

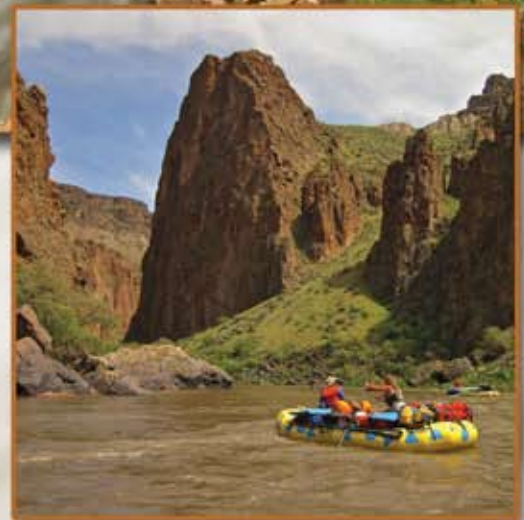
INTERNATIONAL

Journal of Wilderness



In This Issue

- A Legacy of Rivers
- Reframing the Wild and Scenic River Act
- Rivers and Aquatic Biodiversity
- Proposing Protected Rivers in China



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FEATURES

EDITORIAL PERSPECTIVES

- 3 *A Watershed Moment for River Conservation and Science*

BY STEVE CHESTERTON and ALAN WATSON

SOUL OF THE WILDERNESS

- 4 *A Legacy of Rivers*

BY TIM PALMER

STEWARDSHIP

- 10 *The Visitor Use Management Framework*

Application to Wild and Scenic Rivers

BY ROSE I. VERBOS, CARIN VADALA, PETER MALI, and KERRI CAHILL

- 16 *Wild and Scenic Rivers into the Next 50 Years: Lessons from the Re-watering and Restoration of Fossil Creek*

BY BJORN FREDRICKSON and KELLY MOTT LACROIX

SCIENCE & RESEARCH

- 22 *Wild and Scenic Rivers*

An Economic Perspective

BY J. M. BOWKER and JOHN C. BERGSTROM

- 34 *Dam Removal on the Lower White Salmon River*

Rewilding, Sacred Spaces, and "Outstandingly Remarkable Values"

BY RANDY GIMBLETT, CHRISTOPHER A. SCOTT, and MIA HAMMERSLEY

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—Chad P. Dawson,
IJW Editor-in-Chief Emeritus

SCIENCE & RESEARCH, continued

- 41 *Reframing the Wild and Scenic Rivers Act: Ecosystem-based Resilience and Adaptation*

BY DENIELLE PERRY

EDUCATION & COMMUNICATION

- 49 *The Role of Wild and Scenic Rivers in the Conservation of Aquatic Biodiversity*

BY JOHN D. ROTHLSBERGER, TAMARA HEARTSILL SCALLEY, and RUSSELL F. THUROW

INTERNATIONAL PERSPECTIVES

- 64 *Proposing a National Protected River System in China*

Ecological Civilization

BY PENG LI

WILDERNESS DIGEST

- 71 *Book Reviews*

- 71 *Wild and Scenic Rivers: An American Legacy*

By TIM PALMER

REVIEWED BY JOHN SHULTIS

On the Cover

Main image: The Cache la Poudre Wild and Scenic River rushes through the Narrows in northern reaches of the Rocky Mountains' Front Range, Colorado; photo credit: Tim Palmer. For more info, visit www.rivers.gov/rivers/cache-la-poudre.php.

Inset image: Rafts approach Iron Point, deep in the Owyhee Wild and Scenic River canyon between Rome and Birch Creek, Oregon; photo credit: Tim Palmer. For more info, visit www.rivers.gov/rivers/owyhee-or.php.

International Journal of Wilderness

The *International Journal of Wilderness* links wilderness professionals, scientists, educators, environmentalists, and interested citizens worldwide with a forum for reporting and discussing wilderness ideas and events; inspirational ideas; planning, management, and allocation strategies; education; and research and policy aspects of wilderness stewardship.

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A Watershed Moment for River Conservation and Science

BY STEVE CHESTERTON and ALAN WATSON



We are in the midst of a wave of 50th anniversaries. Specifically, the wave consists of 50th anniversaries for legislative milestones in the United States. That's because the 1960s were a time of profound social and environmental change. The Civil Rights Act, the Wilderness Act, and the Land and Water Conservation Fund Act were all enacted in 1964. The Voting Rights Act was passed in 1965. The National Historic Preservation Act was in 1966, and the Wild and Scenic Rivers Act of 1968 was signed into law on the same day as the National Trails System Act. Other groundbreaking legislation will be commemorated with golden anniversaries in the next several years – the National Environmental Policy Act (1970), the Endangered Species Act (1973), and the Clean Air (1970) and Clean Water (1972) Acts, to name a few.

Among conservation legislation and national designations of natural areas, the Wild and Scenic Rivers Act may have the largest chip on its shoulder. Wild and scenic rivers represent our nation's strongest form of protection for free-flowing rivers and streams. The act's passage in 1968 also marked a watershed moment when the nation acknowledged the importance of complementing efforts to manipulate, control, and harness the power of rivers with a focus on perpetually protecting and enhancing select free-flowing rivers for their range of natural, cultural, and recreational values in a manner that crossed political boundaries. And yet, for all that this legislation has done to guide our thinking about river protection since then, the significance of a wild and scenic river designation is largely either unknown or misunderstood. Even among river enthusiasts, the National Wild and Scenic Rivers System resides in relative obscurity. "Wild and scenic" – sounds nice, but what does it really mean?

Perhaps the most effective way to think about the significance of the Wild and Scenic Rivers Act is to imagine the United States without any clean, free-flowing waterways. To grasp that meaning likely requires consideration of the diverse values of these river ecosystems, including their integral connections to the lives of past, present, and future generations of people and communities. From rivers flowing through urban landscapes to creeks in the most remote wildernesses, the importance of healthy, meandering river systems is difficult to overstate.

This special issue of the *International Journal of Wilderness* focuses on the Wild and Scenic Rivers Act to coincide with the 2018 50th anniversary year. Serving as the guest co-editors for this issue, we sought to rejuvenate efforts that began 17 years ago when *IJW* devoted two consecutive issues to wild rivers (December 2000 and April 2001). The hope at that time was that the series of articles in those issues would catalyze an increased emphasis on wild river science and stewardship. Although there is no doubt that much has been accomplished in the intervening years, a continued need exists to promote research and understanding about the importance and relevance of free-flowing rivers in our society.

The values of the waterways protected, and the spectrum of connections we have to the rivers impacted both directly and indirectly due to the passage of this legislation, come clearly into focus if we take the time to consider them. Encouraging that focus is the intent of this special issue. Articles here explore a range of themes, from the history of the act's passage to the stewardship challenges faced in managing wild and scenic rivers today.

Continued on page 9

A Legacy of Rivers

BY TIM PALMER

The world's first and most extensive system of protected rivers began with the United States' passage of the Wild and Scenic Rivers Act in 1968. The 50th anniversary of that legislation in 2018 affords an opportunity to review the program's legacy, which has grown 16-fold in mileage, and to consider its future, which continues to evolve with the changing currents of history.

The idea of a nationally safeguarded system of rivers began with wildlife biologists John and Frank Craighead. Battling plans to dam Montana's Middle Fork of the Flathead, these twin brothers realized that hundreds of massive dams were proposed for rivers across America and that protection would be an endless challenge of rear-guard battles unless Congress permanently set aside some of the finest natural streams to remain free-flowing (Craighead 1957).

The idea fell into the receptive hands of planner Ted Swem at the National Park Service, and of his staff, John Kauffmann and Stan Young, who in the 1960s took bold initiative on their own volition to craft a national strategy and to survey the country for the worthiest streams. Their list of 650 was whittled to 74 for further study (US Department of the Interior 1965).

With fortuitous synergy, President John F. Kennedy appointed Stewart Udall as secretary of the interior. At his new post, Udall was asked by Senator Edmund Muskie of Maine to fly over the Allagash River where a hydropower dam was proposed, and to intercede in its construction (Bennett 2002). Later, Udall canoed the similarly threatened Current River in Missouri. And then a feisty band of Idaho river aficionados approached him to halt Dworshak Dam on the North Fork Clearwater, renowned for steelhead trout. The fate of that stream had already been politically sealed, and it was dammed, but Udall recalled that "it dramatized for me the flaws and misconceptions in the dam-building philosophy of the New Deal" (Palmer 1986, p. 142).

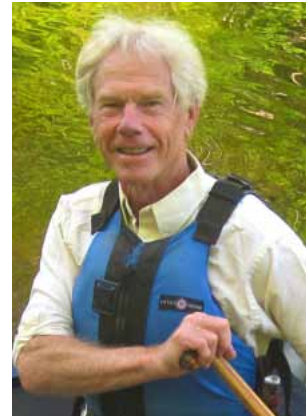
Udall personified the upheaval in water-development philosophy of his time. As an Arizona congressman, he

had supported dams that destroyed rivers. But with the help of river advocates, and inspired by the heady alchemy that effervesces when a person clutches a paddle, steps into a canoe or raft, and kicks off from shore, Udall saw with increasing clarity the need for protection. His internal conflict sparked a new approach: to balance the ubiquitous dam building of his era with conservation of the finest remaining rivers. Avoiding both paralysis and the sway of sharp-suited lobbyists who influence lesser politicians straddling the fence, Udall felt empowered by his new insight.

In a political climate hardly imaginable today, Udall saw the opportunity to build upon the Wilderness Act of 1964. "President Johnson's chief of staff kept saying, 'Johnson wants new legislation.' I told him about the wild and scenic rivers idea and he said, 'That sounds great, get it ready'" (Palmer 1993, p. 21).

Interior Department staff worked with key senators and congresspeople, including Frank Church, Gaylord Nelson, and John Saylor, to draft the Wild and Scenic Rivers Act, and hearings were held. Conservationists testified in support of the bill, and meanwhile the dam-building agencies culled some of the rivers they wanted the most. At a July 3, 1968, hearing, fist-pounding representative Sam Steiger from Arizona growled, "Under the guise of protecting scenic values, this legislation will stifle progress, inhibit economic development and incur a staggering expenditure."

But Udall knew the opposition well. In Arizona, he had grown up with them. "We had the momentum," he recalled to me, "and the dam people who didn't like it just weren't in a frame of mind to fight it. I looked them in the eye and said, 'We're going to balance things off.'"



Tim Palmer

Robert Eastman, later director of rivers programs for the Interior Department, reflected, “Back then, if you had a good idea, you could put it to work.” Ted Swem also wistfully reflected, “I don’t know if we’ll ever have a period like that again” (Palmer 1993, p. 25).

With bipartisanship now forgotten, the Senate voted unanimously for the Wild and Scenic Rivers Act while the House voted in favor 265 to 7, and on October 2, 1968, President Lyndon B. Johnson signed the bill into law. It specified that rivers having “outstandingly remarkable” qualities for “scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values shall be preserved in free-flowing condition.” Rivers can be of any size, and new designations are to be enacted by Congress or by the secretary of the interior if a governor asks for it. Eight major rivers plus four of their tributaries were designated. In addition, 27 rivers were listed for study and possible inclusion later (US Congress 1968).

Foremost, the act bans dams and other federal developments that would damage the specified streams. When federal permits are required for developments by other entities, the act also bars approval of damaging projects such as private hydroelectric dams. Under the act, rivers are classified as wild, scenic, or recreational, depending on the extent of houses, roads, or facilities already there. For federal land, the “wild” designation precludes logging and new mining claims within a corridor averaging one-quarter mile from each bank. Regulation of private land use is not allowed under the act, but it encourages local governments to zone private acreage. Designation does not prescribe open space acquisition, but it can encourage it through required

management plans (US Department of the Interior 1982).

The Wild and Scenic Rivers program was launched, but establishing a larger estate of protected streams had only begun.

Toward a Greater System

Congress’s explicit intention was to add more rivers to the system (US House of Representatives 1968). The required studies, however, involved a lengthy process. In the East, landowners objected to federal engagement, no matter how minor. In the West, proposals for rivers through federal land ran onto the reef of dam-building congresspeople or those with an unfounded fear of losing private water rights.

Disappointed but determined, 33 conservationists met in Denver in 1973 to strategize for moving the Wild and Scenic vision forward. Recognizing that no established groups would carry the ball, they created the American Rivers Conservation Council (later called American Rivers) with the explicit goal of adding rivers to the national system (Palmer 1993).

As a test case, the budding organization adopted North Carolina’s New River – a hopeless situation by any definition. A hydropower corporation had already secured federal permits for a dam, bought the land, and evicted residents. With Bill Painter as a staff of one, American Rivers became the Washington, D.C., connection for residents and state officials still resisting the dam. Against all odds, they prevailed, winning Wild and Scenic designation by the interior secretary in 1976 (Palmer 1986).

Also during this era, a dam proposed for the lower half of the Snake River was stalled when Sierra Club lawyer Brock Evans filed a last-minute appeal. Resulting delays allowed time for a multiyear conservation campaign, and monolithic support for the dam devolved to the point that Idaho governor Cecil Andrus declared it would only be built “over my dead body” (Palmer 1992). Wild and Scenic designation there secured the biggest whitewater in the West next to the Grand Canyon. Other important early designations included the Allagash in Maine, Chattooga in Georgia,



Figure 1 – Idaho governor Cecil Andrus declared a dam proposed for the lower half of the Snake River would only be built “over my dead body.” Photo by Tim Palmer.

and Middle Fork Flathead where the Craighead brothers had formulated the Wild and Scenic idea.

The tedious process of study, public engagement, and political negotiation thwarted designation of many worthy rivers, but then the program blossomed when California representative Phillip Burton stepped onto the stage. This master of old-school politics coerced where he could not convince and in 1978 pushed through the largest package of land protection ever assembled to that date. It designated six major rivers including Washington's Skagit, California's North Fork American, and Pennsylvania's Delaware, where construction of Tocks Island Dam loomed. Dubbed "parks barrel," this bill with 144 conservation projects borrowed from the developers' "pork barrel" packaging of multiple dams, setting a pattern for the future. Advances would typically come with multiple rivers designated at once, followed by periods of limited activity.

In California, wild and scenic enactment under a 1972 state law had evaded plans to dam the Middle Fork Eel and safeguarded a lineup of exquisite streams. State action, however, does not necessarily preclude federal dams, so Governor Jerry Brown in 1980 requested that Interior Secretary Cecil Andrus fold the state wild and scenic rivers into the national system. Agency planners worked around the clock drafting the mandatory Environmental Impact Statement with a six-month deadline to the end of the Carter administration. Needing not to win but only delay, California's water and timber industries appealed the plan in multiple federal courts. Months turned into weeks, then days. With 15 hours remaining until the start of the Reagan administration, Andrus

signed this momentous Wild and Scenic proclamation, protecting four major rivers and many tributaries in northern California (Palmer 2017).

Another great leap came with the Oregon omnibus bill of 1988. Seeking to add a conservation legacy to a career of unwavering support for the timber industry, Senator Mark Hatfield picked up a Pacific Rivers Council proposal and sponsored 53 rivers and tributaries flowing mostly through public land and already found eligible for protection in Forest Service resource plans – a strategy repeated in 1992 in Michigan with 22 rivers and in Arkansas with 8 (Thomas 2014).

Meanwhile, to create another on-ramp for designations, American Rivers and others had urged President Jimmy Carter to declare an executive order under section 5(d)(1) of the act directing federal agencies to consider Wild and Scenic River status for streams through public land. Ultimately this resulted in hundreds of waterways being temporarily protected when found eligible for designation. Likewise, with analysis led by Bern Collins of the Bureau of Outdoor Recreation, the Carter directive adopted a Nationwide Rivers Inventory (NRI) that identified 2.9% of America's river and stream mileage meeting qualitative requirements of the Wild and Scenic Rivers Act (US Department of the Interior 2016; American Rivers 2000). The NRI rivers became a "farm club" for future designations and received special review from Park Service personnel when developments by federal agencies posed threats (US Council on Environmental Quality 1980).

The difficulties of protecting streams through private land spawned a new approach eventually called "Partnership" rivers. Facing

landowner opposition, including violence along the Delaware in 1978, planners with the National Park Service reasoned that along most eastern waters you get nowhere without the support of residents. Talented planners including Glenn Eugster, Rolf Diamont, Drew Parkin, and others in the Northeast crafted an approach that prioritized involvement of local people, formalized river plans before the designations occurred rather than afterward, minimized land acquisition, and aided local governments in hiring stewards to lead continuing efforts. Mostly in New England, the Partnership program became a center for the National Wild and Scenic Rivers System's growth in the 1990s and beyond (Fosburg et al. 2008).

Another major advance came in 2009 as efforts in Wyoming, Idaho, and California were collected into an American Rivers campaign to designate 40 rivers for the 40th anniversary of the Wild and Scenic Act.

Beyond questions of a waterway's designation, the management of streams after their enrollment is critically important for protecting "outstandingly remarkable" values as mandated in the law. Administration and management are assigned to one of four federal agencies – the Forest Service, National Park Service, Bureau of Land Management, or Fish and Wildlife Service – or to the relevant state. Some rivers – for example, the Rogue, North Umpqua, Obed, Tuolumne, and Chattooga – exemplify success in recreation management. Others languish. Required management plans fail to be updated and implemented despite growing threats. With constant turnover, some agency personnel lack adequate training, and dedicated staff are swamped with competing duties from recreation to fire suppression while budgets have shrunk

(Interagency Wild and Scenic Rivers Coordinating Council 1998). Small streams, such as Oregon's Elk, have virtually no Wild and Scenic program on the ground, and others, such as Idaho's Lochsa, have been embroiled in controversy about the mandates of managing agencies (Stahl 2015).

A National Park Service survey in 2007 humbly graded management of rivers in their program with a C, Partnership units a B, and state-administered rivers an F. In 2016, the Forest Service concluded that less than 40% of its designated streams met planning and management standards. Having led the Park Service's efforts from 1983 to 2004, John Haubert said, "The failure of Federal agencies and local and State governments to fulfill their management obligations is my greatest disappointment" (Palmer 2017).

Reflecting on a Rich History of River Conservation

Starting with the original eight rivers designated in 1968, the National Wild and Scenic Rivers System has grown to 208 major rivers. Many of these include multiple tributaries. In all, 495 named rivers and tributaries account for approximately 13,000 miles (20,921 km).

Oregon, California, and Alaska have 70% of the total number of designated rivers. Oregon has the most (59) Alaska has the greatest mileage (3,427 [5,515 km]). The longest reach is Alaska's Noatak at 372 miles (599 km). Longest in the lower 48 is the combined Namekagon-Saint Croix, 200 continuous miles (322 km) excepting a few small dams. The greatest concentration of protected rivers flow in coastal Oregon and California, where the basins of back-to-back designated streams extend 260 miles (418 km) north-south.

Although the act was largely inspired by the need to safeguard rivers for recreation, over time motives have broadened to address other provisions of the law. Protection of native fish was highlighted with the Smith in California in 1980, Oregon rivers in 1988, and Snake River headwaters in 2009. Endangered species became a reason for designation of the Sespe in California, Middle Fork Vermilion in Illinois, and Rio Icacos in Puerto Rico. Motives expanded to ecosystem protection with the Skagit in Washington. Community, cultural, and historical values underpin many Partnership rivers. Recognizing the limits of managing thin corridors, multiple tributaries were added in a watershed approach for Alaska's Fortymile, California's Smith, and several Partnership rivers including Connecticut's Eightmile.

The variable winds of politics have affected the program's growth, especially with acute polarization after 1980. What began with bipartisan support became largely

dependent on Democratic Congresses and presidents, except for Ronald Reagan, whose hand was forced by a Democratic Congress.

In 1983, I had the chance to ask some of the founders of the National Wild and Scenic Rivers System to reflect on its progress. John Craighead said, "I never expected it to grow so much." Stewart Udall said that he was "very pleased" with the results," although he added that the system was "incomplete" when compared to America's national parks and designated wilderness areas (Palmer 1993, p. 63).

Indeed, considering the most explicit and motivating goal of the original legislation – to stop dams – the program hit a grand slam. Impending dams were halted on the New, Snake, Tuolumne, Niobrara, Delaware, Allagash, Feather, and other streams. No section of a protected river has been deleted to allow for a dam (although California's Merced is currently threatened). Additional goals have been met by



Figure 2 – Motives have broadened to address provisions besides recreation. Protection of native fish was highlighted with the Smith River, California, in 1980. Photo by Tim Palmer.

improving recreation management, limiting logging in federal wild river corridors, and aiding municipalities with zoning, setbacks, and access.

It's a strong record, yet the United States, including Alaska, has 2.9 million miles (4,667,098 km) of rivers and perennial streams. The Wild and Scenic share is only 0.4% – hardly the bill's prescribed "complement" to the plethora of developed waters. Consider, 80,000 sizable dams have been built on nearly every major stream outside Alaska, and one-third of the total river mileage is significantly polluted (US Environmental Protection Agency 2000). Most of the rest are diminished by channelization, diversions, or floodplain development. Only about 3% of the nation's stream mileage was found in the NRI to have qualities necessary for Wild and Scenic status (US Department of the Interior 1982).

Only 24 of 74 classic rivers identified by Interior Department planners in their original 1964 survey have been designated, omitting landmarks such as Utah's Green, Montana's Yellowstone, and New York's upper Hudson. Furthermore, growth of the system has slowed, and designations of sizable streams have been thwarted. The system includes 27 reaches longer than 100 miles (161 km) – every one of them inducted before 1989.

Important players in the field of river conservation have expressed disappointment that the system has not encompassed all of America's geographic provinces; subregions of the Great Plains, Midwest, and South are especially lacking. After working on the program for years with the Department of the Interior and then as head of American Rivers, Kevin Coyle said, "The Wild and

Scenic program has never really lived up to its promise. The system should be more robust and widespread. The rivers have never been embraced like National Parks, Refuges, or Wilderness Areas" (Palmer 2017).

Yet, the Wild and Scenic glass is arguably half full – or more – and the program has spawned related advances reaching far beyond designated streams. Retired from leadership roles at American Rivers, the National Park Service, and Forest Service, Chris Brown said, "Above its immediate success in safeguarding rivers, the Wild and Scenic Act ignited a movement and shifted the balance of river development and conservation in ways that spawned far more: the birth of American Rivers, the establishment of state wild and scenic systems, formation of watershed associations, support for water quality, and reform of planning for rivers through federal land" (Palmer 2017).

Looking to the Future

Conservation groups continue to work on campaigns to add worthy streams to the National Wild and Scenic Rivers System. American Rivers now seeks to safeguard a suite of Montana candidates totaling 600 miles (966 km) (Montanans for Healthy Rivers), while American Whitewater proposes a stunning radial complex of arteries flowing from Washington's Olympic Mountains (Wild Olympics Campaign). The Partnership program in the Northeast has nurtured grassroots support for a waiting list of streams primed for study and enactment.

Efforts are needed to safeguard the most classic of America's natural waterways that have been politically entangled in the past. Further, the National Wild and Scenic Riv-

ers System can be used to address imminent threats in the age of global warming by recognizing streams flowing from cool northern aspects of mountain ranges, from glaciers and snowfields, from cold spring sources, and from deep shade of intact forests. All of these nourish imperiled cold-water fish.

From a larger perspective, resilience to the changing climate is buttressed by river conservation measures: tree-shading buffers along the waters' edges, expanded floodplain zoning to accommodate intensifying floods, reinstatement of minimum if not optimum flows to combat droughts and rising water temperatures, and linkage of nature preserves with the vital connective tissue of riparian habitat. River conservationists have shouldered these tasks for decades; now, with climate change, all are increasingly essential, and the Wild and Scenic program offers a ready template for organization and execution of those conservation strategies.

The National Wild and Scenic Rivers System was founded with impressive imagination and determination. Fueled by multiple generations of dedicated public servants and conservationists, it has safeguarded many of our best streams. Now, at the 50th anniversary of America's premier river protection program, all those who are drawn to visions dating from the Craighead brothers' spirited dam fight at the Middle Fork Flathead can reflect, engage, and commit to another half century of care and stewardship for rivers that serve not only ourselves, but all of life.

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TIM PALMER has been involved with the Wild and Scenic Rivers System almost since its founding. His 1993 book, *The Wild and Scenic Rivers of America*, was updated and rewritten in 2017 as *Wild and Scenic Rivers. An American Legacy*. See his work at www.timpalmer.org.

Continued from A WATERSHED MOMENT FOR RIVER CONSERVATION AND SCIENCE, from page 3

Further, authors examine topics spanning from the diverse array of ecological and socioeconomic values of the National Wild and Scenic Rivers System to the potential international applications of the cornerstone principles of the law that set the global standard for river conservation.

Going forward, we hope to cultivate a renewed community of scientific interest that expands upon the work of the authors here to develop a research agenda that looks ahead and informs the next 50 years of river conservation. In addition to the articles in this issue, three additional articles focused on international rivers topics will be published in the March 2018 issue. From this assemblage of papers, it is obvious there is potential for a strategic science program coordinated with allocation and stewardship to protect rivers into the future. These interdisciplinary scientists have

already helped us define seven categories of major science knowledge but with additional needs: (1) economic benefits (see Bowker and Bergstrom); (2) the advantages of evaluating outstandingly remarkable values in an ecosystem service provision framework (see Bowker and Bergstrom; Perry); (3) ways to accomplish better ecosystem and social representation (see Perry); (4) the critical need for sound research to support recreation management decisions (see Verbos et al.); (5) the importance of monitoring to determine positive and negative effects of restoration through dam removal and re-watering streams (see Gimblett et al.; Fredrickson and Lacroix); (6) ways to better link protected river designation and management to aquatic diversity (see Rothlisberger et al.; Křenová in *IJW* March 2018); (7) the importance of collaboration in worldwide assess-

ments of rivers to understand human health and environmental protection policies globally (see Carver in *IJW* March 2018); and (8) the importance of international collaboration to understand the contribution of river protection to quality of life and the environment (see Li – this issue and *IJW* March 2018). As we are inspired by these papers, we hope others are also inspired to collaborate on meeting these science needs to support the complex decisions of our legislative bodies, our managers, and people around the world engaged in river management and protection.

Happy anniversary, United States Wild and Scenic Rivers Act!

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The Visitor Use Management Framework

Application to Wild and Scenic Rivers

BY ROSE VERBOS, CARIN VADALA, PETER MALI, and KERRI CAHILL

The Visitor Use Management (VUM) Framework affords managers the opportunity to describe and achieve specific outcomes – desired resource conditions and visitor experiences – and provide sustainable recreation on federally managed rivers (see <https://visitorusemanagement.nps.gov/>). The need to manage visitor use has grown in importance as recreation on US federal waters has increased in recent decades. Accompanying that increase has been a surge in expectations by the public, both in terms of what types of experiences public waters can provide and the quality of those experiences.

The VUM Framework allows US managers to develop long-term strategies for providing access, connecting visitors to key experiences, protecting resources, and managing visitor use on federally managed rivers. In addition, the Framework will enhance consistency in visitor use management on federally managed waters, since river-administering agencies will have the opportunity to adopt the comprehensive approach that the Framework offers. Here we present recommendations from the Interagency Visitor Use Management Council (IVUMC) for managing wild and scenic rivers as well as applications of a sliding scale of analysis, identifying management strategies, and describe the intersection of IVUMC and Interagency Wild and Scenic River Coordinating Council's (IWSRCC) recommendations for addressing user capacity under the Wild and Scenic Rivers Act (Figure 1).



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What Does the Guidance Do?

Agencies that oversee US federally managed lands and waters (and specifically wild and scenic rivers) are directed by law, regulation, and policy to provide opportunities for recreation to the extent it is compatible with the agency mission and does not degrade resources. The VUM Framework is consistent with the shared aspects of agencies' laws and policies while also allowing for flexibility where differences exist. The Framework is also consistent with agencies' established planning and decision-making processes.

Researchers and agency staff have designed and used tools for recreation and land management planning (e.g., Limits of Acceptable Change, Visitor Experience and Resource Protection, and the Recreation Opportunity Spectrum). The VUM Framework is conceptually consistent with existing tools; however, the guidance expands on these tools and integrates lessons learned, providing a consistent approach for managing visitor use and recreation across agencies. The VUM Framework can be applied to

many different river management settings, including those where visitor capacity (or "user capacities" on river segments designated under the Wild and Scenic Rivers Act) is considered an issue. Section 3(d) (1) of the Wild and Scenic Rivers



Figure 1 – The Interagency Visitor Use Management Council (IVUMC) suggests using a sliding scale to determine the level of analysis needed for addressing user capacity and other issues under the Wild and Scenic Rivers Act.

Act directs US federal river-administering agencies to “address ... user capacities” in a comprehensive river management plan prepared for each federally administered component of the National Wild and Scenic Rivers System. IWSRCC is developing a forthcoming technical paper to explain this requirement and provide a recommended approach for addressing user capacities on wild and scenic rivers that will complement the VUM Framework.

Applications of the VUM Framework

The VUM Framework has potential utility for wild and scenic river managers and researchers in the United States and worldwide. Most applicable for managers are (1) consistent application of a “sliding scale” approach in determining the level of visitor use analysis needed, and (2) the identification of visitor use management strategies to address varying types and intensities of use in different river settings. For researchers, the VUM Framework identifies priority visitor research needs and provides opportunities for applying research to inform planning and decision making.

The Utility of a Sliding Scale

A sliding scale provides a method for determining the level of analysis required to adequately address visitor use management opportunities and issues on federally managed waters.¹ Previous visitor use management frameworks such as Limits of Acceptable Change (Stankey et al. 1985), Carrying Capacity Assessment Process (Shelby and Heberlein 1986),

¹See the IVUMC’s website or Appendix C in the VUM Framework for a blank decision support tool: <http://visitorusemanagement.nps.gov/VUM/Resources>.

Visitor Impact Management (Kuss et al. 1990), and Visitor Experience and Resource Protection (NPS 1997) were uniformly complex, costly, and lengthy in application. While the VUM Framework provides a consistent process, and the process does not vary with project complexity, the sliding scale tool helps determine the level of investment of time and resources needed to make planning decisions about managing visitor use. Applying this “sliding scale of analysis” seeks to match the investment made in the analysis with the level of uncertainty and risk associated with the issues being addressed. An interdisciplinary team uses professional judgment to decide the level of analysis, which affects the investment of time, money, and other resources. The team considers and discusses the following criteria to determine the level of analysis for an issue:

- Issue uncertainty: What is the level of uncertainty about the issue being addressed? A higher level of uncertainty indicates the need for a higher level of analysis.
- Impact risk: Are there considerable threats to the quality of resource conditions and visitor experiences? Are there imminent threats to unique or irreplaceable resources? Are there threats to unique or irreplaceable visitor experiences and recreational opportunities? Answering yes to any of these questions may lead to a higher level of analysis.
- Level of controversy/potential for litigation. If an issue is likely to be litigated, a higher level of analysis is possibly required.
- Stakeholder involvement: What is the level of stakeholder interest in the issue? Engaged stakeholder

groups are more likely to track progress, and this may influence the level of analysis needed.

If the team needs additional input to determine the level of analysis needed, a decision support tool can help inform the level of analysis needed for a project. The decision support tool asks a series of rating questions related to the project. The responses to the questions use a simple “high,” “moderate,” or “low” rating system, and the results of those rating questions are used in conjunction with the broad criteria above to determine the location on the sliding scale. If the overall responses to the questions are “high,” then the level of analysis needed is likely high. If the overall responses are “low,” then the level of analysis needed is likely low. However, if some of the responses to the questions are “high,” some are “low,” and some are “moderate,” the level of analysis needed for the project is likely somewhere in the middle. When only one of the broad criteria or rating questions rates out as high, carefully decide the overall level of analysis needed. For example, a high risk of controversy may mean that the level of analysis needed is also high or that the level of analysis needed is moderate and accompanied by a robust public involvement process. Document the rationale for any determination, regardless of the level of analysis needed.

Sliding Scale Example

The following example is a situation that would be considered on the lower end of the sliding scale of analysis. Consider a river located in a remote, primitive setting that has been designated as a wild and scenic river and, therefore, must have a comprehensive river management

plan that addresses user capacities. Recreational use of the river is low due to the remote location and difficult access, and there is no expectation that use will increase in the foreseeable future. Currently, only about one group typically applies for a river use permit every two weeks during the summer season. The typical group size is less than eight. The group size is limited by the size of the aircraft that private parties must use to access the launch sites. Ample undesignated camping locations are available along the river, which give visitors the opportunity to disperse and avoid contact with other groups. Typically, use levels are low enough that areas recover from campsite use within one season, and previous use is not noticeable the next season. Current natural and cultural resource conditions and visitor experiences through the river corridor are within acceptable thresholds. The plan is not likely to generate controversy because the visitor access and local guide services are not likely to be significantly affected. The analysis will be based on local expert knowledge and professional judgment and will draw on plans and research from similar rivers and primitive settings. This background information regarding this issue suggests a low level of analysis needed.

Now consider an example on the higher end of the sliding scale of analysis. Consider a newly designated wild and scenic river located in a wilderness area, but one that is easily accessible and offers outstanding whitewater recreation opportunities. Numerous commercial guides operate on the river, and a high level of private use occurs. A mix of activities includes whitewater kayaking, rafting, fishing, scenic viewing, and picnicking. High use has impacted

resource conditions and reduced opportunities for solitude. Potential management actions for the affected areas could include actions to limit encounters, separate potentially conflicting users (boaters and others), and address ecological impacts (user-created trails at undesignated camping locations) and related aesthetics (e.g., litter). Decisions to reduce or restrict recreation use, to maximize solitude and preserve natural resources, can affect both private and commercial users on the river. These management actions are being proposed in a revision to the comprehensive management plan. The planning process is being closely followed by multiple stakeholder groups.

These issues pose a high risk of consequences to physical, biological, social, and managerial attributes. On one hand, restricting the use levels of commercial outfitters in the area may have both positive and negative impacts. Any selected alternative is likely to result in substantial change to the recreational use of the river. While other whitewater recreation opportunities exist in the area, this wild and scenic river offers unique wilderness opportunities. However, these opportunities are threatened by the current level of use. Current resource and social conditions are approaching thresholds, according to the comprehensive management plan. Stakeholders are well organized and capable of litigation. A high level of certainty is necessary to make defensible decisions, which places this issue on the high end of the sliding scale of analysis.

Applying a sliding scale of analysis helps the team to determine how much time, money, and resources to invest in a project. Using the decision support tool to better define level of uncertainty, risk of impacts

to resources and visitor experiences, degree of stakeholder interest, and level of controversy/potential for litigation helps place the issues along the sliding scale. Ultimately, determining the appropriate level of analysis for a project is a matter of careful assessment and professional judgment.

Identifying Management Strategies

The VUM Framework can aid managers in collaboratively developing strategies for providing access, connecting visitors to key visitor experiences, protecting resources, and managing visitor use on and along rivers in the United States. In one element of VUM, "Identify Management Strategies," the Framework guides managers to identify management strategies and actions to achieve and maintain the desired conditions of the river. Although there are many management strategies in use, a simple classification in dispersed recreation visitor management includes things such as modifying type of use, visitor behavior, attitudes, and expectations (Cole, Petersen, and Lucas 1987).

This element also assists in identification of a visitor capacity and selecting implementation plans to achieve or maintain use within visitor capacity. Visitor capacity is a component of visitor use management and is the maximum amount and type of visitor use that an area can accommodate while achieving and maintaining the desired resource conditions and visitor experiences, consistent with the purposes for which the area was established. The steps within this element help managers understand the relationship between existing and desired conditions and make defensible decisions about visitor use management

actions, including those regarding visitor capacity. The desired outcomes of this element include documentation of the gap between existing and desired conditions and clarification of the link with visitor use, identification of management strategies and actions to achieve the desired conditions, establishment of visitor capacities where needed or required, and development of a program to monitor conditions over the long term. The identification of management actions is a matter of predicting what is necessary to meet management objectives before unacceptable impacts occur and prevent future unacceptable impacts. Monitoring data can help refine understanding about what actions are necessary to maintain and/or achieve desired conditions and improve the understanding and use of indicators and thresholds.

IVUMC and IWSRCC's Guidance on User Capacity

The VUM guidance on visitor capacity is aligned with the IWSRCC's forthcoming technical paper on user capacities for wild and scenic rivers. The IVUMC developed its recommendation for addressing user capacity under the Wild and Scenic Rivers Act in collaboration with the IWSRCC. Section 3(d)(1) of the Wild and Scenic Rivers Act states: "[T]he Federal agency charged with the administration of each component of the National Wild and Scenic Rivers System shall prepare a comprehensive management plan for such river segment to provide for the protection of the river values. The plan shall address resource protection, development of lands and facilities, user capacities, and other management practices necessary or desirable to achieve the purposes of



Figure 2 – Managing where and when use occurs, or building facilities that are resistant to impacts are possible actions for reaching desired conditions.

this Act" (US Public Law 90-542). The IWSRCC defines "user capacity" to be the maximum amounts and kinds of visitor use as well as administrative use specific to the wild and scenic river. Administrative use specific to a wild and scenic river can be substantial and may affect the types and amounts of visitor use that may be allowed without adversely affecting river values.

Federal courts have defined the phrase "address ... user capacities" to mean the maximum number of people that can be received in a designated river area without adversely impacting river values. Based on this finding, courts have required the inclusion of user capacities in comprehensive river management plans (CRMPs) for each river area and protocols for managing use according to established capacities.²

²See, for example, *Friends of Yosemite Valley v. Kempthorne*, 520 F.3d 1024, 1028-30 (9th Cir. 2008), and *American Whitewater v. Tidwell*, 2013 US Dist. LEXIS 71135 at *36 (D.S.C. 2013).

The federal river-administering agencies have also interpreted Section 10(a) of the Wild and Scenic Rivers Act (Public Law 90-542) as establishing a "nondegradation and enhancement policy" so that "[e]ach component will be managed to protect and enhance the values for which the river was designated, while providing for public recreation and resource uses which do not adversely impact or degrade those values." (USDI and USDA 1982). Because of these judicial and agency interpretations of the act, managers should understand that user capacities adopted in a CRMP function as management decisions to prevent degradation of river values.

Managing use levels within a visitor capacity is one of many strategies for dealing with visitor use issues. Changing visitor behavior, modifying where and when use occurs, or building facilities that are resistant to impacts from heavy use are all possible actions within management strategies necessary for reaching

desired conditions. So, capacity is one piece of the VUM Framework needed to manage visitor use and, in some instances, is legally required (Figure 2). Capacity, therefore, is embedded in a larger framework that includes making decisions about desired conditions and other management actions.

The IWSRCC's forthcoming technical paper provides recommended steps to address these topics for wild and scenic rivers (WSRs). The National Wild and Scenic Rivers System is extremely diverse, with varying types and levels of use. WSRs range from rivers where current use levels threaten river values to those where current or projected use levels are unlikely to threaten river values in the foreseeable future. Even a single WSR may contain multiple segments with varying classifications, "outstandingly remarkable values," uses, and user capacities. Section 1(b) of the Wild and Scenic Rivers Act states "that certain selected rivers of the Nation which, with their immediate environments, possess *outstandingly remarkable* scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar *values*, shall be preserved in free-flowing condition, and that they and their immediate environments shall be protected for the benefit and enjoyment of present and future generations" (emphasis added). IWSRCC guidance assists planners in considering the protection of river values in user capacity decisions such as determining the appropriate geographic scope and scale of investment needed to understand and manage public use of a WSR corridor effectively, and making user capacity decisions that allow for varied implementation sched-

"The VUM framework can aid managers in collaboratively developing strategies for providing access, connecting visitors to key visitor experiences, protecting resources, and managing visitor use."

ules to best prevent degradation of river values. Additional materials on identifying and implementing visitor capacities and user capacities are forthcoming from both interagency councils.

User Capacity Example

On a WSR with a recreation outstandingly remarkable value, a desired condition has been identified to provide freedom from the sounds and sights of others while camping. As a result, it may be preferable for some campsites to remain unoccupied. Using a threshold of maximum 80% campsite occupancy would allow the visitors most sensitive to the sights and sounds of others to camp away from others. Thus, the capacity could be expressed in terms of number of groups (e.g., with a group size limit of 15) that can be accommodated in the river corridor, which would be based on the number of campsites multiplied by 80%. For example, if a river corridor contains 10 campsites, the capacity would be 8 occupied campsites. Regarding the number of visitors, 8 campsites multiplied by 15 people per campsite equals 120 visitors per night. Include both capacity metrics (e.g., 8 campsites, 120 people per night) in the decision document for this area.

Identifying Research Needs

The VUM Framework and IWSRCC's forthcoming technical paper also identify needs for science by river researchers in the United States and worldwide. Scientists are uniquely positioned to help link planners and managers to the "best available science" some of which may already exist under certain circumstances and alternatively initiate new information collection to support comprehensive planning. The VUM Framework can help inform appropriate application of existing and potential new research that informs visitor use management strategies for rivers. For example, research institutions can contribute existing data and analysis support that can aid in building the foundations of a planning process as well as summarizing existing and past conditions. New research can provide the foundation for visitor use management actions by providing input to defining desired conditions for the project area, analyzing the impacts of different visitor activities, facilities, and services as well as helping to inform the selection of indicators and thresholds, visitor capacities, and selecting monitoring protocol.

For example, comprehensive visitor perception research on wildlife viewing in river corridors could inform a variety of steps within the VUM framework. Desired social and natural conditions have been informed by investigating visitors' perceptions of acceptable and preferred levels of impacts to resources and social conditions. Development of management action alternatives are often evaluated through finding visitors' level of support or resistance to specific strategies. Similarly, visitor perceptions of levels and locations of crowding and conflicts can inform visitor capacity determinations. In sum, visitor

research contributes to the selection of potential visitor use management strategies based on understandings of how current conditions compare to desired conditions and the effects of potential actions to accomplish objectives. It is important to note that visitor research is an important data input to inform management decisions, and river managers and planners ultimately use a variety of data sources to inform management decisions.

Conclusion

The VUM Framework, developed collaboratively by six federal agencies, has advanced agency collaboration and a professional approach to visitor use management by setting forth a framework to proactively help federal managers provide high-quality recreational experiences to those who visit protected rivers in the United States. The Framework provides clear direction and expectations about visitor use management and more specifically the legal requirements for meeting visitor capacity requirements. The utility of the VUM Framework for managers and the importance of research about protected rivers in the United States can be found in the application of the sliding scale and the identification of management strategies. Social and biophysical science on U.S. rivers can support use of the Framework with critical understanding of current

conditions, public preferences, and potential benefits of alternative management actions. In celebration of the Wild and Scenic Rivers Act, IVUMC and IWSRCC look forward to continued success stories of visitor use management on federally managed waters.

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Wild and Scenic Rivers into the Next 50 Years

Lessons from the Re-watering and Restoration of Fossil Creek

BY BJORN FREDRICKSON and KELLY MOTT LACROIX

Abstract: Fossil Creek was designated as a Wild and Scenic River in 2009. Its striking turquoise-blue waters support outstandingly remarkable values related to recreation, geology, biological resources, and Apache and Yavapai traditional and contemporary cultural values. However, until recently Fossil Creek was known not for its unique and significant river values but rather for its importance as a hydroelectric resource. Hydroelectric facilities constructed in the early 20th century diverted the majority of Fossil Creek's flows, leaving little water in the creek to support nonconsumptive values. In 2005 a broad group of stakeholders negotiated the removal of these hydroelectric facilities and the "re-watering" of Fossil Creek. This work has restored robust ecological and geologic processes, honored important historic and cultural values associated with this resource, and led to a high level of demand for recreation access. The story of Fossil Creek has broad implications for the protection of rivers under the Wild and Scenic Rivers Act at its 50th year and beyond.

Fossil Creek – one of only two federally designated wild and scenic rivers (WSRs) in Arizona – originates in Fossil Springs Wilderness in the southern part of the Coconino National Forest (CNF). It ultimately flows through Mazatzal Wilderness prior to its confluence with the Verde WSR. Fossil Creek is unique both for its perennial flow in an arid region and for its travertine system. Much of this perennial flow is from springs that have a combined discharge of 43 cubic feet per second (cfs) (Jones and Phillips 2001). These springs are supersaturated with calcium carbonate, which precipitates on logs and rocks, forming unique fossil-like travertine dams that give rise to Fossil Creek's name. The calcium carbonate also creates stunning turquoise-blue waters, which are oxygenated by the system of cascading travertine pools, resulting in high-quality habitat for native fish (Marks et al. 2010).

Intermittent use of the Fossil Creek corridor likely began several millennia ago with the Yavapai people as



Bjorn Fredrickson



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early as the 13th century and the Apache people in the 16th century (Pilles 1981; Gilpin et al. 2003; USDA 2016b). This use of the corridor was likely unchanged until the US Cavalry embarked on a campaign to remove the Yavapai and Apache peoples to reservations in the 1860s and 1870s. Human use of the corridor again changed in 1908 with the construction of the 25-foot (7.6 m) Fossil Springs Dam and flume to supply water

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to the Childs and Irving hydroelectric plants (USDA 2016b). The Childs-Irving Power System reduced flows in Fossil Creek by upwards of 90% to 2–3 cfs (Megdal et al. 2006) (Figure 1), helped to power mining operations in north-central Arizona, and supported the rapid expansion of Phoenix through the mid-1900s. In the 1990s the plant operator, Arizona Public Service (APS), applied to the Federal Energy Regulatory Commission (FERC) to renew its license to generate power through diversion of Fossil Creek. Public interest and input in the relicensing process instead led to decommissioning the dam, flume, and power plants in 2005, allowing for the return of historical flows to the creek – which we refer to as “re-watering” here – along with restoration of a variety of its natural and cultural values (Figures 2 and 3). In 2009, Congress designated 16.8 miles (27 km) of Fossil Creek as a WSR. Outstandingly remarkable values (ORVs) for Fossil Creek include recreation, geology, biological resources, and Apache and Yavapai traditional and contemporary cultural values (USDA 2016b).

Considering the 50th anniversary of the Wild and Scenic Rivers Act in 2018, the story of re-watering and restoring Fossil Creek is relevant in several respects to the next 50 years of river protection. First, restoration of highly modified rivers can enhance and even create ORVs, as well as eligibility for WSR designation. Second, collaborative efforts and leadership by broad coalitions can produce significant conservation achievements. Finally, special places such as Fossil Creek have the potential to increase access to and public support for the National Wild and Scenic Rivers System by urban and underrepresented communi-

ties in addition to more traditional public lands visitors. Balancing the protection of ecological and cultural values with the desire to maximize public use and enjoyment of WSRs, however, requires thoughtful management approaches.

Restoration and Creation of Nonconsumptive River Values in Fossil Creek

Relatively few dam decommissioning efforts in the United States have been studied and documented, and existing studies emphasize physical responses (e.g., sediment and flow) to dam removal as opposed to biological and water-quality responses (Bellmore et al. 2016). The handful of studies that have examined biological responses have found that biotic recovery can be rapid when the physical and chemical condition of the stream is relatively unaltered (Gore et al. 1990; Niemi et al. 1990).

The restoration of Fossil Creek supports previous findings that physical processes and biological values can rebound following dam removal, particularly where complementary restoration actions

are taken. Fossil Creek’s travertine system demonstrated measurable recovery within months of restoration of full flows (Fuller et al. 2011). Macro-invertebrate populations and fungi differed substantially above and below the dam prior to restoration, but quickly equilibrated following the dam removal (Muehlbauer et al. 2009). The restoration of Fossil Creek was also characterized by the recovery of native fish populations, although restoring this natural fishery required significant effort, including installation and maintenance of fish barriers to prevent species invasions from downstream, and the removal of exotic fish (Marks 2007). This is notable because while dam removals alone have allowed for a rapid return of migratory fish to previously inaccessible upstream reaches, responses to dam removal by less mobile fish, animals, and plants that receive no further human assistance have been mixed (O’Connor et al. 2015). The additional efforts to restore native fish on Fossil Creek resulted in initial population increases of 17-fold, 52-fold, 70-fold, and 150-fold in Sonora sucker, desert sucker,



Figure 1 – Fossil Creek after being de-watered for hydroelectric power generation. Photo credit: Coconino National Forest.



Figures 2 and 3 – Fossil Creek and its turquoise-blue waters after being re-watered. Photo credit: Coconino National Forest.

roundtail chub, and speckled dace, respectively (Marks et al. 2010), and as of 2016 Fossil Creek was home to the largest number of native fish species protected from nonnative fish impacts in Arizona (USDA 2016b). Intensive study of the Fossil Creek system by an interdisciplinary team of scientists prior to and upon removal of the dam and flume have enabled this uncommonly robust set of observations that advance the general understanding of biophysical responses to river restoration.

In addition to the recovery of biophysical values, the re-watering and restoration of Fossil Creek demonstrates that river restoration actions can result in the return and creation of cultural and social values. This is indicated in part by the traditional and contemporary values that the Yavapai and Apache place on Fossil Creek, which were enhanced with the re-watering of Fossil Creek (USDA 2016b). One example of these enhanced values relates to the Apache philosophy of water, which has life and

is meant to be free. De-watering Fossil Creek when it was originally dammed and diverted resulted in great misgiving by the Apache, and the return of Fossil Creek's water to its natural, free-flowing state was cause to rejoice (V. Randall, personal communication, March 10, 2017). In contrast to Fossil Creek's other ORVs, which are rooted in natural processes and cultural uses and values of the river corridor, modern forms of recreation were not part of Fossil Creek's historical fabric in an outstandingly remarkable way but rather emerged when flows were restored. It could therefore be argued that the recreation ORV was created with the restoration of Fossil Creek.

Collaborative Efforts and Significant Conservation Achievements

The rapid recovery of Fossil Creek's natural system and sociocultural values resulting from its re-watering and restoration was enabled by a slower moving social process. It took more than a decade of collaboration for Fossil Creek's waters to flow freely again. In many ways, the dam decommissioning and subsequent restoration efforts exemplify the key elements of adaptation for natural resource management through strong leadership, extensive public participation, and repeat engagement by a core set of stakeholders (see, e.g., Folke et al. 2005; Lebel et al. 2006; Pahl-Wostl 2009; Mott Lacroix and Megdal 2016). Specifically, these efforts were possible due to leadership from many sources, including APS given its decision to change course from its initial relicensing request to instead support re-watering Fossil Creek, a diverse coalition of local and national environmental organizations, the Yavapai-Apache Nation, and natural resource management

agencies involved in the Fossil Creek system. Elements of the wide-ranging coalition that worked together to re-water and restore the creek continue to be engaged in planning processes. For example, the Yavapai-Apache Nation and several of the environmental organizations involved in restoration were instrumental in advocating for Fossil Creek's designation as a WSR.

The public also played an important role in the restoration of Fossil Creek. When FERC issued a draft environmental assessment in 1997 recommending a new license be issued, public input and participation in the succeeding years prompted APS to change its request to FERC; to surrender its license; decommission the dam, flume, and hydroelectric plants; and re-water Fossil Creek. Public interest and participation continued beyond the decommissioning effort, contributing to other restoration actions and Fossil Creek's designation as a WSR in 2009. This engagement persists 25 years later with the ongoing development of Fossil Creek Comprehensive River Management Plan (CRMP) by the Forest Service.

Increasing Support through Access and Recreation

Recreation use grew profoundly after Fossil Creek was re-watered and continued to grow following its WSR designation in 2009. Specifically, the CNF estimates that use of Fossil Creek during the primary-use season (May–October) increased from approximately 20,000 visitors in 2006 to 80,000 in 2009 and 2010, and peaked at nearly 95,000 in 2011. A survey from 2013 indicated that 79% of visitors were from the Phoenix metro area, located more than two hours away by car (USDA 2013).

By estimating both the visitation at Fossil Creek and the number of people turned away due to capacity controls implemented beginning in 2011, total demand to visit Fossil Creek peaked at nearly 130,000 people during the primary-use season in 2015. Visitation levels were reduced in 2016 using a permit system to levels approximately equal to 2007, when 45,000 to 50,000 people visited during the primary-use season. Total demand to visit Fossil Creek in 2016 is unknown because data do not exist on how many would-be visitors wanted to obtain a permit but were unable to do so (USDA 2013; USDA 2016a).

The visitor use patterns at Fossil Creek since it was re-watered are notable not only for the significant growth in public demand for visitation, but also for the demographics of visitors. Namely, the CNF estimates that the proportion of Hispanic visitors to Fossil Creek grew from 19% in 2009 to 49% in 2013, compared to a national estimate that 5.5% of visitors to National Forest System lands between 2010 and 2015 self-identified as Spanish, Hispanic, or Latino (USDA 2013; USDA 2015). Nearly 8% of visitors to the CNF in 2010 self-identified as Spanish, Hispanic, or Latino (USDA 2010). Initial analysis of data from the first year of the permit system indicates that the proportion of Hispanic visitors to Fossil Creek decreased to approximately 27% in 2016, a reduction of nearly half (F. Valenzuela, personal communication, January 18, 2017). No studies have been conducted to explore why visitation to Fossil Creek by Hispanic visitors is so high compared to national visitation patterns and those observed for the CNF, and whether the permit system has caused the

substantial decrease in proportion of Hispanic visitors to Fossil Creek. However, these demographic trends and questions for future researchers are noteworthy given published literature that federal public lands tend to serve primarily white visitors (see, e.g., Johnson et al. 2007; Weber and Sultana 2013) and that many urban communities are underserved in terms of access to parks and green space (see, e.g., Byrne et al. 2009; Johnson-Gaither 2011).

The CNF has not finalized the Fossil Creek CRMP and therefore no substantial facilities development has yet occurred in the river corridor. As such, outside of public contacts, signage, prohibitions on camping and campfires, informal designation of parking areas, and minor upland restoration activities, recreation use at Fossil Creek has been largely unconstrained. Due to concerns on the CNF that unconstrained recreation at increasing use levels was resulting in unacceptable crowding and impacts to the river's water quality and ORVs, the CNF implemented capacity controls as part of their interim protection measures beginning in 2011. These interim measures culminated in the implementation of a reservation permit system in 2016. It is possible that Fossil Creek could support higher levels of visitor use without corresponding impacts to its ORVs with appropriate facilities development. Specifically, recreation ecology studies indicate that much of natural resource impacts from recreation occur at low use levels, and impacts from visitor use decrease proportionally as use grows to moderate and high levels. Based on these studies, by strategically locating visitor use at hardened sites through facilities development (e.g., fencing, trails,

etc.), impacts from recreation can be substantially reduced as compared to scenarios where visitor use is unconstrained (Leung and Marion 1999; Marion et al. 2016). In developing the Fossil Creek CRMP, the CNF has proposed an adaptive approach to managing capacity concurrent with strategically locating and developing facilities to more actively manage recreation use, setting aside a specific site of significance to the Yavapai-Apache Nation for tribal uses, exempting tribal traditional and cultural uses and activities from the permit system, and prohibiting swimming at sites with noteworthy cultural and natural values. Taken together, these approaches may result in increased visitor use capacity in the future compared to 2016 while ensuring for the protection of natural and cultural values (USDA 2016c).

Striving to manage WSRs to protect natural and cultural values and provide high levels of access to outstandingly remarkable recreation opportunities by diverse communities can be justified on pragmatic and moral grounds. In pragmatic terms, a variety of studies have demonstrated a correlation between outdoor recreation use and support for the resource; pro-environmental behaviors; and, depending on the recreation activity, support for conservation activities (see, e.g., Jackson 1986; Larson et al. 2011; Cooper et al. 2015). One study also indicates that in addition to WSR visitors accruing social benefits from their recreation experiences, proximity to WSRs is correlated with community members perceiving that they derive ecological, social, and economic benefits from WSR designations (Smith and Moore 2011). It therefore follows that access to high-quality recreation opportunities associated with WSRs

by nontraditional public lands visitors and underserved communities in addition to traditional national forest visitors could lead to broader public support for the National Wild and Scenic Rivers System. Increased support for WSRs by underserved communities may also contribute to more diversity and strength in collaboratives working on behalf of river restoration and future WSR designations. A growing body of literature indicates that inequities in access to parks and open space in urban areas may be widespread (Byrne et al. 2009; Johnson-Gaither 2011). Identifying opportunities to restore and protect rivers in or close to urban communities, including providing river-based recreation opportunities, could contribute to addressing some of these inequities.

The Next 50 Years of River Protection

Fossil Creek is a rare case of WSR designation following a major restoration action. It demonstrates that rivers with impaired flows and ORVs can be restored and subsequently merit inclusion in the National Wild and Scenic Rivers System. Over the past quarter century the robust public interest and involvement together with strong leadership by a wide-ranging coalition of corporate, tribal, environmental nonprofit, and government stakeholders have resulted in decommissioning the dam, several associated restoration actions, Fossil Creek's WSR designation, and the present-day effort to finalize the Fossil Creek CRMP to ensure protection of the river's values in perpetuity.

At its core, the story of Fossil Creek is one of a shift in public values from commodity-driven river management – in this case, hydro-

power – to prioritizing less tangible biophysical and sociocultural values. Replicating this success story in the context of other dammed, diverted, or channelized rivers where the public places increasing value on nonconsumptive uses will by no means be easy. Namely, even with the increasing value that the public places on nonconsumptive uses, successful river restoration and protection efforts often require substantial time and effort to understand the system ecology, ensure broad and persistent collaborative relationships, and promote robust public participation. Although river restoration efforts are complex and time intensive, opportunities for such actions are increasing where safety, sociocultural, and environmental factors are recognized as outweighing the benefits of dams, or as dams are deemed no longer useful in achieving their intended purposes (American Rivers 2016). It stands to reason that rivers with dams or other developments that are unsafe, no longer useful, or inefficiently providing tangible commodity-based services are ripe for public discourse about their relative value in a free-flowing state, particularly where potential exists for the restoration, enhancement, or creation of ORVs.

In addition to the unusual fact that Fossil Creek was once dammed and is now a WSR, the growth in recreation demand by diverse and urban visitors following Fossil Creek's restoration and designation is particularly worthy of consideration. The Wild and Scenic Rivers Act requires that managers protect the free flow, water quality, and ORVs of designated rivers. Where recreation is an ORV, managers should strive to meet public demand for access to WSRs by informing planning and

facilities development with biophysical sciences, cultural resource values, and recreation ecology. With this approach, capacity constraints could be based on addressing recreation goal interference and social value conflicts (as summarized in Watson 2001) as opposed to impacts to natural and cultural resources from unconstrained recreation activities. Considering the 50th anniversary of the Wild and Scenic Rivers Act and looking ahead into the act's next 50 years, such an emphasis on recreation access by diverse and underserved communities in the context of river restoration and protection efforts could result in immense payoff for all who value WSRs. A focus on balancing recreation demands alongside free flow, water quality, and other ORVs will ensure the restoration, enhancement, or even creation of biophysical and sociocultural values; accrual of ecological, social, and economic benefits by visitors and nearby communities; improvement to localized, historic environmental inequities related to access to parks, open space, and high-quality recreation opportunities; opportunities to increase broadened collaboratives working on river restoration and designation; and public support for the National Wild and Scenic Rivers System along with conservation and public lands more broadly into the next 50 years.

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Continued on page 48

Wild and Scenic Rivers

An Economic Perspective

BY J. M. BOWKER and JOHN C. BERGSTROM

Abstract: To date, economic valuation studies have focused on individual rivers and not the National Wild and Scenic Rivers System (NWSRS) as a whole. Following Morton (1999), we provide a brief conceptual taxonomy of on- and off-site economic benefits that might be relevant to the NWSRS. These benefits include values associated with individual rivers within the NWSRS and benefits of the system, including ecosystem services. The published empirical literature is also reviewed, focusing on the economic valuation of wild and scenic rivers. Although the empirical studies and valuation results are relatively sparse, we provide a qualitative and quantitative summary and assessment of these results and an assessment of the economic impacts of wild and scenic rivers on local communities. Finally, we identify and discuss the shortcomings in the existing body of economic literature and resulting research needs to better understand the economic value and impacts of wild and scenic rivers.

The National Wild and Scenic Rivers Act was spawned by public and political realization that exceptional stretches of free-flowing rivers were valuable beyond the reasons of commerce, such as power generation and commercial transportation (Walsh et al. 1985). Walsh et al. (1985) point out that the act provides protection for rivers, or sections thereof, according to three categories of classification: *Wild river areas*, characterized by lack of impoundments and generally inaccessible except by foot, with undisturbed shorelines and unpolluted waters; *Scenic river areas*, characterized by slightly less pristine conditions wherein there still are no impoundments, but shorelines are largely primitive and undeveloped with some road access; and *Recreational river areas*, characterized by possible impoundment in the past with accessibility by rail or road and some level of development along their shorelines.

In “Conservation Reconsidered,” Krutilla (1967) recognized the growing importance of economic benefits from preserving natural environments and that not all economic values derive from market transactions. Since that time, the discipline of economics has developed theoretical and conceptual tools to estimate monetary values for many goods and services for which markets do not



Mike Bowker and Sete on the Upper Kenai River, Alaska.



John Bergstrom and son Luke on Chattooga River, Georgia.

exist. This development has afforded policy makers a more informed and common metric for comparing the benefits of natural areas protection and use. For example, surveys by Bowker et al. (2005, 2014) demonstrated the various types of nonmarket values accruing to the National Wilderness Preservation System (NWPS). Holmes et al. (2016) found evidence suggesting that NWPS values are increasing over time. Patton et al. (2015) developed and implemented methods for measuring the economic values of ecosystem services provided by wetlands in the National Wildlife Refuge System.

In this article, we inventory and assess what is known about the economic benefits, or dollar values, accruing to

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Americans from the National Wild and Scenic Rivers System. Following Morton (1999), we provide a brief taxonomy of the kinds of economic benefits that might be considered relevant to the NWSRS. These benefits include values from individual rivers and ecosystem service benefits arising from the complete NWSRS. To date, economic valuation studies have focused on case studies of individual rivers or parts thereof, not the NWSRS as a whole. Virtually no studies have attempted the difficult task of isolating the value of designation, that is, accounting for the increase (decrease) in value to the public of ensuring protected status for future generations.

We also review the empirical literature focusing on the economic valuation and values of wild and scenic rivers. Although the empirical studies and valuation (e.g., willingness-to-pay) results are relatively limited, we

provide a summary of these results. We also provide an assessment of the economic impacts of wild and scenic rivers on local communities. Finally, we identify and discuss the shortcomings in the existing economic literature and resulting research needs to better understand the economics of wild and scenic rivers.

Economic Value from Wild and Scenic Rivers

Designation and thus preservation of rivers in the NWSRS can lead to many individual and societal benefits not unlike those of designated wilderness. Morton (1999) summarized these benefits into seven categories as they apply to wilderness. These benefits include “on-site” recreation, community, scientific benefits and “off-site” biodiversity conservation, ecological services, and passive use benefits (Figure 1). A key difference is

that unlike wilderness benefits, those arising from river designation can be partial, that is, restricted to a segment of a river, and within any of the three designated classes (see Palmer, this issue). Moreover, many NWSRS rivers transect designated wilderness, thus leading to questions of value attribution and possible double-counting of these benefits. Most of the empirical research to date on NWSRS river values has focused on measuring on-site recreation use value.

On-site recreation benefits derive from visiting NWSRS locations and include activities such as camping, canoeing, fishing, hiking, hunting, kayaking, rafting, and wildlife viewing. These benefits require directly accessing a specific river or buffer zone of a river for a recreation visit. *Passive use benefits*, or nonuse benefits (Krutilla 1967; Freeman 1994) or preservation benefits (Walsh

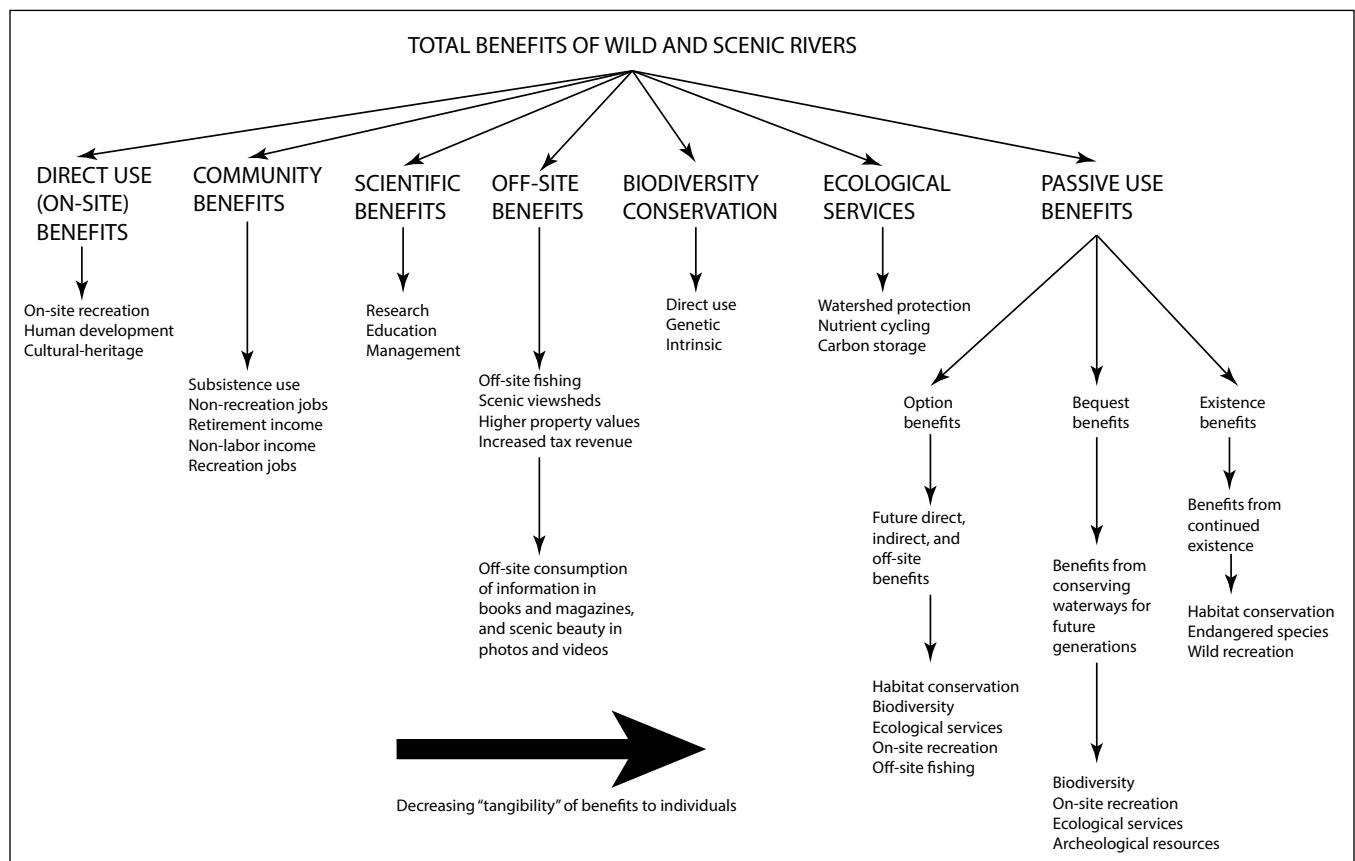


Figure 1 – Total benefits of wild and scenic rivers (adapted from Morton 1999)

et al. 1985), are less tangible as on-site access is not required. Passive use benefits reflect the utility a person receives from knowing that some or all the NWSRS is preserved, even if they neither have visited, nor ever plan to visit, any of the rivers in the system. Passive use benefits include: (1) option, (2) bequest, and (3) existence benefits. In terms of their applicability to the NWSRS, “option benefits” refer to knowing that preservation of these rivers ensures an opportunity to visit a part of the NWSRS in the future. Similarly, “bequest benefits” arise from the knowledge that the NWSRS will continue to be available and enjoyed by present and future generations. Existence benefits derive from simply knowing that NWSRS and the designated rivers and ecosystems contained within the system continue to exist – regardless of current or expected human use. There is some debate among economists over the precise definitions for the various components of passive use benefits, and even more debate over how to reliably parse and estimate their economic value. This would seem particularly problematic for the NWSRS, given the piecemeal nature of designation, that is, multiple classes, and potentially heterogeneous application to any given river. However, economists generally agree that passive use can generate benefits, which do have an economic value (Freeman 1994). Studies also suggest that passive use values may make up the largest component of the total economic value of a protected area (Bowker et al., 2005; Haefele et al. 2016).

Morton identified other benefits of wilderness that one could also apply to the NWSRS, including *community*, *scientific*, *off-site*, *biodiversity conservation*, and *ecological service benefits*. These benefits affect individuals more indirectly and have

proven enigmatic to economists estimating dollar values for a site or system like wilderness, NWSRS, and the National Wildlife Refuge System (e.g., see Patton et al. 2015). Walsh et al. (1985), focusing on benefits strictly applicable to the individual, did not include these values in their seminal work on the economics of the potential designation of Colorado rivers to the NWSRS in 1983.

Community benefits may include jobs and income created and supported through spending by foreign visitors to the NWSRS. Rosenberger and English (2005) addressed the state of knowledge about the community economic impacts of wilderness recreation, focusing on local communities and regional economies. Holmes and Hecox (2004) found that wilderness counties in the West experienced significantly increased employment, income, and population. For the NWSRS, community benefits resulting from designation could accrue similarly. However, most economists would put said *benefits* into a category of income transfers or redistribution rather than net economic benefits, because the spending is likely to simply be transferred to another recreation venue or substitute river in or out of the NWSRS. Insofar as there is a societal benefit from redistributing wealth, (e.g., from urban and suburban wealth centers, or internationally, to more rural areas), this could be viewed as a net gain. However, determining such a net gain, if it exists, would be very difficult empirically and is thus typically left for debate in the political arena.

An alternative type of *community benefit*, argued and empirically demonstrated by Phillips (2004) in the case of wilderness designation in the Green Mountains of Vermont, are concomitant increases in property

values for property owners within a defined spatial limit of the designated area. This type of “hedonic price” benefit could likely be ascribed to select properties proximal to NWSRS designations. Moore and Siderelis (2002) used a similar approach to assess the property value increases associated with designation of the West Branch of the Farmington River.

In keeping with Morton’s (1999) benefit typology for wilderness, three types of *scientific benefits* – research, education, and management – may arise from the wilderness related to the NWSRS. Pristine waters and adjacent land can be recognized as a living laboratory and benchmark for evaluating the impacts of development elsewhere (Loomis and Richardson 2000). Educational benefits include the development of wilderness waterway travel and survival skills, as well as opportunities for personal growth and improved health (Morton 1999; Stolton and Dudley 2010). Wilderness also acts as a model for understanding and restoring natural forest ecosystems, hence the *Wild rivers* classification would contribute in this regard.

Off-site benefits of wilderness include providing habitat for fish, wildlife, and a wide variety of other species. However, species depending on this habitat do not necessarily have to be enjoyed by visiting a wilderness area. A golden eagle soaring beyond the boundary becomes an important off-site benefit. Off-site benefits of nature described here could take the form of enhancing fish and wildlife population numbers downstream. Moreover, benefits could take the form of eliminating or lowering the frequency of externalities such as runoff, contaminant release, and siltation downstream. While these benefits are tangible and conceptually sound, accu-

rately estimating dollar values for such benefits has proven to be quite challenging. Walsh et al. (1985) attempted to estimate such benefits, ex ante, for a set of rivers in Colorado were they to become part of the NWSRS.

Conserving biodiversity is highly important to policy makers and scientists (Ando et al.1998). Biodiversity conservation in wilderness and protected areas legislation and management assures preservation of representative ecosystems, threatened species, and genetic diversity (Loomis and Richardson 2000). Conceivably, the NWSRS contributes to preserving biodiversity in similar ways. This would be particularly applicable to NWSRS rivers falling into the *Wild rivers* and *Scenic rivers* classifications.

In addition, Forest Service-administered units in the NWSRS system also protects more than 1.4 million acres of riparian ecosystems (USDA Forest Service, January 19, 2017), including wetlands and upland forests. These ecosystems provide a variety of ecosystem services, including active and passive use values associated with wildlife habitat, erosion control, flood control, water pollution control, natural pest control, and climate regulation through carbon sequestration. Nonmarket valuation techniques can be applied to monetarily quantify the values of riparian ecosystem services (Bergstrom and Loomis 2017; Holmes et al. 2004; Loomis and Richardson 2000; Morton 1999; Patton et al. 2015; Woodward and Wui 2001). Several examples of previous studies that valued ecosystem services supported by riparian ecosystems are discussed below in the “Ecological Values” section.

While the above economic values are conceptually valid and realistic, two important aspects should not be overlooked. First, the value of the

foregone benefits (or “opportunity costs”) arising from designation to the NWSRS must be acknowledged, as well as the obvious economic costs associated with initial acquisition and investments and annual management of NWSRS lands (Walsh et al. 1985). For example, depending on the location of the river and types of commercial activity in the area, there may be opportunity costs arising from the loss of timber, mineral extraction, or grazing on surrounding land (Walsh et al. 1985). Much harder to capture are the opportunity costs associated with foregone development opportunities proximal to the river. In any case, careful estimation of the net economic benefits and opportunity costs is necessary to determine the economic efficacy of additions to the NWSRS.

Economic Value Research and the NWSRS

In the 1960s, nonmarket valuation gained credibility among economists. Several studies have since focused on estimating the economic benefits for

rivers outside of strictly commercial uses such as transportation and hydroelectric generation. The National Park Service produced an annotated bibliography of studies on the economics of conserved rivers (USDI, NPS 2001). Nine organizing categories were used for the economic benefits, including Floodplain Management, Instream Flow, Property Value, General Value to the Public, Recreation and Tourism, Water Quality, and Wildlife/Habitat/Riparian. The report acknowledges that most studies fall into either the Instream Flow or the Recreation and Tourism categories. Few of the studies looked specifically at the NWSRS, and the time frame was limited to the preceding 10-year window. Moreover, economic benefits, as detailed above, and economic impacts (effects on jobs and income from NWSRS expenditures) were both considered economic benefits.

The relationship between expenditures and net economic benefits is displayed in Figure 2, where direct

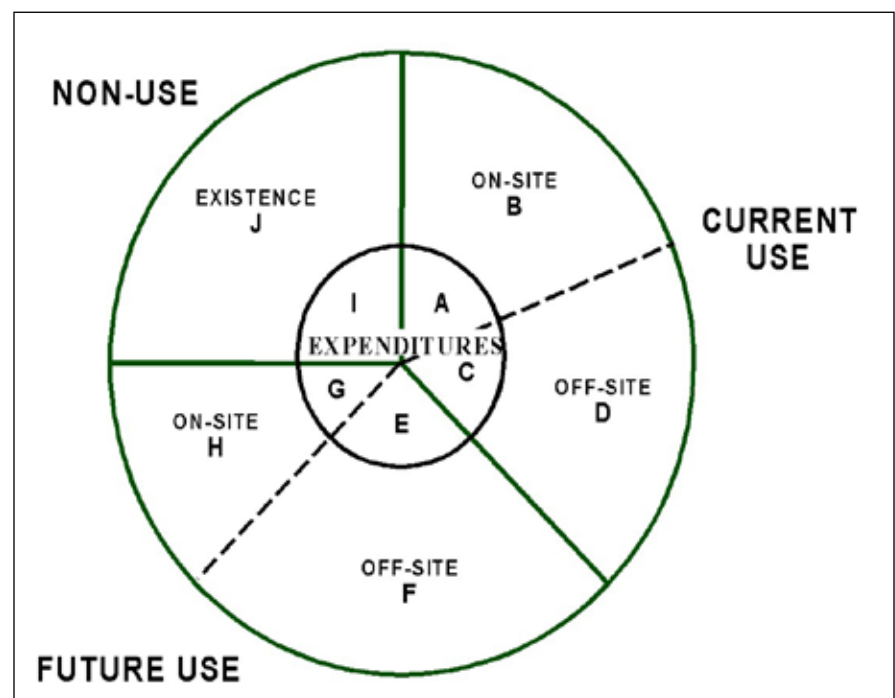


Figure 2 – Total economic value of wild and scenic river use (adapted from Bergstrom et al. 1990)

personal expenditures related to NWSRS benefits (A, C, E, G, I) are juxtaposed with the resulting net economic benefits or consumer surplus (B, D, F, H, I). Thus, to obtain the on-site benefits of a recreation trip to a NWSRS river (A+B), the individual would have to spend A, leaving a net economic benefit of B.

On-Site Recreation Use Value

On-site recreation value estimation constitutes most studies by economists on rivers, in and out of the NWSRS. The number of studies addressing the economic values associated with the NWSRS is quite limited (Rosenberger 2016), with a total of 16 independent studies, from 1977 to 2014, appearing in peer-reviewed publications and proceedings that provide estimates of the *on-site recreation benefits* of the NWSRS. These studies relied on either of two popular methods, travel cost or contingent valuation, to estimate the net economic benefits, or consumer surplus (CS), of river access for recreation. In many cases, for example, English and Bowker (1996a, 1996b) and Bowker, English, and Donovan (1996), the studies provide multiple estimates for recreation access concurrent with exploring methodological issues or differences in underlying assumptions. No studies provide an aggregate value of recreation access to the whole NWSRS. Rosenberger (2016) provides single or multiple estimates reported by study scaled to a common unit (CS/per person/per day in 2016 dollars). These estimates, averaged for studies reporting more than one estimate per river, along with authors, year, river, and miles of designation by category, are provided in Table 1. In addition to the Rosenberger (2016) estimates, we

provide comparable estimates from three additional studies (Walsh et al. 1985; Moore and Siderelis 2002; Moore and Siderelis 2003).

Estimates of the consumer surplus per person per day reported in Table 1 range from \$501 on the spectacular Middle Fork of the Salmon River to \$11 on the very accessible Upper Delaware River. While somewhat simplistic, an average across all studies yields an estimate of \$99 in consumer surplus for one day's recreation on a NWSRS river. This is comparable to estimates for other outdoor recreation activities in many other natural settings (Rosenberger 2016; Sardana et al. 2016). Across NWSRS studies there are considerable differences. First, research approaches including sampling, estimation methodologies, and underlying assumptions vary considerably over such a long period of time, reflecting both researcher judgments and the methods available when the study was conducted. Second, rivers in the NWSRS and populations who frequent them are by no means homogenous. It is beyond the scope of this article to delve further into these issues, and our average CS estimate is rough, resting on the assumption that the studies are a representative sample of rivers and users of the NWSRS, and that the methods are reasonably convergent.

Employing an estimate such as \$99 CS/day/person to obtain the annual value of recreation benefits of a NWSRS river would necessarily require commensurate estimates of recreation visitor days for any given river. For example, Moore and Siderelis (2002) estimated annual visits to the West Branch of the Farmington River at 77,400. For this river, they also estimated a CS of \$48 per person per day, yielding an annual aggregate recreation use value of \$3.7 million

for the designated 14-mile (22.5 km) segment, or about \$265 thousand of use benefits per river mile. Moore and Siderelis (2003) obtained a value of total annual recreation use value for floating (guided and unguided) on the Chattooga of \$7.4 million in 2002 for all visits (42,998) or \$126 thousand of use benefits per river mile. Bowker et al. (1997) arrived at an estimate of \$7.1 million for guided use alone on the Chattooga (about 80% of use). Note that using the overall average of \$99 reported in Table 1 would underestimate value for the Chattooga by about 45% in this case. Thus, we advise caution when applying a system average to obtain the annual recreation use value of any river in the system given the variation in CS estimates.

Passive Use Value

While several passive or nonuse values were reported for the NWPS in Bowker et al. (2014), studies estimating passive values for the NWSRS are rare. As passive use values do not require accessing the site, defining the relevant population of "passive users" is paramount to estimating a protected area's passive use value. We know of only two case studies pertaining to passive use value for NWSRS rivers: Walsh et al. (1985) and Helvoigt and Charlton (2009).

Walsh et al. (1985) used a household contingent valuation survey to value passive use for potential designations of 11 rivers in Colorado, each with sections qualified for protection under the Wild and Scenic Rivers Act. The authors estimated a value of \$78 (per household) to preserve sections of what Colorado residents identified as the three most valuable rivers (Cache la Poudre, Elk, Colorado), or \$26 per household per river. Forty percent of responding

Table 1 – Recreation use values for wild and scenic rivers (2016 dollars)

Authors	River	ST	Wild miles	Scenic miles	Recr. miles	CS/pers/day	CS/pers/day/mile
Daubert and Young (1981)	Cache le Poudre	CO	30	46		\$ 40	0.53
Loomis and McTernan (2014)	Cache le Poudre	CO	30	46		109	1.43
Loomis (2005)	South Fork	ID	30.2	1.2		235	7.48
Johnson, Bregenzer and Shelby (1990)	Rogue	OR	33.6	43.4	7.5	26	0.31
Johnson, Shelby and Bregenzer (1990)	Rogue	OR	33.6	43.4	7.5	18	0.22
Stavins (1984)	Tuolumne	CA	47	13	23	112	1.35
Loomis (2003)	Snake	WY	217.9	29	140.6	20	0.05
Klemperer, Buhyoff, Verbyla and Joyner (1984)	Chattooga, S-III	GA/SC	41.6	14.6	2.5	14	0.24
Bowker, English, and Donovan (1996)	Chattooga	GA/SC	41.6	14.6	2.5	328	5.58
English and Bowker (1996a)	Chattooga	GA/SC	41.6	14.6	2.5	14	0.23
English and Bowker (1996a)	Chattooga	GA/SC	41.6	14.6	2.5	23	0.38
Siderelis, Whitehead and Thigpen (2004)	NC NWSRS	NC	46.2	52	95.5	86	0.45
Matthews, Homan, Easter (1999)	Minnesota (MVNWR)	MN			70	43	0.61
Michalson (1977)	St. Joe	ID	26.6	39.7		53	0.80
Rosenthal and Cordell (1984)	Upper Delaware	DE		50.3	23.1	11	0.15
Michalson (1977)	Middle Fork Salmon	ID	103		1	501	4.8
Rosenthal and Cordell (1984)	Middle Fork Salmon	ID	103		1	64	0.62
Bowker, English and Bergstrom (1997)	Middle Fork Salmon	ID	103		1	106	1.02
Bowker, English and Bergstrom (1997)	Chattooga	GA/SC	41.6	14.6	2.5	181	3.08
Moore and Siderelis (2002)	Farmington	CT		14		48	4.00
Moore and Siderelis (2003)	Chattooga	GA/SC	41.6	14.6	2.5	180	3.06
Walsh, Sanders and Loomis (1985)	Cache la Poudre	CO	30	46		55	0.73
Average CS/day across Studies						\$99	
Average CS/day per designated mile							\$1.62

households reported either no value, or felt that they should not have to pay for passive use. Expanding protection to 11 rivers (Cache la Poudre, Elk, Colorado, Gunnison, Green, Yampa, Piedra, Los Pinos, Conejos, Dolores, Encampment), value rose to \$185 for the system, dropping the average household value per river to \$17. Given Colorado’s population at the time (1.185 million households), the passive use value to preserve identified segments of the three most valuable rivers was about \$30.1 million. As it turns out, relevant sections on one of those rivers, the Cache la Poudre, were designated and are currently the only NWSRS miles

in Colorado, although parts of the remaining rivers are managed much like those in the NWSRS. Walsh et al. (1985) was hampered by methodological issues and the fact that none of the rivers had yet to be designated, but it proved that substantial passive use values exist for high caliber wild and scenic rivers. Acknowledging limitations and societal changes in preferences for preservation as protected areas became scarcer between 1983 and 2016, the Walsh et al. (1985) household average estimates of \$17–\$26 per river, and the designated mileage for the Cache la Poudre river of 76 miles (122 km), could be used to infer an average household

passive use value of \$0.22–\$0.34 per river mile.

Helvoigt and Charlton (2009) estimated nonuse value for the wild and scenic Rogue River in Oregon less directly than Walsh et al. (1985). They estimated the nonuse value of preserving the indigenous salmon fishery as a proxy. Using estimates from previous studies, and extrapolating across the populations of Oregon, Washington, and California, they estimated an annual willingness-to-pay per resident of \$37, or \$97 per household, which equated to \$1.7 billion per year. Considering both designated sections of the Rogue, this amounts to

about \$0.78 per river mile. As there are factors beyond a healthy salmon population contributing to the passive use value of the Rogue River, these estimates are a lower bound. Passive use value estimation for protected resources remains empirically controversial. However, few would argue that humans receive benefits with undeniable economic value from passive use.

Locational Value

Moore and Siderelis (2002) is the only NWSRS river study to assess the monetary effect of designation to adjacent property values. They used a hedonic analysis to assess river proximity and real estate prices within a 6-mile (9.6 km) zone of the West Branch of the Farmington River's 14 miles (22.5 km) designated under the recreational category in 1994. They analyzed property transactions from 1986 to 2001 and found that land values correlated inversely with distance from the river, in other words, prices decreased as one went farther from the river. Lots in immediate proximity to the river had an amenity benefit of 42% of the selling price. On a value per acre basis, being 1,000 feet (305 m) farther from the river dropped per acre value by \$40,000, while being a mile (1.6 km) off the river meant \$75,000 less per acre. Being six miles from the river translated to a decrease in land value per acre of over \$100,000. However, they found that designation did not affect values in a statistically significant way. They suggested cautious interpretation of their results because of the small sample of transactions over the 16-year period, and that their land value model accounted for only 8% of the variation in residential land prices. We know of no studies

formally investigating the value to businesses of being located proximal to the NWSRS.

Ecological Values

We found no previous studies that estimated ecosystem service values such as water purification, carbon sequestration, natural pest control, or flood control for designated wild and scenic rivers. However, several studies provide examples of estimating ecosystem service values for other US rivers. For example, Loomis et al. (2000) used contingent valuation to measure the economic value of ecosystem services supported by a restored riverine ecosystem within a 45-mile (72.4 km) section of the South Platte River corridor in Colorado. These broad ecosystem services included water purification, erosion control, and fish and wildlife habitat. They estimated that households in the South Platte River Basin would pay an average of \$250 and \$27 million total annually to obtain the ecosystem services supported by the restored riverine ecosystem. These values convert on an annual basis to \$8 per river mile per household, and \$600,000 per river mile aggregated across all households in the study area river basin.

Holmes et al. (2004) used contingent valuation to measure the economic value of ecosystem services supported by a restored riverine ecosystem within a 6-mile (9.6 km) section of the Little Tennessee River corridor in North Carolina. Ecosystem services valued included water clarity, wildlife habitat in stream bank buffer zones, and the naturalness of the river corridor. They estimated that in the county where the river segment is located, households would pay an annual average of \$35 and \$450,000 total to obtain the

ecosystem services supported by the restored riverine ecosystem. These values convert to \$6 per river mile per household and \$75,000 per river mile aggregated across all households in the county.

Broadbent et al. (2015) used contingent valuation to measure the economic value of restored riverine ecosystems within a 35-mile (56 km) section of the San Pedro River corridor in Arizona and an 80-mile (128 km) section of the Rio Grande corridor in New Mexico. The primary ecosystem service valued was fish and wildlife habitat. The estimated economic value to Arizona households of the restored San Pedro riverine ecosystem was \$50 annually, which converts to \$1.40 per household per mile and about \$0.16 per household per riverine acre. The estimated value to New Mexico households of the restored Rio Grande riverine ecosystem was \$0.80 per mile per household. This value converts to about \$0.01 per acre per household.

Patton et al. (2015) estimated carbon sequestration values for the riparian wetlands along the Rio Grande in New Mexico flowing through the Sevilleta and Bosque del Apache National Wildlife Refuges. They estimated the net economic value of carbon stored in these riparian wetlands in terms of willingness-to-pay to mitigate negative global climate change impacts in the absence of these carbon sequestration services. The present value of carbon sequestration services provided by the Rio Grande riparian wetlands in the Sevilleta and Bosque del Apache National Wildlife Refuges was estimated at \$2.32 million total – an average of \$470 per wetland acre.

Part of the Rio Grande in northern New Mexico is designated in the NWSRS. The Rio Grande segments

valued by Patton et al. (2015) and Broadbent et al. (2015) are in middle to southern New Mexico, characterized by a more arid climate and environment compared to northern New Mexico. Thus, the ecosystem service values reported in these studies may be of limited use as proxies for the ecosystem service values of the designated portion of the Rio Grande. However, to illustrate how ecosystem service values of NWSRS corridors could be valued, consider the case of carbon sequestration.

The Forest Service-administered section of the Rio Grande corridor contains approximately 1,200 acres (485 ha) (USDA Forest Service, January 19, 2017). Patton et al. (2015) estimated carbon sequestration values of about \$470 per acre in their Rio Grande corridor study area. Transferring this value estimate to the WSR section of the Rio Grande would imply carbon sequestration values for wetlands in this section of the river of about \$564,000. The Patton et al. (2015) study results, however, indicated that wet climates and environments generate higher carbon sequestration values compared to dry climates and environments (because the wetter climates and environments have more carbon-absorbing vegetation). Thus, the estimate of \$564,000 may be a lower bound on the carbon sequestration value of the designated section of the Rio Grande.

Transferring carbon sequestration values from the middle/southern Rio Grande to the northern Rio Grande as illustrated above is an example of benefit transfer procedure. There is a vast literature on best practices for benefit transfer, and concurrence in the literature that benefit transfer is a “second best” valuation approach to valuation based on site-specific, primary data col-

lection (Johnston and Rosenberger 2010). Thus, accurate estimates of the carbon sequestration and other broad ecosystem service benefits of river corridors across the United States, including those associated with NWSRS rivers, requires further case studies specific to the ecosystems where these rivers are found.

Economic Impacts

Economic impacts associated with the NWSRS result directly from recreation use, in other words, spending in local economies due to recreation visits. Recreation expenditures are represented by area B in Figure 2. Alternatively, and more completely, the flow of economic payments, services, values, and benefits is shown in Figure 3 (adapted from Mates and Reyes 2006, p. 8).

“Many people derive multiple benefits from accessing NWSRS rivers and their immediate surroundings, either directly for recreation, or through simply knowing that the system and the rivers and ecosystems within exist in a perpetually protected state.”

Visitor expenditures flow directly to businesses and often back to the managing agency through user fees. The NWSRS provides recreation benefits to visitors and a combination of ecosystem services and nonuse benefits to society at large. Both society and visitors have a total value or willingness-to-pay for such services/

benefits. Businesses and individuals provide tax revenues, which in turn support protected areas and their managing agencies. These agencies contract services and goods from businesses and private individuals and use the same to maintain sites and provide services to visitors.

Studies of the economic impacts of wild and scenic rivers on regional economies (Tables 2 and 3) are few compared to previous studies measuring the net economic value (Table 1). Most of the existing NWSRS economic impact studies are relatively dated, with the most recent being the Rogue River study published about eight years ago (Helvoigt and Charlton 2009). Each of the seven previous studies shown in Table 2 estimated mean expenditures per person per trip associated with recreational trips to an NWSRS site. Average expenditures on gasoline, food, beverages, lodging, fees, and other typical items purchased on a recreational trip across all studies was \$441 per person per trip with the Middle Fork of the Salmon River, and \$148 per person per trip excluding the Middle Fork. The higher relative expenditures for the Middle Fork, Chattooga River, and Rogue River are accounted for by higher fees paid for white-water rafting (e.g., guide fees). The Middle Fork is an expenditure outlier because it offers elite and unique white-water rafting experience.

Per-person-per-trip expenditure data as shown in Table 3 can be combined with visitor use data to estimate aggregate recreational expenditures within an economy attributable to a site or activity. These aggregate expenditures can then be fed into a regional input-output model such as IMPLAN to estimate economic impacts (total output, jobs, and income) generated in the regional economy. The

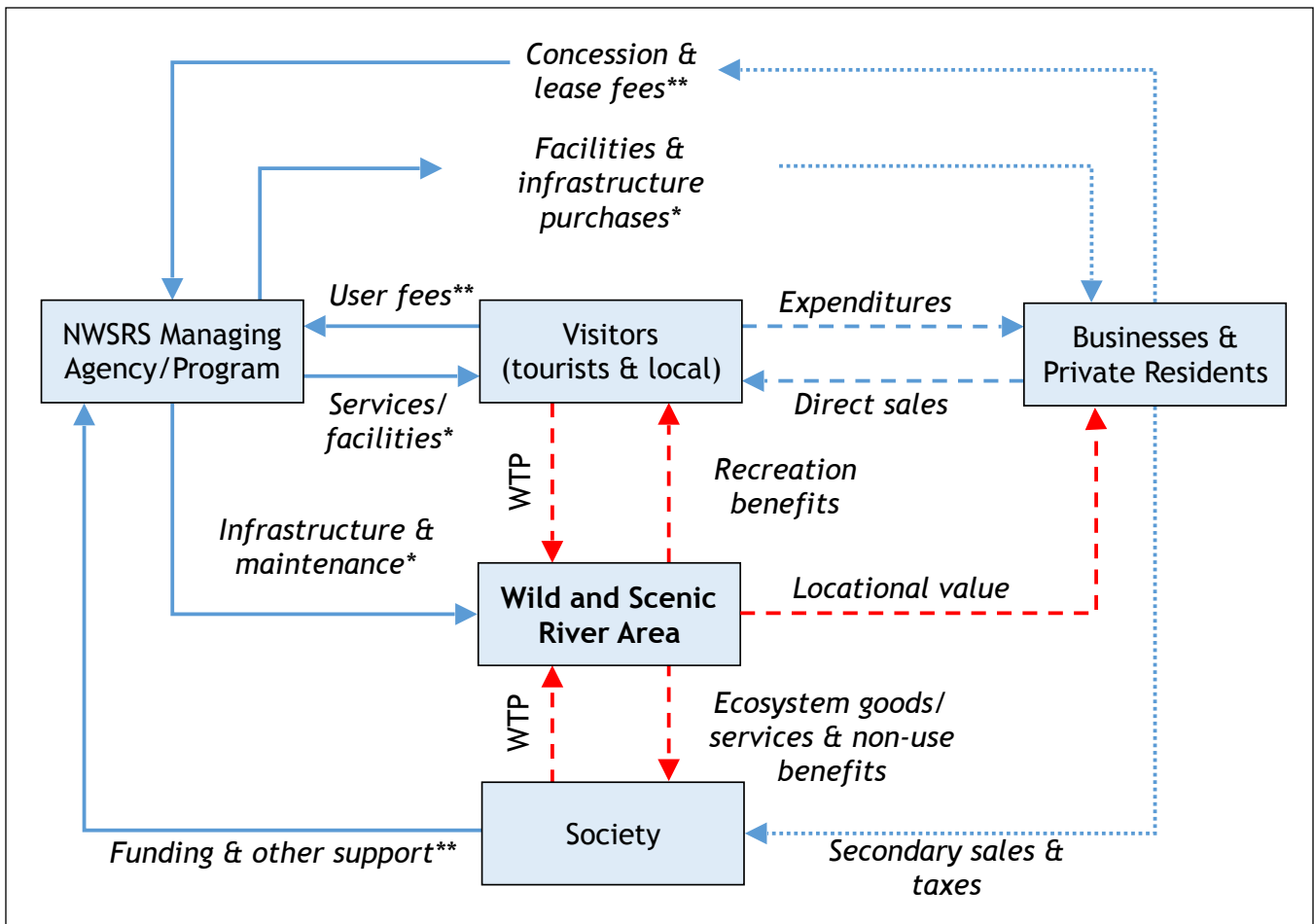


Figure 3 – Economic impact and benefit flows from protected wild and scenic river areas (adapted from Mates and Reyes 2006)

*Expenditures▶ Private sector economic activity
**Revenues	——▶ Public sector economic activity
WTP = Willingness-to-pay	- - -▶ Sources of economic value

contribution of aggregate recreation trip expenditures at NWSRS rivers to total industrial output in impact regions of different size are shown in Table 3. For the studies shown in Table 3, the contribution of NWSRS-related recreational expenditures to total industrial output ranged from about \$3.5 million for a six-county impact region (Moore and Siderelis 2003) to about \$29 million also for a six-county impact region (Cordell et al. 1990).

The addition of total industrial output in a region due to NWSRS-related recreational expenditures stimulates more employment,

employee and property income, and tax revenues (see studies cited in Table 3 for details on these impacts). Whether designation of a river as wild and scenic leads to a net increase in regional economic activity is still unresolved (e.g., see Malm 2012). Malm (2012), using county level data from 1970-2009, presented statistical evidence that designation yields a relatively minor negative impact (0.3% points) on county level per capita economic growth in the short run, but the effect diminished through time. Because boosting regional economic development was not one of Congress' original purposes behind

creating the NWSRS, whether rivers in the system are a net gain or drain on regional economies may be unimportant from a national policy perspective. However, people living in local areas affected by existing or proposed new designations may not see it that way, leading to conflicting goals with respect to NWSRS policy and management at the local, state, and national levels.

Discussion

Creation of the NWSRS by Congress in 1968, like the Wilderness Act of 1964, was based on the recognition by representatives of the public

Table 2. Wild and Scenic River Recreational Trip Expenditures

Wild and Scenic River	Study	State(s)	Mean Expenditures Per Person Per Trip (2016 dollars)
Chattooga River	Moore and Siderelis (2003)	GA, NC, SC	\$340
Chattooga River	English and Bowker (1996b)	GA, SC	\$165
Delaware River (Lower and Middle)	Cordell et al. (1990)	NJ, PA	\$90
Delaware River (Upper)	Cordell et al. (1990)	NY	\$43
Farmington River	Moore and Siderelis (2002)	CT	\$55
Rogue River	Helvoigt and Charlton (2009)	OR	\$197
Salmon River (Middle Fork)	English and Bowker (1996b)	ID	\$2,196
Average			\$441
Average without Salmon River			\$148

that protecting outstanding river resources in essentially undisturbed states for present and future generations would be complementary to commercial development of the nation's waterways in other locations. Many people derive multiple benefits from accessing NWSRS rivers and their immediate surroundings, either directly for recreation, or through simply knowing that the system and the rivers and ecosystems within exist in a perpetually protected state. However, aside from a few studies looking at recreation benefits and nonuse values, limited empirical research has quantified these benefits into a dollar metric. Moreover, the research done

to measure the economic benefits of rivers in the NWSRS remains mostly piecemeal and dated. Nevertheless, the work leaves little doubt that the "values" recognized by Congress are quantifiable and substantial. As Walsh et al. (1985) showed, the estimated economic benefits in many cases exceed the opportunity and management costs associated with designation, thus providing further justification via the economic efficiency criterion.

A second type of economic dollar metric associated with the NWSRS pertains to economic impacts. These impacts result from spending during recreation visits to system rivers. As the spending reverberates through the

local economy, jobs and income are supported contributing to regional economic growth. Many economists would argue that because most visits, and thus spending, in the NWSRS originate domestically, this form of "economic growth" is more a transfer of spending from one region to another. Such a transfer may be in the interests of the nation in cases where policy objectives include sustaining rural economies, or targeting certain subgroups. However, as Malm (2012, p. 72) points out, "[T]he main objective of the 1968 Act was not to promote economic growth, but to preserve these rivers and ecosystems." Indeed, his work looking at the whole system showed that in the short

Table 3 –Total industrial output (TIO) generated by aggregate recreational expenditures on trips to wild and scenic rivers

Wild and Scenic River	Study	State(s)	TIO (2016 dollars)	TIO	
Chattooga River	Moore and Siderelis (2003)	GA, NC, SC	\$3,480,000	2,608,000	6 county region
Chattooga River	English and Bowker (1996b)	GA, SC	\$7,440,000	4,350,000	GA and SC state total
Delaware River (Lower and Middle)	Cordell et al. (1990)	NJ, PA	\$15,220,000	8,900,000	5 country region
Delaware River (Upper)	Cordell et al. (1990)	NY	\$29,420,000	17,200,000	6 county region
Farmington River	Moore and Siderelis (2002)	CT	\$4,920,000	3,630,000	5 riverfront towns
Rogue River	Helvoigt and Charlton (2009)	OR	\$8,910,000	7,700,000	one county
Salmon River (Middle Fork)	English and (1996b)	ID	\$3,900,000	2,280,000	ID state total

run (up to 15 years), designation is negatively correlated with a county's per capita income. But, in the long run, the marginally negative effects became statistically insignificant, indicating that, up to now, the rivers neither impede nor stimulate appreciable economic activity.

We have several thoughts and suggestions for future research regarding economic valuation of wild and scenic rivers, and application of these values to policy and management. First, because the degree of "naturalness," types of use, and consumer preferences can vary significantly between the "Wild," "Scenic," and "Recreational" categories of designation for both recreational use and passive use values, future studies should attempt to disaggregate values categorically. Such disaggregation can help managers determine where to target limited resources to both existing and potential designated rivers to get the most "bang for the buck" (i.e., how to allocate scarce time and money to achieve economic efficiency). This is especially relevant for evaluating future designation of rivers to the NWSRS.

Previous studies of wilderness suggest a growing demand by Americans for passive use and broad, ecosystem service values provided by wilderness that do not involve on-site visits. Such a trend is also likely for wild and scenic rivers, implying that off-site ecosystem service and passive use values of wild and scenic rivers may become just as important and valuable to Americans as on-site recreational values, if they have not already done so. The fact that most previous economic valuation studies of wild and scenic rivers focused on on-site recreational use values suggests a potentially serious knowledge gap. For example, if new studies, such

as those for wilderness protection, show higher individual and aggregate values for more wild and natural rivers due to stronger preferences for off-site ecosystem service and passive use values, Congress and federal resource management agencies may put a higher priority on protecting more rivers as part of the NWSRS. A very good example of looking at system values, and something to be considered for the NWSRS, is provided by Haefele et al. (2016) for the national park system.

Although wild and scenic rivers are becoming scarcer every day on a per capita basis, much of their value is not reflected in the marketplace and remains unknown. Consequently, the value for conserving, rather than developing a river may be relatively underestimated. This inevitably leads to a bias toward development and exploitive use of an area; the result being fewer rivers are protected than would be if all the benefits of conservation were included in the economic analyses of alternative uses. Given the scarce resources currently available, and the persistent human use pressure on the NWSRS, and rivers with designation potential, it is recommended that economic research efforts pertaining to the NWSRS be focused on better accounting for the full suite of benefits derived from natural riverine ecosystems and the likely consequences to those benefit flows from alternative development options. Valuing NWSRS resources based on a more complete estimate of the benefits they provide will help ensure that priorities are set such that healthy river ecosystems and appropriate visitor services are provided and maintained – to leave these areas available in their exceptional state for future generations.

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Dam Removal on the Lower White Salmon River

Rewilding, Sacred Spaces, and “Outstandingly Remarkable Values”

BY RANDY GIMBLETT, CHRISTOPHER A. SCOTT, and MIA HAMMERSLEY

Abstract: Dam removal is a major contribution to rewilding of rivers, through restoring riverine ecosystems; reconnecting upstream and downstream wilderness for fish, predators, and humans; and enhancing social-ecological resilience to climate change and other stressors. We report on the 2011 removal of the Condit Dam on the Lower White Salmon River, which had been declared wild and scenic in 1986. The Condit was decommissioned largely to reintroduce anadromous fish to the river and involved collaboration among many interests. Monitoring data from 2014 and 2016 suggest that the White Salmon River receives some of the heaviest recreational use of any nonpermitted river in the United States. Use levels are increasing, potentially threatening both the outstandingly remarkable values (ORVs) for which the river was designated and rewilding benefits set in motion by dam removal. Our analysis strongly indicates the need for improved postremoval management to ensure protection of ORVs.

Rewilding can be defined as large-scale conservation aimed at restoring and protecting ecological processes and critical wilderness character. It may involve reintroducing large predators and keystone species and providing connectivity between core wilderness areas (Foreman 2004). Rewilding may take the form of ecological restoration (Sandom et al. 2013) across fragmented protected areas and through reintroduction of predators that were previously extirpated. Rivers are crucial to the ecological functioning of core areas, particularly because of biotic and abiotic corridor connectivity, trophic order in lentic (wetlands) and lotic (rapids) systems, and biodiversity and habitat value in general. Restoring ecological functions in impaired river systems is an important subset of broader rewilding efforts.

We define *river rewilding* as the reestablishment of (1) instream aquatic and associated river-corridor terrestrial ecosystems; (2) upstream-downstream connectivity, especially for anadromous and other migratory fish; (3) hydro-geomorphological dynamics including fluxes of sediment, organic matter, dissolved oxygen, nutrients, and



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other constituents; and (4) social-ecological values from a range of ecosystem services, including cultural values of indigenous peoples and recreation. Central to river rewilding is restoration of the natural flow regime (Poff et al. 1997) that allows for free-flowing conditions with variations in temperature, oxygen, and nutrients required for the primary productivity and trophic diversity essential to the functioning of aquatic habitats. Linked to ecological processes is a range of human interactions with river systems, understood in social-ecological systems terms (Gunderson et al. 2010).

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Of multiple forms of impairment, damming rivers can have especially pernicious social-ecological effects. These effects include loss of ecosystem connectivity, alterations in temperature, dissolved oxygen, and nutrient fluxes, as well as degradation or elimination of human use and recreation. Dam decommissioning and removal is gaining acceptance with increasing implementation across the United States and globally, and can result in rewilding river ecosystems, which are indispensable to ensure lasting social-ecological resilience.

Successful and illustrative examples of rewilding through decommissioning dams are unfolding on the Elwha River on the Olympic Peninsula in western Washington (East et al. 2015). There, dams prevented salmon from reaching their spawning grounds; disrupted ecosystem functions including sediment transport and deposition that influenced flow regimes, vegetative cycles, and succession; and reduced the potential for wilderness experiences (Wunderlich et al. 1994). Dams also damaged native cultural and livelihood values on the river. The decommissioning of the Elwha and Glines Canyon Dams represents an important precedent for progressive water management and the evolution of the perception of removal of dams as a method of social-ecological resilience. This case exemplifies how challenges to dam removal, such as a lack of data and scientific knowledge, dissent among stakeholders, and economic barriers can be successfully overcome and rewilding of the river can occur. In the case of the Elwha, although the dams were originally perceived to provide various social-ecological benefits to the surrounding region, the cultural and environmental benefits of removing

and rewilding the river can ultimately outweigh costs.

Rewilding the White Salmon River

The Condit Dam on the White Salmon River in the vicinity of Mount Adams in Washington State (Figure 1) was removed in 2011, largely for the purpose of reintroducing anadromous fish species back to the river (Washington State Department of Ecology 2007). The process involved collaboration among a diverse group of stakeholders, from PacifiCorp (the owner of the dam), the Yakama Nation, NOAA Fisheries, federal and state agencies including the Forest Service (USFS), various

environmental groups, and river raft/running companies. However, in the wake of this collaborative effort a potential conflict of use has recently arisen; how much recreation use is too much, what level of use is sustainable, and what forms and levels of use have harmful effects on the river ecosystem and ultimately the Chinook salmon (*Oncorhynchus tshawytscha*) that are recovering? In this article, we explore the challenges and barriers to rewilding the White Salmon River and discuss the ORVs that must be understood, negotiated, and managed for rewilding to be effective. We address whether significant increases in one of the ORVs established under the Wild and Scenic Rivers Act

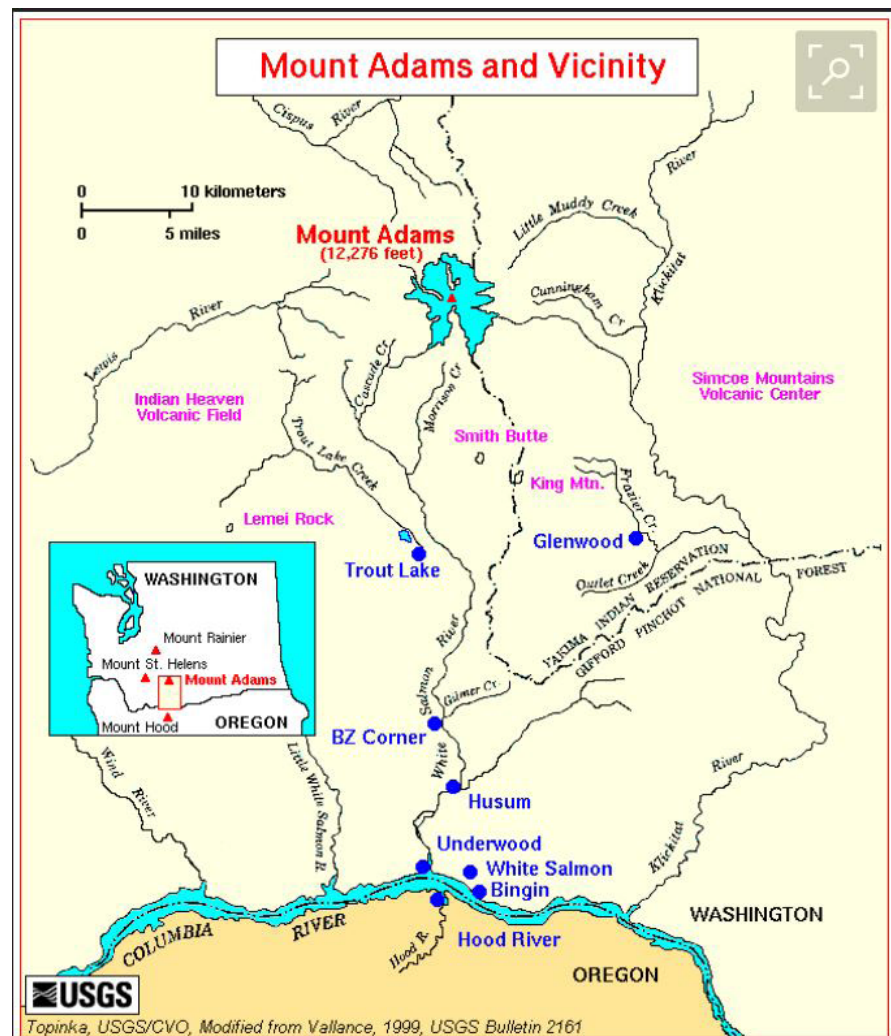


Figure 1 – Map of the White Salmon Watershed



Figure 2 – The Condit Dam on the White Salmon River was removed in 2011, largely for reintroducing anadromous fish species back to the river.

compromise the other values, and if so, whether it threatens river rewilding. Specifically, for the White Salmon, does recreational boating compromise salmon habitat? In addition, we reflect on the importance of river monitoring data and scientific knowledge to aid in protecting ORVs.

The Condit removal has provided an increased opportunity for anadromous fish in the river upstream of the old dam site to BZ falls (Figure 2). In addition to the newly accessible habitat for fish, dam removal has opened

5 more miles of recreational white-water boating in the former reservoir and bypass reach downstream of the former dam. The opportunity for the boating community to float past the dam site and continue down to the Columbia River has prompted much interest. It is estimated that approximately 25,000 boaters, mostly in paddle rafts and kayaks, use the river each year. There is concern among the federal land management agencies regarding effects of boating-related activities on recolonization and pro-

liferation of endangered Chinook salmon (Hardiman and Allen 2015), an important concern in relation to ecosystem restoration. Native fish species, including Chinook salmon, now can return to a river they have not visited for nearly a century (Figure 3). Chinook salmon will have access to an additional 12 miles of habitat upstream of the dam site, and steelhead (*Oncorhynchus mykiss*) will have access to an additional 33 miles of habitat (Northwest Power and Conservation Council [NPCC] 2004).

The White Salmon River is well known as a white-water rafting and kayaking destination (Figure 4). This river offers some of the best class III–IV rapids in a natural setting and it is runnable year-round. As the most popular river in the Columbia River Gorge, the White Salmon is a top destination for boaters nationwide. Although white-water rafting is economically important to many rural communities, it may have adverse effects during pre-spawn holding and spawning periods (Sawtooth National Forest [SNF] 1995; NOAA Fisheries 2003). Rafts and kayaks floating down the river while salmon are staging, selecting redd locations, and/or spawning, have been anecdotally recognized to cause displacement of fish from redds (SNF 1995). The extent to which displacement reduces reproductive success has not been empirically determined. In addition, other assumptions suggest rafts and kayaks (float boats) may impact spawning salmon by either delaying onset of spawning or eliciting more rapid spawning than would occur under natural conditions (Fornander 2008). Because fall Chinook salmon leave the White Salmon River shortly after they emerge, spawning and incubation are thought to be among the most critical stages for their life



Figure 3 – Native fish species, including Chinook salmon, now can return to a river they have not visited for nearly a century.

cycle in freshwater (Quinn 2005). Reduced habitat quantity, reduced channel stability, and increased peak flow may also limit productivity of fall Chinook salmon in the White Salmon River (Allen and Connolly 2005). These and other instream flow characteristics, including transport of sediment, organic matter, dissolved oxygen, and nutrients, are important factors in river rewilding.

The Yakama culture and livelihoods are very closely tied to the salmon runs that have historically occurred throughout the Columbia River Basin (Columbia River Inter-Tribal Fish Commission 2014). However, the construction of the system of dams throughout the basin has radically altered the salmon life cycle and, consequently, the lifestyle of the Native people who have histor-

ically relied upon them (Harnish et al. 2014). Celilo Falls, located on the Columbia River East of The Dalles, Oregon, was an important trading area and sacred fishing grounds for several tribes in the region before it was completely flooded by the construction of the Dalles Dam in 1957 (The Yakama Nation Main Agency Offices 2014). Before the Condit Dam was constructed, the Yakama used to fish for salmon and steelhead on the White Salmon River, and its confluence with the Columbia is a traditional trading area (Washines 2011). The Yakama Nation was a key player in the removal of the Condit Dam in 2011. Along with the Columbia River Inter-Tribal Fish Commission, they cosponsored the first engineering study with PacificCorp that demonstrated that dam

removal was an economically feasible option and were involved in negotiations throughout the entire process.

With a viable population of Chinook salmon returning to the river and the Yakama Nation poised to reestablish its traditional salmon fishing practices, the question that can be asked is if the river is really being properly managed for the ORVs determined according to the Wild and Scenic Rivers Act. On the White Salmon River, NOAA Fisheries are responsible for upholding the protection of endangered species such as Chinook salmon. However, their protection involves potential conflict with other river uses, such as hydro-power, irrigation, and recreation (Poff et al. 2003). Collaboration between scientists and managers is necessary to guide sustainable river management that can balance the needs of these differing uses.

White Salmon Outstandingly Remarkable Values

To be eligible for designation as wild and scenic, a river must be free-flowing and possess one or more



Figure 4 – The White Salmon River offers some of the best class III–IV rapids in a natural setting.

ORVs. Two principal avenues exist to determine eligibility. The first is the conventional approach as established by federal agency or contract personnel, in which “[e]ligibility is based on an examination of the river’s hydrology, including any man-made alterations, and an inventory of its natural, cultural and recreational resources” (National Wild and Scenic River System 1999). The second, which is gaining wider appeal, involves assessment of eligibility and suitability for designation by interdisciplinary study teams that may incorporate local, tribal, county, and state governments, along with landowners, user groups, and other major stakeholders. This approach is less formulaic than the conventional agency-based approach and often requires professional judgment, with input sought and documented from organizations and individuals familiar with specific river resources (US Department of Agriculture [USDA] 2011).

In 1986, the lower White Salmon between Gilmer Creek and Buck Creek was designated wild and scenic based on the formal approach outlined above. This designation was based on five ORVs (USDA 1991), although only one is needed for eligibility:

1. Whitewater Boating – Class III rapids, in a natural setting and runnable year-round
2. White Salmon River Gorge – natural character, bedrock geology, caves, and numerous falls and springs
3. Hydrology – sustained flow, springs, and waterfalls that benefit fish, recreation, and irrigation
4. Native American Indian Longhouse Site and Cemetery – important religious significance to Yakama Nation

5. Resident Fish – home to resident trout, steelhead, and anadromous salmon

The ORVs required were proposed by the USFS as the administering agency to “protect and enhance” the river’s free-flowing condition, water quality, and its ORVs. Subsequently, this was followed in 2005 by designation of a longer segment of the upper river between the headwaters and the boundary of the Gifford Pinchot National Forest. In both cases, protecting and enhancing the free-flowing condition, water quality, and ORVs formed the basis for management of the wild and scenic river corridor.

The Wild and Scenic Rivers Act provides overall legal authority and requirements for planning and management of rivers that are components of the National Wild and Scenic River System. According to the USDA (1991), “The plan will ordinarily be revised on a 10-year cycle, or at least every 15 years. It may also be revised when monitoring and evaluation indicate conditions or demands within or near the boundary have changed significantly, or when the Area Manager determines that changes in major policies, goals or objectives would have significant effect on the ability to implement the plan.”

In 2010, Burns et al. (2010) conducted a river use study on the White Salmon. The principal focus was to better manage Special Use Permits to limit conflicts among visitors during high-use seasons. Specifically, the researchers wanted to identify any perceptions of crowding, acceptable number of times to see others, acceptable time to wait before starting their activity, reasons for recreating, quality of facilities and services, and how others impact their experience. Their work showed that most visitors did

not feel crowded on their trip. Results also showed that visitors indicated the number of people they saw was about what they expected or less. Most visitors indicated that it does matter if they see other groups while on the river, and it also matters if they must wait before starting their activity. When visitors were asked what type of experience they think should be provided, more than one-third (38%) reported undeveloped recreation. Another 30% felt semi-wilderness opportunities should be provided. Visitors’ expectation as to how many other groups are acceptable to see during their trip was 5 times on average. Similarly, visitors reported (mean = 4.70) that they saw approximately what they expected. The majority (77%) of visitors reported 15 people or fewer when asked what their preferred group size is to run the river. Correspondingly, when asked how many people are in their group, the vast majority (90%) stated 15 people or fewer.

Recreational Use Levels on the White Salmon River

The White Salmon has experienced tremendous growth from approximately 4,000 visitors in 1987 to nearly 20,000 in 2007 (Columbia River Gorge National Scenic Area Interagency Team 2014). Recent studies were undertaken in 2014 (Gimblett et al. 2015) and repeated in 2016 using remote cameras on the upper section of the river from BZ Corners to Husum. Cameras continuously recorded boating activities from a fixed position along the river between June 27 and October 5. During this part of 2016, more than 5,475 rafts, 2,911 kayaks, and 31,926 visitors were recorded and documented on the river (Gimblett 2016).

To put use levels on the White Salmon River in perspective, about 26,000 people raft the Colorado River from Lee's Ferry to Diamond Creek each year on permitted trips (Jackson 2012), including both private and commercial users. Approximately 10,000 people float the popular Middle Fork of the Salmon River through the Frank Church – River of No Return Wilderness in Idaho on permitted trips (Middle Fork 2015). The Lower Deschutes River has daily and seasonal targets for boaters established by river segment. Those management targets range from as low as 325 and 19,600 on river section 4 to the highest range on river section 2 of 1,700 and 74,100 (United States Department of Interior [USDI] 1993). Therefore, per width and length, the White Salmon River is one of the most heavily used rafting and kayaking rivers in the country, with the Forest Service being the permitting agency for the commercial rafting companies (Gimblett et al. 2015).

Do Current River Use Levels Threaten the Wild Salmon ORVs?

The White Salmon River runs through a remote, rugged, and thriving wildland setting and is sustained by the human communities that live, work, and play there. The river is recovering, both socially and ecologically, after the removal of the Condit Dam. As this rewilding is in process, social and ecological conditions continue to change. Increased stresses such as increased boating use on the river may be detrimental and result in slowing down the rewilding and recovery processes. In fact, recreation may now be putting pressure on other system components – namely species

and habitats that are known to be vulnerable to human disturbance.

The lack of discernable criteria for determining, monitoring, and evaluating river use capacity on the White Salmon River is problematic in properly managing for ORVs and are without ways to assess the ORV validity and longevity. Current growth in river use (Figure 5) threatens the ability for the river to adequately rewild. It perhaps even has an impact on other ORVs, such as the natural character of the gorge, Yakama cultural values, and returning salmon. It is prudent to say that management strategies are needed to protect other ORVs, implemented via a management plan that more accurately accounts for growing use levels and expectations on the river. River capacity should be formally examined to preserve and protect the ORVs established for the White Salmon River in the 1991 management plan and adequately maintain its status as a federally designated wild and scenic river.

Lessons from Efforts to Rewild and Protect ORVs

This case exemplifies how challenges to dam removal, such as a lack of data and scientific knowledge, dissent among stakeholders, and economic barriers can be overcome so that rivers can begin to be rewilded. However, sustained monitoring, enhanced participation of private land owners as well as other stakeholders, and active management consistent with protecting and enhancing the river as required under the Wild and Scenic Rivers Act are needed to protect multiple ORVs. Following our definition of river rewilding above, the case of the White Salmon River after the Condit Dam removal indicates that: (1) aquatic and river-corridor ecosystems are actively undergoing restoration, (2) connectivity has been reestablished especially for salmon to migrate upstream of the dam site (but with likely impacts from heavy river use), (3) anecdotal evidence suggests that hydro-geomorphological conditions for sediment and water quality have

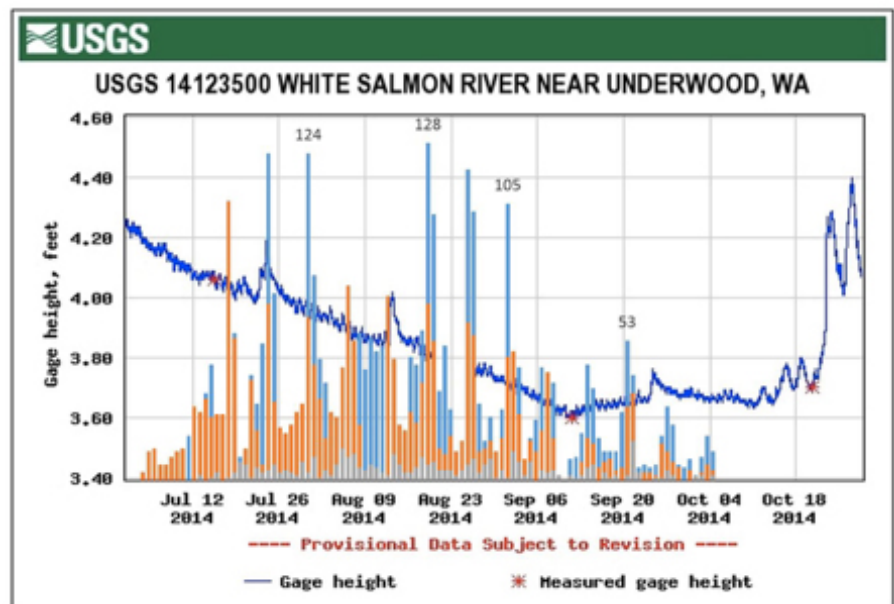


Figure 5 – Stream stage height and rafts by River Section (Blue Upper Section = number of rafts daily noted above peaks on graph), (Orange = Middle Section) (Grey = Lower Section not to scale on x-axis) (Gimblett et al. 2015)

improved, and (4) social-ecological values remain heavily oriented toward river-running recreation with potential high impact on Yakama Indigenous cultural values and aesthetic values of local landowners.

We believe the recovery of the White Salmon River is threatened by increasing human use during post-dam removal rewilding. Ultimately, agencies, an array of stakeholders, the Yakama Nation, and the public need to come together to make conscious decisions about the kind of recreation opportunities and conditions they want to see and properly manage for on the White Salmon River. In the face of increasing river use, the challenge is to make deliberate and well-informed decisions about what kind of place the White Salmon River should be for consistency with its wild and scenic river designation and the mix of recreation opportunities desired in the future.

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Reframing the Wild and Scenic Rivers Act

Ecosystem-based Resilience and Adaptation

BY DENIELLE PERRY

Abstract: A changing climate and increasing societal demands on water resources make river conservation urgent. The US Wild and Scenic Rivers Act (WSRA) provides a flexible policy framework ready to protect the nation's rivers. However, the small fraction of overall protected river miles suggests forces are restraining the flow of new designations into the system. Taking an ecosystem-based approach to adaptation can serve to garner support from stakeholders and decision makers otherwise reluctant to limit water resource development. Thus, framing the "outstandingly remarkable values" (ORVs) of Wild and Scenic Rivers as ecosystem services positions the policy in relevant water resource management terms, illustrates benefits conservation provides to society, and may increase application of the WSRA for river conservation. Moreover, using a standardized ecoregion framework would address the complexity of interjurisdictional management of the national system by providing consistency in ORV identification and management, thus fostering a holistic comprehensive river conservation system. Examining the WSR distribution through the Environmental Protection Agency's Level III Ecoregion framework sheds light on areas ripe for conservation expansion. Together, this reframing could aid in the increased application of conservation policy for ecosystem-based adaptation for river resources.

Rivers are in urgent need of increased protection as growing societal demands and climate change add pressures on water resources, exacerbating already troubled freshwater ecosystems (Strayer and Dudgeon 2010; Vörösmarty et al. 2010). Protection policies are recommended for contending with more frequent and intense floods and droughts, along with increasing resilience for species, forests, and agricultural areas (Strayer and Dudgeon 2010; Thompson 2015). Ecosystem-based adaptation measures are providing low-cost win-win solutions for adaptation that complement or even substitute for costlier hard infrastructure investments (Munang et al. 2013). Expanding and improving upon conservation policies the state already has in place may facilitate such adaptation policies (Parenti 2015). The Wild and Scenic Rivers Act (WSRA) is one such policy.

Carefully crafted to incorporate a complex interjurisdictional landscape of regionally distinct water rights and land tenure patterns, the WSRA was designed to protect

and enhance the free-flowing nature, water quality, and outstandingly remarkable values (ORVs) of rivers across the US territory. The eight specified ORVs include recreation, scenic, fish, wildlife, culture, geologic, historic, and other similar values. This policy was meant to complement a heretofore national

policy of water resources development centered on dams and diversions. The visionary WSRA, intended to "fulfill other vital national conservation purposes," was flexibly designed for broad application to achieve a national river conservation system (WSR n.d.). Yet in 2017, designations total only 208, protecting just 12,733.5 miles



Denielle Perry on the Middle Fork Salmon River, Idaho, one of the first eight WSR.

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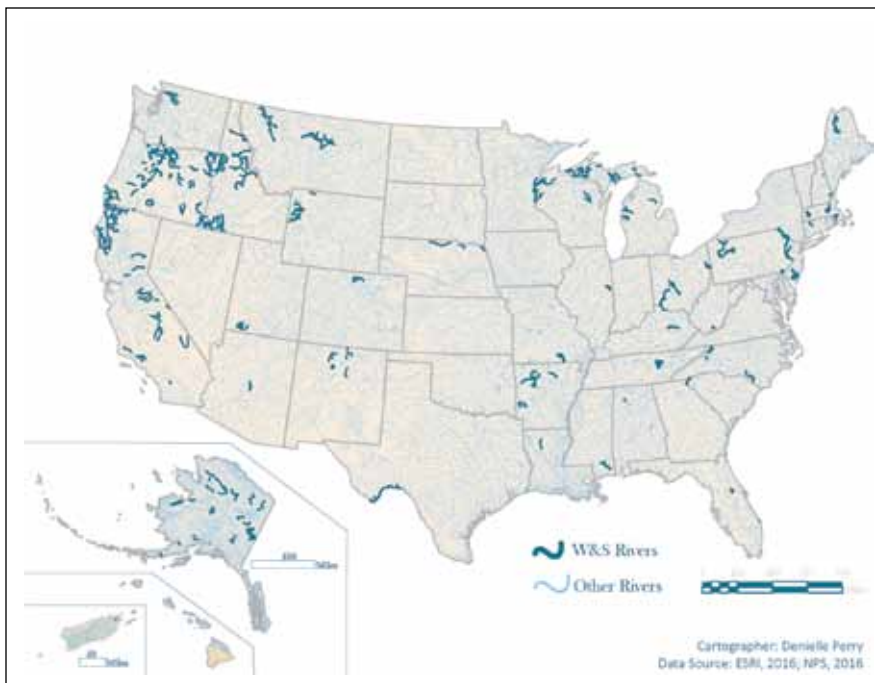


Figure 1 – The 208 Wild and Scenic Rivers flow only 12,733.5 miles (20,493 km).

(20,493 km). As Figure 1 illustrates, these miles comprise a mere fraction of a percent of the more than 3.5 million (5.6 million km) river miles stretching out over more than 250,000 rivers (NOAA 2017).

The uneven distribution of over-all protected river miles across 40 states and Puerto Rico (see Figure 2) suggests application of the WSRA is complicated by both internal and external forces. Consequently, applying a policy of ecosystem-based adaptation depends on knowing what factors influence WSRA implementation. This article employed a mixed-methods analysis to reveal that a lack of standardized guidelines for determining a “region of comparison” limits the scope of the policy to provide a holistic national river conservation system. Moreover, the descriptive language of the policy’s conservation objective lacks relevance for many stakeholders. Thus, standardizing region of comparison models and reframing ORVs as ecosystem services may advance policy objectives.

Methodology

The study’s mixed-methods approach consisted of three distinct research phases. First, spatial and temporal analyses were conducted for a GIS database composed of datasets related to the national system. Datasets included designated rivers and their

corresponding ORVs; the Nationwide Rivers Inventory; the Environmental Protection Agency’s (EPA) Level III Ecoregions; federal jurisdictional boundaries for land management agencies, states, and territories; and political party affiliations for legislative and executive office terms. These data were analyzed with ArcMap and Excel software.

The second phase consisted of discourse analysis of historical documents procured from the LBJ Presidential Library and the National Archives at Denver. Next, semistructured interviews were conducted with personnel attendants to the WSRA from each distinct region of the four federal land management agencies (n = 34) and two national river conservation organizations (American Rivers and American Whitewater [n = 12]), as well as associated technical experts (n = 4). Questions centered on their role in river conservation and the governance of the National Wild and Scenic Rivers System. In accord with grounded theory (Glaser and Strauss 1967), the interviews and

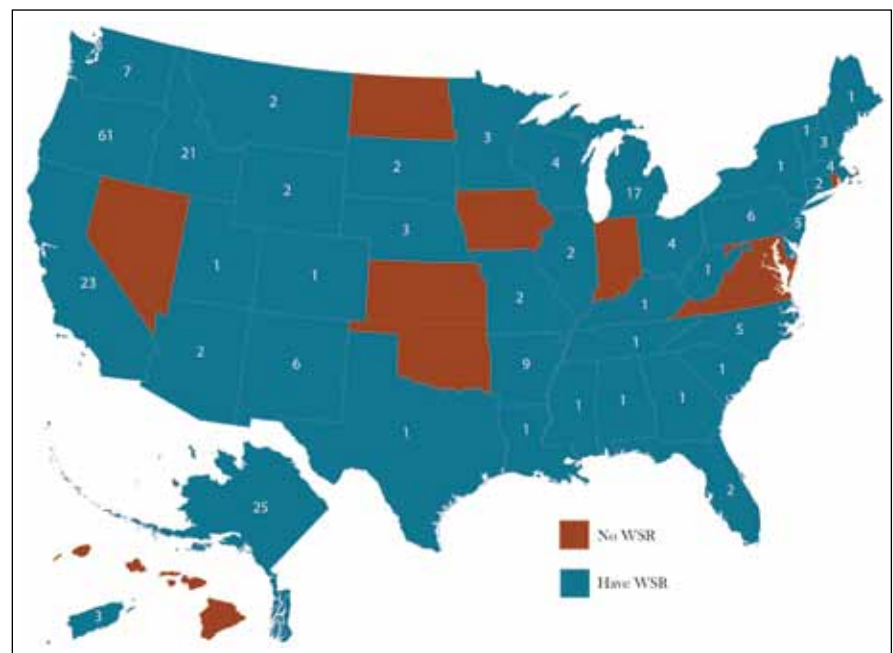


Figure 2 – Total federally protected wild and scenic rivers across 40 states and Puerto Rico

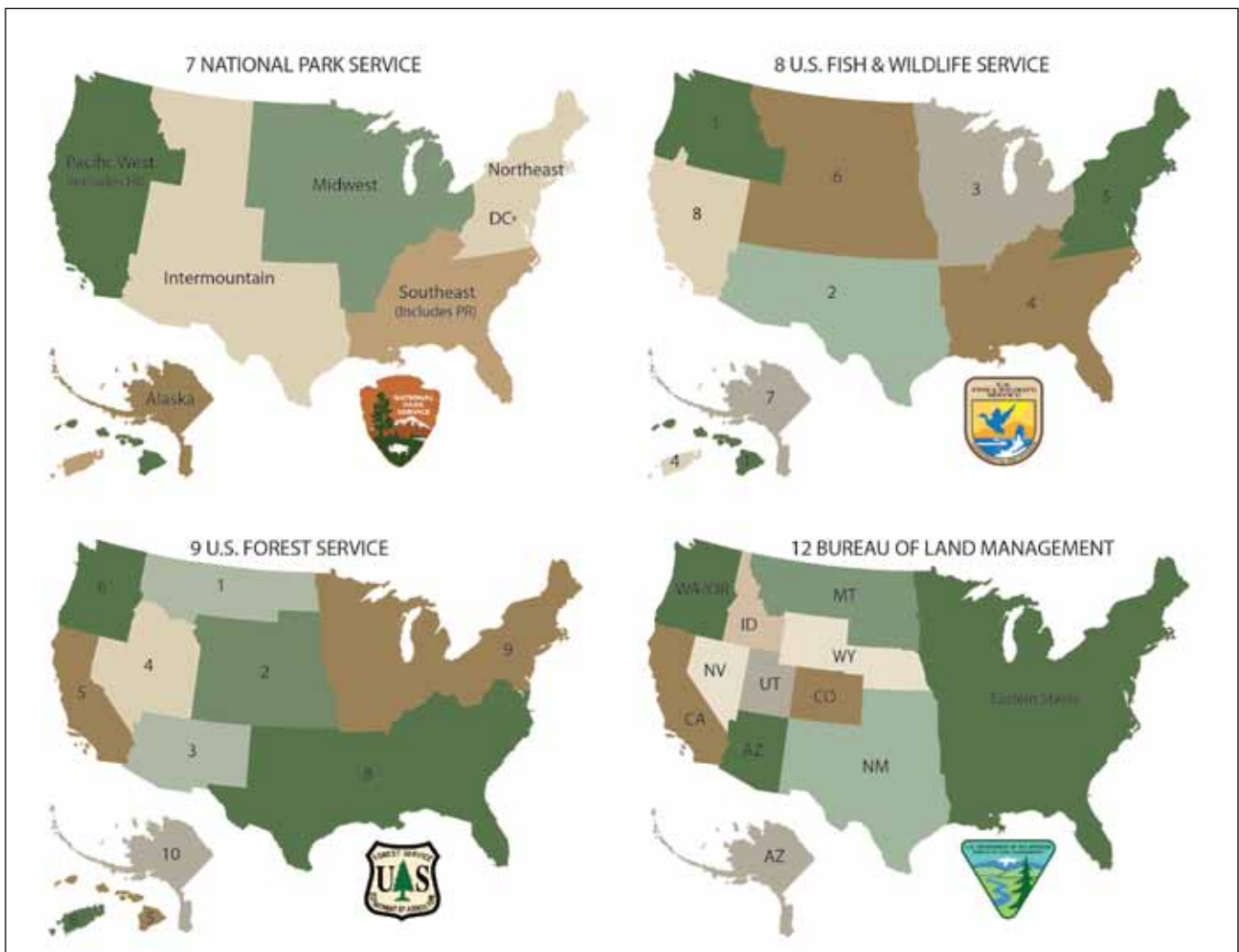


Figure 3 – Regional boundaries of the four federal land management agencies

archival data were coded using NVivo QDA software to break up the data, revealing six broad categories of factors influencing the landscape of the national system, namely environmental values/ideologies, location, policy, stakeholders, capacity, and science.

Protecting and Enhancing ORVs: Challenges across Regions

Section 5(d)(1) of the WSRA directs the US Forest Service (USFS), Bureau of Land Management (BLM), National Park Service (NPS), and the US Fish and Wildlife Service (USFWS) to identify, evaluate, and recommend rivers for potential

inclusion in the national system. Agencies may propose legislation for consideration by the federal administration, although they may not actively advocate for designations. To be deemed eligible for inclusion in the national system, a river must be free-flowing and in possession of at least one ORV. Among the criteria for determining ORVs is the nature of its contribution “to the functioning of the river ecosystem” (Diedrich and Thomas 1999, p. 13). As Wild and Scenic Rivers are intended to be unique unto the nation and their region, a Region of Comparison (hereinafter ROC) or the “geographic area of consideration for each

outstandingly remarkable value that will serve as the basis for meaningful comparative analysis” must be established to assess the unique qualities of river resources (USFS 2015, p. 4). However, no standardized guidelines exist for defining a ROC. Instead the policy affords agency and personnel discretion in the process, which may thwart ORV recognition and protection.

Regional eligibility of ORVs can be determined in several ways, including by comparison across ecoregions. However, ecoregion frameworks are inconsistent throughout the interagency system and across the intra-agency boundaries depicted

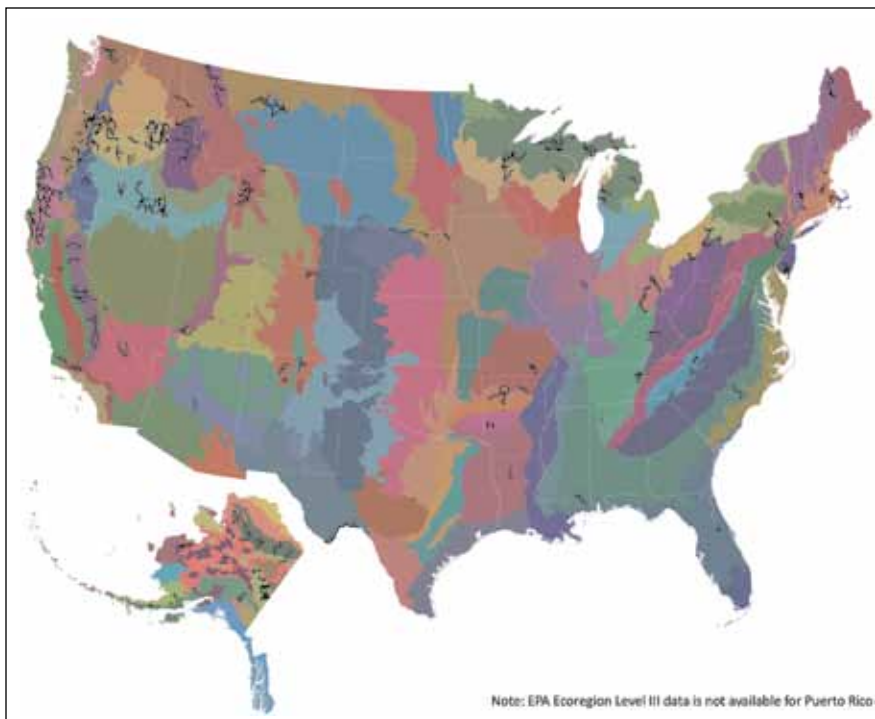


Figure 4 – Wild and scenic river distribution across EPA Level III Ecoregions

in Figure 3. For instance, personnel from distinct BLM regions revealed that in one region The Nature Conservancy (TNC) ecoregion model was applied whereas the USGS physiographic provinces were utilized in another. One agent stated “there’s many ways to look at regions and how you make that split as far as trying to determine regionally significant. It all comes down to interpretation.” Fundamentally, the selection process is a question of regionalization, a problematic exercise due to the subjective nature of selecting region-defining features (Murphy 2013; Walker 2003). For wild and scenic rivers, the process is complicated by a lack of standardized guidelines as each agency either adopts a model or uses proprietary models based on resource management priorities. What may be a significant conservation goal for one agency in a particular region may not translate to the next (Omernik and Griffith 2014). Thus, advancing a holistic national river conservation

policy calls for a standardized, non-partisan ROC model.

This objective is particularly important because freshwater ecosystems have high rates of endemism, or the presence of unique populations of species found nowhere else on the planet (Abell et al. 2008). Endemism makes freshwater ecosystems susceptible to high rates of extinction as impaired and modified rivers lead to local extirpations or extinctions. The risk of such extinctions is rising with climate change and population growth (Strayer and Dudgeon 2010). Therefore, protecting a suite of rivers from each ecoregion would advance the act’s purpose of fulfilling today’s vital conservation needs. The EPA’s Level III Ecoregion model is arguably the most appropriate framework for such a purpose. Chosen for its longevity, level of refinement over 30 years, and independence from land agency agendas, this framework addresses core regionalization challenges (Omernik and Griffith 2014).

Spatial analysis of designated rivers using this model reveals in Figure 4 an uneven distribution of ecoregion representation within the national system. For instance, a single ecoregion contains 24 protected rivers while 35 ecoregions contain none. The question then remains, what other factors are driving this uneven distribution?

Reframing ORVs as Ecosystem Services

Interview participants attributed challenges to designate more rivers to several factors. First, a lack of political will is grounded in perceptions that conservation curtails economic growth by limiting water resources development and entrenching fiscal resources. In a similar vein, constituents fear increased federal oversight and land use restrictions, especially on private property. Third, there is a general lack of understanding about how the WSRA functions. As one conservation advocate explained, “The adjectives Wild and Scenic Outstandingly Remarkable Values just don’t get politicians on your side.”

To contend with the “nature as resource” versus “conservation of nature” paradigm, Henstra (2015) suggests reframing current conservation policies to reflect the “urgency” expressed in calls to advance conservation policy, such as Strayer and Dudgeon’s 2010 call. Such is the case because perceptions of threat can influence public support for policy making and implementation (Stern 2000). Moreover, adaptation concepts rooted in current political demands seemingly pique interest from decision makers, thus fostering acceptability of policy adoption (Schmidt-Thome et al. 2013). Hence, advancing WSRA application for river conservation will require

framing those adjectives in terms germane to stakeholder concerns.

An ecosystem service framing is supported as a method to situate biodiversity within an influential political-economic construct by placing value on the services rivers provide to society, including clean water, flood reduction, groundwater recharge, fisheries, and recreation (Vörösmarty et al. 2010; Tickner and Acreman 2013; Palmer et al. 2008). This framing, in turn, provides policy makers a tool to evaluate the trade-offs between development and conservation (Liu et al. 2010). Thus, ecological economists praise ecosystem services as an effective mechanism for advancing conservation policy (Daily 1997; Liu et al. 2010), as “a means to an end” (Dempsey 2016, p. 5). Ecologists use ecosystem services to rally for increased biodiversity protection and resilience in the face of climate change (Di Baldassarre et al. 2014; Fleishman et al. 2011; Seppälä, Buck, and Katila 2009). Quoting Jessica Dempsey, ecosystem services can be “better understood as a political-scientific strategy to create new interests in nature, to prevent ‘stupid decisions’” than as a means of creating new market commodities (2016, p. 10).

Although the term ecosystem services did not exist during the environmental policy era of the 1960s when the WSRA was being negotiated, the designation of a stretch of river arguably centered on the protection of ecosystem services. For example, facing losses from dam developments in the Columbia Basin, the Pacific Marine Fisheries Commission sought protection for anadromous fish spawning habitat in Idaho’s Salmon River as evidenced from archival documents (James 1966).

Over time as ecological science and education progressed, river resources fitting the characteristics of ecosystem services were included in “Other” ORV designations as shown in Figure 5. One agent reported:

It was very uncommon to see “ecology” or “ecological” used in ORV analysis, but I’m starting to see that more and more often and typically in BLM what that means is that we’ve got a kind of intact ecosystem that provides all the services. It’s got a full range of flows, it’s got a nice riparian area, it’s got a bird population, it’s got the fish there that should be there, and you know we’re putting it forth like “wow, this is an outstanding example of a river that is functioning ecologically like it should” and I’ve noticed how people react to that and that’s a very strong selling tool ... we say hey “one

of the things is that this [river] is a completely high to low full range of elevation, full range of species, full range of ecological functions, it still works and that alone is a reason to protect it” and people say “oh” ... they think of it as a whole system, they don’t think of it as it’s great recreation or it’s great fishing.

Against that backdrop, Tickner and Acreman’s (2013) typology has been adapted to situate ORVs within the four widely used categories of ecosystem services to demonstrate the benefits they provide and to examine the utility of using the WSRA as an ecosystem-based adaptation policy. Figure 6 illustrates that ORVs often span multiple categories providing a host of benefits to society such as food security, public and mental health, a tourism industry, natural infrastructure for flood and drought mitigation, resilience, scientific study, and cultural renewal, among others.

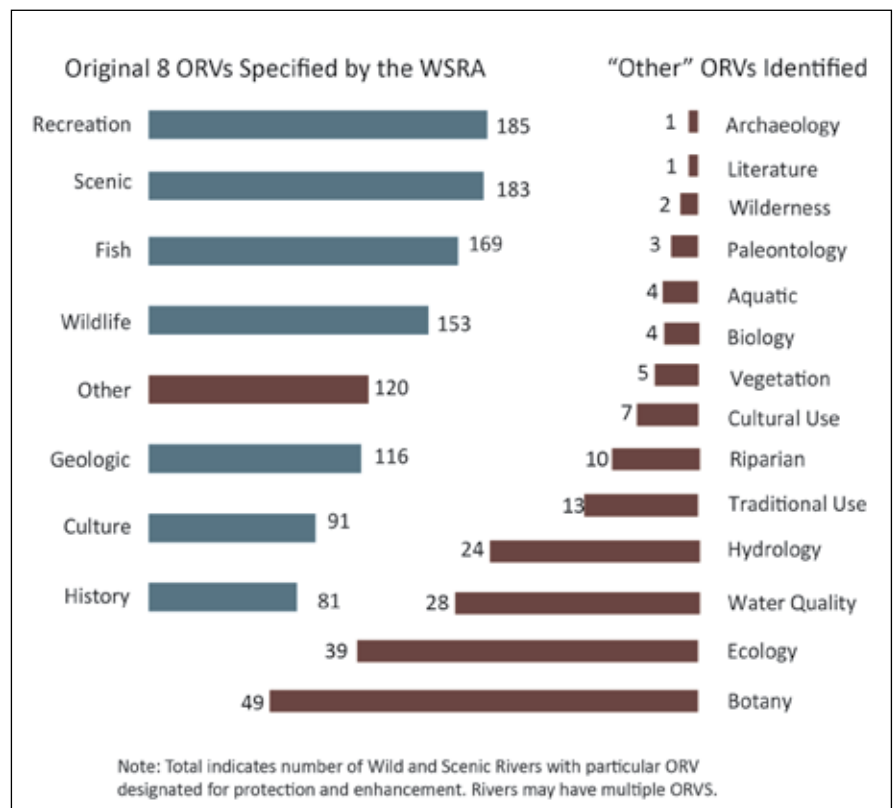


Figure 5 – ORV designations signal importance of ecosystem service protection

PROVISIONING SERVICES	REGULATING SERVICES	SUPPORTING SERVICES	CULTURAL SERVICES
Food: Production of fish, wild game, fruits, grains, etc. Fresh Water: Storage & retention of water, provision of water for irrigation & drinking. Fiber and Fuel: Production of timber, fuelwood, peat, fodder, aggregates. Genetic materials: Medicine; etc. Biodiversity: Species gene pool.	Climate Regulation: greenhouse gases, temperature, precipitation, & other climatic processes; chemical composition of atmosphere. Hydrological regimes: Groundwater recharge & discharge, storage of water for agriculture & industry. Pollution control and detoxification: Retention, recovery, & removal of excess nutrients & pollutants. Erosion: Soil retention & prevention of structural change (bank slumping). Natural Hazards: Flood & storm protection.	Biodiversity: Habitats for resident & transient species. Soil formation: Sediment retention & accumulation of organic matter. Nutrient cycling: Storage, recycling, processing, & acquisition of nutrients Pollination: support for pollinators.	Spiritual & inspirational: Personal feelings & wellbeing, religious significance. Recreational: Opportunities for (eco)tourism & recreational activities. Aesthetic: appreciation of natural features. Educational: Opportunities for formal & informal education & training.
Fish, Wildlife, Riparian, Biology, Hydrology, Botany, Ecology, Traditional Use, Water quality, Vegetation, Aquatic, Wilderness	Geologic, Riparian, Biology, Hydrology, Botany, Ecology, Water Quality, Vegetation, Aquatic, Wilderness	Geologic, Riparian, Biology, Ecology, hydrology, Aquatic, Botany, Water Quality, Vegetation, Wilderness	Culture, Fish, wildlife, Geologic, Recreation, Scenic, Historic, Water Quality, Biology, Aquatic, Ecology, Riparian, Hydrology, Traditional Use, Cultural Use, Paleontology, Botany, Vegetation, Wilderness, Literature, Archeology
Food security, national security, public health, resilience, resource management, economic security, sustainability	Natural infrastructure, resilience, flood mitigation, drought mitigation, public health, national security	Food security, climate refugia, resilience, sustainability, flood recession agriculture	Tourism industry, cultural renewal, mental health, scientific study, economic diversity

Figure 6 – ORVs provide many benefits to society in an ecosystem service framework. Adapted from Tickner and Acreman (2013).

Adapting a Visionary Policy for a Resilient Future

As we look toward a future characterized by a changing climate and greater demands on water resources, the Wild and Scenic Rivers Act provides an opportunity for a more ecosystem-based adaptation policy framework. Federal land management agencies play a vital role in identifying and protecting river resources important to society through their resource management plans. Yet, despite an ostensibly broadly applicable framework for protecting rivers, the variegated patchwork of land management agencies and a lack of political

support troubles both the identification and designation of any broadly applicable, holistic river conservation system. Thus, reframing the WSRA and its outstandingly remarkable values as a policy designed to protect ecosystem services may help advance three matters ripe for improvement within the national system: resource protection, training, and relevancy (TNC 2016).

First, utilizing consistent framings for ecoregion identification while taking into consideration the distribution of rivers across those ecoregions provides an opportunity to better protect a complete portfolio of ecosystem services (e.g., biodiver-

sity, erosion control, fisheries, flood mitigation). The Nationwide Rivers Inventory provides a starting point for closing the gap in underrepresented ecoregions (depicted in Figure 7). As climate change makes river conservation urgent, this approach to fulfilling the WSRA’s conservation intent could expand resource protection while mitigating impacts of climate change on river resources. Given the flexible design of the WSRA and afforded agency discretion, standardizing ecoregion models could be accomplished through a directive from the Interagency Wild and Scenic Rivers Coordinating Council.

Second, if conservation advocates and agency personnel adopt a consistent framework for ecoregion identification, such as the EPA’s Level III Ecoregions, this method could serve to streamline training as well as eligibility and suitability studies for designations, ultimately reducing human and financial resources. Agencies may be reluctant to replace their proprietary system, but moving toward standardization may facilitate interagency coordination for administering the national system.

Finally, framing ORVs as ecosystem services situates the descriptive language of the policy’s “Wild and Scenic” and “Outstandingly Remarkable Values” within a widely accepted political-economic framing and offers stakeholders a model for weighing the trade-offs between conservation and development – essentially making ORVs relevant to decision makers. After all, if you can frame the protection of an intact riparian forest or floodplain in terms of reducing the risk of impacts brought by more frequent and intense floods (or droughts) in the face of climate change – essentially an insurance policy for which the federal government

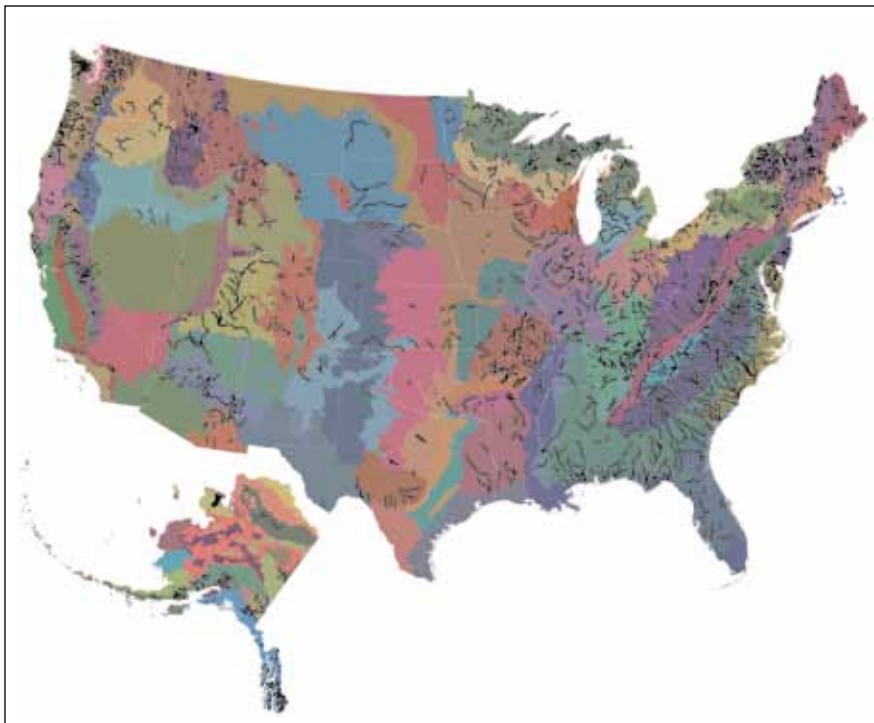


Figure 7 – The Nationwide Rivers Inventory contains 3,213 eligible rivers.

pays the premium – then landowners and politicians might turn an otherwise deaf ear toward negotiations over conservation policy. Moreover, as the WSRA was negotiated during an era of increased understanding of the environment through ecological science, we must adapt the policy to incorporate new scientific understandings of climate impacts on river resources. Suggesting this trend may be under way, “climate refugia,” an ecosystem service for fisheries resilience, recently factored into ORV assessments of proposed designations in Montana’s cold headwaters streams.

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Continued from WILD AND SCENIC RIVERS INTO THE NEXT 50 YEARS, from page 21

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Continued from DAM REMOVAL ON THE LOWER WHITE SALMON, from page 40

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The Role of Wild and Scenic Rivers in the Conservation of Aquatic Biodiversity

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Abstract: Formerly diverse and abundant freshwater species are highly imperiled, with higher extinction rates than many other taxonomic groups worldwide. In the 50 years since passage of the US Wild and Scenic Rivers Act, wild and scenic rivers (WSRs) have contributed significantly to the conservation of native aquatic biodiversity as well as to the conservation and restoration of essential habitats. WSRs also have limitations. Conditions that impair aquatic species are not fully mitigated by WSR designation, although there are ways to reduce these limitations.

The US Wild and Scenic Rivers Act (WSRA) seeks to preserve “selected rivers or sections thereof in their free-flowing condition to protect the water quality of such rivers and to fulfill other vital national conservation purposes.” The mention of fulfilling “other vital national conservation purposes” hints at the essential role free-flowing rivers play in the conservation of native aquatic species. In the 50 years since passage, multiple lines of research have documented the importance of unobstructed rivers and natural hydrologic and disturbance regimes for the maintenance of aquatic biodiversity (Pringle 2000).

Wild and scenic rivers (WSRs) must be free-flowing and possess one or more outstandingly remarkable values (ORVs). Once designated, WSRs become part of the National Wild and Scenic Rivers System which protects their free-flowing condition, and maintains or enhances their water quality and ORVs. Outstandingly remarkable values encompass “scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar values.” A river’s ORVs must be unique, rare, or exemplary



John Rothlisberger.
Photo credit: Leisa Wiest.



Tamara Heartsill Scalley.
Photo credit: Jerry Bauer.



Russ Thurow. Photo credit: J. Younk.

relative to its geographic context. Each WSR has a formal Comprehensive River Management Plan (CRMP) that identifies management objectives and practices designed to maintain and enhance its ORVs (Diedrich 2002; McGrath 2014). Section 10 of the WSRA emphasizes that WSRs are intended to protect “esthetic, scenic, historic, archaeological, and scientific features,” all of which must be addressed in the CRMP.

The three types of WSR classifications (Wild, Scenic, or Recreational) depend on the degree of anthropogenic development along a river. River management objectives

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Table 1 – Selected Terms, Concepts and Definitions associated with the Wild and Scenic Rivers Act.

**Sources WSR Section 16; Karr 1991, Karr and Dudley 1981, Pringle 2001.*

Term/Concept	Definition
River	“a flowing body of water or estuary or section, portion, or tributary thereof, including rivers, streams, creeks, runs, kills, rills, and small lakes”
Free-flowing	“applied to any river or section of a river, means existing or flowing in natural condition without impoundment, diversion, straightening, riprapping, or other modification of the waterway”
Hydrologic connectivity	“water mediated transfer of matter, energy, or organisms within or between elements of the hydrologic cycle”
Biological integrity	“all factors affecting an ecosystem and the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitat of the region.”

depend on WSR type, but in all cases CRMPs seek to conserve and enhance river qualities and conditions for present and future generations. The WSR Wild classification includes those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. Those classified as Scenic must be free of impoundments, with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads. Lastly, those classified as Recreational are readily accessible by road or railroad, have some development along their shorelines, and may

have undergone some impoundment or water diversion in the past. Thus, CRMPs include both monitoring and management activities, as well as restrictions on incompatible uses, and may also include provisions for restoration activities (Haubert 1998). For example, if existing structures do not impede a river’s free flow (see Table 1), the presence of low dams, diversion works, and other minor structures prior to designation do not preclude a river from being designated as a WSR (Diedrich 2002). The restoration objective of removing such structures, therefore, may appear in a river’s CRMP.

Although the Forest Service (USFS), National Park Service

(NPS), Bureau of Land Management (BLM), and Fish and Wildlife Service (USFWS) are the primary agencies managing WSRs, administration occurs by integrating authorities and coordinating actions of states, tribes, and 10 additional federal agencies with jurisdiction over various aspects of the management of water, river substrates, and adjacent riparian areas (Diedrich 1999). Currently, the USFS is the lead management agency for more river kilometers in the national system than any other agency (7,981 km [4,959 miles]) (Table 2). Protecting riparian areas and their immediate surroundings is essential to protecting the biologically favorable values and conditions

Table 2 – National Wild and Scenic River System river kilometers per agency and river type.

**Data from rivers.gov; The National Wild and Scenic River System contains 27 rivers which are managed by a combination of Tribes, States, and Federal agencies; 0.62 miles to 1 km.*

Agency	RIVER TYPE			
	National System	Wild	Scenic	Recreational
U.S. Forest Service	7,981	2,792	2,094	3,096
National Park Service	5,184	2,799	1,200	1,227
Bureau of Land Management	3,903	2,463	566	872
U.S. Fish and Wildlife Service	1,691	1,678	13	0
State-Administered	1,691	224	553	916
*Total km	20,453	9,958	4,427	6,067

of rivers. Stewardship of WSRs is consistent with the USFS mission of “securing favorable conditions of water flows,” which is embodied in the National Forests Organic Act of 1897. WSR designation encompasses rivers and adjacent lands, providing a riparian protection and management corridor that is on average 0.4 km (0.25 miles) wide. Consequently, the WSRA is proactive in recognizing the fundamental connection between aquatic and terrestrial systems.

A river’s assemblage of fishes may qualify as an ORV, especially when threatened or endangered species, or Endangered Species Act (ESA)–designated critical habitat for such species, are present. Remarkable native species diversity or habitat diversity may also qualify as ORVs. Thus, conserving aquatic biodiversity may be among the primary purposes for WSR designation and can feature prominently in CRMPs. All WSRs, regardless of their identified ORVs, provide important benefits to aquatic communities. Even when conserving biodiversity is not specifically a goal of WSR designation, protecting rivers is the freshwater equivalent of creating preserves to protect terrestrial biodiversity. In this article, we briefly describe the aquatic resources of the United States, the threats they face, their conservation needs, and how WSRs contribute to meeting those needs. We also share examples of how specific WSRs benefit native species. Finally, we discuss limitations of WSRs and opportunities to improve their contributions to the conservation of biodiversity.

Aquatic Biodiversity and Threats

North American (NA) rivers and streams support a wide variety of aquatic and semi-aquatic flora and

fauna. These organisms are taxonomically diverse and include microbes, algae, vascular plants, insects, mollusks, crustaceans, amphibians, reptiles, birds, mammals, and fishes. NA ecosystems are notable for their richness and diversity of species, and NA ranks first among continents for freshwater biodiversity (Master et al. 1998). Furthermore, NA aquatic biodiversity is globally critical for the conservation of various taxa. For example, 60% of all world crayfish species are native to NA (Crandall and Buhay 2008), and NA supports approximately 300 species of freshwater mussels, which account for 35% of 856 described global species (Graf and Cummings 2007). Approximately 10% of known freshwater and anadromous fishes are native to NA (801 species) (Master et al. 1998).

Many aquatic species in NA are endemic (i.e., found nowhere else) to a watershed or set of watersheds. Diverse NA ecosystems, ranging from coastal cypress swamps to glacial lakes to desert rivers to high-elevation streams, create unique habitats that contribute to high endemism rates. Large and small differences in the environmental conditions to which species evolutionarily adapted, have been maintained for geologically long periods of time resulting in a diverse set of unique aquatic species, each on its own evolutionary trajectory. Consequently, conserving populations of aquatic species in one region of the continent does not adequately provide for the maintenance of overall aquatic biodiversity.

Freshwater species are consistently recognized as among the world’s most imperiled taxa (Strayer and Dudgeon 2010). Freshwater fishes have higher extinction rates than other vertebrate taxa worldwide, and the current extinction rate

for freshwater fishes in NA is nearly 900 times greater than the historical background rate (Burkhead 2012). In the United States, more than 75 fish species and numerous other aquatic species are designated as threatened or endangered. Endemic species, those confined to a small geographic range, or those with small populations are particularly at risk. To prioritize aquatic conservation efforts, it is essential to identify critical habitats and life history requirements of at-risk species.

Multiple threats and stressors have caused historical declines in species diversity and abundance. North American waterways teemed with aquatic life prior to European settlement. For example, prior to the mid-19th century, huge Atlantic salmon runs entered northeastern US rivers (Webster 1982). Native salmon are no longer abundant in the eastern United States and some populations are endangered (Parrish et al. 1998). The Columbia River Basin was formerly the “most productive Chinook salmon habitat in the world” (Van Hynning 1973), with up to 16 million salmon returning annually. Current wild salmon returns represent about 2% of historical runs (Williams 2006). In undegraded Alaskan rivers, large runs of Chinook, sockeye, pink, chum, and coho salmon persist. Other species, such as freshwater mussels, were also abundant until the early 20th century (Haag 2012). Clench (1925, cited in Haag 2012) visited the Green River in Kentucky and reported “a bed of live shells [...] over 300 feet long and 50 feet wide; they were so thick I could have filled a freight car.” Some previously abundant North American mussels are now threatened or endangered, others are extinct, and few species are abundant (Williams et al. 1993).

A variety of threats continue to affect aquatic and semi-aquatic species. These include habitat fragmentation that limits gene flow and access to critical habitat (Nilsson et al. 2005); water withdrawals and other hydrologic alterations that change the timing and abundance of water, interfering with species' ability to grow, migrate, and reproduce (Pringle 2001; Bunn and Arthington 2002); modifications of channels linked to agricultural, industrial, suburban, and urban land uses; changes in water temperature resulting from thermal pollution, decreases or alterations of riparian cover, and climate change (Rieman and Isaak 2010); chemical pollution (Dudgeon et al. 2006; Rockström and Karlberg 2010); nonnative invasive species that modify native species assemblages through introgression, predation, competition, and habitat modification (Strayer 2010); and increased susceptibility to pathogens and diseases (Snieszko 1974).

With such a daunting array of threats, it is rarely effective to address problems individually. Moreover, given the interconnectedness of ecosystems and the hierarchical nature of aquatic systems embedded within terrestrial landscapes, it is rarely possible to solve one problem in isolation of others. Therefore, conservation efforts that affect large geographic areas and address entire ecosystems are much more likely to benefit species than more narrowly focused efforts (Williams et al. 2011). Although there is no minimum segment length for WSR designation and it is possible for individual WSR designations to be too small to protect biodiversity, when implemented at ecologically significant scales, designation and management of WSRs is consistent with an effective, broad-

scale, holistic approach (Pahl-Wostl et al. 2008; Cid and Pouyat 2013).

Aquatic Conservation Needs

Considering the plethora of aquatic taxa found in North American rivers, here we illustrate the conservation needs of one group by focusing on freshwater fishes, including potamodromous, anadromous, catadromous, and amphidromous forms (Morais and Daverat 2016). Schlosser (1991) provides a synthesis of freshwater fish life stages: life begins when fertilized eggs are either buried within substrates, broadcast over the surface of substrates, broadcast into the water column, or attached to plant material. Eggs mature after an incubation period lasting from a few days to several months when eggs hatch into embryos. When the embryo phase is complete, fish begin feeding on external energy sources and become larvae. When fully formed, larvae become juveniles that undergo many seasonally favorable periods of rapid growth, followed by seasonally less favorable growth periods. In temperate streams, favorable and unfavorable periods frequently involve migration between summer and winter habitats. Juveniles ultimately develop into subadults, the life stage immediately prior to sexual maturity. After sexual maturity, adults complete spawning migrations, locate appropriate sites for egg deposition, and reinitiate the life cycle. Within these general life stages, tremendous diversity occurs in life history characteristics of various species. For example, substantial variation occurs in spawning migrations; seasonal occurrence of eggs, young, and adults; and feeding habitats. Consequently, no single life history definition is all-inclusive.

The interrelationships that have evolved between these diverse

species, life stages, and life history strategies and their habitats is complex. Scott and Crossman (1973) and Meehan (1991) provide detailed descriptions of the life stages and habitat requirements of many North American fishes and salmonids, respectively. The authors illustrate unique temporal and spatial habitat requirements of various life stages and life history types. In general, to persist, fishes require the maintenance of natural processes (e.g. fires, floods, debris flows) that operate on landscapes, deliver wood and sediment, alter stream channels, and create complex habitats (Reeves et al. 1995). Specifically, species require habitat components, including connectivity that enables life stages to move among suitable habitats; sufficient quantities of water to sustain living space and food sources; water of suitable chemical quality; a natural hydrological regime to maintain the conditions species and life stages evolved with; suitable water temperatures, including daily and seasonal temperature fluctuations; complex habitats exhibiting diverse substrates for life stages ranging from incubating embryos to overwintering adults; instream cover components such as large woody debris, aquatic plants, and algae; and appropriate native riparian and upland terrestrial vegetation. Each of these components is critical for maintaining the food webs and essential habitats necessary for species with a variety of life stages and diverse life history strategies to persist.

Contributions of Wild and Scenic Rivers to Aquatic Conservation

By their free-flowing character and the maintenance and enhancement of their ORVs, WSRs provide

relatively intact and complex aquatic and riparian habitat and unimpaired water quality necessary for the long-term persistence of aquatic species. To illustrate the benefits of WSRs for aquatic biodiversity conservation, we provide examples from a temperate (central Idaho) and a tropical (Puerto Rico) region, and briefly describe contributions of WSRs for advancing knowledge, and their potential connections to educational and outreach activities.

Insights from Central Idaho

Central Idaho's Middle Fork Salmon River (MFSR) flows through the heart of the Frank Church–River of No Return Wilderness (FC–RNRW) (Figure 1). In 1968 the MFSR was one of the original eight rivers designated during creation of the National Wild and Scenic Rivers System. From its origin, the MFSR flows north-northwest for 171 kilometers (106 miles) through the Salmon River Mountains and joins the Salmon River. Twelve major streams and hundreds of smaller ones are tributary to the river. From 1930 to 1980, a majority of the region was managed in “primitive area” status (USFS Service 1998). In 1980, the Central Idaho Wilderness Act established the 906,136-hectare (2.2 million acre) wilderness that remains the largest contiguous wilderness in the lower 48 states and the largest in the national forest system. The Central Idaho Wilderness Act also added the main stem Salmon River to the National Wild and Scenic River System.

Landscapes are dynamic systems shaped by a variety of natural processes across a range of spatial and temporal scales. In central Idaho, processes include spring snowmelt and peak flows, winter rain-on-snow

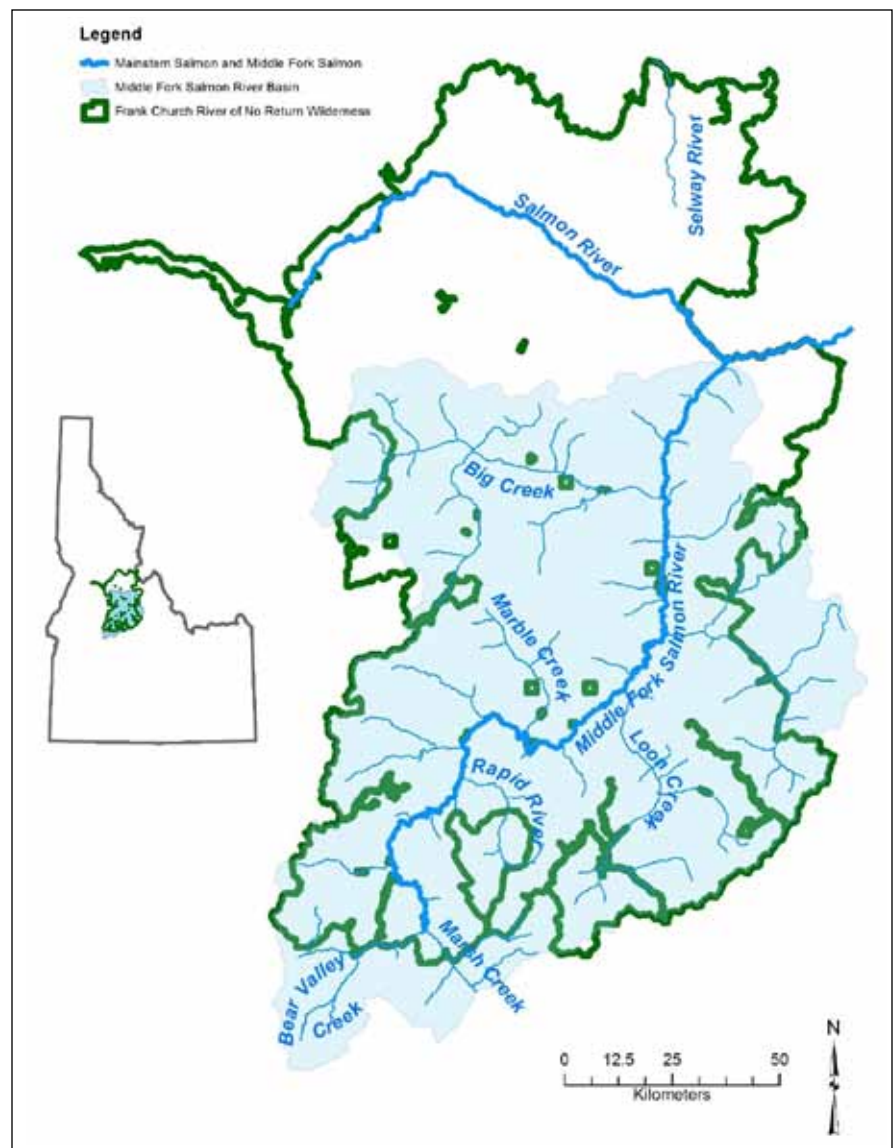


Figure 1 – Central Idaho's Middle Fork Salmon River flows through the heart of the Frank Church–River of No Return Wilderness.

events and floods, snow avalanches, windstorms, droughts, wildfires, high intensity rainstorms, landslides and debris flows, earthquakes, and extreme temperatures. Natural processes play a critical role in creating aquatic habitat complexity, diversity, and connectivity (Reeves et al. 1995; Dunham et al. 2002). Although human activities have degraded most landscapes and altered natural disturbance regimes, the FC–RNRW is an exception. Its protected status enables natural processes to function relatively unimpeded by anthropo-

genic activities across its extensive landscape (Figure 2). Natural processes create and maintain a dynamic mosaic of landscape conditions that support diverse, high quality, and connected habitats (Thurow 2015). Because of its large size, functioning natural processes, and the diverse, high quality, connected habitats they create, a nearly complete native species assemblage persists in the Frank; only grizzly bears and Indigenous people are absent from the region Lewis and Clark explored in 1804 (Thurow 2015).

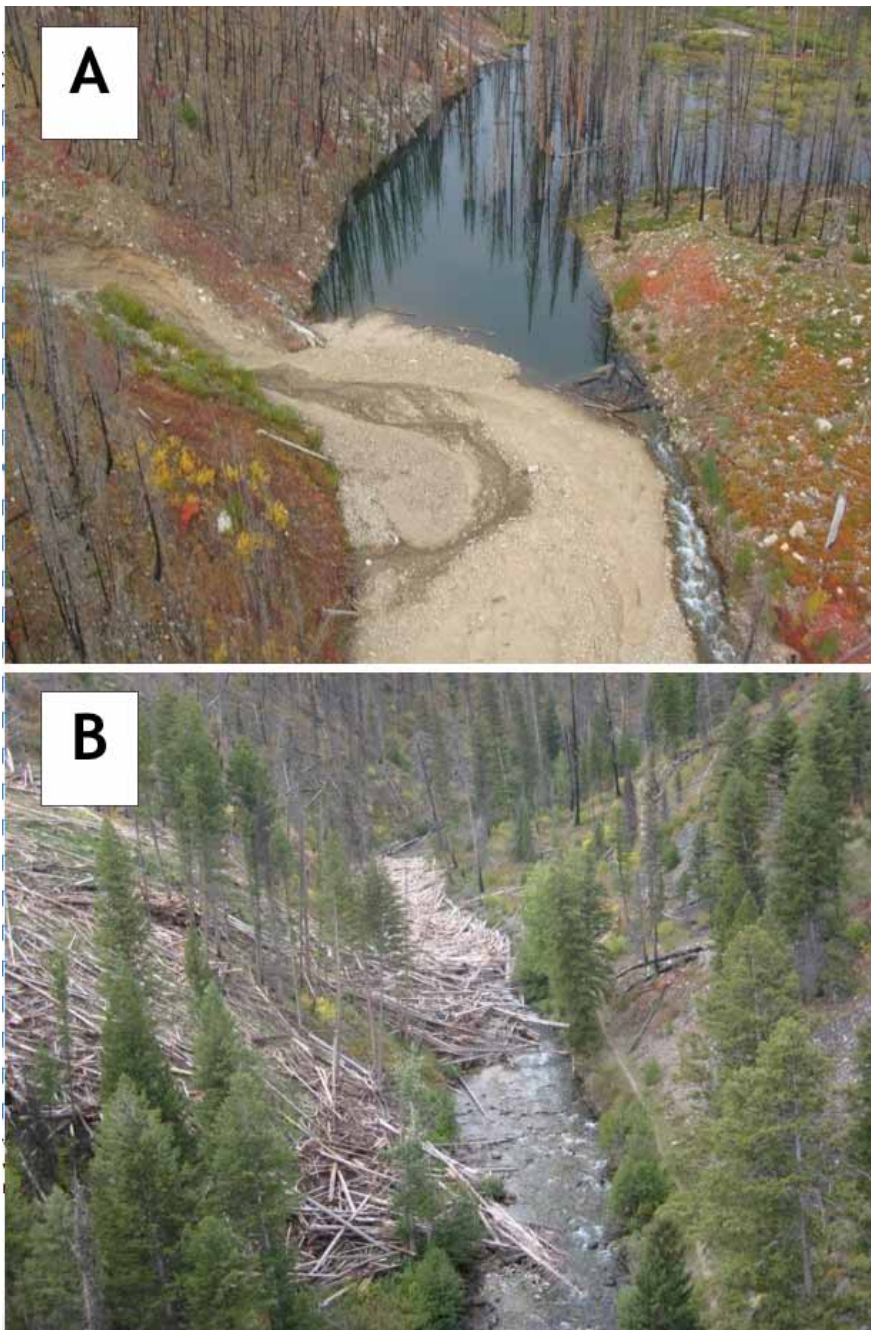


Figure 2 – Within the MFSR, natural processes such as fires, intense storms, and debris flows (A) or avalanches (B) create and alter aquatic habitats by recruiting wood and sediment to streams. Photo credits: R. Thurow, US Forest Service, Rocky Mountain Research Station.

To illustrate these processes, since the mid-1980s, climate-driven increases in the size and severity of wildfires in the western United States (e.g., Westerling et al. 2006) have profoundly affected forested and aquatic ecosystems. High fuel densities, combined with drought, caused forests to be highly susceptible to changes in the timing of snowmelt

and increased the length of the fire season (Westerling et al. 2006). Since 1990, wildfires have burned extensive portions (>52%) of the MFSR Basin (Thurow 2015). Paleo records of fire confirm that intense fires have been a natural part of this landscape for thousands of years (Pierce et al. 2004; Svenson 2010; Whitlock et al. 2010). Fire-related debris flows have been an

integral part of the FC–RNRW for at least 12,000 years (Riley et al. 2011). Intense thunderstorms or rain-on-snow events postfire create debris flows or snow avalanches that recruit wood, carbon, and sediment to streams. Runoff-generated, fire-related debris flows (Meyer and Wells 1987) from tributaries contribute immense volumes of sediment (Kirchner et al. 2001; Riley et al. 2011). Such events also occur in unburned, geologically unstable landscapes. Inputs of fine-particulate carbon and large woody debris (LWD) are critical for aquatic ecosystems; LWD provides essential channel structure, habitat diversity, nutrient retention, and carbon to streams (Bilby and Likens 1980; Bilby 1981; Seo et al. 2008; Martin and Benda 2001), and fine organic carbon forms the basis of aquatic food webs for primary and secondary consumers (Mulholland and Watts 1982).

Pacific salmon and other aquatic species have evolved in these dynamic freshwater environments. A complex suite of disturbance patterns and processes create and alter essential habitats to provide a physical template essential to the expression of native species life history and genetic diversity. Chinook salmon, for example, persist through a host of adaptations such as multiple life history strategies, high fecundity, extended incubation, high mobility, and straying to new spawning sites (Figure 3) (NRC 1996). Survival in dynamic environments is also a matter of scale; persistence will be influenced by how well dispersal dynamics and reproductive rates merge with scales of disturbance on the landscape. The exceptional resilience, flexibility, and diversity that characterize salmon are fundamental to their wide distribution, historic abundance, and value (Martin and Glick 2008). Life history diversity



Figure 3 – Natural processes such as floods and landslides provide the physical template to produce spawning habitat for native salmon. In many instances, the protected status of WSRs enables these natural processes to function relatively unimpeded by anthropogenic activities. After spawning, Chinook salmon enrich natal habitats with marine-derived nutrients. Photo credit: US Forest Service, Rocky Mountain Research Station.

increases production and buffers population fluctuations (Greene et al. 2010; Healey 2009). Within the FC–RNRW, multiple fresh- and saltwater Chinook salmon ages may provide up to 18 different age classes spawning each year (Gebhards 1960; James et al. 1998; Copeland and Venditti 2009). Despite extremely low populations levels (Thurow 2000), salmon populations retain both within- and across-tributary population differentiation (Neville et al. 2006a).

Wild, indigenous Chinook salmon and summer steelhead populations such as those in the FC–RNRW are rare; Thurow et al. (2000) reported their presence in 4% and 10% of the potential historical range, respectively, and 15% and 22% of the current range, respectively, in the Columbia River Basin and portions of the Klamath River Basin. Most other wild populations were either extirpated by impassable dams or have been supplemented with hatchery-reared fish

(Thurow et al. 2000). Federal fisheries management agencies identified “four H’s” (habitat degradation, harvest, hatchery practices, and hydrosystem operation) as the primary causes of anadromous fish declines (NMFS 2000). Construction and operation of main-stem dams on the Columbia and Snake Rivers, however, is considered the proximate cause of anadromous fish declines (CBFWA 1990). The adverse effects of main-stem dams and impoundments on salmon and steelhead survival were well documented (Raymond 1979), and by the early 1990s, all wild Snake River Chinook salmon and steelhead populations were federally listed under ESA. Despite abundant, high quality natal habitat; absence of hatchery fish; and low ocean harvest rates verified by tag returns, MFSR Chinook salmon and summer steelhead remain at risk of extirpation, primarily because of outside basin factors in the Columbia River and Snake River migration cor-

ridor, estuary, and ocean. Today, all anadromous fish in the Salmon River basin must navigate eight dams (four in the Columbia River and four in the lower Snake River) to reach the ocean as smolts and ascend the dams as adults returning to spawn. Because of MFSR population declines, angling has been closed for Chinook salmon and steelhead since 1978. In the 2016 Draft Chinook Salmon and Steelhead Recovery Plan, NOAA reported that “[f]ederal hydropower projects in the lower Columbia and Snake Rivers remain a primary threat to the viability of Snake River spring/summer Chinook salmon and steelhead.”

Native salmonids have generally persisted in the areas least influenced by humans (Thurow et al. 1997). Within the western United States, the strongest and most intact native fish populations occur within a network of federally protected and managed lands, including WSRs, roadless and wilderness areas, and national parks (Williams et al. 2011). Protected areas anchor population strongholds (Lee et al. 1997) and function as refugia. The Frank contains high quality, diverse, and functioning aquatic habitats that provide strongholds for 15 native fishes. A host of other federally listed species, recently federally delisted species (peregrine falcon, bald eagle, and gray wolf), and US Forest Service Regions 1, 4-Sensitive Species and sensitive native plants depend on the Frank and its natural processes for essential, core habitats (Thurow 2015).

Greene et al. (2010) and Haak and Williams (2012) emphasized the importance of such biocomplexity and suggested maintaining diverse life history portfolios of populations may be crucial for their resilience to unfavorable conditions such as climate change. Hilborn et al. (2003)

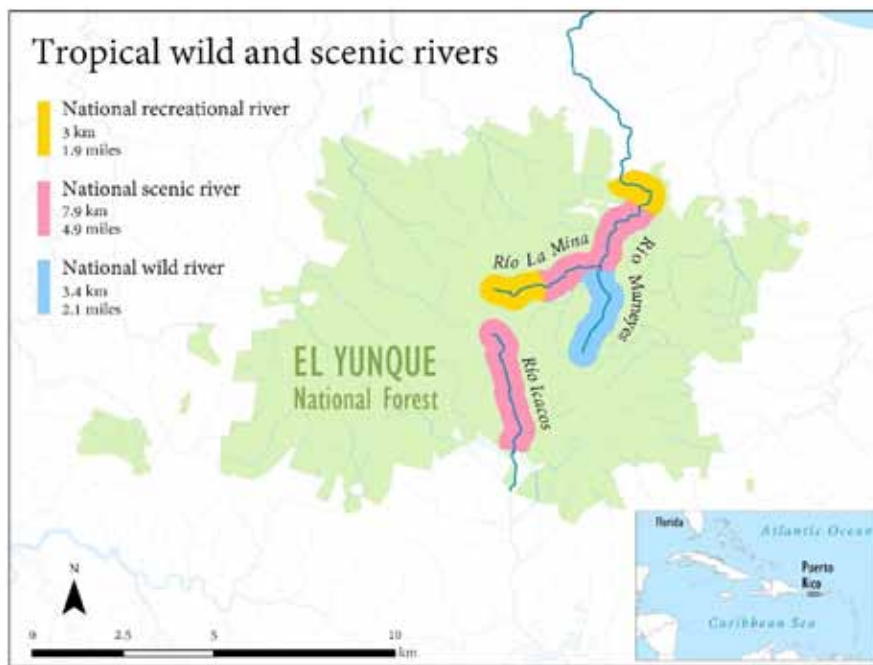


Figure 4 – The tropical wild, scenic, and recreational rivers located in El Yunque National Forest, Puerto Rico. Map credit: Maya Quiñones, US Forest Service, International Institute of Tropical Forestry.

described how the preservation of biodiversity in Alaskan sockeye salmon population has been attributed to the species' ability to persist and support fisheries in a changing climate. Rieinan and Isaak (2010) summarized potential responses to climate change and emphasized maintaining biodiversity to ensure the greatest capacity for natural biological adaptation to variable and changing environments. Crucial steps for conserving biodiversity include (1) maintaining connectivity to allow gene flow, retain genetic diversity, and allow recolonization (Dunham and Rieinan 1999; Isaak et al. 2007; Neville et al. 2006b); (2) conserving the fullest range of genetic and phenotypic diversity (Rieinan and Isaak 2010); and (3) maintaining spatial structure and redundancy to retain phenotypic and genetic diversity (Allendorf et al. 1997; Healey 2009).

Large, well-connected, high-elevation, aquatic habitats may also serve as anchors for species survival and recovery in the era of global warm-

ing (e.g., Martin and Glick 2008). Isaak et al. (2016) reported that the relatively slow pace of water temperature increases in high elevation mountain streams portends their role as refugia for cold-water biodiversity. The MFSR's importance as a cold-water refugia is further enhanced by its unique salmon that spawn at the highest elevations of any spring/summer Chinook salmon population in the world (Crozier et al. 2008).

Insights from Puerto Rico

The National System includes three tropical rivers, all located within the El Yunque National Forest of Puerto Rico (USFS 1993). The Río Mameyes, the Río La Mina, and the Río Icacos were each designated in 2002 (Figure 4). These WSR designations maintain the free-flowing condition of these rivers, which are among the last remaining unobstructed rivers in Puerto Rico (Figure 5). The WSR designations also secure flows that allow migratory native aquatic fauna to complete

their life cycles. Although a majority of the designated WSR areas occur within the national forest, significant portions are located outside of forest boundaries (Heartsill Scalley and López-Marrero 2014). These three rivers dissect terrain with steep hillslopes where flash floods, overland flows, and landslides occur regularly. Such natural disturbances maintain and create high quality habitat for native fauna (Lugo and Heartsill Scalley 2014; Ortíz-Zayas and Scatena 2004).

Aquatic fauna in these WSRs are amphidromous, residing in freshwater habitats as adults and in estuarine or coastal/marine waters during early life stages (Pringle 2000). Native fishes, shrimp, and snails migrate among headwater streams, rivers, and coastal estuaries to reach the Caribbean Sea or Atlantic Ocean (Cook et al. 2009; Covich et al. 2006; Covich and McDowell 1996) (Figure 6). After rearing in salt water, they migrate back upstream as postlarvae to occupy pools in streams along elevational gradients in the WSRs (Heartsill Scalley et al. 2001; Greathouse et al. 2006; Harris et al. 2012). Ten native species of shrimp, at least six fishes, various snails, and one endemic freshwater crab (buruquena) inhabit these WSRs. The diverse shrimp species dominate the aquatic fauna biomass in these tropical WSRs and streams (Harris et al. 2012). Four shrimp species are filter-feeders and scraper-grazers before (gata and guabara) while another species, the salpiche, is a shredder and particle feeder (Crowl et al. 2006). The palaemonid genus *Macrobrachium* includes five species, such as bocú and zurdo, which are the predators and omnivores feeding on leaf detritus, fine particulate organic matter, macrophytes, algae, small invertebrates, mollusks, small



Figure 5 – WSR designation of the Río Mameyes, in the El Yunque National Forest, maintains the free-flowing condition of this and other rivers, which are among the last remaining unobstructed rivers in Puerto Rico. Photo credit: María Rivera-Costa US Forest Service, International Institute of Tropical Forestry.

fishes, and other shrimp (Covich and McDowell 1996). Fishes are also predominantly amphidromous, although recent findings reveal there is variation in the migratory strategies of these native fish assemblages (Kwak et al. 2013). Fishes include omnivorous gobies, saga, and various species of algivorous gobies, sirajo or chupapiedra; the eleotrids, big-mouth sleeper, also known as guavina, and the spiny-cheek sleeper; a freshwater dajao mullet; and American eel. Native diadromous freshwater snails such as the burgao are also found in the WSRs. These snails are so sensitive to water depth that they are not found in rivers that are hydrologically disconnected from the ocean or that exhibit excessive accumulation of estuary sediments (Blanco and Scatena 2006). The WSRs in the El Yunque National Forest maintain fundamental ecosystem components including continuous stream discharge, riparian vegetation, naturally heterogeneous channel substrates, and hydrologic connectivity between

headwaters and designated river sections. The Puerto Rico Department of Natural Resources has developed river protection designations that would extend and complement the free-flowing condition of the WSR section of the Río Mameyes to ensure river connectivity beyond federal lands, all the way to its estuarine sections and its coastal outlet.

Despite differences between tropical Puerto Rican and intermountain western rivers and their fauna, the designation and management of WSRs in both regions is essential

for native species persistence. WSRs ensure that high quality, connected, and naturally functioning aquatic habitats are retained for native species. In both locales, WSRs act as refugia for at-risk aquatic species and help conserve significant elements of aquatic biodiversity.

Advancement of Knowledge

Altered landscapes compromise our ability to examine natural processes and species responses. Wilderness offers unique opportunities for social and biophysical research in locations relatively unmodified by humans. Within the confines of watersheds that hierarchically incorporate both wilderness and nonwilderness areas, WSRs provide the minimum accumulation of anthropogenic effects at the landscape scale. However, because rivers from their headwaters to their drainage outlets are integrated into multiple-use landscapes, true wilderness in WSRs depends on the spatial context and scale of the section of the river being designated. Nevertheless, both wilderness areas and WSRs provide locations for passively examining natural processes and species in the absence of confounding management and land use. Consequently, such areas function as controls, baselines against which we may measure the



Figure 6 – Native diadromous aquatic fauna from El Yunque National Forest's wild and scenic rivers; (clockwise from upper right): algivorous goby, chupapiedras (*Sicydium plumieri*); eleotrid sleeper, guavina (*Gobiomorus dormitor*); saga (*Awaous tajasica*); and one of the five species of predatory shrimp, bocu (*Macrobrachium carcinus*). Photo credit: Katie L. Hein.

results of management experiments (Noss 1991).

The FC–RNRW provides a natural laboratory for USFS scientists and collaborators to examine a host of research topics: the role of debris flows and avalanches in contributing carbon and wood to streams (Figure 2); validating methodologies and sampling designs for salmon population monitoring; examining linkages between fine-scale genetic structure, demographic parameters, and environmental characteristics; assessing salmon dispersal and environmental constraints using spatial autocorrelation; validating hydrologic models that predict spawning gravel distribution; monitoring salmon responses to stochastic events; assessing environmental covariates affecting salmon habitat occupancy; and evaluating changes in salmon phenology in response to a changing climate. Similarly, the Mameyes WSR (Figure 5) provides a unique opportunity to monitor shrimp population dynamics, organic matter export, and water quality in a free-flowing system (Scatena and Johnson 2001; Pérez-Reyes et al. 2015; Heartsill Scalley et al. 2012). Long-term datasets collected in Puerto Rican WSRs have been instrumental in improving our understanding of the effects of disturbance caused by flow alterations and the faunal extirpations and ecosystem process disruptions that occur in dammed and modified rivers (Greathouse et al. 2006; Crook et al. 2009). Research values of WSRs may be enhanced by completing and curating accurate stream length data among WSR management agencies. Current deficiencies in spatial data include WSR boundary delimitations and stream length data at appropriate regional and local scales (McManamay 2013). The Interagency WSR Coordinating Council has also identified the

need for a comprehensive database of aquatic species occurrence, legal status, their habitat, and other management-significant ecological data.

WSRs may also assist efforts to connect people with and educate them about landscapes. Many people who visit WSRs identify them as providing a unique sense of place that is inherently valuable for their well-being (Smith and Moore 2011). Communities local to WSRs also perceive recreational, resource, social, psychological, and economic benefits (Smith and Moore 2011). Much untapped potential remains to expand the role of WSRs in educational and outreach activities connected to ongoing research efforts in these watersheds.

Limitations of Wild and Scenic Rivers for Aquatic Conservation

Despite its considerable value, the WSRA by itself is not a comprehensive tool for conserving aquatic biodiversity. Although the act contributes to maintaining hydrological connectivity of designated rivers, only 0.3% of America's river kilometers are designated as Wild and Scenic (Benke 1990). The WSRA also does not prohibit development (e.g., hydropower projects, water withdrawal) below or above WSR segments. Therefore, a key limitation of WSRs is their inability to protect all life stages of all aquatic species contained in entire watersheds. Consider wide-ranging species such as anadromous fish, which spawn in freshwater, migrate to the ocean, and rear in the marine environment. Although WSRs may protect spawning and natal habitat, essential migratory corridors and estuaries that fall outside designated river segments may be managed separately. For example, despite the MFSR's excellent

natal habitat and uniquely adapted fish, because of factors outside the WSR, all anadromous salmonids in the drainage are ESA listed and at risk of extirpation (Thurow 2000). Disturbances from dams and water withdrawals in lower portions of watersheds are also transmitted to upstream systems by reducing genetic flow among source and sink populations and altering nutrient cycling and primary productivity (Greathouse et al. 2006; Pringle 1997). In the tropical Río Mameyes, it is necessary to find partners outside the WSR to promote actions that limit riparian area land use and land cover change. Riparian areas in this WSR have the second largest percentage of urbanization of all the rivers originating in El Yunque National Forest (Heartsill Scalley and López-Marrero 2014). Land cover changes associated with recreation access, pollution and contamination from recreational activities, and hydrological changes in the lowland and coastal areas are stressors to this river system.

For the full conservation benefits of WSRs to be realized, management must be coordinated across jurisdictions using multiple authorities. In most cases, only a portion of a river receives WSR designation, so upstream and downstream conditions and management objectives in undesignated sections influence aquatic biodiversity in the protected segments (McManamay et al. 2012). In recent years, there has been increasing recognition of the importance of managing rivers at the watershed scale. For example, in 2009, Congress designated partial watershed-scale WSRs for the upper Snake River (WY), the Owyhee River (ID), and the Virgin River (UT). The location of the protected WSR

segment within a watershed (i.e., lower, middle, upper) will bring with it management issues and challenges. Designated segments in lower watersheds portions may become sediment deficient if sediment is retained by upstream dams. Water extraction in upstream river segments may also affect downstream segments (Pringle 2001). WSR segments in middle sections of a watershed may experience degradation from upstream and downstream segments. Groundwater pumping, changes in terrestrial vegetation, and elimination of natural flooding regimes commonly alter middle watershed areas. Designated WSRs in upper watersheds are usually in mountainous or wilderness areas. These upper watershed WSRs are vulnerable to the effect of isolation and diminished hydrological connection to their lower watersheds.

An important shortcoming of the WSRA with respect to the water law of the western United States and the conservation of aquatic biodiversity is that designated river segments can be de-watered if senior water rights are present higher in the watershed. The WSRA protects instream flows only to the extent made possible by the reservation of a federal water right with a priority date that is the same as the date of the river segment's designation. This makes the reserved federal water rights of most WSRs very junior ones and therefore does little to protect or augment instream flows. This shortcoming can be partially overcome, however, by seeking to ensure wherever possible that WSR designations encompass the headwaters of a river's main stem and those of its critical tributaries.

Nonnative species may not be considered in the designation of WSRs, and unless an aquatic or terrestrial species wildlife ORV is

recognized as potentially impaired by nonnative species, a river's CRMP is unlikely to address the prevention and management of nonnative species. State agencies also typically retain authority to manage fish and wildlife populations in both WSRs and designated wilderness. The Central Idaho Wilderness Act of 1980, for example, states: "[N]othing in this Act shall be construed as affecting the jurisdiction or responsibilities of the State of Idaho with respect to wildlife and fish in the national forests in Idaho." Despite the state's authority, stocking of alpine lakes in tributaries to the MFSR WSR is guided by a Memorandum of Understanding between the Idaho Department of Fish and Game (IDFG) and Forest Service. Historically, many of the lakes in the FC-RNRW were fishless and began receiving fish in the early 1900s when stocking was conducted by backpack and horseback; this has been followed by aerial stocking in the last 50 years (IDFG 2013). IDFG (2013) notes that historical alpine lake management was conducted to provide diverse angling opportunities, and little consideration was given to native lake fauna prior to wilderness designation. Fish introductions in some barren lakes have reduced native amphibian populations through predation and competition (Hoffman and Pilliod 1999). As a result, in recent years, IDFG has developed an adaptive management approach to guide the Frank's alpine lake fish-stocking program. Information from a variety of agencies and sources is incorporated, and ecological and biological aspects of maintaining native amphibian and downstream fish populations are considered in determining how alpine lakes are managed (IDFG 2013).

In areas where management objectives and priorities are not

aligned with conservation goals, lack of consideration for nonnative species may limit the contributions of WSRs to the conservation of native aquatic biodiversity because nonnative species may affect native food webs and alter ecosystem functions or displace native species populations. Whether fish and wildlife are an ORV of a particular WSR, the value of WSRs for conserving native aquatic biodiversity would be improved if each CRMP addressed collaborative management of nonnative species. As in the example above, CRMPs could include provisions to avoid the stocking of nonnative fish into designated lakes and river segments. Providing for nonnative species management in WSRs is particularly important because people attracted to WSRs for recreation may inadvertently introduce nonnative species. Furthermore, the free-flowing condition of WSRs allow nonnative aquatic species that establish populations to spread upstream or downstream more readily than in rivers where barriers are present. Clearly, protecting or restoring the free-flowing condition of rivers is highly beneficial to the native species that are evolutionarily adapted to the physical characteristics of free-flowing conditions (e.g., temperature, turbidity, hydrograph). On the other hand, the physical conditions associated with regulated rivers (e.g., low turbidity, flattened hydrograph, and cold temperatures) often favor nonnative plants and animals (e.g., tamarisk, nonnative cold-water salmonids) (Johnson et al. 2008). Altered conditions that promote the establishment of nonnative species to the detriment of native species frequently occur below dams where WSR-designated river segments often begin. Such locations make the inclusion of nonnative

species management in CRMPs even more compelling. WSRs may be particularly good candidates for efforts to prevent and control harmful nonnative species because WSR segments may experience fewer effects from other stressors (e.g., pollution, habitat fragmentation) than other rivers. Thus, benefits from successful nonnative species management may be less likely to be obscured by other environmental problems in WSRs than elsewhere (Abell et al. 2007).

Despite their protected status, some WSRs retain legacy effects from historical activities that occurred prior to designation (e.g., dredge mining). In such instances, habitat restoration projects provide an opportunity to enhance the “wild character,” free-flowing conditions, and water quality of the river and benefit aquatic species. However, constraints imposed on the management of WSRs may complicate efforts to enhance habitat quality for aquatic species. Environmental review standards for all WSR projects, including habitat management and restoration, are more stringent than for undesignated rivers. The WSRA requires the evaluation of any projects on a designated river section to ensure there are no “direct and adverse” impacts to the river (see Section 7 review, <https://www.rivers.gov/documents/section-7.pdf>). To avoid unnecessary complications, WSR management agencies should work to promote consistency in project review standards, within and across agencies. Publications of the Interagency WSR Coordinating Council website provide resources to facilitate this process (<https://www.rivers.gov/publications.php>).

Summary

Formerly diverse and abundant, native aquatic species and their habitats

are at risk from a variety of threats. Despite their limitations, WSRs provide complex aquatic and riparian habitats, favorable hydrological conditions, and natural processes necessary for the long-term persistence of many aquatic species. Achieving sustainable use of freshwater resources for the benefit of present and future generations will require continued pursuit of actions that conserve and restore species and their habitats. McGrath (2014) suggests that a comprehensive approach inclusive of all stakeholders will tend to maximize the WSRA’s effectiveness. A comprehensive approach may include research, monitoring, a combination of protected areas and multiple-use areas, restoration projects, outreach, and educational initiatives (Dudgeon et al. 2006; McGrath 2014). The Interagency Wild and Scenic Rivers Coordinating Council was formed in 1993 to assist the development of an integrated approach transcending political, land, and water management boundaries (<https://www.rivers.gov/council.php>). As Franklin (1993) observed, reserves will never be large enough or sufficiently distributed to maintain all biological diversity. Protection of aquatic strongholds, such as WSRs, will also not be sufficient on its own (Thurow et al. 2000). To conserve biodiversity, a combination of reserves, aquatic restoration efforts, instream flow provisions, and adoption of more ecologically compatible land use policies on adjacent lands (e.g., Thurow et al. 1997) will be required (Abell et al. 2007).

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Continued on page 72

Proposing a National Protected River System in China

Ecological Civilization

生态文明

BY PENG LI

Along with rapid economic development in China have come many environmental threats. The Chinese government adopted an “ecological civilization” (or promoting ecological progress – 生态文明) national strategy to change the land development patterns, promote resource conservation and utilization, protect natural ecosystems and the environment, and improve quality of life in China. Serious damage to the nation’s rivers has been caused by rapid industrialization and urbanization. Bodies of water have been seriously damaged; water pollution has become one of the most serious environmental hazards in China, with 30% of rivers contaminated to different degrees; and water quality is a “hot” topic for everyone (Ministry of Environmental Protection 2015; World Water Assessment Program 2012). Many riverbeds have been channeled, and watershed ecosystems have been degraded. This not only destroys natural landscapes, aggravates riverbed erosion, and decreases the ability of many rivers to store and conserve water, it also blocks the free flow of rivers, reducing heterogeneity and biodiversity. Thus, water protection is an important part of the “eco-civilization” initiative.

To protect rivers and water, China has implemented a series of measures revolving around three elements: treatment of water pollution, ecological restoration of large rivers, and protection of water sources. However, without systematic efforts to rebuild the biodiversity of complete river basins, and by only focusing on small parts of some rivers, these measures are insufficient to protect large basin ecosystems in China. A National Protected Rivers System (NPRS) could help protect China’s rivers. The benefits of establishing a NPRS include promoting comprehensive changes in river utilization, maintain-

ing the integrity and diversity of watershed ecosystems, and increasing the effectiveness of the China National Protected Area System (CNPAS).

In recent years, China has observed and come to highly value the benefits and governance of the US National Park System. China has even announced plans to designate new units in a true Chinese National Park System (CNPS), with more strict focus on nature protection (Wong 2015). China hopes that some trial park designations will demonstrate increased societal benefits flowing from a higher quality environment. This initiative can produce a more desirable model for sustainable development decision making such as described in Watson (2013).

While the US National Park System was created in 1916 and has had tremendous impact on nature protection around the world, the US Wild and Scenic Rivers Act (WSRA) (Public Law 90-542) created the first national protected river system – the Wild and Scenic Rivers System (WSRS) – in 1968, creating a method of continuously adding rivers for protection. In 2018, the system will celebrate its 50th anniversary with 208 rivers protected in 40 states managed for a diverse set of values (Palmer, this issue). The WSRA emphasized the importance of identifying and protecting “outstandingly remarkable values” of rivers under the premise of respecting nature and meeting the needs of society. Because of the unique benefits of river ecosystems, the protection of national parks or other public lands alone are not comprehensive enough



Dr. Peng Li

to accomplish sufficient river protection. Thus, the WSRS emerged in the United States as the times required and threats were increasing, protecting river ecological systems, emphasizing rivers' free-flowing importance and scenic, recreational, geologic, fish and wildlife, historic, cultural, and other values (US Public Law 90-542).

Chinese scholars have proposed establishment of River Nature Reserves in China and encouraging stricter river protection and management (Yang et al. 2016). This article offers an assessment of the potential for systematic river protection, laying the foundation for a future NPRS in China.

China's Protected Areas System

In the 1950s and 1960s, protected areas in China still followed the Nature Reserve Model of the Soviet Union. There are more than 8,000 protected area units in the CNPAS, accounting for 18% of China's total area (Li et al. 2016). Governance of protected areas, however, are divided across different departments based on the natural elements they protect, such as water, forest, or land, leading to a confusing assembly of protected areas (for example, a wetland may be administered as a nature reserve, forest park, wetland park, or water park) (Table 1). Administrative authority over different aspects of the same natural elements may belong to various departments, for example,

the administrative authority of water quality belongs to the Ministry of Environmental Protection (MEP), while the quantity of water is the responsibility of the Ministry of Water Resources (MWR).

Some sections of rivers are protected within the CNPAS, but the river as a protected category does not exist. Four categories of partial river protection or water protection within CNPAS include the aquatic ecosystem of national nature reserves (e.g., Jiuzhaigou in Sichuan), the rivers within national parks (e.g., Li River in Guangxi), the urban rivers (e.g., Jiangsu Qinhuai River), and natural rivers (e.g., Jialingyuan River in Shanxi) of national water parks, and wetland parks, most of which are

Types	Departments in Charge	Protected objects	Legal basis	Established	Number
Nature Reserve	Department of Forestry of the PRC; Ministry of Environmental Protection of the PRC	rare wildlife; nature relics etc	Regulations of the People's Republic of China on Natural Reserves	1980	470
Scenic Area	Ministry of Housing and Urban-Rural Development of the PRC	Mountains , rivers, cultural relics and historic sites etc	Provisional Regulations of Scenic Area	1982	225
Wetland Park	Department of Forestry of the PRC	wetland landscape	Notice of the State Council office on strengthening the management of wetland conservation	2005	164
Geological Park	Ministry of Land and Resources of the PRC	geological relics	Technical requirements for the compilation of National Geological Park Planning	2004	199
Forest Park	Department of Forestry of the PRC	Forest landscape; human landscape etc	Administrative measures for the national Forest Park	1982	848
Water Park	The Ministry of Water Resources of the PRC	Reservoir; urban lakes and rivers; irrigated areas	Administrative measures for the Water Park I	2001	778
Marine Special Conservation	State Oceanic Administration of the PRC	marine ecology	Administrative measures for the Marine Special Conservation	2005	56
Desert Park	Department of Forestry of the PRC;	desert ecology	Administrative measures for the construction of Desert Park pilot	2014	70

Table 1 – Main types of Chinese existing national protected areas system

lakes or static rivers (e.g., Wuqiangxi Wetland Park in Hunan).

Differences between Categories of CNPAS and US WSRS

Ideology for river protection based on the relationship between humans and rivers are different in the United States and China. The US WSRA follows the American wilderness ideology (see Tin and Yang 2016) in that it considers humans a part of the watershed ecosystem and that wild or scenic aspects of a river can be protected while still having compatible human uses. Protected areas in China are based on an ideology of maintaining a harmonious relationship between humans and rivers, but humans can harness and even transform rivers, changing relationships. Human uses are at the center of the values of rivers, wetlands, forests, and other resources within the existing CNPAS.

The US WSRA aims to protect watershed ecosystem function, habitat, cultural values, and river recreation usage (Goodell 1978), especially free-flow and headwater conditions. Protecting free-flowing and pristine conditions of rivers in China are usually ignored and are commonly trammled. Nature reserves, national parks, water parks, and wetland parks protect values embodied by the river only in accordance with other protection purposes. The nature reserves focus on biological diversity and put emphasis on the protection of rare and endangered animal and plant species. National parks protect outstanding natural values and cultural landscapes that were created by the interaction between humans and nature, without paying attention to larger basin ecosystems and cross-boundary flow. Wetland parks emphasize the protection of wetland ecosystems, especially

the wetlands in static condition, not valuing rivers' natural values and free-flowing condition. Water parks regard water bodies, landscape, culture, and hydraulic engineering as objects of protection, undervaluing the natural condition and free-flowing condition of rivers.

Protected areas also have different legal bases in China and the United States. Nature reserves and National parks in China are based on federal regulations, while wetland parks and water parks are based on departmental rules. The US WSRS management, however, is based on one specific law with a clearly stated intent and methods of protection. Management methods are very different in China and the United States. The US WSRS has been implemented in an open management way reflected in three unique aspects – valuing diversity and coordination of management, community participation and input, and self-management, sometimes by nonfederal authorities, which is very different from the closed management model of most of CNPAS.

Feasibility of a National Protected River System

Conditions of China's river resources are threatened with continuous deterioration; however, there is an awakening on environmental protection awareness occurring, financial support for protecting rivers is now feasible, and the efficiency of the government to protect resources could contribute to the feasibility of establishing a national protected river system.

Abundant River Resources

According to the River Survey in 2011, in China there are 22,909 rivers with basin areas totaling more than 100 km² each (39 miles²)

(Ministry of Water Resources 2013). The neotectonic movement since the Quaternary glacial period has created three natural geographical regions in China, higher in the west and lower in the east like a three-step ladder: Qinghai-Tibet Plateau on the first step, large basins and plateaus on the second step, and broad plains dotted with the foothills and lower mountains on the third step. When rivers flow through these different natural geographical regions, a variety of river environments and cultural meanings are shaped. The multiplex aspect of river succession characteristics and ecological function breeds rich and colorful river cultural values. The Yangtze River, for example, flows through the Qinghai-Tibet Plateau, Southwest Mountainous Region, Sichuan Basin, central hills, and middle-downriver plain, forming three types of civilization – nomadic, agricultural, and ocean – with diversity of local culture – Tibetan culture, Bashu culture, Chu culture, and Wu Yue culture.

Awakening Environmental Awareness

Since the beginning of the 21st century, environmental awareness has been increasing in China. In response, the central government has formed some unique initiatives with accompanying slogans, such as “Scenery of green mountains and green water is like mountains of gold and mountains of silver,” “To protect the environment is to protect productivity, and to improve the environment is to boost productivity.” To protect the rivers and lakes, the central government proposed “Let eroding rivers rehabilitate” in 2009. In March 2015, the MEP stopped the Xiaonanhai hydropower project on the Yangtze River in Chongqing. In January 2016, President Xi

Jinping put forward the idea of “No for great development, Yes for great protection of Yangtze River” during a conference about the development of the Yangtze River’s Economic Zone (Zhou 2016). In 2016, the United Nations Environment Program issued a report on China’s strategy and action promoting an ecological civilization. According to the document, ecological civilization in China is considered a beneficial endeavor and practice for sustainable development, which sets a good example for other countries facing similar economic, environmental, and social challenges (United Nations Environment Program 2016).

The ecological civilization initiative is having an important influence on local conservation. Sichuan province has put forward plans for ecological defense of the upper reaches of the Yangtze River. Yunnan province has proposed to become the “vanguard of ecological civilization.” Guizhou province has proposed more protection for the ecological defense of the Yangtze and Pearl Rivers. Qinghai, Fujian, and other provinces have already begun to put a stop to small hydropower station projects. Hubei province, which is famous for thousands of lakes, began to implement the “retreat and return farmland to lake” project. These provinces are putting production space and living space back into ecological space.

Nongovernmental organizations (NGOs) have also become important forces for protecting the environment. Since the establishment of the Chinese Society for Environmental Science in 1978, the number of environmental NGOs in China has grown. The Nature Conservancy, which entered China in 1998, established freshwater protection projects to find effective solutions for maintaining the balance between human development and

water resources protection. A typical NGO river protection example is the “Nu River hydropower contention” activity. Resistance by NGOs successfully delayed a hydropower project on the Nu River (upper reaches of the Irrawaddy River), which is one of two ecologically pristine rivers in China (the other one is the Yarlung Zangbo River, Brahmaputra) (Hong 2007). From 2003 to 2014, there were thousands of public hot spots over environment protection in China, and the People’s Court handed down more than 10,000 judgments related to environmental protection. MEP has handled 275 major environmental incidents during 2014 and 2015 alone.

Strong Potential Financial Support

Since 1978, China’s GDP annual growth rate averaged 9.7%; the GDP in 2015 was 67.67 trillion RMB (about 10.15 trillion USD). The Chinese government’s environmental investment is also increasing year by year. In 1999, the environmental investment was 82 billion RMB, and it was the first time it reached 1% of the GDP. In 2006, environmental investment was formally brought into the central budget. The expenditure

for environmental protection was 99.56 billion RMB in 2007, which has been increased annually (Figure 1).

China invested 50 billion RMB to protect 30 lakes during “12th Five-Year” period, and plans to invest 100 billion RMB to protect high-quality ecological lakes that have areas of more than 50 km² (19 miles²) (Ministry of Environmental Protection 2014). In addition, the Chinese government plans to invest more than 2 trillion RMB for water pollution control (State Council of PRC 2014).

Efficiency of Government

China has formulated a series of positive ecological policies in recent years with the intent of efficient policing of implementation. In 2012, the ecological civilization initiative was incorporated into China’s overall development plan. In November 2013, the Third Plenary Session of the 18th CPC Central Committee clearly indicated commitment to the ecological civilization objective; the CPC Central Committee and State Council issued the “Opinion of Accelerating the Construction of Ecological Civilization,” “Ecological Civilization Reform Over Planning,”

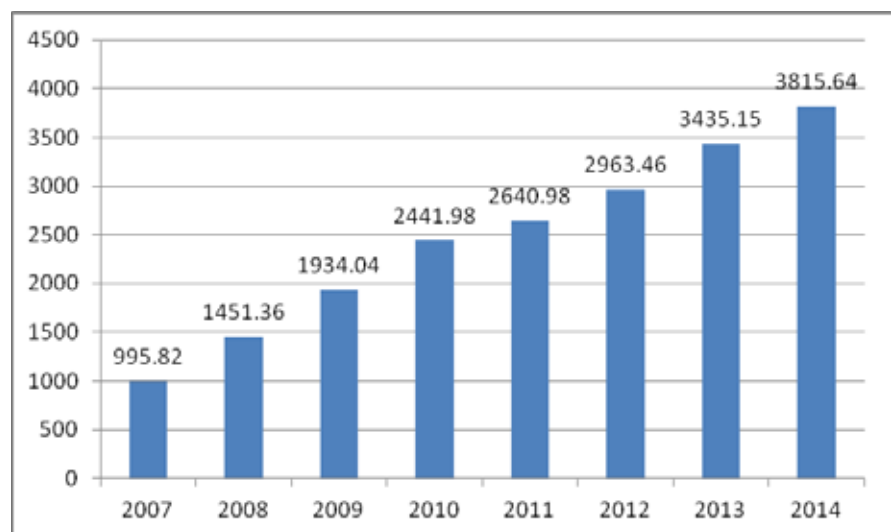


Figure 1 – The national fiscal expenditure on environment protection during 2007–2014 (unit: ¥ Billion) (www.worldbank.org)

“The Action Plan for Prevention and Treatment of Water Pollution,” “The Action Plan for Prevention and Treatment of Air Pollution,” and other special planning initiatives aimed at efficiency in promoting ecological progress.

The “River Chief System” is another new initiative, aimed at efficiency in protecting water resources, preventing water pollution, improving water quality, and restoring water ecological systems, initiated by the Chinese government in December 2016. China will set up a sound nationwide river chief system by the end of 2018. According to the policy, China will establish provincial, municipal, county-, and township-level river chief systems, and appoint heads of local government at various levels as river chiefs. It is going to build a mechanism where responsibility is clear, coordination is orderly, regulation is strict, and protection is effective. The aim of this policy is to manage and protect rivers and lakes, maintain their ecological health, and achieve their sustainable utilization.

The Path to a National Protected Rivers System

Based on realities in China, a NPRS must be built on a new ideology for river protection, respond to the need for innovative management, and implement research to inventory resources and define priorities in protection and threats to combat.

A New River Protection Ideology

For sustainable development and recognition of rivers’ multidimensional values, a NPRS should regard rivers as an important element of China’s heritage and landscape and emphasize “Protection should be first, and then appropriate usage comes.”

1. Important rivers should be free-flowing (Figure 2). This is an important concept of the “wild river” aspect of the US WSRS. A free-flowing condition allows self-restoration and rehabilitation of river ecosystems and is the basis for protection of rivers’ other values. Keeping the river free-flowing is showing respect for a river’s right to be healthy. A NPRS in China should be based on this philosophy, highlighting the importance of rivers’ free-flowing attributes, strictly limiting projects that would impact the free flow of protected rivers.

Dams are one of the most essential factors of river ecosystem degradation, which have blocked both the free flow of many rivers and the natural circulation of ecological systems, and reduced heterogeneity and biodiversity. According to statistics of the International Commission on Large Dams in 2015, the number of dams in China that are 15 meters (49 feet) high or greater accounts for 41%

of the world’s inventory. The number of dams in China ranks first in the world and is 2.6 times the number in the United States (which is second). The Yangtze River is the largest river in China, and contains 19,426 hydro-power stations (by 2011).

2. Identify and protect outstanding values of rivers. The history and culture of China are closely related to its rivers and lakes. Rivers and lakes have fostered development of many watery towns in the southern Yangtze River Basin, and in both urban and rural areas in the middle and west regions.

The NPRS could be classified into three categories: natural, cultural, and mixed. The rivers with outstanding natural values and intact ecosystems can be the potential natural rivers; some rivers with less outstanding natural values but with rich historical and cultural meanings can potentially be cultural rivers; and rivers of both natural and cultural importance can be potential mixed rivers.



Figure 2 – Important rivers should be free-flowing. Qinzhu River, Sichuan Province. Photo by Peng Li.

3. Adhere to the principle of appropriate utilization of rivers. The tension between humans and land in China is intense and historical. A NPRS cannot deprive surrounding residents of living space, but it should contribute to a harmonious relationship between humans and the environment. Even for protection, NPRS can't deprive residents of their right to survive and develop and force them to leave their home where they have lived for generations. The residents should be included in protection planning and be primary beneficiaries of environmental education and ecological compensation measures.

To control flood disaster, but make full use of river function, such as for irrigation and navigation, channelization has been applied to many rivers. For example, the Yellow River, Jinsha River, Minjiang River, Dadu River, Yalong River, and Lancang River have all been channelized. This channelization eliminates natural curving, narrowing riverbeds, and solidifying the riverbanks, and is indeed beneficial to controlling the river, but it also brings a series of adverse effects. The beautiful natural landscape of many rivers has been destroyed; riverbed erosion is aggravated, influencing the stability of riverbanks; and finally, destroying natural circulation occurs along three-dimensions (underground, surface, and overhead) (Dudley 2013), causing further damage to river ecosystems.

NRPS should adhere to the principle of protect first, and then appropriate usage comes. All development projects that could impact protected rivers should require an environmental impact assessment

before approval. Any projects that would damage the outstanding values and free-flowing condition of a protected river should be prohibited. Next, agricultural and industrial activities within the critical parts of National Protected Rivers should be reduced or even prohibited. Eco-tourism can be supported to achieve optimization of benefits for protection and utilization.

Need for Innovative Management

According to the IUCN (International Union for the Conservation of Nature) principle of "good governance of a protected area," the deficiencies of the management system of China's existing protected areas exist in four aspects: legality, decentralization, fairness, and responsibility. The current protected area legal system does not represent the national will, the responsibility of the management agency is usually not clearly determined, and the relationships between protected areas and local residents are not clearly defined or respected. These are key issues to be addressed to perfect China's protected area system. In recent years, China has gradually accepted a more restrictive, nature-based model for a National Park System, and is exploring its possible expansion. The National Park System will remain a centralized management model. The management system of WSRS, however, needs to be more flexible, primarily due to flow across multiple jurisdictions. Innovations achieved in establishing a National Protected Rivers System should avoid deficiencies of the existing protected areas system.

The US WSRS' ownership, management agencies, and sources of funding are diverse. While most protected rivers are managed by the federal, state, and local governments,

some are in private hands. Shared management is a novel system worth study and application in China. In the United States, WSRS respects original ownership and tries not to change ownership, management rights, and usage rights. An NPRS in China can both represent China's people's needs and coordinate multiagency projects, abandoning the method of dividing responsibilities according to natural resource elements, redefining the scope of management based on land management purpose, and improving management efficiency.

An NPRS can be combined with the river chief system. It is a comprehensive watershed governance model with Chinese characteristics, and the heads of government at various levels are appointed as river chiefs. At present, the river chief system is mainly implemented in densely populated areas, such as the Tai Lake Basin in Jiangsu province and Hai River Basin in Tianjin province. It is also used most when protecting water and preventing water pollution. However, it has rarely been applied to rivers with little human interference. Based on the participation of community and protected area governance agencies, separated governance could be integrated through the river chief system, thus improving the efficiency and effectiveness of river protection.

Scientific Research and Inventory

Scientific research is the foundation of a protected areas system. Research to support designation of protected areas commonly start with the questions, "What should be protected?," "Where should it be protected?," and "What are the threats?" (Primack 2010). Research is a key element in these decisions.

1. During the early exploration period, studies are needed to

define outstanding values and suggest how to protect them. The connection between rivers and regional and local populations, as well as larger basin ecosystems, needs to be determined to understand exactly what the outstanding values are that will decide whether a specific river will be protected and how to protect it. Whether it is protected for cultural values, biophysical attributes, or a mix must be determined and specified. Once protection priorities are understood, additional study is necessary to determine the primary threats, under management control, that should be priorities for an innovative management system.

2. Protected areas related to water involve hydrographic features, vertical and horizontal connection with other watersheds, and so forth, so the boundaries and management tend to be complicated. In some cases, important characteristics to be protected could range a considerable distance from the river's banks (for instance, if wildlife corridors or endangered species protection are among the outstanding values justifying protection). In other cases, with adjacent development, very narrow corridors may be acceptable. Economic dependencies, potential recreation uses, and industrial dependencies should be considered along with aesthetic and hydrologic attributes before proposal for protection and specifying innovative management direction.

Conclusion

The ecological civilization initiative provides some guidance for NPRS establishment in China, but the

NPRS necessarily involves a blending of politics, economics, ecology, and sociology. Therefore, this is a process with numerous shareholders competing and collaborating with each other, and it will be a long and difficult way. However, if all forces from society recognize the future benefits of protected rivers, are willing to give up some short-term benefits for long-term quality of the environment and life, and forfeit some local interest for national progress, a coordinated river protection system will become a reality to the benefit of today's China and our future.

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Book Reviews

JOHN SHULTIS, BOOK REVIEW EDITOR

Wild and Scenic Rivers: An American Legacy

By Tim Palmer. 2017. Oregon State University Press. 256 pp. \$45.00 (hc).

This book is a welcome celebration of the 50th anniversary of the Wild and Scenic Rivers Act passed in 1968. Palmer notes that the anniversary “invites everyone to consider, appreciate, and celebrate our collective determination to save the nation’s finest free-flowing waters so that future generations may know them as well” (p. 2). Palmer believes reviewing the history of river conservation in America “can help guide us to the future” and providing a large collection of wonderful images of American rivers “can inspire us to care more deeply for these arteries of nature” (p. 2).

As reviewed in his article in this special issue, Palmer’s historical analysis highlights how extremely passionate, dedicated people managed to battle the formidable pressures to develop these rivers: “Every stream in the wild and scenic system was added because people were motivated to save their waterway, if not from the explicit threat of a dam that would completely bury their place under a reservoir, then from strip mining, clear-cutting, or overdevelopment” (p. 8). Palmer’s analysis also highlights the importance of politics and politicians in safeguarding American rivers. Like all environmental issues, at first they received bipartisan support – the act passed the Senate 84–0 and the House 265–7 in 1968 – but the “polarization by party increased dramatically after 1994” (p. 56), with little if any Republican support for river conservation after this date.

This is only one of many challenges that Palmer identifies. For example, while the number of rivers and streams protected by the act has continued to grow over time, “the number of long reaches has not (p. 56)... Simply a glance at a map of the wild and scenic rivers system shows

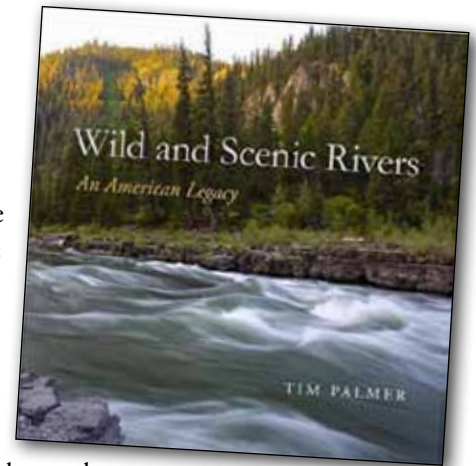
that most of the designated streams are extremely short and not representative of whole rivers” (p. 57). The overall size of the

national system is also problematic, as the 13,000 miles (20,921 km) of designated wild and scenic rivers conserve only 0.4% of the total length of all perennial rivers and streams.

While providing a similar amount of mileage of rivers and streams as the national system, the quality and quantity of state protection varies significantly, so “it appears that most state river programs offer undependable paths toward permanent protection” (p. 201). The National Wild and Scenic Rivers Act remains the flagship program for protecting waterways in the United States.

Palmer’s engaging text and images provide proof that, while additional challenges will certainly appear downstream (e.g., climate change), after 50 years “of both passion and persistence, both labor and luck” (p. 211), the national wild and scenic rivers have managed to protect some of the best remaining natural rivers and streams across America, representing an important chapter in the environmental history of America.

REVIEWED BY JOHN SHULTIS, book review editor for the *IJW* and associate professor, Ecosystem Science and Management Program, University of Northern British Columbia, Canada; email: john.shultis@unbc.ca.



Appendix I. List of Species referenced in the article and their common and scientific names		
Taxonomic Category	Common Name	Scientific Name
Birds	Peregrine falcon	<i>Falco peregrinus</i>
	Bald eagle	<i>Haliaeetus leucocephalus</i>
Crustaceans	Filter-feeding shrimp, Guabara	<i>Atya innocuous</i>
	Filter-feeding shrimp, Gata	<i>A. lanipes</i>
	Filter-feeding shrimp	<i>A. scabra</i>
	Freshwater and riparian crab, Buruquena	<i>Epilobocera sinuatifrons</i>
	Predatory/omnivorous shrimp	<i>Macrobrachium acanthurus</i>
	Predatory/omnivorous shrimp, Bocú	<i>M. carcinus</i>
	Predatory/omnivorous shrimp	<i>M. crenulatum</i>
	Predatory/omnivorous shrimp	<i>M. faustinum</i>
	Predatory/omnivorous shrimp, Zurdo	<i>M. heterochirus</i>
	Filter-feeding shrimp	<i>Micratya poeyis</i>
Shredder shrimp, Salpiche	<i>Xiphocaris elongata</i>	
Fishes	Atlantic salmon	<i>Salmo salar</i>
	Chinook salmon	<i>Oncorhynchus tshawytscha</i>
	Chum salmon	<i>O. keta</i>
	Coho salmon	<i>O. kisutch</i>
	Pink salmon	<i>O. gorbuscha</i>
	Sockeye salmon	<i>O. nerka</i>
	Summer steelhead	<i>O. mykiss</i>
	Algivorous goby, Sirajo, Chupapiedra	<i>Sycidium plumieri, Sycidium spp.</i>
	American eel	<i>Anguilla rostrata</i>
	Eleotrid, Big-mouth sleeper, Guavina	<i>Gobiomorus dormitor</i>
	Eleotrid, Spinycheek sleeper	<i>Eleotris pisonis, E. perniger</i>
	Freshwater mullet, Dajao	<i>Agonostomus monticolus</i>
	Omnivorous/predatory gobid, Saga	<i>Awaous taiasica</i>
Gastropod	Diadromous snails, Burgao	<i>Neritina spp.</i>
Mammals	Gray wolf	<i>Canis lupus</i>
	Grizzly bear	<i>Ursus arctos horribilis</i>
Plant	Tamarisk	<i>Tamarix spp.</i>

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