Chapter 5

The Process of Fisheries Management

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5.1 INTRODUCTION

Fisheries management is a challenging and exciting process of planning and taking actions to manipulate fish populations, fish habitat, and people to achieve specific human objectives (Figure 5.1). The three components of fisheries management could be thought of as the legs of a stool. If any one of the three legs is weak, the stool will not bear the weight it is intended to support. The process is challenging because fisheries managers rarely have all of the information needed to manage fish populations, habitats, and people with maximum effectiveness. Despite the uncertainty created by the lack of information, fisheries managers must make decisions that are important to a wide variety of stakeholders (i.e., anyone who has an interest in the issue or who may be affected by an issue, either positively or negatively; Decker and Enck 1996), including anglers, conservation organizations, government officials at federal, state, and local levels, farmers, ranchers, industries, and many others. Fisheries management is exciting for many reasons, but one of the more exciting aspects is that it is the nexus of science and policy. Fisheries managers serve as central points of communication, translating scientific principles and data into terms their stakeholders can understand and receiving public input regarding management of the resource that is transmitted to policymakers.

It is difficult to overstate the importance of managing people in fisheries management. If you ask fisheries managers what is the most challenging aspect of the job, they will almost certainly tell you it is managing people. Natural resource managers from forestry to wildlife to fisheries have been saying that for a century. Gifford Pinchot, the first chief of the U.S. Forest Service, once said, "To start with, I had to know something about the people, the country and the trees. And of the three, the first was the most important" (Pinchot 1947:32). Aldo Leopold, widely recognized as the father of wildlife management, said, "The real problem … is not how we shall handle the deer… The real problem is one of human management. Wildlife management is comparatively easy; human management difficult" (Meine 1988:444). Peter Larkin (1988) described the difficult job of a fisheries manager as balancing the desires of recreational anglers (making people content), artisanal fishermen (keeping people employed), and commercial fishermen (making money). Larkin suggested that, "because it is not possible to optimize for several kinds of things simultaneously, it is necessary to find a common currency for contentment, employment, and economic performance" (Larkin 1988:8). Note that all aspects of this difficult balancing act focus on people.

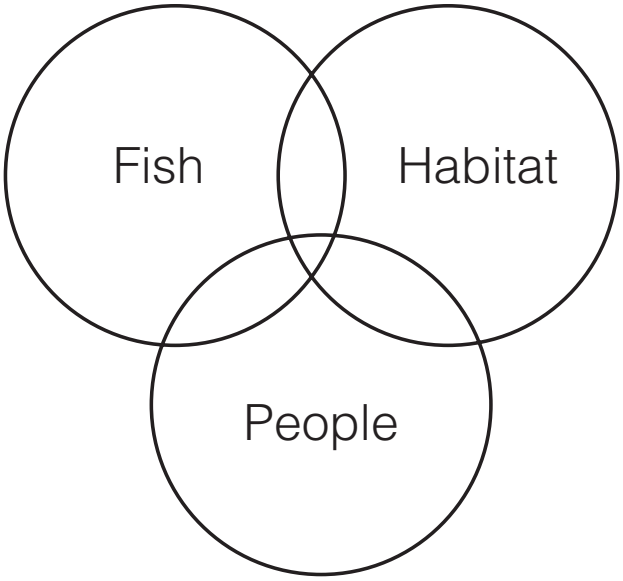

Figure 5.1. Fisheries management consists of the interrelated processes of planning and taking actions to manipulate fish populations, fish habitat and people to achieve specific human objectives.

One of the reasons that the people management aspect of fisheries management is so challenging is that frequently managers have less scientifically sound information about people than they do about fish populations or habitat. Most fisheries managers would be uncomfortable making important decisions about management of a fishery without sound data on fish populations and the status of fish habitat. However, until the emergence of human dimensions as a subdiscipline of fisheries science in the late 20th century, fisheries managers frequently made decisions without the benefit of good data on people and their preferences and opinions regarding management of the resource.

The graphical representation of fisheries management depicted in Figure 5.1 shows the circles surrounding populations, habitat, and people overlapping because, in reality, most issues require that fisheries managers simultaneously deal with two or all three of those areas. For example, fisheries managers throughout North America face the issue of water withdrawal from rivers and lakes. Humans use water for domestic, agricultural, and industrial purposes. While reducing streamflows or lake levels may seem to be simply a habitat issue, it also is a fish population issue because lower flows often result in greater fish mortality, thus reducing overall abundance and possibly species diversity as well. Water withdrawal also becomes a people issue when streamflows or lake levels are reduced to the point of affecting adversely the ability of anglers and boaters to use a body of water. Water provides esthetic and economic as well as utilitarian benefits for people. For example, property with waterfront footage usually has higher economic value than does other property because people value the esthetic qualities associated with the sights and sounds of water near their homes.

The issue of intentional introduction of a new species into a body of water also includes aspects of all three areas (see Box 5.1). Species introductions were once a commonly-used tool of fisheries management and introduced species provide a large portion of the recreational angling in North America. Today, fisheries managers make few intentional species

Box 5.1. Management of Native Species in California's High Mountain Lakes

Fisheries management in high-elevation lakes in California's Sierra Nevada has transitioned from the early days of stocking nonnative trout for fishing to managing fisheries with a strong sensitivity for native species. This change in direction was met with public outcry from stakeholders. Fisheries managers needed to find creative ways to balance fisheries, native species, and stakeholders.

Sierra Nevada fisheries management was based on the goal of improving fishing. This goal was widely supported by the public but did not meet public trust responsibilities placed on the California Department of Fish and Game (CDFG) by the state legislature. Initially, trout were moved by early settlers above natural fish barriers or across watershed divides, thereby extending the distributions of rainbow trout, cutthroat trout, and golden trout. Eventually high-country fish stocking was coordinated by game wardens, hatchery managers, and fisheries managers. The result is that 89% of Sierra Nevada lakes larger than 2.5 ha and deeper than 3 m have extant trout populations where there once were none. Thousands of additional smaller lakes and streams also support self-sustaining populations of trout. Historically, little effort was applied toward evaluating fishery performance and management efficacy. Even less was known about the landscape-scale impact of introduced trout on native animals, especially amphibians and invertebrates.

Almost all high mountain lakes in the Sierra Nevada were fishless, but the term "barren" is hardly applicable. Native amphibians, aquatic invertebrates, and their terrestrial predators were plentiful. For example, the two species of mountain yellow-legged frogs were once thought to be the most abundant aquatic vertebrates in numerous Sierra Nevada basins. These frogs are now candidate species for listing under the U.S. Endangered Species Act (ESA).

Results of early stockings of trout into high elevation lakes were impressive, producing legacy fisheries. Not many anglers that experienced these fisheries are around today; however, there remains a strong expectation that fisheries managers can achieve similar results through increased trout stocking. Some anglers, and many stakeholders that depend on tourism, continue to judge the "quality" of fisheries management by the numbers of trout or lakes stocked rather than on actual performance of fisheries.

Given an increasing awareness of the value of native species, high-elevation fisheries management has evolved toward a more ecosystem-conscious approach that incorporates recreational interests and conservation and protection of native fauna. A rift between those who believed introduced fisheries were benign and those who believed introduced trout exert an impact on native species could only be closed through completing comprehensive assessments of high elevation lakes and incorporating results into basin-scale management plans. The CDFG increased funding for assessments and management in 2001 leading to over 90% (approximately 10,000 waters) of Sierra Nevada Wilderness lakes and ponds being surveyed by 2008, of which approximately one-third were included in management plans.

Most resource managers and scientists now agree that introduced trout can cause local extinctions of amphibians, such as the mountain yellow-legged frog. Other amphibians with shorter larval stages (e.g., Pacific treefrog) or anti-predator toxic skin glands (e.g., Yosemite and western toads) are less affected by nonnative trout.

(Box continues)

Box 5.1. Continued.

In addition to resource assessments, an analysis of public use of fisheries was included in basin management plans. This approach facilitated the development and protection of networked habitats for native species, and the maintenance and improvement of important fisheries. The goal was to implement balanced management between native fauna and historic recreation, stated as follows: manage high mountain lakes and streams in a manner that maintains or restores native biodiversity and habitat quality, supports viable populations of native species, and provides for recreational opportunities, considering historical and future use patterns.

Critical to success was the involvement of stakeholders, whose perspectives and values varied widely. Some anglers questioned the value of native species, whereas the wilderness conservation community opposed changes to the pristine nature of the environment. Initial engagement of stakeholders indicated that the CDFG might be sued by environmental advocates to force compliance with the California Environmental Quality Act. At the same time, some anglers threatened that alterations in angling opportunity would be met with a "bucket stocking" response. Fisheries managers feared the potential movement and further proliferation of brook trout, a species introduced from the eastern USA that is the most common fish in Sierra Nevada lakes but, with few exceptions, has not been stocked for decades. Unfortunately, the majority of these brook trout fisheries consist of stunted individuals. Opposition to fish stocking intensified when both the mountain yellow-legged frog and the Yosemite toad were petitioned for listing under the ESA. To implement basin management plans successfully, it was necessary to involve and educate both anglers who did not want change and environmental advocates who were opposed to maintaining fisheries for nonnative trout.

Fisheries managers with the CDFG presented draft management concepts that integrated comments from stakeholders, including county supervisors and commissioners, chambers of commerce, angling and environmental advocacy groups, professional societies, the Declining Amphibian Task Force conferences, the popular media, and stakeholder workshops. The public perception that all trout should be killed and that no effort was being made to protect native amphibians remained strong. The most directly affected stakeholders were the "pack stock operators," people whose livelihood depended on transporting anglers to mountain lakes. Pack stock operators were historically active in stocking many high mountain lakes and in some areas were still involved. From this relatively small, but intensely controversial, segment of California's fish stocking program, opposition grew that questioned stocking impacts in nearly all waters of the state. The CDFG began working with the U. S. Fish and Wildlife Service to disclose the impacts of its fish stocking program and establish mitigation measures to offset or reduce impacts.

Though changing the management approach for high mountain lakes by the CDFG has been difficult, it has been a success in many ways. Some key factors include:

- a strong resource assessment program that generates pertinent data that are used by resource managers for adaptive decision-making and are shared with stakeholders;

(Box continues)

Box 5.1. Continued.

- development of basin-scale management plans that include detailed objectives for both sport fisheries and protection and recovery of native species;

- early involvement of stakeholders to help refine basin plans to minimize conflict between recreation and native species recovery; and

- successful implementation of plans with improvements in fisheries, in cases which that is the management objective, and recovery of native species, especially mountain yellow-legged frogs.

Through more intensive resource assessment and management, CDFG has improved fisheries where appropriate and the stewardship of native species throughout the Sierra Nevada.

introductions; however, well meaning but poorly informed anglers introduce species into new waters with alarming frequency. Some introduced species alter the habitat. For example, common carp can reduce water clarity and overall primary production in small impoundments and lakes when they stir up bottom sediments as they feed. When an introduced species does well in the new body of water, it may alter the composition of the entire ecological community. For example, predation by illegally-introduced lake trout in Yellowstone Lake significantly reduced the population of native cutthroat trout, which in turn, reduced a seasonal food source for grizzly bears (Ruzycki et al. 2003). An altered aquatic community, in addition to the ecological effects, may have major impacts on human use of the resource. For example, the intentional introduction of opossum shrimp by fisheries managers into lakes throughout the western United States to improve forage for kokanee actually caused crashes in many kokanee populations as the two species competed for food and opossum shrimp provided excellent forage for the juvenile life stages of kokanee predators. In lakes where kokanee populations crashed, popular fisheries were severely affected (Martinez and Bergersen 1989). Fisheries managers today have become more sensitive to both positive and negative ecosystem-wide effects of their management practices than in the past. In fact, fisheries managers can implement activities that purposefully affect not only fisheries but nongame species as well to balance both needs (Box 5.1).

5.2 ROLES OF FISHERIES PROFESSIONALS, STAKEHOLDERS, AND POLICY MAKERS

Fisheries management should be an adaptive process that involves fisheries managers, stakeholders, and policymakers when decisions are being made that combine values and technical choices. Each of the groups involved in the management process has a unique role. When the groups fulfill their roles well, the process tends to work smoothly. When one or more of the groups either does not fulfill its role well or intrudes upon the roles of other groups, the

process is more likely to function poorly. Ideally, the role of the fisheries professional should be to inform the public regarding the status of the fishery in question, the factors that affect the status of the fishery, and the implications of various options for managing the fishery. The specialized training that fisheries professionals receive at universities prepares them to make the technical choices associated with fisheries management. Examples of technical choices include assessing and monitoring fish populations, identifying factors that affect fish populations, and analyzing the implications of management options. Effective fisheries managers also are able to translate highly technical fisheries science and communicate the implications of management options in a way that the average citizen can understand (Figure 5.2).

Fisheries professionals working for government agencies also have a public trust responsibility. The North American model of resource management states that natural resources are public resources held in trust for all citizens to enjoy (Geist et al. 2001; Chapter 4, this volume). Public agency managers are charged with the responsibility of managing those resources with the long-term interest of all the citizens in mind. However, fisheries managers do not determine what is in the public interest by themselves; the public interest is usually determined through policy processes in the political arena. Fisheries managers normally implement programs that reflect policies designed to protect the public interest.

The role of members of the public as stakeholders should be to assist in defining the public interest (i.e., the benefits that the resource should provide), usually indirectly through elected or appointed officials. In the past, many proposed fisheries regulations were developed by fisheries professionals, sometimes with little or no public input. However, because changes in management of a fishery can have profound effects on stakeholders, it is important for fisheries managers to solicit input from the public. Since much of "the public" has little interest in a specific fisheries management issue, fisheries managers usually focus on engag-

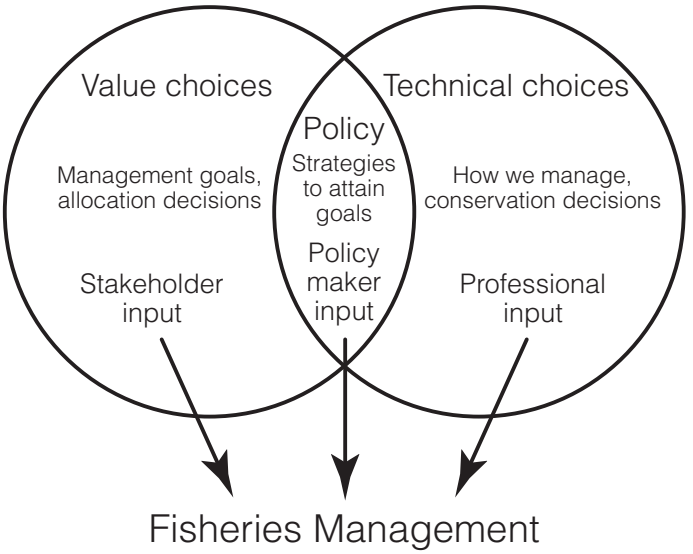

Figure 5.2. Decisions about fisheries management include value choices that should primarily reflect stakeholder values, technical choices that should primarily reflect the expertise of fisheries professionals, and policy choices which overlap both value and technical choices and are primarily the responsibility of policy makers.

ing stakeholders in defining the public interest. Over time, the list of stakeholders interested in fisheries issues has increased dramatically from what was once primarily anglers to what now includes, but is not limited to, anglers, environmental organizations, the business community, and local citizens. Fisheries managers often facilitate collection of information on stakeholder opinions to be used by elected or appointed officials when making policy decisions. Defining desired benefits of the resource is the values aspect of fisheries management.

Policymakers are those elected or appointed officials who represent stakeholders and who make decisions incorporating both values and technical aspects of fisheries management. A common example of appointed policy makers are the state commissioners (sometimes referred to as board members) who are usually appointed by state governors to set policies for state fish and wildlife agencies (Chapter 4). Their qualifications for the position usually include a strong interest in fisheries and wildlife management and a history of support for the political campaigns of the governors who appointed them. Although the great majority of commissioners take their position and its duties seriously, they also face steep learning curves as they become educated about how to integrate fisheries biology and policy, that is, the balancing of technical choices and values choices. The history of fisheries management includes many examples of the struggle to find the appropriate balance between values aspects and technical aspects of fisheries management.

5.3 A CONTRAST OF MARINE AND INLAND FISHERIES MANAGEMENT

Marine and inland fisheries management have taken contrasting but parallel paths to arrive at similar destinations in the search for balancing values and technical aspects of fisheries management. Marine fisheries management frequently has placed greater emphasis on allocation of resources (value choices) than on conservation of resources (technical choices). Marine fisheries management systems in the USA and Canada have traditionally given substantial weight to the role of stakeholders in making technical as well as value choices, leading some experts in the field to question whether foxes were being asked to guard the henhouse (McCay 1996). Conversely, inland fisheries management has often relied more on the input of fisheries managers than stakeholders to make both values choices and technical choices. Studies of effective fish and wildlife management agencies have shown that highly effective agencies maintain a solid biological basis for management decisions (technical choices) while also involving stakeholders in making values choices (McMullin 1993).

5.3.1 Marine Fisheries Management

Marine fisheries management is a complex process of balancing the interests of commercial fishing, recreational fishing, and conservation of fishes. In the USA, lead authority for managing marine fisheries is determined by distance from the shore. Most coastal states have lead authority from the shore to a distance of 3 miles (4.8 km) at sea. Interstate commissions for the Atlantic, Gulf of Mexico, and Pacific states also play a role in marine fisheries management because most marine fisheries overlap multiple state jurisdictions. From 3 to 200 miles (321.8 km) from shore, the federal government has lead authority in what is called the Exclusive Economic Zone (EEZ). Beyond 200 miles from shore are international waters, where fisheries management is determined by multinational treaties. In Canada, the federal govern-

ment regulates all marine fisheries from shore to the 200-mile limit, while the provinces and territories regulate on-shore fish processing. Similarly, marine fisheries in the United Mexican States (Mexico) are regulated by the federal government.

The Magnuson Fishery Conservation and Management Act, first passed by Congress in 1976 and modified in 1996 and 2006 (now called the Magnuson–Stevens Fishery Conservation and Management Act and hereafter referred to as the Magnuson–Stevens Act), created regional fisheries management councils that gave commercial and recreational fishing stakeholders nearly equal standing with fisheries managers when making decisions about management of marine fisheries. The councils were charged with developing management plans for all commercially- and recreationally-important fish stocks in the EEZ. Thirty years after creation of the councils, 24% of the commercially important fish stocks in U.S. waters were overfished because the regional fisheries management councils frequently made management decisions that weighed value choices (keeping commercial fishers fishing) more heavily than technical information, which suggested the harvest of many fish stocks should be reduced (National Marine Fisheries Service 2008).

Comprehensive reviews of the marine fisheries management system resulted in recommendations to redefine the decision-making authority of regional councils and create greater separation of value choices and technical choices (Eagle et al. 2003). The 2006 modifications of the Magnuson–Stevens Act specified that committees composed of primarily fisheries scientists would set annual catch limits (i.e., the amount of fish that can be removed from a fish stock on a sustainable basis), a technical decision. The councils' roles were better defined to focus their decisions on allocation of opportunities to catch fish subject to the annual catch limit (value choices). Prior to the 2006 changes, the councils could override the specified catch limits if they felt such actions were in the best interest of fishing communities, and they often did. The 2006 revisions to the Magnuson–Stevens Act mandated that overfishing (i.e., harvesting fish at a rate greater than they can be replaced on a sustainable basis) must end by specified dates for stocks that are overfished (i.e., stocks in which the biomass is less than the biomass that will sustain maximum sustainable yield). The revisions have created a better balance between value (allocation) and technical (conservation) choices.

Although Canadian and Mexican managers of marine fisheries involve stakeholders in the development of management plans, they do so without the framework of the regional councils established in the USA. Fisheries and Oceans Canada has responsibility for managing marine fisheries in that country, whereas in Mexico, fisheries are regulated by the Ministry for Agriculture, Livestock, Rural Development, Fisheries, and Food.

5.3.2 Inland Fisheries Management

Fisheries management decisions in inland waters of North America have traditionally relied more on fisheries managers than on stakeholders to make both technical choices and values choices. Fisheries professionals have frequently made values choices, such as deciding which species to stock in reservoirs. Therefore, they defined much of the benefits the fishery would produce with little or no input from stakeholders. In addition, stakeholders have rarely been given the authority to make technical decisions regarding fisheries management in inland systems (although stakeholders frequently make suggestions of a technical nature).

The importance of stakeholder involvement in making fisheries management decisions in inland waters began to grow in the latter third of the 20th century, when increased interest in

the environment led to passage of several landmark environmental laws (e.g., the Endangered Species Act, the National Environmental Policy Act, and the Clean Water Act). In the USA the National Environmental Policy Act (NEPA), passed into law in 1970, had a particularly important effect on stakeholder participation in public-arena decision-making processes, as it mandated public involvement during the scoping (identification) of issues and selection of management alternatives by federal resource management agencies. The elevated importance of stakeholders in decision-making processes created by NEPA contributed to a proliferation of nongovernmental special interest groups, many of which were formed to influence federal resource management policies (Figure 5.3).

Although stakeholder input into management decisions in inland waters has grown in importance, it has rarely attained the formal authority or achieved the level of importance seen in marine fisheries management. The major difference between the systems is that far fewer commercial fisheries exist in inland waters than exist in marine waters. Most inland waters support predominately recreational fisheries with more emphasis on catching fish than on harvesting fish. Although harvesting fish is an important component of many inland fisheries, far fewer stakeholders (compared with marine systems) make a living directly from harvesting fish.

Most inland waters in the USA are managed by the individual states within which the waters are located. Federal involvement in inland fisheries management varies considerably. Inland waters located in national parks and national wildlife refuges generally are managed by federal agencies (the National Park Service and the U.S. Fish and Wildlife Service, respectively). The U.S. Forest Service and the U.S. Bureau of Land Management focus most of their efforts in fisheries management to habitat protection and improvement while leaving management of fish populations in waters located on the lands they control to the individual states. When inland waters border more than one state, the states involved usually collaborate to determine how the water will be managed, but each state normally has its own regulations.

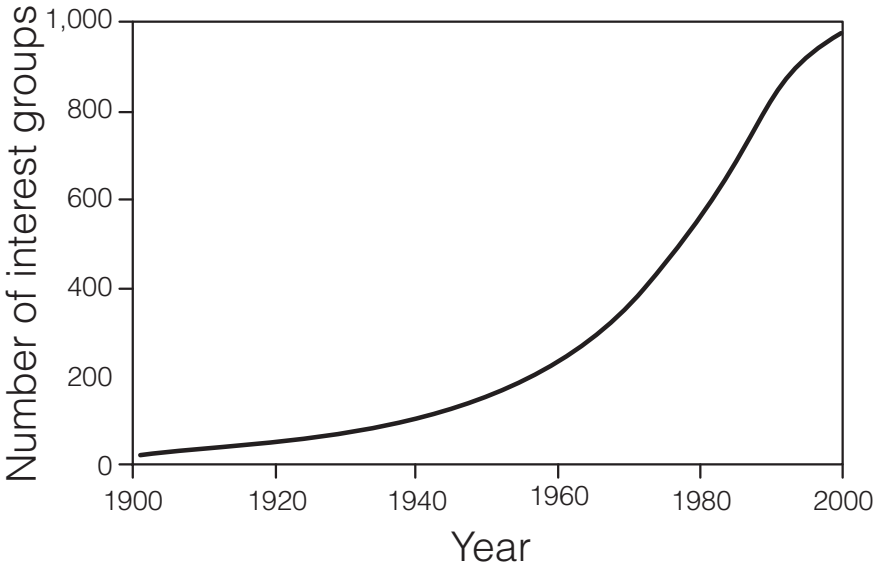

Figure 5.3. A growth curve of nongovernmental organizations with a primary interest in natural resources, 1900–2000 (data from Street 2003).

The Great Lakes Fishery Commission coordinates fisheries research and facilitates cooperative fisheries management among the states and Canadian provinces that border the Great Lakes. Native American tribes that have received federal recognition generally have authority to manage waters located on their reservation lands.

Another important distinction between fisheries management in inland systems and marine systems is the increasing emphasis placed on conservation and restoration of nongame fishes and other species in inland systems (See Box 5.1). Prior to passage of the Endangered Species Act (ESA) in 1972 (and its precursors, the Endangered Species Preservation Act of 1966 and the Endangered Species Conservation Act of 1969), nongame fishes were frequently regarded only as food for sport fish, objects for scientific curiosity, or even pests to be controlled in favor of sport fish species. The ESA represented an important values choice that elevated the importance of nongame species. However, unlike management of sport fish species, and despite the controversy that sometimes accompanies decisions to list species as threatened or endangered, conservation of nongame species has been accomplished mostly by fisheries managers making technical choices with little input from stakeholders. However, see Box 5.1 for a recent example where stakeholder input was very important in the management of nongame species.

It is important to note that even when the biological basis for fisheries management decisions is sound, decisions may be difficult or impossible to implement if stakeholders feel that important values they hold are not being adequately addressed (Churchill et al. 2002). The case of Norris Reservoir, Tennessee provides an excellent example of how difficult it can be to balance public values and good biology (see Box 5.2).

5.4 ADAPTIVE FISHERIES MANAGEMENT

Adaptive fisheries management is an iterative process of describing the current status of the fishery (Where are we?), identifying goals and objectives (Where do we want to go?), designing and implementing strategies to attain those goals and objectives (How will we get there?), evaluating the effects of strategies, and using the evaluation information to learn more about the system and to modify goals and objectives (Did we make it? and, What can we do differently?; Figure 5.4). In-depth discussions of adaptive resource management are available in Walters (1986) and Lee (1993).

5.4.1 Describing the Current Status of a Fishery

Good fisheries management is supported by scientifically-sound information on fish populations, fish habitat, and the stakeholders. One of the primary tasks of fisheries management agencies is to collect data on the fisheries they manage. Although most agencies have databases of information about fish populations (e.g., species abundance, age, and growth) and habitats (e.g., river flows and water quality), agencies rarely are satisfied that they have enough data for every fishery they manage. The resources available to an agency to inventory fish populations and habitats are never sufficient to generate reliable data for every fishery it manages. Additionally, the human dimensions of fisheries management (e.g., angler effort and angler opinions) have received less attention because this field is young compared with other aspects of fisheries management. Because fisheries managers always need additional infor-

Box 5.2. Value Choices and Technical Choices in the Norris Reservoir Fishery, Tennessee

The Tennessee Valley Authority (TVA) constructed Norris Reservoir in 1936 to provide flood control and hydroelectric power. As with many reservoirs, Norris Reservoir supported an initially productive fishery that began to wane as the reservoir aged. Thirty years after impoundment, anglers began expressing concern about declining catch and average size of walleye and sauger. As these fisheries declined, the Tennessee Game and Fish Commission (later to become the Tennessee Wildlife Resources Agency, TWRA) created a new fishery in the reservoir by stocking striped bass. The striped bass grew rapidly and established a popular trophy fishery. Despite the success of the striped bass fishery, many anglers, particularly those interested in fishing for walleye, sauger, crappies, and black basses, were unhappy with management of the reservoir.

At a meeting between anglers and the TWRA in 1988, anglers suggested that striped bass were responsible for poor fishing for other species due to predation and competition for prey fish. Many of the anglers at the meeting demanded that TWRA cease its stocking of striped bass. Although TWRA fisheries managers assured the anglers that predation by striped bass on other sport fishes was inconsequential, they agreed to increase their emphasis on management of native sport fishes in the reservoir. Attacks by the percid and black bass anglers on the striped bass management program led striped bass anglers to get involved in defending their fishery, and subsequently anglers became polarized into two camps (Churchill et al. 2002).

As the controversy escalated, the TWRA formed the Norris Reservoir Task Force and charged it with researching the issues related to fisheries management and developing recommendations for improving fishing in Norris Reservoir (i.e., making both values choices and technical choices). The task force included representatives from universities, TVA, TWRA, anglers, and a boat dock owner. Fisheries managers on the task force drove much of the decision making that resulted in the Norris Reservoir Adaptive Fisheries Management Plan. The plan proposed multiple field studies over a 5-year period designed to determine if changes in fisheries management strategies in Norris Reservoir were warranted. The plan called for a reduction in stocking of striped bass but did not call for a cessation of stocking altogether, as some anti–striped bass interests demanded. Although fisheries professionals, agency administrators, politicians, and some anglers approved of the plan, another group of anglers became increasingly alienated and vocal. The latter group of anglers formed the Tennessee Sportsman's Association (TSA) with the goal of increasing their influence on decisions regarding fisheries management in Tennessee.

The TSA convinced state legislators to introduce bills in the 1995 legislative session that would have prohibited stocking of striped bass in Norris Reservoir and removed harvest regulations for striped bass. These bills and some other attempts to introduce legislation regarding fisheries management were defeated, but legislators ordered the TWRA to fund a new research project to study competition and predation by striped bass. The TWRA solicited proposals to conduct the study from only out-of-state scientists in an attempt to avoid perceived bias by in-state scientists who had worked with TWRA on previous efforts. The independent study eventually concluded that striped bass predation

(Box continues)

Box 5.2. Continued.

on other game fish was negligible but that potential existed for competition between striped bass and other predators during periods of low prey abundance (Raborn et al. 2002, 2003, 2007). The TSA criticized the independent study and remained opposed to TWRA's management strategies for Norris Reservoir.

Following completion of the independent study, the TWRA initiated a second effort to develop a management plan for Norris Reservoir with a different set of stakeholders participating in the Norris Lake Fishery Advisory Committee. Unlike its predecessor, the advisory committee was comprised entirely of stakeholders, and TWRA fisheries managers served only as advisors. Members of the advisory committee included representatives of the antagonists (TSA and striped bass anglers) as well as nonaffiliated anglers, business interests, and county governments. Independent facilitators conducted meetings of the advisory committee. The advisory committee also differed from the task force in that it was tasked with devising management goals for the major sport fisheries in Norris Reservoir (making value choices), while development of alternative management strategies (technical choices) was left to the TWRA. The advisory committee chose which management strategies would become part of the new management plan.

The strategies approved in the new management plan did not differ greatly from those of the previous plan, calling for reduced stocking rates of striped bass and increased emphasis on management of native sport fishes. However, stakeholder acceptance of the management strategies was substantially greater. Churchill et al. (2002) concluded that the improved definition of stakeholder and professional roles in the separation of value choices and technical choices, along with further reductions in stocking rates of striped bass, led to substantial reduction of criticism from stakeholder groups.

Among the most important lessons learned from the Norris Reservoir case study was that dissatisfied anglers cannot be ignored in development of management plans and that research in the human dimensions of fisheries management is just as important as biological research as an underpinning for management. The TWRA had excellent information regarding fish populations and fish habitat during the Norris Reservoir controversy and gained even more information from the studies done as the controversy progressed. Although minor controversies continue to emerge regarding management of the Norris Reservoir fishery, the level of controversy dropped substantially when TWRA fisheries managers were able to focus stakeholders on making value choices and fisheries professionals on making technical choices. For more detail see Churchill et al. (2002).

Figure 5.4. The adaptive fisheries management cycle.

mation, and they have limited resources to obtain this information, they must prioritize what additional data are most important to collect. Adaptive fisheries management is a process of setting priorities that enables managers to strive for a management goal, testing the effects of strategies designed to reach that goal by monitoring implemented strategies, and then adjusting future strategies based on what is learned from the monitoring.

5.4.2 Identifying Goals and Objectives

Goals are broad statements of benefits desired from resources. Goals tend to be qualitative and value-laden expressions of the public interest. For example, a goal for management of a reservoir in the southeastern USA could be "to maintain a high-quality fishery for largemouth bass, including the opportunity to catch trophy-sized fish." Note the qualitative nature of the goal (i.e., high quality is not defined) and the values component (i.e., the emphasis on trophy-sized fish reflects just one of many reasons why people may be interested in fishing the reservoir). Due to the emphasis on the values component of goals, it is important for stakeholders to play an important role in determining them. Policymakers frequently identify tentative goals, after which fisheries managers facilitate public input on their desirability, which helps the policymakers to make decisions regarding final goals (Box 5.3). Since goals rarely have a significant technical choice component, the role of fisheries managers usually is limited to facilitating public input into their development and transmitting that input to policymakers.

Objectives are *specific*, *measurable*, *achievable*, *realistic*, and *time-bound* (SMART) statements of what must be achieved in order to attain goals. Often, multiple objectives are needed to attain a goal. For example, one objective related to the example goal listed above could

Box 5.3. The Process of Setting Fishing Regulations

Fishing regulations represent one of the primary management tools of fisheries managers. In the USA, inland fishing regulations are typically set by individual states through state fish and game regulatory processes. Fish and game commissions are generally separate entities from fish and game agencies, although they work together in various capacities. Fish and game commissioners are typically appointed by state governors, and they are generally appointed because they have a strong interest in some aspect of fisheries and wildlife. In some cases, regulations are established by state legislatures passing bills that are signed into law by the governor. State fish and game commissions use strict public processes to vet issues and receive public input. Fisheries managers must understand how their state commissions function to maximize the chances that fishing regulations are based on an appropriate balance of science and social factors. Because fisheries regulations require blending scientific information and social factors, fish and game commissioners must balance the needs of fisheries resources and the public interest.

Establishing functional, durable, and flexible fishing regulations requires much work and patience by fisheries professionals. Identification of a fisheries problem that can be improved through a regulation change is the first step toward development of new fish regulation. A fish and game commission can become aware of a problem through state fisheries managers, a commission member, members of the public, nongovernmental organizations, elected officials, or other stakeholders. If the commission feels a problem requires a regulatory solution, they will direct the state fisheries agency to bring forth to them a range of recommendations for their consideration. The process of preparing a packet for consideration by fish and game commissions can be a very simple exercise that can be completed in few months or can be extremely complex and last many years.

The four main factors to consider when developing a range of alternatives for a fishing regulation are (1) technical, (2) legal, (3) enforcement, and (4) social. Technical factors include information about the species of interest such as habitat requirements, life history characteristics, or harvest rates. In general, fisheries managers are comfortable in collecting and compiling technical information, though often uncertainties and data gaps exist that open up a decision to one based outside pure science. A legal review of proposed regulations should always occur to ensure that they comply with state and federal legal mandates and requirements. Enforcement staff should also review proposed regulations to ensure that they can be enforced. Establishing regulations that cannot be enforced or do not comply with legal requirements represents not only a waste of time in producing a regulatory package but can also cause problems between the agency and the public by creating confusion or conflict. Hence, it is important to consult early in the process with legal and enforcement staff. Accounting for social factors in developing fishing regulations is typically the most difficult step for fisheries professionals. Rarely do all segments of the fishing public agree on a regulatory solution. For example, there are often differing opinions among constituents regarding how protective a regulation should be (e.g., should a fishery be closed?). Those affected by a regulation because they live near a fishery may have different perspectives than those who travel far to fish there. Different user groups often feel differently about whether a fishery should be managed to allow for the use of bait or only single, barbless hooks.

(Box continues)

Box 5.3. Continued.

A critical component of preparing a range of alternatives for commission consideration is understanding the range of values associated with the proposed regulation. To understand the range of values, outreach should be conducted to include members of the fish and game agency itself, other agencies that could be affected by the regulation, user groups, local land owners, industry leaders, and local fishing businesses that may be affected. In addition to better understanding the issues associated with the proposed regulation, it is less likely the fisheries management agency will be surprised when proposing the regulation to the commission at the public hearing, something neither the management agency nor the commission tends to react to positively. Public outreach can be difficult and can range from contacting organized angling groups to posting information in tackle shops and on appropriate internet sites regarding proposed regulations and how interested parties may offer input about the proposal. This type of outreach can make a world of difference in developing balanced regulations that are palatable to most constituents.

Under the simplest of scenarios, when the technical, legal, enforcement, and social factors are as well understood as possible, fisheries managers develop a regulatory package that generally includes a problem statement with background information, current data on the issue, any pertinent legal and enforcement ramifications, and impacts to anglers and other constituents. This packet should be reviewed through the management agency's chain of command and then forwarded to the fish and game commission. The commission will publicly publish notice of the proposed regulation as required by law. There may be a number of commission hearings on the matter before a vote is taken to ensure adequate public notice. It is typical that fisheries agency staff present the information to the commission and answer any questions. It is important to prepare a clear and concise presentation. Preparation should include a review by agency management as well as anticipating questions that may arise. When presenting material to a fish and game commission it important to understand the roles of the agency and of the commission. Specifically, the agency prepares and presents materials, makes recommendations, and answers questions of the commission. The commission considers information presented, including public testimony, and makes the decision to promulgate a regulation or not.

If the commission adopts a regulation, the regulatory language is sent to the state's office of administrative law (or equivalent) to ensure the language meets legal requirements for clarity and other legal standards. In the event that a regulation is adopted the commission typically has a mechanism to disseminate the new regulations to interested parties.

Any regulation should include a monitoring component to determine if the regulation has the desired effect. Agency staff should plan to update the commission on the effect of the regulation to the fishery and stakeholders. This communication allows the commission to work toward an adaptive management approach by considering adjusting regulations as needed.

Details of the process of establishing fisheries regulations varies somewhat from state to state; however, the basic framework is consistent. Understanding the process for those who engage in regulation changes is critically important. Equally important is a clear grasp and appreciation of the role of the fishery agency, the fish and game commission, and the stakeholders. When all of these parties play their role appropriately, fisheries regulations with the right balance of science and social values should emerge.

be "to increase the average length of largemouth bass caught by anglers to 350 mm within 5 years." Note that the SMART objective is specific and easily measurable (i.e., it states a measurable feature that constitutes success, and it can be measured relatively easily through creel surveys or monitoring of fishing tournaments). It also is time-bound (i.e., within 5 years). We cannot tell from this hypothetical example how realistic or achievable the objective may be; judging how realistic and achievable the objective may be is the job of the fisheries manager. If objectives are SMART, they contribute to the credibility of fisheries management by making it easy to determine if objectives have been attained. Fisheries professionals play an important role in development of objectives because much technical knowledge is required to translate broad, general goals into SMART objectives. Policymakers and stakeholders have to agree that selected objectives are appropriate stepping stones to attaining goals, but they generally play a lesser role in developing the objectives.

5.4.3 Designing and Implementing Strategies

Strategies are the methods used to attain goals and objectives. While goals and objectives focus on what we (fisheries managers, stakeholders and policymakers) want to achieve, strategies focus on how we will achieve goals and objectives. Fisheries managers play a key role in developing strategies and in evaluating the likelihood that strategies will attain an objective. Fisheries managers also should evaluate the effects that proposed strategies are likely to have on the resource and the stakeholders.

Balancing the roles of fisheries managers and stakeholders in development and evaluation of strategies is complex. Stakeholders frequently suggest strategies to fisheries managers (e.g., requesting a change in fishing regulations on a specific body of water) without giving much thought to the objective they want to attain. For example, when I (S. L. McMullin) worked as a fisheries manager in Montana, a local chapter of Trout Unlimited requested that the regulations on a portion of a popular trout river be changed from a 5-fish-per-day limit to catch-and-release angling. Queries as to why the group wanted a catch-and-release regulation identified the organization's goal as the desire to have fish of larger average size in the catch. When information was presented to the group that indicated the fish population in that portion of the river was increasing and that average size was decreasing as the population increased, the group agreed that harvesting some fish was a desirable strategy.

Stakeholders share with fisheries managers the key role of evaluating strategies because choosing how to attain objectives often creates winners and losers. For example, when restrictive regulations like the catch-and-release proposal discussed above are implemented, they usually are accompanied by restrictions on the use of live bait because mortality of fish caught and released on live bait is typically higher than is mortality of fish caught and released on artificial flies and lures (Taylor and White 1992; Muonecke and Childress 1994). The losers in this case are the anglers who prefer to use live bait because they are excluded from fishing the area under the restrictive regulation. The winners may be the anglers who use flies and artificial lures because they now have fewer anglers using the area, unless the restrictive regulation attracts more fly and lure anglers to the area.

Fisheries managers, stakeholders, and policymakers all play important roles in selecting strategies to pursue. Depending on the type of strategy, either fisheries managers or policymakers will probably make the final decision, but stakeholders should have input into most of those decisions. For example, fisheries managers usually make decisions about strategies

related to management of fish habitat, whereas policymakers (commissions or boards) usually make final decisions about strategies related to fishing regulations at the state level (see Box 5.3).

5.4.4 Monitoring and Evaluation

Monitoring and evaluation provide the feedback loop that allows fisheries managers to determine if selected strategies are having intended effects. This critical step in the adaptive management process should be based on scientifically-sound sampling to determine if goals and objectives are being attained. The sampling should be designed to answer questions such as the following.

1. Are fish populations responding as desired or predicted?

2. Is the quality of fish habitat improving, declining, or staying about the same?

3. Are stakeholders satisfied with the quality of the fishery or their fishing experiences?

Fisheries professionals play key roles when designing and implementing monitoring programs, analyzing the data, and reporting to stakeholders and policymakers on the progress toward attaining goals and objectives. The judgment of fisheries managers is important in suggesting why strategies may not be working and what alternative strategies might be more effective. Stakeholder input is important in determining satisfaction or dissatisfaction with progress made toward attaining goals and in modifying goals if that is deemed necessary. Policymakers, as elected or appointed representatives of stakeholders, have oversight responsibility to ensure that fisheries professionals are doing all that they can to attain management goals.

The information gained from monitoring and evaluation should feed back into the adaptive management loop to help determine the status of fish populations, habitat, and people (e.g., stakeholder satisfaction) after strategies have been implemented. The important point is that all participants in the adaptive management process learn more about the system as a result of the monitoring and evaluation activities. When monitoring and evaluation information is shared, fisheries managers, stakeholders, and policymakers may decide that new goals and objectives are needed or that the current goals and objectives are appropriate. In either case, the process should continue through successive iterations to continue learning about the system and to improve management of the fishery. Box 5.4 discusses two contrasting cases of fisheries management on Montana rivers and Box 5.5 discusses a controversial fisheries management project in California that illustrates the importance of gaining public acceptance for management.

5.5 CONCLUSIONS

Fisheries management is a challenging process of understanding fish populations, fish habitat, and stakeholders interested in a fishery and taking actions to manipulate those components of the fishery to achieve goals and specific objectives. The process of fisheries management involves fisheries managers, stakeholders, and policymakers when making values

Box 5.4. Adaptive Fisheries Management in Montana

The Bighorn River is a world-famous trout fishery in south–central Montana. Prior to construction of Yellowtail Dam (1960s) near the Wyoming–Montana border, the Montana portion of the river was virtually ignored by anglers because it held few fish of interest to them. However, the dam created cold, clear water ideal for trout and soon after impoundment, the river was producing many large brown trout and rainbow trout. The river's reputation for producing good trout fishing led to a rapid increase in angler use, but that ended in 1975 when the Crow Tribe of Native Americans closed access to the river to all but members of the tribe. A lengthy legal battle between the Crow Tribe and the State of Montana ensued until 1981 when the U.S. Supreme Court decided that the State of Montana had responsibility for managing the Bighorn River fishery. The court decision opened the river to public access and fishing pressure increased rapidly.

Starting in July 1981, fisheries personnel from the Montana Department of Fish, Wildlife and Parks (MDFWP) began monitoring population abundance, average size, and growth rates of brown trout and rainbow trout in particular as well as angler use. Monitoring indicated that river flows significantly affected fish abundance. Low average flows resulted in higher mortality and lower population abundance, whereas higher average flows produced higher population abundance. Despite high angler use, mortality due to fishing appeared to be insignificant, probably because most anglers voluntarily practiced catch-and-release fishing.

Despite the evidence that habitat factors were more important than was fishing pressure in determining fish population abundance, a series of events led stakeholders to exert pressure on the MDFWP to implement more restrictive regulations. A highly publicized fish kill during the summer of 1984 was followed by extremely low flows and cold temperatures (which reduced growth rates of trout) during the summer of 1985, which led many stakeholders to believe that the fishery, especially the trophy fish component, was in trouble. As a result, MDFWP fishery managers decided to develop a management plan for the Bighorn River based on an adaptive fisheries management process.

The process began with public meetings designed to involve stakeholders in identifying desired goals for management of the fishery (focus on making value choices). Stakeholders identified the opportunity to catch large, wild trout as the highest-priority management goal. With the goal identified, MDFWP fisheries managers developed specific objectives and strategies designed to achieve the goal (technical choices). The goal, objectives, and strategies were published in a draft management plan that included detailed descriptions of trends in fish populations and the factors affecting fish populations. Strategies recommended by the MDFWP focused on improving management of flows in the river with only minor changes in fishing regulations.

Results of a survey distributed with the draft management plan indicated that an overwhelming majority of people who read the plan agreed with the goal, objectives, and recommended strategies. Ninety-three percent of the survey respondents agreed that reading the plan improved their understanding of the Bighorn River fishery. Furthermore, 50% of the survey respondents agreed that they had changed their minds about how the fishery should be managed as a result of reading the plan. The latter result was especially

(Box continues)

Box 5.4. Continued.

gratifying to MDFWP fishery managers because a high percentage of the people who received copies of the draft management plan were stakeholders who had previously contacted the agency with critical comments about management of the fishery.

When the Montana Fish, Wildlife and Parks Commission (the policymakers) met to consider adoption of the management plan, one stakeholder group that disagreed with the proposed strategies presented a competing proposal that would have implemented more restrictive fishing regulations than were called for in the plan. After hearing both the agency proposal and the competing proposal, the commission approved the management plan as proposed. The commissioners cited the adaptive management process used by MDFWP fisheries managers, including its focus on stakeholder involvement in making value choices and professional involvement in making technical choices, as a key factor in their decision to adopt the management plan rather than the competing proposal.

At the same meeting in which the commissioners adopted the Bighorn River management plan, they also denied a request by MDFWP fishery managers in another region of the state to implement new regulations on a portion of the Missouri River. The Missouri River fishery managers had fish population monitoring information that was as good as that available on the Bighorn River. They also faced a competing proposal from stakeholders who opposed the change in regulations proposed by the MDFWP. The major difference between the two fisheries was the adaptive fisheries management process utilized by managers of the Bighorn River fishery. The commissioners expressed their concern that stakeholders on the Missouri River did not have the same level of involvement in the management process as stakeholders on the Bighorn River. The side-by-side contrast of the Bighorn and Missouri river cases led the commission to instruct MDFWP fisheries administrators to develop management plans for the 10 most highly-used fisheries in Montana by means of the adaptive fisheries management process.

It is important to note that the adaptive management process did not eliminate controversy over how the Bighorn River should be managed, as demonstrated by the competing proposal presented at the commission meeting. However, it did defuse most controversies. In addition, it provided opportunity for stakeholders to define the management goal (value choice) and for MDFWP fishery managers to educate stakeholders regarding the rationale for their recommended strategies (technical choices).

Box 5.5. Lake Davis Case Study

A controversial fisheries management project involving California's Lake Davis highlights the importance of the human dimension in fisheries management. Lake Davis is a 1,600-ha reservoir in California's Sierra Nevada. Proposals to use rotenone to eradicate illegally-introduced northern pike from the reservoir seemed straightforward from a technical perspective, but the human dimension added substantial complexity to the process of deciding the course of action and implementation of the eradication project.

A highly controversial eradication effort in 1997 and a generally well-accepted eradication project 10 years later highlight the importance of a broad and integrated fisheries management approach that recognizes and addresses human values as an essential element of a project. In particular, the values of clean drinking water and public health were explicitly integrated into the project as an objective. This was key as managers worked to eradicate an invasive species.

In the 1980s, reproducing northern pike were discovered in California's 1,011-ha Frenchman Reservoir. Soon after, they were discovered in nearby streams. The species was eradicated using rotenone but then were found several miles away in Lake Davis.

The establishment of northern pike in Lake Davis adversely affected the local trout fishery. In addition, the growing potential for their escape or illegal transport from Lake Davis to other parts of California posed significant risk to a number of sensitive species should they become established elsewhere. Consequently, California fisheries managers chose to eradicate the population.

Lake Davis, however, is more than a premier trout fishery. Prior to 1997, the reservoir was used as the drinking water supply for the community of Portola and other local residents. In preparing for the first Lake Davis eradication project in 1997, fisheries managers proposed to take the drinking water off line (alternative groundwater wells were constructed) and treat the reservoir with rotenone. The proposal was greeted with numerous concerns from members of the local community about the safety of chemicals proposed for use. The California Department of Fish and Game (CDFG) fisheries managers repeatedly assured the community that the chemicals were safe. However, because the chemical formulation was considered proprietary by the rotenone formulation manufacturers, the CDFG was unable to provide legally to the public the list of constituents in the rotenone formulation that was proposed for use. As a result, the fisheries management proposal was perceived by the local community as being suspect and harmful to public health and safety. The community responded with protests and legal action, which were reportedly widely by the media.

On the morning of the treatment, about 300 state and local law-enforcement personnel had arrived and were stationed around the reservoir, in part due to death threats to CDFG personnel. To the community, however, the large enforcement presence appeared heavy handed and fueled more anger. Despite the controversy, the CDFG proceeded with the project.

Although the treatment initially appeared successful, a year and a half later in 1999 northern pike were found again in Lake Davis. It has not been determined if these northern pike were illegally reintroduced or survived the 1997 treatment. The vehemence and emotion surrounding the treatment were such that after the rediscovery, the CDFG did not propose a retreatment. Instead the agency's director met with a group of local elected

(Box continues)

Box 5.5. Continued.

officials and community members who formed a steering committee to address the issue. The CDFG and the steering committee prepared a plan to deal with the invasive northern pike that focused on education, enforcement, and intensive manual removal. Rotenone was removed as an option for dealing with the problem. The CDFG established a small office in the local community, and the CDFG fisheries managers became both ambassadors to the community and northern pike removal specialists as they proceeded with removal efforts.

Despite the removal of tens of thousands of northern pike over the next few years by means of backpack and boat electrofishers, gill, trap, and fyke nets, and a purse seine, the population grew; the control and containment efforts were ineffective. The northern pike caused the trout fishery to decline, impacting the local economy, and the risk of escape of northern pike downstream or their transport by humans was increasing. By 2003, the steering committee requested that the CDFG evaluate eradication but only via methods that were completely safe to the public and that considered economic effects to the community. The value of clean drinking water and public health and safety needed to be the primary considerations in fisheries management objectives.

The CDFG considered many options, but rotenone came to the forefront as the safest and most reliable means of eradication. However, if rotenone was to be approved for use in Lake Davis, all of the water quality concerns raised by the public would need to be addressed in an open and public forum. The fact that the formulation had been evaluated by the state and federal regulators was not sufficient to allay concerns of the local citizens. All of the technical questions and concerns needed to be addressed by knowledgeable specialists in a community forum that included all of the relevant public health agencies.

The U.S. Forest Service (USFS), which owned the land around Lake Davis, became a full partner in the project. In September 2006 the CDFG and the USFS issued a notice of preparation of an Environmental Impact Report and Environmental Impact Statement (EIR–EIS), a joint environmental document for full public disclosure under the California Environmental Quality Act and the National Environmental Policy Act. Initial public scoping meetings revealed skepticism by many locals regarding the safety of rotenone to the environment. The CDFG committed to a series of public meetings to disclose fully any information about the chemicals and to address other community concerns. Many concerns regarding the project were also raised by a variety of local, state, and federal agencies. A draft EIR–EIS was produced that examined an array of alternatives for northern pike eradication. After review and response to the public comment, the CDFG and the USFS certified the final environmental document, and a project involving the use of rotenone was approved.

Public outreach continued throughout the planning process; openness and transparency continued to be a top priority. This helped to demystify the project and demonstrate to the public why the project was necessary and that success was likely.

Under a structured leadership system, eradication took place over 1 month and included treatment of the reservoir and all the tributaries to Lake Davis. More than 500 participating staff were housed and fed locally to benefit the local economy. Subsequent to

(Box continues)

Box 5.5. Continued.

the eradication, extensive monitoring and reporting were carried out. The reservoir was restocked with rainbow trout and included a highly publicized event aimed at promoting fishing and tourism in the area.

In 2007 much of the community supported the project because the CDFG and the USFS engaged the community, openly provided information about the project, and answered all questions from the public. The turnaround in the community response to the CDFG resulted from recognition that fisheries managers must address the human elements as well as technical issues to complete the project.

choices (defining desired benefits) and technical choices (how those benefits can be achieved). The process is most effective when stakeholder involvement focuses on making values choices and professional involvement focuses on making technical choices. Policymakers must bridge the gap between values choices and technical choices. Adaptive fisheries management is an iterative process of describing the current status of the fishery (where are we?), identifying goals and objectives (where do we want to go?), designing and implementing strategies to attain those goals and objectives (how will we get there?), evaluating the effects of strategies, and using the evaluation information to learn more about the system and to modify goals and objectives (did we make it and what can we do differently?).

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