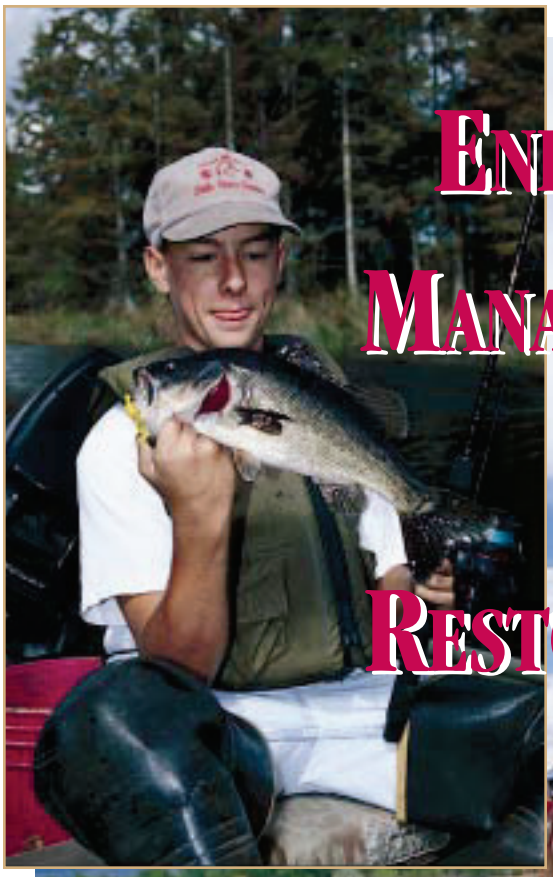
Enhancing Fisheries Management Through The Sport Fish Restoration Program



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SPORT FISH RESTORATION FUNDS IN FISHERIES MANAGEMENT

I was fortunate to have worked as a fisheries research biologist and then as fisheries management chief for a progressive conservation agency during 37 years of the golden age of conservation in the United States. As such, I observed the evolution of the use of Sport Fish Restoration Funds during most of the 50-year history of these funds, particularly in Missouri and the Midwest. The early use of these funds in state sport fishery research investigations set the stage for science-based fisheries management during the latter part of the period. The many surveys of stream and lake fish populations provided the background information on standing crop, relative abundance, species composition, and age and growth rates. Creel surveys provided estimates of fishing pressure and estimated harvest. Later, primarily in the 1960s and 1970s, reliable angler tag return information permitted reasonably accurate estimates of angler exploitation of major sport species as well as natural and total mortality rates. Meaningful fish harvest regulations could then be applied to individual water bodies so that balanced populations could be maintained of both predator species and forage species, resulting in proper functioning of the populations and continuing improved fishing. This approach took advantage of the productive capacity of individual water bodies, and appropriately-set creel limits and properly-sized length limits and slot length limits provided quality size fish for the anglers.

As the background resource information was obtained and research provided the keys to regulate angler harvest to maintain balanced fish populations, and to improve habitat, SFR funds were shifted more toward fisheries management. Close to home fishing was being provided through construction of small lakes; stream access sites were being acquired for boat and bank fishing. Conservation departments were adding fisheries management biologists to manage the existing and the newly built public waters as well as to provide technical assistance to pond owners who allowed public fishing. The 1984 Wallop-Breaux Amendment to the earlier Sport Fish Restoration Act was particularly helpful to many agencies to bolster management staff. Additional staff in many states permitted regular sampling of waters and evaluation of the fish populations and management techniques so that fishing regulations could be adjusted or other management techniques, such as water level drawdowns, partial fish population removal, additional fish stocking, etc., could be applied. The age of science-based fisheries management finally was here. The additional staffs also permitted much needed work on deteriorating stream habitat and stream fish populations. Without the infusion of the additional SFR funds, this would not have happened, at least not on a practicable scale.

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OHIO DEPT. OF NATURAL RESOURCES, FAIRPORT FISHERIES STATION

Stable SFR funding has enchanced new technologies and science-based management.

More recently, SFR funds have permitted stocking of fish where needed, such as in urban fishing programs, kids' fishing programs, angler workshops, and stocking new waters and for corrective stocking of imbalanced waters. The recent completion of Missouri's large, state-of-the art, $22,000,000 Lost Valley Hatchery, a warm and cool water facility, is a good example of wise use of SFR funds to continue to improve fisheries management.

We owe a big thank-you to the anglers who continue to provide these funds, to those individuals who made the act and subsequent amendments happen, to those who see that the funds are used wisely, and to those watch dogs who continue to monitor legislative changes that might affect the funding. The nation's fisheries resources would be in a sorry state without the SFR funds and these past and current supporters of the SFR program.

IMPROVING SPORT FISH MANAGEMENT THROUGH NEW TECHNOLOGIES: THE FLORIDA MARINE RESOURCES GIS

The Florida Marine Research Institute (FMRI) is part of the state's Fish & Wildlife Conservation Commission (FWC). In 1983, FMRI began implementation of the Marine Resources Geographic Information System (MRGIS) as an image-processing system that combined LANDSAT data with aerial photography to map estuarine and marine fisheries habitat (Haddad et al. 1993). Since the early 1990s, funding from the Sport Fish Restoration (SFR) program has allowed FMRI to synthesize information from interrelated sport fish research programs. The resulting databases provide the basis for innovative applications of the MRGIS to issues of sustainable recreational fisheries. Habitat databases were created by the Coastal and Marine Resource Assessment (CAMRA) program, and sport-fishery data from long-term monitoring programs were provided by the Fisheries-Independent Monitoring (FIM) program. The MRGIS has emerged as the de facto clearinghouse for coastal and marine geographic information system (GIS) data in Florida. Ongoing MRGIS expansion and maintenance is made possible by several cooperative funding partnerships. SFR contributes about $250,000 annually, almost 20% of the overall MRGIS budget. Since 1992, CAMRA has accommodated more than 2,500 requests for data and has entered into dozens of mutually beneficial, data-sharing agreements with other organizations. Providing GIS data and maps often leads to more sophisticated projects. The following MRGIS applications were chosen to highlight advancements in fisheries habitat mapping, fisheries protection through educational cartographic products, and future technological directions.

MRGIS Applications Designed to Improve Fishing and Fish Resources

Habitat Assessment and Protection

Managers of recreationally important fishes recognize the importance of habitat to the health of fish stocks. Accurate, spatially explicit habitat maps are one important tool on which managers rely to assess habitat. CAMRA, in partnership with regional and national agencies, has used innovative mapping techniques to create detailed data sets describing coastal vegetation statewide. Maps and habitat data are among the most requested GIS products. Users range from growth-management officials to fishing-tournament organizers. The FMRI/National Oceanic and Atmospheric Administration (NOAA) benthic-mapping project in the Florida Keys is a notable example of using the MRGIS to map fisheries habitat. CAMRA partnered with NOAA's Strategic Environmental Assessment Division and National Geodetic Survey to create a highly accurate and detailed (1:48,000) digital database of all benthic habitats existing in the Florida Keys National Marine Sanctuary. The 53-page, hard-copy atlas created from the database is in its third printing and is being used by researchers, managers, educators, fishing guides, and the general public. Demand for the data and atlas is so great that a CD-ROM was created (now in its second printing) with an interactive tutorial to facilitate direct access to the data.

Identification of Essential Fish Habitat

CAMRA and FIM staff are collaborating with the NOAA Center for Coastal Monitoring and Assessment and the University of Miami's Rosenstiel School of Marine and Atmospheric Science in developing new methods to predict sport fish species distributions, abundance, and habitat affinity. FIM monitors the abundance of juvenile and adult recreational fishes in six estuaries around the state (Nelson et al. 1997). These data are critical to many of the sophisticated sport fish-related MRGIS applications. Preliminary investigations into relationships between environmental conditions and the distributions of recreationally significant species show considerable promise. These new MRGIS applications depend upon the long-term baseline data generated by the SFR-funded FIM program.

In another application of SFR-funded initiatives, various methods of conducting Habitat Suitability Index (HSI) modeling are being evaluated in Tampa Bay and Charlotte Harbor. The objective of these efforts is to determine whether indices can be transferred between estuaries to predict and map fish distributions in estuaries where fish abundance has not been surveyed (Rubec et al. 1999). Sport Fish Restoration funding provides dedicated resources for CAMRA and FIM to refine

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these methods and ensure that they are scientifically defensible, cost-effective, and transferable. The ultimate goal is to provide fisheries managers, sport-fishing enthusiasts, agencies, universities, and the public with maps that highlight environmental conditions needed to ensure the health of future populations of recreational fishes.

Marine Ecosystem Management

FMRI has considerable scientific data and information suitable for adaptive management. Unlike the management of terrestrial watersheds, however, marine resource management in Florida lacks explicit recognition of the interrelationships of the many ecosystem "elements" operating in estuaries. FMRI is advancing the Florida Blueways initiative to create an institutional methodology for mapping ecological, human use, socio-economic, and management relationships in estuarine systems in an effort to articulate this ecosystem connectivity. Developed in partnership with the Florida Coastal Management program, Florida Blueways draws upon the discipline of landscape ecology to support the complementary concepts of ecosystem management and integrated coastal zone management.

As a case study for Florida Blueways, FMRI is using the MRGIS to integrate many data sets and determine the relationships between various aspects of the ecology of Charlotte Harbor. These select ecosystem elements, such as recreationally important fishes or their associated habitat, will be mapped using the best available data and expert interpretation. Through geographic modeling, we will be able to visualize scenarios in which the recreational angling experience is maximized and Florida's sustainable fisheries are protected. Over the long-term, these databases and models will be used to investigate biodiversity at the landscape level and to determine the links between fish population dynamics and ecosystem processes (Friel and Haddad 1992). Although the final maps will reflect only a generalized interpretation of a highly complex and temporally dynamic system, they should provide a more accurate perspective of the long-term viability of Charlotte Harbor. Florida Blueways also holds potential to systematically include human-use concerns, such as recreational fishing, in ecological characterizations.

Educational Guides for Boaters and Anglers

FMRI is producing a statewide series of boating and angling guides to inform the public about Florida's coastal marine ecosystems (Friel 1994). Each regional guide describes a major bay or estuary system and contains one or more large-scale maps displaying the distribution and extent of the natural resources (e.g., seagrasses, mangroves, saltmarshes) and other areas of interest (e.g., boating and fishing facilities, artificial reefs, boating zones). The guides also contain information about such subjects as the plants and animals common to the area and the relationship between healthy habitats and healthy ecosystems, as well as advice for boaters and anglers about how they can protect the environment. All information in the guides is derived from the MRGIS databases. The guides are targeted specifically to reach the state's 700,000 registered boat owners and anglers to enhance their recreational experiences and to educate them about the ecological impacts of their actions. These have proven very popular with both the angling community and environmental educators. Sport Fish Restoration funds provide technical support in the form of MRGIS data manipulation and cartographic layout for these guides. Partner groups finish the layout and design of the guides and secure joint funding for their printing. Guides to estuaries and bays in every region of the state have been produced, with approximately 650,000 guides being distributed and several more in development.

Future Directions

The Sport Fish Restoration program's support of critical programs at FMRI set the stage for the current success of the MRGIS. Application of the MRGIS has benefited the recreational fishing interests of scientists, citizens, policy makers, and the educational community. CAMRA received the Renewable Natural Resource Foundation's Outstanding Achievement Award in 1996 for its development of the MRGIS. Technology advancements by the private sector will continually be used to update the MRGIS, allowing for dramatic improvements in coastal and marine modeling efforts. Someday, people will log into a new form of conference call and use their Internet browser to mark up an interactive map, which will enable debate over ecosystem conditions in near real-time. The synergistic potential of these technologies is staggering, but our ultimate success will be dictated by long-term commitment to baseline monitoring and mapping programs. Sport Fish Restoration program funding will provide critical monies for the development of emerging technologies, monitoring activities, data stewardship, and effective partnerships, all of which will help ensure that Florida's recreational fishes are here for future generations.

FMRI for fisheries managers, sports-fishing enthusiasts, agencies, universities, and the public using the MRGIS.

FISH CULTURE AND THE SPORT FISH RESTORATION ACT

Fish culture (the practice of raising and stocking fish) has been a standard tool of fisheries managers for as long as professional fisheries management has been practiced. Most early fisheries management programs evolved out of the ability to spawn native fishes and harvest fingerlings for distribution (Smith and Reeves 1986) and hatchery-related functions were the emphasis of most agencies in their infancy (Ross 1997). When the American Fisheries Society was originally incorporated as the American Fish Culturists Association in 1870, fish culture was practiced in 19 of the 37 states plus the territories of Colorado and Kansas (Bowen 1970). To early fish culturists, stocking had great appeal "since it was a positive action as opposed to regulations which were restrictive and created no immediate visible results" (Bowen 1970; Smith and Reeves 1986). To some degree, most of today's fisheries managers would agree that a measure of this appeal still exists, although the manner in which fish are raised and stocked has changed dramatically.

Fish culture continued to play a major role in the programs of fisheries agencies, although the quest for a more thorough understanding of the reasons behind fish population changes continued to grow and accelerate into the 1930s and 1940s. At the same time, increasing leisure time enjoyed by the American public following World War II created heavy demand on U.S. fish culture programs (Bowen 1970). Passage of the Sport Fish Restoration Act (SFR) in 1950 enhanced states' abilities to integrate fish culture into a more scientifically based management program (Radonski and Martin 1986). At the time of the original implementation of the act, the types of fish culture activities that could be funded were limited. Hatchery construction was only allowed where existing facilities were deemed to be inadequate, and stocking was not allowed where the sole purpose was immediate harvest (put-and-take stocking). Stocking projects could be funded only "for the permanent improvement of fisheries" (Rutherford 1952). However, in 1991, this policy was revised to allow expanded uses of SFR dollars for stocking activities to provide put-and-take fisheries. Today, state freshwater fisheries agencies spend an average of 33% of their budgets on fish production and stocking. In some states, up to 70% of freshwater fisheries budgets are spent on put-grow-take or put-and-take programs (Ross and Loomis 1999).

Between 1989 and 1998, 3.8 billion sport fish (adults and juveniles) were stocked for maintenance or restoration of fisheries. Hatchery facility development and fish production costs accounted for 14.5% of SFR expenditures between 1985–1991 (USFWS 1993).

Fish culture programs conducted with funding from the Sport Fish Restoration program have played vital roles in a number of diverse areas of fishery management programs, including re-establishment of native stocks of sport fish, establishing new sport fisheries, and providing put-and-take fisheries in areas that cannot sustain adequate populations. In addition, fish culture practices have been improved through funding of special fish health investigations, innovative culture techniques, and special symposia to address techniques for raising and using cultured fishes.

For example, in Alaska, SFR funds are currently used to stock 9 million fish annually throughout the state as part of efforts to provide a half million additional angler days per year (ADFG 2000). Stocking is used for a variety of purposes, including shifting some of the fishing pressure away from heavily fished waters that would not be able to withstand angler pressure that likely would occur if other opportunities (provided through stocking) were not available. In addition, it is used to diversify the types of angling experiences that are available in the state.

In Maryland, SFR is used in part to fund trout rearing operations in partnership with the Mettiki Coal Company and the U.S. Army Corps of Engineers. Trout are reared in treated coal mine water discharge at the Mettiki Coal Mine near Oakland, Maryland and in the reservoir stilling basin at the Jennings Randolph Reservoir on the North Branch of the Potomac River. Trout reared at these facilities are an integral part of restoring the North Branch, a river that was devoid of

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aquatic life for almost one hundred years. Thanks in part to these cooperative fish rearing projects, the North Branch is recovering rapidly and today supports a large and growing sport fishery.

In Vermont, Federal Aid in Sport Fish Restoration provides a major portion of the funding for the Ed Weed Fish Culture Station in Grand Isle. This state-of-the-art fish hatchery produces over three-quarter of a million fish annually for stocking statewide. In Lake Champlain alone, the hatchery provides significant support to a fishery that contributes $50 million annually to Vermont's economy. The fish culture station is also a focal point for tourism, with 20,000–40,000 visitors each year, and provides the Fish and Wildlife Department with an opportunity to educate the public about the aquatic resources of the state.

SFR funds have been used to create, restore and maintain sport fisheries through stocking.

Sport Fish Restoration funds have been used for innumerable stocking programs to establish new sport fisheries. In many of these instances, changing environmental conditions either provided opportunities for new fisheries, or diminished previously established fisheries. For example, changing conditions in the Great Lakes with the invasion of alewife (*Alosa pseudoharengus*), sea lamprey (*Petromyzon marinus*), and other species created the opportunity to establish world class salmon fisheries in the 1960s. Today, these fisheries are being sustained and managed through the use of SFR funded hatchery programs (see related article by Tanner in this issue). In newly created reservoirs throughout the U.S., such as those highlighted in the accompanying article by Namminga, SFR funds are used for production and stocking of a variety of sport fish including black bass (*Micropterus sp.*), striped bass (*Morone saxatilis*) and hybrids, walleye (*Stizostedion vitreum*), and other species that provide thousands of new fishing opportunities. SFR funds have been used to construct new facilities in Oklahoma, such as the Calamus State Fish Hatchery dedicated in 1991, to raise trout, walleye, bass and conduct state-of-the-art research on hybrid fish and other areas.

In addition to actual stocking of fish, the Sport Fish Restoration Act has helped support a number of symposia, publications, and meetings that serve to transfer information between professionals about the latest advances and techniques in fish culture. The landmark publication *Fish Hatchery Management* (Piper et al. 1982) was made possible through the investment of SFR funds and has served as a vital reference and instructional manual to fish culture professionals across the nation. Recognizing the emerging issues surrounding the appropriate use of hatchery-reared fish, SFR funds were invested in a 1994 symposium that brought together experts to address the uses and effects of cultured fishes in modern day management (Schramm and Piper 1995).

The practice of fish culture, its application in management, and managers' understanding of the impact of cultured fish on aquatic systems have advanced a great deal since the days when fish stocking formed the basis of fishery management programs. In the past 50 years, funding from the Sport Fish Restoration Act has fueled tremendous changes in the way that managers rear and stock fish and has contributed greatly to the development of countless sport fishing opportunities.

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ECOSYSTEM MANAGEMENT AND SPORT FISH RESTORATION

Ecosystem management gained prominence in 1994 as a better way (some insisted *the* way) to manage living natural resources. It seems like the term "ecosystem management" has been replaced by "ecosystem-based management," but regardless of the name applied, the concept and the process are what are important. And the concept and process are not new.

What is ecosystem management? This apparently simple question is far from simple. Several definitions have been offered, and there is no "right" definition. Some management leaders have offered that managers don't need a definition; they just need to do it. Other managers have asked how they can change the activities of their agency if they don't know what this new approach is. Ecosystem management is holistic management and has multiple dimensions. One dimension is biological or ecological–ecosystem management means watershed management and it means communities. We all know that what happens in the water is affected by what happens on the surrounding land, and what happens downstream is affected by activities upstream. We also recognize that habitat management benefits multiple species. In the past, management that focused on a single species has, in some cases, adversely affected other species. We must be vigilant that a management program to enhance a single species, such as a premier sport fish, does not negatively impact the ecological community that supports that fish.

INDIANA DNR

Fish ladder through South Bend, Indiana brings fishing to the doorstep of thousands of anglers.

Providing fish passage opens new habitat to migrating salmon.

INDIANA DNR

A second dimension is political. Whether the fishery resource is a lake, reservoir, river, or stream, watersheds often cross political boundaries. The different jurisdictions may be municipal, county, state, or even national. Therefore, managing the watershed often becomes a multijurisdictional process. The authority or responsibility for managing a system may rest with multiple organizations or agencies, both public and private. Thus, addressing a resource issue often may be a multi-agency process.

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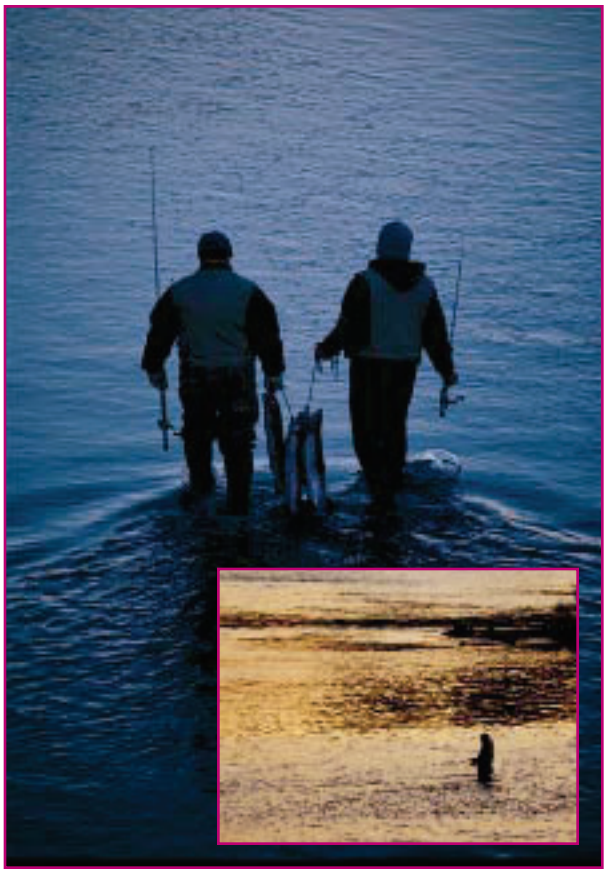
A third dimension is social or socio-economic. All aquatic resources have value. Most, if not all, aquatic resources that provide recreational fishing opportunities are multiple-use resources, which means they also have multiple values. The "uses" can range from aesthetics (a relaxing view) to commercial navigation, electric power generation, and domestic, industrial, and agricultural water supply. Certainly recreational fishing is a valued use of aquatic resources, and managing for fisheries becomes a multi-stakeholder process.

Effective management usually involves all three dimensions. We have many good examples of fisheries management programs utilizing Sport Fish Restoration funds that demonstrate ecosystem management. Let's look at a few.



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Steelhead anglers on the gravel flats in Mishawaka, Indiana.

The St. Joseph River Interstate Anadromous Fish Project

The St. Joseph River originates in south-central Michigan, flows westward through northern Indiana, and eventually discharges into Lake Michigan at Benton Harbor, Michigan. Historically the St. Joseph supported excellent warmwater and coldwater fisheries. Dams built from 1868 to 1940 to harness the river's power (mechanical, then hydroelectric) blocked the migration of Lake Michigan river-spawning fish into Indiana waters, and eventually restricted these valued fish to the lower 23 miles of the St. Joe. Combining Sport Fish Restoration funds with Anadromous Fish Conservation and other funds, the Indiana and Michigan Departments of Natural Resources, working in partnership with the U.S. Fish and Wildlife Service, power companies, conservation clubs, and concerned citizens, installed fish ladders at the five lower dams. National Marine Fisheries Service personnel, who have decades of experience with fish passage around dams blocking Pacific coast streams, assisted with fish ladder design. Although these ladders were designed to pass trout and salmon, 16 species of native river fishes have been observed using them.

To sweeten the deal, Indiana DNR built a hatchery on the St. Joseph at Mishawaka (Richard Clay Bodine State Fish Hatchery). Trout and salmon produced at this facility are stocked annually into the St. Joseph to complement Michigan's stocking program. The fish move into Lake Michigan, grow, and return home to the St. Joseph, benefitting both river and Lake Michigan anglers. To round out the increased fishing opportunities created by fish passage and stocking, both states have enhanced boat ramps and shore fishing areas. According to the Indiana Department of Natural Resources, the $11 million project is expected to generate an additional 125,000 angler days of fishing and $6 million in economic benefits annually. Many of these anglers will be fishing on their doorstep in large cities like Benton Harbor and Niles, Michigan, and South Bend and Mishawaka, Indiana. Is it working? In 1999, anglers harvested 25,000 steelhead (*Oncorhynchus mykiss*) and salmon and caught and released an additional 15,000 in the St. Joseph River.

White River, Beaver Dam Tailwater Restoration Project, Arkansas

One might expect neighboring fishery management agencies to cooperate on a project, as Indiana and Michigan did on the St. Joseph. After all, they both have the same purpose and speak the same language. But in Arkansas, an environmental emergency created some unexpected partnerships. The cold discharges from Beaver Dam have created a popular, and for the surrounding communities, economically lucrative, trout fishery in the White River. Dam discharges usually range between 100 and 9,800 cubic feet per second (cfs) and allow both wade and boat fishing in the tailwater. In 1990, a major flood event caused the U.S. Army Corps of Engineers to evacuate Beaver Reservoir, and tailwater flows exceeded 51,000 cfs. The high discharge extensively damaged the stream channel and banks for several miles downstream and left a fishery in ruin.

Using Sport Fish Restoration Program dollars matched by Fayetteville, Arkansas and Tulsa, Oklahoma chapters of Trout Unlimited, the Arkansas Game and Fish Commission renovated the altered habitat. The Arkansas Soil and Water

Conservation Commission helped obtain additional funding from the U.S. Environmental Protection Agency. The U.S. Navy contributed over $100,000 of time and travel for Navy Seabees to provide much needed people-power for the project. The Southwestern Power Administration and the Corps of Engineers, as well as members of the local community and university, also lent their support.

Stabilizing banks with cedar tree revetments along the banks of the White River.

Streambanks were repaired and fortified with cedar tree revetments. Log cribs were anchored into the banks to deflect erosive flows, hold sediments, and provide cover for fish. Banks were re-vegetated with willow and other native species. Stream channel habitat was improved by placing large boulders (some over 10 tons apiece), boulder clusters, and large woody debris in the channel, providing fish in-stream shelter from the varying currents created by power generation releases.

Sport Fish Restoration funds were also used to fund university-level research to evaluate progress and provide scientific focus to the project. To date, over four miles of river habitat have been restored. Stairways and universally accessible fishing piers have been constructed to improve angler access to this valuable fishery. Trout fishing in the Beaver tailwaters is reported to be better than ever, thanks to the combined efforts of multiple agencies, volunteers, and the Sport Fish Restoration Program

If by now you are thinking that ecosystem management means trout, streams, and dams, you are right. But it also means lakes and all species. Space does not allow details, but the following examples of projects funded by the Sport Fish Restoration program demonstrate that ecosystem management applies to all systems and all species.

■ Iowa. Many natural lakes suffer from severe sedimentation and eutrophication. tate and local agencies are teaming up to restore sport fisheries by lake rehabilitation and soil conservation practices in the surrounding watersheds.

■ Lake Mendota, Wisconsin. Few would debate the statement "good fishing needs good water," but here is a switch. Researchers and managers have collaborated to assess how densities of piscivorous walleye (*Stizostedion vitreum*) and northern pike (*Esox lucius*) affect algal blooms. Results indicate that under stable climatic conditions, harvest regulations that affect fish communities and catch also affect water quality. Agencies propose and enforce regulations; anglers comply with them. It looks like anglers may have a role in water quality management.

■ Throughout the country, state fisheries agencies have teamed with other state agencies, local governments, federal agencies, and long lists of non-government organizations to use Sport Fish Restoration funds for aquatic education programs that lead to wise use of fisheries resources and encourage best management practices on the watershed. These programs directly and indirectly benefit sport fish, but they also benefit all aquatic animals that depend on good habitat and good water quality.

What do the examples share? They all involve fish. The problems are addressed by multiple agencies or organizations, the spatial scope of the solution is often beyond the water or beyond an imaginary line that marks a political border, and people are involved. In all cases the fishery, and the aquatic resource, have value. And in all examples, Sport Fish Restoration funds have been used to conserve fishing and fish habitat.

INDIANA DNR

Biologist checks a chinook salmon for eggs at the South Bend ladder while school children look on.

In the introduction we mentioned that ecosystem management is not new. The above examples were operational before the term ecosystem management became popular. The simple fact is, sometimes a holistic approach, both in terms of the habitat and the involved organizations, is the best way to solve a problem or conserve a resource.