned with the core principles of EE. If we maintain that alignment, we can harness the interest and energy around ES to advance the broader principles of EE; then the two concepts can keep pulling in the same direction.

PROMISING DIRECTIONS AND PRIORITIES IN ES RESEARCH



Note: We used the following process to determine arrow size and shading: First, each author independently ranked both the importance and degree of research for each intersection. We then averaged these rankings and converted the averages into arrow width and shading.

Figure 8.1 The promising directions in ES research that we highlight, and how they relate to the three EE tenets upon which we focus

.

Measure Benefits of ES Broadly

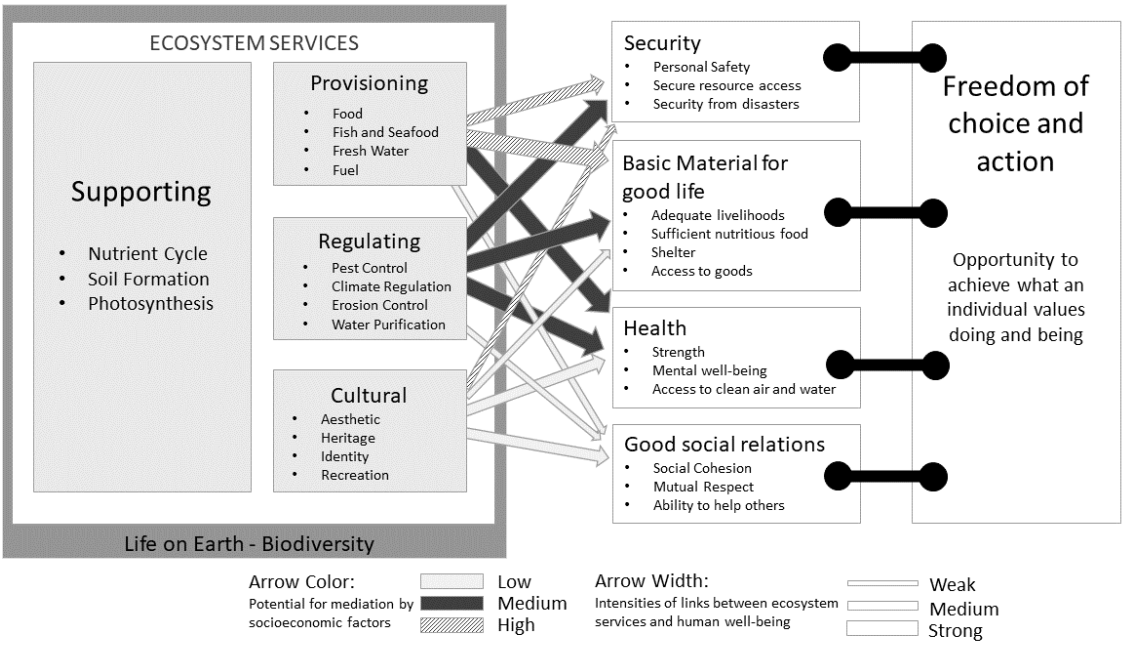
Monetary valuation is at best an incomplete measure of economic utility (Mill, 1863; Sagoff, 2004). At worst, it can distort decisions without improving well-being; as one example, substantial literature demonstrates paradoxical connections between financial wealth and reported happiness (Brekke and Howarth, 2002). In some settings, financial wealth is less of an immediate policy or household concern than health or security (Ruckelshaus et al., 2015). For these and other reasons, EE focuses on well-being as measured broadly, beyond monetary income to include health, security, life satisfaction, etc. (Daly and Farley, 2004).

The goal of the ES framework is to measure (biophysically) and value (socially and economically) the contribution of nature to human well-being, and to elucidate consequences and tradeoffs associated with ecosystem change (Costanza et al., 2017). The Millennium Ecosystem Assessment (2005), one of the efforts that launched modern ES research, made clear that human well-being is a multidimensional goal, including access to security, health, material goods, and

social relations (Figure 8.2). The ES framework is therefore strongly aligned with the EE principle of addressing broadly defined concepts of human well-being.

Source: Reproduced from the Millennium Ecosystem Assessment (2005).

Figure 8.2 Constituents of well-being (and how they relate to ecosystem services), as conceived by the Millennium Ecosystem Assessment in 2005



Despite this broadly defined foundation in human well-being, ES research has traditionally emphasized measuring the benefits of ES in monetary terms (Balmford et al., 2002; Costanza et al., 1997b; Daily and Ellison, 2002; Hermes et al., 2018). Mandle et al. (in revision) reviewed a random sample of 500 ES papers, from the roughly 12,000 published through 2015, and found that the majority of these studies, if they explicitly measured benefits, did so in monetary terms. Relatively few employed measures of self-reported well-being, health outcomes, beneficiary-defined benefits, or any other metrics of well-being. The narrow, monetary concept of value has been challenged by ecological economists and others as inadequate from conceptual and equity points of view (Jax et al., 2013; Mann et al., 2015; Spash, 2008; Wegner and Pascual, 2011). From a practical perspective as well, leaders in developing countries are often less interested in monetary impacts of ecosystem change than they are in other aspects of human well-being, such as physical and mental health, security, cultural identity, malnutrition, and self-reported quality of life (Jacobs et al., 2016; Martín-López et al., 2014; Raworth, 2017).

Fortunately, an increasing number of studies have begun to illustrate how ES benefits can be quantified in rigorous, relevant, and non-monetary terms. Several recent special issues in the journal *Ecosystem Service*s highlight the diverse ways in which ES can be valued, but also make clear the need to further develop these approaches (Inostroza et al., 2017; Jacobs et al., 2016;

Rincón-Ruiz et al., 2019). For example, Sun et al. (2017) compare changes in biodiversity and ecosystem services between two wetlands in China and Thailand. The authors report measures of rice production, fish supply, and food security, rather than monetizing any of these outcomes. Wam et al. (2016) explicitly incorporate monetary and non-monetary values to evaluate management options for boreal forests and find frequent tradeoffs between them. Challenges remain in developing widely accepted and credible non-monetary values, but doing so will help to capture nature's contributions to the full range of human well-being, as called for by the Sustainable Development Goals, IPBES, and other frameworks (Gómez-Baggethun and Martín-López, 2015; Wood and DeClerck, 2015).

Human health benefits are a particularly promising set of outcomes to capture in ecosystem service assessments, and the evidence for nature's contribution to physical health is increasing rapidly (Myers et al., 2013; Whitmee et al., 2015). For example, Golden et al. (2011) estimate the health benefits of bushmeat consumption to children in Madagascar. Without access to wild protein, the authors estimate that anaemia would increase 29 per cent, which would increase cognitive and physical deficits in children. Herrera et al. (2017) relate natural capital to human health as well, quantifying the impact of upstream forests on downstream childhood water-borne disease in 35 countries. They find that increased forest cover is associated with significant reduction in diarrhoea among young children, to the extent that reforesting watersheds could have a similar impact as improving household sanitation.

Ecosystems also provide benefits to mental health, as shown by a diverse and growing set of studies (Frumkin et al., 2017). For example, Bratman et al. (2015) used field experiments to isolate the effects of nature exposure on mood and cognition. They found that walks in natural settings reduced anxiety and rumination, and improved memory tasks, compared to similar walks in urban environments. Schwartz et al. (2019 used social media to compare moods before, during, and after visits to urban greenspace. They too found that mood increased significantly during exposure to nature, and the difference from baseline remained significant for 6 hours afterward. There are many opportunities for controlled experiments, natural experiments, and observational studies to further illuminate the contributions from natural systems to physical and mental health (Frumkin et al., 2017; Myers et al., 2013).

Cultural ecosystem services (e.g., cultural heritage, recreation, landscape aesthetics) are an important set of ES that are typically underrepresented in assessments because the services are often intangible and the values associated with them are often subjective. Monetary valuation is often particularly inappropriate and difficult for cultural ES (Daniel et al., 2012; Gould et al., 2015; Plieninger et al., 2013). The benefits of cultural ES can be measured in a variety of ways: through the frequency of visits or interactions; by interviews and surveys of beneficiaries; and by other novel methods (e.g., analysis of popular music (Coscieme, 2015) or stories (Bieling, 2014)). For example, Keeler et al. (2015) estimated recreational demand for clean water using geotagged photographs from the website Flickr. They found that recreationalists visited clean lakes more often and were willing to travel farther to do so. As another example, Ribe (2009) used surveys to compare cultural and aesthetic preferences among different timber harvesting options. They identified harvest practices such as basal area and spatial cutting patterns that maximized perceived scenic beauty. A particular focus of research on cultural ES is to account

for the diversity of values, as these values can differ widely among cultural perspectives (Daniel et al., 2012).

Research and policy on ES often consider multiple services all at once, and monetizing each can establish (literally) a "common currency" with which to pool or compare values among ES. However, there are several alternative valuation frameworks that do not require monetization. The most widespread is Multi-Criteria Analysis (MCA), which uses a stakeholder process to estimate relative weights for different ES, then combines measures of each into an overall metric of benefit (Kiker et al., 2005; Mavrommati et al., 2017; Saarikoski et al., 2016). For example, Koschke et al. (2012) used an MCA approach to estimate ES benefits within a regional planning process in Germany. They used weighting experiments to establish stakeholders' weights for different ES and showed that combining ES with these weights considerably changed the magnitudes and spatial distributions of aggregate benefits, compared to combining ES via monetary valuation. Of course, techniques that aggregate values into a single metric (such as MCA) confront challenges, as they cannot easily address core issues such as the incommensurability of some values and value differences between stakeholders. They are not appropriate in all cases, but in some cases, and for some sets of values, they may provide useful alternatives to monetization.

This growing body of work is helping to broaden the measurement of ES benefits beyond monetary values, and to better capture the breadth of nature's contributions to human well-being. In so doing, this work is also helping to re-align ES research with EE's core principles, particularly that of considering a broad conception of human well-being (Figure 8.1).

Focus on Stocks in Addition to Flows: On Sustainability of ES Benefits

Ecological economists have recognized that ecosystem stocks and ES flows are deeply intertwined since Herman Daly's foundational analysis in *Steady-State Economics* (1991). Daly argues, based on Irving Fisher's (1906) work, that the economy's wealth consists of a *stock* of capital assets that yields *flows* of benefits through the provisioning of goods and services. In macroeconomics textbooks, the idea of a fruit tree is often employed to illustrate the relationship between capital stocks and the flow of services they provide. The tree is an asset that can be understood as a stock of wealth. The value of that asset (to the fruit producer), is based on the value of the fruit the tree produces over time. The view that natural resources can be viewed as capital assets has much deeper origins, going back to the early work of Faustmann (1849) of the economics of forestry. And indeed, in modern natural resource economics, the "resources as capital" concept is fundamental to the management of exhaustible and renewable resources, the conservation of natural environments (Fisher and Krutilla, 1975), and the measurement of "weak sustainability" using metrics such as Adjusted Net Savings (World Bank, 2018) and the Genuine Progress Indicator (Kubiszewski et al., 2013).

Despite this history of the interwoven importance of stocks and flows, the vast majority of the ecosystem services literature focuses on the *flow* of benefits provided by natural systems; it does not link to the underlying value of the capital assets themselves (Fenichel et al., 2018). Many of the more common ES tools and approaches (e.g., InVEST, the Natural Capital Project's Integrated Valuation of Ecosystem Services and Tradeoffs tool) only analyse flows (Ouyang et al., 2016; Sharp et al., 2018). In the same vein, Costanza et al.'s (1997b) attempt to value the

total global value of ecosystem services is essentially static in this sense. Although it tracks changes in the value of services over time, it is not directly focused on valuing stocks of natural capital per se. This focus illustrates a fundamental tension that ES research needs to address.

Several efforts have begun to develop new techniques to account for natural capital stocks within the ES framework. For example, as part of the *Handbook of Environmental Economics*, Fenichel and colleagues "develop theory and techniques for measuring natural capital shadow prices or asset values in real world situations" (Fenichel et al., 2018, p. 85). In another study, Fenichel and colleagues develop a valuation approach to price natural capital and compare it to other capital in apples-to-apples ways (Fenichel et al., 2016). Several international efforts are working to mainstream the value of natural capital stocks into systems of national economic accounts; the WAVES partnership led by the World Bank and UN-SEEA Experimental Ecosystem Accounting offer two examples (Boyd et al., 2018; Hein et al., 2016).

Two global issues – climate regulation by forests and marine fisheries – can illustrate the importance of considering stocks as well as flows. In the climate regulation context, much of the literature focuses on estimating the annual rate at which growing forests remove CO_2 from the atmosphere, which can be assigned a monetary value using the Social Cost of Carbon (Nordhaus, 2017).[1] Forest management decisions, however, are not based on short-run flows of costs and benefits, but rather on the tradeoffs that exist between costs and benefits that accrue from a particular parcel (i.e., stock) at different points in time. In this setting, what matters economically is the present discounted value of net carbon uptake at different points in time, which involves tradeoffs with the potential benefits of timber harvesting and land-use change (Lubowski et al., 2006; Lutz et al., 2016; Newell and Stavins, 2000). In fisheries, it is the depletion of resource stocks that centrally undermines the ability of systems to provide services. Thus, fisheries science and fisheries economics focus centrally on managing stocks to maximize yields and/or the present value of net benefit streams (Troader, 1983).

In addition, because forest management practices affect the climate in multiple ways, tradeoffs must be considered, and assessment of stocks is required to evaluate many tradeoffs. As one example, Lutz et al. (2016) show that in regions characterized by consistent winter snow cover, such as the North American Northern Forest, maintaining open landscapes can provide important climate benefits by increasing surface albedo, which has a net cooling effect. While the benefits that fast-growing forests provide through carbon uptake dominate this albedo effect under typical conditions in the Northern Forest, there are situations in which maintaining open fields can be preferable from a climate mitigation perspective. Understanding the tradeoffs involved requires a long time horizon (decades to centuries), and also tools that depend on understanding stocks, such as discounted cash-flow analysis, are very important in integrating flows of net benefits over time.

[1] Here, the range of plausible prices is wide, depending on assumptions about the stringency of climate change policies. Low prices arise if one employs a high discount rate and is optimistic about the ability of future generations to adapt to climate change at low cost. High prices arise given low discount rates and/or a perceived need to sharply reduce greenhouse gas emissions to avoid crossing a climate tipping-point.

Better Consider the Distributional Effects of ES

Achieving an equitable distribution of benefits and costs within society is a pillar of EE. Many decisions affecting the provision of ES involve diverse groups of stakeholders. The demand for ES often varies among these groups (and individuals), depending on their preferences, access to substitutes, and vulnerability to environmental hazards (Wolff et al., 2015). Given the heterogeneity in demand among ES beneficiaries, the value of changes in ES varies for different groups (Dawson and Martin, 2015). Ignoring this heterogeneity may result in inefficiently and inequitably allocating ES benefits and exacerbating inequality within and among communities.

As the incorporation of ES in decision-making becomes increasingly mainstream, the question of whether the distribution of services is equitable has become central. Scholars have called for better accounting of the distribution of benefits and costs in ecosystem service valuation (Balmford et al., 2011; Bennett and Chaplin-Kramer, 2016; Daw et al., 2011; Pascual et al., 2010). To date, however, few studies disaggregate ES beneficiaries and account for differences in the value of ES to these groups (see Daw et al., 2015; Halpern et al., 2013; Ward and Pulido-Velazquez, 2008). Yet this is changing: as one example, the journal *Ecosystem Services* has published numerous papers and special issues that foreground distributional issues; these range from perception of values to strategies to deal with access and benefits (Jacobs et al., 2016; Sattler et al., 2018).

We suggest that reliance on biophysical metrics and monetary valuation to evaluate ES presents a major barrier to understanding the distribution of ES benefits. Biophysical metrics do not account for demand for ES or the value of ES to different groups of people. Improvements to water quality from nutrient retention services, for example, may benefit one group of stakeholders by reducing treatment costs for drinking water, while another group may benefit by improved access to recreational opportunities, and another group may not benefit at all (Keeler et al., 2012). Yet many ES analyses solely focus on biophysical metrics, and so do not capture this heterogeneity (Boerema et al., 2017). Among studies that do account for this demand, the value of ES has been shown to change dramatically and priorities for conservation have shifted (Stürck et al., 2014; Verhagen et al., 2017; Watson et al., 2019).

Though monetary valuation of ES facilitates comparison and aggregation of different values and is easily understood by some decision-makers, these approaches often do not capture the plurality of ways that people value nature (Wegner and Pascual, 2011). Decisions made using monetary valuation (i.e., cost–benefit analysis) tend to perpetuate distributional inequality for two reasons (Garmendia and Pascual, 2013). First, the prices of goods and services are based on the preferences of those with greater willingness-to-pay, and therefore may not be valid indicators of their true value to lower-income groups. And second, the pricing of ES benefits assumes that the value of a particular ES is equal for all beneficiaries, disregarding that the marginal utility of ES is often greater for marginalized groups than for wealthier groups (Daw et al., 2011).

Several methods have been developed to better evaluate the benefits of ES to different groups and how ES are distributed. Integrated valuation approaches are a promising frontier for capturing the plurality of ways in which people value nature, and they have been employed in a

diverse range of decision contexts (Jacobs et al., 2016). Rather than reducing the values of nature to a singular metric, integrated valuation approaches seek to recognize intrinsic, relational, and instrumental values of nature as each being distinct and incommensurable (Díaz et al., 2015). Equity-weighted utility functions have not to date been used in ES research but offer another promising avenue that ES research could pursue. To take an example from a different field, several studies on the social costs of carbon use equity-weighted utility functions to account for the differential impacts of climate change to countries of varying wealth (Anthoff et al., 2009; Baer, 2009; Dennig et al., 2015); this work often implies that policies that distribute benefits from the bottom up and costs from the top down create the greatest increases in social welfare. Another option is to use the Gini Index in novel ways; in conservation planning, for instance, using the Gini index to operationalize equity has been shown to alter the optimal configuration of interventions (Halpern et al., 2013). And finally, coupling metrics for services related to environmental risk reduction and indices of social vulnerability to environmental hazards (e.g., Cutter and Finch, 2008) is a promising approach to identify people who will benefit most from those services (Arkema et al., 2013).

A different procedural approach is to use discourse-based approaches (e.g., group deliberation) to value ecosystem services and establish fair outcomes (Wilson and Howarth, 2002). This work applies concepts from deliberative democratic theory as an approach to the construction of norms and values. Mavrommati et al. (2017) present an application of this approach to generate a non-monetary measure of the value of watershed ecosystem services.

Integrate Non-Western Perspectives to Enrich ES Research and Practice

Most ES approaches continue to follow the concept's Western roots.[2] This orientation conflicts with the EE tenet of equity. Distributional impacts, as discussed in the previous section, are a crucial component of equity, but equity concerns also suggest modification of another sort: that ES should integrate worldviews that conceive of humans, environment, and place differently – notably, local, non-Western, and indigenous perspectives. ES researchers have begun this process; they are exploring how those worldviews already overlap with EE and ES, what those views might add to our understanding, and how they might affect action (Chan et al., 2012; von Heland and Folke, 2014).

The Western focus of ES work is most evident in two areas: its conceptual foundations, and the idea of services as uni-directional. First, most concepts used to value ecosystems are grounded in Western economic and ecological worldviews. A pervasive aspect of this perspective is the separation of humans from the Western concept of "nature" (Flint et al., 2013). Though scholarly thinking has in some ways moved beyond the American idea of untouched wilderness (Cronon, 1996; Nash, 1973), much mainstream Western thinking still embodies the idea that nature is something apart from humans. The definition of ES (benefits that nature provides to people) reifies this separate-ness (Flint et al., 2013). The concept of services thus resonates with societies that foreground neoliberal economic thinking and human and nature as

[2] We use the term "Western" as a shorthand for a complex suite of influences and perspectives that generally align with North American and Western European worldviews and habits of thought.

separate; it does not resonate as often, or as well, with societies that have other foundations and worldviews (Pascual et al., 2017). As one example of this Western bias, current ES research and practice fails to capture non-Western systems of exchange (i.e., economies) in which ecosystems interact in important ways with aspects of well-being such as social cohesion (Cavalcanti, 2002; Vaughan and Vitousek, 2013). These can be crucial to community (and individual) well-being, yet ES frameworks do not typically contain mechanisms to incorporate them.

A second manifestation of a Western focus is that the ES concept is presented as a uni-directional flow of services, from ecosystems to people. This largely conflicts with the idea of reciprocal relationships – an idea that permeates many cultures worldwide, particularly indigenous cultures (Chan et al., 2016; Kimmerer, 2013). The dominant ES framework does not comprehensively address humans' roles in impacting ecosystems in ways that increase certain functions – i.e., actions that modify ecosystems and thus increase ES (Comberti et al., 2015). At its core, the idea of Cultural Ecosystem Services leaves space for these types of heritage-based relationships, but the ES framework does not currently make it easy to incorporate them. Scholars have published hundreds of papers on cultural ecosystem services (Milcu et al., 2013), yet this work is still not deeply integrated with mainstream ES research and practice. We know of no analyses that combine regulating and provisioning services with cultural services other than recreation and aesthetics – the cultural ES that are arguably most superficial, and neglect many deeply meaningful considerations, particularly of communities outside of Europe and North America.

ES scholars recognize these limitations of the framework and work to incorporate a wider diversity of perspectives in at least two ways: plural valuation and recognition of the importance of relationship rather than uni-directional flows. Plural valuation, in which multiple forms of value are considered simultaneously, is increasingly discussed by social scientists in, or adjacent to, the ES field. Scholars discuss diverse approaches to how "value" should be defined and conveyed within ES (Arias-Arévalo et al., 2018). One important aspect of this discussion is deliberative assessment of shared and social values (Kenter et al., 2015). A central pillar of advocacy for plural valuation is a traditional focus on monetary valuation precludes incorporation of many types of value, and many of these are important to non-Western or marginalized communities (Jax et al., 2013).

A second development is ES-related research that leaves space for discussion of human-nature relationships more broadly (rather than as confined to a strict producer-consumer ES framework). One manifestation of this is the rise of the relational values concept, which proposes that instrumental and intrinsic values are not "the only show in town," and that some values are specifically about relationships (Chan et al., 2018, 2016; Muraca, 2016). These values are likely to be particularly salient for indigenous and other non-Western communities (Gould et al., 2019). Empirical work shows that relational issues can be central to ES discussions; Pascua et al. (2017), for example, worked with Hawaiian communities to develop a local CES framework that incorporates important relationship-based values; see Table 8.1.

This last study also provides an example of ES initiatives that integrate with broader non-Western perspectives and often morph as a result. Another initiative on Ishigaki Island, southern Japan, also revolves around the local human–ecosystem relationship. Shiraho villagers traditionally have a close relationship with their "ocean of treasures," yet post-war trends such as

in-migration and specialization of livelihoods estranged many villagers from the ocean (Kamimura, 2007). Researchers have supported a village community to regain ownership of their relationship with the ocean. Community-led efforts to recover traditional satoumi fishing techniques and realign with their "coral reef culture [sangoshō bunka]" encompass a mechanism for coral conservation (Kamimura, 2017, 2011; NPO Natsupana, 2019). Recognition of all four types of ES, as well as the impact of human activities on the coral ecosystem, are implicit in their approach. Similarly, researchers working in a Japanese socio-ecological production landscape (satoyama) emphasize the importance of multigenerational dialogues in engaging sensitivities for CES in biodiversity conservation (Toyoda and Kuwako, 2011).

Source: Reproduced from Pascua et al. (2017).

Table 8.1 A Hawai'i-based framework for Cultural Ecosystem Services, developed through community workshops in two sites on the islands of Hawai'i and Kaua'i

Category	**Benefit**	**Examples**
'Ike: Knowledge	*Ma ka hana ka 'ike:* Opportunities to learn place-based practices by actually doing them	Gathering salt; gathering and preparing seasonal seaweeds
	Nānā i ke kumu: Opportunities to observe familiar natural processes and seasonal occurrences	Local weather patterns; plant/animal behavior and cycles
	Hālau 'Ike: Opportunities for diverse (formal and informal) learning	Scientific research; land-based education; learning from elders
Mana: Spirituality	*Ho'omana/Mauli Ola:* Spiritual beliefs and practices that allow people to interact with the mana of a landscape	Ceremonies and other forms of cultural expression; songs, chants, dances, prayers of/for place
	Wahi pana: Existence of, appropriate access to, and understanding of place-specific practices associated with storied landscapes (wahi pana).	Important cultural sites (burial or birthplaces); particular gathering/harvesting sites
	Kinolau: Presence and recognition of plants, animals, and elements that represent/symbolize Hawaiian deities	Form and function of ceremonial garlands (lei) and other ceremonial offerings (water, rain)
	'Aumakua: Presence and recognition of familial guardians/ancestors; resources themselves recognized as kin	Non-human "relatives" that care for and are cared for by human families
	Hō'ailona: Presence of environmental signs/indicators and the ability to recognize them	Weather patterns signal events; species signal natural cycles
	I ka'ōlelo nō ke ola, i ka 'ōlelo nō ka make: Presence of place-based Hawaiian terms/names describing environment	Names for places, species, processes; continually creating these names/proverbs
Pilina Kanaka: Social	*Ho'olako:* Perpetuation of practices/skills that allow individuals to provide for their families	Jobs & related practices that require traditional knowledge

Interactions	*ʻIke aku, ʻike mai:* Opportunities to share traditional/local knowledge and values	Apprenticeships (informal, formal); place-based fishing, gathering practices
	Kōkua aku, kōkua mai: Presence of strong social ties/ social networks	Community networks; gifting / exchange of goods
Ola Mau: Physical and Mental Wellbeing	*Lako/Momona:* Availability and access to subsistence resources for people to thrive	Quantity and quality of water; reef health; soil health
	Hoʻoikaika kino: Opportunities for active lifestyle to support physical demands of specific practices	Outdoor activities that promote health & strength
	ʻOihana: Opportunities for engaging in family roles and occupations	Availability of traditional occupations e.g., fishing, farming
	Moʻokūʻauhau/Noho Papa: Opportunities for multigenerational presence on and interaction with lands that foster security and sense of place	Presence by lease; physical access; ownership; occupation

Projects from many other areas of the globe offer examples of enriching ES research and practice via integration of non-Western viewpoints. These examples include using traditional ecological knowledge to inform or enrich ES initiatives in the Northern Amazon (Cummings and Read, 2016) and creating new categories of CES based on the perspectives of diverse populations in Hawaiʻi (Gould and Lincoln, 2017).

Incorporate Social Learning into ES Analysis

Ecological economics builds on the idea of resilient, dynamic, and sustainable socio-ecological systems (Cote and Nightingale, 2012; Gunderson and Holling, 2002; Holling, 2001). EE principles implicitly recognize that changes in social systems will be necessary to achieve this ideal (Costanza et al., 1997a; Farley et al., 2005). Learning – a process of change in the way we look upon the world (Folke, 2011, p. 11) – is a crucial aspect of moving toward this vision (Meppem and Gill, 1998).

Though EE recognizes the changing nature of social systems (Proops, 1989), the ES field rarely accounts for this dynamism. Here we discuss two forms of dynamism, as follows:

1. *Changes in CES due to social-ecological learning (broadly construed).* The ES field focuses on ecosystem change (Hasegawa et al., 2018), and often overlooks changes in ES that do not depend on ecosystem change. Yet cultural change can change the benefits people receive from ecosystems. Particularly under-studied in the ES field is the fact that social learning, an umbrella concept that concerns collective learning about societal issues (Wals, 2007), can change cultural perceptions and thus shape the benefits provided by cultural services (CES) of the same ecosystem (Dickinson and Hobbs, 2017; Gould et al., 2018). ES, and particularly cultural ES, can change even when an ecosystem remains the same.
2. *Changes in learning and decision processes due to ES framings.* The ES concept and ES frameworks may change how people think about ecosystems and how to manage them. The ES concept provides fundamental framing for how people see human–nature relations, and

particularly human dependence on nature. It thus seems likely that it will affect both policy-makers' and the general public's perceptions and decisions, especially in long-term and broad ways (as opposed to with respect to a single decision).

To address these two under-studied areas, the ES field has begun to explore the social dynamism of these two main types. The first dynamism stems from the fact that CES rely on social factors for their production more than do other ES (Dickinson and Hobbs, 2017), yet most current CES studies discuss static benefits and values. ES researchers have reviewed research on environmental education outcomes – a subset of which overlap with CES – and found that CES-related outcomes can change after educational interventions (Gould et al., 2018). Other fields corroborate this finding; as one of many possible examples, knowledge of invasive species can reduce the aesthetic benefits that people receive from invasive-heavy forested landscapes (Buhyoff, 1979). Research demonstrates, in other words, that learning can change CES.

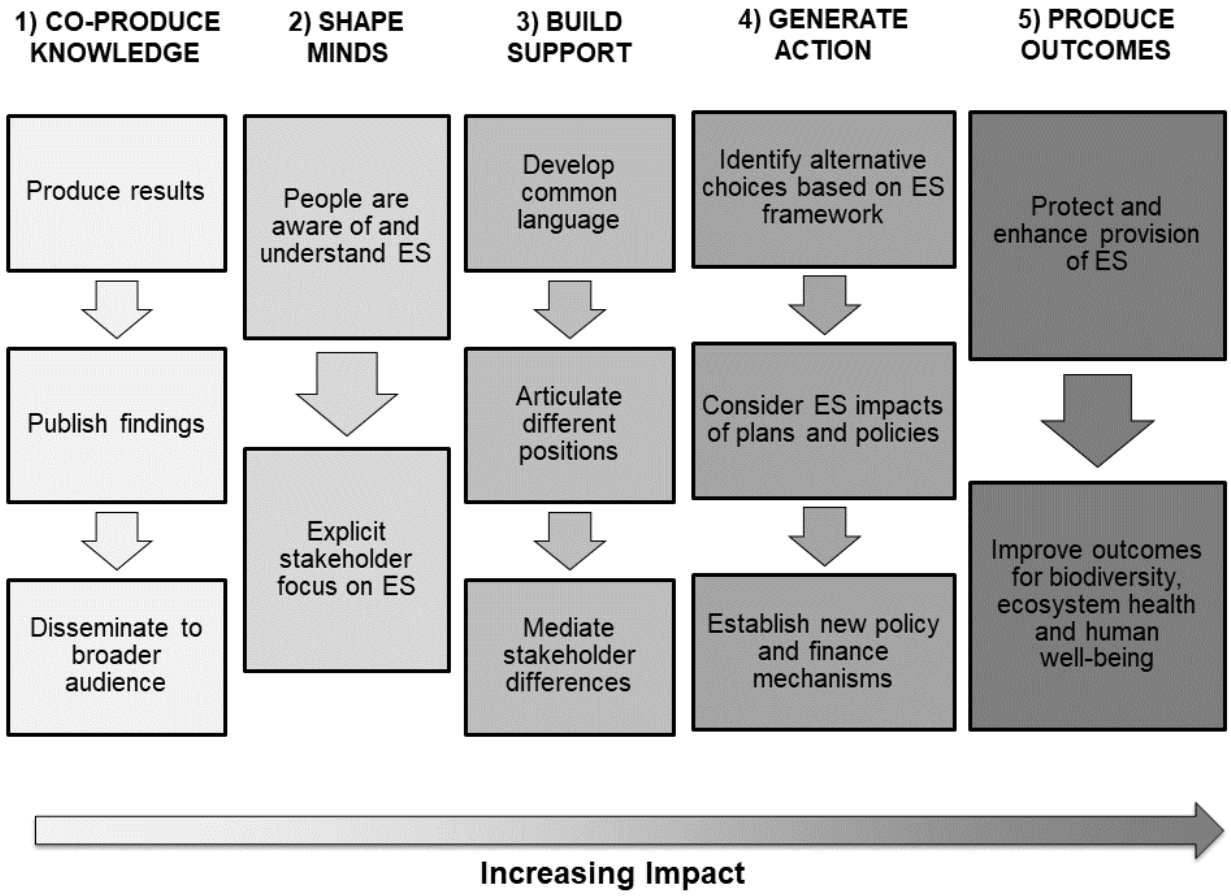
The second dynamism stems from the likelihood that ES perspectives influence how people think about ecosystems. ES framings advance interdisciplinary thinking and help learners make connections between social and ecological systems (Taylor and Bennett, 2016), with obvious relevance for addressing complex environmental problems. This change in thinking is relevant at many levels, but researchers have focused primarily on the effects on decision-makers. Bringing ES ideas into decision processes can shape thinking among decision-makers, affect the language they use to discuss environmental policy issues (McKenzie et al., 2014), and enable new ideas and beliefs. Learning can be subtle and thus difficult to detect, but empirical evidence suggests that it may be occurring (Figure 8.3). This evidence includes policy dialogue that represents an understanding of ES and their value (Karl et al., 2007; Marre et al., 2016) and a perception among decision-makers that ES knowledge is relevant to decisions and useful for improving policy and management (Posner et al., 2016).

Crucial to note, with respect to this second form of dynamism (i.e., how ES framings may impact perception of ecosystems and management), is that the impacts of ES framings may not all be positive. Scholars have written extensively about the deleterious impacts of ES conceptual frames – i.e., how considering ecosystems using this frame may be problematic. These critiques (which intertwine with critiques listed in the Introduction) include: the dangers of imposing ES concepts to the detriment of other value types (Jax et al., 2013); the fundamentally neoliberal foundations of ES (Büscher et al., 2012); changes in relationships, and motivation to conserve, that relate to seeing ecosystems as service providers (García-Amado et al., 2013); reification of the nature–culture divide, as addressed above in the previous section; and many more. Explorations into how ES framing changes perceptions and action related to ecosystems must make ample space for these deeply rooted and potentially problematic aspects of that change, as well as for its helpful and constructive aspects.

Note: Learning is inherent in many of the steps – for example, the first steps in column 2 ("people aware of and understand ES") and in column 3 ("common language developed").

Source: Reproduced from Posner et al. (2016).

Figure 8.3 Framework that denotes how ES knowledge can lead to impact



CONCLUSION

With this paper, we propose five ongoing areas of ES research and implementation that can reinforce and strengthen three core principles of EE. EE and ES developed together and continue to share goals and core ideas. As the two fields have developed, sometimes in unison but often in divergent ways, each has at times criticized the other (e.g., Schröter et al., 2014). Yet even given these constructive challenges to ideas and approaches, much remains in common. We hope that a focus on the research areas reviewed here will help advance both fields.

The trends identified and suggestions made above are certainly not the only useful ones to highlight. Though we suggest five ways forward for ES research, there are surely other important ES research areas; though we focus on three core tenets of EE, there are surely other perspectives on the core principles of EE. What is more, assessments of both the importance of our suggestions and the amount of research that already addresses them are largely subjective; even the authors had divergent opinions about precisely how to assign weights to the relationships depicted in Figure 8.1 (see figure caption for details).

Despite these caveats, the five trends we describe, considered together, have the potential to move the ES field forward, and toward better alignment with EE. The suggestions lead to exciting research questions that will challenge the field as it continues to develop. They provide

bright spots (i.e., positive examples that inspire hope (Bennett et al., 2016)), via the work we describe above, of researchers already engaging with these principles. Finally, and most importantly, they can help to keep ES research and practice grounded in core principles that are essential for long-term economic, environmental, and social sustainability.

RESEARCH AND ACTION AGENDA

- In simple terms, what are the positive and negative effects of ecosystem change on human well-being? Beyond monetary measures, what other aspects of well-being are affected and how?
- Which measures of human well-being are most suited to different stakeholders? Are these different measures more or less salient and credible to local landowners versus global institutions, to governments of developing versus developed countries?
- How do results of ES assessments and the recommendations that flow from them change with different measures of benefit? Are different policy options favoured? Different locations identified as priorities?
- What other fields characterize benefits in ways that may help expand our creativity? How might we adopt these metrics to broaden the ways in which we measure ES benefits?
- How can modelling packages for ES be expanded to incorporate stocks?
- How would key findings, or spatial priorities, or management recommendations differ between ES assessments that focus on flows and those that also incorporate stocks?
- What is the dynamic relationship between stocks and flows in managed ecosystems such as forests?
- Do ES models need to include population dynamics of Service-Providing Units (e.g., populations of bushmeat species or non-timber forest products), in order to inform sustainable levels of use?
- What methods and tools would facilitate evaluating the distribution of ES benefits?
- How are decision outcomes altered when distributional impacts are accounted for? How do different methods for disaggregating ES beneficiaries (i.e., according to race, income, age, nationality, gender, or other characteristics) affect those decision outcomes?
- Does achieving equitable outcomes create tradeoffs with economic efficiency, or other objectives such as biodiversity conservation? Alternatively, does it create co-benefits or synergies?
- What novel metrics would better capture the value of ES to diverse groups of people?
- In conservation initiatives, how does prioritizing distributional equity of some ES affect other outcomes of that initiative?
- How do research findings and practical applications of ES change when non-Western perspectives are included in equal, respectful, and meaningful ways?
- How do non-Western approaches to sacredness of ecosystems apply to ecosystem services?
- Does a more reciprocal framing of ES change the results of the use of ES in decision-making?

- How do outcomes (both social and biophysical) change when plural valuation approaches are combined with "traditional" ES approaches?
- What challenges and benefits arise when engaging in plural valuation that includes ES?
- What metrics would allow ES models to account for social dynamism, particularly from cultural ES, given static ecosystems (e.g., integrated modelling)?
- Does the use of ES framing in environmental education initiatives (e.g., Hartley, 2018; Wilborn, 2013) change program outcomes? If so, how?
- How do decisions made using ES perspectives differ from those made using more traditional environmental science perspectives?
- What are the behavioural outcomes of CES change?
- How do existing policies use ES in decision-making, and how does ES learning impact decision-makers?
- What methods and tools would help account for the social dynamism of ES?

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