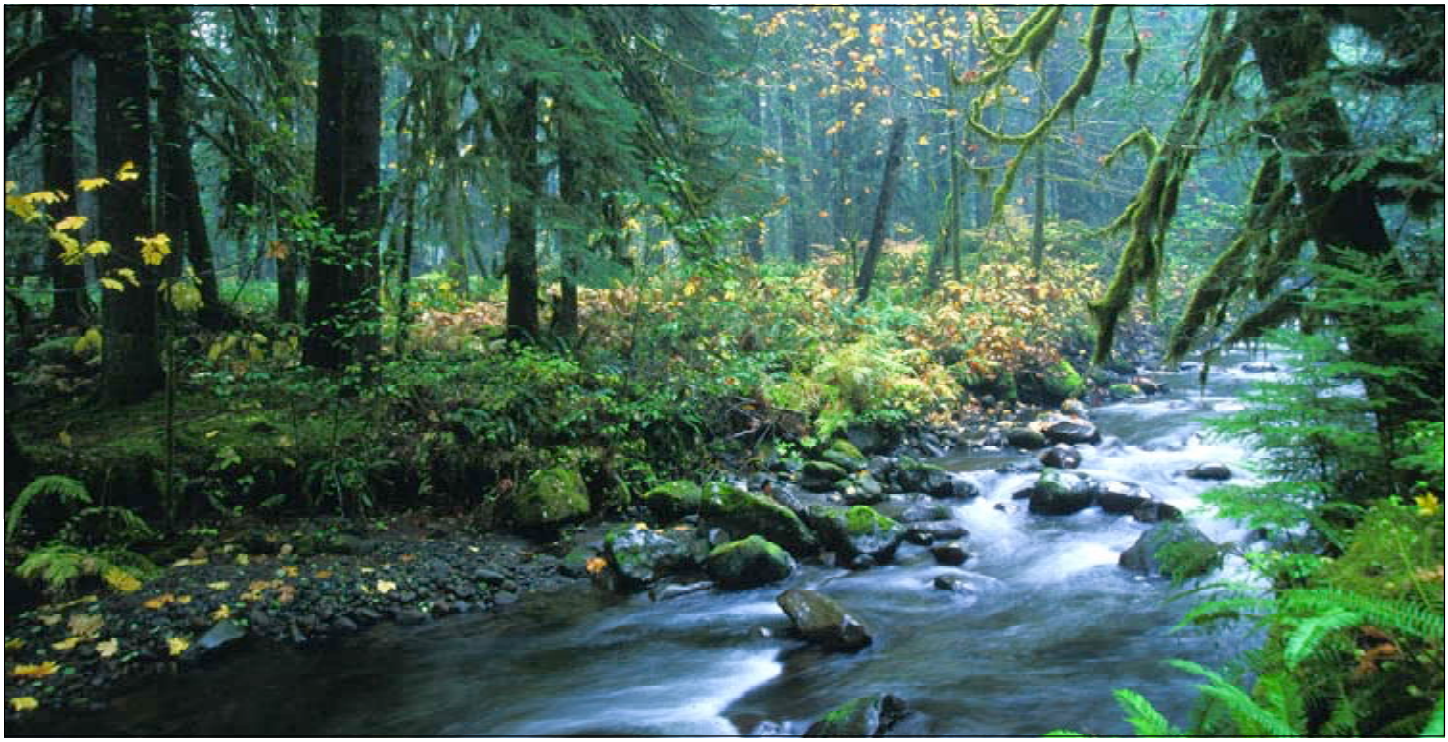
Pacific Northwest Research Station

Science Update

COUNTING ALL THAT MATTERS: RECOGNIZING THE VALUE OF ECOSYSTEM SERVICES



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IN SUMMARY

Broadly defined, ecosystem services are the benefits healthy ecosystems provide to humans. Clean air, clean water, and flood control are just a few examples. Although the term is relatively new, the ecosystem services concept has long been a focus of natural resource and environmental economists. As the U.S. population increases and the forests and grasslands that provide ecosystem services are threatened by development, there is growing interest among natural resource agencies, conservation groups, private landowners, and others to explore the ecosystem services concept as a way to address human impacts on the environment and more effectively communicate the importance of ecosystems.

This issue of Science Update highlights the efforts of Pacific Northwest (PNW) Research Station scientists to develop approaches for implementing an ecosystem services program for the region. Applying the ecosystem services concept to specific issues in Forest Service policy, management, and research presents many challenges and opportunities. An important role for PNW research is providing information that can help increase public awareness and understanding of how public lands contribute to human well-being by providing ecological goods and services. Scientists at PNW are working on ways to evaluate various ecosystem services and use existing information, methods, and tools to support ecosystem services research. Models enabling managers to quantitatively evaluate how different forest management options affect ecosystem services are also being developed.

What are ecosystem services?

The inherent processes of forest and grassland ecosystems provide many benefits to humans. Some of these, such as forest or food products, have well-established markets recognizing their monetary value. Many other benefits or services, however, are vital to our survival but traditionally have not been included on the tally sheet when decisions are made on how to manage a piece of land. These include the ability of ecosystems to provide clean air and water through natural filtration processes, reduce soil erosion and sedimentation in waterways, produce topsoil, sequester carbon to mitigate climate change, moderate weather, reduce floods and drought, and provide habitat for a diversity of plants and animals. Ecosystem services also include less tangible quality-of-life values, such as aesthetic beauty, and cultural and recreational benefits.

Valuing ecosystem services means understanding what we as a society care about.

From an economics viewpoint, ecosystem management is largely about finding compatibility among forest management goals and outcomes. For example, how can the inherent value of habitat protection be compared with rising land values for real estate development? And how will decisions regarding such tradeoffs affect present and future generations? In a bold sense, valuing ecosystem services means understanding what we as a society care about and what we are willing to pay, trade, or give up to maintain it. From an optimistic viewpoint, attention to the values of ecosystem services can facilitate policy approaches to meet a variety of interests and create more agreeable outcomes from traditionally contentious issues. For example, can water quality goals be met through cap and trade programs, where credits can be bought and sold in a market-based system? Many believe that major conservation opportunities lie in these sorts of arrangements.

Is this a new concept?

What the ecosystem services concept represents is not new to the Forest Service. Since its inception, the Forest Service has been entrusted with managing the Nation's forests and grasslands with an ever-evolving set of management objectives that benefit society. Some of the earliest research efforts of the Forest Service to address the benefits society receives from forests date back to the 1960s and 1970s. Work by resource economists John Krutilla, Michael Bowes, and others on multiple-use management and the "amenities associated with unspoiled natural environments" influenced the Forest Service to work on quantifying and assigning economic values to noncommodity forest goods and services. In the early 1990s, ecosystem management emerged as a new management paradigm reflecting a shift in agency focus from timber outputs to ecological health and restoration. Today's emphasis on the concept of ecosystem services may be seen as a natural outgrowth of this shift, with a greater emphasis on human understanding of healthy ecosystems.

Key Findings

- Ecosystem services encompass a wide array of benefits that people derive from healthy functioning ecosystems, including clean air and clean water. The Forest Service is exploring the ecosystem services concept as a framework for evaluating land management and policy decisions, and to better describe to the public what they receive from forested lands.
- Developing methods to describe ecosystem services and their values to society is important for ensuring that the broad array of forest benefits are included in forest policy and management decisionmaking.
- Communicating the value of ecosystem services and the Forest Service's role in sustaining them is critical for justifying public expenditure on Forest Service programs.
- Existing research and tools developed by PNW scientists in the areas of economics, ecology, and other disciplines can be used to enhance understanding of ecosystem services.
- The Forest Service can play an important role in sustaining ecosystem services across landscapes by offering expertise, resources, information, and programs to its neighbors and partners. One area of particular interest is promoting market-based conservation of ecosystem services on private land.

Purpose of PNW Science Update

The purpose of the *PNW Science Update* is to contribute scientific knowledge for pressing decisions about natural resource and environmental issues.

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"What is most new about the ecosystem services concept," says Jeff Kline, research forester with the PNW Research Station in Corvallis, Oregon, "is the current level of enthusiasm for trying different policy approaches in the pursuit of conservation. The rest has been familiar to economists for quite some time." Kline explains that the ecosystem services concept itself is based on two fundamental concepts from economics. The first is "public goods"—benefits that are available to all, such as forest scenery. The second is "externalities"—consequences of actions, good or bad, that affect the well-being of individuals. The adverse effects of agricultural runoff on water quality is an example of a negative externality, and the water filtration provided by a forested watershed is an example of a positive externality. "The disciplines of natural resource and environmental economics were developed largely in response to the need to address such issues, so economics is fundamental to both evaluating ecosystem services and developing a full range of policy approaches to addressing their protection and enhancement," says Kline.

For Richard Haynes, retired program manager for the PNW's Human and Natural Resources Interactions program, the challenge with ecosystem services for the Forest Service lies in moving from concept to implementation: "We have always struggled with how to implement the concepts behind the Multiple-Use Act. Ecosystem services may be the New Millennium version of multiple use," says Haynes.

What is new is the level of enthusiasm for trying different policy approaches in pursuit of conservation.

From concept to implementation. The current interest in ecosystem services led to the creation of a research and development strategy with input from scientists, managers, and leadership. The strategy identifies three key approaches to implementing an ecosystem services program:

- A *research strategy* that capitalizes on existing and ongoing research to illustrate the full value of natural systems and the services that public lands provide.
- A *science delivery program* that works directly with private landowners and other stakeholders to promote the development of markets to conserve ecosystem services that are produced on private lands.
- *Future projects* designed to assess the status and trends of ecosystem goods and services contributed by national forest lands.

Trista Patterson, an ecological economist with the Human and Natural Resources Interactions program, has outlined a potential framework for future ecosystem services research for the PNW Research Station. Patterson notes that a major challenge is the number of definitions and perspectives regarding ecosystem services originating from various disciplines. To create a common language, Patterson suggests that ecosystem services can be viewed from four major perspectives: (1) methods for evaluating ecosystem services, (2) raising public awareness, (3) managing for the production of ecosystem services, (4) and fostering private markets.

Ecosystem services include traditionally recognized goods such as timber and food, as well as clean air, water, and recreational opportunities.

How can ecosystem services be evaluated?

Defining, measuring, and assigning values for ecosystem services. The multitude of efforts to define and classify the ecosystem services concept differ in specificity and focus. Predictably, definitions depend on the vantage point of the group defining the concept. The highest profile work of recent years is the Millennium Ecosystem Assessment (MEA), a study commissioned by the United Nations to assess the conditions and trends of ecosystem services worldwide.

The ecosystem services classifications identified by the MEA are now broadly referenced in ecosystem services literature, including various Forest Service documents.

The challenge for the Forest Service lies in how to apply existing definitions and classifications to an operational framework that can support decisions or drive policy and research. According to Kline, what is most needed is a well-defined set of ecosystem service metrics. "First and foremost, you have to know what to measure," says Kline. "This has not received near the attention it warrants. While useful for advocating ecosystem protection, typologies such as the one defined by the MEA can present problems for researchers who need unabiguous measures that capture the full range of ecosystem services that benefit people without double counting certain benefits." The challenges are not trivial when trying to determine which of the benefits that arise from ecosystems should be evaluated, how to measure them, or how they are valued by society. "Such measures are more difficult to develop than most people realize," says Kline.

Many of the benefits that flow from our national forests have long been considered public goods. As such, many of the services provided by forest ecosystems have been taken for granted, undervalued, or simply not recognized by the public. Patterson explains that, with ever-increasing scarcity of what are sometimes referred to as our Nation's "natural assets" as well as an increasing need to better demonstrate returns on investment of public funds for Forest Service programs, emphasis has been placed on ways to better evaluate a broader range of benefits the public receives from forest ecosystems. One approach that is promising, yet contentious, is to attempt to measure the monetary value of ecosystem services produced.

Ecosystem services valuation. Valuation in this context refers to quantifying and assigning dollar values to ecosystem goods and services. Many ecosystem services have never been recognized in monetary considerations or market-like transactions. Patterson explains that ecosystem service valuation may provide a means to reorient traditional ways of evaluating performance measures for the agency by expanding from exclusively commodity-based indicators of success (i.e., board-feet of timber), to include social and environmental costs and benefits. Thus, ecosystem service valuation can potentially provide the Forest Service with new ways to compare the costs and benefits of different management strategies, using the dollar as the common metric of value.

Ecosystem service valuation may also provide the Forest Service with a different way to communicate the importance of ecosystems and their conservation. It is thought that assigning a dollar value may elevate the standing of ecosystem benefits in the public eye. "Giving a dollar value to something that usually doesn't have one may send a stronger message about what is to be lost if those ecosystems aren't protected," says Patterson. Patterson is exploring the use of ecosystem services valuation methods with a case study on Snoqualmie National Forest lands in the Upper Tolt River watershed in western Washington. (See sidebar: Assigning Monetary Value to the Tolt River Watershed.)

But can the true value of wilderness or water be represented in dollars? Questions like this fuel vigorous scientific and ethical debate. One major concern is that the complexity of ecosystem processes and interactions that result in specific services (such as soil nutrient cycling through soil-plant-animal interactions) cannot, and indeed should not, be accounted for in unit-by-unit monetary measures. Jeff Kline explains that actually assigning dollar values to ecosystem services often may not be feasible or even necessary. "Before we try to assign dollar values, we have to do a better job of describing the production of ecosystem services themselves," says Kline. "In many cases, dollar values are not even needed to make the case that healthy ecosystems are important to people. . . At worst, people may even argue about the dollar values used and miss that larger message."

Communicating the larger message: Why is raising public awareness so important?

The link between healthy ecosystems and human welfare is fundamental to the concept of ecosystem services. Yet, increasingly, Americans live and work in urban areas, separating them from day-to-day interaction with the natural landscapes and ecosystems that support their well-being. Communicating the idea of ecosystem services and other scientific information to an increasingly urban population has been a persistent challenge, yet is a prerequisite to gaining public support for protecting and enhancing ecosystem services and the landscapes that provide them. There is a need to "better describe what the public gets from national forests and other public lands," says Patterson.

"The heart of the [ecosystem services] issue for the Forest Service is how to describe to the public the treasure that the Forest Service manages for them," says Richard Haynes. "Visitor days and timber volume are traditional measures of public benefits from our national forests. People take for granted that there will be 2-by-4s at Home Depot and water in the Willamette [River]."

Knowing the benefits provided by a watershed may lead to greater interest in protecting it.

Take drinking water for example. "Many people don't think past the tap or the treatment plant when thinking about where their water comes from," says Haynes. A forested watershed that is protected from development can provide natural water purification at lower cost than a treatment plant. If a community understands that its drinking water originates from that watershed, it is more likely to see the value in protecting the watershed from development or catastrophic fire. The

Assigning Monetary Value to the Tolt River Watershed

The Tolt River Watershed is located in the foothills of the Cascade Range just east of Seattle, Washington, and is an important source of drinking water for the nearby urban area. Pacific Northwest scientist Trista Patterson and her colleagues at Earth Economics and the Gund Institute for Ecological Economics are conducting a case study to estimate the monetary value of 23 ecosystem services provided by this 3,700-acre watershed in the Snoqualmie National Forest.

Using value transfer methodology, researchers determine the estimated dollar value based on previous valuation studies of similar goods or services in other comparable locations. By using geographic information system data and the best available protocols for estimating the value of forest benefits, annual dollar values per acre for ecosystem services are assessed based on site-specific age, health, and species diversity of forests in the watershed. Long-term monetary value is then calculated to project the annual flow of ecosystem benefits over various timeframes.

The study assesses specific ecosystem services such as water purification, flood control, nutrient cycling, and climate regulation, estimating high and low dollar value ranges for each. However, Patterson explains that there are a lot of challenges to coming up with estimates. Some ecosystem services identified in the Tolt River Watershed could not be estimated because previous valuation studies have not been conducted for those services. For others, such as aesthetic or spiritual benefits, values could not be captured. Still other benefits may not yet be identified. Furthermore, if development pressures continue to increase, ecological services will become more scarce, and the values of many ecosystem services will increase over time.

"The annual values calculated . . . represent only thin slices of the benefits that future generations will gain if the watershed is maintained in an ecologically healthy condition," says Patterson. Even so, although the dollar values may not be correct in absolute terms, they are still useful in evaluating the relative differences in ecosystem service outcomes among various management options, and therefore may be useful in decisionmaking.

Assigning monetary value to the many benefits provided by a healthy watershed is difficult. If values are agreed upon, however, it provides a convenient way to tally the tradeoffs between land uses.

community might come to the conclusion that watershed protection is more cost-effective than building an expensive water treatment plant.

For the Forest Service, effectively communicating the contributions of public lands to human well-being, or as Patterson puts it "keep[ing] forests and their benefits prominent in the minds of Americans" is critical to future research and management programs. As timber revenue shrinks, so does the traditional funding base for noncommodity forest programs. To justify public investment in these programs, the importance of public support and understanding of the Forest Service's role in providing vital ecosystem goods and services becomes paramount.

How can research increase public awareness and understanding?

Getting the public's attention and helping people understand future consequences of today's actions is a big challenge. Environmental issues compete with other concerns such as education, health care, and crime. Fortunately, public concern for the state of the environment has been on the rise over the

National Forest Lands and Water Supplies in an Uncertain Climate Future

The realities of a changing climate are being experienced worldwide. Of great concern are the anticipated impacts on water resources, affecting regions differently throughout the world. Gordon Grant, a research hydrologist with the PNW Research Station in Corvallis, Oregon, has recently completed research on the potential impacts of changing climate conditions on water supplies in the Western United States. Grant's research reveals the tremendous value of public lands as a source for a critical ecosystem service—providing fresh water for communities throughout the region.

Grant explains that, under warmer climate conditions, most of the future water in the Western United States will come from high-elevation Forest Service lands in the Cascade Range. Grant's research looked at the influence of geology, discovering that most of the late summer streamflows in western and central Oregon and northern California are sourced by groundwater that percolates through the deep layers of highly permeable lava flows in the Cascade Range. The volcanic landscape of these national forest lands in the High Cascades Province lends itself to tremendous groundwater storage capacity—the amount of water stored belowground in these lava flows is seven times that stored as snow. Until now, the loss of mountain snowpack has been the major focus of climate-related research on streamflow throughout the West. Grant's research has resulted in a model for predicting the influence of geology on streamflow, showing that geologic variation will affect regional sensitivity to global warming across the West.

In the October 2007 issue of the Pacific Northwest Research Station's *Science Findings*, Grant stated "In the not-so-distant future, clean water will be the single most important commodity produced from national forest lands. It will totally eclipse timber." As the impacts of climate change and access to water supplies become more serious public policy issues, this type of research will be vital in illustrating the importance of public forest lands.

If precipation patterns change as projected, leaving much of the West more arid, water that is stored on and filtered through national forests will become even more valuable.

past few decades, reflected in media coverage of environmental issues, and the "greening" trend of corporate America.

"Part of ecosystem services is a reflection of globalization and the shift in global environmental values," said Haynes, "and as the Forest Service is one of the largest land management agencies in the world, that affects how we manage our national forests." Providing information about ecosystem services during a time of heightened public concern for the environment may help build a constituency for conservation and good stewardship practices.

Research can help demonstrate the explicit link between healthy ecosystems and human welfare by showing how consumptive behaviors and management actions can affect the type, quality, and quantity of services we receive from natural systems now and into the future. A good place to start is addressing issues that resonate with the public—issues that people care about and affect their daily lives. Research on "big ticket" issues like water scarcity and climate change is a good example. (See Sidebar: National Forest Lands and Water Supplies in an Uncertain Climate Future.)

Other potential research contributions to public awareness are analysis and visualization tools that can help inform public dialog. "The ability to visualize what data and models are telling you is a powerful communication tool," says Bob McGaughey, research forester with Resource Management and Productivity program. In 2001, McGaughey completed development of a dynamic visualization tool called EnVision, which produces three-dimensional renderings of forests to illustrate forest stands and landscapes under different management scenarios or resulting from impacts such as fire, disease, or insect outbreaks. EnVision was developed as a tool to help establish a dialog with the public about proposed or possible management alternatives and their effects on the landscape.

"Some people look at numbers and understand; some people look at pictures and understand. Some need both. But if you leave out the visual piece, you leave out many of the people you are trying to communicate with," says McGaughey.

Developing dynamic visualization tools for ecosystem services issues has great potential to enhance public dialog. Demonstrations of the EnVision tool and similar but more sophisticated animation technologies used in PNW research can be viewed on the Internet. (See the *Resources on the Web* section at the end of this issue.)

What challenges exist in applying ecosystem services research to management?

With a focus on production of ecosystem services from national forest lands, key management questions arise:

- How can the national forests be managed to provide a range of ecosystem goods and services that can be sustained for future generations?
- How can the flows of ecosystem services be sustained?
- To achieve these goals, what information and tools are needed to consider ecosystem services in land management planning?

The Station is set to consider how current research programs can support management questions such as these and what a research strategy for ecosystem services would look like. Among the many challenges in developing an ecosystem services research program is describing changes in ecosystem service outputs that result from different types of forest management actions while accounting for natural disturbances and other factors. "That information can be a significant challenge for ecologists, fish and wildlife biologists, hydologists, and other physical scientists to produce," says Kline. There is a need to develop indicators of ecosystem service quality that can be measured over time and at multiple spatial scales. As it is with ecological indicators, "information is spotty and uneven," says Tom Spies, team leader for the PNW's Forest Landscapes and Ecosystems program. "There is a need to test the hypotheses that are embedded in models with more targeted research. As more interest is generated in what research can tell you about ecosystem services, a greater case will be made for testing models and further developing ecosystem service indicators," explains Spies.

One challenge is describing changes in ecosystem service outputs while accounting for natural disturbances and other factors.

Another challenge lies in the ability to look at the net social benefit of ecosystem services now and into the future. "This requires a systems analysis approach . . . and collaboration of experts across disciplines," says Patterson. Kline advocates using the expertise from the social and natural sciences when addressing broader issues of ecosystem services, "with special emphasis on revisiting the lessons in natural resource and environmental economics." (See Sidebar: Applying Ecosystem Services Research to Management.)

Capitalizing on existing research. Although existing research might not have originally been conducted as "ecosystem services studies," PNW scientists nonetheless have amassed a large body of information, and developed methods, models, and tools that will be relevant to future ecosystem services research. "In terms of describing what ecosystems produce, we are making progress," says Tom Spies. "PNW research is developing the scientific building blocks—the tools and information—that can be used to better understand the status and trends of ecosystem services, and to support decision-making for policy and management," says Spies.

John Laurence, program manager for the Ecosystem Processes program, agrees with this assessment, explaining that PNW research programs will be the "purveyors of information for those trying to communicate the values of ecosystem services." Laurence explains that discussions on the role of

Tom Hanley

Deer, moose, and caribou are important food sources for many rural Alaskans. Scientists share information with forest managers to improve the habitat for these species, thus enhancing the ecosystem services provided by the land.

Applying Ecosystem Services Research to Management

Tom Hanley, research wildlife biologist for the Boreal Ecology Cooperative Research Unit in Fairbanks, Alaska, has faced several challenges in applying ecosystem services research to management. Working with scientists at the University of Alaska–Anchorage, Hanley developed a model to quantitatively assess habitat quality and availability for deer in southeast Alaska and moose in the Alaskan interior, giving managers a tool for addressing subsistence hunting needs in the two regions.

In the interior part of Alaska, a region experiencing the effects of climate change more rapidly than most places on Earth, Hanley's work is being used to anticipate moose population response to climate change and, in turn, anticipate what lies ahead for rural communities who rely on subsistence hunting for food. Hanley's model allows managers to quantitatively assess and predict how moose habitat productivity may respond to various silviculture options and changing environmental conditions. Thus, the model allows managers to quantitatively evaluate tradeoffs of forest management options that affect ecosystem services.

However, this type of research is data intensive and functions at the scale of individual stands or watersheds. To be useful at broader regional scales where tradeoff between various ecosystem services are being considered, the challenge lies in the ability to aggregate from specific sites to broader regional scales. In Hanley's view, this is where economists and natural scientists need to collaborate. "The ecosystem services analyst can't get bogged down in the details of moose biology. Moose habitat is just one factor to consider when thinking about values and tradeoffs in ecosystem services."

Yet, without these quantitative models, relationships are based on published literature and best professional judgment—what Hanley refers to as a "black box" of expert opinion. Ecosystem services assessments may be an exercise in finding a middle ground between educated guesswork and rigorous quantitative analysis. The fundamental problem for Hanley is, How do you come up with the numbers (e.g., moose values related to a specific forest type over an entire region) in a way that is quantifiably defensible?

"As managers start using our models more and as more data are collected," says Hanley, "we will be able to derive larger relationships across data sets" that will be more useful for broader scale ecosystem services considerations. Hanley's models are available online at http://cervid.uaa.alaska.edu.

current research programs concerning ecosystem services have centered around what available information will be useful and how to present it. For instance, current research that addresses questions of ecosystem condition and alternative management systems, such as timber harvest practices that produce wildlife habitat benefits, will be valuable in ecosystem services assessments. "There is a lot of available information that . . . will be highly relevant to discussions of ecosystem services," says Laurence.

"To a large extent, the Forest Service has always been about providing and managing ecosystem services," says Jeff Kline. "PNW scientists have a long history in providing information to aid that objective, from the landscape ecologist studying the effects of harvest practices on owl habitat, to the fish biologist examining the effects of road placement on fish, to the social scientist estimating future demands for water or outdoor recreation provided by federal lands. New emphasis on ecosystem services merely highlights the contemporary relevance and importance of that research legacy, and suggests that the PNW Research Station probably is as equipped as anyone to tackle the complex issues inherent in ecosystem sustainability," says Kline.

One way that research legacy can be applied to ecosystem services research is further developing current PNW work that forecasts ecosystem outcomes under different management scenarios or under changing environmental conditions. One such study is the Coastal Landscape Analysis and Modeling Study (CLAMS). Although CLAMS pre-dates the current focus on ecosystem services, the methods, models, and tools associated with it lend themselves to new uses. Tom Spies, the co-leader of the CLAMS project explains that they are building on their past research to address other questions such as the extent to which a forested landscape contributes to carbon storage and water quality.

The CLAMS tools could be used to help identify and prioritize actions that are likely to enhance ecological services in a landscape. For example, they could be used to help strategically direct market investments in carbon offsets in locations that may provide the greatest ecological benefit. Take riparian fish habitat as another example. "Much of the suitable habitat for coho salmon lies on private lands," says Spies. "If we wanted to establish a market for riparian habitat, [CLAMS tools] could be used for setting priorities—finding where the high-quality habitat exists within the landscape, and working with those landowners to provide market incentives to protect those lands. You could target stream reaches that are best suited for a species you want to protect," explains Spies.

How can the Forest Service promote incentive-based conservation on private lands?

Sources of habitat, clean water, and clean air do not recognize land ownership boundaries. The extent, pattern, and condition of forests across the landscape determine the type and quality of ecosystem services that forests can provide. Private forests make up almost 60 percent of the Nation's forested lands, and are under increasing pressures from urbanization and other types of development. Sustaining the flow of ecosystem goods and services requires planning and cooperation across ownership boundaries and at multiple temporal and spatial scales. The Forest Service can play an important role in sustaining ecosystem services across the landscape by offering expertise, resources, information, and programs to its neighbors and partners.

Markets. One area that is generating a lot of interest within the Forest Service is fostering markets for ecosystem services to protect, enhance, and restore ecosystem services on private lands. With ecosystem services markets, individuals are given what amounts to property rights to particular services, allowing them to use, sell, or trade in areas such as water quality, habitat, or carbon offsets. Robert Deal, a research forester with the Focused Science Delivery Program, explains that market-like systems for the purpose of conservation can provide some flexibility in meeting regulatory requirements for laws such as the Endangered Species Act or the Clean Water Act, and are well established for some ecosystem goods and services, such as wetlands mitigation banking.

The Forest Service can help sustain ecosystem services across the landscape by offering expertise to its neighbors.

"A lot of the efforts in ecosystem services will be led by the private side with market-based plans," says Deal. "Cap and trade programs, planting trees for carbon sequestration, wetland mitigation banking, conservation banking . . . all present opportunities for achieving conservation gains using a combination of regulations and incentives while creating new revenue streams for private landowners." According to Deal, "There's lots of interest and excitement out there, with coalitions of conservationists, forest industry and landowners, and other groups that used to work against each other now working together to develop market-based strategies for conserving ecosystem services."

The role of government in markets. Many believe that to promote markets for the private sector, federal lands should not enter these markets. The concern is that public land transactions would hinder markets for private lands by flooding markets and lowering prices for services. Richard Haynes explains that the Forest Service's carbon offset program has been questioned.

"The role of government is not to enter or create markets," says Haynes, "You don't create markets. Markets are organic. They grow on their own. The role of government is to create policies and standards and provide support" for the growth of markets in the private sector."

Managing across landscapes for ecosystem services creates new opportunities for public land agencies and private landowners to work together.

Not a panacea. Although market-based approaches will likely have an important role to play in encouraging private landowners to protect and enhance ecosystem services, Kline warns that they are not a panacea. "For any policy approach to work, you have to be able to measure performance—what will you get by investing in a particular approach in one location or another—and you have to be able to enforce and verify that performance over time. Those challenges exist regardless of whether you are using regulation, tax credits, or cost-sharing to encourage markets" says Kline. "Each approach has the potential to achieve similar outcomes, but for markets, success also depends on being able to institute a regulatory framework that provides an incentive for trading. Then you have to hope that the costs of negotiating trades—what economists call "transaction costs"—can be reduced to the point where trades actually will occur. All of that can be a significant hurdle to overcome," says Kline. For these reasons, Kline contends markets are not always better than other policy approaches for conservation and environmental protection.

Despite these hurdles, Deal believes that ecosystem service markets are most promising, as they provide advantages for "doing business" in an environmentally responsible way. "There is a need to shift our thinking from conservation as a burden or endangered species habitat as a liability, and start exploring how restoration and stewardship of ecosystem services can be a profit-making enterprise," says Deal.

Client information needs. In January 2007, representatives from the forest industry; family forest landowners; timber investment management organizations; local, state, and federal agencies; consultants; bankers; farmers; land trusts; and conservation groups attended a workshop organized by Deal to identify opportunities and barriers for developing markets for specific ecosystem services.

As a result of the workshop and followup meetings, key information and research needs were identified. In general, landowners want to know what potential services (e.g., carbon sequestration, wetland habitat, biodiversity, etc.) can be provided from their land, and how valuable those services might be in dollars. Participants also expressed interest in tools that can track carbon inputs and outputs, or predict impacts on water temperature from planting trees in riparian areas. Other key information needs that were mentioned included determining the relationship between land management actions, such as forest land conversion to development, or various regulation options, and resulting impacts on ecological services.

In Deal's view, the key client needs identified in the workshops represent areas where the PNW Station could make meaningful contributions to the development and application of new knowledge and tools related to ecosystem services and markets. "It helps us focus on some of the most important questions for our clients," says Deal, "and that should be a major priority for our work."

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Tom Spies, tspies@fs.fed.us, Ecosystem Processes Program, PNW Research Station.

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Web Resources

Ecosystem Marketplace
http://www.ecosystemmarketplace.com/

Millennium Ecosystem Assessment. http://www.maweb.org

USDA Forest Service: Valuing Ecosystem Services.
http://www.fs.fed.us/ecosystemservices

USDA Forest Service, PNW Research Station: EnVision tool.
http://www.fs.fed.us/pnw/envision.

USDA Forest Service, PNW Research Station: CLAMS animated visualizations. http://www.fsl.orst.edu/clams/map_index.html.
(CLAMS visualizations were developed by Visual Nature Studio: http://3dnature.com/vnsinfo.html)

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Got Science?

The Pacific Northwest Research Station launches two new Web resources in March 2008.

The Web site for the **Climate Change Resource Center** is a new resource for land managers developing adaptation and mitigation strategies for climate change. It includes a reference library on climatology, climate change, ecological impacts, and carbon relations. Check www.fs.fed.us/ccrc to learn about the projected interactions between changing climate and issues ranging from biodiversity to plant diseases, to land use.

Check the **Western Wildland Environmental Threat Center** Web site to learn about the center's research on risk assessment and management of insects, wildfire, invasive species, and other threats. Find out about upcoming workshops hosted by the center and tools for mapping environmental threats at www.fs.fed.us/wwetac.