

Using an Ecosystem Services Management Framework to Pursue Watershed-Wide Project Priorities in the Silvio O. Conte National Fish and Wildlife Refuge and Connecticut River Watershed

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About This Document

This case is part of the Federal Resource Management and Ecosystem Services (FRMES) Guidebook created by the [National Ecosystem Services Partnership](#) (NESP). NESP, housed at the [Nicholas Institute for Environmental Policy Solutions](#), seeks to enhance collaboration within the ecosystem services community and to strengthen coordination of policy implementation and research at the national level. The FRMES Guidebook represents a collaborative effort by federal agencies and outside experts to develop a credible and feasible approach to incorporating ecosystem services into the decision-making processes of federal agencies.

Cases are written and approved by the author(s)' agency, but they have not been peer reviewed. They describe the decision-making context within which that agency is considering or testing an ecosystem services management framework, and they present approaches or innovations that the agency is using to incorporate ecosystem services into its planning and decision-making processes. Cases informed development of the FRMES Guidebook and could be of value to others embarking on ecosystem services planning and management efforts.

To read other federal agency explorations and applications of an ecosystem services management framework, visit www.nespguidebook.com.

CONTENTS

Critical Issues 4

Motivation for Exploring an Ecosystem Services Management Framework 4

Decision Context 5

 Enhancing Communication and Community Support.....7

 Enhancing Use of Natural Solutions.....7

Partnership Efforts..... 6

Funding..... 7

Options and Trade offs 7

Efforts to Understand the Provision and Beneficiaries of Ecosystem Services 8

**Using an Ecosystem Services Management Framework
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The Silvio O. Conte National Fish and Wildlife Refuge (NFWR) is located in New England's Connecticut River Watershed—New England's largest watershed and home to a diverse group of plant and animal species as well as 400 towns and cities with more than two million residents.¹ The Connecticut River starts in the mountains of northern New Hampshire above Fourth Connecticut Lake near the Canadian border and empties into the Long Island Sound at Old Saybrook and Old Lyme, Connecticut (Figure 1). The 400-some-mile river flows through both rural and urban areas in New Hampshire, Vermont, Massachusetts, and Connecticut.

The waters of the Connecticut River have played an important role in the watershed's history. They powered its mills, factories, cities, and towns; provided transportation for its people and goods; and irrigated its rich farmland. After years of overuse and abuse, the river was dubbed “the most beautiful sewer in the world.” Concerned with the high level of pollution, federal, state, and local governments have spent more than \$600 million to clean up the river and improve the quality of its fish and wildlife habitat. Today, the Connecticut River and its tributaries are regaining their status as unique resources that provide habitat for fish, waterfowl, and other wildlife species, including such threatened or endangered species such as the Atlantic and shortnose sturgeon, dwarf wedge mussel, Puritan tiger beetle, Jesup's milk vetch, and small-whorled pogonia. The watershed also provides its residents and visitors many recreation and environmental education opportunities.

¹ <http://www.fws.gov/r5soc/>.

watershed boundaries. Passage of the Silvio O. Conte National Wildlife Refuge Act directed the FWS to form and lead a coalition of partners to work cooperatively to:

- Conserve, protect, and enhance the Connecticut River valley populations of Atlantic salmon, American shad, river herring, shortnose sturgeon, bald eagles, peregrine falcons, osprey, black ducks, and other native species of plants, fish, and wildlife;
- Conserve, protect and enhance the natural diversity and abundance of plant, fish and wildlife species, and the ecosystems upon which these species depend within the refuge;
- Protect species listed as endangered or threatened, or identified as candidates for listing, pursuant to the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.);
- Restore and maintain the chemical, physical, and biological integrity of wetlands and other waters within the refuge;
- Fulfill the international treaty obligations of the United States relating to fish and wildlife and wetlands; and
- Provide opportunities for scientific research, environmental education, and fish and wildlife-oriented recreation and access to the extent compatible with the other purposes stated in this section.²

As of June 2012, the refuge comprised approximately 36,000 acres extending from northern Vermont and New Hampshire to southern Connecticut. The Nulhegan Basin Division in Vermont's Northeast Kingdom accounts for 26,738 acres and is the largest tract in the refuge. The smallest tract, Third Island, is only 3.8 acres in Massachusetts.

Critical Issues

The Silvio O Conte NFWR faces seven critical issues—how best to:

- Protect rural working landscapes and minimize impacts on agriculture and forestry practices;
- Educate people about their co-dependent relationship with the environmental and biological amenities of the watershed, a task that may require development of different strategies for rural, suburban, and urban residents;
- Keep the water in the Connecticut River and its tributaries clean for human health and recreation, biological diversity, and wetlands functionality;
- Identify and remove barriers that critically impede passage for fish and other species within the watershed, a task that may require replacement of old culverts with archway passages and Remove dams that are no longer productive;
- Improve public access to the Connecticut River and its tributaries to improve recreational opportunities (hunting, fishing, and wildlife viewing);
- Develop partnerships with state and local groups to identify and prioritize needs; and
- Control invasive species.

Motivation for Exploring an Ecosystem Services Management Framework

Since passage of the Silvio O. Conte National Wildlife Refuge Act, the FWS has formed many productive partnerships but lacks a framework through which partner groups can reach agreements on how best to pursue watershed-wide project priorities. The FWS believes an ecosystem services management framework can be useful in coordinating work on three of these priorities: controlling for catastrophic

² http://www.fws.gov/r5soc/library/about/Conte_NFWR_Act.pdf; <http://www.fws.gov/Endangered/pdfs/esaall.pdf>.

flooding events, protecting ecosystem services endangered by agricultural use of land area along the Connecticut River, and improving environmental education and outreach capabilities.

In 2011, Hurricane Irene caused an estimated \$1.2 billion in significant flooding and damage to the communities in the upper watershed states. In Vermont, culverts and bridges were not able to handle the increased flows associated with the storm and more than 200 bridges and 500 miles of roads were damaged or destroyed. Six Vermont residents lost their lives, and thousands were left homeless. Ninety percent of the state's 251 towns suffered infrastructure damage.³ The storm awakened communities to the need to design and build infrastructure more in tune with natural systems.

Heavy conversion to agricultural use of land area along the Connecticut River in Vermont, New Hampshire, and Massachusetts has left little natural area for floodplain protection. Expanding the riparian corridor along the Connecticut River would help to limit runoff into the Connecticut River during large flooding events, and it would help absorb high runoff, acting as a protective barrier to downstream communities and property. In addition, widened riparian barriers would help to absorb agricultural runoff and reduce sedimentation, thus keeping the river waters cleaner, providing important habitat for birds and animals, and potentially serving as a public access point or trail system.

Because the Connecticut River lacks any consistent public right-of-way along its banks, connecting people with the assets the FWS is working to protect is difficult. Development of an ecosystem services management framework could improve environmental education and outreach, one of the establishing purposes of the Silvio O. Conte NFWR.

Decision Context

With regard to adopting an ecosystem services framework, the FWS has two decision contexts.

Enhancing Communication and Community Support

The first motivation for applying an ecosystem services framework is to garner support for land use planning and management actions, which requires the FWS to communicate the benefits of ecosystem services to partners and the 400 individual, autonomous communities in the Connecticut River watershed. This task presents challenges from a resource perspective. One strategy that the service has adopted is to group communities into sub-watersheds. It has found that community leaders and citizens find it much easier to identify with their local watersheds than with the entire basin and that they are more readily able to understand and accept ecosystem services management that is framed within a sub-regional spatial scale.

Developing an ecosystem services framework would also greatly help the FWS Northeast Region better compete for Land and Water Conservation Fund dollars. These monies flow from oil and gas development royalties and are used to help protect highly valued, at-risk natural lands. Because the price of land is relatively higher in the northeastern United States than in other areas of the country, the Northeast Region can conserve a smaller amount of acreage with allotted monies than other FWS regions. The irony is that the high price of real estate in the northeastern United States reflects a large number of competing uses for the land from a populace that is also much larger than other areas of the country. Consequently, small acreages can have large flows of ecosystem services in the northeast due to the larger affected population than larger acreages in less populated areas. An accounting of ecosystem services flows could help the region better justify high dollar purchases of relatively smaller parcels given the potentially larger flow of associated services to the impacted community.

³ http://www.huffingtonpost.com/2013/08/28/hurricane-irene-2-years-later_n_3827088.html.

Land acquisition, a traditional conservation tool, is limited to a few high priority sites in the Silvio O. Conte NFWR. The refuge also uses innovative partnerships to improve conservation efforts, investigate important questions, foster conservation leadership, and educate citizens about critical issues. In these ways, the refuge serves as a leader and catalyst to help citizens protect the Connecticut River watershed's special nature and pass it on to future generations.

Enhancing Use of Natural Solutions

The second motivation for applying an ecosystem services framework is to help local communities better understand and evaluate options for providing flood protection and water quality. In the wake of Hurricane Irene, there are local pressures to rebuild culverts using traditional design practices, yet some empirical evidence suggests that restoring wildlife-friendly corridors could offer benefits both for fishing and for flood management. The U.S. Forest Service began removing old-style culverts some years ago. Areas in which these changes were made suffered far less damage from flooding, erosion, and sedimentation than those areas still served by traditional culverts.⁴ Although the up-front costs of the wildlife-friendly culverts exceed those of traditional culverts, their life-cycle costs may be lower. In addition, the wildlife-friendly culverts provide other ecosystem services, including contributions to enhanced fish populations. Coupling these benefits with avoided costs from flood damage may make the wildlife-friendly culverts cost-effective.

In addition to options for re-designing culverts, there may be opportunities to re-manage, reconnect, and restore more natural river flows and, as a result, enhance the ecosystem services. However, assessing these opportunities requires a more complete understanding of ecosystem services benefits as well as trade-offs associated with dam removal.

Partnership Efforts

Federal agencies, non-profits, and academia are working with the FWS to protect and restore the lands and waters of the Connecticut River Watershed and to understand the ecosystem services associated with that effort. With the North Atlantic Landscape Conservation Cooperative, in which the Silvio O. Conte NFWR lies, the FWS has initiated an in-depth landscape conservation design pilot study to develop and provide tools and information to guide decision makers and inform conservation actions to more effectively address threats, limiting factors, and uncertainties.⁵ The study will also help decision makers efficiently achieve objectives and ensure functional systems under current and predicted future conditions as well as link site-scale actions to landscape and regional-scale goals.

The FWS is working with the University of Massachusetts Northeast Climate Science Center to understand the effects of a changing climate on the frequency and intensity of precipitation events, impacts on agricultural practices, impacts on fish and wildlife, invasive species, and forest resilience.⁶

The University of Massachusetts Civil and Environmental Engineering Department is developing a basin-wide hydrological model of the Connecticut River system. Its model will help decision makers better understand how changes in water flows and timing will affect ecosystem services, including hydropower production, flood control, water supplies, and recreational uses.

The Nature Conservancy (TNC) operates the Connecticut River Program, which promotes the conservation and restoration of lands and watersheds throughout the basin for the betterment of the

⁴ Gillespie, N., et.al., "Economic and Ecological Benefits of Stream Simulation Designs." *Fisheries* 39 (2).

⁵ <http://northatlanticlcc.org/>.

⁶ <http://necsc.umass.edu/>.

communities, fish, and wildlife in the four-state area.⁷ The program has three main strategies. The first is restoring more natural water flows. To do this, TNC has been identifying dams that critically impede natural flows, adversely affecting downstream systems and migratory passage for fish and wildlife. The second strategy is reconnecting all of the waterways in the system. Many of the smaller tributaries have been diked, damned, or impeded by improperly sized culverts that have collectively blocked important spawning and nesting habitat for native fish and dependent species. The third strategy is protecting and restoring the remnant floodplain forests of the Connecticut River and its tributaries. This lack of a natural buffer has intensified flooding impacts on downstream communities.

The Trust for Public Lands (TPL) has conserved more than 170,000 acres in the Connecticut River Watershed.⁸ These acres comprise farmlands with highly productive soils; cold-water fishery habitats, especially those capable of supporting Eastern Brook Trout; and open spaces that benefit local communities.

The non-profit Connecticut River Council, established in 1952, develops programs to educate the public about the watershed's importance, works to remove barriers to fish passage, gets involved in dam relicensing activities to ensure that operations are balanced with protections and improvements for the river, and advocates for reducing the flow of untreated sewage and runoff from surrounding communities into the river system.⁹

Funding

Various funding sources help sustain conservation activities in the Connecticut River watershed. At a national level, funding for planning comes from landscape conservation cooperatives, land and water conservation funds, wildlife refuge system appropriations, and other grants from federal, state, and local agencies as well as from nonprofit foundations. Many of the non-profit entities are funded through private donors. State and local funding is limited due to existing economic conditions. The U.S. Army Corps of Engineers owns and operates 14 flood control dams in the watershed and provides funding for their operations and repairs. Other dams are owned by electric utilities, other private-sector entities, and state and local governments. Some funds for culvert repairs and replacement after Hurricane Irene came from the Federal Emergency Management Agency, but there are restrictions on the use of such funds, in particular, on whether they can be used for natural infrastructure and redesign of culverts.

The Natural Resources Conservation Service within the U.S. Department of Agriculture offers a variety of incentives for land conservation.¹⁰ Landowners and farmers can qualify for financial, technical, and educational assistance through the following programs:

- Agricultural Management Assistance: funds cost-share projects for addressing erosion, water quality, and other matters
- Conservation Reserve Program: pays rent for land to protect erodible and environmentally sensitive lands
- Conservation Reserve Enhancement Program: retires lands to address specific environmental concerns
- Environmental Quality Incentives Program: funds reduction of pesticides and herbicide use, livestock waste management, and more

⁷ <http://www.nature.org/ourinitiatives/regions/northamerica/unitedstates/connecticut/connecticutriver/>.

⁸ <http://www.tpl.org/our-work/land-and-water/connecticut-river>.

⁹ <http://www.criver.org/>.

¹⁰ <http://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/>.

- Farmland Protection Program: funds the purchase of development rights to keep productive land in agriculture
- Wetlands Reserve Program: reimburses landowners for restoring and protecting wetlands
- Wildlife Habitat Incentives Program: funds cost-share projects and provides assistance for wildlife habitat development

Grants for habitat restoration projects can also be obtained from a variety of other non-federal sources, including the National Fish and Wildlife Foundation, the American Sportfishing Association, American Rivers, and the Upper Connecticut River Mitigation and Enhancement Fund.

Options and Trade-offs

Because the Silvio O. Conte NFWR must be managed at a watershed level, the FWS confronts countless trade-offs in determining how best to expend its limited resources to optimize returns for the natural communities that it is required to preserve, protect, and enhance. To successfully achieve this objective, it must also consider how its activities might affect the needs of and the livelihood and economic opportunities of 2.3 million people, a task complicated by that population's spatial and demographic diversity. Upstream management actions often have large potential returns as the benefits flow downstream; however, these actions often come at a disproportionate cost to the smaller upstream communities.

Development of an ecosystem services management framework could help better frame trade-offs and opportunities. Even evaluations of trade-offs in small-scale projects could benefit from consideration of associated ecosystem services. Partners must reach case-by-case agreement on the ecological and economic returns to replacing culverts, dismantling or changing the operational structure of dams, and protecting lands through purchase or easements. An ecosystem services management framework would provide the language to articulate the level of services and the distribution of benefits and costs attributable to project proposals or actions.

At the 2009 Governor's Conference, New England governors agreed to develop land conservation initiatives that would keep farmlands in farming, keep forests as forests, connect people to the outdoors, protect wildlife habitat, and safeguard coastal and estuarine lands. Achieving these objectives—particularly given funding limitations—will require advances in how to think of trade-offs and opportunity costs using an ecosystem services management framework. Use of such a framework in decision making would help all parties efficiently achieve the governors' goals.

Efforts to Understand the Provision and Beneficiaries of Ecosystem Services

Several efforts are ongoing to improve understanding of the provision and beneficiaries of ecosystem services in the Connecticut River Watershed.

The Water Resources, Climate, and Society at the University of Massachusetts is developing detailed models of the watershed to better understand its complex hydrology and how climate change and changes in socio-economic conditions factor into hydrological changes.¹¹ The objectives of one of the group's projects, being conducted in cooperation with The Nature Conservancy and the U.S. Army Corps of Engineers, are to

¹¹ <http://cee.umass.edu/water-climate-society>.

- Create micro-models of regional climate conditions and scenarios to better understand the effects on sub-watersheds of changing conditions of precipitation events;
- Construct seasonal streamflow forecasting capabilities so that water managers can improve their ability to manage reservoir releases;
- Develop decision support tools to guide river operations with the express goal of optimizing river flows under current conditions and streamflow forecasts for power production, flood control, water supply, and replication of natural streamflow conditions; and
- Encourage stakeholder involvement by developing a basin-wide hydrological model that will be accepted by stakeholder groups as a reasonable and unbiased tool for guiding decisions to manage flow operations to optimize power production, flood control, water supply, and natural flows for the benefit of native species.

Development of this model entails many smaller research projects designed to provide important data for modeling the watershed. One such project, designed and funded with the help of The Nature Conservancy, is the Mitchell Brook Culvert Replacement Study. This study is designed to reveal the importance of restoring small stream tributaries for fish passage. Thus far, data suggest that small streams are very important refuges for native species such as Eastern Brook trout. The small tributaries provide important refuge for small fry from larger predators, allowing them a greater chance to survive to adulthood. Small tributaries also offer shelter during high water runoff events in main channel streams. The study is also examining the effects of culvert replacement on the viability of roads during flood events. Replacing small, undersized culverts with larger, bottomless culverts that allow year-long fish passage also allows more water to flow downstream without backing up behind undersized culverts and blowing out roads. The Mitchell Brook study will help determine the cost-effectiveness of replacing the watershed's tens of thousands of improperly designed culverts.

The Nature Conservancy has also funded a study that examines the feasibility of valuing the natural infrastructure in the Connecticut River.¹² The study specifically considered how best to value the river's remaining floodplains from an ecosystem services perspective. Services provided by the floodplains include contributions to water quality, carbon sequestration, and recreation.

Finally, as noted above, the U.S. Fish and Wildlife Service is initiating a study that will consider how best to develop a basin-wide landscape conservation design for the Connecticut River Valley. The goal is to optimize a sustainable natural environment and ecosystem for native plants, fish, and animals while accommodating sustainable, natural growth of local economies.

¹² K. Johnson, *Floodplains by Design: Valuing Natural Infrastructure in the Connecticut River*. North America Freshwater Program.

Cover photo: U.S. Fish and Wildlife Service

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About the National Ecosystem Services Partnership

The National Ecosystem Services Partnership (NESP) engages both public and private individuals and organizations to enhance collaboration within the ecosystem services community and to strengthen coordination of policy and market implementation and research at the national level. The partnership is an initiative of Duke University's Nicholas Institute for Environmental Policy Solutions and was developed with support from the U.S. Environmental Protection Agency and with donations of expertise and time from many public and private institutions. The partnership is led by Lydia Olander, director of the Ecosystem Services Program at the Nicholas Institute, and draws on the expertise of federal agency staff, academics, NGO leaders, and ecosystem services management practitioners.

About the Nicholas Institute for Environmental Policy Solutions

Established in 2005, the Nicholas Institute for Environmental Policy Solutions at Duke University improves environmental policymaking worldwide through objective, fact-based research in the areas of climate change, the economics of limiting carbon pollution, emerging environmental markets, oceans governance and coastal management, and freshwater management. The Nicholas Institute is part of Duke University and its wider community of world-class scholars. This unique resource allows the Nicholas Institute's team of economists, scientists, lawyers, and policy experts not only to deliver timely, credible analyses to a wide variety of decision makers, but also to convene decision makers to reach a shared understanding of this century's most pressing environmental problems.

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