

Southern Regional Aquaculture Center



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Fee-Fishing Ponds

Management of Food Fish and Water Quality

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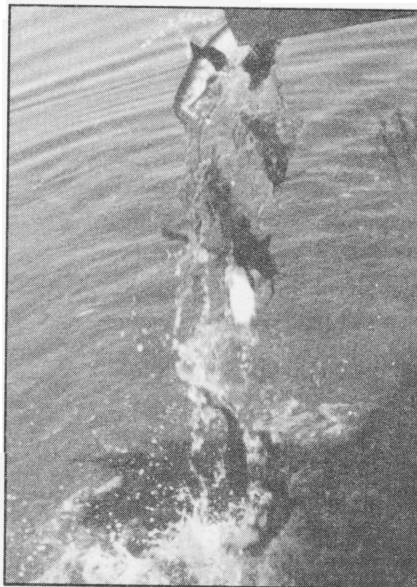
Fee-fishing operations, popular throughout the Southeast, can be a viable business opportunity that blends marketing, recreation and aquaculture. Articles often appear in the popular press about individual fee-fishing establishments, but few scientific studies have looked at their operation or management. Therefore, this fact sheet, and others in this series, rely heavily on personal observations and communications with fee-fishing operators and Extension specialists, and not strictly on scientific experimentation.

Proper management of fee-fishing ponds is extremely important not only to the health and matchability of the fish, but also to the corresponding economic success of the business. Many fee-fishing operators do not understand the basics of fisheries management, and therefore, suffer reduced profitability or financial losses. This publication suggests guidelines for management of the water and the fish to improve fish health, reduce fish mortality and increase angler catch rates, thereby increasing overall profitability of fee-fishing operations.

Species selection

The initial management decision is to determine the type and source of fish to be stocked. Farm-raised

fish are superior to wild-caught fish because farm-raised fish are usually available in consistent quantities, are already conditioned to crowded pond environments and will consume formulated feeds. For sources of farm-raised fish contact your county Extension office, State Fisheries Extension Specialist, local Soil Conservation Service office, or state game and fish agency. The majority of fee-fishing operations in the Southeast stock farm-raised catfish or some combination of catfish with other warmwater species. It is best to remove existing fish populations



Loading, hauling and stocking is always stressful on fish.

from a pond when converting it into a food fish fee-fishing pond.

Farm-raised catfish are popular because of their availability, catchability, hardiness and desirability as a food fish. There are several kinds or species of catfish including channel, blue, white, flathead, hybrid catfish and bullheads. Channel catfish are the predominant farm-raised species and are, therefore, the most readily available and most commonly-stocked species. Farm-raised blue catfish, white catfish and channel x blue catfish hybrids, where available, are also good for stocking into fee-fishing ponds. Flathead catfish and bullheads are seldom farm-raised and are generally undesirable for stocking into fee-fishing ponds. Bullheads can rapidly overpopulate a pond, while flatheads become large predators on other fish in the pond.

Fee-fishing operations in areas with a coldwater source (i.e., mountain streams or large springs) stock rainbow trout. The biggest problem with trout is local availability. Farm-raised rainbow trout are available in several southeastern states, predominantly North Carolina, but also Georgia, Kentucky, Tennessee, Virginia, West Virginia, Arkansas and Missouri. A few fee-fishing operations stock rainbow trout only in the

winter. Winter stocking of rainbow trout allows the fee-fishing establishment to operate when catfish are no longer actively biting. Rainbow trout do well under static pond conditions when water temperatures are below 65°F.

Rainbow trout should not be stocked until pond temperatures are consistently below this temperature. If rainbow trout are stocked on top of existing catfish populations, anglers will catch few catfish because of the aggressive feeding behavior of the trout and because catfish feed less actively when water temperature is low. Rainbow trout need to be removed before the water warms to 70°F in the spring or they will die. Unless otherwise stated, the following information details the use of warmwater species, e.g., channel catfish.

Hauling and stocking

The handling and water quality changes, caused by seining, loading, hauling and stocking, stress fish. Most fee-fishing operators do not produce their own fish and have little control over the seining, loading and hauling of fish they purchase. Operators should work with reputable producers and live-haulers that are experienced in providing fish to fee-fishing operations. Operators should purchase fish that have been denied feed for at least 1 to 2 days prior to transport during warm weather or 3 to 4 days prior to transport during

cold weather. For more information on live-hauling procedures see SRAC Publication Numbers 390, 391, 392 and 393, on Transportation of Warmwater Fish.

Reducing stress during unloading and stocking is one key step to successful fee-fishing management. Fish should also be observed for signs of low dissolved oxygen stress, parasites and diseases. Signs of low dissolved oxygen can include:

- dead fish,
- fish gasping at the surface, and
- pale skin/gill coloration.

Signs of parasites and diseases can include:

- skin or fin sores and discolorations,
- erratic swimming,
- staying or gasping at the surface, and
- discolored or eroded gills.

Observe the fish in the hauling tank. Remove a few fish from the tank (particularly any that look or act unnatural) and check them closely. Look at the gills. If gills of several fish are pale, eroded or bloody, the fish are probably either sick or highly stressed. If signs of disease are visible, fish should be treated in the hauling tank or placed into a holding tank or small pond where they can be isolated from other fish and

treated (see SRAC Publication Number 410, *Calculating Treatments for Ponds and Tanks*).

As many as 3 to 5 percent of transported fish will commonly die within a few days from hauling and stocking stress. Higher losses are indicative of fish that were already diseased or were hauled and handled poorly. Prior agreement of acceptable fish mortality rates and compensation for dead fish should be made before any fish are ordered from the supplier. Discuss mortality problems with the fish producer or live-hauler and work together to reduce future losses.

When purchasing live fish, the concept of "caveat emptor" (buyer beware) cannot be over-stressed. It is important for the operator to establish the point at which the fish become his/her property. Generally, the health of the fish is the responsibility of the producer or live-hauler until they are stocked into the fee-fishing pond. Determine if the producer/ live-hauler will stand behind his/her product in the event of a major fish loss that occurs within a few days of stocking and can be attributed to a verifiable disease.

Fish should be acclimated or conditioned to the pond water before being placed into the pond. It is a good idea to exchange water between the pond and the hauling tank prior to stocking. A slow exchange of water acclimates or tempers the fish to the new water conditions. Check the temperature and pH of both the pond and the hauling tank water. Most fish can generally tolerate a sudden change in temperature of up to 5°F and in pH of up to 2 units. Some water exchange/ adjustment period is beneficial even if the hauling tank water and pond water are very close to the same temperature and pH. A good rule-of-thumb is to temper fish at least 20 minutes for each 10°F difference in water temperature and/or for each unit of pH difference. Tempering is more important when moving fish from cold hauling water into warm



Routine oxygen testing is an important management tool.

pond water (e.g., in summer) and when moving fish from hard or brackish water into soft fresh water. Always watch the fish closely during the tempering process and keep the hauling tank well aerated.

Stocking density and frequency

Stocking densities for fee-fishing ponds can vary from 1,000 to 10,000 pounds or more of fish per surface acre. Usually, fee-fishing operations which charge a single entrance fee ("ticket-lakes") in an all-you-can-catch system are stocked at 1,000 to 2,500 pounds of fish per acre. Operations that charge by the weight of fish that are caught ("fishout" or "by-the-pound" ponds) are usually stocked at higher densities under the assumption that more fish in the pond will result in higher catch rates. Most "fishout" ponds are stocked at 4,000 to 6,000 pounds of fish per acre.

However, recent research results with channel catfish at the University of Georgia suggest that angler catch rates are not related to pond stocking density. Catch rates were not significantly different in fee-fishing ponds initially stocked at 2,000 or 4,000 pounds of channel catfish per acre. Catch rates did not decline as densities declined. Regardless of stocking density, catch rates were high (8 to 10 fish per angler hour) when ponds were initially opened for fishing and declined to an average of 1 to 2 fish per angler hour after a few weeks of fishing.

Fish tend to be shy and elusive creatures. Healthy fish, when first stocked into ponds, tend to swim around the pond as though they are adjusting or orienting themselves. This behavior continues for several days, during which time the fish are easily caught, and fishing success is usually high. After this period, the fish that remain tend to move around less, possibly establishing territories, and are more difficult to catch. These fish

are referred to as being "hook-shy". Many experienced fee-fishing operators believe that fishing success is increased when small to moderate amounts of fish are stocked frequently, rather than stocking large numbers of fish at less frequent intervals.

Managing fish inventory

"Hook-shy" fish are not easily caught and tend to accumulate in the pond, reducing the remaining carrying capacity of the pond and fishing success. Good recordkeeping on the weight of fish removed will suggest how many fish can be restocked without over-loading the pond, and will give a fairly accurate account of the weight of "hook-shy" fish remaining in the pond. As many as 30 to 40 percent of the fish in a pond can be unmatchable or "hook-shy."



"Hook-shy" fish can be seined from ponds and held in live wells for sale to customers.

Many operators fish a pond until few fish are being caught, then either drain or seine the pond to remove the remaining fish. These fish can then be restocked into other ponds or sold as live or processed fish. Ideally, in an intensively-managed operation, non-biters are removed regularly and offered for sale either as live or processed fish, and the ponds restocked with new fish. Several fee-fishing operators have reported some success in moving "hook-shy" fish to other fee-fishing ponds. Moving these fish to other ponds seems to reduce their "shy-

ness," at least for a short period of time. Even ponds that can be seined should be drained every three or four years to remove unseizable fish.

Feeding

Fish in fee-fishing ponds should be fed. Research has shown that a complete feed of at least 26 percent protein should be used. Feeding helps to keep fish healthy and prevents substantial weight loss. Many operators like to feed as much as possible and still maintain good water quality. At high stocking densities, this will not be much more than a maintenance diet or ration.

A maintenance ration will keep the fish healthy, but still hungry, so they will continue to bite. A maintenance ration is around 1/2 to 1 percent of the body weight of the fish. Feed the maintenance ration every day or at least three times per week when water temperatures mandate feeding. Table 1 gives an estimated maintenance ration for feeding 1,000 pounds of fish. If good inventory records are kept, then maintenance feeding rates can be accurately calculated. If records are not available, an effort should still be made to provide a maintenance level of feed to the fish.

Winter feeding is also important. Fish that are not fed throughout the winter will lose weight and have higher disease and mortality rates. Most diseases and resulting fish losses will not appear until the water warms in the spring and may be due to the consequence of not following a winter feeding schedule. With proper winter feeding, fish will usually grow 5 to 25 percent, are healthier and start biting earlier in the spring. Table 2 gives a practical winter feeding schedule for catfish.

Feed age and storage conditions are also important as vitamin and mineral quality of feed deteriorates with time. This deterioration is accelerated by high temperatures and moisture. Store feed in a

Water Temperature °F	% of Total Fish Weight to Feed	Pounds of Feed per 1,000 Pounds of Fish
Warmwater fish		
70-75	0.5	5
76-89	1.0	10
above 89	0.5	5
Coldwater fish		
45-55	0.5	5
56-60	0.7	7
61-65	1.0	10
above 65	0.5	5

Temperature °F	% of Total Fish Weight to Feed	Feeding Frequency
45-50	0.5	once/week
51-55	1.0	twice/week
56-60	1.0	every other day
61-65	1.5	every other day
66-70	2.1	every other day

cool, dry place. **Never** use feed that is moldy, clumped or discolored. Note the date the feed was manufactured and never use feed that is 90 days past its production date.

Water quality

Good quality water is essential in any successful aquaculture venture. In the case of fee-fishing operations, water quality management must include not only the water in the pond(s), but the change in water quality from the hauling system to the pond. Since ponds can have different water quality, each one must be observed, tested and managed individually. Fee-fishing operators should seek additional information on water quality from their county Extension office or State Fisheries Extension Specialist, and refer to SRAC water quality videos (*Water Quality Dynamics, Introduction to Water Quality Testing and Procedures for Water Quality Management*).

Water quality management factors to be considered in fee-fishing pond(s) include: dissolved oxygen, pH, alkalinity, ammonia and nitrite. Chemical test kits or meters are available commercially to test these water quality components. It is highly recommended that fee-fishing operations have these kits or meters to assess water quality on a regular basis.

Oxygen

Once healthy fish are stocked into a fee-fishing-pond, the most important water quality factor is dissolved oxygen. Low dissolved oxy-

gen stress is fairly common in fee-fishing ponds and is a common cause of many disease outbreaks.

All living things consume oxygen in the process of respiration. In the pond, fish, insects, worms, bacteria and plants (at night) consume oxygen.

Oxygen dissolves into water, thus, the term “dissolved oxygen.” Oxygen dissolves into static ponds by diffusion from the air and from aquatic plants. Unfortunately, oxygen is not very soluble in water. So little oxygen dissolves in water that it must be measured in parts per million (ppm) or milligrams per liter (mg/L). The atmosphere contains about 20 percent oxygen or 200,000 ppm, yet pond water seldom contains as much as 20 mg/L. The amount of oxygen that will dissolve in water depends on the temperature and salinity of the water and the barometric pressure. If pure water is allowed to sit undisturbed, oxygen will diffuse into it until no more will dissolve at that temperature, salinity and pressure. This is called the saturation point (Table 3). Note that as water temperatures increase, the oxygen saturation level decreases. Therefore, low dissolved oxygen problems are more common in warm weather.

Ponds can become supersaturated with dissolved oxygen through the action of aquatic plants. Microscopic aquatic plants, called algae, produce most of the oxygen in ponds through the process of photosynthesis, which occurs during the daylight hours. Production of

°C	°F	D.O. mg/L (ppm)	°C	°F	D.O. mg/L (ppm)
10	50.0	10.92	24	75.2	8.25
12	53.6	10.43	26	78.8	7.99
14	57.2	9.98	28	82.4	7.75
16	60.8	9.56	30	86.0	7.53
18	64.4	9.18	32	89.6	7.32
20	68.0	8.84	34	93.2	7.13
22	71.6	8.53	36	96.8	6.95

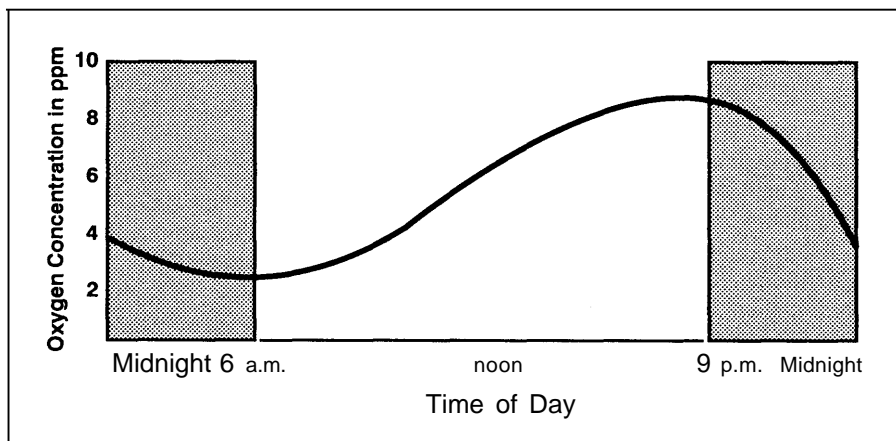


Figure 1. Typical daily oxygen cycle in warmwater ponds.

excess oxygen in the daytime, followed by high consumption of oxygen at night (i.e., respiration), causes oxygen concentrations to cycle up and down daily (Figure 1). Lowest oxygen concentrations typically occur near sunrise.

Fortunately, under normal circumstances more oxygen is produced by plants via photosynthesis than is consumed through respiration by all plant and animal life in the pond. Problems appear when dissolved oxygen concentrations drop below critical levels in the pond. In many trout, catfish and even carp ponds, with substantial water inflow, the primary source of oxygen is the dissolved oxygen in the inflowing water.

Dissolved oxygen below 4 mg/L generally causes stress to warmwater fish. This stress reduces the fish's feeding behavior and lowers resistance to disease. Coldwater fish generally start to stress at dissolved oxygen concentrations below 6 mg/L. Dissolved oxygen should be checked whenever a problem is believed to exist, such as when pond water changes color or when fish show signs of stress.

Dissolved oxygen can be checked either with a chemical test kit or an electronic oxygen meter. Chemical tests are inexpensive, but are tedious and take as long as 20 minutes to conduct. Chemical tests can be used if only two or three ponds are to be checked. Electronic oxygen meters are relatively expensive, but are a must if ponds

need to be checked frequently because of high fish densities or if several ponds must be managed at the same time.

Oxygen depletions can occur because of high respiration rates, rapid dilution of oxygen (during pond turnover), and/or chemical depletion of dissolved oxygen. High respiration rates can occur when fish are stocked at too high a density, an algae bloom becomes too dense, or high bacterial decomposition rates exist. From a practical management standpoint, this means that fish should not be overstocked in the pond. Fish densities in some existing intensively managed fee-fishing ponds do exceed 10,000 pounds per acre, in warmwater ponds with some nightly aeration, but no continuous water exchange. But the maximum density normally should not exceed 6,000 pounds per surface acre.

Algae blooms turn the pond water various shades of green, greenish-blue or greenish-brown. If algae blooms become too dense (e.g., "pea-soup" green), they can cause oxygen depletions at night during overcast weather conditions, or as they die. Algae blooms increase in density in response to increased nutrients from fertilization and feeding. Most fee-fishing ponds should not be fertilized if the fish are fed. If feeding alone does not sustain an algae bloom, then check the alkalinity of the pond. If alkalinity is above 20 mg/L, then the pond could be lightly fertilized in

early spring to develop a bloom. **Be careful, do not overfertilize!**

A summer pond "turnover" can cause an oxygen depletion. Turnovers are caused by cold winds and/or intense, cold rains which break up temperature stratification (layers) in deep ponds. The deep, cooler layers of the pond are usually devoid of oxygen. After the upper water layer (with oxygen) mixes with the deeper water layer (no oxygen) during a turnover, the pond may have critically low dissolved oxygen concentrations. Pond destratifiers, mechanical devices which keep the pond well mixed, have been used to prevent stratification and, therefore, turnovers. Aeration and/or flushing with well-oxygenated water are the only management options available after a turnover has occurred. In ponds with substantial outflow, an inverted standpipe drain system can help prevent stratification and, therefore, oxygen depletion from turnover.

Algae blooms should be carefully watched and dissolved oxygen concentrations checked when blooms become dense or pond color changes. When algae blooms die, the water changes color (usually becomes dark brown) quickly. Ponds should be aerated if dissolved oxygen drops below 3 mg/L. Continue to aerate until dissolved oxygen concentrations remain above recommended levels for the fish species that are present. Dissolved oxygen should be checked whenever the pond changes color, when fish stop biting or feeding, or when fish are observed near the surface. Dissolved oxygen should be checked routinely in the morning and evening.

pH

Hydrogen ions (acidity) in solution are measured in pH units. A pH of 7 is neutral, below 7 is acidic and above 7 is basic or alkaline. Ponds with algae blooms will experience daily swings of one half to two pH units or more depending on the density of the algae bloom and the alkalinity of the

pond. Fish generally do well when pH is between 6.0 and 9.5. A rapid pH change of 2 units (e.g., 7 to 9) or more in a short period of time is stressful to fish. Also, ammonia toxicity is affected by water pH. The daily fluctuations in pH can be reduced or buffered by the addition of alkaline ions.

Alkalinity

Alkalinity is a measure (in mg/L) of the total concentration of bases in water. Bases in pond water are mostly carbonate and bicarbonate ions. These bases react with hydrogen ions to slow or buffer pH changes. The higher the total alkalinity, the less pH generally fluctuates (see SRAC Publication Number 464, *Interactions of pH, Carbon Dioxide, Alkalinity and Hardness in Fish Ponds*). An alkalinity of at least 20 mg/L is needed to promote algae blooms.

Alkalinity can be increased in ponds by the addition of agricultural lime. A soil test of pond mud is the most accurate method to determine how much lime is needed. Pond mud can be tested by the Soil Testing Lab associated with your county Extension office. Contact your county Extension office for information on the proper methods of taking and preparing pond mud samples. In the absence of mud samples, water samples should be analyzed.

Ammonia

Ammonia is the principal waste product of fish and is released during bacterial decay. Ammonia dissolves in water into two compounds: ionized and un-ionized ammonia. Un-ionized ammonia is very toxic to fish. The proportion of ionized to un-ionized ammonia in solution depends on the pH and temperature of the solution (see SRAC Publication Number 463, *Ammonia in Fish Ponds*). As temperature and pH increase, the percentage of un-ionized ammonia increases. At high temperatures and pH, total ammonia concentrations of 2 or 3 mg/L can be very stressful or deadly to fish. Fish exposed

to high ammonia concentrations will not feed and will become more susceptible to disease.

Ammonia seldom becomes a problem in fee-fishing ponds. High ammonia concentrations can, however, occur if a pond has been overstocked or overfed, or after an algae die-off. Check ammonia levels after algae die-offs or whenever the fish stop biting (or feeding). If high ammonia concentrations occur, stop feeding the fish and flush the pond with fresh water if possible.

Nitrite

Ammonia is converted into nitrite which is also toxic to fish (see SRAC Publication Number 462, *Nitrite in Fish Ponds*). Nitrite as low as 0.5 mg/L causes severe stress in fish. Nitrite can become a problem and should be checked after a fall turnover, in deep ponds, or after a high ammonia episode. At these times, nitrite levels often reach 3 to 5 mg/L.

Nitrite toxicity can be controlled through the addition of chloride (salt). Forty-five pounds of salt per acre-foot of pond water will bring the chloride concentration to 10 mg/L. Ten parts per million chloride will counteract 3 1/3 of a mg/L nitrite. If salt cannot be added to the pond, then stop feeding the fish, flush the pond with fresh water and try to reestablish or maintain the algae bloom.

After any episode of low dissolved oxygen, high ammonia or nitrite, the fish should be watched closely for disease outbreaks. Usually diseases will start to appear within three to ten days after a water quality problem.

Aeration

Aeration will seldom be needed at stocking rates below 1,500 pounds per surface acre and feeding rates below 10 pounds per acre per day. Aeration may be needed periodically if higher stocking or feeding rates are employed, or under certain weather conditions (hot, windless, cloudy summer days).

Many types of mechanical aerators are commercially available. Aerators can be powered electrically, by diesel or gasoline engines, or from the power-take-off of a tractor. Paddlewheel aerators are very efficient, but are expensive to purchase and are not usually manufactured in low horsepowers for small ponds (i.e., less than 3 acres). As a general rule, about one to one-and-one-half horsepower of electric paddlewheel aeration is sufficient to aerate one surface acre of pond. Other aerator designs may need additional horsepower, but many are available in small sizes which adapt well to small fee-fishing ponds. For help in choosing a good aerator for specific ponds, contact your county Extension office or State Fisheries Extension Specialist.

Off-flavor

Off-flavor is caused by certain algae, fungi and bacteria which most commonly develop in summer and fall in nutrient-rich ponds. Ponds that develop scums (paint-like films or droplets) and those that give off strong odors often contain off-flavor fish. Off-flavor can occur in fee-fishing ponds if they develop dense algae blooms from over-fertilization or over-feeding. Many times fish purchased from producers are off-flavor when purchased. In fact, some producers attempt to sell off-flavor fish to fee-fishing establishments when they cannot sell them to processing plants. Not all customers will notice off-flavor (since it is common in wild fish), but many will be dissatisfied by off-flavor fish and may not return as customers.

Always ask producers or live-haulers if the fish are on-flavor. In many cases producers will discount off-flavor fish. Take one to three fish from the hauling tank and check them for off-flavor (see SRAC Publication Number 431, *Testing Flavor Quality of Preharvest Channel Catfish*). If off-flavor is present, it maybe possible to isolate these fish in a separate pond for a

few days (usually 7 to 21 days) until they are purged of the off-flavor. If isolation is not possible and if your customers dislike off-flavor fish, then reject the load of fish.

Weed control

Fee-fishing ponds experience aquatic weed problems like all other ponds. Aquatic herbicides can be used to control aquatic vegetation (see SRAC Publication Numbers 360 and 361, *Aquatic Weed Management*). If you intend to use a herbicide read the label carefully. Most aquatic herbicides have restrictions on fishing and water use after treatment. If the fee-fishing establishment has several ponds for fishing, then herbicide treatment can be rotated (along with fishing) from pond to pond without great inconvenience to the customers. Herbicide use may temporarily restrict fishing in a single-pond establishment, however. In addition, the control of algae or vascular plants may cause dissolved oxygen depletions; be aware of the consequences before treating.

An alternative in many southeastern states is to stock grass carp (white amur). Grass carp stocked at 5 to 20 fish per acre will control most aquatic weed problems that would directly affect fee-fishing operations. Many states require the use of sterile triploid grass carp. Check state regulations and stocking recommendations with your county Extension office or State Fisheries Extension Specialist, Soil Conservation Service office or state fish and game agency before stocking grass carp.

One problem with using grass carp in fee-fishing ponds is that they readily take many popular catfish baits, but often break off because of their large size and great strength. This can result in their injury and death. Anglers must be told to release any grass carp they catch, or their value for vegetation control will be lost. Grass carp are edible, so the fee-fishing operator could allow anglers to keep these fish, paying for them by the

pound as they do for other fish. The grass carp would then have to be replaced with new fish. Check with your county Extension office or State Fisheries Extension Specialist, Soil Conservation Service office or state fish and game agency on the legality of selling grass carp for food.

Fish health management

Fish diseases/parasites are always present in the pond environment. Fish are susceptible to these diseases when they become stressed or their resistance is lowered by poor water quality, handling, or nutritional problems (see SRAC Publication Number 474, *The Role of Stress in Fish Disease*). Signs of stress or disease include:

- not feeding (or biting),
- swimming erratically or flashing,
- acting highly excitable or irritable,
- swimming at the surface or lying in shallow water,
- not swimming away rapidly when disturbed, and/or
- having visible sores or discolorations.

If these signs appear, collect a fish or several fish and look for: open sores; eroded areas on fins, skin, mouth, or gills; pale or swollen gills; excessive slime on skin or gills; protruding eyes; and swollen or sunken bellies. Do not collect fish by hook-and-line; healthy fish bite, sick fish don't! If any of these symptoms appear, take or send the fish to a fish diagnostic lab as quickly as possible. Check with your county Extension office or State Fisheries Extension Specialist for the location of the nearest fish disease diagnostic lab and proper shipping procedures to follow for sending samples (see SRAC Publication Number 472, *Submitting a Sample for Fish Kill Investigation*). **Do not wait!** Diseases spread rapidly and treatments need to begin as soon as possible. Disease outbreaks will often occur after fish

are stocked, especially if captured wild fish are purchased.

A final word of caution about diseases. Many diseases have similar symptoms. Do not assume that because fish show the same symptoms as a previous disease that it is the same disease. Treatments change with the specific disease. An incorrect treatment may cause higher fish losses than doing nothing at all. Always get a diagnosis by a qualified fish disease specialist before starting treatment.

Other considerations

Managing a fee-fishing operation is a complex undertaking. The above discussions have attempted to explain management of the water and the fish. People management is still the key to running a successful fee-fishing operation. This section will discuss management considerations concerning the regulation of fishing through rules related to tackle requirements, fish releases and bait restrictions.

Fishing tackle should be strong enough to catch the fish that are stocked. Light tackle and line will result in many fish being lost by anglers. Fish can be injured and may later die, or they may not feed again until healed. They often become "hook-shy." Set minimum line or tackle requirements that will reduce the loss of fish (or be the sole source of suitable tackle). Most fee-fishing operations have a "no release" requirement. Escaped or released fish severely reduce profitability in fee-fishing operations which charge by the pound. All fish must be kept and not released for the same reasons as outlined above. One notable exception is a fee-fishing operation connected to a restaurant which charges youngsters a fishing fee, then allows them to catch unlimited numbers of fish; however, all fish must be taken to the restaurant where they are cleaned and served to customers.

Most fee-fishing operations restrict the use of live fish (e.g., shad, gold-

en shiners and sunfish) as bait in order to prevent their escape and establishment in the ponds. These bait species can rapidly overpopulate the pond and may introduce new disease organisms. Live bait should be restricted to non-fish species such as worms, crickets and crawfish. Many fee-fishing operations restrict live bait to only that which it sells and do not allow live bait to be brought in by the customer.

Recordkeeping

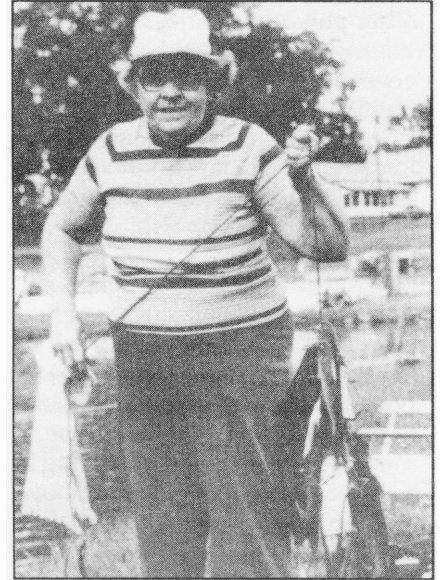
Fee-fishing is a business, and like any good business operation it requires good recordkeeping. Managers of fee-fishing operations should keep records on numbers and weight of fish stocked and on those removed by anglers or found dead in the ponds. Accurate records will help the manager make better decisions on when to restock with new fish, when to seine to remove "hook-shy" fish, and how much to feed to maintain healthy fish. Many fee-fishing operations that do not charge by the

pound still require that all fish be weighed before the customer leaves the premises. Records of water quality (dissolved oxygen, ammonia, etc.) will help managers monitor trends and help identify stressors when disease outbreaks occur. Keep good records, and many management decisions will be clearer and less costly.

Conclusion

This fact sheet has dealt with the management of fish and water quality in food-fish type, fee-fishing ponds. Many of the same water quality considerations discussed, however, would be applicable to the management of large-mouth bass-bluegill ponds which are leased for fishing. Of course, there is more to a successful fee-fishing operation than just the management of the fish and water. Fee-fishing operators have to consider location, physical layout, concessions and all the things that impact on their customers. In other words, people management is just as important to consider as fish

management. For information on these and other aspects of fee-fishing please refer to SRAC Publication Numbers 479 (*Fee-fishing: An Introduction*), 482 (*Fee-fishing: Location, Site Development and Costs*) and 481 (*Development and Management of Fishing Leases*).



People management is the key to running a successful fee-fishing operation.

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