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THE BENEFICIARY PERSPECTIVE

Benefits and beyond

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Introduction

Humans are dependent on the environment, and the ecosystem services concept helps us see how much. Within the academic and policy communities, subtle differences in definition can greatly affect how we identify and measure ecosystem services and what analysts report to policymakers. Efforts to define, measure, map, and value ecosystem services have met with varying success, but to date, no comprehensive framework or approach has emerged that can consistently inform policymakers in terms useful at different spatial scales. Natural scientists interested in physical measures must directly collaborate with social scientists concerned with valuation and decision-making. This chapter argues that a paradigm shift in how scientists articulate the differences between deeper natural processes and the products of those processes that people use or care about can help to resolve many issues within the ecosystem service community. We pose that great care in separating intermediate ecosystem services from Final Ecosystem Goods and Services will narrow research focus away from inconceivably large values for broad single-metric indicators (e.g., all carbon, all biodiversity in an area), and toward values that are human-scale and clearly affected by specific choices (e.g., Will conversion of wetlands to a new housing development raise the cost of a city's water for decades?). Our approach does not ignore intermediate ecological processes, but instead focusses measurement attention on ecosystem services that people more directly use or appreciate, and on who these people are – because the value of something changes with the user and with the context of their choice.

The objectives of this chapter are threefold. We first explore distinctions between nature's benefits and human beneficiaries of nature, and how seemingly slight differences in the definition of ecosystem services can lead to vastly different outcomes. We adopt a *beneficiary approach* by expressing ecosystem services in terms of use-user combinations, as opposed to a *benefits approach*, which lists myriad potential uses of ecosystem services while implying, but in no way empirically identifying, users. We propose that a beneficiary approach promotes the practicality and feasibility necessary for achieving ecosystem service research and policy objectives, including measuring, mapping, and valuing ecosystem services. A beneficiary perspective may also offer much-needed momentum in moving ecosystem services from concept to implementation, and eventually, to influencing societies (i.e., communities) and economies by refining and highlighting decision-making that affects the environment. Second, we introduce the use

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of Final Ecosystem Goods and Services (FEGS) as the underlying definition and concept for a beneficiary approach. Distinguishing intermediate ecosystem services from FEGS is a useful foundation for classifications systems that serve both natural and social science objectives. Finally, we present a Final Ecosystem Goods and Services Classification System (FEGS-CS) that appears to meet the needs of a variety of different users interested in quantifying and valuing nature's benefits in a defined and non-duplicative way, by incorporating the perspectives of beneficiaries and, therefore, directly linking to human well-being. Merging the FEGS-CS with an economic approach allows the mapping of flows of FEGS through economic production functions to human well-being. We introduce and briefly describe such an economic approach, the National Ecosystem Service Classification System (NESCS; more easily voiced when slightly rephrased as 'nexus').

The millennium ecosystem assessment and our diversion from it

Since 2005, many natural and social scientists have turned to the ecosystem service definition and general categories that the Millennium Ecosystem Assessment (MA) offers (MA, 2005). Multiple approaches for implementing the MA vision have been proposed – in our view, not necessarily with clarity and consistency (Carpenter *et al.*, 2009; Nahlik *et al.*, 2012). Despite on-going efforts, none of these has successfully met the objective of moving ecosystem services forward into practice by devising a system that supports measuring, mapping, and valuing ecosystem services using the MA categories. This follows from the fact that there is virtually no attempt in the MA approach to explicitly link ecosystem services derived from ecological components to the people that use the services, or beneficiaries. Potential users of the MA's 'benefit approach' (thus so because MA equates services and benefits) are required to separate some ecosystem services from others and to select – without the perspective of how humans perceive them – which of the near-infinite list of environmental things should be measured when characterizing the provision of ecosystem services for policymakers. Even if all these obstacles could be overcome, a further issue associated with a benefit approach remains: How can ecosystem services be prioritized or valued outside of the beneficiary's context? This issue confounds economists and social scientists attempting to estimate values for any ecosystem service.

Benefits versus beneficiaries

For practical reasons, a stronger coupling between ecosystem service uses and users is required. Potential use must connect with an actual user for an ecosystem service to be discretely identified. Only by explicitly matching the uses of nature's services, the *benefits*, to known users, the *beneficiaries*, do we gain the means to measure and account for how much of which of nature's services are used or appreciated, and by whom. Beneficiaries are 'users' of nature's services, but in the broadest sense – 'use' includes consumption, appreciation, and *any* way a person might value the ecosystem service – not excluding valuing that it exists, or benefits others, or in the opinion of the 'user' should be passed unspoiled to future generations, even if the 'user' never touches or even sees it. Without explicit matching of benefits to beneficiaries, there is no uniquely identified value to any *human*'s well-being that we can hope to measure accurately and consistently, and nature's services may continue to be dramatically underappreciated in policy debates and elsewhere.

Humans, whether we recognize it or not, are dependent on the environment for multitudes of benefits that sustain us, our societies, and our economies. How then did our society develop the environmental blind spot that motivated Gretchen Daily and others to compose *Nature's Services*, in which the authors promote the use of ecosystem services to counteract 'the near total lack of public appreciation of societal dependence upon natural ecosystems . . . [which presents] a major hindrance to the formulation and implementation of policy designed to safeguard earth's life-support systems' (Daily, 1997, p. xv)?

Development of the environmental blind spot

In any academic field, the first great work attempting to break from, yet build upon, earlier concepts often demonstrates context and sensitivity that later acolytes and practitioners fail to appreciate at some risk to effective progress. This is true of Adam Smith's *Wealth of Nations*, the American Founding Fathers' attempts to define a sustainable and functioning democracy in a new Age of Enlightenment, and Daily's *Nature's Services* (Daily, 1997). The failure of the general public to understand how deeply they rely on nature's processes is in part the result of an Industrial Age worldview that evolved from common readings of Adam Smith's work and ideas tried by the United States' Founding Fathers, among others – a worldview that favors the value of the individual abstractly, as well as favoring the values of productivity, efficiency, and the happiness of individuals relative to society and to the larger ecosphere. In *Nature's Services*, Costanza and Folke note that when societies prioritize goals, the goal of efficiency is naturally coupled with individual preferences, the goal of fairness is naturally coupled with social preferences, and the goal of sustainability is naturally coupled with 'whole system' preferences (see Table 4.1 and surrounding text on p. 57 of Daily, 1997). Favoring individual preferences over 'whole system' preferences would thus place economic production-unit level efficiency before sustainability in decision-making. There is ample evidence that exactly this has happened – MA (2005) presents evidence of cumulative conversion of ecosystem-service-producing areas to commercial use.

Over the centuries, economists have built an idealistic but plausible structure rooted in specific assumptions, which holds that individuals rationally and efficiently pursuing their own interests will also reach a fair, and even sustainable, outcome for society. Much modern economic work: a) explores how reality deviates from the ideals and assumptions, b) seeks to understand by how much, and c) seeks to determine whether and how to correct incentives so that economic dynamics shift toward ideal processes and outcomes. Regardless of one's opinion about how far actual markets are from an ideal process, one must admit that the underlying perspective favoring individual preference action and happiness has come to dominate political-economic thinking.

Many stakeholders and policymakers remain relatively deaf to arguments that do not assume that pursuit of company-level economic goals will also best serve society over the long run. Despite ample evidence that human disruption of natural ecosystems now threatens ecological functions and yields that people care about (Daily, 1997; MA, 2005), overcoming 'the near total lack of public appreciation of societal dependence upon natural ecosystems' (Daily, 1997, p. xv) must involve the dominant individual/economic perspective, if policies needed to safeguard natural systems are to succeed. The hard truth is that the term ecosystem services (in using the word 'services') suggests that natural science, with its objective disciplines, *must* be grafted to social science, with its often subjective disciplines, when determining how and how much humans value the processes and provisions of nature. If the value of nature is not made clearer to them, people will continue to ignore the provisions of nature at direct risk to themselves. We offer an approach that natural and social scientists can agree on, one that defines and identifies measureable ecosystem services, benefits, and beneficiaries.

Why economics matters to everyone who wants ecosystem services to influence policy

Economics includes the study of how to efficiently use limited resources to meet objectives – a seemingly eternal problem for decision-makers, individual, national, or global. In classical economics, limited resources constrain choices, so tracking how resources are produced, processed, and distributed is a primary interest. Under conditions that hold for many limited resources and the goods and services made with them, markets are quite adept at coordinating buyer and seller exchange through price signals. Prices, or some bundle of goods judged to be equivalent in worth, reflect the value people place on non-infinite goods and services.

Classical economics begins from the perspective and with the premise that individual consumer choice as exercised through complete and fair markets will leave everyone as well off as they can be, given the distribution of resources with which everyone began. Because almost all quantitative economic analysis must be formulated in a framework whose foundation is individual choice and actions to raise individual satisfaction, arguments not founded on individual choices must fight an uphill battle for acceptance as an alternative formulation. Economic production functions match inputs, producers, and processes with outputs, and the outputs become inputs for individuals to meet their goals.

Welfare economics – how economics links to measures of well-being and policy choices

Welfare economics is used to compare how different economic states of being affect the well-being of a population, and is thus the basis for policy recommendations by economists. Welfare economics all but demands that a user be able to place (or estimate) a value for goods or services. Values should be comparable to purchase choices in a market (Bockstael *et al.*, 2000), and work best if they can be summed and compared across individuals. 'Values' for things that do not have prices attached to them – as for most ecosystem services – are at a structural disadvantage in analysis that favors a single common scale of comparison (like a price or known bundle of goods). Most ecological processes and resources are un-priced, so they are ignored or subtly embedded in models of economic production. In practice, a price-based perspective assumes away complex ecological production dynamics and any chance that small overlooked effects may accumulate to disrupt the continuing flow of ecosystem services. The default presumption is that if any resource becomes scarce enough, a price will rise and significant effects will be captured in market transactions.

Market failures and how economists can have trouble seeing ecosystem services

Economists are trained to be forthright about the limitations of the assumptions that must be made for basic economic theory to work. Markets are unlikely to work best, or even well, when *market failures* exist – conditions under which markets from their own dynamics will not reach an efficient and mutually beneficial equilibrium. Market failures include the existence of public goods, environmental externalities (good or bad), and asymmetries of information (under which not all parties are sufficiently well-informed to most effectively pursue their own best interests). There should be no surprise that ecosystem services very often correlate with conditions associated with exactly these market failures. Indeed, the ecosystem services concept was defined as a means of identifying some of the un-market-able, but vital, processes and products of the environment otherwise often ignored in everyday economic decision-making (Daily, 1997).

It is precisely because people benefit from many ecosystem services without having to expressly buy them that simply listing potential ecosystem services is not argument enough to include them as certain elements in the set of an individual's *realized* economic choices – meaning the individual actually derives satisfaction (or *utility*) from the ecosystem service, whether they ever use it (e.g., drinking water from snow pack) or just enjoy knowing it exists (e.g., snow leopards). Ecosystem processes and fundamental materials (e.g., soil in the lithosphere) in some objective way exist in an 'ecological production function' that results in ecosystem goods or services that someone values, but without prices there may be little motivation to discover or account for that ecological production function. This is a blind spot between economic theory and practice that the notion of ecosystem services is meant to redress.

Absolute stock versus relative flow: biodiversity as an example

To actually be an ecosystem service, a candidate must have recognizable value to someone. From this understanding, 'biodiversity' might seem to be an ecosystem service/benefit that an individual would value. But without identifying elements of a larger context such as geographical area, or estimated number of species relative to pre-industrial influence, simply naming 'biodiversity' does not evoke the type of trade-off decision-making that an individual might undertake daily (e.g., a *marginal* choice between condition A and condition B, all else being equal, that will make the individual more satisfied).

Without a larger context, the individual can only choose 'biodiversity = yes', or 'biodiversity = no'. Without a biodiverse production environment, the human species cannot fulfill our biological need for a varied diet. Because there can be no rational 'biodiversity = no' choice, 'biodiversity' cannot be 'used/valued' in a *choice* an individual can reasonably make. Economists that model relevant (marginal) choices, rather than economists helping to measure stocks of limited resources, may turn their backs on the discussion. Biodiversity is extremely valuable, but not in ways that individuals consciously choose, as whether one eats a $2 cookie after lunch.

Biodiversity may be depicted in crass financial terms as a *capital stock*, like the capital stock of a firm, where having and using more of it well translates to higher productivity and higher yields for the same level of other inputs. In this sense biodiversity is like the machinery in a factory (physical capital), but in another sense is like the principal in a bank account. Either implies that when biodiversity exists in adequate quantity, it contributes to a *flow* of 'harvestable' income that need not degrade the physical capital/capital stock to the point of exhaustion. Once biodiversity helps generate the *flow* of ('harvestable'/useable/appreciable) goods or services, policy choices may affect these flows, and individuals may derive value from them.

Context, value, and marginal choices

The value a human places on anything depends on context. The context for valuing any particular thing includes: its relative scarcity/abundance; the relative sustainability of the systemic production of the good or service in question; and the degree to which it serves a unique function or the degree to which the functions and the characteristics for which the good is valued can be substituted by a good or goods with similar characteristics. Ultimately, whether a potential substitute is naturally or synthetically produced matters, because the *marginal* cost of using or switching to the second option also factors into the *marginal value calculation*.

For valuing ecosystem services, aspects of context that are likely to matter include:

- the ecological scale needed to maintain the ecosystem service;
- the geographically specific (environmental) context;
- the local economic context (e.g., a beautiful lake may anchor a local economy); and
- elements that affect how someone assigns value, including their culture and place in society, as well as decision-making factors described in behavioral economics and decision theory.

Any attempt to estimate anyone's or everyone's value for a flow of ecosystem services must be made assuming contextual factors defining all these aspects of context. Identifying the flows of ecosystem services is important, but important barriers remain to the transfer of estimations of the value for an ecosystem service from one environmental context to another.

There is no reasonable money-value for 'world carbon' or 'all biodiversity', because the chain of assumptions we make to get monetary values breaks in numerous places (Bockstael *et al.*, 2000). This is why economists focus on *marginal* analysis – how one thing compares to another in a given context – 'on valuing ecological changes, rather than on valuing entire ecosystems' (USEPA, 2009, p.15). Only by comparing changes can there be clear trade-offs, where choices affect outcomes in ways that manifest in different levels of satisfaction for the affected population, whether money values are involved or not.

Ecosystem service flows: distinguishing between **intermediate** *and* **final**

Recognizing that biodiversity is not a flow of goods or services does not diminish its vital structural role in an ecosystem's production and resilience. The marginal *level* of biodiversity endemic to a location may be included in any ecological production function that models physical stock, inputs, processes, and outputs in the environment as one might model them for a factory. Biodiversity may support a variety of zooplankton and pelagic amphipods upon which salmon thrive, where the species consumed by salmon are *intermediate*, just as the production of steel is *intermediate* for new cars (Boyd and Banzhaf, 2007, p.619). Cars are the *final* economic product a consumer buys, so in accounting for economic flows, counting the cars also counts all of the inputs and processes that comprise them. In this way, calling an ecosystem *structure or process* (terms as used by de Groot *et al.*, 2002) like biodiversity an ecosystem service would lead to counting it twice when we try to keep track of what people value (the ecosystem service, or in this case, the salmon), because the *intermediate* effects will already have affected production of the *final* ecosystem services that we do count. If something has an important ecological function, but this function cannot be expressly connected to someone's value for it, it is not a final ecosystem service.

The separation of intermediate from final ecosystem services when modeling the transmission of ecosystem products into the human value chain (or 'economy', where any *thing* may be used, transformed, or directly appreciated) is a critical step, distinguishing intermediate ecological processes, structures, and production functions from final uses and users (Boyd and Banzhaf, 2007). This separation more clearly identifies uses with users and minimizes double counting of ecosystem services (see Box 6.1). It does not solve all problems associated with trying to convert a complex holistic cyclical and circular (i.e., ecological) system into economic production functions and uses, but it is an important stride forward.

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Box 6.1 Double counting ecosystem services

Many now recognize substantial overlap among the broad MA categories to be a potential pitfall of the MA approach (Boyd and Banzhaf, 2007; Fisher *et al.*, 2008; Ott and Staub, 2009; Haines-Young and Potschin, 2013; Staub *et al.*, 2011; Nahlik *et al.*, 2012). Supporting and Regulating services in the MA context are generally biogeochemical processes, functions, or ecological structures that necessarily create and underpin the Provisioning and Cultural service categories – implicitly inducing double counting, because a single ecosystem service may depend upon elements in multiple MA categories. Double counting should be minimized or avoided in classification or accounting schemes. An ecosystem services classification system that minimizes or avoids double counting of both stocks and flows of ecosystem services must categorize both uses and users. A listing of uses (benefits) *cannot* be tallied because it is exploratory or qualitative, whereas users (beneficiaries) and the incremental amounts of FEGS the users are identified as using or appreciating *can* be tallied, because one or more users or a larger amount is quantifiable. While perhaps frustratingly difficult to enumerate, this philosophical connection between ecosystem services and users is key to practical application of the ecosystem services concept – for identifying relevant indicators and metrics, for highlighting direct and indirect uses, and for valuation.

Final Ecosystem Goods and Services (FEGS) conceptually and theoretically link a product derived from a particular sector of the environment with a specific user or beneficiary. FEGS are 'the components of nature, directly enjoyed, consumed, or used to yield human well-being' (Boyd and Banzhaf, 2007, p. 619). FEGS explicitly allow one to separate the infinite list of ecosystem services into intermediate ecosystem services (i.e., most ecological processes and functions that we recognize are important to understand, but that do not directly influence human well-being) and FEGS (Figure 6.1). Clear and concise separation between intermediate and final ecosystem services has five advantageous characteristics that support the development and use of an ecosystem service classification system:

1 FEGS can be associated with readily definable ecological production functions;
2 FEGS link to biophysical measures;
3 FEGS count only direct interactions (uses) between a user (or beneficiary) and the ecosystem, thereby minimizing double counting;

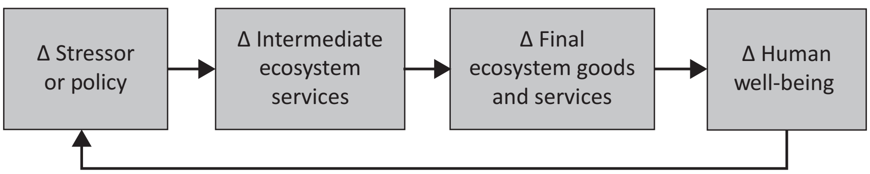

Figure 6.1 Flowchart illustrating how Final Ecosystem Goods and Services (FEGS) relate environmental stressors or policy changes, intermediate ecosystem services, and human well-being.

Source: adapted from P. Ringold (pers. comm)

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4 FEGS relate clearly to human beneficiaries and connect to human well-being; and,
5 FEGS facilitate direct communication and collaboration between natural and social scientists (Nahlik *et al.*, 2012).

The use of the FEGS definition provides order within the previously discussed broad notion of ecosystem services. The FEGS approach avoids much of the ambiguity inherent in other ecosystem services definitions and approaches, while providing the insight necessary for ecologists to measure ecosystem services, and for economists to value ecosystem services by connecting a specific beneficiary to what they directly utilize, consume, or enjoy from the environment. In short, FEGS are the intersection of nature and people, or what is produced by the environment and what is valued in the economy.

The use or appreciation by a beneficiary of an environmental element makes that element a FEGS. Remove the user, the environmental element, or the relationship between the user and that element, and there is no FEGS – as when one lists ecosystem-service 'benefits' for which users are implied but not identified. In any classification system for potential FEGS, the potential of the user to use or appreciate a candidate ecosystem service must exist. In any accounting of FEGS, there must be a distinction between potential use (i.e., stocks of FEGS) and actual use (i.e., flows of FEGS to beneficiaries), for which a quantity of FEGS should be specified (or a proxy for use or quantity).

Limits of economics do not limit contribution of the 'marginal decision' perspective

Economists model and track marginal changes in stocks and flows because these are their tools of trade, so the intermediate-versus-final distinction, which better enables marginal analysis, is critical to how policies will be determined. Similarly, the intermediate-versus-final distinction helps national accounting of the environmental or 'green' variety to track total changes and flows of ecosystem services based on exchange values for services in an accounting period (calculated to reflect what would have been paid had there been a market for these ecosystem services). Defining ecosystem services in terms economists and accountants can accommodate may seem impure to many ecologists, but policymakers will continue to employ economists and accountants who rely on information that favors precise definitions, distinct *single-direction* flows, and dollar-specific bottom lines. Certain characteristics of environmental elements we call ecosystem services do challenge conventional uses of standard definitions and metrics used in economics and accounting. This does not mean that economic and accounting systems are incapable of accommodating the more subtle productions of ecosystems – it means that economics and accounting must adapt.

The need to adapt is no surprise to many economists or accountants. Ecosystem services are, by definition, resources that are increasingly recognized as limited and are 'used' in the broadest sense to raise human welfare, so they *should* be used efficiently. Within ecosystem services, FEGS fall squarely within the natural purview of economics, although not as squarely within the set of things that markets allocate or even price well. Ecosystem services are not used efficiently for the same reasons that so few of them are marketable items with a unit price – they often exist as public goods, are diminished by negative externalities of the market system, are loosely defined, are poorly understood, are not well-modeled or quantified, and are notoriously difficult to value in money terms.

Economists will need more of this missing information to formally bring FEGS into decisions about efficient use of resources, including benefit-cost analyses. Bringing FEGS into formal analyses works toward the ideal of estimating the true value, or Total Economic Value (TEV),

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of alternative outcomes. TEV includes direct use, indirect use, the option to use, and a range of values a person may attach to the existence of a thing that they will not directly or indirectly use now or later. When benefit-cost analyses are requested or required (USEPA, 2010), quantified and dollar-valued figures born of this process generally exclude most elements currently associated with ecosystem services – not because they are not limited resources, but because they have been poorly defined, modeled, and measured. Formal inclusion of ecosystem services in decision-making may help make clear the societal interest in affordable and sustainable flows of FEGS relative to a single industry's profit motive.

The clearer we can define resources, quantities, system dynamics, and use-user combinations, the more accurately we can identify which people value which FEGS, the type of value, and how much they value the FEGS – and the more efficiently economists can model the contextual trade-offs that individuals, firms, or governments may responsibly consider. Careful economic approaches may favour the ease of monetizable values first, quantifiable values second, and qualitative values third, but should respect all three types in valuation research and reporting, precisely because decision-makers would be unwise to focus on only monetized values in their decision-making about ecosystem services (given challenges within the science that are unlikely to be overcome in the foreseeable future). Issues of fairness and the choice of which stakeholders' priorities should be treated as dominant are not directly addressed by the tools of economics. Nonetheless, the formalization required to address issues implicit in economic modeling will offer greater information and context for these and other decision problems.

Why targeted ecological measurements matter to everyone who wants ecosystem services to influence policy

To explore the practical difference between a beneficiary approach and a benefits approach, consider the example of fresh water. Water is often considered a benefit provided by the ecosystem. How would an ecologist measure fresh water? Would they measure water quality, quantity, clarity, temperature, or one (or all) of the myriad measurements that exist for water? Starting from the benefit – water in this case – is not particularly informative because, while fresh water will always be a vital provision for many uses and people, its own ubiquitous usefulness means that vague categorization offers little insight to ecologists about how to measure it, or to economists estimating its value. What to measure and value depends on who is using the water (i.e., the beneficiary), how the water is being used, and in what larger context.

Consider water from a stream in the context of three specific interests: a farmer irrigating crops, a subsistence user drinking water for survival, and a steel mill using water for cooling. Knowing the farmer's needs, an ecologist might measure water quantity during the growing season, salinity, certain chemical concentrations, and pathogens that could harm crops or those who eat them. For the subsistence user, the degree to which the water is safe to drink may be the most important criterion to measure (e.g., laboratory screening for pathogens, inorganic chemicals, and organic compounds). The industrial use of water for cooling will be affected by the volume or quantity of water available and its temperature – measurements ecologists can provide. From a practical perspective, using a beneficiary approach to hypothesize or identify the interests of beneficiaries (i.e., users or individuals) is necessary to select a biophysical measurement that aptly captures a specific benefit for a specific user. Linking beneficiaries to a specific sector of the environment from which they ultimately receive benefits also: a) divides potential benefits into concise, minimally-overlapping components based on uses, and b) minimizes overlap in beneficiaries. The beneficiary approach is also imperative for connecting these measurements to what people care about, and, ultimately, for relating these characteristics to human well-being.

Final ecosystem goods and services classification system (FEGS-CS)

FEGS are the basis of the Final Ecosystem Goods and Services Classification System (FEGS-CS). The fundamental goal in developing the FEGS-CS was to organize ecosystem services in a comprehensive, consistent, and meaningful manner. To meet these goals, FEGS that pertain explicitly both to the environmental landscape and to specific beneficiaries were identified and defined. A series of guiding questions, outlined in the United States Environmental Protection Agency (USEPA) FEGS-CS Report (Landers and Nahlik, 2013), was used to hypothesize how beneficiaries use, interact with, or perceive benefits derived from nature. These questions helped to direct the identification and definition of FEGS by describing their importance to the beneficiary. Combining a classification of environmentally derived goods and services with a requirement that a human beneficiary be part of the definition of FEGS separates the FEGS-CS from other ecosystem service classification approaches. So far, FEGS-CS efforts have identified 338 FEGS, which Landers and Nahlik (2013) place into 21 different categories of FEGS.

National ecosystem services classification system (NESCS)

The FEGS-CS defines elements integral to the production of ecosystem services in a geographic space, and fixes the 'use' of these to actual users/beneficiaries of the ecosystem products. While this fusion of use and user is perfectly acceptable for many applications of FEGS-CS, it can constrain economists attempting to map the flow of FEGS into the economic sector. The National Ecosystem Services Classification System (NESCS) begins from an economic perspective and offers more flexibility on the beneficiary side by separating uses from users. In NESCS different users may employ the same 'use', or any particular user may employ the same FEGS to different uses. NESCS maps flows of *environmental end-products*, which like FEGS are 'final', being only those ecosystem services at the pass-point from the environment to human use or appreciation of them. By mapping flows of environmental end-products through specific users and uses, NESCS can identify and represent relevant FEGS fully, completely, and uniquely in any user's utility function. This approach satisfies microeconomic theory, helps minimize double counting, and links directly to users comparable to categories in standard industrial accounting frameworks like the North American Industry Classification System (United States Census Bureau, 2014). It is these capacities of NESCS that may help ecosystem services find their proper weight in policy decisions about how to manage renewable environmental resources.

Figure 6.2 demonstrates how an economic way of considering production and human well-being may be expanded to include how products or services from nature (that may never be marketed or priced in a discrete way) may nonetheless influence human well-being. Beginning in the upper left with physical capital (e.g., machinery) and labor resources (i.e., employees), we see that services from capital and labor factor into intermediate and final economic production functions. Final *economic* goods or services are those that a household may buy directly (e.g. not the motor housing or factory labor, but the whole refrigerator, which, when added to the household stock, can provide a flow of food-cooling services over time). Households buy things to raise their *utility*, or level of satisfaction, contributing to individual human well-being. Final *ecosystem* goods and services provide explicit environmental inputs to intermediate or final economic production functions (first circles, top row), or to level of satisfaction (third circle, top row). FEGS enter the human economy as 'final' in any of these places, because by definition they are 'final' at the point the FEGS become used or appreciated.

Considering the natural environment as a productive resource for humanity follows directly from Daily and others' choice of the word 'services'. From this point of view, natural capital (the

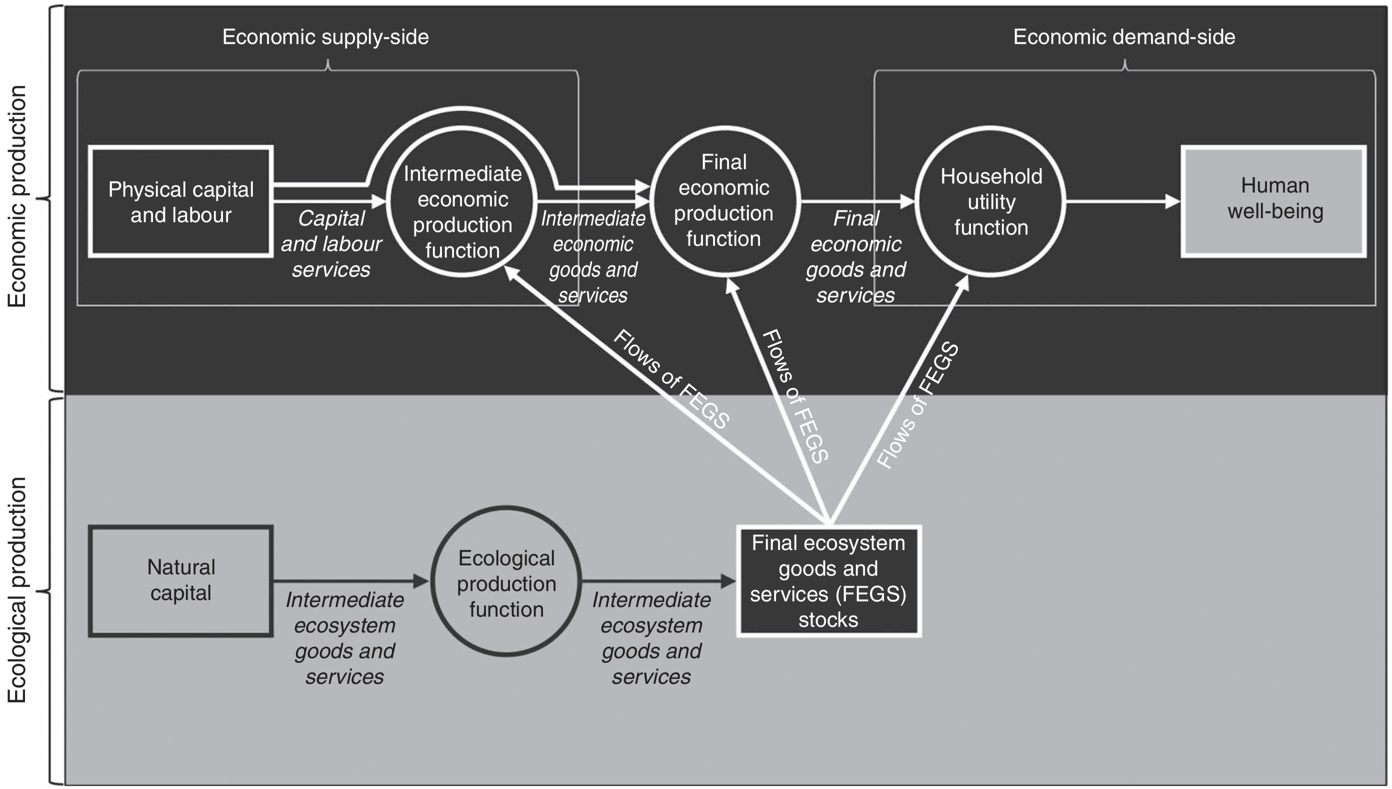

Figure 6.2 National Ecosystem Services Classification System (NESCS) conceptual framework: relationships between ecological and economic systems, with Final Ecosystem Goods and Services (FEGS) as the 'hand-off' between the two systems.

Source: adapted from USEPA (2015)

dynamic elements that in harmony generate the Supporting and Regulating services described in the MA) provides inputs for ecological production functions. Stocks of FEGS do not necessarily raise utility (e.g. the sea cucumber that lives and dies beyond human attention), but flows of FEGS (along the arrows from the ecological box to the economic box) *do* raise utility. This critical distinction between potential and actual use is made possible only by identifying the use and user of the ecological end-product. FEGS can pass into the human value chain as economic inputs (e.g., fish caught for a cannery), as final economic products (e.g., fresh fish at a restaurant), or directly to end consumers (e.g., catch-and-eat recreational fishing). Note that the end-consumer example especially involves no market transaction for the fish – a more explicit problem of economic measurement than the commercial fishermen not 'giving money to Mother Nature' for the wild fish they extracted to sell in the market. Both cases defy standard market measures of value.

NESCS begins with the same final ecosystem services perspective as the FEGS-CS, making possible a unique and non-duplicative mapping of ecosystem service flows, something difficult to achieve using earlier versions of MA-based categorization where ecological processes (i.e., potentially intermediate ecosystem services) exist on the same level as Provisioning and Cultural services. The further ability of NESCS to uniquely identify uses and users of FEGS makes it possible to gauge values for the same FEGS according to the different contexts of use that different users face. Without the ability to specify context, 'valuation' means little because the value of something changes with the user and with the context of the choice.

Next steps and conclusions

Classification is a discretionary process, important to science because each classification system poses a platform for common-standard definitions. Still, classification ultimately remains an iterative and evolving exercise in theory and in educated judgment, to make scientific discussions and strategies more efficient. The FEGS-CS and the NESCS provide improvements on previous ecosystem service classification systems by recognizing that without pairing them to specific users (beneficiaries), uses (benefits) cannot be tabulated in discussions of one policy choice versus another. FEGS-CS and NESCS are each a set of rules intended to define unique combinations of classification layers and candidate ecosystem services.

Specific applications of the FEGS-CS and NESCS will pose challenges, and thereby inform the development and expansion of these systems for later applications. A priority will be to identify which among all possible FEGS use-user combinations are relevant for the specific place and scale of a specific policy question, then to determine appropriate metrics to quantify not only the stocks of FEGS, but also their flows in the NECS context.

Determining appropriate metrics will likely prove easier for the production side than for the valuation side, because it is easier to confidently measure what *is* than what *might be* – yet both parts are necessary. Part of TEV includes someone valuing the existence of a thing, or a desire to preserve it for posterity, even if they themselves will never see or physically interact with it. Such values are hard to assign to a specific person, and harder to quantify or put in dollar terms even when one can. The less information one has about a thing or about the way someone values it, the harder it will be to put an amount or price on it. Ecosystem services remain difficult in this way.

A beneficiary-based classification system is an important step forward in helping ecosystem services hold deserved gravitas in policy discussions. The beneficiary approach makes it easier to focus on environmental measurements relevant to actual users, while also making it easier to distinguish actual beneficiaries of ecosystem services from prospective ones. Better identification

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does not solve questions of the best way to perform valuation of ecosystem services. But the ability to designate specific uses and users is progress – a milestone on the road to the quantification and valuation that policymakers will continue to demand.

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