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# The Law and Policy Beginnings of Ecosystem Services

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When we bite into a juicy apple and pause to think about where it came from, once we look beyond the store where it was purchased and the orchard where it was grown, we may think of soil and water, but it is unlikely we also consider the natural pollinators that fertilized the apple blossom so the fruit can set. When we drink a cool glass of water from the tap we may think of the local reservoir, but the real source of the water quality lies many miles upstream in the wooded watershed that filters and cleans the water as it flows downhill. When we enjoy a fun holiday at the beach we may think of the warm sun, but not of the carbon sequestration by plants that contributes to climate stability.

Largely taken for granted, healthy ecosystems provide a variety of such critical goods and services. Created by the interactions of living organisms with their environment, it is no exaggeration to state that the suite of "ecosystem services" — purifying air and water, detoxifying and decomposing waste, renewing soil fertility, regulating climate, mitigating droughts and floods, controlling pests, and pollinating vegetation — quite literally underpins human society.[3] One cannot begin to understand flood control, for example, without realizing the impact that widespread wetland destruction has had on the ecosystem service of water retention;[4] nor can one understand water quality without recognizing how development in forested watersheds has degraded the service of water purification.[5]

Over the past decade, there has been an explosion of interest in ecosystem services from scientists, economists, government officials, entrepreneurs, and the media. Yet, the importance of natu-

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3. *See generally* NATURE'S SERVICES: SOCIETAL DEPENDENCE ON NATURAL ECOSYSTEMS 3 (Gretchen Daily ed., 1997) [hereinafter NATURE'S SERVICES].

4. *See, e.g.*, The Trust for Public Land, Building Green Infrastructure: Land Conservation as a Watershed Protection Strategy 13 (2000); Norman Myers, *The World's Forests and Their Ecosystem Services*, *in* Nature's Services, *supra* note 3 at 215—17.

5. *See, e.g.*, THE TRUST FOR PUBLIC LAND, AN OUNCE OF PREVENTION: LAND CONSERVATION AND THE PROTECTION OF CONNECTICUT'S WATER QUALITY 5—8 (1998); Katherine C. Ewel, *Water Quality Improvement by Wetlands*, *in* NATURE'S SERVICES, *Supra* note 3 at 329, 334—36.

ral services to human welfare is neither a novel nor a recent idea. One can trace references to ecosystem services as far back as Plato, and more recently through the writings of George Perkins Marsh, the father of modern-day ecology, and observations of famed environmental writer, Aldo Leopold, among others.[6] So why all the recent excitement over an idea that has been around for millennia?

If we look to fix a date for the birth of ecosystem services as a big "new" idea, it would be 1997 and three influential publications. The first was the book, *Nature's Services.*[7] Its origins were explained by its editor, ecologist Gretchen Daily, in the book's Preface. After dinner one night at an annual meeting of Pew Fellows in Conservation and the Environment, beneath the Arizona stars,

> A small group gathered informally to lament the near total lack of public appreciation of societal dependence upon natural ecosystems. . . . [L]ack of understanding of the character and value of natural ecosystems traces ultimately to a failure of the scientific community to generate, synthesize, and effectively convey the necessary information to the public. A collective strategy to address this problem emerged from the group's discussion, the first phase of which consisted of producing a rigorous, detailed

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6. Plato wrote,

> What now remains of the formerly rich land is like the skeleton of a sick man with all the fat and soft earth having wasted away and only the bare framework remaizning. . . . The soil [used to be] deep, it absorbed and kept the water . . . , and the water that soaked into the hills fed springs and running streams everywhere.

NATURE'S SERVICES, *Supra* note 3, at 5-6 (quoting Plato as quoted in HILLEL, OUT OF THE EARTH: CIVILIZATION AND THE LIFE OF THE SOIL 104 (1991)).

In the 19th century, George Perkins Marsh similarly observed, "Earth, water, the ducts and fluids of vegetation and animal life, the very air we breathe, are peopled by minute organisms which perform most important functions in both the living and inanimate kingdoms of nature." NATURE'S SERVICES, *Supra* note 3 at 12 (quoting GREGORY PERKINS MARSH, MAN AND NATURE 108 (David Lowenthal ed., Harvard Univ. Press 1965) (1864)).

And the great environmental ethicist Aldo Leopold noted,

> The cowman who cleans his range of wolves does not realize he is taking over the wolf's job of trimming the herd to fit the range. He has not learned to think like a mountain. Hence we have dustbowls, and rivers washing the future into the sea . . . . A land ethic changes the role of *Homo sapiens* from conqueror of the land community to plain member and citizen of it.

ALDO LEOPOLD, A SAND COUNTY ALMANAC AND SKETCHES HERE AND THERE 132 (1949).

7. NATURE'S SERVICES, *supra* note 3.

> synthesis of our current understanding of a suite of ecosystem services and a preliminary assessment of their economic value.[8]

The result was a book written by world-class scientists and economists that, for the very first time, presented a well-researched and accessible description of the suite of ecosystem services. *Nature's Services* addressed two basic questions — (1) what services do natural ecosystems provide society, and (2) what is a first approximation of their monetary value? Separate chapters described the range of services and physical benefits provided by climate, biodiversity, soil, pollinators, pest control, the major biomes (oceans, freshwater, forests and grasslands), and case studies where the values of ecosystem services are particularly well-known. Lower-bound estimates of monetary value were determined through replacement costs where possible.

The chapter on soil provides a useful example of the book's findings. More than a clump of dirt, soil is a complex matrix of organic and inorganic constituents transformed by numerous tiny organisms. This living soil provides six ecosystem services: buffering and moderation of the hydrological cycle (so precipitation may be soaked up and metered out rather than rushing off the land in flash floods), physical support for plants, retention and delivery of nutrients to plants, disposal of wastes and dead organic matter, renewal of soil fertility, and regulation of the major element cycles.[9] What are these services worth in the aggregate?

Looking at just one ecosystem service that soil provides, the provision of nitrogen to plants, serves as an example. Nitrogen is supplied to plants through both nitrogen-fixing organisms and recycling of nutrients in the soil. As mentioned above, the authors primarily relied on replacement costs to estimate the value of ecosystem services. If nitrogen were provided by commercial fertilizer rather than natural processes, the lowest cost estimate for crops in the U.S. would be $45 billion, the figure for all land plants $320 billion.[10]

Foundation funds were provided both for writing the book and, equally important, a media campaign accompanying its publication. People took notice. The *New York Times* hailed the book as "the pioneering efforts of some practical ecologists who are eager to make common cause with economists."[11]

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8. *Id.* at xv.
9. *Id.* at 117.
10. *Id.* at 125.
11. Peter Passell, *Economic Science*, N. Y. TIMES, Mar. 27, 1997, at D3.

While a buzz was just forming around *Nature's Services,* the famed scientific journal, *Nature,* published a multi-author article entitled, "The Value of the World's Ecosystem Services and Natural Capital." [12] Examining a range of ecosystem services, the article estimated their global value at between $16-54 trillion per year (the global GNP is $18 trillion).[13] This study generated heated debate within the academic community, with many arguing that the methodology was fundamentally flawed.[14] But it also provided great sound-bite material for the general public — "Nature provides greater wealth than world's economy!"[15]

The third publication was just a short piece by economists Geoff Heal and Graciela Chichilnisky in *Nature.* In two pages, they recounted the story of New York City's strategy of paying landholders and communities in the Catskills watershed in order to ensure clean drinking water. Faced with EPA regulations requiring pre-treatment of drinking water, New York City's water managers found they could ensure clean water more cheaply by paying for landscape management practices in the upper watershed than in building a pre-treatment plant.[16] The moral of the story was simple — investing in natural capital can be a better commercial option than investing in built capital. This example has since become somewhat of a creation myth, certainly the best-known and oft-repeated case for the merits and commercial promise of paying ecosystem services.[17]

To be sure, much had already been published on the operation and value of ecosystem services, and ecosystem service payment schemes were already operating in many parts of the globe,[18] but the concurrent release and media response to these publications both raised the profile of ecosystem services and, more important, began to generate interest among quite diverse audiences — from

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12. Robert Costanza et al., *The Value of the World's Ecosystem Services and Natural Capital,* NATURE, May 15, 1997, at 253.

13. *Id.*

14. *See, e.g.,* David Pearce, *Auditing the Earth: The Value of the World's Ecosystem Services and Natural Capital,* ENVIRONMENT March 1998, at 23-28 (disputing bases for estimate but supporting effort).

15. *See, e.g.,* Tom Horton, *A $54 Trillion Paycheck For Our Ecosystems,* PLAIN DEALER, Aug. 29, 1997.

16. *See* Graciela Chichilnisky & Geoffrey Heal, *Economic Returns from the Biosphere,* NATURE Feb. 12, 1998, at 629.

17. For a debate on the meaning of the Catskills case, see Mark Sagoff, *The Catskills Parable: A Billion-Dollar Misunderstanding,* PERC REPORTS, June 2005, *available at* http://www.perc.org/perc.php?subsection=5&id=547; *see also* James Salzman, *What Paying for Ecosystem Services Means,* Property & Environment Research Center, Letters to the Editor (2005) *available at* http://www.perc.org/perc.php?subsection=5&id=771.

18. See the work of Oliver Houck on wetlands in Louisiana for an example. *See, e.g.,* Oliver A. Houck, *Land Loss in Coastal Louisiana: Causes, Consequences, and Remedies,* 58 TUL. L. REV. 3 (1983).

academics and policy wonks to companies and environmental groups. Each group saw the potential of an ecosystem services approach to further their own interests, whether it was a new stream of income for conservation or a money-making opportunity.

In less than a decade, ecosystem services have gone mainstream, whether as "environmental services," "ecological services," or simply "investing in nature." Virtually anywhere one looks, whether at political initiatives and research projects or market creation and NGO activities, interest in ecosystem services is on the rise around the globe, and still rising. As an instructive snapshot, consider, for example, the following snippets of the most significant developments across a broad range of sectors.

### *Scholarship*

If one focuses on legal scholarship as a proxy, from 1990 through 1996 there were only 17 articles containing the term "ecosystem services." During the following seven years, from 1997-2003, over ten times that number of law review articles referred to ecosystem services. Similar increases in scholarly attention occurred in scientific and economics publishing during this period, as well.[19] The National Academy of Sciences published a major study on the Catskills story[20] and a number of books came out full of case studies on payments for ecosystem services all over the globe.[21] There have also been a number of scientific studies published that directly link agricultural productivity with ecosystem service provision.[22]

### *Payments for Ecosystem Services*

Business opportunities have proven powerful drivers of interest in service provision in many other sectors. With growing interest in the money to be made by investing in service provision, people have begun to realize that many markets for services already exist.

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19. A search on JSTOR found that cites in Economics journals increased 9-fold over the same period, and cites in scientific journals increased five-fold (from 73 cites in 1990-1996 to 372 cites in 1997-2003).

20. NATIONAL ACADEMY OF SCIENCES, WATERSHED MANAGEMENT FOR POTABLE WATER SUPPLY: ASSESSING THE NEW YORK CITY STRATEGY (2000).

21. *See, e.g.*, NATASHA LANDELL-MILLS & INA T. PORRAS, SILVER BULLET OR FOOLS' GOLD: A GLOBAL REVIEW OF MARKETS FOR FOREST ENVIRONMENTAL SERVICES AND THEIR IMPACT ON THE POOR (2002) [hereinafter SILVER BULLET]; SELLING FOREST ENVIRONMENTAL SERVICES 37, 37—62 (Stefano Pagiola et al. eds., 2002).

22. *See, e.g.*, Roland Olschewski et al., *Economic Evaluation of Pollination Services Comparing Coffee Landscapes in Ecuador and Indonesia*, 11 ECOLOGY AND SOCIETY 7 (2006), *available at* http://www.ecologyandsociety.org/vol11/iss1/art7.

Over 280 cases of payments have been documented for *forest* ecosystem services from around the world,[23] not to mention mitigation markets, subsidy schemes, government competitive payments, etc.[24] More enticing, there is great interest in potential new opportunities. It was no coincidence that the influential magazine, *The Economist,* dedicated its April 23, 2005 cover story to ecosystem service markets.[25]

For markets to work, people need to know they exist, and participants need to see, with clarity and ease, who is buying, who is selling, and at what price. There also needs to be a clear understanding of the policy changes that drive these markets, as well as the science that underpins them. Anyone who wants to participate in a market needs basic information — prices, transactions, how the services are measured, packaged and sold, where the buyers and sellers are, etc. To date, this information gap has been a major barrier to ecosystem service market growth. Carbon sequestration has proven an exception to this trend, and an entire cottage industry has developed around this service, for example, with the growth of consultants, markets and newsletters trying both to form and inform the carbon market.[26]

More generally, a website known as the Ecosystem Marketplace has been launched to provide a "one-stop shop" for basic and timely information on emerging markets and payment schemes for ecosystem services around the world.[27] Lloyds of London is known to everyone today as an insurance giant, but it's worth remembering that it started as a popular coffee house where merchants came together to exchange information about shipping news. The Marketplace seeks to provide the same central source of information and networking to buyers and sellers today, facilitating transactions, catalyzing new thinking, and spurring the development of new ecosystem markets.

### *Environmental Groups*

The environmental group, Forest Trends, and its visionary leader, Michael Jenkins, have played a critical role in popularizing

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23. *See* SILVER BULLET, *Supra* note 21, at 3.

24. *See, e.g.,* The Ecosystem Marketplace,Library, http://ecosystemmarketplace.com/pages/section_landing.library.php?component_class_name=case_study (last visited August 27, 2007).

25. *See Rescuing Environmentalism (and the Planet),* THE ECONOMIST, Apr. 23, 2005.

26. *See, e.g.,* Point Carbon, http://www.pointcarbon.com/ (last visited August 27, 2007).

27. See The Katoomba Group's Ecosystem Marketplace, http://ecosystemmarketplace.com/, (last visited August 22, 2007).

the model of payments for ecosystem services. Convinced that market mechanisms needed to be harnessed in order to save the world's forests, Forest Trends was an early leader in identifying and documenting examples of payments for ecosystem services as well as developing a business model to generate income streams from service provision. Over a series of international workshops starting in 2000, Forest Trends brought together key individuals from a wide range of sectors — forest product companies, insurers, bankers, grassroots activists, journalists, international civil servants, etc. — from dozens of countries. The goal of this loose network, which came to be known as the Katoomba Group,[28] was both to popularize and serve as the catalyst for ecosystem service payment schemes. The Katoomba Group launched the Ecosystem Marketplace and created regional networks in Latin America and Africa.[29]

Traditional conservation and land trust organizations have also picked up the ecosystem services bug. In a fascinating initiative known as the Natural Capital Project (the brainchild of Gretchen Daily, among others), the Nature Conservancy, the World Wildlife Fund, and Stanford University joined together in a multi-year, multi-million dollar undertaking. Working with study sites in Tanzania, China and central California, the project seeks to develop tools that capture the value of ecosystem services in decision-making, further integrate the consideration of ecosystem services in the policy process, and demonstrate how this can and should be done in practice.[30]

### *National Governments*

The U.S. Environmental Protection Agency created a Science Advisory Board on Valuing the Protection of Ecological Systems and Services in 2003.[31] That same year in Australia, a high-level advisory body, known as The Wentworth Group, called for a new approach to environmental protection that focused on provision of ecosystem services.[32] Perhaps most impressive, the U.S. Forest Service explicitly revised its agency mission to incorporate conser-

28. In the interests of full disclosure, co-author Jim Salzman is on the Katoomba Group Board.

29. *See* Katoomba: Home, http://www.katoombagroup.org/ (last visited August 27, 2007).

30. *See* Natural Capital Project, http://www.naturalcapitalproject.org (last visited August 22, 2007).

31. Sci. Advisory Bd., Request for Nominations for Experts for a Panel on Valuing the Protection of Ecological Systems and Services, 68 Fed. Reg. 11,082-01 (Mar. 7, 2003).

32. *See* THE WENTWORTH GROUP, BLUEPRINT FOR A LIVING CONTINENT 3, 14 (2002), *available at* http://www.ccsa.asn.au/Blueprint_for_a_Living_Continen.pdf.

vation of ecosystem services.[33] This change of heart is perhaps best exemplified by the statement of the Secretary of Agriculture, Mike Johanns, who declared, "Today, I am announcing that USDA will seek to broaden the use of markets for ecosystem services through voluntary market mechanisms. I see a future where credits for clean water, greenhouse gases, or wetlands can be traded as easily as corn or soybeans."[34] It is a sign of the times when the most important government official for farm policy openly calls for a future premised upon the growth and flourishing of ecosystem service markets.

*International Organizations*

International governmental organizations have also gotten into the act. For example, the World Bank has undertaken significant research on payment for ecosystem services projects and created a financing mechanism for carbon sequestration projects.[35] The UN Food and Agriculture Program is devoting its influential annual publication in 2007, *The State of Food and Agriculture*, to payments for ecosystem services. Most impressive, though, has been the Millennium Ecosystem Assessment. Launched in 2001, the Assessment was modeled on the Intergovernmental Panel on Climate Change and partnered with secretariats of the Biodiversity, Desertification, Ramsar and Migratory Species conventions. Relying on the contributions of more than 1,360 experts from over 95 countries around the globe, the Assessment published a series of reports that represented the first attempt by the scientific community to assess globally the full range of benefits provided by nature. The Assessment took an explicitly ecosystem services perspective, focusing on:

- Ecosystem services (the benefits people obtain from ecosystems);
- How changes in ecosystem services have affected human well-being;

33. The lead person behind this development, Associate Chief of the U.S. Forest Service Sally Collins, was the keynote speaker at the symposium. *See, e.g.*, Sally Collins, The Forest Service's Role in Markets For Ecosystem Services (June 8, 2006), (speech available at http://www.fs.fed.us/news/2006/speeches/06/ecosystem-services.shtml).

34. Mike Johanns, Sec'y, U.S. Dep't of Agric., Remarks at the White House Conference on Cooperative Conservation: Innovations In Land and Resource Governance, (Aug. 29, 2005) (transcript available at http://www.usda.gov/wps/portal/!ut/p/_s.7_0_A/7_0_1OB?contentidonly=true&contentid=2005/08/0335.xml).

35. *See* Carbon Finance at the World Bank: Home, http://carbonfinance.org/ (last visited August 27, 2007).

- How ecosystem changes may affect people in future decades; and
- Response options that might be adopted at local, national, or global scales to improve ecosystem management and thereby contribute to human well-being and poverty alleviation.[36]

*What's in a Name?*

As noted above, the basic idea behind ecosystem services is not new, so why has this term had such traction among such a wide range of groups? One clear strength of the ecosystem service perspective has been to re-frame land management and conservation in familiar financial terms. People are used to thinking in terms of financial capital and human capital. Framing the issue in terms of natural capital makes it easy for people to think of assets (the ecosystem services), streams of revenue (ecosystem goods), outside investment to grow the asset, and creating markets to sell the goods. As in any well-managed portfolio, one also naturally thinks of managing multiple assets, just as one should consider managing land for multiple service provision.

Second, putting a dollar figure on services, however controversial among professional economists, makes it easy for the public to appreciate just how valuable they are. And finally, where people see value they also see markets and, importantly, a way to make money. An ecosystem perspective makes land management and nature conservation potentially lucrative to entrepreneurs and financiers. Equally, from the viewpoint of land trusts and conservation organizations, ecosystem services represent a potential source of revenue to supplement their activities. Put simply, if there's money to be made, people get interested.

In 1998, Jim Salzman supervised a STAR grant funded by EPA to examine the extent to which EPA was currently protecting ecosystem services and, given its statutory authority, how it might strengthen protection of services. Bringing together economists, hydrologists, lawyers and economists, a series of papers were written examining the legal protection of services under NEPA's environmental impact statements,[37] CERCLA and the Oil Pollution Act's provisions for natural resource damages,[38] the Clean Water

36. *See* Millennium Ecosystem Assessment, http://millenniumassessment.org/en/Synthesis.aspx (last visited August 27, 2007).

37. *See* Robert L. Fischman, *The EPA's NEPA Duties and Ecosystem Services*, 20 STAN. ENVTL. L.J. 497 (2001).

38. *See* Janet Herman et al., *Groundwater Ecosystems and the Service of Water Purification*, 20 STAN. ENVTL. L.J. 479 (2001).

Act's requirements of mitigation for dredging and filling wetlands,[39] and local government authority.[40] These papers and others were presented at a multi-stakeholder workshop at Stanford in 2000 and published in a special symposium issue of the *Stanford Environmental Law Journal* in May 2001. This represented the first comprehensive assessment of the legal status of ecosystem services.

As the brief descriptions of recent developments made clear, though, the field has changed greatly since the late 1990s and there are a lot of exciting developments underway. With the partnership of the *Journal of Land Use & Environmental Law,* we thought it important to revisit the state of the field five years after the Stanford workshop. Thus we invited experts across the range of environmental law to Florida State for a two-day workshop assessing the current status of ecosystem services in environmental law. The results are set out in this symposium issue.

As background to the authors, we set out five distinct law and policy challenges to consider:

**Scale of Service Provision**

- What is the right scale for service management?
- Because ecological and political boundaries rarely overlap, how can the law overcome collective action problems and the challenge of extending authority beyond traditional institutional boundaries?

**Market Failures**

- Given that many services are public goods, how can the law influence price signals to encourage protection and provision of services?
- How can service scarcity be linked more closely with market mechanisms?
- How can the obstacles to linking discrete buyers and sellers of services be overcome?

**Property Rights**

- Who owns the positive externalities from service provision?
- What are the limits of nuisance law when the flow of services is impaired?

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39. *See* J.B. Ruhl & R. Juge Gregg, *Integrating Ecosystem Services Into Environmental Law: A Case Study of Wetlands Mitigation Banking,* 20 STAN. ENVTL. L.J. 365 (2001).

40. *See* Geoffrey Heal et al., *Protecting Natural Capital Through Ecosystem Service Districts,* 20 STAN. ENVTL. L.J. 333 (2001).

- To what extent can or should government commodify services?
- Can we find and use effective metrics of service provision?

**Instrument Choice**

- How should we choose among the range of possible policy approaches to provide services?
  - prescriptive regulation
  - financial sanction
  - property rights
  - payment
  - persuasion
- Given the increasing attention on payments for ecosystem services, what are the perils of payments?

**Implementation**

- What are the limits of the law?
- When will non-legal approaches be more effective in conserving service provision?
- To what extent does the vision of mission-driven agencies preclude service protection? How can this be changed?

The presentations at the symposium, which then developed into the articles in this special issue, approached the topic of ecosystem services and the law from two perspectives. One set of presentations focused on the law of specific natural resources, and the other set focused on different legal institutions as agents of integration of ecosystem services into law and policy. The resource presentations covered water and watershed resources, agricultural and rangeland resources, and coastal resources, while the institutional presentations addressed land use regulation, common law remedies, public law enforcement regimes, and "second generation" approaches in energy policy.

Contributions to the water and watershed resources topic came from a trio of the nation's most prominent scholars in the field—Jan Neuman, Dan Tarlock, and Robert Abrams. Jan Neuman uses the Tillamook State Forest in Oregon as the lens through which to explore the integration of ecosystem services into "multiple use" public land management regimes. As she explains, multiple use land management is designed to erect a "big tent" under which there is something for everyone to be gained from the public land resource—timber companies, salmon fisheries, weekend hikers, scientists, water users, and the list goes on. But, the tent is only so big; eventually, the state forest agency's mandate to give every

interest its spot under the tent leads to "spending down the principal" in classic tragedy of the commons form. Attention to ecosystem services and the conservation of the natural capital principal of the forest, she posits, is not only consistent with multiple use management, but would alter the calculus to promote sustainable conservation of the principal and ensure a stream of ecosystem service revenues for future generations.

Multiple use in the Tillamook State Forest is a legislative policy decision implemented by a single decision maker—the state forest agency. By contrast, Dan Tarlock explores the problems of multiple use that stem from a watershed landscape owned by innumerable private and public interests—the Klamath River Basin that straddles southern Oregon and northern California. There is no "big tent" for the Klamath, only a vast collection of small tents, each vying for the best position in the campground from which to get what it wants from the bounty of the Klamath resources system. Tarlock traces the history of this once remote, sparsely inhabited land to its present condition of over-consumption of water resources. Over time, the proxy for the single decision maker on public lands came in the form of three imperiled species of fish and the Endangered Species Act. The jolt these three fish gave to public and private resource users from one end of the basin to the other has radically altered the dialogue on the future of the system, making it clear that while there is no return to pre-settlement conditions, there is no hope of continuing the commodity production model in what has become, to put it mildly, a highly stressed ecosystem landscape. Tarlock suggests that the Klamath thus has become the place to conduct "a service provision experiment," though he cautions that, as the prime example of why ecosystem service provision institutions have failed to take hold, the experiment will be no easy undertaking.

Robert Abrams transports us across the nation on the long diagonal from Oregon to Florida. The Apalachicola-Chattahoochee-Flint (ACF) River Basin, which stretches from north of Atlanta across the Florida Panhandle to the Gulf of Mexico, is the scene for a battle between Florida's interest in maintaining a valuable estuary system and Georgia's interest in supplying drinking water to sprawling Atlanta's urban dwellers and irrigation water to south Georgia's farmers. As with the Tillamook and the Klamath, Abrams explains how fragmented and special-interest dominated management of a unitary watershed resource leads to ecosystem stress. In particular, water law and water institutions favor upstream resources users over downstream interests, which constrains the ability of the ecological resources to deliver service

benefits at the downstream end. Abrams suggests that the increased knowledge of ecosystem service values and the manner in which river systems deliver them is likely to provide a counterweight to this upstream-heavy imbalance, with interstate public nuisance doctrine supplying the institutional mechanism for forcing the adjustment.

Turning to rangeland resources, Deb Donahue uses invasive weed species as an indicator of the health of federal public rangelands managed by the Bureau of Land Management (BLM) and U.S Forest Service. Notwithstanding the multiple use mandate for BLM and Forest Service rangelands, Donahue shows that livestock production has been the favored use, and it has led inexorably to invasive weeds and the resulting build-up of hazardous fuels. Yet she argues that BLM and the Forest Service have the authority under the multiple use mandate, if not the duty, to remove livestock from lands to reverse the weed problem and restore ecosystem services that will truly support multiple uses.

The next article, by Robin Kundis Craig, moves the focus off the terrestrial to the marine. Craig explains that ocean and coastal ecosystems provide about two-thirds of the ecosystem services produced by the world's natural capital. Despite their value, however, marine resources have historically been managed at international, federal, state, and local levels where markets traditionally have focused on commercial commodities such as fisheries and on the skyrocketing land values of coastal development, which has led in turn to depletion of the very natural capital that supports those markets. Yet markets learn, and new consumer demands for lifestyle values such as recreation, tourism, "eco-living," and protection from disaster increasingly are aligning market preferences with ecosystem services. Political will, Craig argues, is likely to follow suit.

The final article in the resources series is Dale Goble's discussion of biodiversity, and it serves as a bridge from the resource focus to the institutional focus. Whereas the previous authors found much potential in the concept of ecosystem services as a way of realigning and improving public and private resource management decisions, Goble is less sure of its application in the context of conservation of biological diversity. The question he addresses is rather straightforward: is ecosystem services a viable surrogate for biodiversity conservation, and will sustaining the former conserve the latter? The answer is more complex. For Goble, it depends on why we believe we should conserve biodiversity. The ecosystem services concept frames questions in a distinctly utilitarian context, whereas we might have reasons beyond maximizing social

welfare to conserve biodiversity. And even if we do not, spatial and temporal scales might differ as between what makes good management sense for ecosystem services versus biodiversity conservation. How institutions perceive biodiversity as a resource thus may influence how useful the ecosystem services concept is for its conservation.

Land use regulation opened the symposium focus on institutional design. Craig Anthony (Tony) Arnold turns attention in the first article in this series to the structure of local land use regulation. He argues that the nature of land use regulation as a legal institution implemented primarily at the local level has led to fundamental misconceptions of its capacity to participate in complex public policy problems. Local land use regulation is not, in his view, simply a miniature and lower-tiered version of state and federal policy governance. Rather, local land use regulation is a distinct and dynamic system of governance that is uniquely positioned to address human-environment policy issues from a perspective quite apart from state and federal institutions. From this broad perspective of land use regulation, Arnold uses ecosystem services as a case study for examining how land use regulation can contribute to solutions as well as the limits of that capacity. The land use regulatory system, he concludes, is not primarily an ecosystem protection institution—it has a broad variety of goals to meet in the human-environment policy realm. It is, however, responsive to the increasing importance of ecosystem services and will incorporate natural capital and ecosystem service values into its decision making structure in specific ways.

Next, J.B Ruhl's article examines the "background principles" of natural capital and ecosystem services in the American common law of property. Other scholars have shown that American property law has created systematic disincentives for landowners to retain intact natural capital. Ruhl shows as well that the common law has traditionally provided little relief for landowners who have lost the benefit of ecosystem services when other landowners degrade natural capital. The impetus for change in both respects comes from, of all places, the Supreme Court's regulatory takings jurisprudence, which shields the government from takings claims when regulation merely duplicates land use restrictions embedded in the "background principles" of property law. The Court has acknowledged that these background principles evolve with new knowledge, and Ruhl argues that the ecosystem services concept is just that—new knowledge of how land use that degrades natural capital can injure property interests on other lands. As he shows, courts have begun to pick up on this new knowledge, suggesting a

potential for rapid evolution in the common law.

Shifting to a public law institution focus, Dave Markell explores the role ecosystem service valuation could play in regulatory enforcement decisions. Using this remedial focus, Markell demonstrates how three different enforcement mechanisms—penalties, injunctive relief, and supplemental environmental projects—all could integrate protection of natural capital and ecosystem services as a means of improving enforcement performance. Markell argues that doing so will help deter violations, enhance agency capacity to cease ongoing violations, improve agencies' ability to negotiate enforcement settlements, and ultimately contribute to our knowledge of ecosystem service values. Whereas much of the focus of the previous articles has been the "front end" design of resource management and institutions, Markell demonstrates that attention to the "back end" of the regulatory state holds much promise as well.

Energy policy supplied fodder for the closing set of presentations at the symposium. In his article, David Hodas reminds us of one of the most bountiful and valuable forms of natural capital—energy. In particular, fossil fuels such as coal, petroleum, and natural gas are forms of energy gifted to us by the sun and stored for our use. Yet, Hodas shows that, ironically, almost none of the literature on ecosystem services, including some of the groundbreaking work of the late 1990s as well as more recent treatments, recognizes fossil fuels in this context. Hodas argues that, unless we begin to understand stored energy as an ecosystem service, we cannot reasonably expect to manage our fossil fuel energy resources sustainably. Yet, as he shows, current international and domestic energy law and policy evidences nearly complete ignorance of this feature of fossil fuel energy. The ultimate consequences of this disconnect, he argues, are not just a matter of concern to energy policy, but are of the utmost significance to national security as well.

Dennis Hirsch's article closes this issue by examining the role ecosystem service values could play in market-based instruments such as carbon trading mechanisms. Ecosystem services often behave like public goods—their physical and biological nature makes it difficult for them to be priced in markets. Difficult, that is, without any regulatory help. As Hirsch explores, regulatory markets—markets constructed with the help of regulation when none would have otherwise materialized—have become common in environmental policy and could take advantage of ecosystem service values as a metric. Yet he distinguishes in this respect between regulatory markets that trade one ecosystem service for another,

such as the wetland mitigation banking program, and regulatory markets that trade between technological services and ecosystem services, such as the carbon sequestration trading program. By allowing developed nations to purchase the ecosystem service of carbon sequestration in the form of forest resources, the carbon program allows trades between technology and natural capital. Hirsch argues that the two kinds of regulatory markets demand different analytical frameworks.

Many people not represented in the articles in this issue contributed to the success of the symposium. Martha Noble of the Sustainable Agriculture Coalition provided insights on agricultural policy, and Sally Collins, Associate Chief of the Forest Service, along with Rob Doudrick of that agency explained how ecosystem services are beginning to take hold in public land management policy. Donna Christie of the FSU environmental law faculty organized a fascinating panel on coastal development issues at which Billy Buzzett of the St. Joe Company and Bradley Pickel of the South Walton County Tourist Bureau described the rising consciousness of local and private land managers to ecosystem service values. Mark Seidenfeld of FSU presented comments on the papers by J.B. Ruhl and Dave Markell, and Jacqueline Weaver of the University of Houston Law Center contributed to the panel on energy policy with a rousing exploration of the carbon-based energy economy. Don Elliott of Yale Law School provided closing remarks assessing what the symposium had covered and suggesting next steps for the formulation of ecosystem services law and policy.

Of course, coordinating a gathering of so many people from so many different places was no mean feat. FSU Environmental Law Society members and Journal staff helped with many symposium tasks, and the FSU College of Law provided more than generous financial support. Lastly, but by no means least in terms of gratitude owed, we thank FSU Environmental Program Assistant Meghan McQuellon, who has since moved on to pursue an advanced degree, for her logistical support of both the symposium and the *Journal* issue.

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