Chapter 10: Water Managers Can Enhance Biodiversity

Water is vital to all living organisms and plays a major role in shaping Oklahoma's natural communities. Water quality and quantity are important for both aquatic and terrestrial communities. Pollutants can disrupt natural functions and cause species to disappear from systems. Disruptions in hydrology can alter natural communities. Frequency and seasonality of floods also have large impacts on biodiversity, especially along Oklahoma's streams and rivers.

Because biodiversity is intertwined with water quality and quantity, maintaining high levels of biodiversity can have significant benefits in managing water for human needs. Functions of native species and natural communities may be harnessed to benefit human needs. This arena should be explored much more thoroughly.

The large number of species inhabiting healthy wetlands contributes to the many functions performed by the community. Many of these are useful for achieving human goals. One goal of water managers is providing an adequate water supply while minimizing flood damage to human activities. Historically, bands of marshes bordered Oklahoma's streams and rivers and absorbed flood waters, thereby lowering peak flood levels downstream. These marshes stored flood water and released it slowly back into the stream, creating a more constant flow in the river and reducing severity of both floods and droughts. By slowing and storing flood water, these wetlands also served as important recharge areas for ground water reserves.

Organisms in wetlands filter nutrients from their waters. Water moving among the plants is slowed enough that sediment settles from the water before entering the stream and causing sedimentation and turbidity problems. Plants and animals remove excess nutrients, such as nitrates and phosphorous, that

degrade water quality. More research is focusing on ways to use manmade wetlands in the treatment of wastewater.

High levels of biodiversity associated with aquatic environments often enhance economic growth of the human community. Whole economies may be developed around recreational and tourism activities involving aquatic and wetland communities. Fishing, hunting, birdwatching, photography, boating, canoeing and floating are a few of the activities that benefit from high levels of biodiversity in areas associated with water. The aesthetic value of many of these areas also attracts economic development in the form of housing and industry. Although precautions must be taken to ensure that development does not destroy the very resource that attracted it initially, the availability of recreational opportunities often is considered when companies and developers consider potential development sites.

Monitoring species and natural aquatic communities can provide early warnings of problems in the environment. In diverse communities, some species often become highly specialized and have very low tolerances for pollutants or other degradations of their environment. Aquatic species present in an area often reflect the water quality. Population declines or disappearance of a sensitive species may serve as early alerts that water quality or quantity has declined. By maintaining healthy natural communities in which these species live, we may detect problems before they become severe enough to cause problems for human health or other uses.

Native species and diverse natural communities may be used to control erosion or floods at lower costs than structures built to perform the same tasks. Healthy riparian corridors along drainage ditches, streams and other water bodies trap sediment and other particles before they enter the waterway. These communities also reduce erosion along the stream where rip-rap might otherwise be needed. Not only does this improve water quality and prolong the life of reservoirs and ponds, but it also maintains aquatic communities that are destroyed as silt and sediment accumulate. Using riparian vegetation and wetlands to absorb flood waters and reduce peak flows may be less expensive than channelizing streams and lining them with concrete or rip-rap. By using natural communities to perform these tasks, managers can solve the root cause rather than merely treat the symptoms that result from abuses to natural systems.

Water Managers Benefit Biodiversity

A variety of measures are practiced by landowners and governmental agencies to protect water quality and quantity. Although most of these actions are targeted toward meeting human needs, many also provide benefits for biodiversity conservation. Some of these actions are conducted on a voluntary basis, whether from a stewardship ethic or a financial incentive. Others are legally required and closely regulated.

A variety of governmental programs that clean up polluted sites that have been abandoned are funded by voluntary contributions. The Oklahoma Conservation Commission reclaims abandoned coal mines that cause pollution from acidic runoff using funds collected from a tax on coal sales. The Oklahoma Department of Environmental Quality (Department of Environmental Quality) receives a portion of fuel taxes to clean up leaking underground storage tanks to stop pollution of surface and ground waters.

Because upgrading wastewater treatment facilities is expensive, various state and federal funds are available to assist municipalities and industries in improving their facilities. These grants enable these communities to meet regulations for water quality and discharge better quality water.

Various human activities result in soil, chemicals and other substances entering Oklahoma's streams through surface runoff and erosion. These pollutants are called "non-point source pollution" because they are not discharged from a single, identifiable location. Because these pollutants enter streams through runoff waters, the Oklahoma Conservation Commission spearheads a program to encourage and assist landowners, especially agricultural producers, to maintain strips of vegetation along drainages to slow and filter sediment and nutrients from run-off water. The Oklahoma Department of Agriculture—Forestry Services provides information on Best Management Practices for building roads. Not only do these im-

prove the water quality for aquatic communities, but they also provide valuable riparian habitat.

Commodity subsidies have encouraged many farmers to raise crops on highly erodible lands, causing erosion and siltation problems. The 1985 Farm Bill initiated the Conservation Reserve Program to reduce the acreage of highly erodible land in crop production. In return for monthly payments, farmers sign 10-year agreements to stop cropping the land and establish permanent vegetative cover. A similar program, the Wetlands Reserve Program, was implemented in the 1990 Farm Bill to encourage farmers to conserve wetlands on their property.

Water Quality

Discharge of substances into "waters of the state" is regulated to control the amounts of various substances entering aquatic environments. Although these regulations usually are designed to prevent water quality degradation, they also protect aquatic biodiversity.

The Department of Environmental Quality is the state agency responsible for permitting pollutant discharges. Water Quality Standards have been established by the Oklahoma Water Resources Board to guide management of the state's waters. These standards determine the maximum amounts of various substances that can be released into a water body. Other agencies, such as the Corporation Commission and Department of Agriculture, are responsible for regulating pollutants and wastes from oil and agricultural industries, respectively.

The Department of Environmental Quality conducts a program to monitor pollutant levels present in various streams and reservoirs in the state. Water and fish tissue samples are analyzed to detect the presence of various substances. This Department cooperates with the Oklahoma Conservation Commission and various councils of government to determine "Total Maximum Daily Loads" (the maximum amount of discharges that may be made into a watershed or stream in one day) for watersheds or streams. These results are used to determine permitting requirements for activities affecting the water quality of the watershed. The Oklahoma Conservation Commission and Water Resources Board also conduct monitoring programs. Currently, potential reference conditions are being identified to serve as examples of high-quality streams with which other streams can be compared. Potential reference conditions will be identified for each ecoregion in the state and will represent the most natural conditions for the area's aquatic communities. This information will be useful for projects involving development and implementation of guidelines to protect aquatic communities.

The Oklahoma Department of Agriculture requires applicators of pesticides to be certified to prevent inappropriate and illegal applications of these chemicals, including overapplication and use of pesticides for purposes other than those for which they are registered. Requiring applicators to be knowledgeable about these chemicals and the restrictions placed on them helps minimize their impacts on biodiversity. The Oklahoma Department of Agriculture—Forestry Services assists forest landowners and woodsworkers in minimizing water quality problems from forestry activities, through use of the state's forest best management practices, monitoring, education and complaint investigation.

The Oklahoma Department of Mines regulates the operation and reclamation of mining operations to protect water quality in accordance with federal mining regulations. These regulations minimize water pollution during the removal of minerals and require that surface mines be reclaimed so further pollution is prevented.

The U.S. Army Corps of Engineers regulates construction activities in all waters of the United States, except farm ponds and sewage lagoons. Fill, discharge and alterations of these waters and their hydrology must receive a permit under Section 404 of the Clean Water Act. Biodiversity impacts are considered when determining whether a permit should be granted. The Corps also conducts water quality studies to define existing conditions on their lakes and to provide a basis for future water quality investigations. These services can be provided to other federal, state or local agencies and tribal nations.

Five state agencies respond to citizen complaints or reports of pollution. The Department of Environmental Quality is the primary agency responsible for regulating pollutant discharges and enforcing regulations when a pollution event occurs. The Corporation Commission investigates spills of pollutants associated with the production of oil and gas, while the Depart-

ment of Agriculture investigates those involving agricultural wastes and forestry. When pollution kills fish or wildlife, the Department of Wildlife Conservation investigates damages to these resources. The Oklahoma Conservation Commission serves as a clearinghouse for all pollution complaints. All of these agencies, except the Department of Wildlife Conservation, are responsible for ensuring that the pollution is cleaned up to prevent further damage.

Cleanup of severely polluted sites that have been declared as National Priority Listings, nicknamed "superfund" sites, is coordinated by the U.S. Environmental Protection Agency and the Department of Environmental Quality. Once a site has been listed, available funds are allocated based on the needs of the site. The U.S. Fish and Wildlife Service and the Department of Wildlife Conservation coordinate restoration of the natural communities damaged by such pollution.

Water Quantity

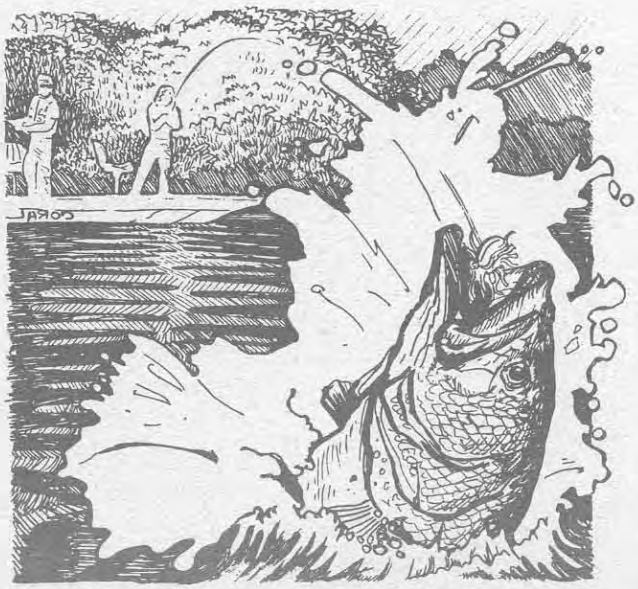
The Grand River Dam Authority and Cherokee Nation allocate water withdrawals and dam releases in the Neosho River (also called the Grand River) and Cherokee County, respectively. A number of municipalities and other governmental agencies manage other reservoirs. The Water Resources Board regulates withdrawal of water from the remaining reservoirs, rivers and groundwater supplies in the state. Because the quantity of water present in streams, rivers and, in many cases, groundwater reserves has tremendous impacts on biodiversity, the withdrawal of large amounts of water significantly affects aquatic communities.

Management of Wetlands and Fisheries

Several state and federal agencies are involved with the restoration or creation of wetlands on both public and private lands. Partners for Wildlife, operated by the U.S. Fish and Wildlife Service, is a cost-share and technical assistance program that has helped a number of private landowners restore and create wetlands on their properties. The Oklahoma Department of Wildlife Conservation, Oklahoma Conservation Commission and Natural Resources Conservation Service also assist private landowners with management of wetlands. The Department of Wildlife Conservation and U.S. Fish and Wildlife Service manage wetlands on public lands and provide technical assistance to private landowners for the benefit of wildlife species, including waterfowl, shorebirds and a myriad of others that depend on these habitats. The U.S. Army Corps of Engineers protects wetlands on both public and private lands. The Oklahoma Water Resources Board is currently reviewing the viability of a regional approach using reference wetlands to gather data for the wetlands standard setting process.

The Oklahoma Department of Wildlife Conservation and Corps of Engineers enhance fishery habitat in many of the state's reservoirs. Practices such as sinking brush piles to provide cover for fish and lake level management plans, which improve habitat for fish and waterfowl, have been implemented on several reservoirs. The increased shoreline vegetation resulting from management of lake levels also reduces shoreline erosion and improves water quality. The Department of Wildlife Conservation also works with private landowners to develop fishery habitats in their ponds or small reservoirs, including technical assistance and fish stocking.

Several species inhabiting Oklahoma's aquatic communities are important for sportfishing or for commercial products. To prevent overharvest of these



Sportfishing is an important use of Oklahoma's waters for recreation and boosts local economies.

species, the Department of Wildlife Conservation enforces a number of regulations. These include minimum size requirements and creel limits for anglers. Other regulations control commercial harvest of wild populations of minnows, aquatic turtles, mussels and fish. This agency also regulates fish farming to ensure that undesirable exotic species do not escape into Oklahoma waters.

Various governmental agencies are required by law to protect and manage threatened and endangered species. Because several of Oklahoma's threatened or endangered species are associated with aquatic habitats, several governmental agencies that manage Oklahoma's waters protect or enhance habitat for these species. The U.S. Army Corps of Engineers regulates releases from dams during the breeding season to avoid flooding interior least tern nests on sandbars downstream. The presence of other threatened or endangered fish and mussels are considered when permitting various activities in streams and rivers. In some cases, habitat is purchased or created to provide benefits for these rare species.

Ways Water Managers Can Enhance Biodiversity

Water Quality

Not only is the amount of water present vital to aquatic biodiversity, but it also must be of sufficient quality for the species to survive. Although some pollutants are easily visible and aesthetically offensive, some are not visible and most people would not realize that the water is polluted.

Sedimentation. Erosion carries large amounts of soil into the state's streams and rivers each year. Activities that remove or disturb vegetation near water increase the soil's vulnerability to erosion. After entering the stream, sediments settle onto the bottom in areas where the water is slowed. This causes pools that are important for fish populations to fill with sediment. Beds of mussels may be covered by sediment, killing the population. Eventually the stream bed may become very uniform and provide little habitat for aquatic species.

Maintaining healthy vegetation in riparian areas is an important way of protecting the stream from sedimentation. Stilling pools below dredge or fill operations may be used to trap sediments before they move farther downstream. A variety of other BMPs have been developed to minimize soil erosion during construction operations and other activities which could impact aquatic habitats.

Toxics. Toxic substances that enter water through accident or design degrade water quality and may severely affect aquatic biodiversity. Although governmental agencies regulate discharges of harmful substances, unreported or accidental releases still occur. Federal and state agencies need to continue working to stop these sources of pollutants. Agencies should provide the public with appropriate contacts to notify when in the event of a pollution occurrence. Incentives should be developed for individuals or companies who report unregulated discharges so they can be resolved before serious damage occurs.

Fertilizers and pesticides are the most common causes of pollution in urban areas. Agencies and conservation groups should educate the public that lawn chemicals have serious effects on biodiversity. Alternate landscaping methods—for example, buffalo grass as a turf grass—that reduce dependency upon these chemicals should be explored and publicized.

Agricultural wastes and nuclear or radioactive materials applied as fertilizer can enter waterways if application rates are too high or a precipitation event occurs before plants absorb the nutrients. These substances can destroy aquatic communities, which then require long periods of time before they recover. Applicators should be aware of the amount of fertilizer their land can efficiently use and should avoid applying during periods of high rainfall.

Heavy metals and acid mine drainage can have permanent effects on biodiversity unless contaminated soil is removed. Continued efforts should be directed toward preventing these materials from entering the water and for cleaning affected sites.

Landfill locations should be carefully selected to ensure that harmful substances cannot escape into ground or surface waters.

Underground injection sites for saltwater and hazardous waste should be inspected regularly to ensure that they do not leak into groundwater or

streams. Any problems identified should be resolved quickly to prevent resource damages. Alternative methods of disposal also should be investigated.

Reservoir Operation. Reservoir operation can impact biodiversity in a number of ways. Dams physically prevent fish from moving upstream and the flood pool destroys bottomland communities and some upland areas. However, release policies can impact downstream aquatic communities as well. Releasing cold water from lower levels of the reservoir can convert a warm water system into a cold water stream for a distance below the dam until the water warms. This may be a factor in the decline of mussel species in the state.

Unless water flows over structures designed to aerate it, discharges from the bottoms of reservoirs usually contain very low levels of dissolved oxygen. Until this water flows a particular distance downstream and absorbs oxygen from the air, aquatic species may be stressed or killed. Similar low-oxygen kills may be caused when releases are stopped abruptly, trapping fish in the stilling pool.

Litter. One of the most visible degradations of water quality is litter and trash. Roadside dumping and dumping trash on private property along rivers can seriously pollute the water.

Recycling programs could have significant impacts on reducing illegal dumping and pressures on landfills. However, recycling is quite inconvenient in most areas, especially in rural parts of the state. Most people are unwilling to expend the effort currently required to store recyclable materials and transport them to collection areas. Although some communities have established roadside collection or other more convenient methods of recycling, these are expensive. The determining factor of the success of recycling programs is the demand for these resources for manufacturing products. Most efforts to increase recycling should be directed toward creating markets for the supply of recyclable material.

An "Adopt-A-Stream" program could be developed to encourage volunteer groups to remove litter from a stream segment on a regular basis. This could operate similar to a similar program which has been popular for highways. Efforts could focus on heavily used streams where litter is a significant problem. Large bags could be supplied to canoe rental locations so canoeists could collect any litter they find during their trips and properly dispose of it at the end point.

Water Quantity

For obvious reasons, water quantity is a determining factor in shaping aquatic communities. Some wetlands depend on variations in water depth to allow vegetation to grow. Other aquatic systems require relatively stable water levels. Alterations in the amount of water present in aquatic systems and in the timing and frequency of water level changes have caused profound impacts to our state's biodiversity.

Flood control practices can affect biodiversity in many ways. Structures may physically prevent aquatic species, such as the paddlefish, from moving upstream into headwater spawning areas. Abrupt changes in flow patterns may leave fish stranded below dams. Interrupting annual flood patterns breaks the life cycle of mussels and several fish species. Vegetation grows on sandbars in Oklahoma's large rivers in the absence of periodic scouring and makes these areas unsuitable as nesting areas for the interior least tern and snowy plover. Flow patterns also can affect bottomland forests, resulting in changes in their composition.

Managers of flood control structures should attempt to mimic natural stream flows in their releases. Releases should be increased during the spring, when rainfall usually is highest. Research should be devoted to finding alternate methods of flood control, apart from constructing dams. Floodplains downstream from flood control dams could be used as parks and allowed to flood during periods of high flows.

As an alternative to dams for flood control, wetlands constructed upstream from areas prone to flooding might be useful for absorbing peak flows and serve as buffers to low flows during drought periods. The feasibility and proper design for this use of wetlands should be investigated. If this system proves to be functional, landowners could be targeted in necessary locations and incentives could be given for them to allow the wetlands to occur on their property.

Extensive irrigation-dependent agriculture has lowered the groundwater table in some areas to such an extent that some streams and sections of rivers no longer contain surface water except during periods of high precipitation. Efforts need to be made to find ways to use less water, such as more efficient irrigation

methods, no-till practices or new drought-resistant crop varieties. Not only will this protect the area's biodiversity, it also will extend the useful life of the aquifer.

Habitat

Habitat structure, both within the water and along the banks, is important for maintaining the aquatic community. Riparian vegetation traps sediment in runoff water, keeping it from entering the stream. In the Ozark and Ouachita Mountain ecoregions, shade from riparian trees is important for the cool water communities inhabiting the streams. In-stream structures, such as riffles and pools, are essential for many species survival.

Best Management Practices (BMPs) have been developed for many activities to minimize their impacts on aquatic communities. Various incentives should be investigated to encourage more use of these practices.

Stream channelization severely impacts aquatic habitats. Straightening and widening the stream channel causes water to flow through more quickly and in a uniform manner. In-stream structures, such as pools and side channels, are destroyed by this practice and those downstream are impacted through sedimentation. Higher stream velocities with no curves or in-stream structures to slow the water create erosion problems and eventually result in the formation of deep ravines. Because channelization usually treats a symptom rather than a cause and always impacts biodiversity, it should only be conducted after other erosion or flood-control measures have been attempted.

Demonstration sites need to be developed to educate landowners about the value of riparian vegetation and how to manage these sensitive areas. These sites should occur in a variety of ecoregions to span the range of conditions and riparian vegetation in the state.

Wetland regulations need to be examined for their effectiveness. In some cases, tighter restrictions on development in "natural" wetlands may need to be enacted. In others, more flexibility may be beneficial to encourage landowners to develop wetlands on their property. Incentives or cost-share programs, like the U.S. Fish and Wildlife Service's Partners for Wildlife program, should be promoted so more landowners will take advantage of them.

Experimentation should be conducted to identify ways to use manmade wetlands to perform functions, such as wastewater treatment. Projects in other states have shown wetlands to be effective in treating wastewater from municipalities and confined feeding operations. Not only did these wetlands provide additional habitat for aquatic communities, but they also were more cost-efficient than conventional treatment methods.

Managed wetlands may be useful to treat wastewater from a variety of sources.

Exotic Species

Due to the problems many exotic species create, water managers should be cautious when using introduced species. Erosion control efforts should focus on using native species whenever possible. If an exotic species must be used, it should be tested to ensure that it will not spread into other areas and invade natural communities.

Because exotic species pose serious threats for both aquatic and terrestrial communities, efforts are made to prevent the introduction of many species that could become established in Oklahoma and cause damage to our native communities. Because aquarium owners purchase a wide range of exotic species, the pet trade is a large potential route for some of these species to

become introduced into Oklahoma waters. Some aquarium owners release fish into ponds or streams when the fish get too large or the owner becomes tired of maintaining the aquarium. Because of this potential threat, the Oklahoma Department of Wildlife Conservation prohibits a number of species, such as piranhas, from being sold in Oklahoma. The Oklahoma Zebra Mussel Task Force currently is encouraging boaters to take special precautions, such as carefully cleaning the hull and bilge areas, to slow the spread of zebra mussels.

Education

Although most people realize that protecting water quality is important, many are less familiar with otherfactors that affect aquatic biodiversity. In fact, although they are concerned about water quality, many people do not know what actions cause pollution. Most people believe that large businesses are the primary source of water pollution and do not realize that their own actions can have significant effects.

Both adults and children should be informed about the importance of water to biodiversity and about the impacts they might have on water. They should realize that their actions affect habitat, water quantity or quality. They also should be informed about actions they can take to protect these resources.