Texas Agricultural Extension Service
The Texas A&M University System

Texas Farm Ponds:
Stocking, Assessment, and Management Recommendations

Special Publication No. 1
Texas Chapter
American Fisheries Society

Revised September 1996

This publication was prepared by members of the Texas Chapter of the American Fisheries Society. It represents a consensus on guidelines for stocking and managing Texas farm ponds and has been endorsed by the Texas Aquaculture Association.

Most farm ponds and small impoundments in Texas are not managed at their highest potential for fish production.This is especially unfortunate, since an estimated 20 percent of fishing trips in Texas are to these waters. This publication presents a concise set of guidelines for stocking and managing fish in new, renovated, or old ponds.

This publication was prepared by the Texas Chapter of the American Fisheries Society to provide information to the pond owner who has little or no knowledge of fishery management. Specific information on assessment techniques, interpreting assessment data, and corrective management are included to help the pond owner develop long-range management plans.

This information is intended primarily for ponds less than 5 acres in surface area, but it may be useful for larger impoundments as well. However, you should discuss the management of these larger bodies of water and/or unusual management problems with a qualified fisheries biologist. Stocking and management advice is available from various state and federal agencies, universities, private consultants, and fish farmers.

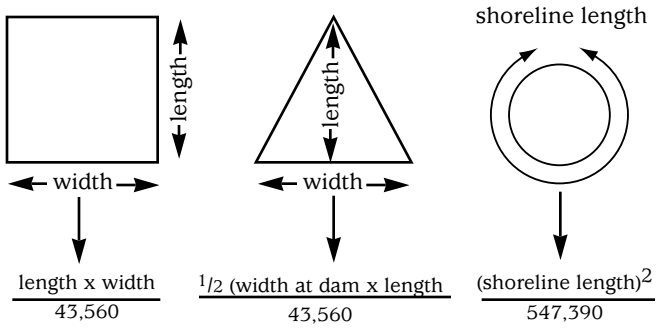
Management Considerations And Objectives

Before you can develop a management plan for your pond, you must first decide on objectives that are both desirable and attainable. These objectives will be influenced by your preferences for certain species and sizes of fish, the pond's basic productivity, and your interest in and commitment to increasing that productivity.

Pond Characteristics

Pond Size. The size of your pond is the major factor that will determine what fish you need to stock, the degree of management needed to maintain these fish, and how many fish you can harvest each year. Most farm ponds in Texas are built for livestock watering and are less than 1 acre in surface area. Although owners of small ponds traditionally want "bass in their tanks," these small ponds are really not suited for bass populations. Bass harvest in small ponds is especially difficult because over-fishing may allow overpopulation of forage species, while under-fishing may lead to a forage deficiency that reduces bass growth. In small ponds, it is usually better to stock catfish alone, since they provide more fishing recreation and food for the table and they can be fed commercially prepared feed. Ponds larger than 1 surface acre are more suitable for more than one species. If these larger ponds are stocked, managed, and harvested properly, you can expect many years of satisfactory fishing for all sport species. Or, if you prefer, they can also be managed for catfish only.

Many pond owners have difficulty estimating the surface area of their ponds. It is easy to overestimate, and this often leads to overstocking. If your pond fluctuates considerably in surface area, stock it based on the average annual low-water surface area. Remember that 1 surface acre contains 43,560 square feet. Formulas for calculating the surface area in acres of the most common pond shapes (square or rectangular, triangular, and round) are provided below to assist you in determining the size of your pond. All dimensions should be measured in feet.



Muddy Water. Some Texas ponds tend to stay muddy. This muddiness is caused by suspended clay particles in the water; don't confuse it with the turbidity resulting from a plankton bloom. Muddy waters hinder the growth of organisms the fish eat and may also affect the reproduction and growth of the fish themselves. Suspended soil particles in pond water can result from watershed erosion, wave action, large populations of bullheads or carp, or cattle wading into the water and stirring the mud. Correcting the problem usually causes the material to settle to the bottom of the pond. If, however, the suspended material is colloidal clay particles, it will not settle out, and you must add organic material or chemicals to the water to correct the situation. In muddy water, bass do not usually do well, and you should stock only catfish. Sources of more information about clearing muddy ponds are listed in the References section.

Total Alkalinity. Ponds in different areas of the state have different water chemistry, caused by factors like soil type, water sources, and watershed. The water chemistry in a pond affects the primary productivity, which in turn determines the number of fish to stock. One characteristic that controls the ability of a pond to produce food for fish is alkalinity. Alkalinity is the measure of buffering capacity. If you plan to fertilize, you should have the alkalinity checked. Total alkalinity should be at least 20 parts per million (ppm) if your fertilization program is to be effective. If the alkalinity is less than 20 ppm and you want to fertilize, agricultural limestone can be added to increase alkalinity. Your county Extension agent, local Natural Resources Conservation Service office, Texas Parks and Wildlife fisheries biologist, or information in the References can help you estimate the alkalinity in your pond and provide guidance for adding lime.

Water Fluctuation. Ponds in different parts of the state experience different annual rainfall and evaporation rates. While East Texas farm ponds are usually full most of the year, South and West Texas ponds may experience drastic draw-downs during the summer months. These draw-downs concentrate all the fish in small areas and can reduce populations through either predation or oxygen depletion. You can minimize the impact of such draw-downs by providing deep water (12 to 16 feet) in part of the pond. If your pond is subject to drastic draw-downs, stock it based on its size during the draw-down.

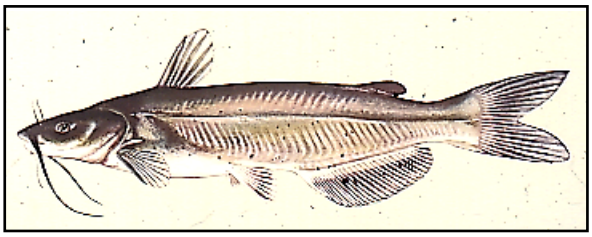
Fertilization. Commercial inorganic fertilizer can greatly increase fish production in ponds. Fertilization will not only increase the basic productivity of a body of water but, when properly managed, it will control aquatic vegetation in water deeper than 2 feet. Too much fertilizer can, however, lead to oxygen depletion in the pond. Do not fertilize muddy ponds, ponds that have a continuous water flow, or ponds that are stocked with catfish only and fed more than three times a week. Because of the increased production in properly fertilized ponds, higher stocking rates are recommended for them.

Any type of water-soluble granular or liquid fertilizer may be used. Use about 1 to 2 pounds of nitrogen (N) and 8 pounds of phosphorous ($P_2 0_5$) per acre per application. Nitrogen may not be needed for some older ponds. Apply granular fertilizer on a platform or plastic bag in shallow water. Dilute liquid fertilizer about 10 to 1 with water and apply it on the pond surface. Begin pond fertilization in the spring when the days become consistently warm. Check the response with an 8-inch diameter disk made of metal or plastic and painted black and white (this is called a "secchi disk"). Make fertilizer applications at 1- to 2-week intervals until the disk is no longer visible 24 inches below the water surface (this indicates a secchi disk value of 24). Wait until the disk is visible deeper than 24 inches before making additional treatments. Continue fertilizing until late September.

Do not fertilize muddy ponds, ponds infested with aquatic weeds, or ponds that are flushed with large volumes of water until these problems are corrected. Several available publications (listed in the References section) give detailed instructions for pond fertilization; consult them before beginning a fertilization program for your pond.

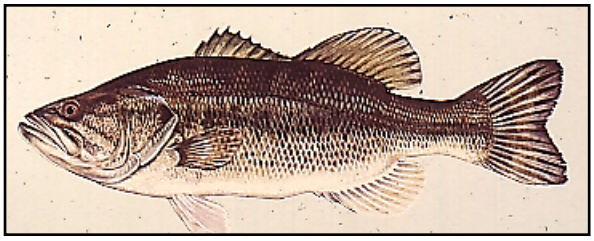
Fish Species

Channel and Blue Catfish. These species do well in most pond environments and can be stocked alone in ponds of any size or as a supplement to bass and forage populations in ponds larger than 1 acre. Channel catfish are more available for stocking, although some pond owners prefer blue catfish or a combination of the two species.



Largemouth Bass. This species is the most sought-after sport fish in Texas and, in almost all multi-species pond environments, it is the primary predator. The northern largemouth bass subspecies is native to Texas and has been widely stocked since the turn of the century. Although the Florida subspecies grows to a larger size, it is more sensitive to very cold temperatures and more difficult to catch than the native (northern subspecies) bass. Because of its sensitivity to cold, Florida largemouth should not be stocked alone in ponds in the Texas Panhandle.

The native bass and Florida bass are often crossed to produce an intergrade offspring, commonly referred to as the F1 "hybrid." The F1 may provide some of the advantages of both species. Florida largemouth will interbreed with natives, so if both subspecies are stocked in the same body of water, a mixture of Floridas, natives, hybrids, and back-crosses of various mixes will eventually occur.



Bluegill. Many pond owners are reluctant to stock ponds with bluegill because of the fish's reputation for overpopulation. The bluegill is, however, a fine sport fish and the only fish species which can produce the large numbers of small fish needed to provide food for bass. Without them, a quality bass population will probably not develop. Overpopulation of bluegills most commonly occurs because of excessive escape cover (aquatic vegetation) or over-harvesting of the bass in the first season of fishing—both of which reduce predation on the young bluegills (See Proper Harvest Section). Coppernose bluegill is a unique strain that reaches larger sizes in Texas ponds than other varieties. If you have a strong interest in bluegill fishing, consider stocking this species.

Redear Sunfish. Redear sunfish can be stocked with bluegill in Texas ponds as supplemental forage. This species is also a fine sport fish and can increase angling opportunities. Because they eat snails, they may also reduce fish parasites within a pond.

Hybrid Striped Bass. Hybrid striped bass are another sport fish that can be stocked in any size pond to provide additional sport fishing. They will readily accept artificial feeds, but they will not reproduce in ponds. Hybrids can be stocked alone, with fathead minnows or sunfish, or in bass-bluegill ponds. Consult a biologist if you plan to stock these fish.

Fathead Minnows. The fathead minnow is a relatively slow swimmer (very vulnerable to predation), and therefore offers no benefit when stocked in ponds containing established bass populations. However, they are very useful when stocked with catfish that are not being fed regularly or in new bass-bluegill ponds to increase first-year growth of the bass and bluegill.

Threadfin Shad. This species is an excellent supplemental forage species for bass, but, like the fathead, it generally cannot withstand bass predation for an extended period of time in a small pond. They are also sensitive to cold temperatures and perform best in South Texas, but they can survive mild winters in North, East, and Central Texas. A fertilization program will greatly increase the success of threadfin introductions by reducing water clarity and increasing productivity.

Grass Carp (White Amur). This species, when stocked in proper numbers, can provide long-term, cost-effective control of submerged aquatic vegetation in ponds. However, only specially produced sterile (triploid) grass carp are legal in Texas ponds, and a special permit is required. Contact the Texas Parks and Wildlife Department for details.

Undesirable Fish. Many other species of fish have been stocked in Texas ponds, but none have been as consistently successful as largemouth bass, channel catfish, bluegills, redear sunfish, fathead minnows, or combinations of these fish. While other species may do well in streams, lakes, or reservoirs, they often cause problems in ponds or are not suited for pond environments. Do not stock the species listed below or any species not listed without first consulting a fisheries biologist.

Crappie are very undesirable for stocking in ponds. They compete with bass for food, eat small bass, and tend to overpopulate and become stunted.

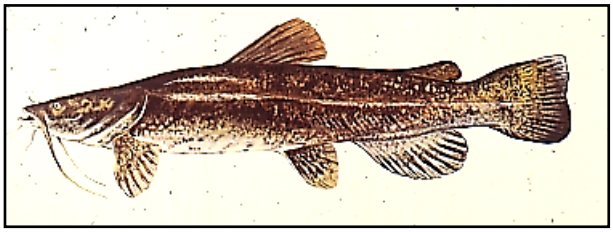
Hybrid sunfish are often touted as a "superfish." However, the crosses used to produce these hybrids are not good forage fish and should not be stocked with bass. Hybrid sunfish perform best when stocked alone or with channel catfish and fed regularly with a commercial catfish ration. Some reproduction can be expected, but the offspring will not be as desirable as the original hybrid. Eventually, pond renovation and restocking become necessary because of overpopulation and stunting.

Golden shiners are occasionally stocked in old ponds to increase forage for bass. They should not be stocked in new ponds.

Carp, bullheads, and **green sunfish** often are inadvertently stocked or enter the pond from the upper watershed, in-flowing streams, or downstream during spillway flow. Carp and bullheads are bottom feeders that can stir up the pond and cause muddy water. Bullheads and green sunfish

are notorious for overpopulating, particularly if bass populations are reduced.

Flathead (opelousas or yellow) catfish are often stocked in ponds by the pond owner or well-meaning anglers, but this is a big mistake. This predator consumes large numbers of all species of fish. An unbalanced pond can seldom be corrected by adding this fish.



Planning For Stocking

Small Ponds. Impoundments and reservoirs less than 1 surface acre in size are considered "small ponds" for the purposes of this publication. Most ponds in Texas are less than 1 acre in size, and many are less than 1/2 acre in surface area. These waters are almost always used for livestock, and fish management is usually not considered when the pond is built. But, after the pond is full of water, the owner often becomes interested in stocking fish.

Before stocking your small pond, remove any existing fish. New ponds should present no problems. Older ponds may have many different combinations of fish that will interfere with production. Avoid management hassles—clean out the pond. Consult the References for information on using rotenone to renovate ponds. Catfish are recommended for stocking in small ponds, since they provide the most fishing recreation and food for the table. Because catfish are more widely distributed and transportation costs of fish can be prohibitive, most small pond owners prefer to stock catfish, either channels or blues. Catfish may be stocked anytime; however, fish-eating birds can take a heavy toll from late October through April.

If you are feeding the catfish, feed them daily during the growing season (April through November), giving them the amount of feed they will eat in 10 to 15 minutes, but not more than 30 pounds per acre per day. Feed them about once a week during the other months. A daily feeding program with a good-quality commercial feed can result in 1 pound of fish gain for every 2 pounds of feed and will grow catfish to a catchable size in the shortest period of time. If daily visits to the pond are not practical, you can use an automatic feeder. Commercial catfish feed is available from feed and seed stores. Choose a good commercial floating or sinking pellet with at least 30-percent protein. Floating feeds may be more expensive, but they allow you to watch the fish while they feed, which reduces waste and provides entertainment.

Do not encourage catfish reproduction in small ponds by adding spawning devices or structures. Spawning will result in stunted fish. The total weight of the catfish should never be allowed to exceed the pond's carrying capacity (a maximum of 1,000 pounds per surface acre during the warm months). If your goal is to produce larger catfish, decrease the stocking rates accordingly. The probability of losing fish because of an oxygen depletion increases dramatically when the pond's carrying capacity is exceeded.

Large Ponds. For this discussion, ponds larger than 1 acre are considered "large ponds." Many large ponds are stocked with largemouth bass, and proper management of bass is the key to good fishing. Species stocked primarily to provide forage for bass are bluegill, redear sunfish, forage minnows, and possibly threadfin shad. A well-managed, fertilized farm pond should support 300 to 500 total pounds of fish per surface acre.

Channel catfish can be stocked to provide additional sport and will not interfere with the critical balance between bass and forage. Expect most or all of the reproduction to be removed by the bass, particularly in clear ponds. Muddy ponds and other large ponds, if desired, may be managed for catfish and fathead minnows alone, as recommended for small ponds.

Successful multi-species management in large ponds requires stocking combinations of species to achieve a balance between predators (largemouth bass) and their principal forage species (bluegill). A balanced pond will have:

- Annual reproduction by largemouth bass and bluegills.
- Bluegills of many different sizes to provide food for all sizes of largemouth bass.
- Sufficient growth of both species for satisfactory sustained catches by the angler.

Maintaining balanced bass and forage populations is important for good fishing. Proper harvest of intermediate-sized bass and proper stocking schedules are critical for maintaining this balance. Proper bass harvest is discussed in more depth elsewhere in this publication.

The stocking schedule depends mainly upon the size of the bass stocked. When you plan to stock fingerling (1- to 3-inch) bass, stock fingerling (1- to 3-inch) bluegills and redear sunfish, forage minnows, and catfish larger than 4 inches in the late fall, followed by the bass fingerlings the next spring. This schedule ensures that:

- The forage species and catfish are large enough when the bass are stocked that the bass will not deplete the original stocking of the forage fish and catfish.
- The forage species will have had an opportunity to spawn, creating a food supply for newly stocked bass.

If adult (longer than 3 inches) bluegills and redear sunfish are used, you may stock them either simultaneously with the fingerling bass or in the late fall followed by the fingerling bass the next spring.

Large bass and bluegill are sometimes used to stock new ponds, but this practice is not recom-

mended because it makes the achieving a proper balance less certain.

Stocking Guide

Recommended numbers of fingerling fish to be stocked in small or large ponds are shown in Table 1.

Proper Harvest

Bass. Improper harvest of largemouth bass ruins future fishing in Texas ponds more often than any other cause. Pond owners and other anglers often overharvest bass in the first season of fishing, allowing bluegills to overpopulate. No bass should be removed for the first 2 years after stocking.

You can reduce the chances of overharvesting the bass by making your pond off-limits to everyone. But this is not recommended, because underfishing can lead to about as many problems as over-fishing. In established bass populations, it is a good idea to remove surplus bass less than 12 inches long. Although you control access to your pond, don't deny entrance to a responsible angler willing to follow a few simple rules regarding catch-and-release of certain sizes of fish. Encourage all anglers to record their catch by species and size (see the Appendix for more information on using these records). This record-keeping system provides you with an estimate of the size composition and relative abundance of game species over time.

The growth rate for largemouth bass is affected by several factors, including genetics, water quality, habitat, and forage availability. Average growth rates for bass in Texas are:

Age I	8 inches
Age II	12 inches
Age III	15 inches
Age IV	17 inches
Age V	18 inches

The most sensible way to prevent bass overharvest is to establish a minimum length limit of 15 inches for the first 3 years after stocking. If anglers abide by the restriction and release all bass smaller than 15 inches, the pond should begin producing good fish of all species. The bass that were originally stocked will have to support the majority of the catch for 3 years, so they have to be used wisely.

After 3 years, you need to make a decision about the kind of bass-fishing you want to promote for your pond. Bass will have reproduced two or three times during this 3-year period, and the pond may have large numbers of young bass. If the young bass are under-harvested, they will have to compete for the available food and their growth rates will be poor. The result will be a bass population consisting mainly of fish less than 12 inches long. All these small bass will reduce the numbers of small bluegill, and the pond will have a surplus of 7- to 8-inch bluegills.

Table 1. Recommended Numbers of Fingerlings to Stock for Various Management Options in Texas Farm Ponds.

Pond Size	Stocking Option	Fish Species	Number per Surface Acre to Stock		
			Un-Fed		Fed[1]
			Fertilized	Unfertilized	
Any Size	Catfish Only	Channel Catfish or Blue Catfish	Up to 300 + 3 pounds fathead minnows	Up to 150 +3 pounds fathead minnows	Up to 1000[3]
More Than One Acre	Bass/Bluegill	Largemouth Bass Bluegill	100 1,000	50 500	
	or	Channel Catfish[2]	100	50	
	Bass/Bluegill/ Redear	Largemouth Bass Bluegill and Redear Sunfish Channel Catfish[2]	100 750 and 250 100	50 375 and 125 50	

[1]Do not fertilize catfish ponds where catfish are being fed.

[2]May be stocked to increase fishing opportunities.

[3]Above 700 fish, harvest is mandatory at 2 to 3 pounds.

If you are interested in catching bass larger than 12 inches long, 8- to 12-inch bass must be harvested. Harvest about 25 8- to 12-inch bass (weighing a total of 10 to 15 pounds) per acre each year after the third year from stocking. Removing these small bass reduces competition and allows some fish to grow to larger sizes. The following chart shows average weights for bass of various lengths. These statistics are useful for estimating the total poundage removed per surface acre per year.

Bass Length (inches)	Average Weight (pounds)
8	0.25
9	0.35
10	0.50
11	0.70
12	0.90
13	1.10
14	1.50
15	1.80
16	2.25
17	2.70
18	3.30
19	3.90
20	4.50
21	5.40

To keep the bluegill in good condition, incorporate a "slot limit" for releasing 12- to 15-inch bass from the third year on. Releasing bass of this size will also ensure that some bass will grow to more than 15 inches. Keep the harvest of bass longer than 15 inches to a minimum so that some larger, quality bass will survive.

If bass have not been harvested properly, you may need to make adjustments to the fish community. It is likely that the bass have been overharvested if anglers are catching mainly 3- to 5-inch bluegills and few or no bass. This problem can be corrected by stocking 40 8- to 12-inch bass per acre. Until small bass become abundant, make sure that all bass caught are released. Then, bass smaller than 12 inches and larger than 15 inches can again be harvested.

If many small bass and only a few large bluegills are caught, the bass have been underharvested. In this case, stock 30 bluegills, at least 5 inches long, per acre. Harvest about 25 8- to 12-inch bass per acre each year thereafter. Again, bass 12 inches long and larger should be released.

If you decide to stock a new pond with limited numbers of advanced bass and bluegills rather than fingerling fish, the few bass must be returned to the pond and carefully protected. You cannot afford to lose the original fish, as they are present in limited numbers.

Catfish. You may begin harvesting catfish whenever the fish reach an edible size. Check catfish of catchable size for body condition. Numerous "skinny" catfish could be caused by overcrowding (corrected by increased harvest) and/or inadequate food supply (corrected by increased feeding frequency).

Catch records are important for determining when supplemental stocking is needed. In catfish-only ponds, at least half of the original fish should be caught before restocking. The total weight of catfish in these ponds should not exceed 1,000 pounds per surface acre during the warm months to decrease the risk of fish losses from oxygen depletion. In ponds where catfish were stocked in combination with largemouth bass and forage, occasional restocking may be needed to maintain the catfish populations over time. In these ponds, supplementally stock catfish at least 10 inches in length at the rate of 25 to 50 per surface acre at 2- to 4-year intervals. However, the total weight of catfish in "combination" ponds should not exceed 250 pounds per surface acre to reduce potential competition for food between species.

Assessment and Corrective Actions in Small Impoundments

The size of the pond and the clarity of the water are critical factors to consider in assessing the status of the fish in your pond. The specific effects are discussed in the first section of this publication.

Identifying Fish Species

Identifying major sport, forage, and rough fish species is essential for interpreting assessment information. While it is neither practical to include every species and subspecies found in Texas in this publication nor necessary for you to know them, being able to identify the species shown here will enhance your management efforts.

Assessment Techniques for Analyzing Fish Populations

Poor-quality fishing in most farm ponds is caused by unbalanced and/or undesirable fish populations. To determine the status of a fish population, you must take samples to assess the

species composition and size distribution in your pond. You can use one of several methods to sample fish populations, including partial rotenone treatments, electro-shockers, gill nets, traps, shoreline seining, and angler catch records. Although the first four techniques can provide excellent information, they are not practical for most pond owners. So, most pond owners rely on shoreline seining and angler catch records for making management decisions.

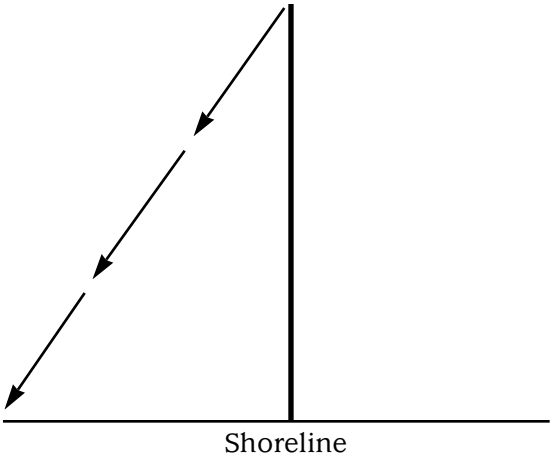


Figure ?. Quadrant seine haul technique.

Shoreline Seining. Shoreline seining is a good technique for assessing the status of many fish populations. Seine from June through September. A 15-x-4-foot minnow seine with 1/4-inch mesh is good for most ponds. Seining provides information on the presence and reproductive success of largemouth bass and bluegill. Excessive aquatic vegetation and brush will make seining difficult. Make a minimum of three quadrant hauls (more in larger lakes) in different areas to collect a representative fish sample from shoreline habitat (see diagram). Record the numbers and sizes of each species collected for each seine haul.

Angler Catch Records. You can also gather assessment information from angler catch records, which often provide information on species not easily collected by shoreline seining. It sounds like fun, but to collect meaningful information, anglers should fish regularly with a variety of lures and baits (to catch as many of the species as possible) or fish consistently with similar gear from year to year (to identify changes in length and abundance). A sample record form (see Appendix) has been included to indicate pertinent information to be recorded.

Assessment using angler catch records is only as good as the information collected; therefore make an extra effort to record the numbers and lengths of all species caught, along with other pertinent observations. Definite trends in harvest composition will become apparent over time, providing you with reliable information necessary for making management decisions.

A recent research study found a strong correlation between sport fishing and electrofishing data in largemouth bass populations, when %PSD (Percentage Size Distribution), %RSD-15 (Relative Stock Density), and Wr (relative weight) values were compared.

There was a weaker correlation between sport fishing and electrofishing data for sunfish populations when values for %PSD, %RSD-8, and Wr were compared. The fishing method described below for largemouth bass was used in that study, and the method described for sunfish should increase the strength of that correlation.

The objective of these fishing methods is to catch fish that represent the proportion of different sizes present in the pond.

A: To collect largemouth bass

1. Use artificial lures in three length categories: 1- to 2-inch, 2- to 4-inch, and 4- to 8-inch. The combination of these lure lengths allows you to target all sizes of bass in the pond.
2. Fish each lure for 30-minute intervals until you have caught 20 largemouth bass 8 inches or longer.
3. Be sure to fish all three lures an equal amount of time before you stop fishing.
4. Fish all areas of the pond.

The fish caught in each 30-minute interval should be kept alive until the end of the interval and then weighed and measured. If you are returning them to the pond, clip their fins so you can be sure not to count them again in the analysis. Be aware that, in muddy ponds (secchi disk values 12 inches or less), this fishing method will overestimate the proportion of large fish in the population.

B: To collect sunfish

1. Use 1 or 2 segments of a Berkley Power Wiggler or some other small lure on a #8 hook, 1 split shot, and light line.
2. Fish until you collect 100 sunfish. Return the fish to the pond every 30 minutes, after weighing and measuring them.
3. Fish each lure an equal amount of time.
4. Fish all areas of the pond.

With these fishing methods, you can use the data you collect to calculate population structure indices for largemouth bass and sunfish in ponds. However, this method is not a substitute for having an experienced biologist sample your pond and make management recommendations.

Interpreting the Results

Once you have collected assessment data for your pond,you must interpret it to make management decisions. Interpretations are based on the species composition and sizes for bass-bluegill populations.

Species Composition. The first factor to examine for all ponds is the presence or absence of certain key species. If undesirable fish have been stocked or have entered the pond, you must assess their impact as competitors or predators of the desirable species.

Species like gar, bowfin, flathead catfish, or chain pickerel compete with largemouth bass for available forage. Green sunfish, hybrid sunfish, and warmouth produce small numbers of young and compete for forage with small largemouth bass. As a result, largemouth bass do not perform well in ponds with only those species. The presence of these species in a pond with an adequate bluegill population, however, poses little threat to bass populations.

Crappie also compete with largemouth bass for forage, and their high reproductive rate may create stunted, starving crappie populations in small impoundments.

Other undesirables, regardless of the size of the pond, include black or yellow bullheads, common carp, carpsuckers, buffalo, and Rio Grande cichlid (Rio Grande perch). These species compete with desirable species for food and space. Several of these species can create muddy conditions in ponds.

In ponds managed for catfish only, any predator capable of feeding on catfish (such as largemouth bass, gar, or flathead catfish) should be avoided. Likewise, species that compete with the catfish for food (like green sunfish, golden shiners, and black or yellow bullheads) are undesirable.

Bass-Bluegill Population Structure. After you have determined which species are present, seine to determine the presence or absence of bass and bluegill reproduction. These two species provide the basis for predator-prey relationships in Texas farm ponds. The seine is the best single method for gathering information on overall pond balance. Use Table 2 to evaluate the data collected by the quadrant seine haul technique. The presence or absence of bass and bluegill reproduction should almost always provide the information required for pond management decisions. Supplement this information with angler catch records whenever possible to provide information on the sizes of adult sport species in the pond. Some pond owners can use accurate records of numbers and sizes of fish caught by anglers for more in-depth assessment and management. A detailed description of the methods is contained in the Appendix.

Catfish Population Structure. Since shoreline seining will not provide much information on catfish, base your assessment of catfish populations on catch records and the general condition of the fish caught. Although these techniques apply specifically to catfish-only ponds, they can be useful for catfish assessment in multi-species ponds as well. At appropriate stocking rates (see Table 1), survival of stocked catfish will approach 100 percent. Knowing how many catfish have been removed will allow you to calculate how many remain in the pond. Under no circumstances should the total weight of catfish exceed 1,000 pounds per surface acre during the warm months.

Although some pond owners do not regularly feed their catfish, occasional feeding (at intervals of 1 to 3 weeks) with floating pellets allows you to determine whether the population has declined. If the number of catfish coming to feed drops markedly and remains low even in a variety of weather conditions, the population has probably been reduced by disease or vandalism. When you collect the catfish for population assessment, also make note of their body condition (plumpness).

Since a distended gut can be misleading when you are making visual appraisals, concentrate on the thickness of the flesh when you observe the fish from above. If the catfish are overstocked and/or the food supply is insufficient, the fish will become "skinnier" over time. This sometimes happens if unexpected natural spawning occurs. In contrast, as the fish population declines because of fishing (or other mortality), the flesh will become thicker and "fatter."

Corrective Management

Three techniques can be used for correcting unbalanced or undesirable fish populations: renovation, harvest manipulation, and supplemental stocking. However, if unsatisfactory fish populations are the result of poor water quality, improper pond design, or an overabundance of aquatic vegetation, these techniques used alone may not be successful.

Renovation. Consider total renovation using rotenone if species such as gar, bowfin, flathead catfish, chain pickerel, black bullheads, common carp, buffalo, and carpsuckers are present. If crappie are present, stunting (poor growth) and overpopulation can sometimes occur, and renovation may be necessary. The presence of warmouth and green sunfish does not require renovation if bluegill are present or can be supplementally stocked.

Harvest Manipulation. Angler harvest is an important management tool for adjusting the population structure of sport species. For bass and bluegill ponds, harvest recommendations are determined by the relative abundance of the two species and their size distributions based on angling records and PSD values (Table 2). Harvest recommendations for balanced bass-bluegill populations are given in the Harvest Recommendations section.

For blue or channel catfish, maintain harvest records to determine the number of the original stocking removed. Balanced bass and bluegill populations may limit catfish reproduction even if spawning habitat is provided. If the catfish seem to be in poor condition (they look skinny), increase the harvest substantially to reduce competition for the food supply.

All other species caught should be removed from the pond regardless of size and number. These include gar, bowfin, flathead catfish, chain pickerel, bullhead, Rio Grande cichlid (Rio Grande perch), common carp, buffalo, carpsucker, green sunfish, and warmouth.

Supplemental Stocking. Soemtimes, pond assessment evaluations determine that supplemental stocking is needed to restore balance or establish a fishery. If shoreline seining and angler records reveal that bass are not present, a population could be established by stocking 20 8- to 12-inch bass per surface acre, if forage is available. If bluegills are abundant and stunted at about 3 inches, increase this rate to 40 bass per surface acre. If you stock smaller fingerlings, they usually won't survive in a pond with an established popu-

Table 2. Assessment of Fish Populations Based on Seining June to October.

Seine Contents	Status	Recommendations
Young bass[1] present; many recently hatched bluegills[2]; few intermediate[3] bluegills	Population balanced	Use 12" to 15" slot or other goal- oriented harvest regulation
No young bass[1]; no recently hatched bluegills[2]; many intermediate bluegills[3]	Bluegills overcrowded	Stock 20 to 40 8" to 12" bass per acre; stop bass harvest for 1 year or completely renovate & restock pond
No young bass[1]; many recently hatched bluegills[2] and very few intermediate bluegill	Bass badly overcrowded	Remove 25 to 40 of overcrowded size per acre; return larger bass
No young bass[1]; no recently hatched bluegills[2]; few intermediate bluegills[3]	Competition from undesirable fish species	Renovate with rotenone and restock
Young largemouth bass present; many recently hatched sunfish; few intermediate sunfish	Moderately overcrowded bass	Remove 10 to 15 overcrowded bass/acre

[1]Less than 4 inches long

[2]Less than 2 inches long

[3]3 inches to 6 inches

lation. A common but unwise practice of many avid bass anglers is to add more bass just because bass are what they like to catch. But if the bass are already unable to sustain their numbers because of poor water quality or inadequate forage, adding fingerlings will not correct the situation.

The only time you should stock bass on top of an existing balanced bass population is to introduce Florida bass to spawn with native bass. The resulting F1 cross of the two subspecies may grow faster and larger than the parents, if proper forage, habitat, and water quality are present. Stocking 20 advanced (6- to 8-inch) Florida bass fingerlings per surface acre should establish a breeding population in most ponds. However, you should first consult with a fisheries biologist before you supplementally stock Florida bass. If your assessment indicates that bluegill are not present, you should stock advanced bluegill fingerlings (3 inches and larger) at the rate of 40 per surface acre. This is often needed in ponds where warmouth and green sunfish are the only forage species available for bass. Several species can be stocked with the bluegill to further increase forage availability. Threadfin shad are often stocked at 200 to 500 per surface acre, although restocking is sometimes needed in small shallow ponds because of die-offs due to this species' sensitivity to water temperatures below 42°F and/or over-predation by the bass. This species is a relatively slow swimmer and will often be rapidly eliminated.

In established multi-species ponds, you can stock channel and/or blue catfish (if none are already present) at the rate of 100 per surface acre. Fingerlings should be no smaller than 10 inches to avoid predation by adult bass. Re-stocking may be needed every 3 to 5 years at rates of up to 100 fingerlings per surface acre, since bass and bluegill populations often limit the natural reproduction of catfish. Do not restock catfish-only ponds until half of the original number have been removed. However, the total weight of catfish present should never exceed 1,000 pounds per surface acre during the warm months. The stocking rate you use should be based on the size of the pond, the condition and total weight of the catfish present, and the frequency of feeding. Fathead minnows are often supplementally stocked in catfish-only ponds at the rate of 500 to 1,000 per surface acre to provide additional forage. Although catfish do not normally spawn in small ponds, catfish stocked alone should not be encouraged to reproduce by adding spawning habitat, since reproduction cannot be controlled and overpopulation and stunting may result.

Other Management Considerations

Some aspects of pond management are not covered in detail in this publication. Aquatic weed control, pond renovation, habitat improvement, fertilization, and pond construction are a few examples. However, material has been published about these and other important aspects of pond management (see References). Remember, appropriate stocking is only one step toward enjoying good farm-pond fishing. Many of these additional management techniques are also necessary.

Summary

This publication provides management information to pond owners to increase the recreational value of their sport fishery. The information here should help you to effectively stock and manage your pond under most conditions. Even after the pond has been properly stocked, an assessment made, and necessary corrective actions taken, you should continue to monitor fish populations. Shoreline seining and accurate catch records will provide good assessment information for your future management decisions. If you encounter special problems or conditions, advice is available from qualified fisheries biologists with consulting firms, fish farms, universities, and state and federal agencies.

Proper management of fish in a pond is as much an art as a science. As research continues and the results are developed into recommendations, pond management will become more successful.

The art of management will always be a necessity. Even if all the science needed for pond management were available in this publication, you would still need to be able to choose the best combination of facts to deal with your particular problems. Experience, learning from mistakes and successes, is the only way to develop the art of management.

References

U.S. Department of Agriculture
Natural Resources Conservation Service
101 South Main Street
Temple, Texas 76501

"Building a Pond." Farmers Bulletin No. 2256. 1973. 13 pp.

"Catfish Farming." Farmers Bulletin No. 2260. 1981. 29 pp.

"Ponds: Planning, Design, Construction." Agricultural Handbook No. 590. 1982.51 pp.

Texas Parks and Wildlife Department
4200 Smith School Road
Austin, Texas 78744

Forshage, Allen A., and Kenneth R. Moore. "Fish Habitat Improvement in Reservoirs." PWD Booklet 30QO-12. Printed May 1980.

Inman, C. R. "Construction Hints and Preliminary Management Practices for New Ponds and Lakes." PWD Booklet 3000-7. Printed March 1980. 10 pp.

Kemp, Robert J. "Freshwater Fishes of Texas." 1971. 40 pp.

Menn, C. T. "Rotenone: Its Use in Fisheries Management." PWD Brochure 3000-77.October 1979.

Smith, Dwane Q., and John M. Mitchell. "The Ecology of Farm Pond Fertilization." PWD Brochure 3000-24. Printed June 1978.

Texas Agricultural Extension Service
Department of Wildlife and Fisheries
Nagle Hall, Texas A&M University
College Station, Texas 77843

Davis, James T., and Kim Jefferson. "Aquatic Plants Field Identification Guide." CD-ROM.

Higginbotham, Billy. "Threadfin Shad Management and Culture." Texas Agricultural Extension Service publication L-2085. 2 pp.

Higginbotham, Billy. "Texas Farm Pond Management Calendar." Prairie View Cooperative Extension Program publication. 2 pp.

Higginbotham, Billy. "Forage Species: Range, Description, and Life History." Southern Regional Aquaculture Center publication SRAC 140.

Higginbotham, Billy and Donny W. Steinbach. "Renovation of Farm Ponds." Texas Agricultural Extension Service publication L-2084. 2 pp.

Lock, Joe. "Pond Fertilization." Publication A0904. 2 pp.

Lock, Joe. "Management of Recreational Fish Ponds in Texas." 1995. Texas Agricultural Extension Service publication B-213. August 1993. 18 pp.

Lock, Joe. "Largemouth Bass: Biology and Life History." Southern Regional Aquaculture Center publication SRAC 200.

Lock, Joe, and James Davis. "Liming Farm Fish Ponds in East Texas Publication." Texas Agricultural Extension Service publication L-1864. January 1986. 2 pp.

Lock, Joe, and Don Steinbach. "Catfish in Farm Ponds For Food and Recreation." Texas Agricultural Extension Service publication B-1319. June 1992. 5 pp.

Masser, Michael P., and John W. Jensen. "Calculating Area and Volume of Ponds and Tanks." Southern Regional Aquaculture Center publication SRAC 103. August 1991. 7 pp.

Masser, Michael P., and John W. Jensen. "Calculating Treatments for Ponds and Tanks." Southern Regional Aquaculture Center publication SRAC 410. August 1991. 7 pp.

Steinbach, Donny W., and Richard Noble. "Largemouth Bass." Texas Agricultural Extension Service publication L-2083. 2 pp.

Steinbach, Donny W., and Billy Higginbotham. "Clearing Muddy Ponds." Publication A0905. 1 p.

Wurts, William A., and Robert M. Durborow. "Interactions of pH, Carbon Dioxide, Alkalinity, and Hardness in Fish Ponds." Southern Regional Aquaculture Center publication SRAC 464. December 1992. 4 pp.

Appendix

Assessing Population Size Structure

A technical index commonly used to analyze the size distribution of bass-bluegill populations from catch records is Percentage Size Distribution (PSD). To determine the angling PSD for bass, the number of quality bass (12 inches and longer) is

divided by the total number of bass and then multiplied by 100. A balanced bass population should have an angling PSD between 20 percent and 60 percent.

Example: Catch records indicate that 100 bass were caught, 33 of which were 12 inches or longer. The PSD would be:

33 (bass 12 inches and longer)/100
(all bass) x 100 = 33%

A PSD (bass) of 33 percent means that, of all the bass caught, one-third were at least 12 inches long.

For bluegill, the number of quality bluegill (6 inches and longer) is divided by the total number of bluegill and then multiplied by 100. A satisfactory bluegill angling PSD range is 50 percent to 80 percent.

Example: Catch records indicate that 40 bluegill were caught, 20 of which were 6 inches or longer. The PSD would be:

20 (bluegill 6 inches and longer)/40
(all bluegill) x 100 = 50%

A PSD (bluegill) of 50 percent means that, of all bluegill caught, one-half were at least 6 inches long.

To achieve balanced populations, you should strive to maintain PSD values for both species within these suggested ranges. Table A shows evaluations based on angling PSD. The values that fall outside the suggested ranges may be indicate a need for corrective management. Be sure to fish with a variety of lures and baits, with your angling efforts spread throughout the year.

Table A. Harvest Recommendations Based on Angling PSD Values.

Catch Composition	Angling PSD (%)		Harvest Recommendations
	Bass	Bluegill	
Bass average 12" to 15"; bluegill range 3" to 6" or larger	40-70	40-60	Balanced pond-release 12" to 15" bass
Bass average 12" to 15": bluegill caught are smaller than 5"	20-60	less than 40	Bluegill reaching overcrowded condition-harvest more bluegill; release 12" to 15" bass
Most bass are 12" or larger; bluegill caught are smaller than 5"	greater than 70	less than 40	Bluegill overcrowded- harvest more bluegill; release all bass
Bass are easy to catch. Most are smaller than 12"; bluegill 3" to 6" or larger	less than 20	50-80	Bass reaching over-crowded condition-harvest more bass smaller than 12"; release 12" to 15" bass and all bluegill
Bass are easy to catch. Most are smaller than 12"; bluegill (6" plus) abundant	less than 20	more than 80	Bass overcrowded. Harvest more bass smaller than 12"; release 12" to 15" bass and all bluegill
Undesirable species			Consider renovation

Catch Record Form

All fishing, whether or not any fish were caught, should be recorded. If no fish are caught, place a zero (0) under the species you fished for. Otherwise provide the number of fish caught, regardless of whether kept or released. One fisherman from the group should sign his initials, just in case some futher information is needed.

Date	Start Time	End Time	Number Fishing	Initials	Bass						Bluegill		Channel and blue catfish		Other	
					Less than 12"		12"-15"		15" +		Less than 6"	6" +	kept	released	Number	Species
					kept	released	kept	released	kept	released						

Editor: Elizabeth Gregory
Typesetting and Page Design: Vera Johnson
Texas Agricultural Extension Service

Issued in furtherance of Cooperative Extension Work in Agriculture and Home Economics, Acts of Congress of May 8, 1914, as amended, and June 30, 1914, in cooperation with the United States Department of Agriculture. Zerle L. Carpenter, Director, Texas Agricultural Extension Service, The Texas A&M University System.