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Caring for Our Natural Assets

An Ecosystem Services Perspective

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Abstract

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Global attention to climate change has advanced an awareness of human impacts on the environment. Progressing more slowly is recognition of the critical link between forest ecosystems and human welfare. Forests provide a number of societal benefits or ecosystem services, such as water purification, climate and flood regulation, recreational opportunities, and spiritual fulfillment. This paper examines an emerging perspective that describes ecosystems as natural assets that support human health and well-being. The perspective serves as both a conservation approach and an extension of ecosystem management, involving the connection of ecosystem services to the people who benefit, in some cases with an assigned market value. We argue that the emergence of an ecosystem services perspective is timely as public interest in the state of the environment increases and natural resource managers face the reality of rapid forest ecosystem change. Forest conservation that considers the supply and delivery of ecosystem services will enhance the health and resiliency of ecosystems, engage and serve a broader public, and attract private investment and leadership in a common effort to safeguard natural systems.

Keywords: Ecosystem services, ecosystem management, natural capital, climate change, human well-being.

The City of Los Angeles was one of the first cities in the United States to address air quality concerns. Pressured by citizens to recognize the harmful health effects of smog, the city formed the Los Angeles Air Pollution Control District in 1947 and began a public campaign to control industrial emissions. In 1959, the State of California became the first state to establish air quality standards for public health (California Air Resources Board 2007). At the same time, California state legislators were refining pesticide regulations in response to an increased use of pesticides and a growing awareness of their toxicity. Just a few years later Rachel Carson completed her landmark text *Silent Spring*, exposing the environmental and human health risks of pesticides.

For many, the publication of *Silent Spring* marked the beginning of America's modern environmental movement, leading to the first Earth Day in 1970 and a series of federal regulations for environmental protection. Carson's compelling case successfully captured the attention of the American public. She instilled a broad awareness of human life as part of the natural environment, portraying both as interconnected and equally vulnerable to the side-effects of technological progress.

Today we are witnessing the stirrings of a new environmental movement related to human health and the environment. Climate change is the focus. The potential impacts of rising temperatures and sea levels around the world are stimulating public discourse and political action on a global scale; the energy around the issue reminds us of the urgency generated by *Silent Spring* and the environmental spirit that continued to shape the movement of the 1970s. Today forests are part of the conversation. Forests are a key player in climate regulation, but more notably, forests have become a symbol of popular environmentalism and sustainability, their image displayed in part on any "green" corporate strategy or "environmentally friendly" product.

The climate change issue will continue to mobilize forest awareness and conservation efforts across the globe. As society begins to internalize the costs of unsustainable development into the future, natural resource managers have a story to tell—a story about managing and investing in forests for the continued supply and delivery of ecosystem services.

Indeed, forests as healthy, functioning ecosystems support life and human welfare, providing important services in addition to storing carbon, such as water purification, erosion control, natural hazard regulation, and spiritual and cultural fulfillment.¹

It is this critical relationship between forests and people that can lead natural resource managers to a conservation approach or perspective that is inherently tied to the dynamic needs of society. An ecosystem services perspective involves measuring the flow of ecosystem services across a landscape and connecting these services to the people who benefit. The approach is forward looking, as conservation and restoration objectives focus on the ability of ecosystems to adapt to change and to continue to supply benefits. It helps forest management remain relevant in a time of growing concern about environmental change; forest management that considers water quality, carbon sequestration, ecotourism, bioenergy, and other benefits engages and serves a broad public. Finally, an ecosystem services perspective involves the private sector in finding ways to value and conserve ecosystems. The emergence of markets for new environmental assets, for example, presents financial opportunities for working forests that extend beyond traditional forest products. Market-based approaches to conservation have the potential to provide landowners with additional incentives to manage and continue owning forest land.

¹ Ecosystem services are commonly defined as the benefits people obtain from ecosystems. A review of the definition and its history is offered by the Millennium Ecosystem Assessment (2003) and Mooney and Ehrlich (1997).

Ecosystem Change and the Loss of Services

For the City of Los Angeles and for Rachel Carson, the sources and impacts of smog and pesticides seemed clear and the solutions straightforward: regulated behavior would ameliorate human health effects. Today we are aware of a much more complicated picture of ecosystem change, a global network of interrelated drivers peppered with uncertainty (fig. 1).

Climate scientists agree that human activities have led to elevated atmospheric concentrations of carbon dioxide and other greenhouse gases that cause global warming, and observed concentrations are projected to increase (IPCC 2007b). Why such concern? Climate change can intensify the risk of abrupt ecosystem change for terrestrial and marine systems, affecting ecosystem structure, function, and productivity. Such change will substantially impact freshwater resources, food supplies, biodiversity, and other ecosystem services at significant social and economic cost (IPCC 2007a, MA 2005, Stern 2006).

Regional climate changes and climate variations over the past century have already had a measurable impact on our natural systems, including changes in hydrology, species distribution and range, population sizes, the timing of life cycle events, and, especially in forest systems, an increase in the frequency of fire as well as pest and disease outbreaks (Brown et al. 2004; IPCC 2007a; Logan and Powell, in press; MA 2005). Globalization and associated changes in trade patterns have contributed to some of these trends, particularly through the spread of invasive species, as have past land management practices, which have contributed to forest health problems related to fire and fuels.

Land use change is an immediate issue throughout the United States, which is experiencing a loss of privately owned forest land owing to conversion to developed uses. Over 11 percent—approximately 44.2 million acres (17.9 million hectares)—of the Nation’s private forests are likely to see dramatic increases in housing development by 2030 (Stein et al. 2005). This projection doesn’t take into account the already fragmented woodlots in and around urban areas that

are subject to local development pressures as cities expand. Indeed, urban land in the contiguous United States is expected to nearly triple over the next several decades, an increase in area larger than the state of Montana (Nowak and Walton 2005). Housing growth is also a key concern across the rural landscape, where rural sprawl or exurban development affects a much larger area, amplifying environmental impacts (Radeloff et al. 2005) (fig. 2). Expanding urbanization and rural sprawl affect the Nation’s private forests, which compose nearly three-fifths of all forest land, as well as public lands and public land management. Forest-land conversion is a conservation challenge across a mixed-ownership landscape, impacting water quality, wildlife diversity, forest health, recreational access, and the many other benefits of open space.

The trends are complicated by their interaction at multiple temporal and spatial scales: changes in climate can affect land cover and use, for example, and changes in land cover and use will, in turn, affect climate variability (Loveland et al. 2003). It is clear, however, that, together and individually, these drivers of ecosystem change directly affect the supply and delivery of ecosystem services to the United States population and the international community. When forest land is developed or degraded we lose a range of goods and services provided, further increasing pressures on preserved areas to deliver the benefits lost.

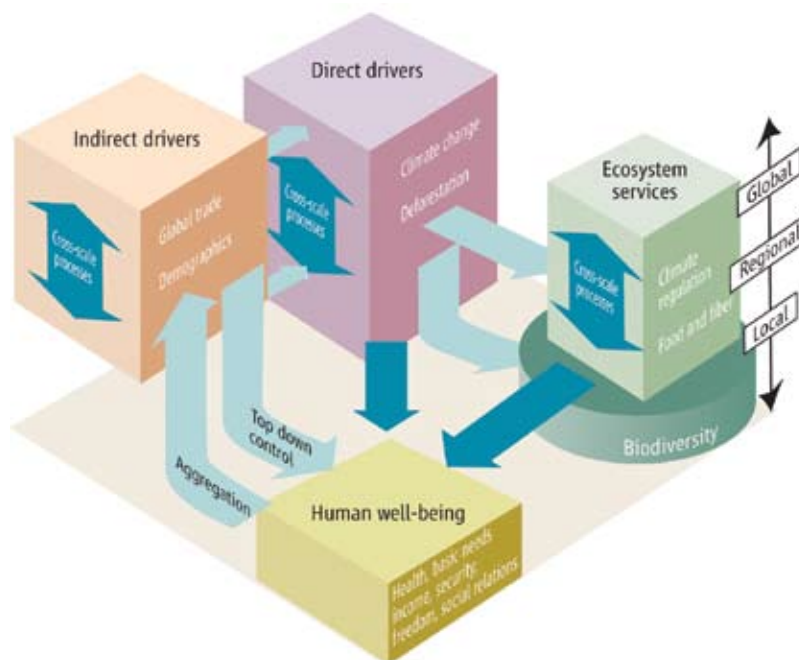


Figure 1—A conceptual framework of interactions between biodiversity, ecosystem services, human well-being, and drivers of change (MA 2005), modified by Carpenter et al. (2006) to illustrate connections among local, regional, and global scales.

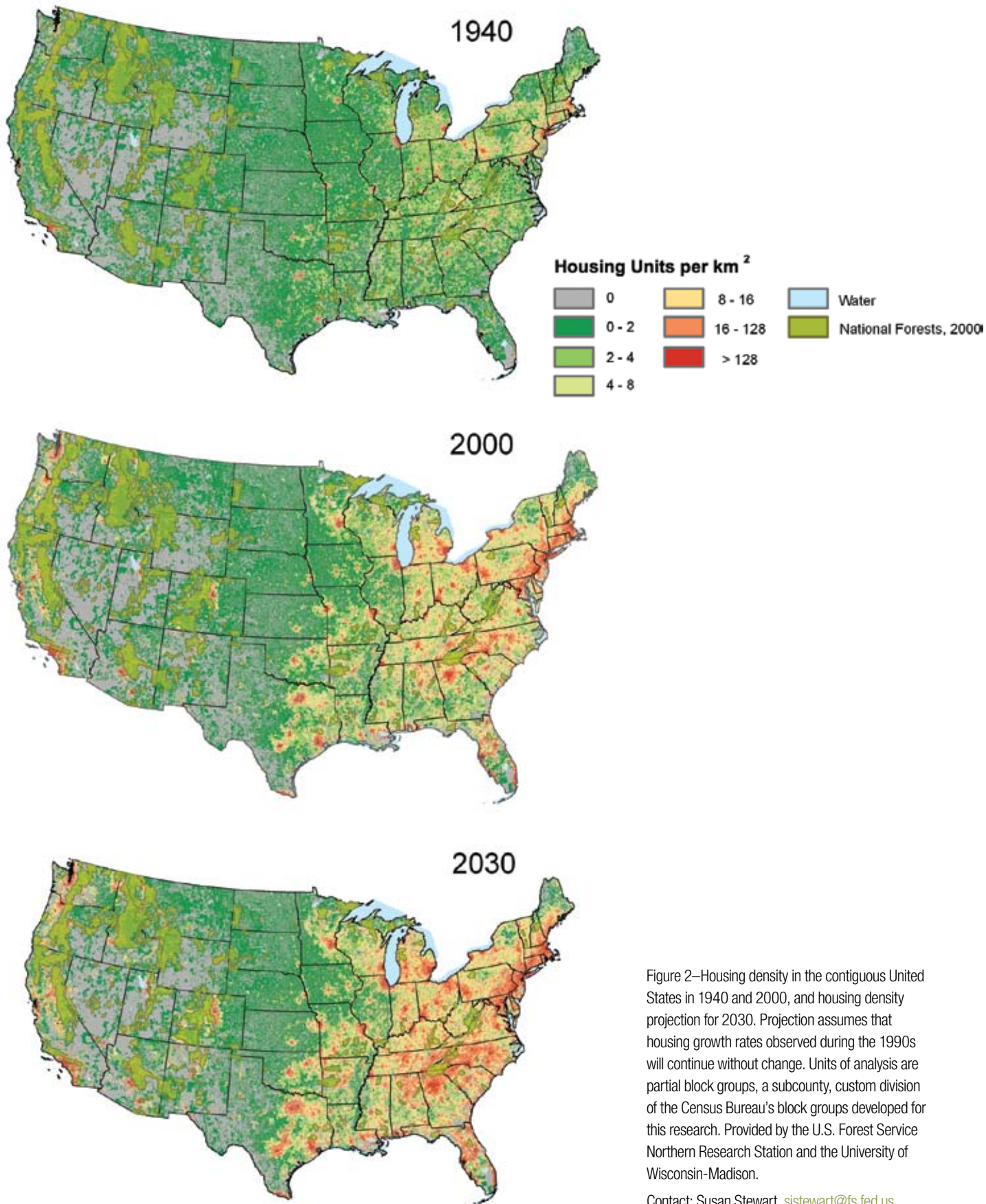


Figure 2—Housing density in the contiguous United States in 1940 and 2000, and housing density projection for 2030. Projection assumes that housing growth rates observed during the 1990s will continue without change. Units of analysis are partial block groups, a subcounty, custom division of the Census Bureau's block groups developed for this research. Provided by the U.S. Forest Service Northern Research Station and the University of Wisconsin-Madison.

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An Ecosystem Services Perspective

As population, income, and consumption levels increase, humans put more and more pressure on the natural environment. In 2005, the United Nations commissioned a study of the extent to which human activities have altered ecosystems around the globe. Known as the Millennium Ecosystem Assessment (MA), the study catalogued and evaluated the status of a range of ecosystem services (fig. 3). The MA framework includes the most basic services from nature—provisioning services like the delivery of food, fresh water, wood and fiber, and medicine—and services that are less tangible and harder to measure but equally as critical, such as regulating, supporting, and cultural services. The MA scientists found that 60 percent of the world’s ecosystem services are currently being degraded or used unsustainably; 70 percent of the regulating and cultural services evaluated in the assessment are in decline. The assessment predicts that the degradation of ecosystem services might significantly worsen during the first half of this century, substantially affecting human well-being.

The MA framework (2003) provides a new lens through which to check the state of the environment, one that rests on “human

livelihoods, health, and local and national economies” (p. 49). The findings raise important questions for natural resource managers: **Are we adequately conserving the world’s ecosystems? How can we keep pace with the growing pressures of human populations? How can forest management secure ecosystem services into the future?** We have moved into a new century with a set of conservation challenges that together seem unprecedented. We need to enhance our ecosystem management approach accordingly, with a new logic and a fresh, forward-looking perspective that can meet these challenges.

Interpretations of ecosystem management evolved throughout the early to mid-1990s in response to a continuing loss of biodiversity (Grumbine 1994). For national forest managers, ecosystem management emerged as a new approach to multiple-use, sustained-yield management that incorporated the public’s changing desires and needs. Resting on the concept of sustainability, ecosystem management is described as the optimum integration of human needs and requirements, the ecological potential of a landscape, and economic and technical considerations (Jensen and Everett 1994, Zonneveld 1988). The main principle, then, is to sustain the integrity of ecosystems (i.e., ecosystem functions, composition, and structure) for future generations while providing immediate goods and services to an increasingly diverse public (Jensen and Everett 1994, Overbay 1992).

ECOSYSTEM SERVICES	
Supporting Services Nutrient cycling Soil formation Primary production	Provisioning Services Food (crops, livestock, wild foods, etc...) Fiber (timber, cotton/hemp/silk, wood fuel) Genetic resources Biochemicals, natural medicines, pharmaceuticals Fresh water
	Regulating Services Air quality regulation Climate regulation (global, regional, and local) Water regulation Erosion regulation Water purification and waste treatment Disease regulation Pest regulation Pollination Natural hazard regulation
	Cultural Services Aesthetic values Spiritual and religious values Recreation and ecotourism

Figure 3—Ecosystem services classified by the Millennium Ecosystem Assessment (2005). The assessment evaluated the global status of provisioning, regulating, and cultural services.

Grumbine (1994: 34) argued that ecosystem management is an early stage in a fundamental reframing of the role of humans in nature. How, then, does an ecosystem services perspective advance this thinking? An ecosystem services perspective encourages natural resource managers to extend the classification of “multiple uses” to include a broader array of services or values; managing for water, wildlife, timber, and recreation addresses the need to sustain “provisioning” services, but land managers are also stewards of regulating, cultural, and supporting services, all of which are critical to human health and well-being.

An ecosystem services perspective encourages natural resource managers to consider the following:

Managing natural capital

Ecosystem services make up our natural life support system and are a form of natural capital. Like financial capital, manufactured capital, and human capital, **natural capital** is a requisite for economic progress and human welfare (Hawken et al. 1999). Yet natural capital is usually absent from government or corporate balance sheets; in some cases, it can take the form of a liability. An ecosystem services perspective leads natural resource managers to regard landscapes as natural capital and to account for the assets they are managing. Accounting for natural assets requires measuring the stocks and flows of ecosystem services (and their indicators or appropriate surrogates) and making sure the people who rely on these assets know their value and the cost of losing them. Information relating to the status, trends, and, to the extent possible, the economic worth of ecosystem services can better inform policymakers and the public. Understanding the extent to which a forested landscape purifies the air or moderates coastal flooding, for example, can lend priority to regional investments in land management and conservation.

Urban forestry specialists have pioneered this ecosystem services approach. In urban forestry research, management, and communications, trees are regarded as natural assets that contribute to energy savings, better air and water quality, reduced stormwater runoff, local climate moderation, increased property values—even reductions in city crime and personal stress. Empowered by this information, municipalities across the country are setting tree canopy goals and investing in tree planting efforts to enhance public benefits.

Connecting ecosystem services to the people who benefit

Ecosystem management accommodates human values and uses, but management goals are structured around the protection of ecosystems. Common themes include maintaining viable populations

of native species, representing native ecosystem types across their natural range of variation, and maintaining the evolutionary potential of species and ecosystems (Grumbine 1994). From an ecosystem services perspective, by contrast, management objectives are motivated by the supply and delivery of ecosystem services. Ecosystem functions are associated with a set of life-supporting services valued by humans, and management activities are designed to maintain or enhance these services. Measures of ecosystem health, then, extend beyond forest condition to incorporate the ability of an ecosystem to deliver services to a changing population.

In practice, managers first identify the ecosystem services provided by a landscape, then assess human use and dependency on these services at local, regional, and global scales (Heal et al. 2001). Key management questions driving this process are: **Who benefits from these services? Have they identified themselves as stakeholders? Are they aware of the value of these services? Are there services at risk or in decline? How can we prevent their degradation? What are the management tradeoffs?** Answering these questions across a landscape engages a broader set of disciplines, stakeholders, and decisionmakers.

Anticipating future change

Forest management traditionally assumes an historical perspective. Forestry models are based on former conditions and assumptions, and although management objectives address a desired future condition, they are often driven by past realities. The emergence of ecosystem management reflected a growing awareness of landscapes, dynamic processes, multiple objectives, and adaptive response. But the tendency to mimic historical processes and patterns remains, and management goals for healthy, functioning forests rarely incorporate change. An ecosystem services perspective leads managers to focus on a future landscape in recognition that human needs are increasing, historical patterns are being disrupted, and natural processes are challenged by climate change. Conservation aims shift to address the ability of forested landscapes to adapt to change and continue to provide ecosystem services. Within this context a “restored” ecosystem might not mirror the original landscape, but it will be a healthy, productive system capable of meeting societal needs for a broad array of ecosystem services (MA 2005).

Managing for an uncertain future is a difficult task. Resource managers and decisionmakers who take ecosystem services into account must rely on scenario building, assessments of risk and ecological tradeoffs, economic valuation, and other methods of managing uncertainty (Carpenter et al. 2006, Heal et al. 2001,

MA 2005). An ecosystem services approach underscores the importance of assessing alternative management strategies and takes demographic, economic, sociopolitical, and cultural factors into account, in addition to direct drivers of ecosystem change (Carpenter et al. 2006).

Embracing a new language

Natural resource managers now have a new language to describe the benefits of forest management—a language that helps them connect a changing population to the land and the services it provides. Too often resource specialists rely on the technical language of their profession to describe their work. Technical language enhances professional credibility and enables research and application, but it can also be highly exclusive. An ecosystem services perspective moves land managers to frame a purpose that reflects a broader set of values, with greater potential to resonate with the public. It helps build bridges of understanding between different interest groups.

Investing in Natural Capital: Market-Based Approaches to Conservation

The ecosystem services framework developed as part of the MA is effective. It explains the full extent to which people depend on healthy ecosystems—and how much they take for granted. Whereas provisioning services are valued by society—they are, for the most part, measured, counted, and fiscally inventoried—the rest are typically absent from conventional accounting. By default, regulating, supporting, and cultural services are public goods or common resources, in most cases considered free and limitless.

Without market data or evaluation in monetary terms, the contribution of these services is often misrepresented or ignored in policy formulation and decisionmaking. Measures of economic progress and wealth do not take natural assets into account, let alone the costs of environmental degradation. A devastating oil spill, for example, will increase a Nation's gross domestic product (GDP) because each of the monetary transactions involved in its cleanup equate to positive economic growth. Similarly, an increase in a developing country's agricultural exports may register as a growth in GDP, but social costs associated with the local loss of these goods are not weighed, nor is the decline in regulating and cultural services caused by the land conversion required to increase production.

Economists have long studied how to assign monetary value to public goods in an effort to account for environmental exter-

nalities. Economic approaches to valuing the environment form the backbone of any natural resource economics text-book. But nature is priceless, some say; how can we capture its full value? Nature is priceless indeed; but unless a monetary value can be assigned, the importance of flood regulation, the role of nutrient cycling, or the restorative power of a scenic vista might be lost. Without investments in natural capital, life support systems are at risk. Nowhere is this clearer than on private lands, which account for almost 60 percent of the Nation's forests and are critical to the supply of ecosystem services. Because ecosystem services aren't valued financially, private forest landowners lack many incentives and resources to consider them in land use decisions (Kline et al. 2004). The result can be poor forest management, or forest-land conversion to developed uses.

The solution is not simple or clear, nor is it immediate. To help slow the loss and degradation of ecosystem services, economic and financial motivations need to incorporate a conservation objective. New technologies and new business models are needed to help integrate environmental goals into decisionmaking. Economic norms and accounting measures must be broadened. A necessary step is to align individual incentives with the collective interest.

In response to these needs, market-based conservation attempts to capture the value of natural capital and make land stewardship profitable. Markets for ecosystem services connect natural assets to beneficiaries who are willing to pay for their stewardship. In many cases, investments in ecosystem protection are more cost-effective alternatives to building new, or improving existing infrastructure designed to meet the same societal goals.

The carbon market is one example of associating a monetary value with nature's services. Other ecosystem service markets for wetlands, water quality, endangered species habitat, ecotourism, and bioenergy are also evolving—and with them, a chance to supplement traditional forest revenues and promote sustainable management, especially when used together with other conservation tools.

Although traditional conservation approaches have brought us far in safeguarding landscapes and biodiversity, we need to look beyond our own circle to find new tools, stakeholders, and environmental leaders. An ecosystem services perspective encourages us to be creative and entrepreneurial in bringing people together to design effective solutions.

There is no better time. Growing concern about climate change is inspiring a renewed public awareness of nature and its connection

Forest Service Snapshot

Ten things the U.S. Forest Service can do in the spirit of ecosystem services. Adapted from Associate Chief Collins' opening remarks at the National Silviculture Workshop in Ketchikan, Alaska (May 7, 2007)

1. Bring certainty to the ecosystem marketplace. Uniform standards, established baselines, risk mitigation, and early demonstration can accelerate and lend credibility to emerging ecosystem service markets. Our effort to help shape the 2007 Farm Bill to facilitate market-based conservation is one step in this direction.
2. Provide the most reliable and trusted information on forests for all audiences. We are helping to reconnect children to nature through education and involvement; at the same time we're informing policymakers of the positive role that forestry can play in a climate change strategy.
3. Experiment and learn on the national forests. National forest land serves as a natural laboratory for testing ideas. Demonstration projects can serve as a resource as we help private landowners benefit from market-based conservation.
4. Become market savvy. New markets for ecosystem services require an understanding of how natural assets can be enhanced through forest management. We also need to know how the demand side works—how we can attract investments in conservation and connect conservation buyers to land stewards.
5. Reduce our environmental footprint and be the environmental leader we expect others to be.
6. Lead in research that can answer critical questions about climate change and about carbon sequestration and other ecosystem services.
7. Refresh our language. Much of our vocabulary came from the production forestry era; our words often reinforce practices and a mindset that might need to evolve.
8. Rethink forest plans—what goes into them and how we consider them. Do we need to build climate change scenarios? How can we incorporate a management approach that sustains the flow of ecosystem services across the landscape?
9. Resist the impulse to jump on the ecosystem services “bandwagon” without some thinking—and resist the impulse to dismiss the ecosystem services concept as the latest in a series of attempts to redefine forestry. At the very least, we can appreciate the dialogue that the concept is stimulating.
10. Learn as much as we can. Read, share, and connect with the issues in forestry today, and consider how they relate to the agency's mission and each of our own individual programs. Learning is a key part of our work—and we have important work to do.

to human health, an awareness characterized in part by business action and involvement. Companies are beginning to recognize the link between environmental health and their business interests; in some cases, it is their shareholders or customers who seek a corporate environmental pledge. Markets for ecosystem services have the potential to seize the enthusiasm, catalyze private investments, and organize community leadership around a shared conservation objective.

Conclusion

Natural resource managers have long recognized the fundamental link between nature and society. As early as 1864, George Perkins Marsh explored the causal effects of human-induced deforestation on regional climate in his seminal work, *Man and Nature*. But we haven't always articulated the returns from investing in nature's services, or the cost of losing them. We haven't explicitly served as natural **asset** managers. As populations develop and prosper, the full weight of human impact on Earth's resources becomes more apparent, as does the importance of managing and accounting for these resources as natural capital that supports human well-being. Connecting ecosystem services with the people who benefit can help us manage our resources more effectively and prevent their decline.

Public interest in the state of the world's resources is on the rise, and the emergence of an ecosystem services perspective could not be timelier. We have new tools for valuing ecosystems, a new language to help us impart the benefits of forest management and conservation, and, most importantly, a restored purpose for serving as nature's stewards.

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