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A Framework for Ecosystem Services Conservation Zoning: An Integration into Land Use Planning

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Presented to the Faculties of the University of Pennsylvania in Partial Fulfillment of the Requirements for the Degree of Master of Environmental Studies 2007.

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The ecosystem services conservation zoning framework offers an alternative to current land use decision processes that present incomplete, misinformed, and unaccountable land use options and alternatives. The framework presents holistic tools to make more informed land use decisions, and begins to integrate ecosystem services into the existing polices that govern land development. The principal goal of the framework is to balance local land development and conservation planning by presenting a comprehensive, multi-faceted, multi-disciplined decision process that frames land use choices around the social, financial, and environmental utility ecosystem services provide human well being.

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Introduction

Current land use decision frameworks present incomplete options. Such land use decisions and options are framed primarily from a development perspective, in that ecological, social, and economic goals are achieved through land alteration and development. Rarely is conservation entered into the decision framework as a viable option in achieving desired land use goals. To promote such a process, a shift in environmental and land use decision making needs to occur.

The concept of ecosystem services presents a new way of defining our relationship with the environment and provides a means from which to frame holistic decision processes that integrate and balance conservation with land use goals. It promotes justified conservation of the environment on the basis that ecosystems generate goods and services that humans use and need to sustain their livelihood. Ecosystem services attempt to break down the traditional land use decisions by correlating human well being to status of the environment. Such an approach strengthens the ability to promote a more accountable and complete process within land use decisions by presenting conservation of ecosystem services as realistic options and alternatives in achieving ecological, social, and economic land use goals.

An “ecosystem is the array of organisms –plants animals, and microbes-found in a defined area and the physical chemical environment with which the living community interacts (Heal et al: 1).” The ecosystem services are a product of the organisms “that are generated by complex natural cycles, driven by solar energy, that constitute the workings of the biosphere-the thin layer near the Earth’s surface that contains all known life (Heal et al: 4).”Gretchen Daily presents a more encompassing definition in that “ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life (Daily: 3).” Robert Costanza offers a similar definition in that “ecosystem goods (such as food) and services (such as waste assimilation) represent the benefits human populations derive directly or indirectly, from ecosystem functions (MEAF: 55).” The Millennium Ecosystem Assessment: Ecosystem and Human Well Being, A Framework for Assessment (MEAF)[1] combines

[1] From here Ecosystem and Human Well Being: The Millennium Ecosystem Assessment: A Framework for Assessment will be known as MEA Framework

the definitions to include “both natural and human modified ecosystems as sources of ecosystem services, the term “services” to encompass both the tangible and the intangible benefits humans obtain from ecosystems, which are sometimes separated into “goods” and “services” respectively (MEAF: 56).”

It is my intent to provide an ecosystem service conservation zoning framework which attempts to integrate ecosystem services into local communities land use, planning, and development schemes, thereby establishing a framework of how to consider, formulate, and view ecosystem service studies and valuations within a land use, planning, and development decision context. The principal goal of the paper is to contribute to better land use decisions by exploring ecosystem services conservation zoning from a multi-disciplinary and comprehensive perspective, emphasizing the topics and tools needed to make choices that are more informed and sustainable. The framework is divided into three major parts: (i) identification of services and establishing study area, (ii) placing services in a valuation context, and (iii) ensuring the continued provisioning of services.[2]

The ecosystem service conservation zoning framework has many distinct characteristics and goals: (i) integrate ecosystem services into the local land use, planning, and development decisions, (ii) promote and justify the conservation of ecosystem services via local zoning ordinances, (iii) accurately weigh, frame, and develop land use options, (iv) economically, environmentally, and socially justify the conservation of ecosystem services, (v) implementation will occur on the local governmental scale, such as townships, counties, and municipalities, (vi) frame land use decisions around the benefits and necessities ecosystem services provide human well being, (vii) and to be effective, the framework should be applied at beginning stage of the land use planning process.

The framework utilizes zoning ordinances as a means for conservation via the local land development and planning regimes. When developing on private or public lands, local municipal, township, county, or city governments routinely enact zoning ordinances in response to residents' needs as pertaining to land use. Most municipalities

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[2] An overview of the intended process and flow of the framework is portrayed in figure 1.

today have land use plans that tend to subdivide land into zones, specifying where, what, and how much land use and development can occur. Therefore, as a prerequisite for development, local governments could require that pieces or parcels of land be zoned for conservation, as justified by the framework and the services that are produced. Local ecosystem service conservation zones are a viable and realistic option, for municipal and local governments are the institutions that govern allocation of land use rights, and it is within their jurisdiction to zone land accordingly. In fact “local scale decisions often are limited to local government, local citizen groups, and major local businesses,” thereby implying a sense of autonomy within municipal land use decisions (Dale: 16). In addition, natural resource management is largely done within defined geographical areas, where “local or county government units routinely make on the ground management decisions relevant to the provision of ecosystem services (Heal et al: 18).” However, conservation zoning does not imply a transfer of land ownership. Conservation zoning implies that in order for a proposed land use project to continue, developers must respect the zoning distinction and set the areas aside for conservation as needed.

Literature Review

I used numerous research sources, however in terms of ecosystem services policy development precedence, there are three relevant sources of literature, (i) the “The Millennium Ecosystem Assessment: Ecosystems and Human Well Being-A Framework for Assessment” (2003), (ii) the “Millennium Ecosystem Assessment: Ecosystems and Human Well Being: Synthesis” (2005), (iii) and the National Research Council’s Valuing Ecosystem Services: Toward Better Environmental Decision Making” (2005).

“The Millennium Ecosystem Assessment: Ecosystems and Human Well Being-A Framework for Assessment” presents a framework from which to approach the development of ecosystem services into the decision framework. The assessment describes and elaborates on the processes and the concepts that need to be considered when developing a policy framework. The publication recognizes that, inherent within the ecosystem services school of thought, humans need to be placed at the center of the framework, for ecosystem services attempts to link environmental functioning and decision making with human well being. This is considered to be “state of the art”, for the current environmental regulatory structure places nature at the center and assumes an intrinsic, moral authority to promote conservation, however, by placing humans at the center, nature and ecosystems are viewed from a functional perspective in terms of the services provided and used by humans. The question of why to balance growth with conservation has a more tangible application, thereby exhibiting that conservation should not only occur for the environment's sake, but also for humans, for the consequences of irresponsible actions have repercussions on systems that humans utilize.

Between 2001 and 2005, the United Nations in conjunction with international institutions, governments, businesses, NGOs and indigenous peoples, conducted ecosystem studies to "asses the consequences of ecosystem change for human well being, and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to human well being…while focusing on the linkages between ecosystems and human well being, and in particular on ecosystem services (MEAS: V)." The findings were published in The Ecosystems and Human Well Being: Synthesis Report and concluded that humans are rapidly affecting the continued provisioning of all ecosystem services. The conclusions emphasize that everyday decisions are perpetuating the degradation of ecosystem services, where tradeoffs inherently occur within all decisions- choices to keep ecosystem services intact are weighed against the options to convert the services to alternate uses. The report describes four major findings which I will present:

> (i)"Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, fresh water, timber, fiber and fuel. This has resulted in a substantial and largely irreversible loss of the diversity of life (MEAS: 1)."
> (ii) "The changes that have been made to ecosystems have contributed to a substantial net gains in human well being and economic development, but these gains have been achieved at growing costs in the form of degradation of many ecosystem services, increased risks of nonlinear changes, and the exacerbation of poverty for some groups of people. These problems, unless addressed, will substantially diminish the benefits that future generations obtain from ecosystems (MEAS: 1)."
> (iii) "The degradation of ecosystem services could grow significantly worse during the first half of this century and is a barrier to achieving the Millennium Development Goals (MEAS: 1)."
> (iv) "The challenge of reversing the degradation of ecosystems while meeting increasing demands for their services can be partially met under some scenarios that the MA has considered, but these involve significant changes in policies, institutions, and practices that are not currently under way. Many options exist to conserve or enhance specific ecosystem services in ways that

> reduce negative tradeoffs or that provide positive synergies with other services (MEAS: 1)."

The National Research Council's report (2005) represents the most recent and most complete collection of data presented in a regulatory viewpoint and is perhaps the most valuable source of literature to date. Although the report it largely written from an economic and valuation perspective, many key ideas and approaches are presented that attempt to combine and operationalize the foundations of ecosystem services, economics, and biology, into a working useable form, and important considerations to include when developing policy and regulatory structures. Although many separate reports have been published to date that discuss certain ideas of ecosystem services as related to policy, the National Research Council's report represents the most complete and thorough analysis of ecosystem services within a policy perspective.

Methods

The field of developing, applying, and integrating ecosystem services into land use decisions is not well established. A great deal of information is scatted among many sources, for the infrastructure of ecosystem services is built upon the physical and social sciences. It is not my intent to elaborate or expand on the social or physical theoretical frameworks, for there is a rich collection of supporting literature which has been commented on extensively. Rather, as noted, I intend to develop a working policy framework that attempts to operationalize ecosystem services by combining certain aspects of economics, biology, local land use policies, ecology, and market structures to form a working policy framework.

All the information used for the paper is taken from articles, reports, and books, which will be gathered from libraries, repositories, and the internet. The information will be used from a suggestive and guiding perspective, in that I will analyze, combine, and expand on many separate ecosystem service based conclusions, applications, and approaches, to ultimately to develop a policy framework that has practical and real applications within land development and growth. Due to the nature of the paper, there is no real method by which to validate the work in determining if the paper is a success. Such a determination can only be made in time by implementing the conclusions, which are not immediately realistic.

The Ecosystem Service Conservation Zoning Framework

Why is the framework needed?

Law and Governance. The ecosystem services conservation zoning framework is needed for there is a scant legal infrastructure and precedence within ecosystem services, mainly for current laws were not designed with ecosystem services in mind. James Salzman, a professor at Duke Law School and a seminal thinker in natural capital and ecosystem services, accurately notes that, in general, our laws fall short of accounting for ecosystem services, where "our pollution laws (e.g., the Clean Air Act and Clean Water Act) rely on human health-based standards, our conservation laws (e.g., the Endangered Species Act and Marine Mammal Protection Act) are species-specific, and planning under our resource management laws (e.g., the National Forest Management Act and Federal Land Policy and Management Act) must accommodate multiple and conflicting uses (Salzman:111)." Parts of these laws do promote the conservation of certain ecosystem services, however, when the laws were designed, it was not their intent to provide conservation of natural capital and the services that are delivered from ecosystems (Salzman: 111). Therefore, since modern laws have largely fallen short in including ecosystem services into a legal and policy infrastructure, it is imperative to develop a working framework that begins to integrate ecosystem services into the existing decision making environment.

Promotes investment in conservation. An ecosystem service conservation framework is necessary to promote justified investment in conservation of services. Investment in conservation sustains the earth's infrastructure for our benefit, an infrastructure that we need to survive, and an infrastructure that provides humans with necessary food, fuel, air, climate regulation, water regulation, soils regulation, etc. Investing in conservation is similar to investing in other necessary social and political infrastructures, such as education, road improvements, communications, governance, or investing in a business to obtain returns. However, due to the long term nature of the environment, investments of time, money, and energy into conservation of services is not deemed a priority, when in fact it should be.

Environmental degradation. As elaborated in the MEA Synthesis report, humans are impacting and altering ecosystem services and subsequent processes on an unprecedented scale. For instance, "to list a few of may impacts, humans activity has heavily transformed 40-59% of the ice-free land surface; coopted 50% of accessible, renewable fresh water; fully exploited or over exploited 65% of marine fisheries; increased carbon dioxide concentration in the atmosphere by 30%; and driven 25% of bird species to extinction (Heal et al: 6)." Despite such apparent degradation, ecosystem services frequently go unrecognized by people and decision makers. Perhaps ecosystem services are overlooked for decision makers and the public view services as a constant, something that has always been and will always be around. However, as the inertia of degradation gains momentum, it emphasizes the need to stop taking services for granted and bestow a sense of accountability.

Places human well being in the center of the decision framework. As noted, current environmental decision frameworks place the protection of the environment at the center of the framework. In an ideal setting such a framework would promote and justify conservation of the natural environment, however, when compared with economic and political interests, such an argument is easy to refute. The framework lacks tangibility, and does not present "why" to conserve and protect, it merely presents that we should, for it is the right thing to do.

It is therefore necessary to adopt a decision framework that includes the utility and benefit services provide human well being in addition to the moral argument for conservation and protection. Such an approach presents why conservation and accountability are important by linking the status of the environment to human well being (mea: 37). Overall, a focus on human well being, utility, and benefits allows the examination of how ecosystems influence human outcomes, where such an analysis inherently presents a more accurate, justified, and inclusive argument for conservation.

Naturally promotes full accountability. Land use decision making is traditionally considered in patchwork, evaluating one medium at a time. Traditional approaches do not recognize that ecosystem and environmental services are produced from the interactions among the entire set of processes occurring within ecosystems. The traditional approach "focuses on the impacts of human actions on the environment" by treating ecosystems and the environment as externalities, whereas the framework internalizes ecosystems and services as something that can be conserved and contribute to overall development (MEA: 42).

Focusing on ecosystem services encourages decision makers to look at landscapes, ecosystems, and processes in a different way that can reveal new opportunities for decision making. It goes beyond the relatively narrow view currently considered, and identifies important services to conserve based on a communities use and reliance upon the services. An ecosystem services approach forces us to view our interaction with the environment holistically, for when evaluating the service, we are evaluating the product of all mediums simultaneously interacting and functioning. Ecosystem services are naturally more inclusive and base decisions on the most thorough, educated information.

Operationalizes sustainability. Although sustainability should be the goal of every environmental policy, operationalizing sustainability presents difficult challenges. Sustainability is large concept that applies to all forms of responsible growth. There are many forms of sustainable development scattered throughout different environmental policies, where bringing them together under one umbrella is a difficult challenge. However, accounting for ecosystem services represents a tangible application of sustainability that brings together all the separate facets. For instance, sustainability and ecosystem services promote long term, holistic thinking, promotes systems thinking-how one action affects another, promotes multi scope and scale analyses, promotes analyses of alternative options, promotes smart balanced growth, promotes the analysis of human’s relationship with the natural environment, and links the social, environmental, and economic factors. When ecosystem services are applied, sustainability is also applied.

Promotes biodiversity. Biodiversity is a well established field of study and can be seen as a topic within ecosystem services. In the simplest form, biodiversity is defined as “the totality of life forms, from the planetary spectrum of species to subunits of species together with ecosystems and their ecological processes (Naeem: 1).” Intuitively biodiversity would seem to have a direct correlation to ecosystem services, yet establishing clear links have proven to be an elusive task due to the uncertain relationship of biodiversity and ecosystem functioning. Ecosystem functioning is important to establish, for it provides the services utilized by society. Rudolf S. De Groot defines ecosystem function “as a subset of ecological processes and system structures, where each function is the result of the natural processes of the total ecological sub-system of which it is a part (De Groot et al: 394).” It is therefore understood that every organism contributes to ecosystem functioning and processes, however the nature and magnitude of individual contributions vary considerably. Biodiversity focuses on the uniqueness of individual species and their singular contributions to ecosystem services. Yet “most ecosystem processes are driven by the combined biological activities of many species, and it is often not possible to determine the relative contributions of individual species to ecosystem processes (Naeem et al: 3).” Therefore, since function provides service and is a measurement of the collective interactions, and biodiversity assumes diverse interactions enable function, how much do ecosystem services depend on biodiversity? This is a question that scientist have been and will continue to debate for some time. However, assuming biodiversity contains intrinsic value in and of itself, protecting biodiversity is a platform for the protection of ecosystem services.

Identification of Services and Establishing Study Area

Scale

Establishing the scale of analysis is necessary to frame any ecosystem service study, however, doing so presents complicated issues.[3] Ecosystem processes and subsequent services function over a wide range of contexts. The MEA Framework describes ecosystems “as geographic mosaics that are nested within larger pieces, where those are within larger pieces (MEAF: 118).” Their description is practical, for ecosystem services function over a wide variety of scales, notably the physical scale of the ecosystem itself, and the scale at which societies utilize the services provided (De Groot: 397).[4] However, ecosystem services rarely exhibit linear relationships in cross scale interactions. Processes at particular scales are typically related to processes at other scales as well, whereas a single ecosystem service could be the product of many processes at varying scales. Only in rare situations can complete data inform the framing of a study. Other situations present incomplete data that reveal framing uncertainties due to a lack of understanding among the functional interactions among and within systems, data on the

[3] Scale refers to the spatial extent of analysis.
[4] Figure 2 visually explains how scale and ecosystems are related to produce and deliver services.

larger systems, and the services provided. Therefore, due to such variables and complexities, there is no universal scale of analysis from which to approach a study.

There are many scaling options from which to frame an analysis, however, as noted, the framework is being implemented within local scales, and refers to small scaled areas, such as municipalities, townships, and counties. Anything larger, the framework is considering to be on a regional, national, international, or global scale. The framework is focusing on local jurisdictions for it is the most advantageous for implementation and integration of land planning, land use, and ecosystem service conservation zoning for two reasons.

At the local scale "the biophysical delivery of ecosystem goods and services" can be established, for knowledge of who the beneficiaries are, where they reside, and how they perceive the value provided by an individual ecosystem service" can be determined with relative clarity (Naidoo et al: 2154). As an analysis becomes larger in scale, the details become blurred, making it is increasingly difficult to establish clear, linear paths of service delivery and use, thereby inhibiting targeted conservation. The main challenge in conducting large scale assessments is the inability to link functional scale relationships to services provided. This primarily lies in the difficulty to recognize the relationships and processes among ecosystem scales, which requires appropriate methods to transfer, synthesize, and integrate information on data, variables, and processes between different scales, which is currently incomplete (MEAF: 112).

The relationship of humans and ecosystems is most obvious at the local scale. Local actions have direct effects on the delivery and production of services, and subsequently their livelihoods. This is due to the relative short linear path of service delivery, for people and communities live within the ecosystem in which the services are delivered, and directly use and rely upon the services. Therefore, as pertaining to land use applications, local communities are in the best position to make educated choices about the services for a number of reasons. (i) Local scales, as compared to other scales, feel the consequences of degradation through alerting delivery, condition, and capacity of ecosystems and services significantly more. (ii) Implementation of conservation zones at the local scale presents the potential to see real results for "the factors causing ecosystem service decline, such as rapid urban development and habitat fragmentation, occur at the local level and are generated by local land use decisions (Brody: 407).” (iii) “Natural resource and land use planners recognize that while ecosystem management requires looking beyond specific jurisdictions and focusing on broad spatial scales, the approach will in part be implemented at the local level with local land use decisions (Brody: 407).” (iv) “Thoughtful policies and actions at the local level can often protect critical habitats of regional significance more effectively and less expensively than the best international state or federal protection schemes (Brody: 407).”

Therefore, “dynamic issues such as proximity to resources, connectedness to markets, and buffer effects” are more visible from the local perspective (Bohensky: 1059).

Multi Scale Analysis

Although the framework focuses on the local scale a multi-scale assessment may be necessary to conduct a holistic analysis. Multi scale assessments involve the analysis of “processes at several scales in space and time and at various institutional levels (MEAF: 112).”Since ecosystem processes function across scales, multi scale assessments have the potential to be beneficial when applied in the right circumstances: (i) “They permit individual ecological and social processes to be assessed at the scale at which they operate and to be linked to processes at different scales and levels of social organization (MEAF: 112).” (ii) “They allow progressively greater spatial, temporal, or causal detail to be considered as the scale becomes finer (MEAF: 112).” (iii) “They permit reporting and response options to match the scales at which social decision-making occurs, with which people can relate, and on which they can act-the local community, the province, the nation, the regional bloc, and the planet (MEAF: 112).” However, despite the benefits, multi scale assessments should be applied very carefully. The MEA Framework describes three multi-scaling categories and contexts in which multi scale extrapolation can occur, the categories include: scale independent, scale dependant with known scaling rules, and non-scalable.

Scale independence implies weak interdependencies, in that the variables of the analysis can be “translated from the scale at which data were collected to a larger or smaller scale-in a very straightforward way through simple addition or proportionality (MEAF: 112).” For instance, variables such as biomass and population density can be determined by applying a sample taken from a subset and multiplying it by the total area of interest. Scale dependant with known scaling rules involves variables that are "scaleable, this is they can be expressed in smaller or aggregated units (MEAF: 113)." However, in order correlate the different scaled units, the variables need to be organized into similar terms of analysis.

In theory the idea seems straightforward, however in practice presents complex challenges due to non-linear and discontinuous relationships, and difficulties in interpreting the changes within the temporal and spatial scales. For instance, the concept of transpiration represents the challenge of nonlinear and discontinuous relationships. As stated in the MEA Framework, although transpiration represents a similar term of analysis, "transpiration from a hectare of forest is not simply the transpiration measured at the scale of a leaf multiplied by the number of leaves in a hectare…because the transpiration from one leaf alters the humidity surrounding the leaves down wind, and thus the transpiration rate (MEA: 113)." To determine such a complex scenario involves intricate modeling with "nonlinear coupling constants (MEA: 113)."

The challenge of aggregating a terrestrial carbon balance represents the difficulties in interpreting the changes within the temporal and spatial scales. Although terrestrial carbon can be expressed by a physical constant, the aggregating groupings change with time and scale. For instance, within the small scale of minutes, the terrestrial carbon balance is viewed as photosynthesis, within 24 hours it is referred to as net primary production, and over years, decades, or centuries the balance is referred to as biome production-"where the numerical value of net biome production is one hundredth or less the value of net photosynthesis (MEAF: 113)." Therefore establishing a link of correlation is very difficult. Lastly, non-scalable variables only contain meaning within the context of the observation (MEAF: 112-113).

Upscaling and downscaling can also be used as ways to extrapolate data across scales, however requires data to be converted to a common metric, similar to scale dependant with known scaling rules. Upscaling is the application of micro level data to larger scales, and downscaling applies general large scale data to a finer more detailed level. Scholars have presented models by which to conduct upscaling and downscaling, however limitations on data and establishing causal relationships present major challenges to cross scale extrapolation. Although upscaling/downscaling may be unavoidable and sometimes effective, it should be used with great care for there is a high potential to render misleading, inaccurate results.

Temporal Analysis

Part of a holistic assessment includes considering temporal scaling considerations. Temporal studies should include the short, mid, and long term scaling considerations. In The Ecosystems and Human Well Being: Synthesis, the MEA notes that the "time scale of change refers to the time required for the effects of perturbation of a process to be expressed (MEAS: 88)." However, there is a disparity of information-the uncertainties that surround future contextual conditions, the relationship between ecosystem change, time, and service provided, how the short term affects the long term, and that large scale systems often function slower than small scale systems. For instance, constant phosphorus accumulation in soils can have detrimental impacts on services maintained by rivers, lakes, and costal oceans. However, the impacts through the delivery of services may not be fully realized for years or decades, simply, it is not known (MEAS: 88). It is noted that "different categories of ecosystem services tend to change over different time scales, making it difficult for managers to evaluate tradeoffs fully (MEAS :88)." For instance, "supporting services such as soil formation and primary production and regulating services such as water and disease regulation tend to change over much longer time scales than provisioning services, consequently impacts on more slowly changing supporting services are often overlooked by managers in pursuit of increased use of provision services (MEAS: 88)." In addition, the time frame in which change occurs within an ecosystem varies, where the time frame in which ecosystem change is realized through the delivery of services, by humans and society, is slow. For instance, "the use of groundwater supplies can exceed the recharge rate for some time before costs of extraction grow significantly (MEAS: 88)."

Due to the fact that ecosystems are complex and dynamic and our understanding of them is typically incomplete or flawed," our knowledge of how ecosystems evolve and change as inputs to services is a very slow process (NRC: 190). Therefore, from a service delivery perspective, it is very difficult to determine a system's marginal or aggregate threshold, for "the point at which abrupt shifts in services occurs may be controversial and unpredictable (NRC: 86)." The lack of immediate knowledge about future conditions makes it necessary, at the minimum, to take a precautionary approach by considering and entering long term speculations into the decision formula, thereby considering long term damages to systems and the services provided for future generations.

Scope

Establishing the scope of analysis is necessary to frame a targeted ecosystem service conservation study.[5] The National Research Council (NRC), in their 2005 report Valuing Ecosystem Services, discusses the importance of utilizing policy questions to frame the overall scope of analysis to identify and include the relevant ecosystem services. The NRC approach attempts to simplify the scoping of a study by deriving the intent and desired goals from the specific contextual circumstances of the policy question. Using the specific circumstances, expectations, and desired future outcomes to frame the scope accurately identifies the services that should be included. Basic questions need to be considered, such as what/how ecosystem services are relevant to the goals of the policy question? What services exist in the area? Who are beneficiaries of the services, in other words, ecosystem services for whom (NCR: 253)? What is the policy question to be made? What information is needed to answer the policy question?

Such an approach gives insight into what services are provided, focuses the study by pinpointing the relevant services, and forms the basis for a more detailed assessment. Basing the scope on the policy question reveals the full range of services that the community uses, identifies the dependence on these services and ecosystems, and identifies the ecosystem services of highest priorities for further study and conservation. In addition, the framing of the analysis establishes the parameters of the study, for how an analysis is framed “affects the questions that are asked in an ecosystem study, and therefore the type and level of analysis needed to answer the questions (NRC: 195).”

For instance, New York City recently debated over the issue of building new water filtration plants or implementing watershed protection within the Catskills watershed. Filtration plants were estimated to be about $6 to $8 billion, and about another $3000,000 annually to operate, where a program to purchase and preserve up to 350,000 acres of land in the Catskills watershed was estimated to be $250 million, which is one of

[5] Scope refers to what ecosystem services will be included in that study.

three major basins the city obtains its water from (Salzman et al: 8) When faced with the choice, New York City decided to implement protection of the Catskills watershed. The New York City drinking water case study represents a unique situation in many regards, and in the end, the decision of watershed protection was largely fiscal.

The New York City example has been repeatedly cited as a successful implementation of ecosystem services into the decision making process. The case study is relevant for decision makers "fit the analysis conducted to the precise decision being made (NRC: 214)." The policy question of water filtration plants versus watershed protection framed the analysis by identifying the ecosystem services of interest that were relevant to the policy question and debate, thereby presenting the ecosystem services from the perspective of desired goals, ecosystem service users, alternatives, and how ecosystem services fit into the policy analysis.

Delineating Study Area Boundaries

Part of establishing scope of study is delineating study area boundaries that correlate with the services being considered. Boundaries should not be determined arbitrarily, and should be based off of contextual ecosystem data. Boundaries should be considered within the context of the study, however there are some basic methods that can be utilized. The MEA Framework offers an approach towards boundary delineation that focuses on the feedbacks within systems by building "up a series of overlays of significant factors, mapping the location of discontinuities-for instance the distribution of organisms, the biophysical environment (soil types, drainage basins, shared markets), and spatial interactions (home ranges, migration patterns, fluxes of matter). A useful ecosystem boundary is one where a number of these relative discontinues coincide (MEAF: 125)." The MEA Framework also promotes a method of consistently classifying ecosystems and their spatial extent by type to establish boundary distinctions-which is divided into two basic classifications: "those based on actual ecosystem extent and those based on "original" or "potential" extent (MEAF: 159)."Although the methods provide useful constructs from which to frame an approach, they only take into account the physical/structural attributes of a system and do not link them to the functional attributes of a system, more so ecosystem structure to function to service. Ecosystem functioning is what creates the service and subsequent use, and establishing such a link is perhaps the greatest difficulty facing boundary delineation, and our understanding of ecosystem services. There is a need for further research in this area.

The MEA Framework notes two important points that should be considered during the boundary delineation process. (i) "Factors determining ecosystems vary continuously in space, the boundaries of any set of ecological defined units will necessarily represent zones of transition instead of sharp boundaries (MEAF: 160)." This is an excellent point, for in establishing how boundaries correlate to services, the understanding of the interactions among general ecosystem boundaries is more important than establishing absolute boundary delineations. (ii) The distinction between political boundaries and ecosystem boundaries needs to be recognized (MEAF: 161). The concept of ecosystems and boundaries has been elaborated on within the highly discussed topic of ecosystem management. Although the scope of ecosystem services and ecosystem management inherently vary, the idea of boundary analysis based on ecosystem data can be extrapolated. Within a management context, policies and laws "tend to divide ecosystems by arbitrary political boundaries that bear no relationship to ecological structures or functions responsibilities (Grumbine: 29)." More so, political boundaries are somewhat artificial in that "they are only as real as we want them to be…for so long as we agree to accept them as real (Grumbine: 29)." It is therefore imperative that when establishing boundaries for ecosystem service analysis that political boundaries should not be used as a default boundary due to their pre-existence. It is necessary that boundaries be established on a need basis that correlates to the context of the services being considered.

Flow of Services: Ecosystem Functioning and Services

Ecosystem function is defined as "a translation of ecological complexity (structures and processes) into a more limited number of functions, where the functions, in turn, provide the goods and services that are valued by humans (de Groot: 394)." Analyzing an ecosystem's functional components helps identify where to target conservation efforts, shows how the components contribute to services, provides a method of measuring the functional components productivity, and locates sensitive and important areas that should be prioritized due to their functional delivery of services. The functioning of ecosystems is what enables the use and delivery of services, therefore it necessary to establish how functional parts correlate to the service of interest, and enable function.

Claire Kremen, an ecologist and biologist at Princeton University, has presented insights into the challenge of identifying important ecosystem service functional components. However, before discussing her approach, it is important to understand three fundamental concepts. (i) Kremen uses the term 'ecosystem service providers' (ESPs) to describe the key species or other entities that play fundamental roles in the delivery of services. (ii) When analyzing ecosystem service functioning, analysis must be undertaken within the service providing unit. This refers to focusing analysis to the service dependant ecological level, or the "to the segment of a population or populations providing services in a given area (Kremen: 469)." For instance, to evaluate the service of water flow regulation by vegetation, the appropriate ecological level to define ESPs components would be at the habitat level. Or, when managing the biological control of crop pests, the appropriate level would be at the food-web level. (iii) Kremen's approach is largely based on the concept of aggregate ecosystem function[6]. Utilizing an aggregate approach attempts to account for the idea that "ecosystem processes are driven by combined biological activities (Naeem et al: 3)."

To accurately identify the important functional traits, Kremen promotes a method of establishing functional inventories which "identify the component ESPs while measuring or estimating the importance of each ESP's contribution to the aggregate function (Kremen: 469)." This is accomplished by determining the functional importance of each ESP by evaluating their effectiveness, efficiency, and abundance. Functional importance is used to identify ESPs that are disproportionately or proportionately important relative to their abundance, while efficiencies and effectiveness can be used to identify mean and variance within ESPs ability to provide and deliver services. Utilizing functional importance values can help identify how aggregate function will change as the composition of ESPs change, which is used to better inform the sustaining of services.

For instance, in the article *An assessment of ecosystem services: water flow regulation and hydroelectric power production*, Guo et al "measured water flow regulation provided by different forest habitats in a Chinese watershed, and used this

[6] Aggregate ecosystem function is defined as the sum of the contributions of each ESP (Kremen: 471).

information to calculate habitat-specific contributions to electric power generation from hydroelectric power plant (Kremen: 471).” Therefore, the ESPs are the forest habitats, while water flow regulation is the aggregate function. In the article *Extinction and ecosystem function in the marine benthos*, Solan et al “estimated the contribution of different species of bethnic marine invertebrates to sediment mixing, and used the data to estimate ‘biogenic mixing depth’, a determination of oxygen concentrations and decomposition rates, for communities of varying composition (Kremen: 471).”

Function is identified through two standards. The first standard is an ESP centered approach that uses basic ecology and conservation biology to identify the environmental variables affecting the abundances, effectiveness, efficiencies, and distributions of important ESPs. Such a system should be applied when “individual ESPs are highly uneven in their functional contributions, for example when a service is dominated by a single species (Kremen: 474).” The second standard is a function centered approach which focuses on aggregate function, regardless of individual ESP fluctuations. Such a system would be appropriate when the “functional structure is even (not dominated by a single ESP), or interactions among ESPs are thought to greatly alter function, or the community is made up of ESPs that differ widely in functional traits (Kremen: 474).” However, despite which system is applied, a functional inventory of ESPs initiates the process for both standards, and it is recommended that both are utilized simultaneously, to produce more thorough results.

It is helpful to classify ecosystems along functional lines. The classifications include: provisioning services, “the products obtained from ecosystems, such as food, fiber, fuel, fresh water, biochemicals, genetic resources, and ornamental resources.” Regulating services, “the benefits obtained from the regulation of ecosystem processes, including air quality maintenance, climate regulation, eater regulation, erosion control, water purification and waste treatment, pollination, and storm protection. Cultural services, “the nonmaterial benefits people obtain from ecosystems through spiritual enrichment, cognitive development, refection, and aesthetic experiences.” Lastly, supporting services are “services that are necessary for the production of all other ecosystem services (MEAF: 57-59).”

Once the important ESPs are known, it is useful to spatially organize the ecosystem service features and ESPs from the point of origin to the point of use (Chan et al). This entails spatially organizing the project area according to ecosystem type, land use, and services via mapping. Analyzing the aerial extent of service flow through mapping “highlights which areas…are the most efficient for targeting of efforts towards conservation (Naidoo et al: 2154).” The mapping provides a picture of the physical flow of the services, where services are produced, supplied, and consumed, what services are produced, supplied, and consumed, and if services are exported or imported. Establishing service flows via mapping is very important for it highlights conservation priority areas, which can be compared to “the current degree of landscape degradation fragmentation and/or the probability of degradation and fragmentation in the future…comprising the current or future human infrastructure, activity, and land use (Naidoo et al: 2154).” In addition, if there are numerous services within the project area, each service should be mapped individually, to overlay the maps to determine if there is correlation and overlap among the services. More so, “it would illuminate the relation between the level of services (quantity and quality) supplied by an ecosystem and its aerial extent (Heal et al: 21).”

Functional inventories have the potential to be an effective approach for a number of reasons. (i) Functional inventories, classifications, and mapping illuminate how natural resources and ESPs provide inputs to the “production” of ecosystem services. (ii) They assist in developing the conservation groundwork by clearly identifying and measuring the collective functional contributions of the ecosystem, which in conjunction, form the ecosystem service. (iii) Targets the important functional components in an effort to show where conservation efforts are needed and can be effective to continue the provisioning of services. (iv) Focusing on abundances, means, and variances provides a straightforward way of measuring the service. Ecosystem functioning is a highly technical and specialized field, however such measurements simplifies the approach while maintaining integrity in measurement. (v) Functional inventories are a good fit for small scale use for the biophysical flow and delivery of services can be determined within local ecosystems.

Placing Services in a Valuation Context

Once the services of interest, the scope, scale, and data have been generally established, the focus then turns to placing ecosystems and services into the context of value for comparison purposes. I do not intend to describe in technical detail how valuations are undertaken. The valuation of services is a complex field, and the question of valuations is a well established discipline that has resulted in a rich collection of research and literature. Rather, I will outline the philosophical and ethical basis of what constitutes the source of value within the context of ecosystem services, how valuation and quantification are applied to the framework, and how to weigh and frame alternative options within the valuation context.

Defining Value

A large portion of valuing ecosystem services is being able to place the services within a valuation context. However, the source of value largely depends on the approach. Part of the economic roots of valuation stems from an anthropocentric philosophy, in that "elements of nature are valuable insofar as they serve human beings in one way or another (Daily: 24)." Imbedded within the anthropocentric viewpoint is the concept of utilitarianism, in that ecosystem services provide satisfaction or utility for humans. There is a difference between strong and weak utilitarianism. A strong form implies "the value of a species (or other natural things) to society. It claims that the value to society of the natural thing is the sum of the values it confers to persons (Daily: 25)." Strong utilitarianism is largely based on cost-benefit analysis, in that it attempts to place value within the aggregate viewpoint by weighing the net costs and net benefits in monetary terms, thereby presenting a collective societal viewpoint. Weak utilitarianism "asserts that the value of a given species or form of nature to an individual is entirely based on its ability to yield satisfaction to the person (directly or indirectly) (Daily: 24)." Therefore, the inherent quality of basic utilitarianism is that nature or services must convey satisfaction, directly or indirectly, to have value. More so, value stems from the "usefulness in achieving a goal (NRC: 35)."

The opposite end of philosophical spectrum promotes a biocentric approach, in that nature intrinsically contains value. This viewpoint stems from a moral argument as opposed to value, in that nature is placed "on a moral plane comparable to that of human beings (Daily: 26).” When referring to the traditional decision framework, a majority of the policy decisions assume a utilitarian approach, for policy makers attempt to quantify services to compare options in terms of cost and value. This approach implies that nature and the services are substitutable, for the means of deriving utility or satisfaction is not the focus, rather, as long as the utility is provided. However, policy makers have assumed a biocentric approach within many policy decisions. For instance, the designation of national parks, the Clean Water Act, the Endangered Species Act, to name a few, assume that the characteristics they are attempting to protect contains intrinsic value within themselves, regardless of use, and warrants protection.

It is important to understand the different levels of use within ecosystem services, for use defines value. There are two main categories, direct and indirect use. Direct use value is something that is “directly used”, like food. Within direct use, consumptive use values and non-consumptive use values exist. Consumptive use value usually implies the existence of a market, which helps employ direct valuation. For instance, “when natural ecosystems provide habitat for animals that are harvested and sold commercially, the commercial market value provides a gauge of the value of the habitat services (Daily: 31).” However, the market price can be misleading in that it only represents the marginal value of a product, in that it reflects society’s willingness-to-pay for an additional unit. Non-consumptive use values imply non-consumption and are more difficult to gauge due to the lack of a market. For instance, a park site that is used for recreation is not consumed, however it is used. Therefore placing the parks provisioning of ecosystem services within a valuation context is more difficult. Gretchen Daily suggests that travel costs and other expenses occurred can be used to determine an individual’s willingness-to-pay to use such a site. Indirect use value simply refers to a “non-direct use”, for instance, organisms that support an ecosystem help provide direct use in the form of food. There is a disparity among economists in valuing indirect use. Some claim that is not necessary to value the indirect aspects, for the end product of the many systems involved captures the full direct use value. Others claim that by limiting the valuation to the end product, the full value of a systems functioning, or the indirect aspects, are not fully captured, for as I have elaborated, the service provided is the product numerous systems interacting.

In addition to direct and indirect use, economists have non-use values, which is illustrated in existence value. Existence value implies that an individual or society values the mere existence of a resource regardless of use, the Grand Canyon for instance. Valuing such a resource is difficult for value may exist within cultural, social, or other sources, but economists have developed contingent valuation surveys which attempt to determine the willingness-to-pay to preserve or use.

The ultimate goal of valuing ecosystems and services is to more effectively weigh the alternatives within policy decisions. Services need to be placed within comparable contexts in which decisions are made, thus, quantification may be necessary. Under most circumstances monetary metrics are used for "they provide a natural metric for quantification since such prices, absent any market distortions, reflect the consumer valuation of that good. Thus when policies involve tradeoffs between market goods (already valued in dollar terms) and ecosystem services that are not traded in markets, quantifying the value of these non-market services using the same metric allows a direct assessment of the tradeoffs (NRC: 38)."

Quantification plays an important role in environmental policy analysis and decision making, however data for accurate ecosystem valuation and quantification is scattered and incomplete. Ecosystem service values typically lack transferability, meaning that general, baseline values are difficult to apply universally to different situations. Values are dependant upon specific contextual circumstances, such as location, scale, stakeholder perception of value, and market specifics, among other variables. Valuations and resulting values should be developed and used within the context of the policy question in consideration, for values are based upon the inputs entered into the valuation framework-how a valuation question is framed, significantly effects the results. Ideally, quantification should "seek to value the changes in ecosystem goods or services attributable to the policy change, and that the scope considers all relevant impacts and stakeholders (NRC: 44)."

Cost, Benefits, and Conservation Planning

Once values have been established, the ecological and economic attributes must be evaluated in terms of alternative actions. This involves a spatial comparative analysis of the cost and benefits of ecosystem service conservation with the proposed policy question, to determine if “the proportion of expected costs might be offset by payments for environmental services (Naidoo et al: 2161).” A comparative analysis has two primary goals: (i) to determine if provisioning of services through conservation provides the services necessary for human welfare at the lowest cost, and (ii) to bring economic values associated with natural habitats into the land use decision formula. The goals are fundamental, for if society does not recognize, realize, or understand the services nature provides, than an effort to promote the provisioning of services is unfortunately not justified.

A comparative cost benefit analysis is framed by looking at the cost of replacing the ecosystem services with technologies, or other substitutes that are available, versus the costs of conservation to enable the provisioning of services, which is valued in terms of opportunity cost and real costs of conservation. Such a comparison enables decision makers to consider ecosystems as valuable providers of services, and as viable alternatives worthy of consideration. For instance, if part of a policy question is attempting to address wetlands and flooding issues near a proposed site for development, the typical route of mediation would be the construction of levees, dykes, or other artificial structures. To frame the cost benefit comparison, the full price of the levees/dykes should be compared to the costs of conserving and/or restoring the wetlands to provide and deliver flood control services. It is imperative to capture the full lifecycle cost of levees and dykes, everything from materials and parts, to construction costs, labor costs, upkeep and repair costs, and decommissioning costs. By not including the full lifecycle cost of the substitutes, the value and benefits of the wetlands ability to deliver services is undervalued and underweighted, thereby creating an inaccurate comparison of the costs and benefits. The ultimate goal of a comparative cost benefit analysis is to promote full accountability among associated costs, benefits, alternative options, and promote correct resource pricing. It is noted that in some cases, “artificial provisioning of services will be in fact an optimal strategy, providing social benefits at the lowest cost (Heal: 1).” However, it is absolutely necessary that explicit comparisons between the natural and built provision of services are framed, undertaken, and evaluated correctly, for without, “we will continue missing opportunities where natural capital provides the lowest-cost services (Heal: 1).”

In the article *Mapping the Economic Costs and Benefits of Conservation,* Robin Naidoo et al. discusses the relationship of conservation planning, biodiversity, and cost benefit analysis. Although the theme is focused on biodiversity planning, her discussion on how cost benefit analysis provides new insights into conservation planning can be extrapolated. “A cost benefit analysis would highlight which areas have the greatest benefits per unit cost, thus allowing the most efficient targeting of efforts towards conservation (Naidoo et al: 2154).” A comparative cost benefit analysis is beneficial for it works within the existing decision framework by justifying the conservation of ecosystem service benefits “relative to costs, and would indicate in which areas conservation makes economic sense, providing an economic case for conservation to bolster moral and aesthetic arguments (Naidoo et al: 2154).”

A comparative analysis is largely utilitarian. This idea approaches conservation from a pragmatic perspective, however, the framework is not discounting intrinsic and ethical values, for they are clearly necessary to conservation. Ethical values are extremely difficult to quantify in economic terms. However, all values do not have to be quantified into numerical data to be included into a decision framework, for economic valuation methods are “inputs into the regulatory decisions and not the sole criterion for them (NRC: 41).” To avoid neglecting intrinsic values, “it is necessary to provide qualitative ways of gathering and communicating such intrinsic information-”stakeholder participation represents an avenue to include the important, yet non-quantifiable perspectives and values (MEA: 191).

Stakeholder Participation

Stakeholder involvement represents a platform from which to engage stakeholder’s perception of values, priorities, the relationship of human well being and services, and important resources at the local scale for various reasons. (i) Stakeholders are associated with land ownership and resources, and when brought to the decision process, can increase the quality of a study. More specifically, “with participation from a range of stakeholders comes a knowledge of the resources and technical expertise that will inevitably contribute to a higher quality of analysis (Brody: 410).” For instance, stakeholders possess knowledge of how services are related to their individual well being, thereby forming a collective communal understanding of the overall well being of the community. Therefore, the way in which stakeholders voice and define their relationship with the services becomes a complimentary input into the assessment and the decision making process. (ii) Stakeholder involvement inherently includes intrinsic and moral values. As noted, transferring to quantitative values is extremely difficult, however, by communities voicing their needs, perspectives, and priorities, a balance between formal quantitative values and social values can be found. However, the inclusion of such social values highly depends on the local government's willingness to listen and include the stakeholders in the democratic process. However, due to the relatively small scale of municipalities, county, and township boards, it is viable that such an inclusion could occur. (iii) "The presence of stakeholders in the planning process can boost the collective capacity" at all steps of an analysis (Brody: 410)." Stakeholders can provide greater accountability within all recourses, services, and ensure that all necessary areas are included within the targeted study area and given due consideration. (iv) Perhaps the most important point, stakeholder participation "imparts a sense of ownership, rather than spectatorship, on a process that will affect their future (Bohensky et al: 1059)." This refers to the stakeholder's vested interest within the project. As noted, local stakeholders live within the ecosystem they are attempting to manage, and greatly feel the repercussions of ecosystem degradation. It is in their best interest to ensure that all studies are conducted accurately and fully.

Ensuring the Continued Provision of Services

Thus far, the framework has focused on justifying the conservation of ecosystem services by identifying relevant ecosystem services as pertaining to the policy question, developing a study area, and correctly weighing options as related to ecosystem services. Once the ecosystem services have been conserved via zoning ordinances, the focus turns to ensuring the continued provision of the ecosystem services and management of services. Two key questions are posed: (i) can the services be sustained in a way that supports the production and consumption of the services? (ii) Since conservation zones will be located on both private and publicly owned lands, who bears the responsibility of ensuring that the services are sustained? The answer to both questions lies in engaging the community in conservation of ecosystem services to effectively sustain the provision of services via adaptive management, markets, and investments from ecosystem service sellers and buyers.

Adaptive Management

As discussed, a great deal of scientific uncertainty exists within ecosystem services and ecosystem dynamics, where choosing the best management approach to sustain the services, given the current state of knowledge, poses a major challenge. However, conservation zoning allows a certain freedom, creativity, and flexibility in management. It is not necessary that a management plan reach ideal conservation goals initially, for the services and land will not be exploited, the land and services have already been conserved. The concept of adaptive management offers a method of how to promote such freedoms through "active learning by introducing new management policies to lean more about the systems behavior and thereby reduce uncertainty (NRC: 220)."

Adaptive management is not an experiment, but rather a method of systematic learning and managing with the goal of resiliency while optimizing benefits to society (NRC: 220). Adaptive management "looks to law and policy to lead science, rather than be led by it," to guide further research and studies (Manno: 6). Such a distinction is fundamental, for further research fills the gaps within scientific uncertainty. Overall, adaptive management helps illuminate the relationship of humans with ecosystems and services, and provides more information on the interaction to accurately inform decisions. Therefore, as our knowledge expands, management choices can be expanded and applied. Much of adaptive management is based on the ability to measure progress. However, a large "emphasis is placed on the development of measurable criteria and indicators to inform management over time. Such indicators are information tools…in the sense that they can be used to conceptualize, evaluate, implement, and communicate sustainable management (Manno: 6)."

Indicators

Although the framework is being applied on the local scale, there is much debate on the use and scale of indicators within ecosystem services. Indicators can be a useful tool to gauge actions, direct analysis, and measure the overall state of the provisioning of services. However, if indicators are to be developed and used, what is the proper scale from which to apply them to obtain the most accurate measurements? In the article *Aggregate Measures of Ecosystem Services: Can We Take the Pulse of Nature*, Laura Meyerson et al discusses the possibility of a national level aggregate indicator of ecosystem services, similar to the concept of national economic indicators, although inherent differences and challenges exists between the two. For instance, the national economy is "reasonably connected," where ecosystems in contrast are not as connected (Meyerson et al.:56). Therefore, Meryerson et al proposes a method that would geographically map ecosystem service indicators by regional scales of occurrence (Meyerson et al: 56). However, due to inherent complexities, development of a national level indicator cannot be all inclusive. The choices of which services to include, how services should be weighted, and how to characterize tradeoffs needs to be determined, which present many methodological challenges and controversies (Meyerson et al: 56).

However, since the indicator would be based on the regional provisioning of ecosystem services, such an aggregation would require extensive interdisciplinary research to analyze the inherent tradeoffs. For instance, key questions would have to be considered: What is lost by using an aggregate indicator? What is gained? Does aggregation provide more benefits than using separate disaggregated measurements (Meyerson et al: 58)?

A national level indicator is definitely a step in the right direction. It presents a method by which to create consistency and transparency in the data used, which is a necessary step to enhancing our ability to be able to analyze the interactions among systems and scales. However, in terms of local use and implementation, a national level indicator would be difficult to down scale for local communities to utilize. Therefore, local authorities could use the functional inventories and ESPs, as described earlier, as a method by which to measure the effectiveness of services sustainability. Such an approach measures management effectiveness by measuring abundances and effectiveness of ecosystem service functioning to deliver services.

Market Incentives for Sustaining Services

Markets represent forms of sustaining ecosystem service conservation zones. The framework is promoting the use of investment and payment schemes through ecosystem service buyers and sellers, however many different types of markets can be developed to sustain services: such as tradable permit schemes, credit based programs, and resource banking. Therefore, when developing any conservation oriented market, it is essential to consider questions that aid in targeting the appropriate method of market implementation. (i) “What is the service being provided (Salzman: 128)?” This question identifies the service of interest and how it can be mitigated and accounted for. For instance, if erosion is a concern, the issue is land management procedures, where the service of soil retention would be promoted through market incentives. (ii) “How is the service provided (Salzman: 129)?” (iii) “Who provides the service and who benefits (Salzman: 131)?” In using a market based approach, one not only needs to know what action one is trying to influence, but also who the target audience is, for markets cannot be effective unless the specific actions and the parties responsible are determined. For instance, in attempting to establish a market to preserve wetlands, the buyers and sellers need to be clearly established. More so, “markets for services can be established only if there are discrete groups of providers and beneficiaries. Otherwise transaction costs become too high for contract formation (Salzman: 131).” (iv) “How much service is needed (Salzman: 132)?” The central idea behind this question is efficiency and effectiveness, “we need to know which actions should be proscribed, and by how much (Salzman: 132).” For instance, it is important to realize where the solution lies, however, “determining how much service a particular landholder provides and, more to the point, can provide, through land management changes is the greatest challenge to using market instruments to ensure provision of ecosystem services (Salzman: 133).”

Ecosystem Service Buyers and Sellers

Ecosystem service buying and selling involves payments to landowners or businesses to sustain the services produced within the ecosystem service zones on their land. In terms of the framework, ecosystem service buyers are represented through three distinctions, governmental, private, and voluntary investment, and the sellers are the landholders and businesses whose land the conservation zone falls within. Ecosystem service buyers and sellers represent an avenue to promote the sustaining of services by providing payment and/or financial incentives.

Sellers

Businesses and landholders traditionally have little or no financial incentives to maintain ecosystem services. Typically, businesses and landholders associated with natural resource use, receive income from the exploitation, extraction, or conversion of resources into alternate uses. Therefore, the challenge lies in involving businesses and landholders in conservation and provisioning of services through financial incentives, to manage and sustain the services within the ecosystem service conservation zones. However, since the conservation zoning is taking place within diverse land use schemes, all landholders may not have the capabilities or knowledge to implement conservation plans. Therefore, it may be necessary to involve a third party to manage the services.

Such arrangements are considered streams of ecosystem service finance incentives which provide “innovative financial instruments that link revenue streams to ecosystem service benefits to encourage and adopt conservation land uses (Goldstein et al: 10140).” Such financial incentives provide revenue opportunities that could come from several sources, “such as payments for ecosystem service provision, government conservation payments, partnerships with non-governmental organizations, and sustainable production and natural resource extraction (Goldstein et al: 10140).” For instance, when using government conservation payments, payments are in the form of subsides, “either as a direct payment or tax break,” which disperses funds to businesses and private land owners to encourage and engage them in conservation of services (Salzman: 116). The financial incentives essentially pay for the conservation of services, creating a “win-win” situation-the business is receiving additional funds, and the public, is receiving the necessary services that are correlated to social well being.

For example, in the Macquarie River Valley in Australia, the ecosystem service of transpiration has been significantly affected by clear cutting of forests. Therefore, due to the geographical circumstances, ground water is mixing with salt deposits, thereby increasing saline concentrations. The New South Wales Government created “salinity control credits” where the government purchases “the ecosystem service of evapotranspiration for ten years by paying private land owners to plant 100 hectares of native forest in the upper Macquarie River catchments (Salzman: 130).” Although the results and effectiveness of the project are not known, on a basic level, the project illustrates that private land owners are willing to engage in the sustaining of ecosystem services through conservation when financing incentives are provided. In 1997, the Costa Rican government launched the successful Payment for Environmental Services Program which serves a model for a successful ecosystem service finance program. The program “pays private land owners and businesses for the provision of four ecosystem services: carbon sequestration, biodiversity conservation, hydrological services, and provision of scenic beauty for recreation and ecotourism (Goldstein et al: 10140).” Such programs align conservation with profitability, allowing ample opportunities for conservation of services to be broadly implemented.

Ecosystem Service Buyers

Presently, “governments are the most significant investor (buyers) of environmental services through grants and direct investment (website).” However, impediments to government investment frequently arise due to limitations in government spending, for the task of funding the number of projects needed to conserve the delivery of ecosystem services can be substantial, therefore, targeted investment is necessary. The ecosystem services conservation zoning framework presents an efficient means to target investment and prioritize spending. The framework evaluates the policy choices to be made relative to the costs and benefits of investment in ecosystem services, thereby identifying and targeting the conservation projects and areas, rehabilitation projects, provisioning projects, and other options that are economically, environmentally, and socially beneficial. In addition, by evaluating projects from the perspective of ecosystem services, projects are analyzed from how the conservation of ecosystem services will yield the highest outcome and produce costs savings, which can subsequently be reinvested to implement conservation initiatives.

Voluntary and private investment can be grouped together for the motives for investment are similar. (i) “Philanthropic: investment by a person and/or company for altruistic reasons or personal fulfillment. (ii) Socially responsible investment: investors in capital markets are increasingly looking to performances across “triple bottom line” when deciding to invest, thus there is a small but growing market for projects that demonstrate their social, environmental, and financial performance. (iii) Corporate identity: a marketing tool to promote a corporation’s good image. (iv) First movers: corporations may move to participate in markets in order to influence their development and thereby have a role in defining how this type of investment will be conducted in the future and gain a head start in creating efficiency and enhancing their market competitiveness. (v) Self regulation: corporations may invest in addressing environmental problems before the need or regulation. Along with first movers, these investors will try and help define where the market is currently and how it will be conducted in the future. (vi) Cost minimizes: in some cases it may be more cost effective to invest in the maintenance of natural assets rather than investing in technological substitutes (website)."

Property Rights

Discussions on ecosystem service management and investment approaches are facilitated by clarifying entitlements within property rights. This pertains to securing long term investments for the services that stem from a landholder's property. However, conservation zoning instills a sense of security in investment for zoning ordinances clearly define an enforceable, verifiable, valuable, and transferable system that enables the provision of services over time (Murtough: 10). If taken a step further, and investments are to be secured in perpetuity, perhaps "a change of title would be necessary that allows separation of ownership of environmental services from the land (website)." In fact, "New South Wales is the first Australian state to pass legislation that allows for the separation of carbon rights from the land (website)."

When dealing with ecosystem services and the environment, the issue of property rights is also concerned with common property, or common pool resources. Common pool resources are property that that is common and owned by no one. Within land use planning ecosystem services tread a fine line within this distinction, for it is the services produced from property that is common, not the actual parcel of land itself. Therefore the discussion of property rights can also refer to a community's right to access, utilize, and benefit from the services that are provided from both private and publicly owned lands.

However, in "defining the domain where common property management works best, empirical studies have converged on a number of factors: relatively small groups with shared needs, clear boundaries for resource management, stability in the group undertaking the management, and relatively low costs of enforcement (Adger et al: 80)." Conservation zoning implemented on the local levels fulfills all factors listed above. The local community is a small government body where there are a limited number of stakeholders who all depend on the services. The boundaries for conservation zones are clearly defined, the municipal government represents a stable body enforcing the zoning ordinances, and the costs of enforcement are typical costs associated with zoning and land planning.

The success of common property resource management "needs to be gauged by reference to its efficiency, the sustainability of resource use and also by its success in promoting social goals such as equitable distribution of benefits and functions of social security (Adger et al: 80)." Conservation zoning would promote such sustainable, equitable distribution of resources, benefits, and services due to that conservation of parcels of land are set aside for the benefit and sustainability of the community.

Conclusions: Additional Research

The framework summarizes a starting point for designing ecosystem service land use studies and strategies. The approach is attempting to push land use decision making towards a more integrated process. This is a preliminary framework and is intended to complement existing conservation planning methods, not replace. It is understood that such a transition will not be easy, as John Maynard Keynes once said, "the difficulty lies not so much in developing new ideas, as in escaping the old ones (Sexton: 450)." This is represented in transitioning away from the current paradigms that we as a society have become accustomed to using, and switching to a more accountable framework that includes all the factors associated with land use and development. I acknowledge that the conservation of services may not always occur nor be justified, however the goal of the framework is to integrate such thinking and approaches into land use planning discussions and decisions.

To accomplish, there are numerous fields of research that need to be developed, however I will briefly list a few. (i) "Need new data, methods development: to plan thoroughly for ecosystem services, we need considerable advances in data and planning methodologies (Chan et al: 2149)." (ii) Conduct multi-disciplinary research and collaboration: need additional research and expertise in biology, chemistry, physics, economics, finance, geography, and analytical tools to deepen our understanding of ecosystems and services. (iii) Improve modeling capabilities within land use, biodiversity, and ecosystem services: need to improve techniques to build scenarios and models of how biodiversity, ecosystem services, and land use are interrelated to anticipate responses of services under different policy decisions (Tallis et al: 562). (iv) Increase our knowledge of resilience, vulnerability, and inertia within ecosystems: "an ecosystems ability to resist stress and shocks, to absorb disturbance, and to recover from disruptive changes (Myers: 2766)."

Implementing ecosystem services is a difficult, but necessary step. As noted, current methods of land use decision making do not fully account for the consequences of growth. Ecosystem services provide the opportunity to view growth from a new perspective, and to establish the relationship, with each other and the earth itself, based on our interaction and use of the planet's resources. The ecosystem service conservation zoning framework could facilitate such a transition, and as our general knowledge of ecosystems is expanded, perhaps additional frameworks at varying scales could also be developed and utilized.

Figure 1

Overview of Ecosystem Services Conservation Zoning Framework

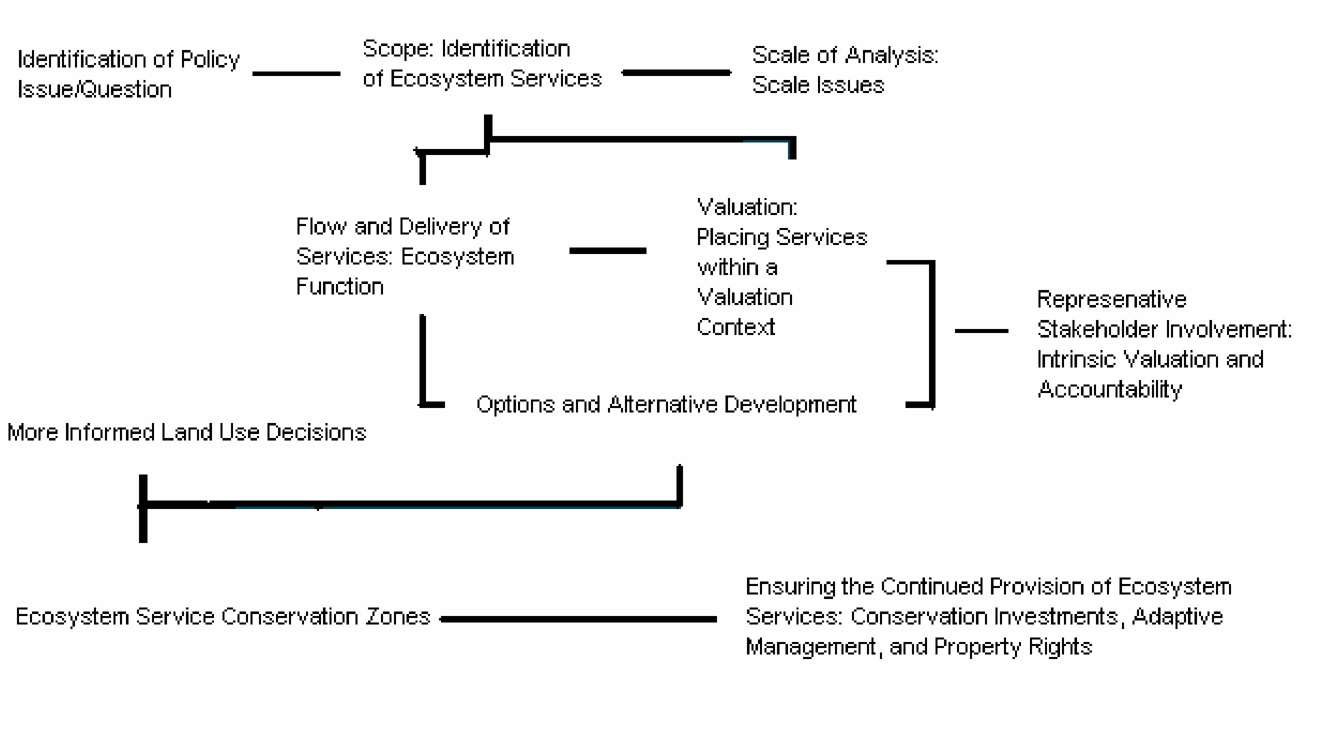
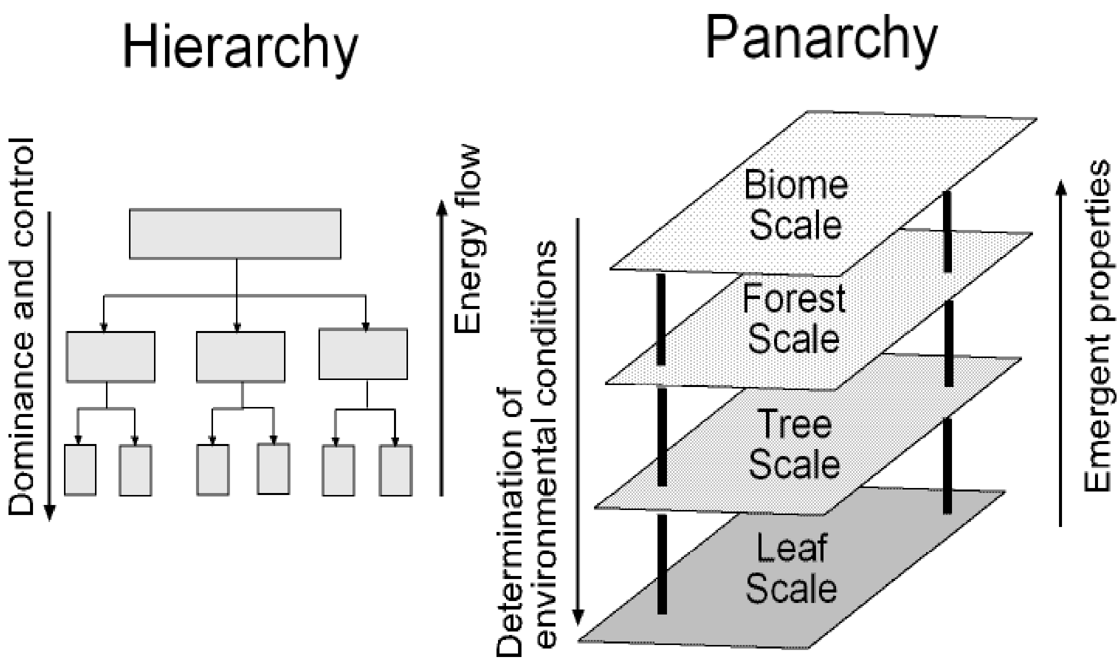


Figure 1 shows the general process and concepts that are considered when establishing ecosystem service conservation zones.

Figure 2

Visual Portrayal of Scale, Ecosystems, and Services



The figure portrays how ecosystem scales are "nested" within larger scales, where each ecosystem scale contributes to the production and delivery of ecosystem services.

Figure 2 was taken from a presentation given by J.B. Ruhl at the Environmental Law Institute, Washington DC, February 2007. J.B. Ruhl is a law professor at Florida State University who continually contributes innovative approaches and ideas to integrating ecosystem services into law/policy.

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