Photo credit: R. Medel

FEATURE

Socioeconomic Benefits of Recreational, Commercial, and Subsistence Fishing Associated with National Forests

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The socioeconomic benefits of recreational, commercial, and subsistence fishing associated with lands managed by the U.S. Forest Service are substantial and are expected to increase over time. Recreational fishing on national forests and grasslands generate over US$2.2 billion annually through fishing equipment, boats, travel, outfitter and guiding services, fuel, and licenses, which in turn provide critical funding for fisheries habitat management and conservation by federal and state agencies. The sustainable nature of recreational fishing by the public complements the agency's multiple use mandate to conserve fish and aquatic resources, which include a high percentage of the nation's threatened, endangered, and sensitive fish and aquatic species. National forests in the Pacific Northwest and the western USA, particularly Alaska, support significant commercial and subsistence salmon fisheries. A growing restoration economy associated with fisheries habitat and watershed restoration contributes to local economies. Although more difficult to quantify, important social and cultural benefits of fishing are provided to the public nationwide, including connecting the public to the outdoors and to public lands. Managing fisheries habitat and watershed health amid competing demands for water, natural resources, and outdoor recreation will continue to challenge the U.S. Forest Service and its partners into the future.

The U.S. Forest Service (USFS) has a history of protecting water and managing resources dating to the agency's inception (Shively et al. 2018, this issue). In 1897, the U.S. Congress sought to create, protect, and care for the nation's forest reserves by passing the Organic Administration Act; in 1905, the USFS was established via the Transfer Act. Forest reserves were created "to improve and protect the forest within the reservation, or for securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States" (Organic Administration Act of 1897). Since its inception, the USFS has sought to balance the delivery of drinking water from the National Forest System, which provides about 20% of all fresh water in the USA, with the provision of sustainable timber, fish and wildlife, oil and gas, mining, and grazing activities as well as an immense and growing outdoor recreation industry. The USFS is charged with sustainably managing these multiple resources and uses while protecting diverse habitats, which contain some of the nation's healthiest, intact aquatic ecosystems (Roper et al. 2018, this issue). The management and protection of healthy aquatic habitat, coupled with clean and abundant water resources and public accessibility to more than 354,056 km (220,000 mi) of fishable rivers and streams and 4 million ha (10 million acres) of lakes, form the foundation for socioeconomic benefits through recreational, commercial, and subsistence fishing.

RECREATIONAL FISHING ON NATIONAL FOREST SYSTEM LANDS

Recreational fishing is one of the most popular outdoor activities in the United States (Cordell 2012; USFS 2012), and national forests and grasslands play a major role in meeting this demand (ASA 2007; USFWS 2017). Fishing provides food, relaxation, and quality time with friends and family as well as providing physical and mental health benefits (Louv 2005; see Figure 1). The purchase of licenses, tackle, and boat fuel as part of recreating outdoors through fishing and boating is critical for state and federal conservation work, contributing the largest source of funding for habitat enhancement and for the protection and management of fishing habitat (Responsive Management and Southwick Associates 2012).

About 13% of the U.S. adult population goes fishing each year (USFWS and U.S. Census Bureau 2012). The percentage may be higher due to the fact that not all who consider themselves anglers participate every year. Although many other activities compete for people's time, anglers generally prefer outdoor to indoor activities (Responsive Management and Southwick Associates 2012). In an extensive study using multiple data sources, Pergams and Zaradic (2008) found that after 50 years of steady increases in people using public lands for outdoor recreation, including freshwater fishing, per capita visits to U.S. public lands have declined since 1987. Villamagna et al. (2014) reported that between 2006 and 2011, participation in freshwater fishing nationwide increased by 8%, while the U.S. Fish and Wildlife Service (USWFS) and the U.S. Census Bureau reported an 11% increase for the same period (USFWS and U.S. Census Bureau 2012). Figure 2 displays the general trends for fishing participation (rate, total participants, and total number of days) relative to hunting and wildlife viewing since 1991. The data indicate an 8% increase in angling participation since 2011: from 33.1 million anglers to 35.8 million anglers in 2016. The greatest increase in participation (10%) was seen in the Great Lakes area (USFWS 2017).

Although the fishing participation trends and projections cited above are national and unrestricted to public lands, we expect recreational angling on public lands, including national forests and grasslands, to generally follow the same patterns. Participation in recreational fishing varies geographically by population density, socioeconomic status, gender, race, personal values, and cultural preferences (Bowker et al. 2012). As these factors change along with population growth, future fishing participation is expected to change as well. Both nationally and regionally, the fishing participation rate is projected to decline in the future, but the total number of participants and the number of annual angling days are expected to increase (USFS 2016). Figure 3 displays projected fishing

Figure 1. Recreational fishing on Granite Creek in the Bridger-Teton National Forest, Wyoming. Photo credit: D. Deiter.

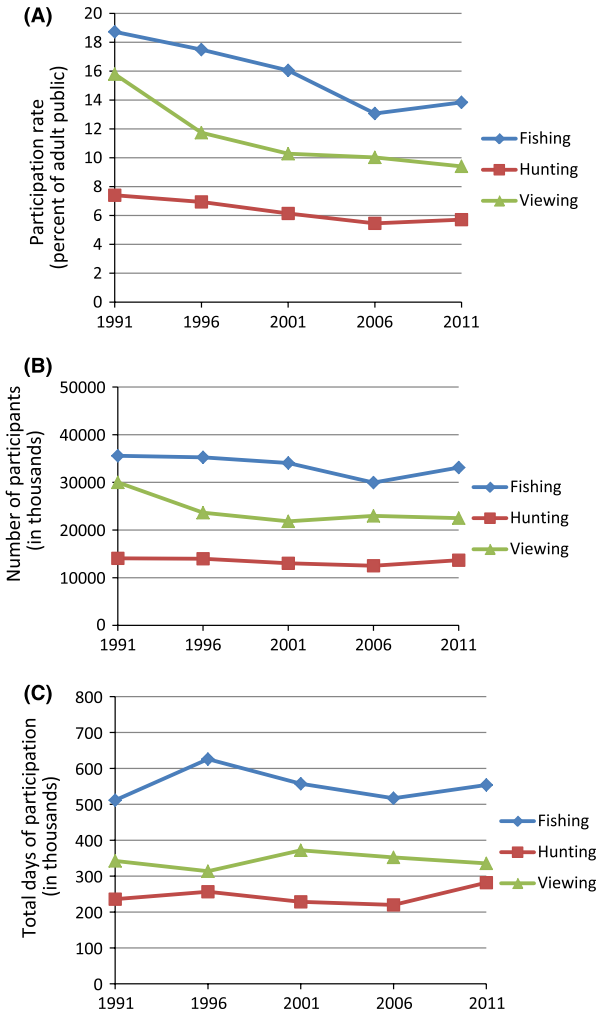

Figure 2. The (A) participation rate, (B) number of participants, and (C) total days of participation for fishing, hunting, and wildlife viewing from 1991 to 2011, based on data from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation (adapted from Mockrin et al. 2016).

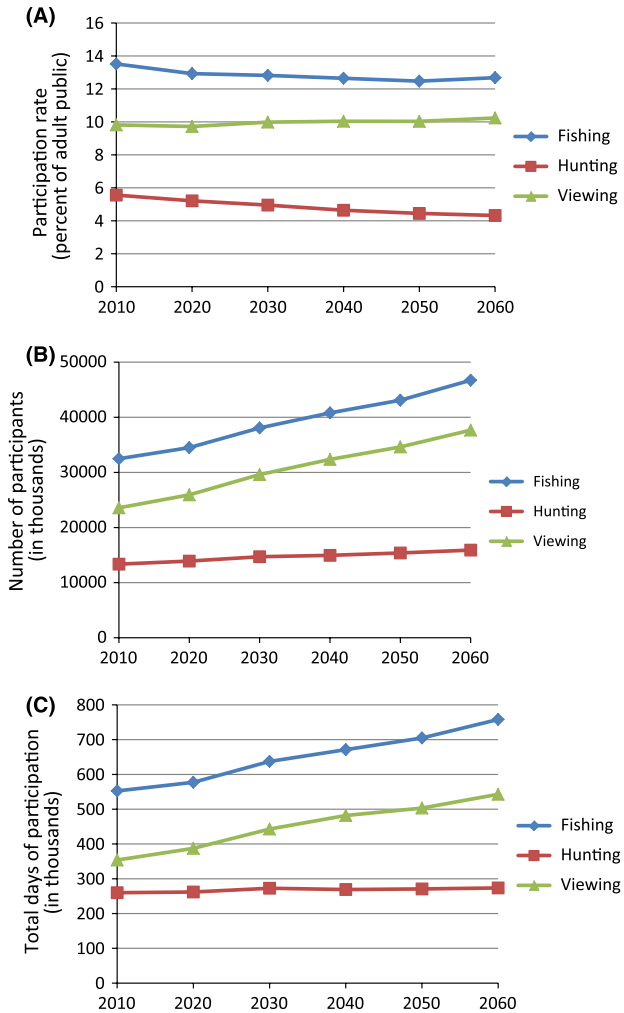

Figure 3. Projected (A) participation rate, (B) number of participants, and (C) total days of participation for fishing, hunting, and wildlife viewing from 2010 to 2060 (adapted from Mockrin et al. 2016).

participation relative to hunting and wildlife viewing through the year 2060.

Economic expenditures for recreational angling and related activities on National Forest System waters are significant. Americans spent more than US$41billion on fishing-related equipment, licenses, transportation, and other services in 2011 (USFWS and U.S. Census Bureau 2012). Total expenditures by anglers nationwide rose 2% from $45 billion in 2011 to $46.1 billion in 2016. In 2011, 33.1 million people at least 16 years old fished, and they spent $41.8 billion on fishing activities. As might be expected, the USFWS and U.S. Census Bureau (2012) survey found that there was a considerable overlap between recreational anglers, hunters, and wildlife watchers. In 2011, 69% of hunters fished, and 28% of anglers hunted. In addition, 51% of anglers watched wildlife, 57% of hunters watched wildlife, and 29% of all wildlife watchers reported hunting and/or fishing during the year (USFWS and U.S. Census Bureau 2012). A focused 2007 study by the American Sportfishing Association reported that anglers annually spent $592 million within 80.5 km (50 mi) of USFS lands, and these expenditures supported 14,500 jobs (ASA 2007). This economic contribution study was based on USFS National Visitor Use Monitoring data collected between 2000 and 2003. By including expenditures made in-state on angling activities, economic contributions by people fishing on USFS lands increased to $2.2 billion per year and supported 57,700 jobs (ASA 2007).

White et al. (2016) summarized over 52 years of literature on the net economic value of outdoor recreation on public lands and provided a net willingness to pay or consumer surplus for recreational activities at the national level. Government benefit–cost guidelines (U.S. Water Resources Council 1983) define economic value as visitors' net willingness to pay or consumer surplus (Freeman 1993). White et al. (2016) calculated a mean consumer surplus of $75.34 per person per day for fishing, nationwide, from 1958 to 2015. The value of "economic benefit" for recreational fishing on National Forest System land was estimated at $1.35 billion (Rosenberger et al. 2017).

Many famous, highly sought-after fisheries are located on National Forest System lands and support robust recreational sportfishing and guide and outfitter economies. The agency issues thousands of special use permits annually to guides and

CULTURAL VALUE: CASE STUDY

A long history of land use throughout the John Day River watershed (timber harvest, road construction, livestock grazing, wildfire suppression, beaver trapping, and mining) has led to a highly disturbed aquatic ecosystem. Given the severity of disturbance and sensing the opportunity for improvement, the Confederated Tribes of the Warm Springs Reservation of Oregon coordinated the multi-partner, multi-year John Day Watershed Restoration Program to improve conditions for federally threatened and endangered fish species, including the middle Columbia River steelhead *Oncorhynchus mykiss*, Columbia River Bull Trout *Salvelinus confluentus*, and John Day basin spring Chinook Salmon *O. tshawytscha*.

The Tribes' Fisheries Program Mission is deeply embedded as part of their cultural heritage: "to provide fisheries populations at harvestable levels, allowing opportunities for tribal members to exercise their treaty rights of harvest using information gained from research, management and habitat programs within the Natural Resources branch." The Tribes have worked closely with the Malheur National Forest and a number of other entities, including the Bonneville Power Administration, Bureau of Reclamation, U.S. Fish and Wildlife Service, Oregon Watershed Enhancement Board, Oregon Department of Fish and Wildlife, National Oceanic and Atmospheric Administration, and The Nature Conservancy, to remove barriers to fish passage; increase the instream flow of water; improve water quality and stream channels through updating irrigation systems, riparian fencing, and planting; eradicating noxious weeds; and reconnecting historic aquatic habitat. In partnership, the Tribes and the Malheur National Forest were able to come to a shared understanding about desired future conditions to improve habitat for the highly valued fish species and build a strategic long-term plan that aligns elements of both tribal and national forest objectives. The hundreds of projects already completed utilize local crews to accomplish activities and continue to educate local communities on the benefits of watershed restoration.

Videos on the Oxbow Dredge Mining Restoration Project are available at: (https://www.youtube.com/watch?v=3DcGA4kOBz8 and Náimuni: Connecting Oxbow Conservation Area).

outfitters who fish on national forests and grasslands (USFS 2016). It is widely recognized that USFS lands are home to 60% of the Columbia basin salmon habitat, for example, as well as thousands of kilometers of "blue ribbon" and other specially designated trout waters (TRCP 2017). In southeast Alaska, world-class ocean, estuarine, and freshwater fisheries support a destination sportfishing and charter industry, where two of every three harvested fish are salmon. The salmon fishery supported an estimated total of $358.7 million in southeast Alaska sportfishing revenues during 2007 (TWC Economics 2010).

In addition to direct economic benefits to local communities, recreational fishing provides a variety of personal benefits as well as support for the agency and public lands. Because environmentally responsible behavior results from direct contact with the environment (Hungerford and Volk 1990), it is argued that people must be exposed to natural areas as children if they are to value and care about them as adults (Duda et al. 1998; Louv 2005).

COMMERCIAL FISHERIES BENEFITS

While most efforts to define fisheries resource outputs from National Forest System lands have focused on "indirect" outputs and values, such as sport fish guiding, license fees, and other recreation-associated activities, the Tongass National Forest in the USFS' Alaska Region provides an accountable, direct example of commercial fisheries outputs associated with the production and harvest of wild Pacific salmon *Oncorhynchus* spp. (Figure 4). The Tongass National Forest is charged with the protection, maintenance, and restoration (as needed) of the 25,370 km (15,764 mi) of streams and rivers supporting and producing wild salmon, as well as 83,770 ha (207,000 acres) of lakes and ponds. The Tongass National Forest (nearly 6.9 million ha [17 million acres] in size) and Glacier Bay National Park (1.3 million ha [3.2 million acres]) account for the majority of southeast Alaska's 9.1 million ha (22.5 million acres).

States manage fish and game populations; in Alaska, the Commercial Fisheries Division of the Alaska Department of Fish and Game (ADFG) is charged with the responsibility of managing the state's annual harvest of salmon. Various policies and directives (State Sustainable Salmon Act, USA–Canada Treaty, etc.) require that the state protect the wild stocks, acknowledged as the backbone of the industry. Specific ADFG fisheries studies, which are required to monitor and manage those stocks, have established the general percentages of the hatchery fish versus wild fish components for each of the five salmon species and their contributions to the annual southeast Alaska commercial salmon harvest (TWC Economics 2010). Figure 5 illustrates that of 11 State Commercial Salmon Harvest Management Areas, southeast Alaska produced nearly 34% of Alaska's total harvest (60.1 of 177.9 million salmon) on average from 1994 to 2015, worth an

Figure 4. A successful morning of commercial trolling for Coho Salmon *Oncorhynchus kisutch* on the Tongass National Forest near Ketchikan, Alaska. Photo credit: R. Medel.

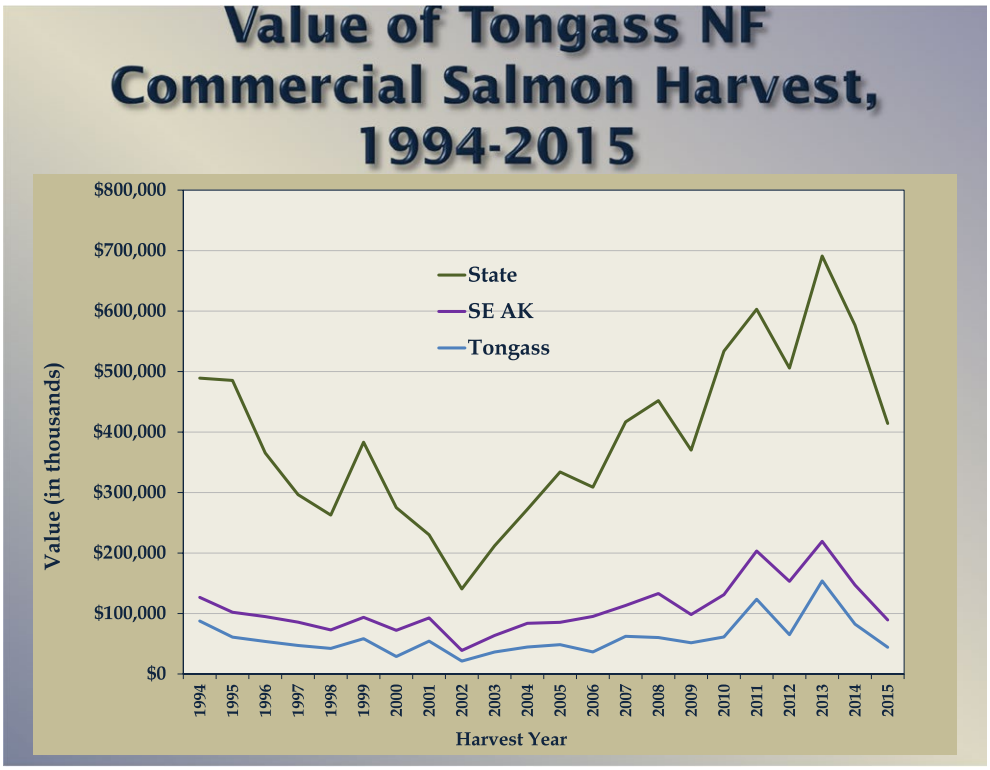

Figure 5. Ex-vessel commercial salmon harvest value of the Tongass National Forest (NF; blue), all of Southeast Alaska (SE AK; purple), and the entire state of Alaska (green), 1994–2015. Figure credit: NPAFC 2016.

annual ex-vessel value (paid to the fishers) of $108.9 million from 2010 to 2014 (NPAFC 2016).

The Tongass National Forest anchors a substantial and increasingly valuable proportion of the commercial salmon economy in Alaska. Using the ADFG study percentage figures for wild versus hatchery fish, direct outputs for both harvest numbers and dollar values associated with the commercial harvest of wild salmon produced from the Tongass National Forest can be calculated and established. For the period 1994–2015, this national forest produced on average about 49 million wild salmon annually, with an average direct value of $100 million paid to fishers (ex-vessel) between 2010 and 2014. The Tongass National Forest provides 28% of the state's annual average harvest of 177.9 million salmon (and 79% of the Southeast Alaska harvest). Alaska's salmon harvest annually comprises over 90% of the entire northeast Pacific salmon harvest (NPAFC 2016). This equates to nearly 25% of the northeast Pacific harvest being wild fish produced from the Tongass National Forest. As for indirect outputs associated with salmon in Southeast Alaska, the commercial salmon fishery supports 1 in 10 jobs (totaling over 4,500), both in direct fishing and in the processing of salmon (TWC Economics 2010).

SUBSISTENCE FISHERIES BENEFITS

Additional benefits derived from fisheries are the more difficult-to-quantify cultural values and intrinsic connections to sacred sites and indigenous ways of life spanning thousands of years. The agency has increased efforts to utilize traditional ecological knowledge in national forest management and monitoring (traditional ecological knowledge was defined by Jim Ransom, director of Tehotiiennawakon, Mohawk Council of Akwesasne, as "a science rooted in our relationship with creation and based on living in peace and harmony with the natural world"). The USFS relies on local tribes to collaborate in aquatic restoration work. Protection of federally listed species that are of tribal importance is frequently the impetus driving these partnerships. Two recipients of the USFS 2016 National Rise to the Future Awards given for outstanding leadership in fisheries and watershed programs reflect the integrated planning and significant ecological and cultural accomplishments achieved through relationships and partnerships with two separate tribal governments: the Confederated Tribes of the Warm Springs Reservation in Oregon (see Case Study) and the Jamestown S'Klallam Tribe in Washington to implement recovery action plans for steelhead *Oncorhynchus mykiss*, Bull Trout *Salvelinus confluentus*, and spring Chinook Salmon *O. tshawytscha.*

National Forest System lands in Alaska provide a unique and central role for Alaska Native and Rural Alaskan communities by supporting subsistence use. Alaska Native communities have relied upon the traditional harvest of wild foods for thousands of years and have passed this way of life, its culture, and its values down through generations. Subsistence fishing is also ingrained in the food culture of many non-Native Alaskans, particularly in rural Alaska, and that of Alaska Native communities (see Figure 6). Subsistence fishing and hunting provide a large share of the food consumed in rural Alaska, and subsistence activities are protected for rural Alaska residents by the Alaska National Interest Lands Conservation Act (ANILCA 1980).

The Chugach and Tongass national forests on the Kenai Peninsula, the Copper River Delta, Prince William Sound, and Southeast Alaska host some of the world's richest fisheries. This dependence on wild resources, including salmon, finfish, and shellfish, is cultural, social, and economic. For both

Figure 6. Subsistence use by Native communities and Rural Alaskans represents a culturally invaluable amenity and way of life: **(A)** Sockeye Salmon *Oncorhynchus nerka* population monitoring at Sitkoh Lake (photo credit: W. Owen); and **(B)** Angoon residents Roger Williams, Sr. and Roger Williams, Jr. seining Sockeye Salmon for a population study at Sitkoh Lake to inform subsistence harvest on the Tongass National Forest. Photo credit: D. Martin.

users, subsistence fishing provides an important protein source with high substitute values, incalculable cultural importance, and a link to a way of life that has vanished in most of the continental United States. The state's rural residents harvest about 19,958 metric tons (22,000 tons) of wild foods each year—an average of 170 kg (375 lb) per person. Fish make up about 60% of this harvest statewide (ADFG 2000). Nowhere else in the United States is there such a heavy reliance upon wild foods.

SOCIAL AND CULTURAL BENEFITS

Aside from the traditional aquatic habitat management and restoration that most people associate with the agency, USFS programs contribute to social well-being in ways that are difficult to quantify but are nonetheless extremely valuable to the American public. Throughout the years, the agency has devoted time and resources to conservation education and public outreach. In 2016, the USFS engaged approximately 490,765 people through conservation education-related events, festivals, underwater fish camera "hits," and various fishing derbies. As demographic shifts bring more people into urban centers, the wilderness and conservation ethic embraced by past generations is likely to evolve. If the public fails to recognize and support the inherent values of natural resource conservation through public land management, the political challenges facing public land managers will intensify. Fishing and related experiences on lakes, rivers, streams, and other water bodies form the foundation of many connections to conservation, tradition, sense of place, and value of public lands. Connecting the American public through a range of real and virtual activities related to fishing should remain an agency priority, especially given the perceived significant lack of opportunities for those in more urbanized areas (Kellert and Case 2017).

In addition to the economic, tribal, and social awareness benefits resulting from healthy aquatic habitat, healthy watersheds and fisheries inspire and draw a new generation of entrepreneurs who simply want to live close to and recreate on public land. A recent analysis undertaken by Headwaters Economics (Rasker 2012) found that western U.S. rural counties with the highest share of federal lands received on average faster population growth, higher rates of employment, and greater personal income growth than their counterparts with the lowest share of federal lands. In general, the counties that experienced rapid economic success benefited from increased recreational spending or attraction of second homeowners and retirees in an increasingly service-based economy (Rasker 2012). This narrative is supported by public polling: a 2010 survey from a bipartisan public opinion research and strategy initiative found that a competitive advantage of the western USA was the unique combination of wide open spaces, scenic vistas, and recreational opportunities alongside vibrant and growing communities connected to larger markets. Connection to natural areas was found to improve quality of life and encourage business establishment; 87% of Americans polled agreed that national parks, forests, monuments, and wildlife areas were an essential part of their state's quality of life (Metz and Weigel 2010).

THE GROWING RESTORATION ECONOMY TARGETING FISHERIES AND WATERSHED HEALTH

Fisheries and aquatic habitat restoration on national forests and grasslands is a key contributor to providing jobs, income, youth development, and training opportunities to local and regional economies. Aggregating the various types of economic activity associated with the restoration economy, including professional engineering design, construction equipment operation, and manual labor activities, enables economists to quantify economic impact in retrospective analyses (BenDor et al. 2015). A University of Oregon study found that between 2001 and 2010, 3,288 stream kilometers (2,043 stream miles) of fish passage, 1,033 km (642 mi) of

instream habitat, and 3,724 km (2,314 mi) of riparian habitat restoration accounted for approximately $200 million in contracting dollars, resulting in an estimated $404 million of stimulated economic activity (Nielson-Pincus and Moseley 2010). Generated industrial activities reflect an almost 2 : 1 return on investment, representing a larger sector share of state economic contribution than transportation, renewable energy, building retrofits, or coal, oil, or natural gas extraction (jobs per million dollars invested; Kellon and Hesselgrave 2014). On a more site-specific scale, Headwaters Economics (Alexander et al. 2014) modeled impacts from 140 restoration projects spanning 2008–2013 in a two-county study area in Idaho. A majority of these projects were focused on riparian and fish habitat restoration (endangered species recovery, wetland protection from grazing impacts, stream protection, erosion control, mine reclamation, etc.). On average, the $6.8 million spent on these projects resulted in approximately 70 jobs and over $9 million in total economic activity stimulated from jobs and associated business spending (Alexander et al. 2014).

Fisheries and aquatic habitat restoration can provide both ecological and economic benefits over time (Figure 7). Aquatic organism passage projects using the stream simulation design approach to eliminate barriers to movements by fish and other aquatic organisms at road–stream crossings have been proven to provide road infrastructure, property, and water quality benefits by surviving large flood events without maintenance needs (Gillespie et al. 2014). Up-front investments in upgrading culverts can result in avoided costs of $40,000–500,000 per unit due to continued maintenance and flood risk. Similarly, the costs of dam removal to ensure aquatic connectivity have been shown to generate savings of 30–400% over a 30-year life span compared to continued upgrades and maintenance (MDFG 2015) while eliminating the safety risk of a catastrophic dam failure.

Figure 7. A partnership between Trout Unlimited and the Pisgah National Forest, North Carolina, to replace an undersized culvert (upper panel) with a flood-resilient bridge (lower panel) restored aquatic connectivity on Revels Prong and socioeconomic benefits to the local community. Photo credits: Trout Unlimited.

As the demand for sustainably managed and commercially harvested salmon in Alaska continue to grow, economists are developing increasingly refined methods to quantitatively evaluate traditional and more innovative socioeconomic values. These multiple benefits associated with fisheries, aquatic habitat, clean water, resilient watersheds, and ecosystem services will all increase the socioeconomic valuation and recognition of the importance of fishing and fisheries on national forests and grasslands over time. Managing fisheries habitat and watershed health amid competing demands for water, natural resources, and outdoor recreation will challenge the USFS. Meeting these demands will spur the agency's continued evolution in terms of how it achieves its mandate for multiple use and how it meets its conservation legacy into the future as described by Gifford Pinchot, the first chief of the USFS: "to provide the greatest good for the greatest number in the long run."

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