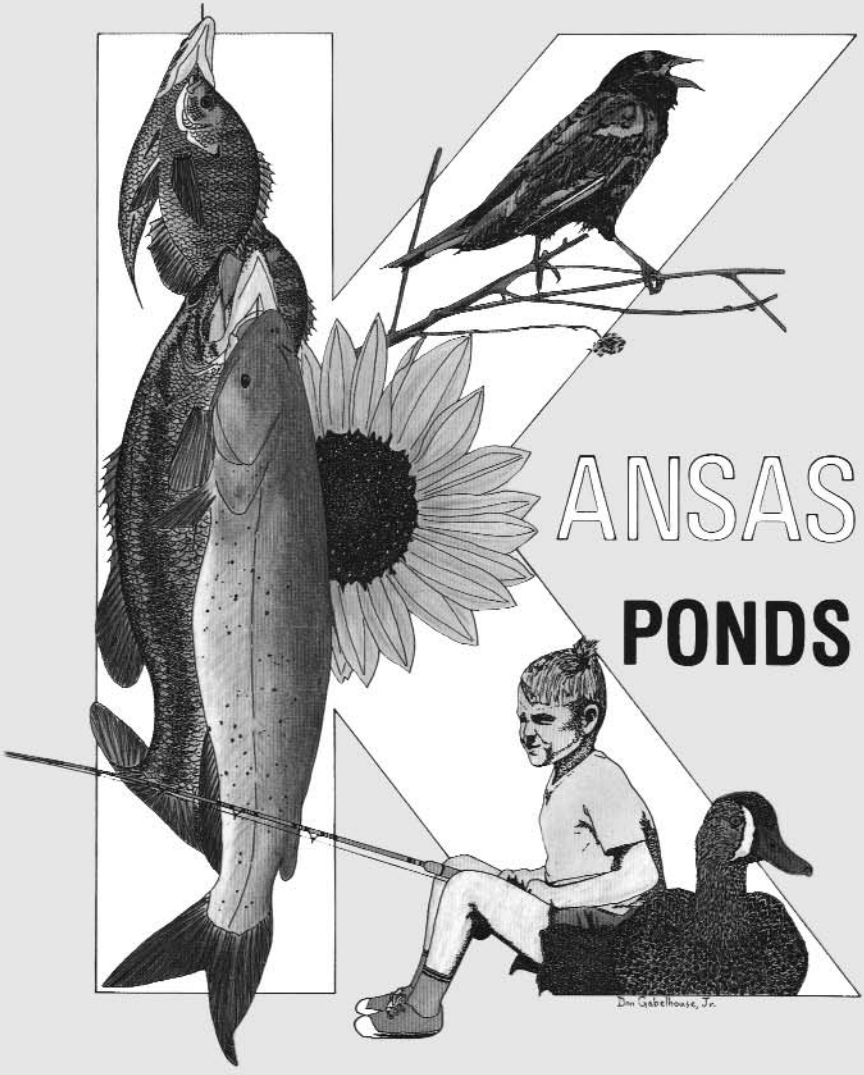
PRODUCING FISH AND WILDLIFE FROM



ACKNOWLEDGEMENTS

This booklet is the result of effort by several people. The authors wish to thank the following people for their contributions: The Kansas Department of Wildlife & Parks employees Tommie Berger, Bruce Bertwell, Steve Price; former Kansas Department of Wildlife & Parks employees Steven Becker, Michael Cox, James Goudzwaard, Ronald Peterson, Robert Wood; and George Schurr, Soil Conservation Service, retired.

Gratitude is expressed to the following for review of preliminary drafts: Kansas Department of Wildlife & Parks Personnel Robert Hartman (retired), Jerry Hazlett (retired), Val Jansen, and Mike Theurer; Rex Hamilton, formerly of the Soil Conservation Service, and Richard Anderson, former Unit Leader, Missouri Cooperative Fish & Wildlife Research Unit.

Thanks are also extended to Alvin Lopinot, formerly of the Illinois Department of Conservation, and Joe Dillard of the Missouri Department of Conservation whose pond fish management booklets served as guides for subject matter, organization, and illustration needs.

Illustrated by DONALD W. GABELHOUSE, JR.

PRODUCING FISH AND WILDLIFE FROM KANSAS PONDS

4th Edition

Donald W Gabelhouse, Jr., *Former Pond Fisheries Investigator*
Kansas Department of Wildlife & Parks

Richard L. Hager, *Former State Biologist*
United States Department of Agriculture
Natural Resources Conservation Service

Harold E. Klaassen, *Former Associate Professor of Biology*
Kansas State University

Revised by Randall Schultz, *Aquatic Research Biologist*
Kansas Department of Wildlife & Parks

Graphic design by Dustin Teasley, *Senior Graphic Designer*
Kansas Department of Wildlife & Parks

CONTENTS

INTRODUCTION

Approximately 100,000 Kansas ponds offer some of the best and some of the worst fishing the state has to offer. Under good conditions, ponds are capable of producing high quality fishing because the kinds of fish stocked in ponds interact and complement each other. The size of a pond also makes fish readily available to anglers of all ages.

Poor fishing occurs in Kansas ponds for two major reasons. First, most ponds are not built expressly for fishing. Potential fishery benefits are often unrealized because some uses such as direct watering of livestock destroy fish habitat and decrease water quality. The pond owner may be interested in fishing, but unwilling to manage the pond to produce good fishing, especially if a primary use must be altered.

Poor fishing also occurs because most pond owners and anglers lack understanding of appropriate fish management practices. This booklet will provide pond owners and anglers with information to effectively manage fish and wildlife resources associated with ponds. Fish and wildlife can be accommodated in a multi-purpose pond with minimal adverse effects on other uses. While it may be infeasible to put all of these ideas into practice, pond owners and anglers should be aware of the potentials that exist for a pond that is built, developed, and managed as outlined in this booklet. Fish and wildlife can contribute significantly to the quality of life in Kansas!

GETTING STARTED

Technical Assistance

The Kansas Department of Wildlife and Parks, Natural Resources Conservation Service, and Kansas State University all provide technical assistance to landowners for various conservation practices.

The Department of Wildlife and Parks conducts research to discover new and better ways to manage ponds for fishing. Knowledge of improved management techniques is then passed on to the public through presentations, personal contact, and written material such as this booklet.

The Department of Wildlife and Parks Wildlife Habitat Improvement Program (WHIP) is specifically designed to provide technical assistance to landowners desiring to improve terrestrial wildlife habitat on their property. Depending on agency budget, WHIP may also offer financial help to acquire seed and plant material, labor and machinery. Advice and assistance pertaining to construction, development, and management of ponds for both fish and wildlife can be obtained by contacting any Department of Wildlife and Parks office.

The Natural Resources Conservation Service (NRCS) provides conservation information and assistance to landowners. Help regarding location, design, construction and maintenance of ponds can be secured from Natural Resources Conservation Service offices in all Kansas counties. Pond owners may obtain cost-share funding through programs administered by the Farm Service Agency (FSA).

The Division of Biology at Kansas State University conducts fish and wildlife research and provides advice to pond owners. The Kansas Cooperative Fish and Wildlife Research Unit, a cooperative venture between the National Biological Service, K-State, the Department and the Wildlife Management Institute, enhances research and education in fisheries and wildlife. The Unit trains students in the fields of fisheries and wildlife, and provides information that is available to assist pond and owners and the public. The University's Cooperative Extension Service also supplies information and advice as well as trees and shrubs for planting at nominal prices. Assistance from these groups can be secured by contacting any county agricultural agent, the Unit, or the fisheries and wildlife extension specialist at Kansas State University.

Pond Permit Requirements

When building a new pond or refurbishing an old one, a landowner must obtain a permit if the structure will impound 30 acre-feet or more of water measuring to the top of the dam. Applications are available free of charge from the Chief Engineer, Division of Water Resources, State Board of Agriculture, 109 SW 9th Street, Topeka, KS 66612-1283, from the water commissioners at Garden City, Stafford, Stockton, or Topeka field offices, or from any county Natural Resources Conservation Service or Farm Service Agency office.

The applicant is required to submit a detailed construction plan, specifications of the dam, and any other information the Chief Engineer may request, including compliance requirements for the Environmental Coordination Act. The Chief Engineer has the authority to accept, condition, or reject any pond application. Failure to comply with the requirements is a class "C" misdemeanor and the court may, by mandatory injunction, require the removal or modification of any dam.

A permit is also required to construct a pond or otherwise modify habitat occupied by threatened or endangered fish and wildlife species. Such permits can be obtained from the Kansas Department of Wildlife and Parks.

Cost sharing programs administered by the Farm Service Agency will not be allowed without proper permits. Farm Service Agency personnel are familiar with pond permit requirements and can help fill out applications. Natural Resources Conservation Service personnel can also provide this assistance.

The landowner must also file for a water right on impoundments built to retain 15 acre-feet or more of water if a beneficial use is made of the water. Water appropriation rights are obtained through the Division of Water Resources for a fee that is based upon the volume of water to be impounded. The minimum fee is $100. Without a water storage right, the pond will be subject to removal, or water releases may be necessary for water right holders downstream from the impoundment.

SITE SELECTION

Watershed Size

The size of the watershed, or the amount of the area that drains into a pond, is important to the success of the pond. Without special construction considerations, damming an area that carries too much water may cause erosion problems within the pond while too little water may allow the pond to go dry. The minimum area needed in the watershed for each acre of pond surface varies from 1,000 acres in western Kansas to 10 acres in eastern Kansas. Central Kansas ponds usually require a ratio of approximately 30 acres of drainage to 1 acre of pond surface. The best ratio for any specific location depends on the soils, type of vegetation in the watershed, the intended uses of the pond, drainage pattern, springs and slope of the watershed.

Land Use

Land use in the watershed above the pond should be considered when selecting a site because the quality of the fish community in the impoundment will reflect the quality of the watershed. Active erosion may fill a pond with sediment in relatively few years. Land with grass cover generally has less erosion and is desirable. Land with row crops can produce erosion and sedimentation problems if soil conservation practices are not applied and if a grass buffer area is not developed. Cropland can also contribute toxic materials such as pesticides and excessive nutrients in the form of fertilizer, which can lead to fish kills and aquatic vegetation problems.

Topography

A site with suitable topography can save money during construction and avoid problems in operation. A natural draw or low area with a moderate slope which narrows at the dam site involves less earth moving and still provides adequate amounts of deep water. Extensive flat areas usually provide too much shallow water, which encourages the growth of aquatic vegetation and results in excessive evaporation losses. Extremely steep sides often contain too little shallow water for fish spawning to occur and may be unstable and slump into the pond. Major drainages should be avoided as pond sites because large amounts of runoff are difficult to retain. Damming a stream usually required an extensive spillway and modified dam to handle the volume of the flow. Streams also commonly carry high silt loads and provide access to the pond for undesirable fish species.

Soils

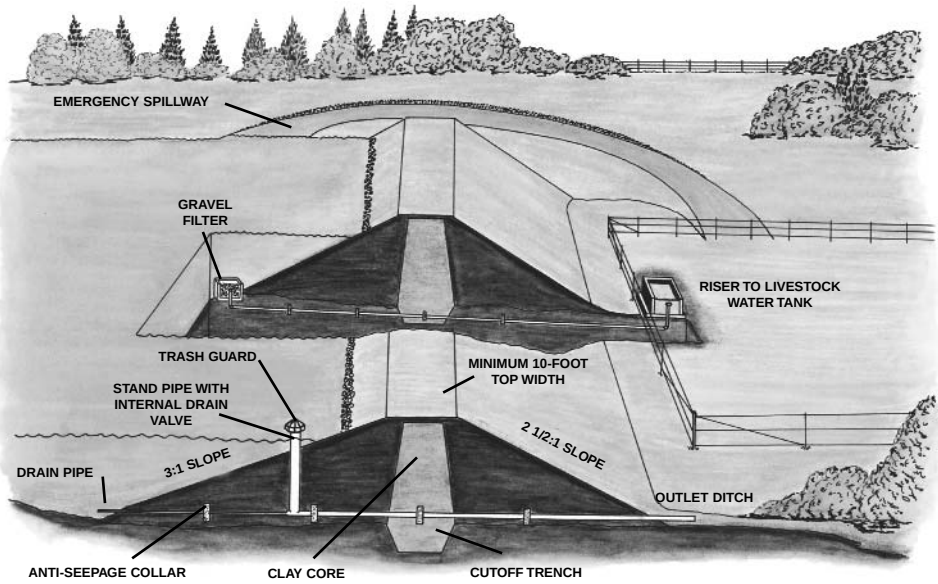
It is important to determine soil type at the site before construction begins. Soils in the area to be impounded must hold water with a minimum of seepage. Soils for an embankment pond must also be suitable for dam and spillway construction. Clay and silty clay are good soils for impounded areas, but some clay soils stay in suspension, causing water to remain turbid. Sandy clay is generally suitable, while sand, gravel and sand-gravel mixtures are unsuitable. Outcrops of shale, limestone, sandstone or other bedded materials should be avoided. These may contain crevices or channels that can cause excessive water loss or seepage from the pond. Detailed information on the suitability of various soils for pond construction is available from the Natural Resources Conservation Service.

Pond Uses

Intended pond uses and the question of whether to stock fish should be determined before a site is selected and the pond is designed. While it is sometimes best to design a pond for its primary use, multi-purpose ponds can be constructed for a variety of uses as long as all uses are considered in the design stage. While not normally compatible with fish production, even livestock can be accommodated through proper pond design.

POND CONSTRUCTION CONSIDERATIONS

Ponds designed and constructed primarily to provide sport fishing usually provide fewer management and maintenance problems. The following construction features can make the difference between a good, average or poor fish pond.



Pond Size

Ideal fishponds cover from 2 to 5 acres. Without exacting harvest restrictions, ponds smaller than 1 acre are suitable for catfish but are usually unsatisfactory for bass and bluegill due to the potential for over harvest of bass. Ponds over 5 acres can provide angling to greater numbers of fishermen, but if problems occur, management is usually more difficult and expensive.

Pond Depth

Recommended minimum depths vary depending on the site and location. Adequate depth is necessary for continued fish survival. Ponds which are spring fed should be at least 8 feet deep over at least one-quarter of the impounded area. Ponds which have surface runoff as their primary source of water should be 15 feet deep over one-quarter of the impounded area in western Kansas and at least 10 feet deep in eastern Kansas. Not more than one-fifth of the impounded area should have a water depth of less than 2 feet. Slopes along the shoreline for two-thirds of the distance from the dam to the upper end of the impounded area should be no flatter than 3 feet horizontal for every 1 foot vertical.

Deep water protects fish from winterkill and discourages excessive growth of aquatic vegetation. A pond over 15 feet deep is usually a waste of money, as extra-deep waters are rarely used by fish in the summer and do not add to the pounds of fish produced in the pond.

Site Preparation

Construction of a pond alters the environment and thus affects associated wildlife. Negative impacts on wildlife can be minimized if stabilized draws leading into and out of what will be a pond are left unchanged. Trees and other plants growing along such areas serve as wildlife habitat while detaining silt.

The dam or foundation area should always be cleared of trees, boulders, stumps, roots, sod and rubbish. Brush and trees in the fill could lead to leakage through the dam. Brush and trees can be left for fish cover in upper end and side drain pool areas of larger ponds containing bass. More information on this subject is presented in the "Fish Attractors" section. Topsoil containing organic matter should be stockpiled for later use. After construction is complete, this topsoil should be spread over the dam and spillway to help the growth of grasses, and over the basin to increase the productivity of the pond.

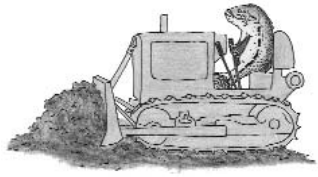
Small ponds should have all brush and trees removed from the pool area. This is necessary in small ponds because the majority of soil removed from the impounded area will likely be needed to construct the dam. Brush and trees need to be removed from catfish-only ponds because catfish typically overpopulate in the absence of bass predation if brush and trees are available as spawning sites.

The bottom of the pond should be left rough or irregular to create fish habitat in bass-bluegill-catfish ponds. In addition, drop-offs, islands and trenches should be constructed in the basin when feasible. Catfish-only ponds should have a smooth bottom, again to discourage excessive spawning which could produce an overpopulation of small catfish.

Potentially Leaky Ponds

Soils in some pond sites must be sealed to prevent potential leakage. These sites should be used for a pond location only if there is no alternate site, because most methods of sealing ponds are expensive. Professional advice should be obtained before attempting to seal a potentially leaky pond. This subject is discussed further under "Sealing Leaky Ponds."

Dam



It is important that the material in the dam be tied to the soil in the foundation. A cutoff trench should run lengthwise along the dam. This cutoff or core trench should be backfilled with clay-type material compacted in layers. Failure to install a core trench may result in seepage and even loss of the dam.

The dam should be constructed of impervious moist material that is compacted in continuous horizontal layers as it is

installed. Dams pushed up with a dozer and not compacted have a greater chance of failure.

The dam should be constructed with slopes that will not slump or slide. The steepness of the slope on the pond side of the dam should not exceed 3 feet horizontal to 1 foot vertical; and the steepness of the slope on the downstream side should not be greater than 2 1/2 feet horizontal to 1 foot vertical.

The recommended top width is 10 feet for a dam less than 20 feet in height. This width should be increased an extra 2 feet for each 5 feet of dam height over 20 feet.

All dams should have extra height or freeboard to prevent floodwater and waves from topping the dam. The minimum elevation of the top of a dam should be 1 foot higher than peak flow of water in the emergency spillway or 3 feet higher than the non-flowing elevation of the emergency spillway.

Spillways

All embankment ponds require one or more spillways for overflow water. It is common to have a vegetated earthen emergency spillway around one end of the dam for flood flows and a pipe spillway through the dam for normal flows. The stand pipe or trickle tube should be installed a foot or more below the level of the earthen emergency spillway. Anti-seepage collars are needed along the pipe through the dam to help prevent the pipe from washing out. A trash guard should be installed on the stand pipe for safety purposes and to prevent clogging with debris.

The design capacity and type of materials needed for both the emergency and pipe spillways are variable for different pond sizes and watersheds. Technical advice should be obtained from the Natural Resources Conservation Service or a civil or agricultural engineer for this portion of the pond design.

Drain Pipes

All fishponds should have a drain so that the pond can be emptied if undesirable fish populations develop. The drainpipe may be a separate installation or incorporated as a valve in the stand pipe. A separate drainpipe which runs through the dam should meet loading pressures and have anti-seepage collars.

Banks

Shorelines should have 3:1 slopes to reduce the chance of aquatic vegetation problems. Slopes that are too steep (more than 2:1) can be a safety hazard for people and livestock and could slump or slide into the pond. Shaping of the banks during pond construction may cost extra but can save money in the long run by reducing aquatic vegetation problems. The dam should be protected from wave action and erosion. Rock riprap or special purpose grasses are commonly used on dams for wave protection.

Making Uses Compatible

A fishpond may have other compatible uses if these uses are planned in advance and the appropriate features are included in design and construction.

Livestock Water

Fishponds are good sources of livestock water if properly constructed. Ponds less than 2 acres should be fenced to exclude livestock, and a pipe should be installed through the dam to a stock tank located below the dam outside the fenced area. Keeping livestock out of the pond benefits both the pond and livestock from an animal health and economic standpoint. Weight gains are greater for cattle that water out of tanks than those that drink the same water they live in. When livestock are allowed access to the pond shoreline, they trample banks, decrease the useful life span of the pond, and prevent development of desirable fish communities by muddying and overenriching the water.

Irrigation

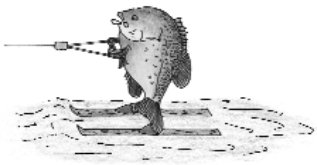
Irrigation and sport fishing are usually not compatible uses due to the large fluctuation of water levels and possibilities of summer and winter fish kills. Small gardens and lawns can be irrigated from large ponds if sufficient drainage area is available to offset water use and losses such as leakage and evaporation.

Silt and Flood Water Detention

Ponds designed to retain silt and high volumes of water normally remain turbid for long periods. Sight feeding fish like bass and bluegill do poorly in such ponds. Channel catfish can be stocked in ponds with muddy water with success as long as no spawning sites are available. Catfish overpopulation is a threat if spawning occurs.

Recreation

A pond of from 2 to 5 acres can provide many hours of fishing, non-power boating, and other recreation activities. Power boating and skiing do not normally mix well with fishing because wave action can erode the shoreline and muddy the water. Sight feeding fish do poorly under such conditions. Ponds over 5 acres are sometimes suitable for public recreation on a fee basis. If the pond is to be used for recreation, safety measures are needed. All trees and other material should be removed from the marked swimming area, and lifesaving equipment such as ring buoys and ropes should be available. A ladder or long plank should be placed near the pond during ice skating season in case of an accident.



Ponds, like any body of water, attract people. This can lead to the possibility of an accident. The liability of the pond owner can vary depending on whether the party is an invited guest, a

trespasser, or an individual who has paid fees. Many other factors can influence the pond owner's liability in case of accident. It is recommended that pond owners consult their attorneys and insurance agents for proper protection against lawsuit.

Fire Protection

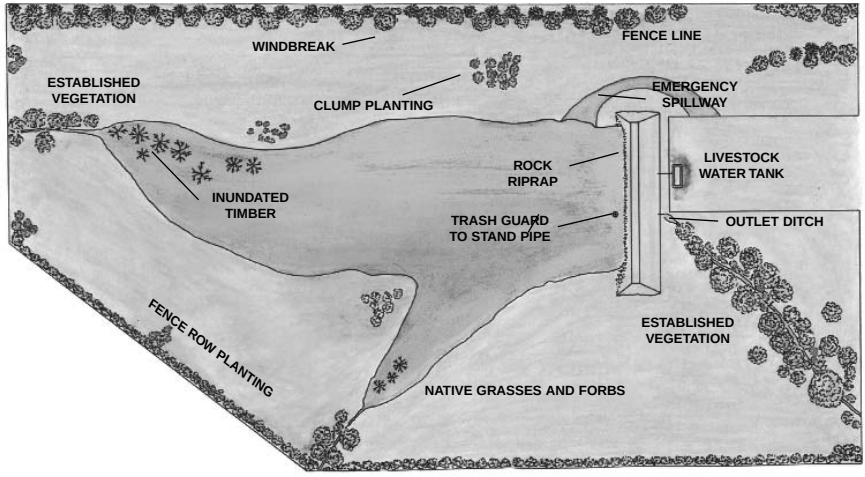
A fishpond can provide water for fire fighting if it is located near a house or buildings. A pond can also be used to fill a fire truck if a proper access road is available.

Maintenance

Proper maintenance of the pond is as important as good design and construction. The pond should be checked on a regular basis for erosion, pipe damage and obstruction, and fencing. Timely maintenance usually prevents expensive repairs or possible failure of the dam. It is much easier to shape small eroded areas and keep pipes free of trash than it is to replace the dam.

AREA DEVELOPMENT

Development around the pond can influence use and maintenance of the pond itself. The dual usage of fishing and wildlife can even cause management conflicts if consideration is not given in the development stage.



Fencing From Livestock

All fishponds with impounded areas less than 2 acres need to be completely fenced if livestock are present. Larger ponds should be fenced if physically possible. Even partial fencing of large ponds provides some benefits. The amount of fenced area required for any given pond will vary with adjacent land uses and pond owner desires. A minimum would be to set the fence

back 40-50 feet from the pond's maximum high water level. The shoreline, dam and spillway must be protected from livestock access. On existing ponds with no easy means to provide water except from the pond itself, livestock access should be restricted to one or two watering points.

Establishing Vegetation

Permanent native vegetation should be planted on the dam, spillway, terraces, waterways, and other construction areas as soon as possible. Native grasses, such as buffalograss, Indiangrass, switchgrass and western wheatgrass, planted in combination with forbs such as Maximilian sunflower, and legumes such as prairie clover, provide cover for wildlife and protection from erosion. Local Natural Resources Conservation Service personnel and Department of Wildlife and Parks district wildlife biologists can provide recommendations on species, seedbed preparation, fertilization and planting times.

Pond Basin

Planting a cover crop in the pond basin or the area to be flooded is recommended for new ponds over 5 acres. Planting rye, oats, wheat, sudan grass, or other cover crops before flooding helps tie down the bottom soil and keeps the water clear, provided the seed has sufficient time to grow prior to being covered with water. Flooded vegetation also supplies a substrate on which fish food organisms develop. Ponds less than 5 acres frequently fill too rapidly for planted vegetation to establish.

Dam Plantings

The dam should be protected from erosion due to wave damage with either rock riprap or special grasses. A dense cover of prairie cordgrass, Kanlow switchgrass, Chinese silvergrass, or Reed canarygrass may adequately protect the dam where wave action is minimal. Trees should not be planted or allowed to grow on the dam because their roots can cause water leakage problems.

Pond Banks

The banks and a buffer area around the pond should be planted to permanent vegetation. Native vegetation, including switchgrass and other water-tolerant grasses, should be used. This buffer strip provides wildlife habitat as well as preventing silt from entering the pond from adjacent areas. Vegetated banks also provide a pleasing setting for fishing and other pond uses.

Wildlife Habitat

Regardless of how a pond is built or managed, fish are not the only animals that will benefit from its presence. In fact, creatures such as frogs, salamanders, turtles, and many birds may begin using a new pond immediately, often before fish are established. While it's true we don't often go to a pond just to watch wildlife, a brood of wood ducks or a deer coming to

drink can highlight a fishing trip. What child is not fascinated watching the dervishing of whirligig beetles on the glass-smooth surface of a pond?

The point is, a pond is not just a "fish" pond. It is a community of many living things, most of which depend on each other for survival. The pond itself forms a connecting link between the aquatic and terrestrial worlds. By considering the pond's influence on land animals as well as water dwellers, the pond owner can enjoy the best of both worlds.

Fencing

To enhance wildlife habitat around a pond with livestock nearby, the first thing to do is start driving fence posts. Fencing has been recommended in nearly every pond booklet and leaflet ever written. The same recommendation will be included in every booklet printed in the future. Fencing is an important, if not the most important, measure needed on most ponds to protect and enhance wildlife habitat. The effects of livestock grazing and trampling around concentration areas like ponds have been well documented in many scientific and popular publications. Livestock may make a pond edge more attractive to mourning doves, but the bare mud will offer little to other wildlife.

Planting the Pond Periphery

Planting the pond area has already been discussed to some extent from the standpoint of erosion and sediment control. However, pond owners should also be aware that vegetative cover would largely influence what types of wildlife regularly use the pond.

In native rangeland, merely fencing the grassed area around the pond will provide the low, herbaceous cover needed to benefit ground nesting birds and mammals. If the pond is to be located in cropland or tame pasture, a native grass mixture should be planted within the fenced area. The Natural Resources Conservation Service's specifications for range seeding and critical area planting should be followed.

Depending on the land available, tree and shrub plantings should be considered. A windbreak of trees on the south and west sides of the pond will provide cover for birds and small mammals and help reduce wave action and turbidity in the pond. A two-row planting of cottonwood or autumn olive and Rocky Mountain juniper or redcedar will usually begin to provide some wind protection within 5-7 years after planting.

Random clump plantings of trees and shrubs can also be incorporated if sufficient space is available. Plants which are adapted to the site conditions and have proven wildlife values should be used. Some woody plants known to be attractive to wildlife include the native dogwoods, wild plums, aromatic sumac, redcedar, autumn olive and multiflora rose. In some parts of eastern Kansas, cedar and rose have proven to be problem invaders on grasslands, so their use in wildlife plantings

may not be desirable. Other plants can be substituted, however, and still achieve results. The pond owner is invited to contact the local Department of Wildlife and Parks, Natural Resources Conservation Service, or Extension Service office to obtain technical assistance in planning vegetation introductions.

Waterfowl Management

Ponds with permanent water will attract a variety of birds, ranging from tiny shorebirds to an occasional goose. Most pond owners enjoy seeing waterfowl use their ponds, and most ponds can be enhanced to increase chances for their usage. However, the decision to manage a pond for waterfowl must be made before the pond is built. No matter which management technique is eventually used, a water control structure must be included in the dam. Nearly all successful waterfowl efforts on impoundments require some water level manipulation.

The most suitable method for attracting waterfowl during migration is to provide a flooded food source. This can be accomplished by lowering the pond's level 2-3 feet during late June or July. A grain crop such as millet should be seeded on exposed mud flats just as soon as the water is removed. The water should be maintained at this lower level while the millet germinates and grows. The water level can be raised back to normal beginning about October 1. This will create flooded food source highly attractive to many kinds of waterfowl.

Conditions almost as desirable can be created simply by drawing the water down in late June or July, allowing annual weeds and grasses to develop naturally on exposed mud flats. Reflooding should begin about October 1. This is a simpler method and is often just as successful as sowing a grain crop.

Some potential problems must be considered before a pond is managed for waterfowl by using water-level fluctuation. Water supply often is a limiting factor in pond management for waterfowl. Unless sufficient inflow is available for reflooding, lowering water levels should not be attempted. If a pond cannot be refilled, the decreased water depth may be harmful to fish during the winter. Another problem results even if enough water is available for refilling. Decomposition of flooded vegetation may result in a rapid loss of oxygen in the water and can cause substantial fish kills. Lastly, a pond built to maximize waterfowl use would contain extensive areas of shallow water with large amounts of aquatic vegetation desired. Fishponds, on the other hand, minimize shallow water areas so that excessive aquatic vegetation is avoided.

If land is available, a more suitable way to provide waterfowl habitat without interfering with fish management potential is to construct a 1-3 acre shallow water area below the pond dam. Water from the pond can be used to seasonally flood the area, creating a man-made marsh. Timely drainage during May should result in a dense stand of desirable wetland plants such as smartweed, which can be flooded in the fall. Shallow water

areas can also be drained in late June or July and seeded to millet if the pond owner desires. Such shallow water areas offer many more wildlife options than trying to rely on water level manipulation within the pond itself. The pond-marsh combination provides for much more efficient use of water since only a 12-15 inch average depth is needed in the marsh. To further enhance such shallow water areas, openings should be mowed in dense, tall vegetation before flooding. A good rule of thumb is to provide a marsh habitat with half open water and half emergent vegetation. Department of Wildlife and Parks district wildlife biologists and Natural Resources Conservation Service personnel can provide further information regarding construction of the cost-share funding for marshes. Wildlife biologists can also provide information regarding the installation of nesting structures for giant Canada geese.

Habitat Maintenance

All too often it is assumed that, when wildlife habitat is established, the job is done. Since vegetation is the major component of habitat, the habitat is always changing due to plant succession. Consider an abandoned crop field. For the first several years, it is mostly annual grasses and weeds. Gradually, it grows into perennial grasses and weeds. Over the eastern third of the state, such areas will eventually become dominated by brush and trees.

The secret of encouraging wildlife use of a habitat is to maintain a stage of succession which will benefit the kinds of wildlife desired. Since it is impossible to hold vegetation in just one stage for any great length of time, it becomes necessary to set back succession and allow the process to occur again, thus recycling the most beneficial succession stages.

Succession is more rapid in eastern Kansas than in the more arid regions of western Kansas. Nevertheless, it occurs statewide and must be considered in a maintenance program. Limited or controlled burning, mowing, plowing, discing, and grazing can all be valuable habitat maintenance tools. Even chemicals, with careful use, can be of value. Department of Wildlife and Parks district wildlife biologists can assist in recommending and explaining habitat maintenance procedures.

Fish Attractors

Trees and brush that must be removed to obtain fill for the dam should not be burned. A beneficial use is to relocate this material within the pond basin to serve as fish attractors. Fish attractors are designed to produce food and provide cover for fish in the pond. Their ultimate purpose is to concentrate fish for angling.

Fish attractors in the pond can benefit all species of fish. Bluegills, minnows, and any other prey use fish attractors as a place to hide from predators. While hiding there, they generally find an increased food supply of aquatic insects. Bass will find an attractor a good place to feed on bluegills or to rest.

Any type of tree will work as a habitat structure. Hardwoods, such as hedge or oak, are excellent choices, and the abundant redcedar is ideal. These trees can be tied together in any number of configurations or placed separately with pre-formed or custom-made concrete blocks as anchors. A tree is best secured to an anchor with heavy gauge wire, which has been passed through a hole drilled in the tree's trunk.

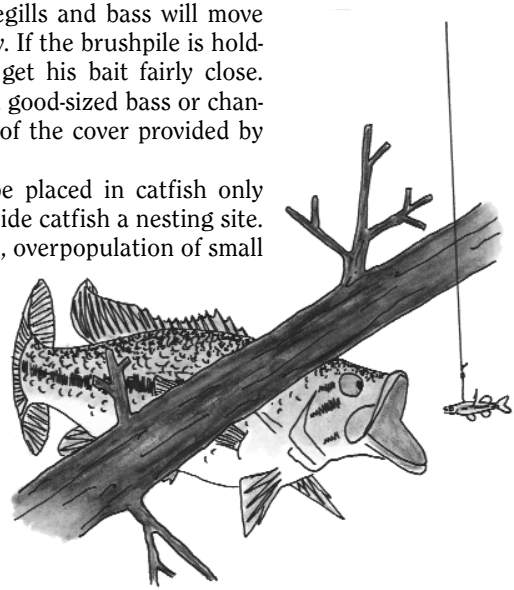
Other good materials for fish attractors include tires, piles of old or broken concrete blocks, and piles of old clay tiles or pipes. Tires can be wired or bolted together in any design that suits the pond owner. A group of tires generally works better than single tire units. Several holes should be drilled in each tire to allow air to escape so the tire will sink easily.

The best attractor locations in a pond are near natural gathering places for fish or in areas where fish are to be attracted for angling. Attractors congregate fish in a particular area, but don't necessarily attract fish from great distances. Therefore, logical locations for habitat attractors would be off points, at the edges of creek channels, in the mouths of coves, and near boat docks and fishing piers.

Brushpiles can be constructed in any water depth and may protrude from the shoreline into deep water. Tires, blocks and sewer tiles are generally unsightly if exposed above the surface, so these will need to be placed in water deep enough to cover them. There is no particular depth that is most conducive to concentrating fish, so the depth of structures can be varied. Shoreline attractors can be made by cutting two-thirds of the way through a tree and felling it into the water, leaving it attached to the stump.

Fishing brushpiles is a challenge. Skill is needed to avoid the loss of lures and bait. The angler should fish straight down or near the edges of the brushpile. Bluegills and bass will move out of brush to feed if they are hungry. If the brushpile is holding catfish, the angler may have to get his bait fairly close. Strong line may be necessary to pull a good-sized bass or channel catfish away from the protection of the cover provided by an attractor.

No type of fish attractor should be placed in catfish only ponds. Any type of structure may provide catfish a nesting site. If catfish spawn in the absence of bass, overpopulation of small catfish is likely.

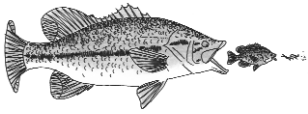


POND AND FISH ECOLOGY

A basic understanding of the biology of fishes and their interactions with their environment is helpful in understanding how to manage fish. Knowledge is useful in all aspects of pond management from initial pond construction to salvaging a problem pond.

The basic needs of fishes are (1) food; (2) good quality water; (3) shelter; and (4) a spawning area. The first two items are generally the most critical, but all are important to varying degrees at some time. Each of these items will be briefly discussed to give the reader a basic understanding of the reasons for management recommendations contained in this booklet.

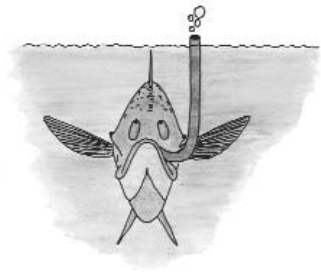
Fish Food



The natural foods of fishes are either produced in the pond or are washed or fall into the pond from the surrounding area. Food produced in the pond has its origin in the nutrients that are dissolved in the water and in the pond bottom. A variety of plants utilize these nutrients to grow. These plants may be microscopic algae that give a green color to the water or they may be large rooted plants that grow in shallow water areas. Plant material in turn is food for a variety of small animals such as insects and microscopic zooplankton. These small animals are eaten by fish such as bluegills and young bass. Large fish like the bass will feed mainly on small fish, crayfish, and tadpoles. The chain of events leading to the production of large fish can follow different routes. It can follow a "food chain" from nutrients, to algae, to zooplankton, to small fish, to large fish, or it can go from nutrients, to rooted plants, to insects, to small fish, or large fish. In reality, food chains have more links or steps than mentioned here and there are considerable crossing over between the various chains. What really exists is a "food web."

All ponds contain nutrients, which ultimately produce food for fish. The amount of nutrients present depends upon the productivity of the watershed. The amount of fish that the pond can support is called the "carrying capacity." This is comparable to a pasture's capacity to support only a certain amount of cattle or a garden's ability to produce only a certain amount of vegetables. In Kansas, mixed species ponds typically support between 100 and 400 pounds of fish per acre if supplemental feeding is not provided. The average pond supports about 250 pounds of fish per acre. Populations can comprise many small individuals or fewer large individuals, but the total weight of fish will depend upon what the pond can support. The amount of fish food a pond will produce is limited by the amount of nutrients and will be shared by the existing fish community. By managing for fewer fish, larger fish can be produced.

Water Quality



Fish require good quality water to survive, grow, and reproduce. Good quality water is free of pollutants such as toxic materials, excessive organic matter, and silt. Water should also have high oxygen content. Oxygen deficiency is a common water quality problem encountered in ponds. Most fish species require at least 5 parts per million (ppm) of dissolved oxygen for good health and vigorous growth. They can tolerate 1 or 2 ppm for short periods, but they will become stressed, will cease feeding, and may become susceptible to diseases.

The amount of oxygen contained in the pond depends upon the water temperature and the depth. During late winter and early spring, the water in a pond will have the same temperature from top to bottom. In late spring, increased atmospheric temperatures begin warming the pond from the surface down. Water in shallow ponds located in open areas exposed to the wind may continue to mix through ice-free periods, but by the summer the surface water in deeper, less windswept ponds is considerably warmer (and much lighter) than the bottom water, so a thermal stratification occurs. This is a fairly stable condition with the warm upper layer (epilimnion) floating on the cool bottom layer (hypolimnion) separated by the transition zone (thermocline). As the wind blows, only the upper layer is mixed and oxygenated. The lower layer does not receive additional oxygen and in fact slowly loses its oxygen by the decay of organic matter on the bottom. By mid-summer oxygen is consumed in the lower layer so fish are confined to the upper layer and thermocline. This is why ponds built deeper than 15 feet waste space during the summer. On the other hand, a pond that is too shallow (less than 10 feet deep) may encounter summer-kill problems. This topic is discussed further in the “Fish Kills” section.

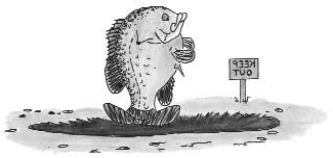
In late summer and fall, the surface water cools until its density is similar to the bottom water. Strong winds are then able to mix the water from top to bottom. This carries oxygenated water to the bottom and fish are again able to inhabit the entire pond.

After ice forms in the winter, water on the bottom of the pond is slightly warmer than water just under the ice. Fish usually prefer to locate near the bottom for this reason. Since ice prevents a mixing action from occurring, organic wastes again settle to the bottom, much as occurs during the summer. Decomposition of organic wastes uses oxygen, and excessive decomposition can drive fish off the bottom, up the water column, in search of oxygen. Severe cases of decomposition in combination with lack of oxygen production by plants results in an oxygen deficiency throughout the pond and eventually winterkill. Particulars on this subject are discussed in the “Fish Kills” section.

Shelter

Fishes are eaten by a great variety of mammals, birds, reptiles, amphibians, other fishes, and even invertebrates (some insects eat small fish). In order to survive, fishes have evolved various behavior patterns. Pond fishes always try to hide when danger threatens. They can hide by swimming to deeper water or by moving behind a rock, stump, brush, or plant. In a pond, fish communities will exist without physical structure, but fish are sure to concentrate near a structure if it is present. In fishing ponds, structures benefit fishermen more than the fish since anglers know the most productive areas for angling are near areas with habitat structure. This is why the addition of fish attractors is recommended in all but catfish-only ponds.

Spawning Area

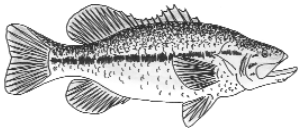


Some species of fish require specific bottom material to reproduce. Largemouth bass and bluegill are generalists and will spawn on about any type of bottom material, but the channel catfish is more particular. It requires some type of cavity such as a hole in the bank or solid structure in the form of a stump or rock for nest establishment. As stated several times previously, catfish reproduction is not desired in catfish-only ponds, so nesting structures should not be provided.

When species other than bass, bluegill, and catfish are desired in a pond, it is necessary to know their reproductive requirements in order to determine whether they will be able to maintain a population.

Common Pond Fishes

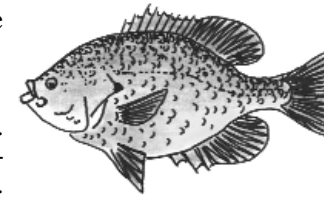
Many fish species can be found in Kansas ponds, but only a few lend themselves to effective management for sport fishing purposes. The most common species stocked in ponds are the largemouth bass, bluegill, and channel catfish. Other species that can be used for specific management objectives include fathead minnows, crappie, black bullhead, redear sunfish, and gizzard shad. Green sunfish and carp are also often found in ponds. A brief description of these species' life histories and some information on additional species follows.



Largemouth Bass

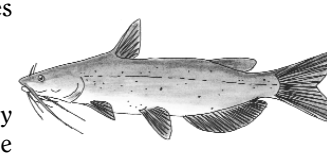
The largemouth bass is a large predatory fish that belongs to the sunfish family. It is one of three kinds of black bass found in Kansas, the others being the smallmouth and spotted or Kentucky bass. The largemouth is greenish colored on the back with a white belly and a dark band along its side. Its mouth is large with the upper jaw extending beyond the eye when the mouth is closed. This feature and coloration set the largemouth apart from the other two basses. This fish will eat anything it can get into its mouth. Common food items include insects, crayfish, frogs, and small fish. In the southern United

States, largemouth bass commonly attain weights of over 10 pounds, but anything over 7 pounds is considered a trophy in Kansas. Largemouth will spawn after reaching a size of about 10 inches. This usually corresponds to an age of one or two years. Spawning occurs during spring when water temperatures reach 60-70°F. The male makes a large saucer-shaped nest on the bottom in shallow water by fanning an area free of debris with his tail. The female deposits eggs in the nest, and the male fertilizes them. The male protects the eggs as best he can from predation and maintains good water quality by fanning with his tail. If the male bass is removed, the eggs will die. He guards the eggs until they hatch and the young are large enough to swim and find food. This takes about 1-2 weeks.



Bluegill

The bluegill is a deep-bodied sunfish with a small mouth. With an increase in size, the fish changes from a silver lavender color to greenish brown, with an orange or yellow breast. All sizes of bluegills possess a blue-black gill cover flap. Bluegills feed primarily on insects. Bluegills typically mature at a length of 3-5 inches. They should reach a length of 6-8 inches, but larger fish can be produced if properly managed. Fingerling bluegills stocked in the fall will spawn the next summer. Bluegills spawn from May to the beginning of September with a peak in June. The male makes a saucer-shaped nest on the bottom in shallow water like the bass and guards the eggs and young. The bluegill's ability to spawn so prolifically makes it a good food fish for bass.

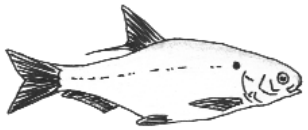


Channel Catfish

The channel catfish is a native stream fish with a deeply forked tail, gray back, white belly, and 8 barbels around the mouth. Young fish have some black spots, but these are lost with maturity. The channel catfish's diet consists mainly of invertebrates and small fish. Channels grow rapidly if enough food is available and often exceed 5 pounds. They spawn in early summer when the water temperature reaches 70-75°F. The male makes a nest in a hole in the bank, under a log, or next to any material that will provide protection for the young. The male also guards the eggs and young fish. Male channel catfish develop a bluish color, which often causes them to be misidentified as blue catfish. The anal fin of a blue catfish has 30 or more rays while channel catfish have 24-29 rays.

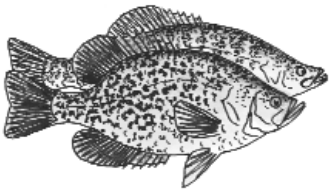
Fathead Minnow

The fathead minnow is a common baitfish and is also stocked in ponds to accelerate initial bass growth rates. It is a dull silvery color and reaches a length of 2-3 inches. Fatheads feed on small invertebrates and plant material and are hardy and prolific spawners. Spawning occurs all summer. Eggs are deposited on rocks or other objects.



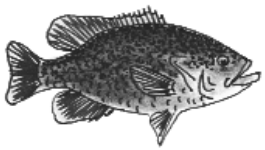
Gizzard Shad

The gizzard shad is a member of the herring family. It is silvery colored and has a sharp, saw-like ridge on its belly. It is the primary food for large predatory fishes in large reservoirs. It feeds on microscopic plants and animals and can produce high numbers of young. Shad spawn from spring to summer by randomly scattering eggs in shallow water.



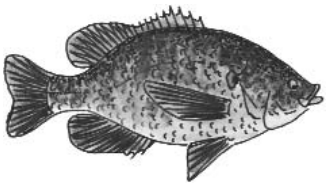
Crappie

There are two kinds of crappie, the black and the white. The black crappie prefers clear water and has seven to eight dorsal spines and black spots scattered randomly over its body. The white crappie is slimmer than the black, has five or six dorsal spines, and its spots tend to form vertical bars on it sides. In turbid water, white crappie usually predominate. Both kinds feed on invertebrates and small fish. Their reproduction is similar to that of the bass and bluegill. The minimum length at maturity is 6-7 inches. They tend to overpopulate if there is not enough predation on the young. In combination with larger numbers of bass, they grow rapidly and often reach lengths of 10-12 inches.



Green Sunfish

The green sunfish is often incorrectly called a perch. It is a member of the sunfish family along with the black basses, bluegill, and crappie. It is greenish in color and has a medium-sized mouth. It feeds on a variety of small animals and seldom grows over 6-7 inches in length. Green sunfish are common in small streams and often get into ponds by swimming over spillways. They can be a nuisance in a pond if bass are not abundant. Green sunfish reproduction is similar to that of bass and bluegill.



Redear Sunfish

The redear or “shellcracker” sunfish is a native of the southern United States. It has been stocked in place of or in combination with bluegills because it grows larger than the bluegill and does not have a high reproductive potential. Redear do not typically overpopulate like other sunfish and, in fact, do not provide enough prey for largemouth bass. Use of redear as only a sport fish in combination with largemouth bass works well as long as bluegills are also present to serve as the primary prey. A mixed stocking of two-thirds bluegills and one-third redear can add variety to a pond. Redear feed primarily on bottom organisms, particularly snails, and require clear, deep water with abundant aquatic vegetation. Their commercial availability in Kansas is limited.

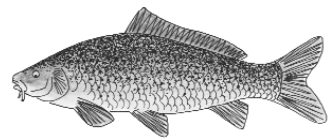
Hybrid Sunfish

The three sunfishes previously described, along with some others, have all been hybridized with each other in an effort to produce offspring that do not overpopulate, grow larger than

either species, and are easy to catch. Hybrid sunfish fill these requirements, but parental species (consisting of only males of one species and only females of the other) need to be stocked about every 4-5 years to maintain hybrid population numbers. Hybrid sunfish also provide too little prey to support desirable largemouth bass populations.

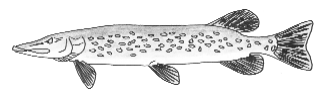
Black Bullhead

This bullhead is a common catfish of small sluggish streams. Its back is gray or black, and its belly is yellow or white. The tail is not forked but slightly indented. It feeds on a variety of small animals and seldom gets over 15 inches long. Bullheads often gain access to a pond by swimming over the spillway. This species quickly becomes overpopulated if the pond is muddy or low on bass numbers. Reproduction is similar to that of the channel catfish. After hatching, young bullheads will travel in a compact school accompanied by one or more adults.



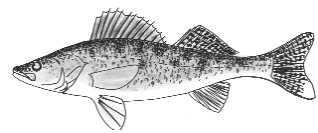
Carp

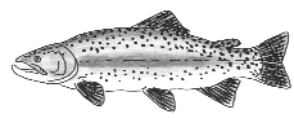
The carp is a large member of the minnow family. It feeds on bottom organisms and tends to stir up the mud and is thus undesirable in ponds if sight-feeding fish are desired. Carp usually get into ponds when they are seined from creeks for bait and released or lost in the impoundment. A well-established bass population will control this species, but overpopulation problems can result if the pond is already muddy or few bass are present.



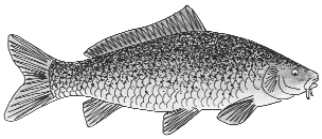
Other Species

Northern pike, walleye, flathead catfish, and trout are desired by some pond owners. While they do not cause problems in ponds, they are not particularly well suited to the pond environment. They do not reproduce adequately in ponds to maintain their own numbers; they are costly to stock, difficult to obtain, and a pond cannot support many of them. Northern pike and walleye may be part of the stocking combination in large watershed structures as long as the owner realizes that he will probably need to supplementally stock them every few years to maintain them in his impoundment. Walleye should not be stocked where bluegills are the only prey fish. Gizzard shad should be present if walleye are desired. The flathead catfish is often stocked into ponds as a trophy or predator fish. While the flathead eats primarily fish, it will not control bluegills as well as a properly managed largemouth bass population. Flatheads should therefore not be stocked in place of bass. Few Kansas ponds are capable of supporting trout yearround. Trout require water temperatures below 70°F along with a high oxygen content. These conditions do not occur simultaneously in most Kansas ponds during summer months.





Exotics

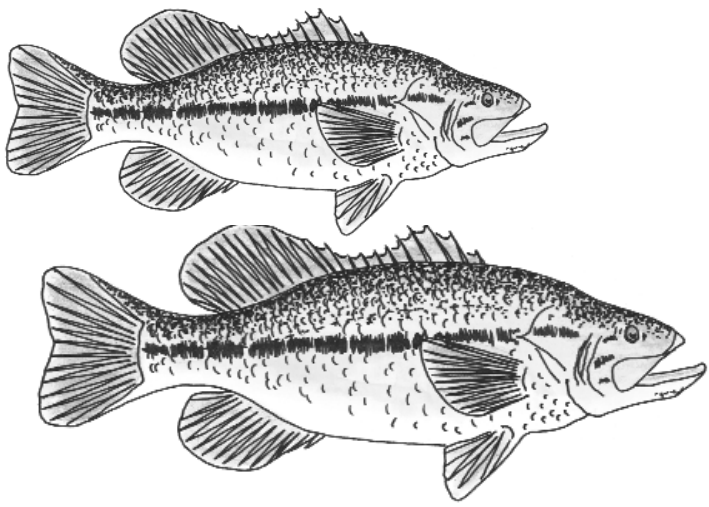


Organisms released into habitats where they are not native often out-compete natives through a lack of predators, parasites, and competitors that kept the non-natives in check where they originated. In favorable environments their numbers can explode, and, once established, are seldom eradicated. Some exotics common to Kansas are the common carp, Asian clams, and white perch.

Anglers can help prevent the spread of exotics by monitoring their boats (including pond bass boats, canoes, float tubes), trailers, anchors, and anything else that comes in contact with the water. Remove any plants or animals from boating equipment and drain the livewell before leaving the water body. Empty bait buckets on land – not into the water – before leaving the waterbody. Wash boating equipment with hot (at least 104°F) water and dry for at least 5 days before transporting to another waterbody. Learn to recognize exotics that may be in or near your area. Consult the Department of Wildlife & Parks for more information.

Florida-strain Largemouth Bass

In southern United States reservoirs this genetic strain of largemouth bass has produced record-sized fish. Pond results have not been as productive. Florida-strain largemouth bass are less temperature tolerant than our native, northern-strain largemouth. Since temperature effects in ponds can occur quicker and last longer, the effect of winter temperatures can wipe out a pond owner's attemp to produce trophy Florida-strain largemouth bass. It is much more productive to stock northern-strain largemouth bass and manage your pond for big bass as specified later in this booklet.



STOCKING

What to Stock Initially

A standard initial stocking of largemouth bass, bluegills, and channel catfish is recommended for all ponds one acre or larger with underwater visibility of at least 12 inches. Additional fish species may be added later depending upon management objectives.

It is critical that correct numbers of each kind of fish be stocked. Improper stocking may prevent a pond from ever producing a quality fishery. The pond owner should stock 100 bass, 500 bluegills, and 100 channel catfish fingerlings per acre. These fish will usually not be fishable for two years. If larger fish are stocked, numbers should be reduced. Stocking 50 8- to 12 inch bass; 100 - 250 4- to 5 inch bluegills; and 50 8- to 12 inch channel catfish per acre gives a pond a head start and minimizes mortality if an existing wild fish population is present.

Catfish alone are recommended for ponds less than 1 acre or for ponds with underwater visibility less than 12 inches. If only catfish are stocked, the number is dependent upon the turbidity. In clear ponds, 200 fingerlings or 100 larger fish can be supported per acre. In turbid ponds, half this number should be stocked.

To accelerate initial bass growth rates, it is recommended that 3 pounds of fathead minnows be stocked per acre when fingerling bass are introduced, or a year before adult bass are stocked. However, it should be realized that fatheads will only sustain bass for a year or two, so bluegills need to be stocked as well.

Some pond owners are reluctant to stock their ponds with

bluegills because of the fish's tendency to overpopulate. Bluegills are, however, needed to provide food for bass. Without them, a good quality bass population will not develop. Bluegills are also fine sport fish if bass are able to contain their population numbers through predation so that survivors grow to desirable sizes.

Many pond owners and anglers think that 500 small or 100-250 intermediate-size bluegills are more than needed. They feel that by stocking fewer bluegills, the fish would be less likely to overpopulate. Just the opposite is true! Bluegill overpopulation usually occurs not because too many bluegills are stocked but because too few are stocked. If too few bluegills are stocked, an unusually high number of their first spawn will survive. The high survival is a result of little competition for available space. The problem is further intensified if bass are overharvested during the first season of fishing, leaving the young bluegills with no control, or if the pond is too muddy for bass to see to feed, or too vegetated for bluegills to be available to bass. Stocking 500 small or 100-250 intermediate-size bluegills per acre also produces good bluegill fishing sooner and more reliably than stocking lower densities will.

Channel catfish in moderate numbers do not compete significantly with bass or bluegills for food or space. They can be considered a "bonus fish" in that they are not an important part of the predator-prey relationship. Bass and bluegills can function just as well with or without channel catfish present. By using all three species, the pond's potential to produce fish is more fully utilized. If properly managed, bass and bluegills need to be stocked only once. Channel catfish will need to be restocked periodically since bass will eat almost all young channel catfish that are spawned.

Expected lengths (in inches) of fish stocked in a typical Kansas pond. Growth of subsequent year classes may be slower.

Species	When Stocked	Length When Stocked	Years After Stocking				
			1	2	3	4	5
Bluegill	Fall	1-2"	4.5	6	7	7.5	8
Channel Catfish	Fall	2-4"	10	14	16	17	18
Largemouth Bass	Following Spring	1-2"	9	11	13	15	16.5

Sources of Fish

Pond owners can purchase fish from commercial fish growers for stocking ponds. Purchased fish are considered to be the pond owner's livestock. Such ponds are free of any restrictions, including license requirements and harvest methods. A list of

commercial fish growers can be obtained from any Department of Wildlife and Parks, Natural Resources Conservation Service or Extension Service office. A pond can be stocked with fish legally caught elsewhere but this practice is not advised because it is usually difficult to obtain adequate numbers, especially for large ponds, and wild fish are more likely to have disease problems than those raised by a commercial fish grower.

When and How to Stock

Chlorinated water should not be used to transport fish because it will kill them! Water taken directly from the pond is best. It should be obtained just before picking up fish. Water collected the day before may cool significantly during the night, causing fish to die when transferred from the delivery truck into the container.

Before fish are stocked into a pond, the temperature of the water the fish are being transported in should be equalized to the temperature of the pond. A sudden change in water temperature will cause fish to go into shock and will often result in death. Half the water in the container used to transport fish should be poured out and replaced with water from the pond. The fish should then be given 5-10 minutes to adjust to the temperature change. This procedure should be repeated until the water temperature in the container is within 3°F of that in the pond. The fish can then be released into the pond without going into shock.

New or renovated ponds are commonly stocked with fingerling (1 1/2 - to 4-inch) fish. Since these fish are small, there should be no salamanders or other fish (besides fathead minnows) in the pond before stocking. If fish or salamanders are present, the stocked fish will be quickly consumed or will be unable to compete for food. To prevent wild fish from becoming established, a pond should be stocked as soon after it fills as possible. However, it is best to avoid stocking in summer months because high temperatures and low oxygen content in the water weaken fish being transported.

FISH Program

The Fishing Impoundments and Stream Habitats (FISH) program was developed by the Kansas Department of Wildlife and Parks to increase angling opportunities, and has been popular with landowners and anglers alike. FISH leases impounded water, streams, and stream access, opening most of these areas to public access from March 1 through October 31. Landowner permission is not required to fish these areas, but anglers must respect and follow the rules on these properties. Under certain conditions and in certain areas, fish produced by the Department of Wildlife and Parks may be available for stocking. Consult the Department of Wildlife and Parks for more information.

FISH MANAGEMENT

Proper pond construction, development, and fish stocking will not guarantee sustained good fishing. A correct start must be followed by periodic management. Some of the techniques described in this and the following section seek to affect fish populations directly, while others modify habitat within the pond, affecting fish indirectly.

Regulating Fish Harvest

Improper harvest of fish ruins future fishing in more potentially good Kansas ponds than any other cause. Pond owners and other anglers are anxious to fish a newly stocked pond and they frequently overharvest the bass population in the first season of fishing. This allows bluegills to overpopulate the pond.

A pond owner can reduce the likelihood of bass overharvest from occurring by not letting anyone fish the pond. This practice is not encouraged, however, because underfishing as well can also lead to problems. Pond owners are urged to let others fish their ponds as long as the pond owner's rules are followed.

One way to prevent bass overharvest is to release all bass less than 15 inches long for a period of 4 years from stocking, even though bass may be large enough to catch after 1 or 2 years. This means that few bass can be harvested for 4 years from the time of stocking unless adult fish were introduced. If 8-inch bass were stocked, the 15-inch minimum length limit would be needed for only 3 years (2 years if 12-inch bass were stocked).

After 4 years from stocking (2 to 3 years if adult bass were stocked) a management decision must be made. The choice made will depend upon what numbers, sizes, and kinds of fish are desired. Are good sized fish of several species preferred, or is catching large individuals of fewer species more important? Often, quantity has to be sacrificed to achieve greater size.

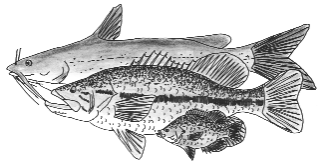
Five management options are presented here: (1) The "All Purpose Option"; (2) The "Panfish Option"; (3) The "Big Bass Option"; (4) The "Harvest Quota Option"; and (5) The "Catfish Only Option." The first four options differ from one another in the ways angler harvest of bass is used to manipulate fish populations.

Bass will probably have spawned three times during the 4-year period after fingerlings were stocked or three times in 3 years if 8-inch bass were stocked. If 12-inch bass were stocked, new year classes would have been produced in both years after the original stock were introduced. Young bass produced can come to exist in surplus numbers. If unharvested, poor growth rates occur due to excessive competition. The result will be a bass population comprised primarily of individuals less than 15 inches long.

The guidelines for each of the management options include stocking recommendations for additional fish species. Expected results from a pond not managed according to one of the options are also discussed.

The "All - Purpose Option"

This option affords the opportunity to catch fish of a variety of sizes. To catch bass over 15 inches long with any consistency, numbers of 8- to 12-inch bass must be reduced. In a pond of average fertility, about 30 8- to 12-inch bass should be harvested per acre per year after the fourth year from stocking (second and third year if adult bass were stocked). For high-fertility ponds, as many as 50 small bass might be removed per acre per year. The removal of these small bass reduces competition and makes it possible for some fish to attain lengths over 15 inches.



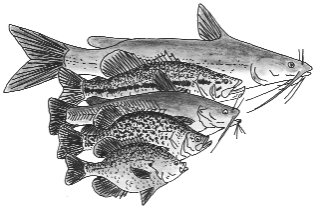
To ensure that at least 10% of the catchable-size bass survive to lengths of 15 inches and longer, all 12 - to 15 - inch bass that are caught should be released. A good supply of 12 - to 15-inch bass will also reduce densities of intermediate-size bluegills so that some individuals grow to sizes of interest to anglers. This management option will produce bluegills of several sizes, with some reaching 8 inches.

Bluegills and catfish can be harvested as desired. Catfish that are harvested must be replaced with 8-inch or longer individuals to maintain a sizeable catfish fishery. Without periodic supplemental stocking, few catfish will be caught because few young catfish will survive bass predation.

Northern pike can be stocked in large lakes as an additional sport fish and predator as long as the pond owner realizes the fish's limitations described previously. Rapid northern pike growth rates in Kansas present a threat to survival of original stock bass if pike are stocked too soon. Fingerling pike (6-10 inches) can be stocked at a density of 10 per acre 2 or more years after bass have been introduced. If pike are stocked sooner than this, they may prey on original stock bass or their initial reproduction, preventing a good bass population from developing. Walleye should not be stocked in an impoundment managed according to the "All- Purpose Option" because bluegills do not provide sufficient prey for walleye.

The "Panfish Option"

If catching big panfish is more important than harvesting bass and catching big bass, the pond owner and anglers should continue to release all bass less than 15 inches long past the initial 2-, 3-, or 4-year period after stocking. Bass over 15 inches long can be harvested, but few fish will grow to such a size if the 15- inch length limit is maintained. High densities of 8- to 15- inch bass are more effective in controlling bluegills and other panfish than moderate numbers of bass of several sizes. By purposefully overpopulating bass, the "Panfish Option" will produce more 8- inch and longer bluegills. It is important to note that the "Panfish Option" should be followed only if the pond's water has an underwater visibility greater than 18 inches. Bluegill and other panfish will overpopulate if bass cannot see well enough to feed on them.



A variation of this management option might include crappie and/or bullheads in the stocking combination along with largemouth bass, bluegills, channel catfish, and fathead minnows.

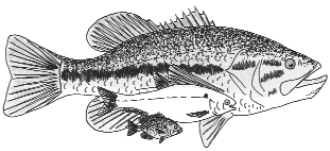
Crappie and bullheads are not usually recommended for ponds because both fish have a tendency to overpopulate if bass numbers are low or if the pond is muddy and bass cannot see to feed. Problems with crappie and bullheads as well as green sunfish and carp can usually be avoided if a good bass population has developed prior to their gaining access to the pond and if the pond's water remains clear (an underwater visibility of at least 18 inches).

Twenty adult crappie and/or 20 adult bullheads can be stocked per acre after it is apparent that the pond has sufficient numbers of bass to prey on young crappies and/or bullheads. This situation is demonstrated by the ability of the pond to consistently produce bluegills 8 inches and longer.

Black crappie should be stocked instead of white crappie because black crappie do better than whites in clear water and this option is recommended only when underwater visibility exceeds 18 inches. After adult crappie and bullheads spawn, it will take about 3 years for their offspring to attain lengths of 10 inches and longer.

With crappie and bullheads present, it will be necessary to release nearly all bass that are caught so that crappie and bullhead numbers can be kept under control through bass predation. The quality of bass fishing will be sacrificed to produce good crappie, bullhead, and bluegill fishing because bass must be allowed to overpopulate. Few, if any, bass over 15 inches long would exist in a pond managed in this fashion. If however, fewer than 10% of the bass caught are 12 inches or longer, bass may be too dense, prey too heavily on panfish, and compete with them for food. Approximately 30 bass 8-12 inches long should be removed per acre per year until 10-30% of all bass caught are 12 inches or longer. No harvest restrictions are needed on any species but bass. Northern pike stocked as described in the "All - Purpose Option" might be used to provide additional predation on panfish.

The "Big Bass Option"



To consistently produce bass longer than 18 inches without regard for the size of bluegills, anglers should again release all bass under 15 inches for 4 years after stocking (2 to 3 years if adult bass were stocked) just as described for the "All- Purpose Option" and the "Panfish Option." In addition, no bass over 15 inches should be harvested during this period. After that time, densities of 8- to 15- inch bass should be reduced even more than described for the "All- Purpose Option" to allow for rapid growth by survivors. In a pond of average fertility, anglers should harvest 30-50 8-to 12-inch bass per acre per year as well as about 5 12-to 15-inch bass per acre per year. Bass over 15 inches should continue to be released unless a trophy is caught.

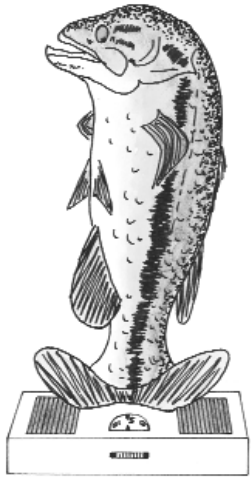
The odds of a 9-pound bass living another year may not be good, but fish that beat the odds are those that set records.

Twenty adult gizzard shad might be stocked per acre 2 years after bass have been introduced. With adult gizzard shad stocked into the pond, the likelihood of producing a trophy bass is greatly enhanced. Bluegills will serve as the primary prey for small bass, and shad will be eaten by large bass. It is important to realize that stocking gizzard shad involves a certain amount of risk. Without sufficient numbers of bass present, gizzard shad can overpopulate a pond!

This alternative to the basic bass-bluegill-catfish combination is relatively unevaluated, but gizzard shad along with bluegills should produce bigger bass than bluegills alone. With bass eating both kinds of prey, it should be remembered that few bluegills over 6 inches will be present because survival of small bluegills will be higher than would occur without shad. The practicability of this management option may be limited to larger ponds because no more than about 10 bass 3 pounds and larger can be maintained per acre of water.

Since the bluegill population in a pond managed in this fashion will comprise high numbers of small individuals, such a pond might serve to satisfy adult anglers seeking big bass and children trying to catch high numbers of fish with no concern for size. Channel catfish stocking is not required for this management option and harvest of both catfish and bluegills is unrestricted. Periodic supplemental catfish stocking will be required to maintain a population with bass present.

In large impoundment's managed according to the "Big Bass Option," fingerling walleye can be stocked 1 year after fingerling bass at a density of 100 per acre. If adult bass are stocked, walleye fingerlings can be stocked simultaneously with bass. Fingerling walleye should be stocked in the middle of the impoundment to avoid shoreline bass predation. It should be realized that by stocking walleye, fewer big bass are likely to be produced because gizzard shad that might have fed only bass will have to support both bass and walleye.



The "Harvest Quota Option"

In the past, ponds have frequently been managed by allowing only a given weight or number of bass to be harvested annually. After the desired bass harvest is achieved, angling must consist entirely of catch and release regardless of the sizes of bass caught. This may occur after one or two trips in small ponds. For the first 4 years after stocking (2-3 years if 8-to 12-inch bass were stocked), little or no bass harvest should occur. After that time, about 20 individuals or 20 pounds of bass can be harvested per acre annually without regard for length.

The potential for bass overharvest is present with this option if the pond owner does not have complete control of fishing access and does not maintain excellent records. Even under good management, this option may not produce bass popula-

tions as desirable as those that are managed by the "All-Purpose Option" because the potential for overharvest of large bass and underharvest of small bass exists.

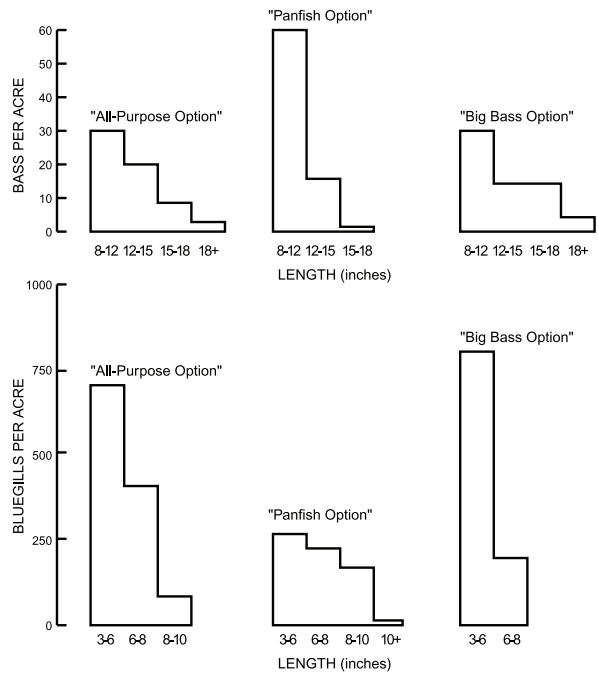
Channel catfish harvest is unrestricted, but catfish removed should be replaced with 8-inch or larger individuals. There is no harvest limit for bluegills using the "Harvest Quota Option." Historically, pond fish management booklets have suggested that a harvest of from 3 to 10 pounds of bluegills for every pound of bass taken would keep the pond's fish community in "balance." While anglers can afford to harvest as many bluegills as desired, such a practice without additional bass harvest restriction will not effectively keep a fish community in good condition.

Appropriate harvest of bass in a pond of average fertility given the management option followed.

Option	Year after stocking fingerlings	Length		
		8-12"	12-15"	15 +"
"All-Purpose"	0-4	none	none	as desired
	4+	30/acre	none	as desired
"Panfish"	0-4	none	none	as desired
	4+	none *	none	as desired
"Big Bass"	0-4	none	none	none
	4+	30-50/acre	5/acre	trophies only

* 30/acre if fewer than 10% of all bass caught are 12 inches or longer.

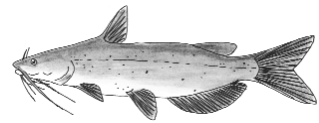
Approximate numbers of catchable-size bass and bluegills present at the end of the fishing season in a well-managed Kansas pond of average fertility given the management option followed.



This option is difficult to manage successfully. It is generally best suited for fee fishing recreation areas and children's fishing ponds.

The "Catfish - Only Option"

The channel catfish is one of the most popular fish in Kansas. In fact, many pond owners want to stock it alone. This is advisable in muddy ponds where sight feeding fish like bass and bluegills would do poorly or in ponds under one-half acre where bass overharvest would likely occur. In large, clear ponds, stocking catfish alone is a waste of space because a pond will produce about the same weight of catfish even if it contains bass and bluegills. The pond owner might just as well take advantage of the angling benefits of all three species.



For a muddy pond or a pond that is smaller than one-half acre, channel catfish-only is the recommended option. The pond should be free of any structure which would provide seclusion for spawning such as sewer tiles, stumps, large rocks, tires, or cream cans. Ponds which contain only catfish are often characterized by excessive numbers of small catfish, when suitable spawning sites exist. If reproduction can be avoided,

Suggested time and number of fish to stock per acre.

Option	Year			
	1	2	3	4+
"All-Purpose" and "Harvest Quota"	500 bluegill fingerlings & 100 channel catfish fingerlings	3 lbs. fathead minnows, 100 largemouth bass fingerlings	*100 walleye fingerlings	*10 northern pike fingerlings
		OR		
	3 lbs. fathead minnows, 250 bluegill adults & 50 channel catfish adults	50 largemouth bass adults		*10 northern pike fingerlings
"Panfish"	500 bluegill fingerlings & 100 channel catfish fingerlings	3 lbs. Fathead minnows, 100 largemouth bass fingerlings		*20 black crappie adults and/or *20 black bullhead adults & *10 northern pike fingerlings
		OR		
	3 lbs. fathead minnows, 250 bluegill adults & 50 channel catfish adults	50 largemouth bass adults		*20 black crappie adults and/or *20 black bullhead adults & *10 northern pike fingerlings
"Big Bass"	500 bluegill fingerlings & *100 channel catfish fingerlings	3 lbs. fathead minnows, 100 largemouth bass fingerlings		20 gizzard shad adults (see text regarding rest)
		OR		
	3 lbs. fathead minnows, 250 bluegill adults & *50 channel catfish adults	50 largemouth bass adults & *100 walleye fingerlings		20 gizzard shad adults
"Catfish-Only"	3 lbs. fathead minnows, 100-200 channel catfish fingerlings			
	OR			
	3 lbs. fathead minnows & 50-100 channel catfish adults			

* Stocking these species is not required for the option to be successful.

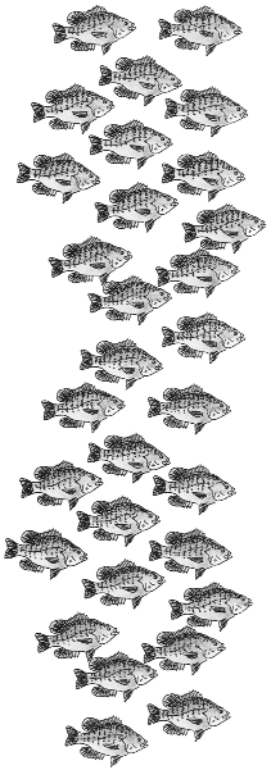
replacement fish will have to be stocked periodically to maintain the population. Fathead minnows can also be stocked to provide additional food for catfish and a ready source of bait for the pond owner.

This option is the easiest of the five options to manage as long as natural reproduction does not occur. Harvest can begin as soon as fish reach a size considered to be harvestable and no restrictions need exist on the number harvested. As catfish numbers decrease, fishing success will decline, so supplemental stocking will be required to maintain catfish at a density of 100 fish per acre (200 or more per acre with supplemental feeding). Catfish at least 8 inches long should be stocked each fall or spring when the water is cool. The number stocked should equal the number harvested in the previous angling season along with an additional 10% to replace those fish lost to natural mortality.

Catfish production in small or muddy ponds is usually quite low. If the yield of catfish is inadequate, the owner may want to consider a feeding program described later in this booklet.

Consequences of Unrestricted Harvest

Some pond owners do not care enough about fishing to regulate bass harvest. All species of fish are harvested in unrestricted numbers as soon as they are large enough to take a hook. While this may not be considered sound pond management, it is important to illustrate what kinds of fish populations might be expected to develop in a pond fished in such a fashion. The outcome of unrestricted fish harvest will depend upon the number of bass harvested annually. One angler could remove the majority of the original-stock bass from a small pond in a day's fishing. Such a bass harvest would quickly allow bluegills to overpopulate the pond. Anglers rarely catch the last two bass in a pond, so young bass may continue to be produced. If anglers continue to harvest the majority of bass produced, bluegills will continue to overpopulate and few large bass will be caught.



Some ponds receive little bass fishing pressure and harvest due to their remote location, because few people fish the pond, or because area anglers do not like to catch small bass. Such ponds eventually develop high numbers of small bass and large bluegills as described in the "Panfish Option." The results from low bass harvest due to low fishing pressure or angler preferences are the same as those that occur with a 15-inch minimum length limit and high fishing pressure. Ponds that normally receive minimal bass harvest can withstand the harvest of an occasional 12-inch bass and even periodic high bass harvests without change because bass reproduction soon returns the pond to crowded bass and large bluegills. Other than habitat changes, annual harvests of 30 or more 8- to 12- inch bass per acre are the only way to increase numbers of larger bass. If harvest of small bass *and* 12- to 15- inch bass becomes continually high each year, the fish population will eventually become dominated by small bluegills.

Feeding Fish

All ponds produce some natural food for fish. The amount of food produced is a function of the pond's productivity. Food quantity, in turn, determines what weight of fish the pond can support. The average amount of fish in a Kansas pond of average fertility is about 250 pounds per acre, of which only a portion (30-50% by weight) can be harvested per year. Fish populations in most Kansas ponds are not harvested heavily enough to overtax natural food production. Supplemental feeding is thus not usually required. In special cases where the harvest demand is high or where large fish are desired, feeding can be beneficial.

Formulated fish feeds in pellet form are available at most feed stores. The most common feed is formulated for catfish, but it is also suitable for bluegills. These feeds are available in the form of sinking pellets or floating pellets. The advantage of floating pellets is that the person feeding the fish can determine whether the fish are eating the feed.

Bluegills will eat artificial feed, but feeding alone will not usually increase the sizes of overpopulated bluegills. Adequate predation on small bluegills by bass along with the feeding can, however, result in increased bluegill growth rates and larger bluegills.

Channel catfish are practical to feed, either as the only species in a pond or together with other species. They quickly learn to eat artificial feed and their growth rate increases. Both catfish and bluegill should be fed no more than they can consume in 15 minutes, up to a maximum of 20 pounds per acre per day. If fish are overfed, decomposition of wasted feed can result in oxygen depletion, killing fish. It is a good idea to monitor water temperature and oxygen content. Feeding should occur daily or at least every other day when water temperatures are over 60°F. Once a feeding program has been started it should continue throughout the growing season unless the pond's oxygen content falls below 5 ppm at the surface. If it is stopped, fish will lose weight.

Muddy ponds or ponds less than half an acre usually do not produce enough bass and bluegills for consistently good angling. It is in such ponds that densities of 200 or more channel catfish per acre can be maintained through supplemental feeding.

Channel catfish can also be fed in cages constructed of 1/2-3/4 inch mesh screen suspended from floats and anchored in a pond. A cage with a volume of one cubic yard can support 200-275 channel catfish 6-10 inches long. Diseases and oxygen deficiencies due to overfeeding are much more common with confined fish; no more than 1,000 fish per acre should be raised in cages. Food formulated for cage culture should be provided every day of the growing season, but no more food should be furnished than can be consumed in 15 minutes.

Fertilization

Fertilization of Kansas ponds is not recommended. Phosphate and nitrate fertilizers are used in some states to increase productivity in ponds. Kansas' typically rich soils make this unnecessary. Fertilizers are also used in some states to control excessive rooted aquatic vegetation. Fertilizers will cause microscopic plants (phytoplankton) to develop, shading rooted plants. Without light, rooted plants do not grow. Oxygen depletion problems often develop when a pond is fertilized, so the risk of fish kills always exists. In addition, if fertilization is stopped, rooted plants will grow back in even greater quantities than existed before fertilization.

Improving Undesirable Fish Populations

Undesirable fish populations can develop if bass numbers are low, if bass were never stocked, or if the pond has turbidity or vegetation problems. If anglers catch mainly 3- to 6-inch bluegills and few or no bass are taken, it is likely that either (1) bass overharvest has occurred, (2) bass are not present, (3) bass cannot see to feed, or (4) excessive aquatic vegetation has made bluegill unavailable to bass. The first two problems can be rectified by stocking 50 8- to 12-inch bass per acre. If the pond has an underwater visibility of less than 12 inches or if over 50% of the surface area of the pond is covered by vegetation, these problems must be treated before bass are stocked. Procedures for dealing with "problem ponds" are discussed in the next section. If turbidity problems cannot be overcome, the pond owner might consider stocking 100 8-inch and longer channel catfish per acre and forget about trying to produce bass and bluegills. After 8-inch bass have been stocked in a clear pond, bass less than 15 inches long should not be harvested for a 3-year period (2 years if 12-inch bass were stocked). Then, one of the four management options previously described should be followed, depending upon pond owner and angler desires.

If only small bass and no bluegills are caught, 100-250 4- to 5-inch or larger bluegills should be stocked per acre. Then, appropriate bass harvest restrictions and stocking strategies should be followed as outlined in one of the four management options.

If the pond contains neither bass or bluegills and small bullheads and green sunfish are present, 50 8- to 12-inch bass should be stocked per acre. Once the bullheads or green sunfish are under control, 100-250 4- to 5-inch or larger bluegills should be stocked per acre because bullheads and green sunfish will not provide adequate prey to sustain a desirable bass population.

In the absence of bass, bullheads and carp sometimes develop such dense populations that their bottom feeding activities roil the water severely. Even if bass were stocked in such ponds, they could not see to feed, and their impact on bull-

heads and carp would be negligible. Draining the pond is the most economical alternative for removing unwanted fish given these circumstances. If the pond cannot be drained, the fish community can be chemically removed. Liquid rotenone (5% or 2 1/2% synergized) is the chemical most frequently used. The chemical kills only animals with gills and is not harmful to warm-blooded animals. It should be mixed at a volume of 1 gallon per acre-foot of water. The amount of rotenone required may be reduced if the pond's water volume can be lowered through siphoning or pumping. This is desirable because the chemical is expensive. Application of rotenone must be conducted by a registered herbicide applicator and a permit is required from the Kansas Department of Health and Environment. Contact a district fisheries biologist for further information.

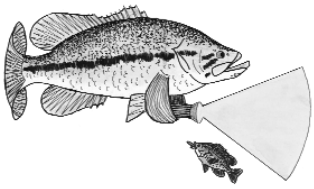
Treatment should occur when the water temperature is 70°F or above. In ponds smaller than about 2 acres, the chemical should be mixed into the water using the propwash of a stationary outboard motor. The front end of a small boat should be pointed into the pond's bank and the motor should be run in forward gear while the rotenone is poured slowly into the propwash. It is best to dilute the rotenone with water before it is poured into the pond so that the treatment is done gradually. The propwash will circulate the chemical to all depths of the pond. The motor should be run as fast as safely possible to assure maximum circulation. The front and sides of the boat should be tied to stakes driven into the pond's bottom to keep the boat from running up the bank.

It is important to change the location of the boat several times so that the mixing action reaches all areas of the pond. Shallow areas or areas not reached by the propwash should be treated with a hand sprayer or by "bucketing" in the chemical. The mixing action is ineffective when the boat is only driven around the pond. While the upper 3 feet of water may be well mixed, little chemical will reach lower depths.

Rotenone may not reach all areas of large ponds or ponds deeper than 10 feet when the chemical is mixed with an outboard motor. The chemical should be pumped into areas not reached by motor mixing and into the deepest portions of such ponds. Fish can be stocked back into a pond within 3 weeks after rotenone has been applied.

POND PROBLEMS

Pond owners can encounter numerous problems when attempting to manage their ponds for fish production. Many of these problems can be prevented or at least lessened by proper planning prior to pond construction and in the initial stages of area development and fish stocking. While it is usually easier to prevent potential causes earlier than it is to treat symptoms later, the following information may help pond owners deal with established problems.



Muddy Water

Pond water needs to be reasonably clear for production of desirable sight-feeding fish populations. Clear ponds produce several times the amount of fish as turbid ponds. Most ponds will be muddy after a heavy in-flow, but in good ponds silt should settle out within a week. Water clarity should be at least 1 foot or more during most of the year. If the underwater visibility is less than 1 foot, fish production will be decreased due to water turbidity. This amount of clarity is necessary for the production of algae, an important component of the food chain or web. In addition to limiting food production, muddy water can reduce the success of fish reproduction, particularly bass.

To cure the muddy water problem, the source of the turbidity should be identified. An easy way to determine the cause of turbidity is to collect a jar of water from the pond. If the suspended silt settles out within a week and the water above it is fairly clear, the problem is probably due to wind action or the activities of some animals such as livestock, fish like carp or bullheads, or crayfish. If after a week, the water in the jar still remains muddy, the problem is due to the chemistry of the soil type suspended in the water. Often, the problem is a combination of factors.

Muddiness Caused by Soil Type

This is the most difficult muddy water problem to cure. The turbidity is caused by the suspension of clay particles that repel each other and will not clump together to form a particle large enough to settle out. This problem can be treated by adding material which will cause these particles to clump together and settle out.

Agricultural grade gypsum (hydrated calcium sulfate), available from most fertilizer dealers, can clear colloidal clay problems temporarily. It should be scattered evenly over the surface of the pond at 12 pounds per 1,000 cubic feet of water or 525 pounds per acre-foot of water. An acre-foot is 43,560 cubic feet. To calculate the pond's volume in acre-feet, the surface area of the pond should be measured in square feet and multiplied by the average depth of the pond in feet. This figure is then divided by 43,560. Some ponds built with Natural Resources Conservation Service assistance have acre-feet volumes calculated and on file. If the pond does not clear within four weeks and there is no other source of turbidity, one-quarter the orig-

inal amount of gypsum should be added.

Another material that can be used to clear clay turbidity is aluminum sulfate (filter alum). This material will cause the clay to flocculate and settle out. An application of about 50 pounds per acre-foot of water will clear most turbid ponds within a week. Alum should be dissolved in water and then quickly sprayed over the entire surface of the pond on a calm day since wave action will break up the floc so it will not settle out. Alum has an acid reaction with the water. If the pond is acidic (low pH) or has very soft water, about 20 pounds of hydrated lime (calcium hydroxide) should first be added per acre-foot of water. Sometimes this liming will cause the clay to settle out.

Organic matter can also be added to water to settle clay particles. This treatment technique is preferred to the addition of gypsum or alum because organic matter increases the pond's productivity rather than decreasing it. Organic matter provides food for desirable bacteria. As the bacteria break down the organic matter, by-products cause the clay particles to clump together and settle out. Manure, weeds, hays, and cottonseed meal will all work. When organic matter decays, oxygen is consumed. Too much organic matter can cause oxygen deficiency in the pond. If organic matter is added, it is best to use something that will decompose rather slowly, such as dry hay. It should be applied at a rate of two small bales per surface acre at 14-day intervals. The bales should be pulled apart and scattered in the shallow water around the pond. No more than 4 or 5 applications should be made per year. Solid bales can also be placed along the shoreline every 40 feet, just into the water.

The above mentioned methods are only temporary measures. These treatments will probably have to be repeated each year (usually at lower application levels) and after periods of heavy water inflow. Ponds with chronic clay turbidity may be best stocked with channel catfish and minnows, in which case treatment of turbidity is unnecessary. Artificial feeding is desirable in turbid ponds because little natural food exists.

Muddiness Due to Wind and Erosion

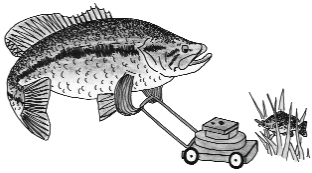
Strong Kansas winds often cause shoreline erosion and wave action which keep soil particles in suspension. The effect of wind can be minimized by the use of windbreaks and shoreline protection. A standard windbreak can be planted on the upwind side of the pond to dissipate the prevailing summer winds. If the dam is eroding badly, it can be protected with rock riprap or seeded shoreline vegetation. Erosion on the rest of the shoreline can be lessened by deepening the shoreline during construction, thus eliminating mud flats. Eroded shores and/or mud flats on existing ponds can be stabilized by planting a water-tolerant grass such as reed canarygrass or millet. Millet seed can be broadcast over the mud at 10 pounds per acre. Millet grows rapidly to form a dense cover but must be planted each year to maintain a stand.

Muddiness Due to Animal Activity

Livestock having access to a pond will trample shoreline vegetation and wade in the water, especially during the summer. These activities stir mud which can then be carried over the entire pond by wind and wave action. Livestock should be fenced out of a pond if production of fish is important. If livestock water is needed, a pipe through the dam to a tank below the dam will supply it. If this is not possible or feasible, all but a small corner of the pond should be fenced off. This limited livestock access will cause some muddy water, but less than if stock had access to the entire pond.

Fish such as bullheads and carp will cause water to be muddy because of their feeding activities. Removal or control of these species has been described previously.

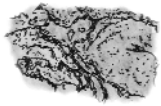
A dense crayfish population will cause pond water to be muddy due to their burrowing and bottom feeding activities which stir up the bottom mud. The introduction of predatory fish such as largemouth bass or channel catfish will solve this problem. Ponds with a good population of predatory fish will not have crayfish problems.



Aquatic Vegetation

All vegetation is not bad. A certain amount is needed for good fish growth and protection. In fact fish will benefit from more vegetation than anglers will typically tolerate. Plants produce food for many insects which in turn are eaten by fish. They also provide habitat for many fish food organisms and cover for small fish. Plants produce oxygen, protect the shoreline from wave erosion, and serve as feeding and nesting habitat for wildlife.

Aquatic plants can become so abundant that they interfere with fishing, swimming, and boating. Excessive vegetation can also provide too many hiding places for small bluegills so bass have difficulty controlling their numbers. This often leads to overpopulated bluegills. Periodic die-offs of dense vegetation, which usually occur after periods of cloudy weather, or when the water is muddy after a rain, or at the end of their growing season, can also threaten fish. Oxygen is consumed by bacteria that decompose dead plants. Low oxygen levels stress fish so they do not feed and grow, and often die (summerkills and winterkills). Decayed plant material also produces offensive odors and imparts undesirable flavors to water.



filamentous Algae

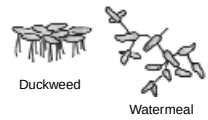
Chara

Identification

To control aquatic plants, it is important to know what type is causing problems. Aquatic plants can be grouped into four general categories: algae, floating plants, submersed plants, and emersed or marginal plants.

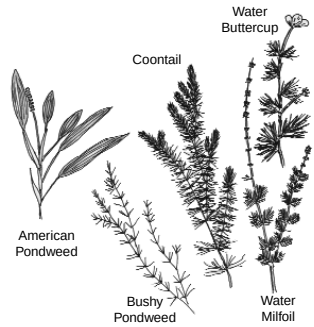
Algae: Algae are small plants which do not have true leaves or flowers. Different types of algae take on different forms. Microscopic, single-celled, free-floating algae are called phyto-

plankton. This form is used by microscopic animals (zooplankton) as food. Phytoplankton gives water a green to greenish-brown tint, but individual plants cannot be seen. Filamentous algae, commonly called "moss," consists of masses of long, stringy, slimy or cottony strands which float on top or just under the surface of the water. *Chara*, commonly called muskgrass or stonewort, is a larger form of algae which grows on the pond bottom and has stem-like and leaf-like structures. It is often confused with flowering aquatic plants. Filamentous algae and *Chara* are usually considered undesirable.

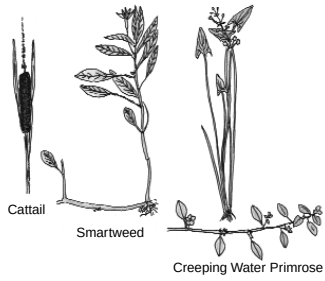


Floating Plants: This group includes plants which have leaves that float on the surface and roots that hang down in the water without being connected to the bottom. Duckweed (*Lemna*) and watermeal (*Wolffia*) are common members of this group.

Submersed Plants: These plants grow under water, are rooted in the bottom, have stems, leaves, and produce seeds. These plants usually consist of a long flexible stem with clumps of narrow leaves along the stem. Some species have leaves that reach the surface which are a different shape than the lower leaves. Common examples of this group which occur in Kansas are pondweeds *(Potamogeton*), bushy pondweed (*Najas*), coontail (*Ceratophyllum*), and water milfoil (*Myriophyllum*), and water buttercup (*Ranunculus*).



Emersed or Marginal Plants: Emersed or marginal plants are rooted in the pond bottom and have parts extending above the water's surface. Shoreline plants are also included in this group. These plants usually occur in shallow water, but some species can grow out from shore, forming a thick belt of vegetation. Common examples of this group of plants are cattail (*Typha*), bulrush (*Scirpus*), rush (*Juncus*), cut-grass (*Zizaniopsis*), smartweed (*Polygonum*), creeping water primrose (*Jussiaea*), arrowhead (*Sagittaria*), willow (*Salix*), and cottonwood (*Populus*).



Control

If aquatic plants occupy more than one-third of the pond area, one of four categories of control can be considered. They are: preventative, mechanical, chemical, and biological.

Preventative: Prevention is always the best control method. Plants are common in ponds that have clear water, high fertility and extensive shallow areas. Plant problems can be minimized through pond construction. All shallow mud flats should be eliminated by digging the shore areas to at least 3 feet deep with a 3:1 slope. Existing ponds with extensive shallow areas can be dug deeper during periods of low water.

High fertility can cause a plant problem because nutrients can be channeled into plants. It is desirable to avoid rich sources of nutrients, such as runoff from livestock holding areas or septic tank drainage.

Mechanical or Physical: Vegetation around the shore can

be controlled by hand pulling, cutting, or mowing. Hand pulling is effective for controlling cattails, willow trees and cottonwood trees while they are small. As they get larger, chemical control is needed. Most submersed plants can be partially removed by raking or by pulling a chain or cable through the pond between two tractors.

Submersed vegetation can also be controlled by shading with dark plastic screen, similar to screening used for shade in greenhouses. A large piece of screen should be weighted down on the patch of plants. This compresses and shades the plants and they die. After 2 weeks, the screen can be moved to a new area. The advantage of this method is that fishing, swimming and boating can take place over the screen.

All mechanical and physical methods are temporary and normally affect only a portion of the pond's vegetation. They must also be used frequently during the growing season.

Chemical: It is important to identify the problem plants, since there is no all-purpose chemical for aquatic vegetation control. Different herbicides are effective on different types of plants. Since the status of chemical registration is always changing, specific chemical names will not be listed. Aquatic herbicides are available at most dealers that handle agricultural chemicals. County agricultural agents and district fisheries biologists can give recommendations on which specific chemical to use.

Chemicals are registered for specific uses. Directions on the label should be followed explicitly and precautions should be observed. Many chemicals have restrictions on the use of water for a period of time after application. With some chemicals, fish should not be eaten for a period after application, or livestock should not drink the water for some time. These restrictions will determine which chemicals can be used.

Most chemicals are applied at a certain dosage per acre-foot of water in the affected area. Volume of the area to be treated can be calculated as described previously in the "Muddiness Caused by Soil Type" section or obtained from the Natural Resources Conservation Service if they designed the pond.

Most aquatic herbicides will not harm fish if applied according to directions. They are most effective if applied during April or May as the vegetation begins to grow. If applied after May or if the growth is heavy, only half of the pond should be treated at a time. The second half of the pond should be treated 2 weeks later. If the entire pond is treated at once, bacteria decomposing the dead vegetation could consume all of the dissolved oxygen, resulting in a fish kill.

One chemical treatment per year is usually sufficient, but, in some cases, a partial treatment is needed later in the summer. Chemical control is only temporary and must be repeated almost every year. It is expensive but effective if executed properly.

Certain chemical dyes can be added to the water to shade out the plants. These also are temporary and they impart an

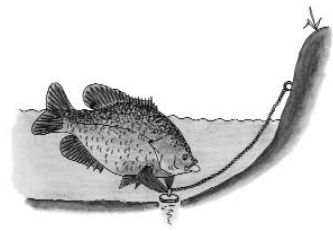
unnatural tint to the water for a period of time.

Biological: The most effective form of biological control is use of the herbivorous fish, the grass carp. This fish is a native of the large rivers of China and Siberia. It will not reproduce in ponds because it requires large rivers for spawning. Grass carp are mobile, and often escape through emergency spillways with high water flow. When small, it feeds on small crustaceans and insects. As it gets larger, its diet consists almost entirely of aquatic plants. It prefers some plants more than others but will eat most submersed aquatic vegetation found in Kansas. It has a voracious appetite and grows rapidly. Grass carp should be stocked at a density of 5-15 individuals per acre in ponds with severe vegetation problems. If adult bass are present, the grass carp should be at least 10 inches long when stocked to avoid predation. Ponds with only a narrow belt of vegetation should not be stocked with grass carp because these fish will eliminate habitat bass and bluegills need. More and bigger fish can be caught from a boat in such a pond than would be taken from shore if no vegetation existed.

Since the grass carp is an exotic fish, its use is not recommended by some federal agencies. In addition, the fish is not permitted to be used by the public in some states. In Kansas, no such bans exist and grass carp are available from many commercial fish growers. District fisheries biologists can provide further information and suggestions.

Fertilization can be used to control aquatic plants, but as stated previously, it can cause oxygen depletion problems and is not recommended in Kansas. Ducks, geese, or swans have also been used to control aquatic plants. They are esthetically pleasing but can be messy.

Sealing Leaky Ponds



It is discouraging to have a new pond fill with water and then see it go dry within a few weeks. Leaky ponds are common in some areas of Kansas, and almost all ponds will leak to some degree, especially new ponds. In Kansas, evaporation can be expected to range from about 4 feet per year in the eastern part of the state to about 6 feet per year in the west. Most evaporation occurs during the summer, especially in hot, dry, windy periods. During this time, about half an inch of water can be lost to evaporation each day. Water loss greater than this can usually be considered leakage. The pond owner can determine his pond's leakage rate by measuring the water level drop with a marked stick during a period of cold or very humid, calm weather.

Leaks in ponds may be the result of permeable sand, gravel, or fractured rock layers that either exist throughout the basin naturally or were exposed by construction. Improper bonding of the embankment to an impermeable foundation soil can also lead to leakage. Some ponds are constructed in areas where all the soil in the basin is permeable, so the leak cannot be pin-

pointed. Deeper ponds tend to leak more because of the increased water pressure on the porous areas.

Techniques are available to seal the leaky and potentially leaky areas. Most sealing techniques are expensive and require considerable work.

Soil Layer

If a small gravel or rock area is causing leaks, a bulldozer can be used to remove some of the problem material. The area can then be covered with a layer of soil high in clay (at least 10% clay) from some part of the basin. The added soil should be at least 1 foot thick and preferably 2 feet thick. This soil should be compacted as it is being deposited. A sheepfoot roller is recommended for serious leak areas.

Bentonite

Bentonite is a material that expands greatly when wet. Mixed with sand or permeable soil and water, it seeps into pores making an impermeable layer. Bentonite is usually applied at 1-2 pounds per square foot of pond bottom (more in areas over 10 feet deep). The dry powdered form creates a protective barrier when placed in a thin layer and covered with several inches of soil. Powdered bentonite can also be uniformly applied on the pond bottom and then mixed into the top 4-6 inches of soil with a disc and compacted. This method is quite successful in sealing a pond, but the seal can be punctured if cattle walk on the muddy pond bottom. A leaky pond which contains water can also be sealed by pouring a slurry of bentonite or spreading granular bentonite over the surface of the pond. This technique is usually not as successful as applying bentonite to the dry pond bottom because it is difficult to achieve an even application of the material. Bentonite is available from most feed mills or well drillers.

Livestock

Trampling a pond basin with cattle or hogs will sometimes seal permeable soil. Livestock should be fenced into the pond area and fed in the dry pond basin for several months. The combination of many hooves and manure and waste feed being worked into the soil sometimes makes a seal. This is especially effective if the pond basin occasionally becomes wet. However, the pond could fill up before the basin has been completely sealed.

Gleization

For ponds with rock 2 1/2 feet or more below the surface, organic matter can be used for sealing. The soil surface should be covered with about 6 pounds (dry weight) of livestock manure, straw, grass, leaves, or sawdust per square yard. An 8 inch protective layer of soil should then be placed over the organic matter. A biochemical reaction will take place between the soil and the organic matter to seal the basin.

Liners

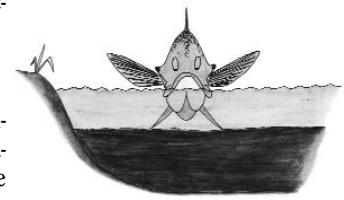
Plastic membranes which can be placed over pond basins are available. They are expensive and must be protected from rupture. If livestock are present, their access to the pond must be prevented.

Polymers

An emulsion of oil-soluble resinous polymers can be used to seal a pond without draining. The effectiveness of this material varies with condition and character of the soil, water, and climate, as well as manner of application. It is expensive and is toxic to fish, but a pond treated with polymers can be restocked within a few days after the water clears.

Salt

In the past, salt was used because sodium disperses clay particles, causing them to plug pores in the soil. It is no longer recommended because of possible water contamination.



Old Filled-In Ponds

Many ponds that are 20-30 years old have filled in so extensively that they are shallow with vast areas of aquatic vegetation. Ponds are temporary features on the landscape because they accumulate silt, debris, and decaying vegetation, eventually becoming marshes and even dry land. Although filling is inevitable, some measure can be taken to slow down the successional process.

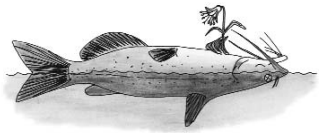
If a pond is reclaimed that has received excessive amounts of silt from erosion, soil conservation measures such as terraces, grassed waterways, and minimum tillage should be implemented. Small dams can also be built just upstream from large impoundments to act as settling basins for silt.

Livestock trampling the shoreline can cause the pond's banks and the dam to slough in. In addition to benefiting fish production, the practice of excluding livestock from the pond also increases the life of the pond.

Aquatic vegetation settles to the bottom when it dies. Part of it decays, but a considerable amount of residue remains on the bottom, filling a pond in over several years. Vegetation control slows this process.

Ponds that are filled in can be renovated, but the process is expensive. It is often easier to build a new pond if other good sites are available. If the pond is located at the only good site available, it can be deepened by dredging with a drag line. A cheaper method is to drain or pump the water out of the pond and let the bottom dry. If the bottom muck is too deep it will dry very slowly, and the pond will fill with water before the bottom gets a chance to completely dry. In most cases, it is best to break the dam with a back hoe down to a level below the pond bottom. After drying for about a year, the pond bottom should be firm enough for a bulldozer to push out the sediments. This material can be pushed out to the back side of the dam and the

break can be patched and packed with clay soil. It is important to "stair step" both sides of the break from bottom to top and compact each layer of added clay separately. The pond side of the dam should also have a new layer of soil pushed up against it and packed to be sure the dam is resealed.



Fish Kills

Fish populations commonly have high mortality rates. In some ponds, one-quarter to one–half of all fish present will die of natural causes each year. This mortality takes place throughout the year. Many fish succumb to predation. Fish dying from other causes are usually quickly eaten by scavengers, so dead fish are seldom seen. On some occasions in some ponds, noticeable mass mortalities of fish do occur. Once dead fish are seen, it is usually too late to do anything, but knowing the possible causes can sometimes help the pond owner prevent fish kills from recurring or at least reduce their severity.

Pesticides

A variety of chemicals are being introduced into our environment, and those used in agriculture can gain access into ponds. Some pesticides are extremely toxic to fish, and others are low in toxicity. Most herbicides used today have a low toxicity to fish, and most persistent insecticides have now been banned from use. Many of the currently used insecticides are short-lived, especially when exposed to water and are usually broken down and non-toxic by the time they get into ponds. Problems can, however, occur when someone carelessly sprays a pond while spraying a field, or when heavy rains wash pesticide-loaded silt into a pond immediately following application on a nearby field. Washing out a spray tank and equipment in a pond can also cause fish mortalities.

It is difficult to establish with certainty that a fish mortality was related to chemical use. Analysis of water samples is expensive and time consuming, and chemicals will break down by the time analysis is possible. Circumstantial evidence can be used in determining whether chemicals caused a fish kill. The pattern of mortality is usually the best clue. In a chemical poisoning, small fish die sooner than large fish, and all species of vertebrates including turtles and frogs are affected.

In addition to massive fish kills, pesticides can have long-range effects on fish production if sub-lethal dosages are continuous or repeated. Pesticides may affect food organisms; they may alter fish reproduction, or they may be an added stress, causing decreased resistance to low oxygen levels and diseases.

Winterkills

Fish kills are common during the winter in Kansas. Mass mortalities are noticed in late winter when ice cover disappears. This type of mortality is caused by oxygen depletion under the ice. A long period of snow cover on the ice is usual-

ly responsible for a winterkill. Ice is usually clear enough to allow sunlight penetration so that plants can produce oxygen, but snow cover greatly reduces the amount of light penetration so plants are unable to produce oxygen. Instead, there is a steady decline in oxygen due to the decay of organic matter and respiration by bacteria and other organisms. If snow persists long enough, complete oxygen depletion will occur. Winterkill ponds are typically shallow and have a high organic matter content commonly in the form of decaying vegetation or livestock wastes.

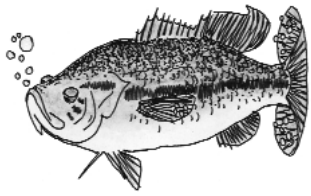
Winterkills can often be prevented by controlling aquatic vegetation and reducing the amount of livestock or other wastes that get into the pond. Water depth in Kansas should be at least 8 feet going into the winter to hold enough oxygen to carry fish through a normal period of ice cover. Ponds that rely on surface runoff should be built at least 10 feet deep in eastern Kansas and 15 feet deep in the western part of the state. Removal of even a strip of snow from the ice may prevent winterkill. Another effective way to prevent winterkill is to place an aeration device on the pond bottom or to install a water circulator to keep an area free of ice. Much of the water is then exposed to the air for oxygen absorption. Just cutting a hole in the ice is not effective since too little water gets exposed to the air.

Summerkills

Summerkills are massive fish mortalities which occur during the summer due to oxygen depletion. The chain of events leading to summerkills was described in the "Aquatic Vegetation" section. Fish mortality due to summerkill usually occurs early in the morning, at which time the dissolved oxygen in the pond is at its lowest level. The mortality pattern is different than occurs due to pesticide poisoning, with larger fish dying first and frogs and turtles not affected.

Summerkills can be prevented by keeping aquatic vegetation from becoming too abundant. Excessive nutrients should also be prevented from entering the pond. This will reduce heavy algae blooms. If a fish kill is beginning or about to begin (fish are gulping for air at the surface), heavy mortality can often be prevented by pumping fresh water into the pond or by installing an aeration device.

Summerkills are common in fish feeding programs where high densities of fish are crowded into small shallow ponds. The addition of the organic matter in the form of feed can deplete the oxygen content in the pond.



Diseases and Parasites

Fish are affected by a wide variety of diseases and parasites just like any other group of animals. Diseases can be caused by viruses, bacteria, or fungi. Fish are most susceptible to diseases in early spring when their resistance is low coming out of the winter. In most cases, mortality is not extensive in pond fish

populations. Diseases are a greater problem where fish are crowded as in hatcheries and commercial operations. Disease diagnosis is difficult, and treatment is expensive and usually not feasible except in large investment situations such as fish farming.

Most fish will have at least a few parasites. Parasites may be protozoa, flukes, tapeworms, roundworms, leeches, or crustaceans. A healthy fish can tolerate some parasites and show no ill effects. It is difficult to rid a pond of parasites, since there are a variety of parasites that can be readily introduced from a variety of sources. The best way to keep fish populations healthy is to maintain good water quality and prevent overpopulation.

"Black spot" and "yellow grub" are the fish parasites people most commonly encounter. Black spot (or black grub) consists of small, round, black grains (about pinhead size) embedded in the skin and flesh. Sunfish and minnows are commonly affected. Yellow grubs appear as small yellow or white nodules under the skin and in the flesh, especially near the base of fins and the tail. These parasites are found in many species of fishes, but are most noticeable in largemouth bass. The yellow grub is an immature stage of a parasitic flatworm which has a complicated life cycle. The adult worms live in fish-eating birds such as kingfishers and herons. The eggs are expelled into the water and hatch, producing larvae which enter snails. They then undergo massive asexual reproduction and numerous free-swimming individuals are released. These penetrate fish and become embedded. This is the stage that is readily observed by anglers. When the fish-eating bird eats the fish, the grubs have a chance to become adults and complete the cycle.

Most fish diseases and parasites are specifically found in fishes and are not harmful to man, especially if the fish flesh is properly cooked before being eaten.

Muskrat and Beaver Control in Ponds

Identification of Damage

Muskrats damage ponds by burrowing into dams and banks to make dens, thus increasing the chance of seepage and erosion. Den openings are 4-6 inches in diameter and are usually near the surface, though in ponds with frequent water level fluctuations they may be in deeper water. In clear water, dens are usually visible, but in turbid water, they must be detected with hands, feet, or a pole. When ice appears, trails of bubbles and chewed vegetation will lead to active dens.

Beavers burrow into dams and banks, cut trees, and plug outlet tubes. Their work is conspicuous and they are extremely persistent. Bank dens are 12-18 inches in diameter and will be present whether a dammed lodge is present or not. In fall and winter, a pile of fresh cuttings will be evident near the lodge or main den.

Prevention of Damage

Muskrat damage is unlikely in ponds where the dam is sodded, ungrazed, and built to Natural Resources Conservation Service specifications. Hard clay should be used in construction to discourage burrowing. To control burrowing after it has begun, all muskrats in the pond should be trapped, and affected areas should be riprapped. Wire mesh or fencing can also be used, but these materials yield to corrosion after several years. If all muskrats are not removed, survivors will find a way to reopen their traditional burrows

Beaver burrows are big enough to damage even well-built dams. Riprap will discourage initial burrowing, but all beaver must be trapped if burrows are to be sealed. If burrows break through the surface of the dam, the opening should be collapsed as far back as possible and filled with clay.

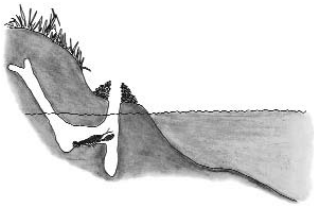
To keep beaver from plugging outlet tubes, the pond owner should string electrified fence wire around the tube and connect it to a fencer and battery. Wood or fiberglass posts should be used or the system will not work. After beaver have been shocked a few times, the power can be turned off until problems recur. Outlet tubes are easier to keep free of debris if they are covered with a heavy trash rack of welded metal which is periodically cleaned. “Chicken wire” should not be used, as it cannot be cleaned. To prevent cutting of ornamental trees, bases should be wrapped with 1/4-inch wirecloth or similar fence material. No effective repellent is commercially available.

Population Control

Sustained population control is the best damage prevention method available for both animals. Small, stable populations of muskrats and beaver will do little damage. Pond owners should not wait until furbearers become overabundant before initiating control, because by then the damage has been done.

For most pond owners, the most feasible method of population control is to have a local trapper work the pond every year. Everyone, including the surviving animals themselves, benefit from this arrangement. The pond owner keeps the problems to a minimum; the trapper earns money for pelts, and the animals are kept within the capacity of the pond to support them. If the pond owner wishes to try trapping beaver and muskrats, he should contact the Kansas State University Extension Service or the nearest Department of Wildlife and Parks office for detailed information on proper equipment and methods. These agencies can also provide names of trappers who are available to help with problems. If damage is severe, muskrats and beaver can be shot or trapped out of season provided a permit is obtained from the Department of Wildlife and Parks. Pelts obtained out of season must be turned in to the area conservation officer. The pond owner may pay a trapper market value for fur that is turned in on a permit as incentive for him to work on problems.

Both muskrats and beaver can be live-trapped although equipment costs may be prohibitive. Beaver can be taken in suitcase-style Bailey or Hancock traps, and muskrats can be taken in wire box traps (Havahart type) that are set on a float made from two- by eight-inch boards. Poisons are not recommended for beaver or muskrats due to undesirable effects on non-target species (particularly fish). A permit is required for use of poisons, and these are seldom issued by the Department of Wildlife and Parks.



The Role of Crayfish in Ponds

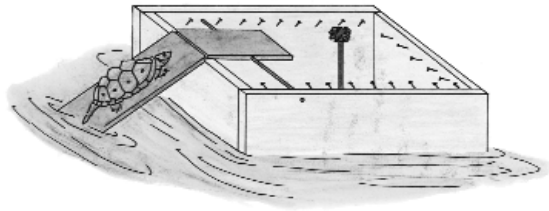
When a pond owner discovers that his pond has crayfish, an image of a leaky pond comes to mind, followed by thoughts of how to eradicate them without harming the fish. Without much effort, crayfish can be managed to provide benefits for the pond owner.

Crayfish burrows rarely cause ponds to leak. Controlling crayfish in established ponds is best done by stabilizing the water level. Crayfish reproduction is closely tied to changing water levels and is most successful in waters that have regular seasonal fluctuation patterns. Wire basket traps or lift nets baited with meat can remove large numbers of these crustaceans in short periods of time.

Having crayfish in a pond isn't all bad. In the process of eating minute plants that grow on submerged vegetation, crayfish also eat larger pond plants, giving limited vegetation control. Since crayfish are consumed as prey throughout their lives by bass, bluegills, and channel catfish, they also provide benefits as a fish food. Catching crayfish using a rod can sometimes be as much a sport as angling for fish. Substituting crayfish for crab, shrimp or lobster in recipes offers an excellent table fare for a fraction of the cost.

The Role of Turtles in Ponds

Most pond owners and anglers view turtles as a threat to fish communities in ponds. Such is not the case. Turtles are primarily scavengers, feeding on dead or dying fish and other aquatic organisms. They thus serve to clean the pond more than cause harm, and should not be indiscriminately destroyed. Turtles may cause problems by stealing bait and even fish from stringers. Snapping turtles may also prey on small ducks that hatch around the pond.

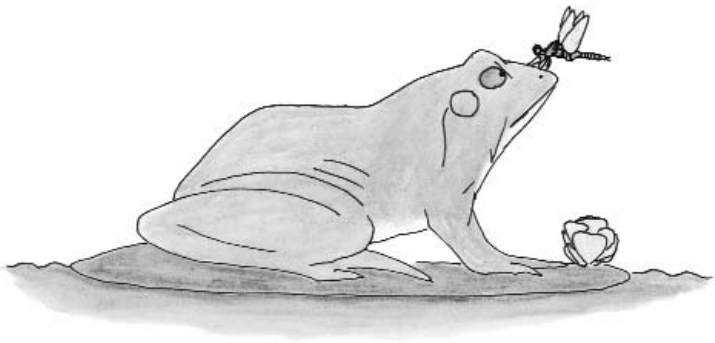


If the pond owner enjoys turtle soup, stew, or fried turtle, or if turtles become too plentiful, they can be removed by trapping. An effective trap can be constructed by attaching a hardware cloth or "chicken wire" bottom to a square, four-board wood frame. A slanted board is then nailed to the outside of the trap, leading to the top edge. It serves as a ramp on which the turtle can crawl out of the water to the trap. A metal rod is driven horizontally through two of the frame boards. The rod is also passed through another "teeter" board which extends from the edge of the trap to near the middle. When the turtle crawls to the end of the board, his weight will tip it forward and he will fall into the trap. A tough piece of fresh beef or pork should be suspended in the middle of the trap for bait. To keep the turtle in the trap 20 D nails should be driven into the frame, slanting upward, 4 inches apart, 2 inches above the water.

Role of Frogs in Ponds

Frogs need water to reproduce. Masses of gelatinous eggs are often found in pond water during spring and summer. In Kansas, the bullfrog is the only common species that has a tadpole stage lasting longer than a year. All others will develop into tiny frogs the same season the eggs are laid. These amphibians are an interesting addition to the aquatic ecosystem, but they usually do not substantially help or hinder the fish community. The adults are quite mobile and often leave the pond. Bullfrogs, however, will take up residence by a pond and can usually be seen sitting on the edge of the water. Frog legs are tasty, and frog harvest during the legal season is another benefit of a pond..

Frogs seldom are a problem because bass and other predators usually keep populations low. Bullfrog tadpoles can become a problem in channel catfish-only ponds or minnow ponds because they can become abundant. Excessive numbers of tadpoles can be reduced by seining, and the adults can be eliminated by capturing them during the legal frogging season.

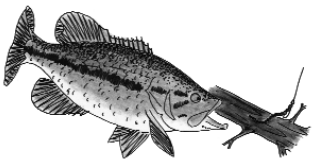


FISHING THE POND

The Angler's Responsibility

Since ponds are located on private property, it is the angler's responsibility to obtain permission before fishing. The pond angler should be aware of any other restrictions that the pond owner may have imposed, such as bass length, number, or poundage limits.

Access to ponds is usually not difficult if the angler makes a point of informing the pond owner that he respects property and appreciates the privilege of fishing. An angler is, however, likely to have problems convincing a pond owner of his sincerity if the pond owner has experienced cases of vandalism or thoughtlessness in the past. To keep ponds from becoming totally private, anglers may need to take a more active part in pond management. Perhaps more pond owners would be willing to allow fishing access if more anglers were physically and monetarily involved in carrying out management practices described in this booklet.



Bass Fishing Techniques

Pond bass fishing can be an exciting and rewarding venture. More big bass are harvested from ponds than from any other water type in Kansas.

The bass is probably one of the easiest fish to catch, which explains why overharvest of bass in ponds is so prevalent. One angler can overharvest the bass in an acre pond in a single successful fishing trip if bass are actively feeding.

Small bass will bite just about anything tied on the end of a fishing line. Artificial baits such a spinners, jigs, beetle spins, plastic worms, and surface lures are deadly. Yellow, purple, and black are the preferred colors. Natural baits such as minnows, worms, frogs, crayfish, and grasshoppers will also catch bass. Big bass will also hit any of the above baits but not as readily as smaller fish. Technique is important if the angler wants to catch big bass.

Techniques vary according to the season. Spring time in a pond means cold water and relatively inactive bass. They will move to the shallows during the day as the sunshine warms the water but are difficult to catch there. Slow moving spinners or small jigs should be fished near habitat structures or along steep drop-offs at this time of the year. Bass may also be caught in deep water along the edges of vegetation.

As summer approaches, bass move to the shallows to spawn and can be caught fairly easily. Plastic worms and fast moving lures such as spinner baits work well. Minnows and crawfish fished around shoreline habitat will produce bass in the May-June period.

Hot summer days mean warm water temperatures, probably pond stratification, and vegetation growth. This drives bass to

shady areas around shallow habitat. Bass are aggressive at this time, and surface lures, popping bugs and floating plastic worms excite them. Grasshoppers and frogs make excellent summer baits, either fished on the surface or hung 12-18 inches under a bobber. Many times, bass will come out of the water to hit a bait in the summer. Nighttime fishing may increase success even further.

Fall weather cools the water and bass feed actively, fattening up for the winter. Surface baits become less effective as the water cools so the angler should again use spinners, beetle spins or plastic worms. Minnows are a good fall bait. The angler should fish around any existing habitat (brushpiles, vegetation, or fallen trees).

During the winter bass are slow, sluggish, and finicky, but they can be caught through the ice on small minnows or jigs smaller than 1/16th ounce. Deep brushpiles, habitat structures, or areas near deeper parts of the pond should be fished in the winter.

Bluegill Fishing Techniques

Bluegills can be caught using nearly any fishing rig known to man, but the most successful bluegill anglers use a delicate approach. In most cases, that means 2- to 6-pound test line, a number eight hook baited with a worm or grasshopper, a single split shot for weight, and a thumbnail-sized bobber in situations that require flotation.

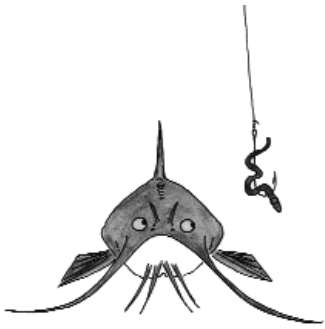
It isn't necessary to cast to a bluegill; many top notch anglers just reach out and drop the bait on him. The cane pole most fishermen learned on is an excellent tool for bluegill fishing. Its length lets an angler present the bait quietly from a distance, and the spring in the pole is more than any bluegill can handle. Some fishermen use flyrods for the same purpose, dangling a baited hook under heavy cover along the bank or in a flooded brush. Casting with an ultralight spinning rod is also an effective as well as sporty way to catch bluegills. This approach, regardless of the type of rod used, is the most effective year-round method for catching bluegills.

Bluegills are particularly vulnerable to the fly fisherman when they're on their spawning nests or "beds" in shallow water during June. The biggest fish take the preferred locations on the beds usually next to the bank under an arch of brush. A flyrod expert who can lay a popper, fly, or rubber spider into these tight spots can often catch several bluegills in succession.

Before the bed fishing gets hot, bluegills can be taken with ultralight spinning tackle. The fish are sluggish until the water warms up. They react slowly to bait, and take it delicately when they decide to bite. A small (16th ounce or less) jig suspended under a small bobber is a good rig for the early fishing. It casts surprisingly well and lets the fisherman work the bait slowly, vibrating the bobber a few inches across the water, then letting it sit for half a minute. This technique gives the jig a subtle

action and lets the fish make up his mind and move in.

Ultralight spinning tackle with small jigs or spinners also work well in midsummer after the fish have come off their beds. Bluegill and most other fish move into deep water during the heat of the day and come into the shallows to feed at dusk and especially at dawn when water temperature is at its lowest. Fishing for bluegills with a cricket or small worm works well through the summer, too.



Bluegills are the staple for ice fishermen who work small ponds. Bluegills congregate in the deepest holes around cover in the winter. A red wiggler angle worm fished a foot or so off the bottom works well, especially when it's attached to delicate tackle—two-pound line, one split shot, and a tiny bobber.

Channel Catfish Fishing Techniques

Still fishing is the best and most sporting method for catching pond catfish. Channel catfish in ponds generally bite on the same baits as those in other waters. Earthworms and smelly baits, such as shad sides, chicken intestines, chicken and turkey livers,, shrimp, sponge baits and prepared baits will all attract hungry catfish. If the angler doesn't have bait with him when he goes fishing, he may be able to catch his own at the pond. Leopard frogs, crayfish and bluegill halves make excellent catfish bait.

Channel catfish begin feeding as soon as the ice goes off in the spring. Shad or sponge baits work well, but the crayfish is the mainstay of the catfish diet in the spring. As summer approaches, catfish feed more actively and can be taken just about anywhere in the pond as long as the bait is on or near the bottom. Good late spring baits are worms, liver, and shrimp.

Summertime weather will likely cause a pond to stratify, and fishing for catfish in the deep parts of the pond is then a waste of time. Baits should be fished below a bobber, seldom deeper than 4-5 feet. If the angler wants to fish on the bottom, he should cast along the edges of vegetation or around fish attractors in water less than 5 feet deep. The most exciting fishing during the summer months in ponds occurs during or right after a heavy rain.. Catfish feed actively on food that washes in, and the angler can fill his stringer in a hurry by fishing earthworms on the bottom in shallow water near the upper end of a pond.

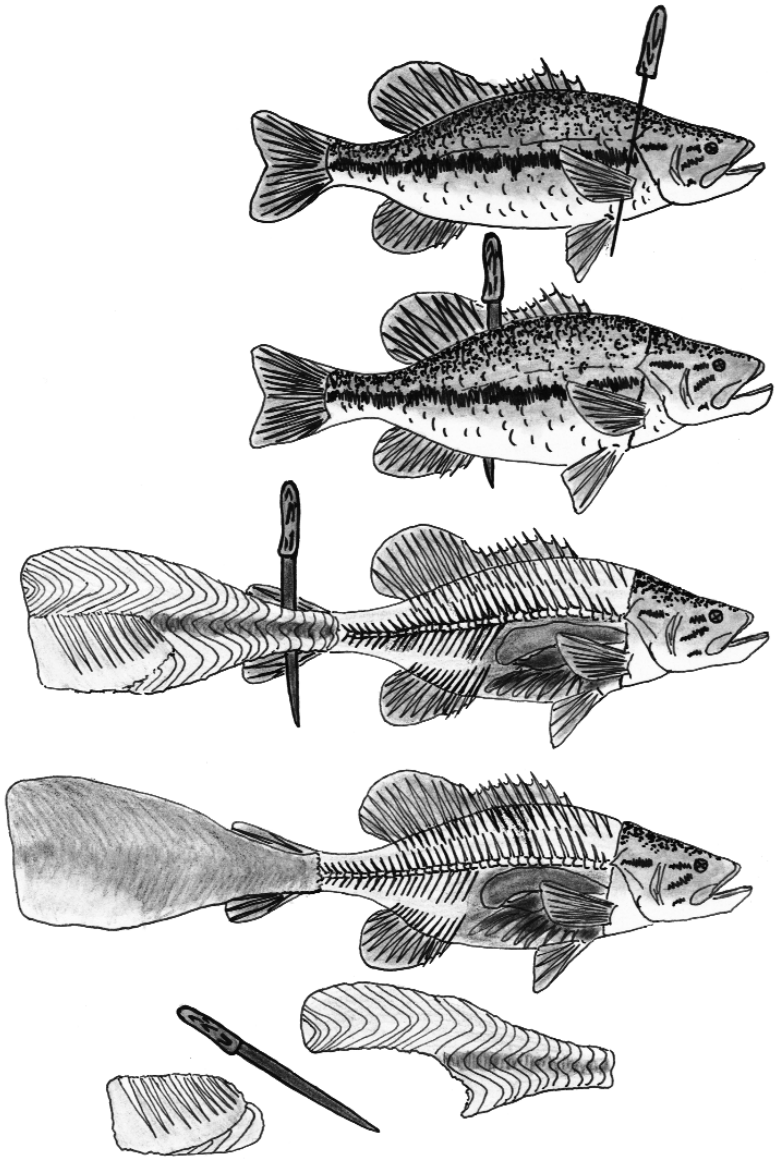
Fall pond catfishing is much like spring fishing. As the wind mixes the water column, catfish feed throughout the pond and grasshoppers generally replace crayfish as the best natural bait. Fishing will become more difficult as the water cools. The angler should fish deeper water and be patient.

Cleaning and Preparing Fish

To some, the fun is over when the fish are caught because cleaning fish is an unpleasant task. This attitude is most common among those who are not aware of the cleaning technique best suited for the fish species they have caught. Once proper

techniques are learned and applied, the task becomes a small price to pay for the delicious eating that is yet to come.

The most common method of cleaning catfish is to make an incision around the body in back of the head, after which the skin and fins are pulled off with pliers or a skinning tool, the body is cut open, the entrails are removed, and the head and tail are cut off. The fish is then washed, dipped in batter, and fried. The bones remain intact, but it is an easy matter to pick large pieces of meat off large bones.



Other fish species can be scaled with a teaspoon or scaling tool and then cleaned much like catfish. The problem is that most people don't like to pick through small bones of several small fish to find small pieces of meat. Filleting is thus a much preferred method of cleaning for most fish besides catfish and even catfish lend themselves well to filleting.

Without question, filleting is the most efficient method of cleaning fish. The traditional tool for filleting fish is the flexible, thin-bladed, razor sharp fillet knife. An electric knife, once mastered, can greatly speed fish cleaning.

There are two types of electric knives on the market. One has a straight handle with a trigger on the bottom operated by the forefinger. The second type has a large moon-shaped handle with a trigger button on top operated by the thumb. The knife with a straight handle allows for better leverage on the blade and works much better for filleting than the other model.

To fillet a fish using either a fillet knife or an electric knife, the angler should grasp his fish by the head with one hand and lay it on one side. A vertical incision is then made just behind the gill cover from the nape of the neck to the belly, down to the backbone. The knife is then run horizontally along the backbone, cutting through the ribs. Just before the knife reaches the tail, the fillet is flipped off the carcass, and the skin is sliced off the meat by pressing the knife blade flat on the cleaning surface as the cut proceeds toward the ribs. The ribs are then cut from the fillet. This process is then applied to the other side.

This conventional filleting technique works especially well on large fish such as bass or walleye. For panfish like crappie, and particularly bluegills, there is yet another approach. The first step is to scale both sides of the fish thoroughly. The fish is then dipped in a bucket of clean water to remove loose scales and mucous. A small fillet knife is inserted into the nape of the neck. The knife is run along the top edge of the ribs next to the bones which branch off the spine. After the knife has passed by the ribs, the cut proceeds toward the belly with the tip of the knife exiting the fish at the front edge of the anal fin. The cut continues all the way out to the tail. A vertical incision is then made just behind the gill cover and the fillet is pulled and sliced off the ribs. The fillet is separated from the carcass along the belly by cutting from the vertical incision made previously to the front of the anal fin. The fish is then flipped over and the cutting process is repeated on the other side.

By leaving the skin intact, the fillet holds together better, fries up crisper, and has more flavor. In addition, cutting along the outside of the ribs and then out at the bottom of the fish salvages a bit more meat along the belly. This area is discarded when ribs are cut out in the conventional method. The conventional method also wastes some meat near the tail. In both areas there isn't much wasted using the conventional method, but every little bit counts, especially when cleaning fish as small and as good tasting as bluegills.

LAW ENFORCEMENT AND THE POND

Separate Rules Apply to Private and Non-Private ponds.

A private pond is defined as a manmade body of water which is located entirely on the property of only one landowner or lessee. There must be no connection with streams or other bodies of water that would allow fish to pass between. A pipe may be installed between a private pond and other bodies of water as long as a screen or other method is used to prevent fish from passing from one to the other. Private ponds enrolled in the Department's F.I.S.H. program are exceptions to the following rules for private ponds:

- No fishing license is required to fish in a private pond.
- No creel or size limits apply to fish caught from a private pond.
- Fish may be caught from a private pond using any methods, except for substances which could escape, endanger or kill fish in other waters.
- Private ponds may not be stocked with fish provided by the Department.
- Private ponds are open to fishing year-round.
- The landowner or legal tenant of a private pond controls access to the pond.
- The landowner or legal tenant may raise and sell fish from a private pond.
- Statewide rules, as published in the Kansas Fishing Regulations Summary, apply to the taking of bullfrogs from private ponds.

Some private ponds are enrolled in the Kansas Department of Wildlife & Parks Fishing Impoundments and Stream Habitats program. Through leasing, the status of these ponds changes from private to public. These rules apply:

- The landowner or legal tenant, and the immediate family living with him, of the F.I.S.H. pond are exempt from a fishing license. Everyone else fishing there is required to have a valid Kansas fishing license.
- The statewide creel and length limits which are listed in the current year Kansas Fishing Regulations Summary apply.
- The statewide legal fishing methods which are listed in the current year Kansas Fishing Regulations Summary must be used.

- Under the lease arrangement, the Department may furnish and stock fish in a F.I.S.H. pond or body of water.
- F.I.S.H. waters vary from being open to the public year around to time frames between March 1 and October 31 only; F.I.S.H. areas are only open from sunrise to 1/2 hour after sunset.
- F.I.S.H. areas are open to the public, are posted with special rules and are patrolled by The Kansas Department of Wildlife & Parks.
- Statewide rules as published in the Kansas Fishing Regulations Summary govern the taking of bullfrogs from F.I.S.H. areas.

Non-private ponds include those which lie on the property of more than one landowner or are connected to another body of water with movement of fish between them. This classification also includes private ponds which have been stocked with fish by the Department during the preceding ten years. Non-private ponds are subject to these rules:

- The landowner or legal tenant, and his immediate family living with him, are exempt from license requirements. A fishing license is required for all others.
- Statewide creel and length limits, and statewide fishing methods apply.
- Fish may not be raised and sold from non-private ponds.
- The taking of bullfrogs on non-private ponds is regulated by statewide rules published in the Kansas Fishing Regulations Summary.

Trespassing and Fishing Access

Landowners and legal tenants control access to their property for fishing. Many choose to post their property with signs to limit that access. To allow fishing, they may give verbal permission. Most signs and posting requires the landowner to swear out a complaint against the offending party and be available to testify to the offense in court. Some landowners and tenants opt to erect "no hunting, fishing, or trapping without written permission" signs, or to utilize written permission and to issue citations without involvement of the landowner. If this system is used, the landowner must be certain to provide the required written permission to everyone except his immediate family residing with him, who are exempt.

Conservation Officers and other law enforcement officers may enter private property to perform their duties in the enforcement of statewide fishing regulations where they apply, as well as the taking of bullfrogs from ponds or other waters.

FISH FACTS AND FALLACIES

The mucous on a fish's body serves to protect it from diseases and reduces friction between the water and the fish's body. A fish that is to be released should be handled gently, preferably by the lower jaw, to avoid mucous loss. The angler should also wet his hands before touching the fish.

Although a fish does not have external ears, sound vibrations are transmitted to inner ears and the air bladder. The lateral line which extends down a fish's side is used to detect low-frequency vibrations and aids in avoiding collisions and capturing prey.

Fish have nostrils used to smell, and a catfish's barbels are used to taste. Catfish also have venomous glands associated with their dorsal and pectoral spines.

Fish have a poorly developed nervous system as compared to man. Rather than feel pain, a hooked fish senses only discomfort.

Fish cannot regulate their body temperature. They become less active in cold water because their body temperature matches that of their surroundings.

Fish do not have eyelids, but they "sleep" by hovering in place in open water, on the bottom or near an object.

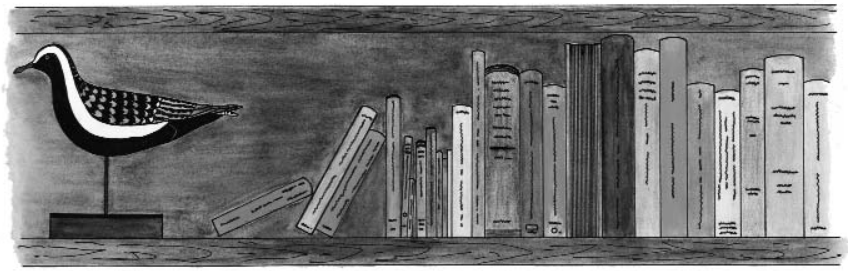
The age of a fish can be determined by examining a scale or certain bones. A ten-year-old fish would be considered a "senior citizen" in Kansas. Most fish here live no longer than 6-8 years.

Fish do not gain access to a pond on birds' feet or in birds', bodies. Fish eggs die quickly when dry and would not survive even a short flight. Eggs that are eaten are quickly digested. Fish are introduced into ponds by *someone* or from nearby creeks or ponds that have flooded.

There are more than 20,000 fish species on earth. Of the 142 species inhabiting Kansas waters only 29 are regularly caught by anglers and only 19 are commonly harvested.

REFERENCE MATERIAL

A booklet such as this seeks only to provide an overview of pond management techniques. A pond owner may require more complete explanations for some of the topics covered. The following is by no means a complete list of references, but these sources will provide additional or more detailed information concerning the subject headings under which they are listed.



Pond Construction and Management

Ponds – Planning, Design, Construction, Agriculture Handbook No. 590, U.S. Department of Agriculture, Natural Resources Conservation Service.

Uses and Effects of Cultured Fishes in Aquatic Ecosystems, H.L. Schramm, Jr., and R.G. Piper, editors. American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814-2199.

Fish Hatchery Management, second edition, G.A. Wedemeyer, editor. American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814-2199.

Fish Farming

Principles of Warmwater Aquaculture, by R.R. Stickney, published by John Wiley and Sons, Inc., 111 River Street, Hoboken, NJ 07030.

Introduction to Aquaculture, by M. Landau, published by John Wiley Sons, Inc., 111 River Street, Hoboken, NJ 07030.

Dynamics of Pond Aquaculture, by H.S. Edna, and C.E. Boyd, published by CRC Press, CRC Press LLC, 2000 NW Corporate Blvd., Boca Raton, FL 33431-9868.

Identification Aids

Fishes in Kansas, second edition, by F.B. Cross and J.T. Collins, Public Education Series No. 14, Museum of Natural History, the University Press of Kansas, Lawrence, KS 66049.

The Fishes of Missouri, revised edition, by W.L. Pflieger, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102-0180.

Iowa Fish and Fishing, by J.R. Harlan, E.B. Speaker, and J. Mayhew, Iowa Department of Natural Resources, Wallace State Office Bldg., East 9th and Grand Avenue, Des Moines, IA 50319-0034.

Fishes of the Central United States, by J. R. Tomelleri and M.E. Eberle, the University Press of Kansas, Lawrence, KS 66049.

Introduction to Fish Health Management, second edition, edited by B.A. Lasee, U.S. Fish and Wildlife Service, La Crosse Fish Health Center, 555 Lester Ave., Onalaska, WI 54650.

Amphibians and Reptiles in Kansas, third edition, by J.T. Collins, Public Education Series No. 13, Museum of Natural History, the University Press of Kansas, Lawrence, KS 66049.

Water Plants for Missouri Ponds, by J.R. Whitley, B. Bassett, J.G. Dillard, and R.A. Haefner, Missouri Department of Conservation, P.O. Box 180, Jefferson City, MO 65102-0180.

Aquatic Plants and their Control, by D.E. Peterson, and H.E. Klaassen, Cooperative Extension Service, Manhattan, KS 66506.

How to Identify and Control Water Weeds and Algae, Applied Biochemists, Inc., 6120 W. Douglas Ave., Milwaukee, WI 53218.

Periodicals

Farm Pond Harvest, 1390 N 14500 E. Rd., Momence, IL 60954.
Aquaculture Magazine, P.O. Box 2329, Asheville, NC 28801.
Kansas Wildlife and Parks Magazine, Kansas Department of Wildlife and Parks, 512 SE 25th Ave., Pratt, KS 67124.

Sources of Fish

Kansas Fish Producers Directory, Kansas State Board of Agriculture, Marketing Division, 109 S.W. 9th, Topeka, KS 66612-1282. Free upon written request for above address and Kansas Wildlife and Parks, Natural Resources Conservation Service and Extension Service office.

FURTHER ADVICE

Kansas Department of Wildlife and Parks

Operations Office
512 SE 25th Ave. Pratt, KS 67124 (620) 672-5911
Region 1 Office
P.O. Box 338, 1426 Hwy 183 Alt., Hays, KS 67601 (785) 628-8614
Region 2 Office
3300 SW 29th, Topeka, KS 66614 (785) 273-6740
Region 3 Office
1001 W McArtor Rd., Dodge City, KS 67801 (620) 227-8609
Region 4 Office
6232 E 29th St., N, Wichita, KS 67220 (316) 683-8635
Region 5 Office
1500 W. 7th, P.O. Box 777, Chanute, KS 66720 (620) 431-0381
Emporia Research Office
1830 Merchant, P.O. Box 1525, Emporia, KS 66801 (620) 342-0658

Natural Resources Conservation Service

State Office
760 S. Broadway, Salina, KS 67401 (785) 823-4500
Area 1 Office
1010 East 17th, Hays, KS 67601 (785) 625-2588
Area 2 Office
107 Layton, Dodge City, KS 67801 (620) 227-2392
Area 3 Office
9 West 28th, Suite B, Hutchinson, KS 67502 (620) 663-3501
Area 4 Office
1125 Westport Dr., Manhattan, KS 66502 (785) 776-5182
Area 5 Office
2917 W Hwy 50, Emporia, KS 66801 (620) 343-7276

Extension

Cooperative Extension Service
Call Hall, Manhattan KS 66506 (785) 532-1210
North Central Regional Aquaculture Center
Publications Office Department of Animal Ecology
124 Science Hall II, Iowa State University
Ames, IA 50011-3221 (515) 294-5280