

FEATURE

Historical Perspectives and a New U.S. Forest Service Strategy for Fish and Aquatic Stewardship

Photo credit: USDA/USFS, *Rise to the Future: National Fish and Aquatic Strategy*, USFS Publication FS-1100b, November 2017.



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The U.S. Forest Service has a long, rich history of helping to steward the nation's fish and aquatic resources and contributing to the broader fish and aquatic conservation and scientific community in the United States and worldwide. The agency recently updated its national strategy for fish and aquatic resource stewardship. The new strategy builds on 30 years of lessons learned through implementing the agency's original *Rise to the Future: National Fish and Aquatic Strategy*, the first national freshwater fisheries strategy by a federal agency. It also addresses 21st century challenges, establishing a stronger foundation for integrated aquatic resource stewardship throughout the agency and renewing an emphasis on cooperation with local, state, federal, and tribal governments and partnering with nongovernmental organizations, private landowners and water users, private businesses, the sportfishing industry, and others. The new strategy outlines six goals that provide a robust framework to guide future efforts: (1) conserve fish and aquatic resources; (2) connect people to the outdoors through fishing, boating, and other aquatic activities; (3) strengthen partnerships and work across boundaries; (4) deliver and apply scientific research; (5) build capacity through mentoring and training; and (6) communicate the value of fish and aquatic resources.

IMPORTANCE OF THE U.S. FOREST SERVICE IN CONSERVING THE NATION'S FISH AND AQUATIC RESOURCES

The U.S. Forest Service (USFS) plays a key role in stewardship of fish and aquatic resources and aquatic habitats of the United States. The agency's mission, "to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations," requires conserving the wide range of aquatic ecosystems found in forests and grasslands. The 154 national forests and 20 national grasslands that constitute the 78.1-million-ha (193-million-acre) National Forest System (NFS) contain some of the nation's healthiest and most intact aquatic ecosystems, providing abundant clean water, high-quality fisheries, and aquatic biodiversity strongholds (Figure 1; Roper et al. 2018, this issue). The USFS' mission also extends beyond the NFS boundaries. The agency cooperates closely with states, other federal agencies, and tribal governments; and partners with private landowners and water users, industry, nongovernmental organizations, and others; to sustain all of the nation's forests and grasslands and their associated fisheries and aquatic biodiversity.

The USFS has a mandate to protect water resources. With the passage of the Organic Administration Act (16 U.S. Code, sections 473–478, 479–482, and 551) in 1897, Congress created federal forest reserves "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." Eight years later, in 1905, Congress created the USFS, and the forest reserves were renamed national forests and grasslands. Two key federal laws guide management of national forests and grasslands: the Multiple Use-Sustained Yield Act of 1960 (Public Law 86-517; 16 U.S. Code, sections 528–531), which declares that national forests and grasslands are to be managed to sustain the benefits provided by timber, watersheds, rangelands, fish and wildlife, and outdoor recreation; and the National Forest Management Act of 1976 (Public Law 94-588; 16 U.S. Code, sections 1600–1614), which obligates each national forest or grassland to implement a resource management plan and to sustain the diversity of plants and animals within the planning area as part of the plan's overall multiple-use objectives. Two other federal laws relevant

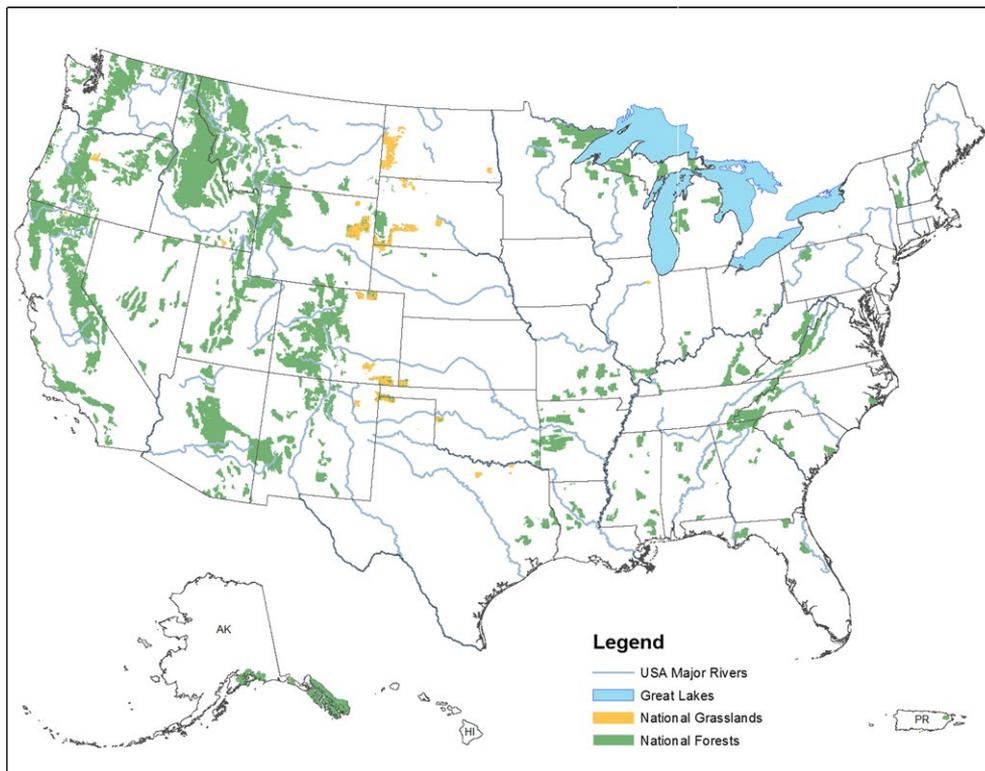


Figure 1. National forests and national grasslands administered by the U.S. Forest Service.

to aquatic species and aquatic ecosystems—the Endangered Species Act of 1973 (Public Law 93-205; 16 U.S. Code, sections 1531–1536, 1538–1540) and the Clean Water Act of 1972 (Public Law 80-845; 33 U.S. Code, sections 1251–1387)—require the USFS to play an important role in protecting threatened and endangered species and in restoring and maintaining the chemical, physical, and biological integrity of aquatic ecosystems. Managing for the sustained provision of multiple natural resources is challenging. The first chief of the USFS, Gifford Pinchot, stated that “where conflicting interests must be reconciled the question will always be decided from the standpoint of the greatest good for the greatest number in the long run” (Pinchot 1906). This ethos continues to guide the USFS today.

The land base, mission, and legislative foundations of the USFS imbue it with substantial authority, responsibility, and opportunity to contribute to the stewardship of fish and aquatic resources nationwide. The agency consists of three primary mission areas that each participate in the stewardship of fish and aquatic resources: NFS, Research and Development (R&D), and State and Private Forestry (S&PF).

Some of the highest quality aquatic habitats in the United States are found within NFS boundaries (Rieman et al. 1997; Reeves et al. 2006; Williams et al. 2011). National forests and grasslands hold more than 354,056 km (220,000 mi) of fishable streams and rivers and more than 4.05 million ha (10 million acres) of fishable lakes and reservoirs. According to the USFS’ most recent estimate (National Visitor Use Monitoring Program 2011–2015), 14.7 million angler visits occur each year on national forests and grasslands. This angling participation generates more than US\$2.2 billion worth of economic activity each year and contributes revenue to state fish and wildlife agencies through license sales and excise taxes levied on fishing and boating equipment and fuel (ASA 2007). These revenues help to fund state fish and wildlife agencies’ work on public access, fisheries management, and habitat restoration. In Southeast Alaska, the Tongass National Forest supports a world-renowned salmon fishery valued at \$986 million annually for recreational, commercial, and culturally important subsistence fisheries, including Chum Salmon *Oncorhynchus keta* hatchery operations (TCW Economics 2010; Fall et al. 2014; ADFG 2016). In fact, aquatic habitats on the Tongass National Forest provide for the natural production of more than one-quarter of Alaska’s annual commercial salmon harvest (USFS 2015; Gillespie et al. 2018, this issue). National forests and grasslands also provide some of the best—and often the only—remaining habitat for imperiled fish and other aquatic species (Roper et al. 2018, this issue).

The R&D mission area employs fish biologists and aquatic ecologists who generate knowledge and tools to inform policy and management activities that affect fish and other aquatic species and their habitats on NFS lands and beyond. U.S. Forest Service scientists have a strong track record of developing and applying innovative methods for studying fishes and aquatic ecosystems at all geographic scales and over long periods of time. Their work has produced crucial insights into the importance of watershed integrity, natural disturbance regimes, habitat complexity and connectivity, and gene flow for the long-term viability of aquatic species (Penaluna et al. 2018, this issue). In recent years, USFS scientists have created user-friendly tools to organize, analyze, and share information about fish habitat and associated watershed characteristics to

improve the cost effectiveness of investments in aquatic stewardship (Isaak et al. 2018, this issue).

The S&PF mission area works in cooperation with state and local governments and partners with nongovernmental organizations to give financial and technical assistance that allows communities and family woodland owners to maintain resilient, healthy forests. Over two-thirds of the nation’s forests are in nonfederal ownership. These 180 million ha (445 million acres) of forest are owned and managed by private individuals and businesses, tribal governments, state and local governments, and nonprofit organizations. Urban and other nonfederal forests yield numerous public benefits, including protecting streams and rivers by intercepting stormwater and reducing pollutant runoff, enhancing fish and aquatic habitat, providing clean and abundant water, and furnishing numerous recreational opportunities. The S&PF mission area is vital to ensuring the health of all forested lands and safeguarding water quality and fish and aquatic resources nationwide. For example, since its establishment in 1990, S&PF’s Forest Legacy Program has conserved more than 68,797 ha (170,000 acres) of lakes and wetlands and more than 5,311 km (3,300 mi) of streams (www.fs.fed.us/spf/coop/programs/loa/flp.shtml).

RETROSPECTIVE LOOK: THE RISE TO THE FUTURE FISHERIES STRATEGY IN THE MID-1980s

Emphasis on fish and aquatic stewardship in the USFS is relatively recent. Throughout the 20th century, the agency primarily focused on multiple-use land management to produce goods, services, and jobs for a growing America. This was especially the case in the post-World War II era, when agency management emphasized logging, grazing, mining, and energy and transportation development (Brouha 1987; USFS 1998), sometimes to the detriment of water quality, fishes and other aquatic organisms, and aquatic habitats (Gregory and Bisson 1997; Warren et al. 2000; Jelks et al. 2008). These legacy impacts still affect many public and private lands collectively (NFHP 2010, 2015). Environmental laws in the 1960s and 1970s, along with litigation and public outcry for increased environmental protections, triggered a period of improved practices and new standards for protection of fish habitat and water quality. During the mid-1980s, the agency recognized the need to increase emphasis on protecting, restoring, and enhancing fish habitat through partnerships. Concurrently, the American Fisheries Society conducted an independent review of the agency’s fisheries program (Brouha 1987). In response, USFS Chief F. Dale Robertson commissioned a national team to increase awareness and delivery of fish and aquatic stewardship across the agency. In 1987, the USFS became the first federal agency to establish a national strategy for fish and aquatic habitat stewardship, including emphasis on ecosystem management and providing for long-term aquatic biodiversity. This strategy was named *Rise to the Future* (Robertson 1988).

Over the last 30 years, guided by *Rise to the Future*, the USFS has increased its emphasis on habitat restoration, connecting people to the outdoors through fishing and other aquatic activities, and science (Box 1). Since 1987, the USFS has restored or enhanced stream and riparian habitat, improving conditions for over 177,028 km (110,000 mi) of rivers and streams (Figure 2) and over 364,217 ha (900,000 acres) of lakes, reservoirs, ponds, and wetlands. In addition, the USFS has made improvements to or eliminated over 8,400

BOX 1
SUMMARY OF 30 YEARS OF KEY U.S. FOREST SERVICE
FISH AND AQUATIC STEWARDSHIP ACCOMPLISHMENTS
UNDER RISE TO THE FUTURE

- Over 177,028 km (110,000 mi) of rivers and streams were restored or enhanced to improve habitat conditions for fish and aquatic resources.
- Over 364,217 ha (900,000 acres) of lakes, reservoirs, ponds, and wetlands were restored or enhanced to improve habitat conditions for fish and aquatic resources.
- Over 8,400 fish passage barriers were improved or eliminated to provide access to historical habitat that was blocked by culverts, dams, tide gates, and other physical impediments.
- Over 1.5 billion impressions made in partnership with Wildlife Forever to raise public awareness about how to prevent the introduction and spread of aquatic invasive species (Wildlife Forever 2014).
- Participation in the development of hundreds of fish and other aquatic species conservation, recovery, and management plans.
- Over 3 million youth were reached through youth fishing events.
- Over 3,000 scientific publications in aquatic ecology and related research, including science delivery support, were generated.

fish passage barriers, providing access to habitat blocked by culverts, dams, and other physical impediments (Figure 3). The agency has become a national leader in aquatic organism passage, working to provide unobstructed movement for all aquatic organisms, not just fishes, as well as sediment and woody material (see www.fs.fed.us/biology/fish/1000-culverts). In the last decade, the USFS developed national design standards for its transportation system, implemented effectiveness monitoring protocols (USFS 2008; Heredia et al. 2015), and provided training in aquatic organism passage to internal and external audiences. The USFS has also contributed to aquatic invasive species management, including detection methods and surveys, public education and outreach, eradication efforts, and installation and staffing of boat inspection stations. Furthermore, the USFS has contributed to and implemented hundreds of fish and other aquatic species conservation, recovery, and management plans, including its own Aquatic Conservation Strategy under the Northwest Forest Plan in Oregon, Washington, and California, establishing a landscape-level strategy for conservation of at-risk fish species (USDA and USDI 1994).

Rise to the Future emphasized cooperating with state fish and wildlife agencies, partnering with nongovernmental organizations, enhancing recreational fishing opportunities, increasing recognition of the economic value of fish and aquatic resources, delivering science and technology for effective fish and aquatic stewardship, and increasing public and stakeholder awareness through outreach, marketing, and workforce

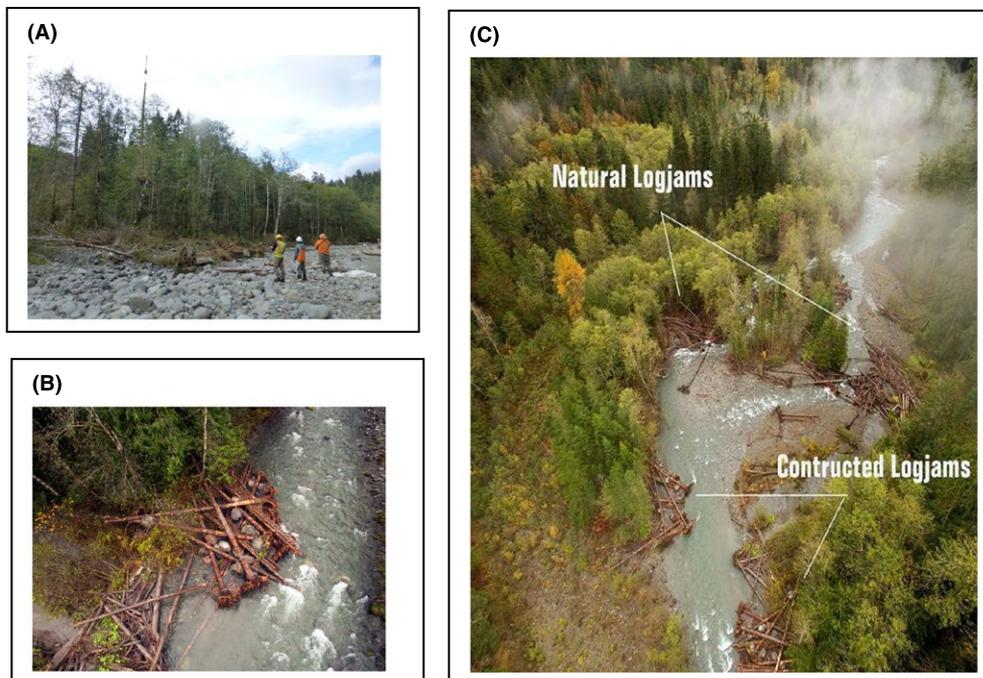


Figure 2. Restoring large wood in rivers and streams improves pool habitat, collection of spawning gravels, and floodplain connectivity, to name just a few of its functions benefiting fish and other aquatic species. The U.S. Forest Service works with many partners both on and adjacent to National Forest System lands to improve habitat conditions for fish conservation and recovery. In 2016, the U.S. Forest Service partnered with the Jamestown S’Klallam Tribe to improve fish habitat on the Gray Wolf River, a tributary to the Dungeness River in Puget Sound, Washington. (A) Large wood was placed by helicopter and (B), (C) was used to construct logjam features along the channel margins and floodplain to create meander bends, pools, and habitat complexity benefiting several fishes, including three species that are listed under the Endangered Species Act: Puget Sound Chinook Salmon *Oncorhynchus tshawytscha*, Puget Sound Steelhead Trout *O. mykiss*, and Olympic Peninsula Bull Trout *Salvelinus confluentus*. Fish habitat in the upper watershed on the Olympic National Forest serves as a refugia for these at-risk fish populations.

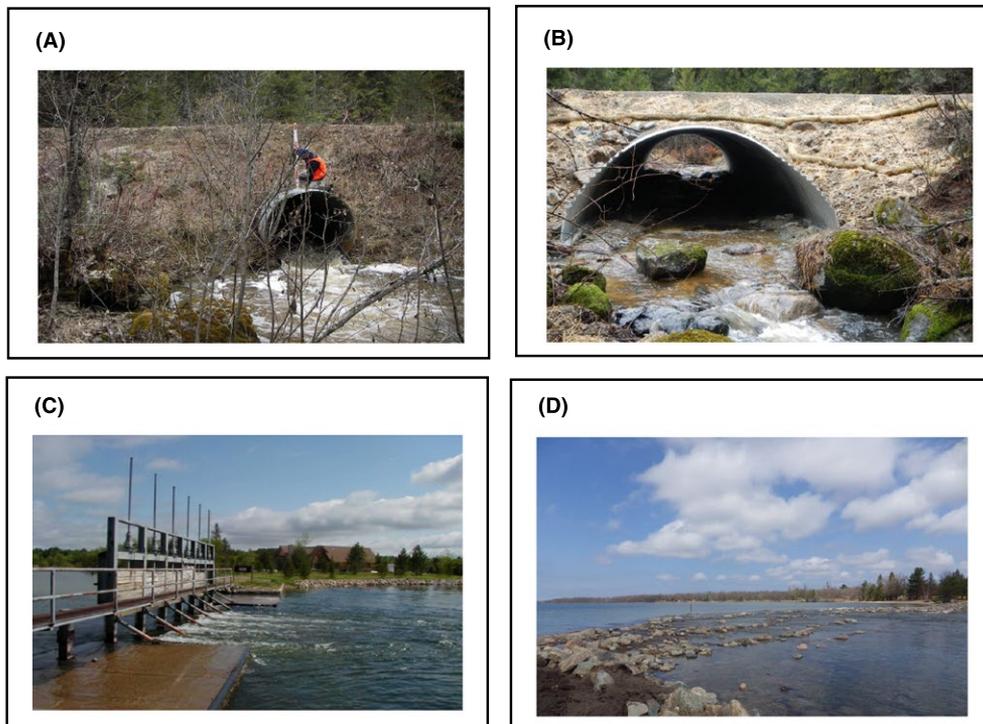


Figure 3. Restoring connectivity in aquatic ecosystems is often the first step in a holistic approach to fish and other aquatic species recovery efforts. The U.S. Forest Service partners with many others both on and adjacent to National Forest System lands to improve aquatic organism passage so that fishes and other aquatic species can migrate freely to reach spawning and rearing habitat. In partnership with the Kalispel Tribe of Indians and the U.S. Fish and Wildlife Service, the U.S. Forest Service in 2016 (A) replaced this undersized and perched culvert on Quartz Creek, a tributary to Lake Pend Oreille, Idaho, with (B) an open-bottom arch culvert designed to meet stream simulation, aquatic organism passage standards, and to re-open 11.3 km (7 mi) of habitat for adfluvial Westslope Cutthroat Trout *Oncorhynchus clarkii lewisi*. Additionally, in partnership with the Leech Lake Band of Ojibwe, Minnesota Department of Natural Resources, Midwest Glacial Lakes Partnership, and Ottetail Power Company, the U.S. Forest Service (C) removed the failing Knutson Dam on the upper Mississippi River in 2015 and (D) constructed an innovative rock-arch rapids that reconnected over 48.3 km (30 mi) of river and more than 29,137 ha (72,000 acres) of lakes that included a world-class Walleye *Sander vitreus* fishery.

mentoring, capacity building, and professional excellence (USFS 1991). During *Rise to the Future's* first decade, the USFS strengthened cooperation with state fish and wildlife agencies through development of hundreds of memoranda of understanding that fostered regular interagency communication about aquatic habitat, water, watershed restoration, and access to recreational fishing opportunities. The USFS also increased cooperation with other federal agencies and, in 1990, released a joint National Recreational Fisheries Policy with the Bureau of Land Management to strengthen delivery of recreational fishing access to nearly 202.3 million ha (500 million acres) of federal land (USFS and BLM 1990). Recreational fishing access on national forests and grasslands was substantially improved, offering a wide range of public fishing opportunities (Figure 4). Outreach and marketing efforts focused on connecting people to their national forests through recreational fishing (Figure 5). In an effort to increase angling participation and promote stewardship of fish and aquatic resources, the USFS and its cooperating state fish and wildlife agencies, other federal agencies, tribal governments, and partner organizations conduct substantial public awareness and outreach efforts and annually host over 300 fishing events, reaching more than 100,000 youth and adults nationwide. It is estimated that over the last 30 years, these collaborative efforts have reached at least 3 million youth and adults nationwide.

The USFS and sportfishing industry evaluated the economic impact and value of fishery resources on national forests throughout the country (USFS 1990a). Many national forests and grasslands incorporated elements acknowledging the important economic value of fishery resources into their land management plans. For example, in 1990, the Mt. Hood National Forest in Oregon estimated the economic value of its fishery resources at \$4 million per year (USFS 1990b).

The USFS has made significant contributions to aquatic ecology and related research in support of adaptive management through its participation in more than 3,000 scientific publications (Isaak et al. 2018, this issue). Investments in science and technology during the 1990s and early 2000s continue to provide a strong foundation for effective stewardship of fish and aquatic resources. Assessment tools, modeling approaches, and inventory methods developed during this era inform sustainable management of national forests and grasslands and help to provide for healthy aquatic habitats (e.g., Sedell et al. 1990; Hawkins et al. 1993; Rieman et al. 2000; Bisson et al. 2003).

THE NEW RISE TO THE FUTURE: NATIONAL FISH AND AQUATIC STRATEGY

The USFS' new *National Fish and Aquatic Strategy* builds upon past successes and better positions the agency to respond



Figure 4. A woman and her niece fish and create lifetime memories together on the San Juan National Forest, Colorado.

to current and future challenges and opportunities for aquatic stewardship, many of which were not addressed in the former strategy. For example, the agency's original strategy did not address the ecological and economic threats of invasive species or the effects of climate on fish and aquatic resources, both of which present serious challenges to aquatic ecosystems (Dudgeon et al. 2006; Strayer and Dudgeon 2010). The previous strategy also did not address present-day societal trends, such as Americans' overall diminishing connection to nature (Louv 2005; Soga and Gaston 2016; Kellert et al. 2017), shifting demographics of anglers (Arlinghaus et al. 2015; Lee et al. 2016), and growing interest in citizen science and non-consumptive "nature watching" (McKinley et al. 2017; Poudel et al. 2017). Growing societal demands for aquatic resources and ecosystem services from watersheds on the nation's forests and grasslands also needed to be addressed. These societal demands include meeting public water resource needs, mitigating hydrologic fluctuations, and providing habitat for fish and other aquatic species. The new strategy takes into account other important social, economic, ecological, and scientific developments. It recognizes that restoring watershed health and function is critical to sustaining clean, reliable water supplies for fish and wildlife habitat and to meeting human demands. As the country grows and changes, the new strategy will guide the USFS, in collaboration with its cooperators and partners, in using the best available science to sustain and restore fish and wildlife habitat, recreational infrastructure, and healthy watersheds.

The new strategy also aligns a diverse array of actions that contribute to aquatic stewardship throughout the agency by

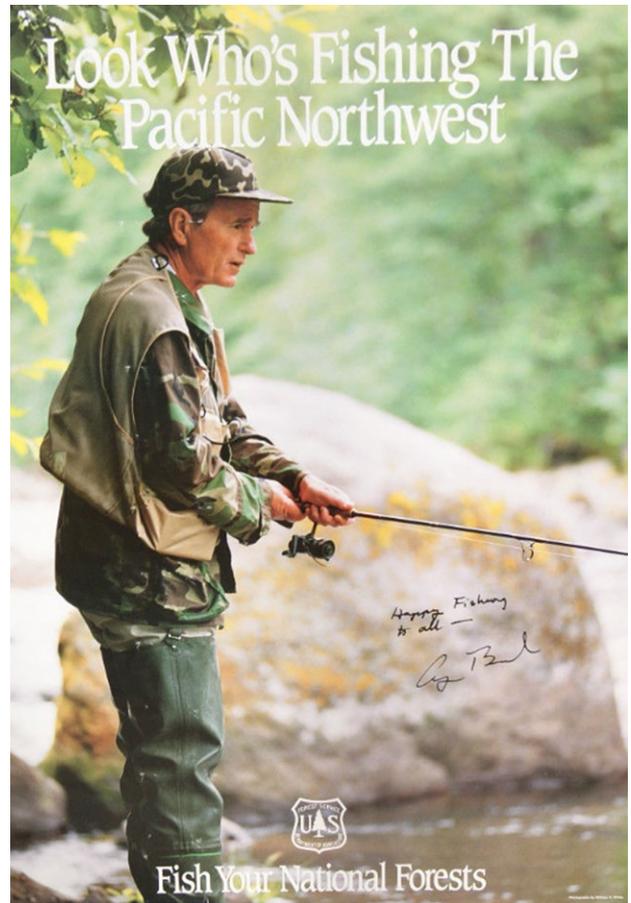


Figure 5. Promotional poster featuring President George Bush to recruit anglers to fish on national forests.

calling for a more interdisciplinary, collaborative approach than ever before. In the last decade, the USFS has emphasized integrated program delivery, moving away from the autonomy of individual programs (e.g., fisheries, timber, and recreation programs). The agency's recent progress in implementing watershed-scale projects to achieve multiple resource objectives demonstrates the advantages of integrated management of natural resources (Schultz et al. 2012). The new strategy calls for continued incorporation of fish and aquatic stewardship actions into integrated multiple-resource projects that achieve multiple benefits.

The USFS is strongly committed to its role in stewarding the nation's fish and aquatic resources. The new strategy incorporates lessons learned from the past and charts a path forward while addressing current and future challenges and opportunities. The agency has made substantial progress on fish and aquatic stewardship during the last 30 years, and there is more work to do.

Goals

The six goals of the new strategy are as follows. With each goal, we provide a short description of its purpose and envisioned results as well as its underlying guiding principles. These guiding principles emerged as the team that developed the new strategy reflected on lessons learned during the last three decades under the previous strategy. We applied these principles to improve the new strategy. These principles may also serve to inform similar strategies by other agencies and

organizations and will help to ensure collaborative fish and aquatic stewardship success.

Goal 1: Conserve fish and aquatic resources

Sustaining the health and diversity of fish, other aquatic species (e.g., amphibians, crayfishes, and freshwater mussels), and their habitats is inherent to this goal. The USFS will protect, conserve, and restore watersheds and aquatic ecosystems upon which populations of fish and other aquatic species depend. The USFS will implement plans to help aquatic species and ecosystems respond to stressors, including drought, floods, invasive species, and disease. The agency's vision is for healthy watersheds and aquatic ecosystems characterized by complex, interconnected, and diverse habitats that contain self-sustaining assemblages of fish and other aquatic species.

Goal 1 guiding principles.—A strategic landscape approach to fish and aquatic resource stewardship is paramount, especially one informed by forecasted changes in conditions due to climate and invasive species. It has become ever more important to focus holistically at the watershed scale when protecting, conserving, and restoring aquatic ecosystems for the long-term sustainability of fish and other aquatic species. The USFS has developed a consistent, nationwide approach to watershed restoration through its Watershed Condition Framework (USFS 2011a, 2011b; see www.fs.fed.us/biology/watershed/condition_framework.html). Building upon the Watershed Condition Framework, the new strategy calls for identifying conservation watersheds on NFS lands that will be especially important for the stewardship and long-term sustainability of fish and aquatic resources. Collaborative management of conservation watersheds will become more important in the years ahead and will play a critical role in stewarding the nation's fish and aquatic resources as the human population increases and as pressure on water and scarce natural resources grows.

Goal 2: Connect people to the outdoors through fishing, boating, and other aquatic activities

Fishing, boating, and other aquatic activities afford many economic, social, and cultural benefits. The USFS will enhance recreational fishing and aquatic recreation activities on NFS lands by providing or supporting access, facilities, and programs that connect people in urban, rural, and underserved communities with the outdoors. The agency's vision is for everyone to enjoy fishing and other aquatic activities on NFS lands and to better understand the value of public lands in sustaining clean water, aquatic recreation, and healthy aquatic environments.

Goal 2 guiding principles.—We must recognize and stay attuned to changing societal values and shifting demographics as we carry out the strategy. Data trends indicate that the general public will become increasingly diverse and more urban—expected to reach 87% of the U.S. population by 2050 (United Nations 2014). Connecting non-traditional audiences to the outdoors will be increasingly important in building a sense of shared stewardship for fish and aquatic resources. We must continue to invest in connecting people to the outdoors through non-traditional uses and technology, such as nature viewing and web applications like Discover the Forest Discovery Agents (see www.discovertheforest.org/discoveryagents).

Goal 3: Strengthen partnerships and work across boundaries

The USFS relies on many cooperators and partners to achieve its mission, including state agencies, other federal

agencies, tribal governments, nongovernmental organizations, private landowners and water users, private business, and the sportfishing industry. Cooperators and partners help the agency achieve shared objectives for fish and aquatic stewardship across jurisdictional boundaries and multiple landownerships. The agency's vision is to have a large, diverse portfolio of cooperators and partners and to be a partner of choice for public-private ecosystem restoration and education and outreach projects.

Goal 3 guiding principles.—Cooperation with state fish and wildlife agencies, other federal agencies, and tribal governments as well as partnering with nongovernmental organizations, private businesses, landowners and water users, and others is vital to the stewardship of the nation's fish and aquatic resources. A strong emphasis on partnerships was a central theme of the original *Rise to the Future* strategy, and this will continue to be the case. Collectively, we accomplish far more when focused on common interests. The new strategy places a stronger focus on cooperation with states, other federal agencies, and tribal governments. Corporate, private landowner, and private water user partnerships will become increasingly important in the future.

Goal 4: Deliver and apply scientific research

Science is the foundation for stewardship of fish and aquatic resources. The USFS produces and relies on high-quality science to formulate strategies and actions to steward fish and aquatic resources. The agency contributes to and supports progress in fisheries science and aquatic ecology by ensuring data consistency and quality and by sharing knowledge, both internally and externally. USFS employees support stewardship of fish and aquatic resources by applying science and technology, building research partnerships, and creating and maintaining reliable databases. The agency's vision is to excel in science and science-based management of aquatic resources. The agency aspires to produce national, publicly-accessible databases that document aquatic species and habitats across NFS lands to increase awareness of the status and trends of fish and aquatic resources and the importance of public lands for their long-term sustainability.

Goal 4 guiding principles.—Continued investment in science and technology is necessary, especially valuable are innovative methods and data sharing techniques to identify efficiencies and more effectively utilize existing data (Isaak et al. 2018, this issue).

Goal 5: Build capacity through mentoring and training

Competent, motivated, and connected employees are essential to successful aquatic resource stewardship. The USFS seeks to improve the skills, capabilities, and professionalism of its workforce. The agency endeavors to foster a diverse workforce and an inclusive work environment, recognizing and valuing the perspectives and contributions of all employees. The agency's vision is for all employees to receive training, mentoring, and other support needed to be effective stewards of fish and aquatic resources.

Goal 5 guiding principles.—Support from the executives of natural resource agencies and organizations for stewardship of fish and aquatic resources is vital, especially during these times of diminished capacity and resources. An empowered, diverse, and inclusive workforce—where professional development is

promoted and professional excellence is recognized—is critical for ensuring organizational capacity and vitality to meet future challenges and opportunities.

Goal 6: Communicate the value of fish and aquatic resources

Sharing the value of healthy, sustainable fish and aquatic resources is critical to the USFS' ability to steward those resources. The agency is committed to awakening and strengthening the connection of all people to aquatic ecosystems. The agency will listen and respond to the needs and values of the American public, and it will strive to effectively communicate the benefits of fish and aquatic resources to the public. The agency's vision is that all people will appreciate the value of fish and aquatic resources.

Goal 6 guiding principles.—Successfully communicating the benefits of healthy fish and aquatic resources to the American public is essential for the agency's work to remain relevant. We must strive to continually understand and communicate how stewardship of the nation's fish and aquatic resources improves the lives of people across the country in rural and urban communities.

Under each of the strategy's goals are objectives that describe the actions and deliverables necessary to achieve that goal. Space limitations prevent inclusion of the objectives and action items here. The full strategy is available online at www.fed.us/naturalresources/fisheries/about.shtml.

High-Priority Actions

The strategy contains numerous objectives and sub-objectives that provide a comprehensive description of the USFS program of work as it relates to fisheries. To focus strategy implementation in the near term, the USFS has selected eight high-priority actions on which to place emphasis and for which the agency has identified timelines and metrics for success:

1. Increase the number of youth and adults connecting to the outdoors through recreational fishing and other aquatic activities at events sponsored or co-sponsored by the USFS or held on national forests and grasslands by 50%, from 2017 levels, by 2023.
2. Increase USFS partnerships with states, tribal governments, water providers, private businesses, and multi-stakeholder groups that result in meaningful fish and aquatic stewardship outcomes with multiple benefits by 20%, from 2017 levels, by 2023.
3. Cooperate with state fish and wildlife agencies and partner with nongovernmental organizations, the sportfishing industry, and stakeholders to identify barriers to increasing recreational fishing participation and identify high-priority actions that will yield the greatest increase in participation by 2019.
4. Develop a coarse-scale national assessment of aquatic biodiversity by 2019.
5. Cooperate with states, other federal agencies, and tribal governments and partner with nongovernmental organizations and others to develop criteria and identify conservation watersheds for fish and aquatic species on national forests and grasslands by 2020. Conservation watersheds are defined as those watersheds identified as important for the long-term protection of common and rare species and habitats as well as natural processes at multiple scales.

They form a network of connected, healthy functioning watersheds across the landscape.

6. Conduct and distribute a national fish and aquatic ecology research needs assessment by 2019.
7. Develop business practices and protocols for effective mentoring of fisheries biologists and aquatic ecologists by 2018.
8. Develop and implement a communications and outreach plan by 2018.

Work on these priorities is underway. Achieving these benchmarks will demonstrate that the new strategy is producing results and that the USFS is performing strategically in its contributions to collaborative stewardship of fish and aquatic resources.

CONCLUSION

When people think of the national forests and grasslands, they often think of spectacular scenery, including wild rivers and mountain lakes. They might remember seeing a deer, hearing an owl, or catching a fish in a clear mountain stream. Such memories can last a lifetime, and they are integral to what the national forests and grasslands mean to the American people. President Theodore Roosevelt and other visionaries who founded the NFS did so, in part, to conserve America's heritage of fish and aquatic resources. Since the beginning, the USFS has found that conserving healthy fish habitat and restoring aquatic resources are central to its mission to sustain the health, diversity, and productivity of the nation's forests and grasslands to meet the needs of present and future generations. Healthy streams, lakes, and rivers benefit Americans in myriad ways, from clean drinking water to diverse recreational opportunities. One in five Americans relies on water that comes from NFS lands. Abundant clean water that gives life to human communities is clearly connected to healthy habitats for fish and other aquatic species. The national forests and grasslands include some of the nation's best remaining habitats for many threatened and endangered fish species. Such habitats are vital for sustaining fish populations that are important for commercial, recreational, and subsistence uses. This strategy will guide the USFS to work with its partners to sustain these valuable resources. The agency's work to protect, restore, and enhance natural resources has become increasingly integrated across USFS mission areas and disciplines and has become ever more collaborative. As the USFS carries out its new strategy, it will ensure that abundant fish and aquatic resources and healthy aquatic habitats are available for Americans to enjoy both now and for generations to come.

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REFERENCES

- ADFG (Alaska Department of Fish and Game). 2016. Subsistence in Alaska: a year 2014 update. ADFG, Division of Subsistence Research. Available: http://www.adfg.alaska.gov/index.cfm?adfg=subsistence_research.main. (September 2017).
- Arlinghaus, R., R. Tillner, and M. Bork. 2015. Explaining participation rates in recreational fishing across industrialised countries. *Fisheries Management and Ecology* 22:45–55.
- ASA (American Sportfishing Association). 2007. State and national economic effects of fishing, hunting and wildlife-related recreation on U.S. Forest Service-managed lands. Prepared for the U.S. Forest Service by the ASA, Alexandria, Virginia.
- Bisson, P. A., B. E. Rieman, C. Luce, P. F. Hessburg, D. C. Lee, J. L. Kershner, G. H. Reeves, and R. E. Gresswell. 2003. Fire and aquatic ecosystems of the western USA: current knowledge and key questions. *Forest Ecology and Management* 178:213–229.
- Brouha, P. 1987. Agency policy and practices: wildlife and fisheries management in the USDA Forest Service. *Fisheries* 12(3):8–10.
- Dudgeon, D., A. H. Arthington, M. O. Gessner, Z. I. Kawabata, D. J. Knowler, C. Lévêque, R. J. Naiman, A. H. Prieur-Richard, D. Soto, M. L. J. Stiassny, and C. A. Sullivan. 2006. Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews* 81:163.
- Fall, J. A., N. M. Braem, C. L. Brown, S. S. Evans, L. Hutchinson-Scarborough, H. Ikuta, B. Jones, R. La Vine, T. Lemons, M. A. Marchioni, E. Mikow, J. T. Ream, and L. A. Sill. 2014. Alaska subsistence and personal use salmon fisheries 2012 annual report. Alaska Department of Fish and Game, Division of Subsistence, Technical Paper Number 406, Anchorage, Alaska.
- Gillespie, N., J. Epstein, S. Alexander, J. M. Bowker, R. Medel, M. Leonard, and A. Thoms. 2018. Socioeconomic benefits of recreational, commercial and subsistence fishing associated with national forests. *Fisheries* 43:432–439.
- Gregory, S. V., and P. A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. Pages 277–314 in D. J. Stouder, P. A. Bisson, and R. Naiman, editors. *Pacific salmon and their ecosystems*. Springer, New York.
- Hawkins, C. P., J. L. Kershner, P. A. Bisson, M. D. Bryant, L. M. Decker, S. V. Gregory, D. A. McCullough, C. K. Overton, G. H. Reeves, R. J. Steedman, and M. K. Young. 1993. A hierarchical approach to classifying stream habitat features. *Fisheries* 18:3–12.
- Heredia, N., B. Roper, and N. Gillespie. 2015. Technical guide for field practitioners: understanding and monitoring aquatic organism passage at road-stream crossings. U.S. Forest Service, National Stream and Aquatic Ecology Center, Technical Report TR-101, Fort Collins, Colorado.
- Isaak, D., M. K. Young, C. McConnell, B. Roper, E. Archer, B. Staab, C. Hirsch, D. Nagel, M. Schwartz, and G. Chandler. 2018. Crowd-sourced databases as essential elements for Forest Service partnerships and aquatic resource conservation. *Fisheries* 43:423–430.
- Jelks, H. L., S. J. Walsh, N. M. Burkhead, S. Contreras-Balderas, E. Diaz-Pardo, D. A. Hendrickson, J. Lyons, N. E. Mandrak, F. McCormick, J. S. Nelson, and S. P. Platania. 2008. Conservation status of imperiled North American freshwater and diadromous fishes. *Fisheries* 33:372–407.
- Kellert, S. R., D. J. Case, D. Escher, D. J. Witter, J. Mikels-Carrasco, and P. T. Seng. 2017. The nature of Americans: disconnection and recommendations for reconnection. DJ Case and Associates, Mishawaka, Indiana.
- Lee, K. J., D. Scott, M. F. Floyd, and M. B. Edwards. 2016. Social stratification in fishing participation in the United States: a multiple hierarchy stratification perspective. *Journal of Leisure Research* 48:245–263.
- Louv, R. 2005. *Last child in the woods: saving our children from nature-deficit disorder*. Algonquin Books, Chapel Hill, North Carolina.
- McKinley, D. C., A. J. Miller-Rushing, H. L. Ballard, R. Bonney, H. Brown, S. C. Cook-Patton, D. M. Evans, R. A. French, J. K. Parrish, T. B. Phillips, S. F. Ryan, L. A. Shanley, J. L. Shirk, K. F. Stepenuck, J. F. Weltzin, A. Wiggins, O. D. Boyle, R. D. Briggs, S. F. Chapin, D. A. Hewitt, P. W. Preuss, and M. A. Soukup. 2017. Citizen science can improve conservation science, natural resource management, and environmental protection. *Biological Conservation* 208:15–28.
- NFHP (National Fish Habitat Partnership). 2010. *Through a fish's eye: the status of fish habitats in the United States, 2010*. National Fish Habitat Partnership, Washington, D.C.
- NFHP (National Fish Habitat Partnership). 2015. *Through a fish's eye: the status of fish habitats in the United States, 2015*. National Fish Habitat Partnership, Washington, D.C. Available: <http://assessment.fishhabitat.org> (October 2017).
- NVUM (National Visitor Use Monitoring). 2011–2015. National visitor use monitoring data from national forests and grasslands public uses. U.S. Forest Service, Washington, D.C. Available: <https://apps.fs.usda.gov/nvum/results>. (October 2017).
- Penaluna, B. E., G. H. Reeves, Z. Barnett, P. A. Bisson, J. M. Buffington, A. Dolloff, R. Flitcroft, C. H. Luce, K. Nislow, J. Rothlisberger, and M. L. Warren Jr. 2018. Using natural disturbance and portfolio concepts to guide aquatic-riparian ecosystem management. *Fisheries* 43:406–422.
- Pinchot, G. 1906. *The use book: regulations and instructions for the use of the national forest reserves*. U.S. Government Printing Office, Washington, D.C.
- Poudel, J., I. A. Munn, and J. E. Henderson. 2017. Economic contributions of wildlife watching recreation expenditures (2006 and 2011) across the U.S. south: an input-output analysis. *Journal of Outdoor Recreation and Tourism* 17:93–99.
- Reeves, G. H., J. E. Williams, K. M. Burnett, and K. Gallo. 2006. The aquatic conservation strategy of the Northwest Forest Plan. *Conservation Biology* 20:319–329.
- Rieman, B. E., D. C. Lee, and R. F. Thurow. 1997. Distribution, status, and likely future trends of Bull Trout within the Columbia River and Klamath River basins. *North American Journal of Fisheries Management* 17:1111–1125.
- Rieman, B. E., D. C. Lee, R. F. Thurow, P. F. Hessburg, and J. R. Sedell. 2000. Toward an integrated classification of ecosystems: defining opportunities for managing fish and forest health. *Environmental Management* 25:425–444.
- Robertson, F. D. 1988. Rise to the Future: the Forest Service fisheries program. *Fisheries* 13(3):22–23.
- Roper, B., J. M. Capurso, Y. Paroz, and M. K. Young. 2018. Aquatic biodiversity conservation in the context of multiple use management of National Forest System lands. *Fisheries* 43:396–405.
- Schultz, C. A., T. Jedd, and R. D. Beam. 2012. The Collaborative Forest Landscape Restoration Program: a history and overview of the first projects. *Journal of Forestry* 110:381–391.
- Sedell, J. R., G. H. Reeves, F. R. Hauer, J. A. Stanford, and C. P. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. *Environmental Management* 14:711–724.
- Soga, M., and K. J. Gaston. 2016. Extinction of experience: the loss of human-nature interactions. *Frontiers in Ecology and the Environment* 14:94–101.
- Strayer, D. L., and D. Dudgeon. 2010. Freshwater biodiversity conservation: recent progress and future challenges. *Journal of the North American Benthological Society* 29:344–358.
- TCW Economics. 2010. *Economic contributions and impacts of salmonid resources in southeast Alaska, final report*. Prepared for the Trout Unlimited Alaska Program by TCW Economics, Sacramento, California.
- United Nations. 2014. *World urbanization prospects: the 2014 revision, highlights (ST/ESA/SER.A/352)*. United Nations, Department of Economic and Social Affairs, Population Division, New York.
- USFS (U.S. Forest Service). 1990a. *The fishery resources of the national forests: extent, uses, and economic benefits—1988*. USFS, Washington, D.C.
- USFS (U.S. Forest Service). 1990b. *Land and resource management plan, Mt. Hood National Forest*. USFS, Pacific Northwest Region, Portland, Oregon.
- USFS (U.S. Forest Service). 1991. *Rise to the Future: action plan for the '90s*. USFS Publication, Washington, D.C.
- USFS (U.S. Forest Service). 1998. *The fish and wildlife job on national forests: a century of game and fish conservation, habitat protection, and ecosystem management*. USFS, Washington, D.C.
- USFS (U.S. Forest Service). 2008. *Stream Simulation: an ecological approach to providing passage for aquatic organisms at road-stream crossings*. USFS, National Technology and Development Program, Missoula, Montana.
- USFS (U.S. Forest Service). 2011a. *Watershed condition framework*. USFS Publication FS-977, Washington, D.C.
- USFS (U.S. Forest Service). 2011b. *Watershed condition classification technical guide*. USFS Publication FS-978, Washington, D.C.

- USFS (U.S. Forest Service). 2015. Tongass salmon fact sheet. USFS, Region 10, Juneau, AK. Available: https://www.fs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb5408056.pdf (January 2018).
- USFS (U.S. Forest Service) and BLM (Bureau of Land Management). 1990. Recreational fisheries policy. USFS and BLM, Washington, D.C.
- USFS (U.S. Forest Service) and BLM (Bureau of Land Management). 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern spotted owl. USFS and BLM, Washington, D.C.
- Warren, M. L., Jr., B. M. Burr, S. J. Walsh, H. L. Bart Jr., R. C. Cashner, D. A. Etnier, B. J. Freeman, B. R. Kuhajda, R. L. Mayden, H. W. Robison, and S. T. Ross. 2000. Diversity, distribution, and conservation status of the native freshwater fishes of the southern United States. *Fisheries* 25(10):7–31.
- Wildlife Forever. 2014. National invasive species outreach and education 2014 annual report. Available: <http://wildlifeforever.org/wp-content/uploads/2017/05/2014-Threat-Campaign-Final-LR-CD2.pdf> (January 2018).
- Williams, J. E., R. N. Williams, R. F. Thurow, L. Elwell, D. P. Philipp, F. A. Harris, J. L. Kershner, P. J. Martinez, D. Miller, G. H. Reeves, C. A. Frissell, and J. R. Sedell. 2011. Native fish conservation areas: a vision for large-scale conservation of native fish communities. *Fisheries* 36:267–277. **AFS**