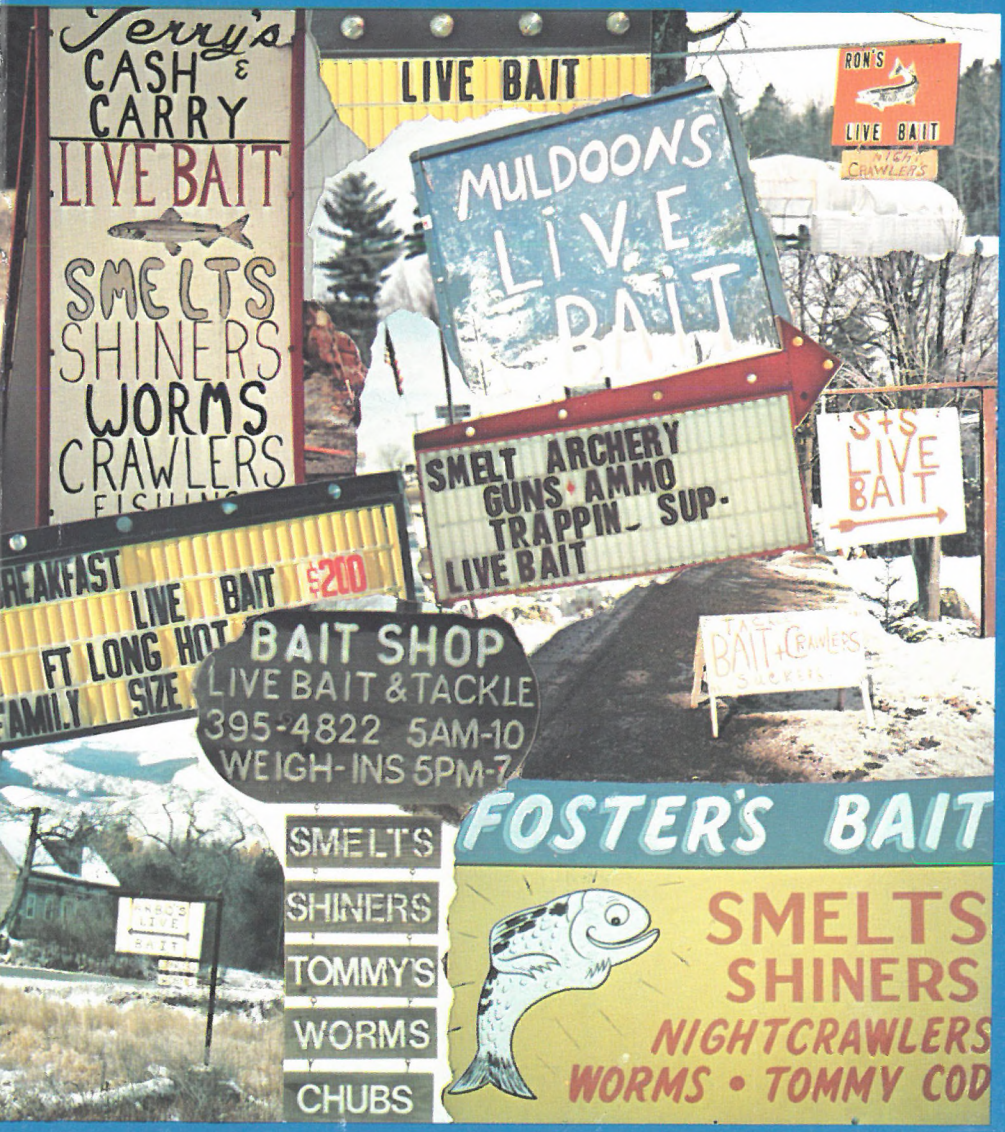
BAITFISH
FOR FUN AND PROFIT IN MAINE



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INTRODUCTION

The use of small fish as bait is an integral part of angling in Maine, especially during the winter ice-fishing season. Some of these fish are captured by people who intend to use them, but many more are purchased from dealers who sell live bait. Retailers may be in the bait business as a sideline to another enterprise, such as a grocery store or tackle shop, or they may depend on the sale of bait for a significant proportion of their income. Whatever the degree of involvement, these people all, at times, have a need for information on how to work with fish.

The purpose of this publication is to assist anglers, baitfish culturists, and baitfish dealers in understanding various methods of capturing, rearing, holding, and selling live bait. The authors have attempted to briefly cover most aspects of the live bait business, including: legal and financial pitfalls; practical methods of catching fish; and health problems that may be encountered when dealing with large numbers of fish. Other sources of information are referenced for those who wish to expand their knowledge in a particular area.

LAWS, REGULATIONS, AND LICENSING

In the bait business, as in most other endeavors, there are certain steps that must be taken to ensure that everything is being done in accordance with the law. In Maine, it is illegal to import any live baitfish; therefore, all live fish that are used for bait must either be captured from wild populations or raised within the state. It should also be emphasized that the unauthorized release of any fish into the wild is illegal, and violators are subject to substantial penalties. The dealer may capture wild fish or buy them from a bait wholesaler. If the dealer is energetic and industrious, baitfish may be reared in ponds managed for that purpose.

Appendix 1 lists Maine state laws and regulations that govern taking and selling of live bait; copies of these can be obtained from your legislator. One of these laws lists the species of fish that are legal for use as live bait. This list (Appendix 2) includes all of the non-game, non-spiny rayed fish currently known to inhabit Maine waters.

There are a number of licenses that may be required, depending upon your involvement in the bait business. Note: all fees listed were applicable when this publication was written and may be subject to revision.

1. Fish culture license ($21): Allows a person to breed, rear, and sell fish. This license does not allow the holder to capture any fish from the wild.

2. Live bait retailer's license ($10): Allows a person or an establishment to sell live baitfish, including smelt. This license does not allow the holder to capture any fish from the wild.

3. Baitfish wholesaler's license ($20): Allows a person to capture, hold, and sell live fish, except smelt, for bait.

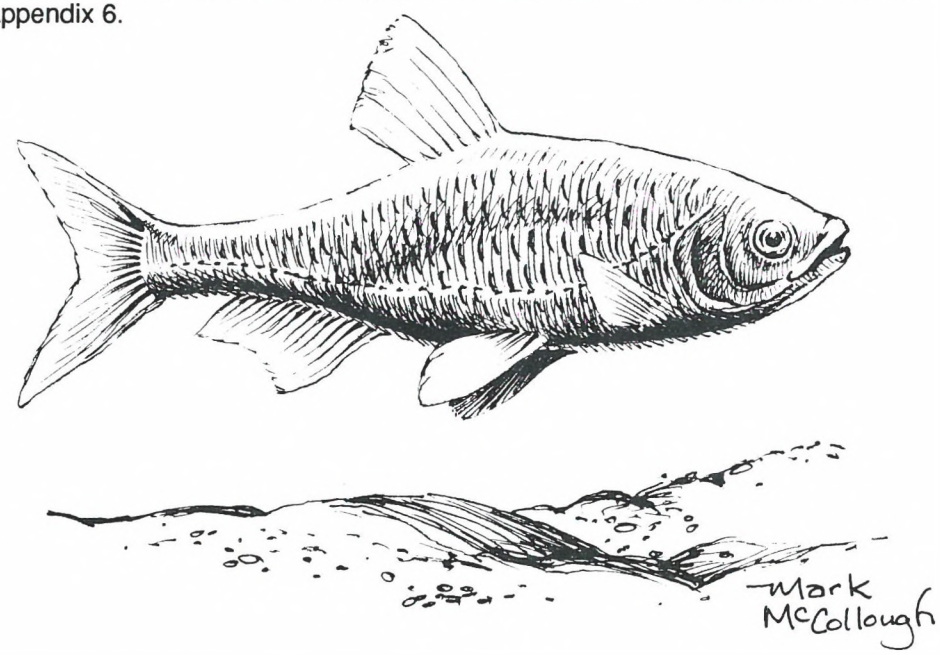
4. Live smelt wholesaler's license ($65): Allows a person to capture, transport, hold, and sell live smelts for bait.

If you intend to build a fish pond on your property, there are several environmental laws that may apply: a discharge permit may be needed from the Maine Department of Environmental Protection (DEP) if the pond has an outlet into public waters; a stream alteration permit from DEP may be required if the pond is built on a stream; a letter of intent must be sent to the Commissioner of the Maine Department of Inland Fisheries and Wildlife (MDIFW) if you intend to dam a stream; a wetlands alteration permit may be needed from the Army Corps of Engineers if more than one acre of wetland will be involved; and finally, a shoreland zoning variance may be required in some towns. If you have any questions about what permits are needed, these should be directed to your local Soil Conservation Service (SCS) district office (Appendix 4). The SCS personnel are aware of these laws and permitting procedures and are the best source of this type of information. Other sources of information on pond construction, state laws and rules, fish health and management problems, and business taxes and permits can be found in Appendix 4.

BIOLOGY OF BAITFISH SUITABLE FOR CULTURE IN MAINE

In Maine, as many as 17 species of baitfish are offered for sale, but the majority of shops carry only two or three species. The most common species, golden shiner, fathead minnow, white sucker, longnose sucker, and rainbow smelt, are discussed in the following pages. The anatomical parts of a fish mentioned in each species' description are identified in Appendix 3.

For information about other species of baitfish, refer to the literature listed in Appendix 6.



GOLDEN SHINER *(Notemigonus crysoleucas)*

DESCRIPTION

The golden shiner is a large, deep-bodied minnow, thin and flat from side to side. Its mouth is small, upturned, and without barbels. The scales are fairly large and loosely attached. The pointed dorsal fin has eight rays and is located far behind the pelvic fins. The anal fin is long and sharply pointed and has 11-15 rays. A scaleless, fleshy keel on the belly extends from near the pelvic fins to the anus. The lateral line has a characteristic downward curve that follows the ventral body curve.

Adults are a golden yellow color that may fade to silver on the belly. The young are more silvery and often have a dark lateral band running from head to tail that fades with age.

Golden shiners are one of the most preferred baitfish species in Maine. They are a colorful, hardy fish that can stay alive on a hook for a long period of time, and game fish of all types are attracted to them.

HABITAT AND RANGE IN MAINE

Golden shiners are found throughout Maine and are known to exist in at least 700 lakes and ponds. They prefer clear, clean water and are often associated with submergent vegetation. They may also be found in larger rivers and streams in shallow, quiet sections with weedy bays and shoals.

GROWTH RATE

The maximum length of golden shiners is usually 6 to 8 inches, although a few may attain a length of 10 to 12 inches. Under normal conditions, they may reach sexual maturity at one year of age and a length of 2.5 inches, but in Maine they usually do not mature until their second year. In warm water ponds, golden shiners can grow about three inches in 70 days. A pH in the range of 8 to 8.5 will also encourage rapid growth. Table 1 presents various relationships among length, weight, volume, and number of golden shiners. Females grow faster and larger than males.

SPAWNING AND REARING METHODS

Golden shiners are "vegetation spawners," depositing their adhesive eggs on living plants or artificial mats in shallow water. Spawning in Maine starts when water temperatures reach 70°F and continues until water temperatures cool or exceed 80°F. Spawning in Maine has been reported as late as October. No care is given the eggs by the adults, and adults may prey on their own fry.

During the spawning season, the availability of high quality water is essential. Siltation or over-abundant plant and animal life may curtail spawning and must be controlled by rapid addition of fresh water. Overcrowding will also curtail spawning. Artificial feed can be used to compensate for lack of natural food. Three methods of propagating golden shiners in captivity are commonly used.

Method I: Wild or Free Spawning

The vegetation necessary for spawning golden shiners is commonly supplied by lowering the water level in early spring to allow planted or naturally seeded grasses to grow along the shoreline. Together with aquatic plants, the grass provides spawning substrate when the ponds are refilled. Spawning mats of plastic, hay, straw, or Spanish moss sandwiched between 2-inch by 4- inch mesh woven wire can be used if vegetation is lacking or scarce (Figure 1). The mats should measure about 20 inches by 48 inches, and selected wires removed to make the mesh 4-inch by 4-inch. Hog rings are used to hold the top and bottom together. These mats must be anchored to prevent drifting, and should be removed after hatching is complete.

Brood fish are generally introduced at a rate of 20 to 40 pounds per acre, but a stocking rate of 200 pounds per acre has produced good results in Maine. If spawning activity decreases before the normal season is over, it may be increased by rapidly adding fresh water to the pond.

Egg laying, hatching, and growth to marketable size occur in the same pond. Adults can be left in the pond, but removing them will decrease the transfer of

parasites from the adults to the young, and will discourage predation on the young by the adults.

Table 1. Relationships among golden shiner length, number per pound and per gallon, and weight per 1,000 individuals (adapted from Dobie et al. 1956).

Length (inches)	Number per pound	Number per gallon	Weight (pounds) per 1000 individuals
1.0	4,250	34,000	0.2
1.5	1,120	8,960	0.9
2.0	430	3,440	2.3
2.5	215	1,720	4.6
3.0	118	944	8.5
3.5	71	568	14.1
4.0	47	376	21.3
4.5	32	256	31.2
5.0	23	184	43.5
5.5	16	128	62.5
6.0	12	96	83.3

Method II: Egg Transfer

When using the egg transfer method, it is essential that both the pond and the pond margin be kept completely free of vegetation. Brood stock are kept in the ponds at a stocking density of 400 to 500 pounds per acre.

Spawning mats, as described in Method I, are placed in the pond when the fish are ready to spawn. The water level in the pond can be rapidly raised to stimulate spawning if necessary.

Groups of mats should be placed in an end-to-end arrangement along the shoreline (Figure 1). The top of each mat should be one inch below and parallel to the water surface.

The number of mats needed per acre of rearing pond will vary from 50 to 75, depending upon the number of eggs per mat. The objective is to obtain an even

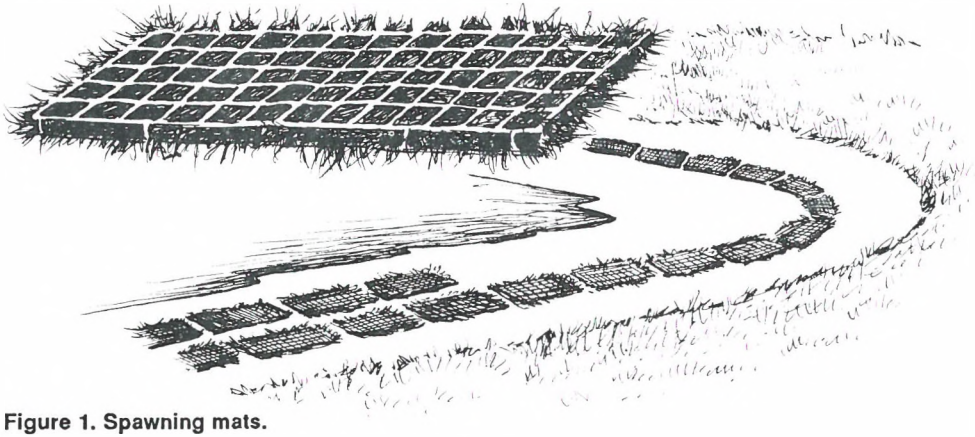


Figure 1. Spawning mats.

covering of eggs in 12 hours. Too few mats will result in over-crowding (eggs touching each other) and growth of saprophytic fungi; too many mats will result in inefficient use by the spawning adults. As the mats are filled, they are transferred to rearing ponds and new mats placed in the spawning pond. Hatching will begin in two to three days at temperatures of 72°F to 76°F. When hatching is complete, the mats should be removed. Clean plastic mats before storing; other materials should be replaced each year.

Method III: Fry Transfer

With this method, fry are produced by either Method I or II in hatching ponds that have been purposely overstocked with eggs. When the fry are about 0.75 inches long, they are captured with small seines or fine mesh lift-nets. After counting, the fry are transferred to rearing ponds. Counting is most easily done by the displacement method (Figure 2): if, for example, there are 200 fry per liquid ounce and a stocking of 200,000 fry is required, 1,000 ounces of fry must be transferred. This process should be done when the weather is cool (early morning or on a cloudy day) to prevent injury to the fry.

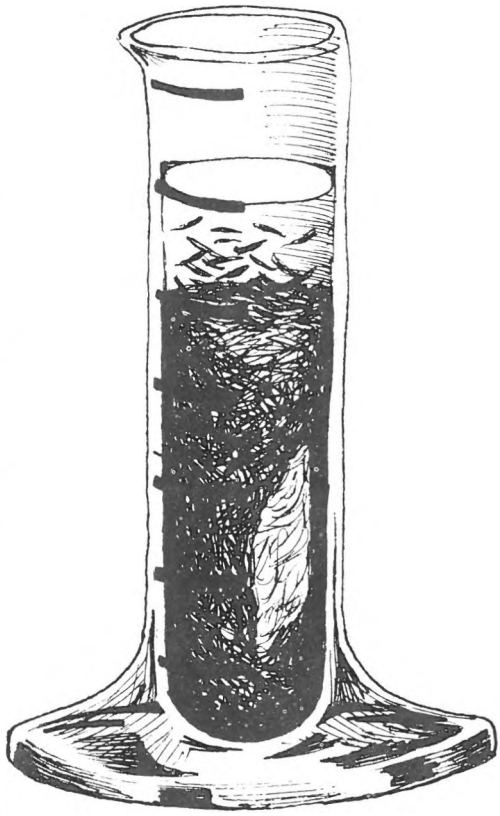
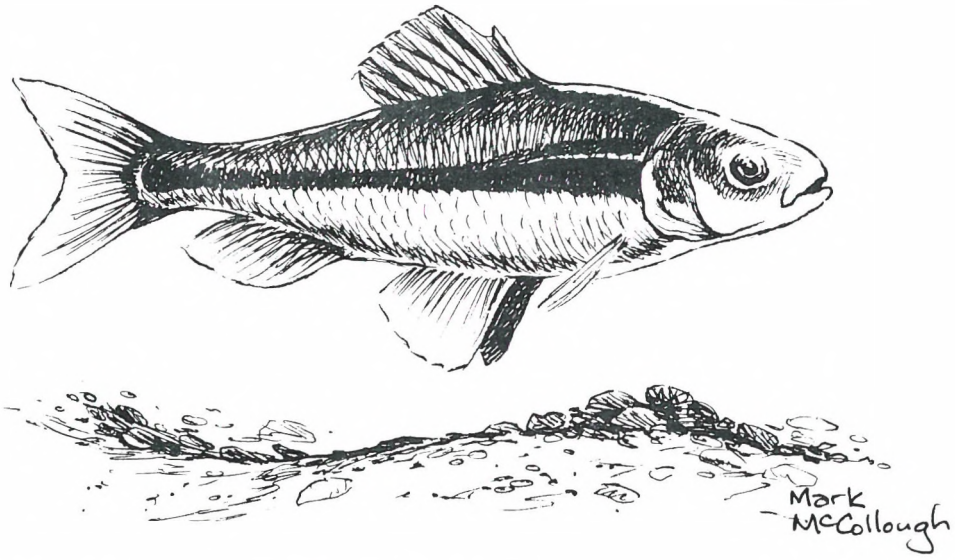


Figure 2. Graduated cylinder used to estimate number of fry.

By using the fry transfer method, it is possible to accurately determine the number of fry and control stocking density in the rearing ponds. This provides uniform stocking and optimal use of pond space.

Stocking density for fry will vary from 25,000 to 50,000 per acre depending on the size of fish desired, when saleable fish are needed, intensity of pond management, length of the growing season, and pond productivity. The number of fish per acre of water (stocking density), will affect growth and disease susceptibility. Too many fish will slow growth, and increase stress and diseases. Too few fish and you won't reach your production potential. Some trial and error may be required to find the best stocking density for your ponds.



FATHEAD MINNOW *(Pimephales promelas)*

DESCRIPTION

Fathead minnows are a stout, full-bodied fish with a small mouth, round, blunt snout, and small scales. The first ray of the dorsal fin is thick, short, and connected to the rest of the fin by a membrane. The lateral line is incomplete, ending below the point of the dorsal fin origin.

Young females and non-breeding males are dark above, fading to white below, with a distinct dark stripe along the sides. Breeding males are dark about the head, and develop a soft swollen pad on the top of the head and tubercles on the chin and snout.

Fathead minnows are a very hardy, lively fish, and as such they make an excellent live bait. Their size makes them ideal bait for trout, salmon, and brook trout. Some anglers will use no other live bait.

HABITAT AND RANGE IN MAINE

Adult fathead minnows can be found on the bottom or in the middle depths of lakes and ponds, and young-of-the-year may be found in the shallows. In streams and rivers, fatheads are usually found along undercut banks or in backwater areas with little or no current. These hardy fish are tolerant of a wide range of environmental conditions, including high temperatures, high nutrient concentrations, low oxygen levels, high turbidity, and fairly stagnant conditions. Fathead minnows are not as common or as widely distributed in Maine as the golden shiner. Fatheads are found in 85 waters, mostly in the northern and western parts of the state.

GROWTH RATE

Male fathead minnows are larger than females and grow to a length of 3 to 3.5 inches. Under normal conditions, young will grow about 0.2 inches every 10 days to reach a length of 2.3 inches at 120 days. Relationships among length, weight, and number of fish are given in Table 2.

SPAWNING AND REARING METHODS

Fathead minnows reach sexual maturity at one year. Spawning begins in May, when water temperatures reach 64°F to 68°F, and continues throughout the summer. Females produce 200 to 500 eggs per spawn, with repeated spawning. During a spawning period, the female releases a few eggs at a time that the male fertilizes, picks up, and places in a nest site that is located on the underside of rocks, logs, or vegetation. One male may use eggs from several females in a single nest, and he guards the nest until the fry emerge in 4 to 6 days. The majority of males die within 30 days of spawning and many females die within 60 days.

Fathead culture is restricted to the wild or free spawning method and the fry transfer method.

Table 2. Relationships among fathead minnow length, number per pound and per gallon, and weight per 1,000 individuals (adapted from Dobie et al. 1956).

Length (inches)	Number per pound	Number per gallon	Weight (pounds) per 1000 individuals
1.0	2,600	20,800	0.4
1.5	740	5,920	1.4
2.0	300	2,400	3.3
2.5	150	1,200	6.7
3.0	84	672	11.9
3.5	52	416	19.2
4.0	34	272	29.4

Method I: Wild or Free Spawning

Brood fish should be stocked at 500 to 2,000 per acre with a preferred sex ratio of five females to one male. Artificial spawning sites such as rocks, pieces of tile, or boards, can be provided to supplement natural sites. Caution: this method tends to over-stock the ponds and may result in stunted growth.

Method II: Fry Transfer

Brood fish are stocked at 20,000 to 25,000 per acre with a sex ratio and artificial spawning sites as stated in Method I.

A common method of providing nest sites is to staple several 1-inch by 4-inch by 12-inch boards, spaced 12 inches apart, to a wire strung between two posts placed in shallow water (Figure 3).

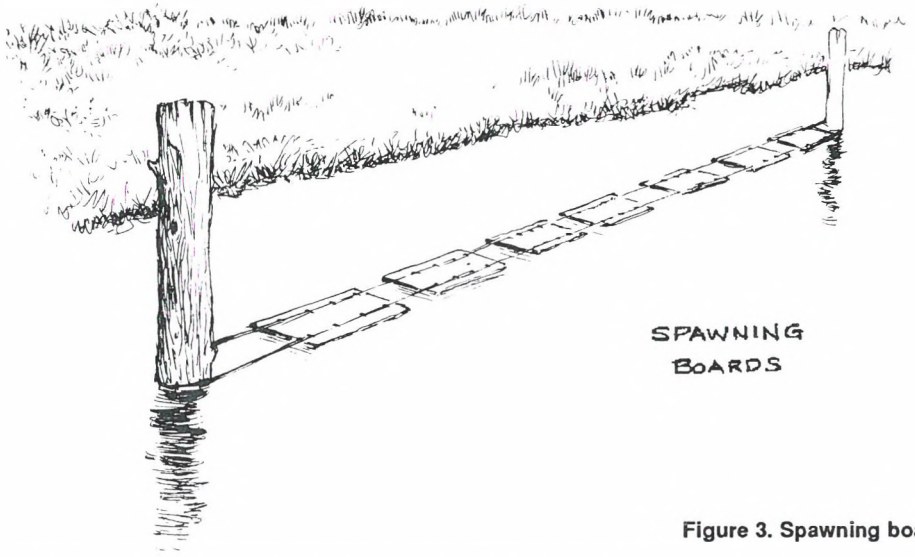
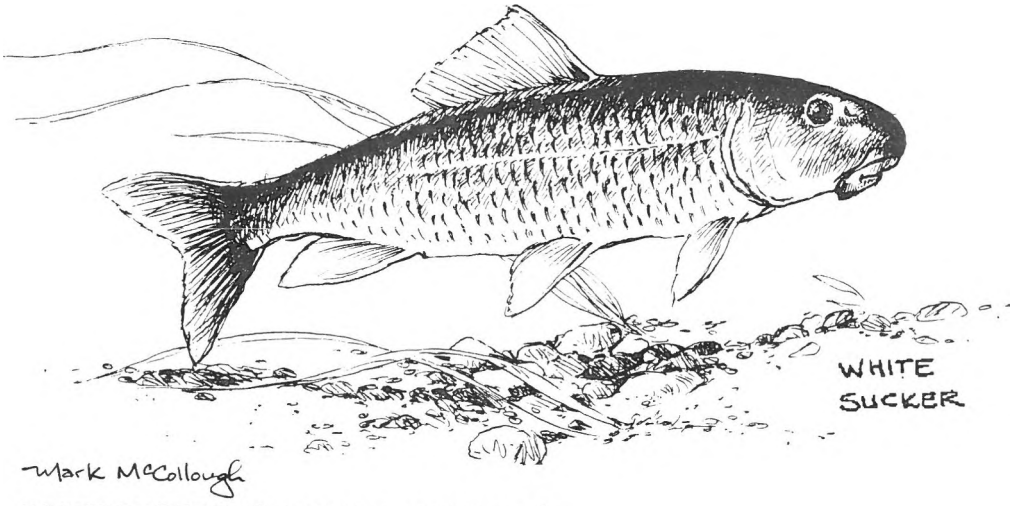


Figure 3. Spawning boards

Capture, counting, and transfer of fry is done in the same manner as for golden shiners, except that fatheads can be transferred at a slightly smaller size. Fry are stocked at 25,000 to 75,000 per acre, depending on intensity of culture, size of fish required, when saleable fish are required, and length of the growing season.



WHITE SUCKER *(Catostomus commersoni)*

DESCRIPTION

The most conspicuous feature of the white sucker is its ventral sucking mouth. The body is round to oval in cross-section with fine scales near the head and coarser ones near the tail. The dorsal fin has 10 to 13 rays, and there are no spiny rays in any of the fins.

Adults are olive-brown on the back, fading to white on the belly. During the breeding season, both males and females become very dark on the back and sides. Young are lighter colored and may have three large dark blotches on each side of the body.

HABITAT AND RANGE IN MAINE

White suckers thrive under a variety of conditions but prefer clear-water lakes, rivers, and streams. In streams and rivers, adult white suckers are found in pools and runs with low to moderate currents, especially near rip-rap banks, bridge abutments, boulders, and undercut banks. Young suckers can be found in riffles and runs with moderate currents, and in backwater areas. The white (or "common") sucker is found in more than 1,100 waters, evenly distributed throughout Maine; as such it is readily available to almost anyone.

Suckers are an important bait for catching lake trout in some parts of Maine, although in other areas they are hardly used at all. Where suckers are used, they command a premium price: $0.50 each for 4 to 6 inch fish and up to $1.00 each for 8 to 10 inch fish. If a bait business is located in an area where suckers are the preferred bait for lake trout, it would be very worthwhile to invest time and effort into rearing these fish.

GROWTH RATE

Adult white suckers can reach lengths of 30 inches and weigh five pounds; one-year-old suckers average 4 to 6 inches.

The growth rate of white suckers can be controlled by adjusting the number of fish per acre in the pond. When stocked at 19,000 fish per acre, 60-day-old fish will be about 2 inches long. At 8,000 per acre, the fish will be about 2.5 inches at 60 days, and at 4,000 per acre will be about 3 inches. In general, white suckers grow about 0.4 inches every 10 days. Table 3 shows the relationship among length, weight, and number of white suckers.

SPAWNING AND REARING METHODS

White suckers spawn in May and June in moving water near a gravel bottom; nests are not built. During each three to four second spawning activity, two to four males press against each female. As the female expels her eggs, they are fertilized by the males and drift downstream, adhering to the stream bottom in pools and eddies or scattered on the bottom in lakes.

CHOICE OF PONDS

The choice of ponds for white sucker production is critical because they need relatively clear water. Four characteristics that are important to consider are:

1) Fertility: Moderate fertility will produce the best crop of white suckers. Infertile ponds do not provide sufficient food and very fertile ponds may produce enough algae to cause oxygen and pH fluctuations that may kill the fish.

Table 3. Relationships among white sucker lengths, number per pound and per gallon, and weight per 1,000 individuals (adapted from Dobie et al. 1956).

Length (inches)	Number per pound	Number per gallon	Weight (pounds) per 1000 individuals
1.0	4,250	34,000	0.2
1.5	1,120	8,960	0.9
2.0	440	3,520	2.3
2.5	220	1,760	4.5
3.0	118	944	8.5
3.5	70	560	14.3
4.0	46	368	21.7
4.5	31	248	32.2
5.0	22	176	45.4
5.5	16	128	62.5
6.0	12	96	83.3
6.5	10	80	100.0
7.0	8	64	125.0

2) Food supply: Ponds with an ample supply of chironomid fly larvae (midge larvae) in the bottom mud will be more consistent producers of good sucker crops than ponds without.

3) Soil texture: Pond soil affects both the fertility of the pond and the production of chironomid fly larvae. Best production is from ponds with loam and sandy-loam soils. Peat and peat-loam ponds are average producers, silt and clay-loam ponds are poor producers.

4) Algae: Heavy, moss-like growths of filamentous algae on the bottom of the pond can reduce or eliminate production of suckers. Filamentous algae affects production by interfering with feeding activity of the suckers and by releasing ammonia as a by-product of decomposition.

COLLECTING AND FERTILIZING THE EGGS

After capture in seines or traps, spawning suckers are sorted; ripe males and females are placed in separate tubs of water and unripe fish released. The fish are stripped of eggs and milt by pressing lightly with the thumb and forefinger downward over the abdomen toward the vent (Figure 4). If heavy pressure is required to force eggs or milt from the fish, these fish should also be released because the eggs will not be fertile. Males mature somewhat earlier in the season than females, resulting in a local scarcity of males. Males may need to be caught earlier and put in a holding tank until needed. Eggs should not be stripped unless there are males available to supply milt.

Figure 4. Stripping eggs and milt.

Females are held over a dampened pan, the eggs are stripped, and the males immediately stripped of their sperm. The eggs and milt are thoroughly mixed by gently swirling the pan. Four or five pairs may be stripped into the same pan if each batch of milt and eggs are thoroughly mixed after stripping. An extra male or two may be stripped to ensure complete fertilization of all of the eggs. After two or three minutes, water can be slowly added to the pan, gently mixing the eggs and water using a swirling motion. If the eggs stick together, the addition of a cupful of cornstarch dissolved in water or a similar amount of muck, will keep the eggs separate. Rinse this out when the milt is removed after fertilization.

The milt is now washed out by using several changes of clean water. The green fertilized eggs are transferred to a tub and allowed to harden for two to three hours. The tub should be placed in cold water and shaded. During hardening, the eggs should be stirred and the water changed periodically. The eggs are now ready for transport to the hatchery.

ARTIFICIAL HATCHING

The culture of fish eggs in jars is described in an article by Bass (1959) that should be reviewed before attempting to rear fish using this method. Basically, jar culture requires a controlled flow of water, through a tube, to the bottom of a glass or plastic jar (Figure 5). The water flows upward, mixing with the fish eggs in the jar, and then flows out over the rim. This mixing activity keeps the eggs well oxygenated and, if fungicides are used, the eggs do not need to be handled at all while hatching.

At the hatchery, two to three quarts of eggs are transferred to each hatching jar. Water flowing into each jar should contain an abundant supply of dissolved oxygen. Keep the eggs in constant, gentle motion and the water free of air bubbles that will adhere to the eggs and carry them up and out of the jar.

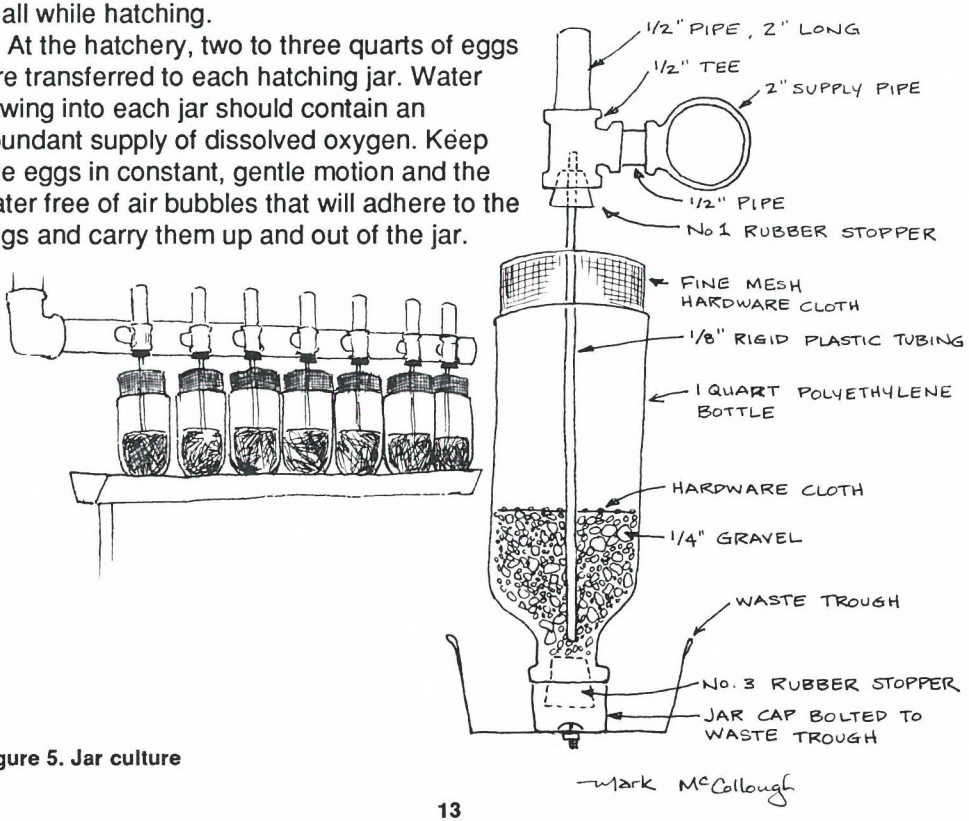


Figure 5. Jar culture

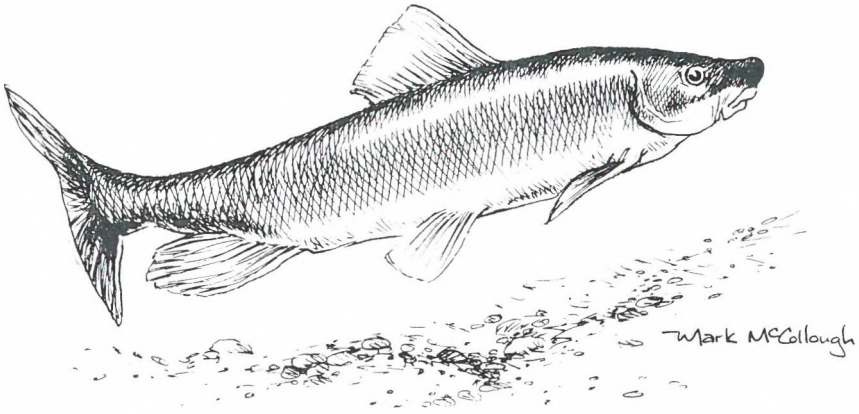
Hatching will occur in one to six days in water temperature above 68°F, in 10 to 15 days in 50°F water, and will not occur in water colder than 50°F. The eggs can, if possible, be started at 50°F to reduce clumping, then the temperature increased to 54°F to 60°F for hatching

After hatching, the fry will stay in the jar for five to ten days and not swim out with the circulating water. This means that the fry can be held in the jar until they are free swimming and strong enough to search for food when put into the rearing pond. It is then easy to determine the number of fry, and to control stocking density, by pouring them into a glass measure graduated in ounces and allowing them to settle to the bottom. There are about 2,720 five-day-old white sucker fry per ounce.

STOCKING PONDS WITH FRY

Optimum stocking rates will vary with the conditions in each pond and the size of fish desired at different times of year. Experience and experimentation are required to determine what stocking density is best for each situation. In general, growth rate and survival are greater at lower densities (see section on growth rate of white suckers). A stocking density of 40,000 fry per acre is often used with good results.

Growth rate can also be adjusted by monitoring the ponds and moving fish from one pond to another to increase growth (reduce density) or inhibit growth (increase density). In this way, the preferred fish size will be available throughout the fishing season. Make sure that all fish are removed at harvest time so that none remain to become predators on the next batch of small fish that are stocked.



LONGNOSE SUCKER *(Catostomus catostomus)*

DESCRIPTION

The longnose sucker has, as its name implies, a long snout that overhangs the ventral sucking mouth. The body is long, round, and torpedo-shaped, with small scales near the head and larger scales near the tail. The dorsal fin has 10 to 12 rays.

Adults are dark olive or gray on the back, shading to white on the belly. During the breeding season, adults develop a broad, wine-red lateral band. Young are dark tan.

HABITAT AND RANGE IN MAINE

Although it prefers deep, cold water, the longnose sucker can be found in both lakes and streams, in both warm and cold waters. Both pool and riffle areas are used by longnose suckers, but they are most often found in areas of moderate to fast flow, and in the depths of our deepest lakes. The longnose sucker is much less common in Maine than the white sucker. The longnose is only found in about 125 waters and most of these are north and west of Bangor.

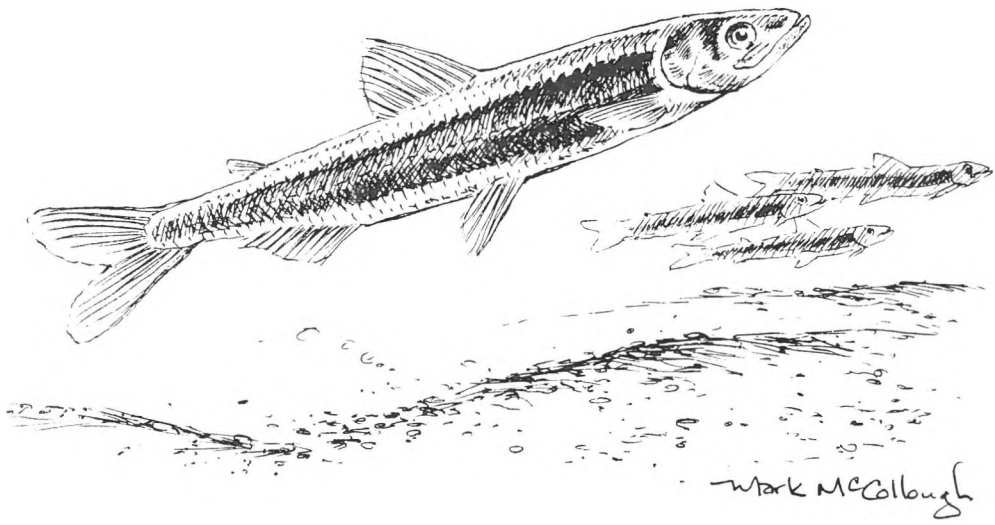
Like the white sucker, the longnose sucker is a very fine lake trout bait. Although seen less often in bait shops because it is more difficult to capture in the wild, longnose suckers will sell very quickly when they are available.

GROWTH RATE

The longnose sucker is a smaller fish than the white sucker, with adults reaching 25 inches and 3 to 4 pounds. Two-year-olds may reach a length of 9 inches. Growth rate of young longnose can be controlled as for white suckers.

SPAWNING AND REARING METHODS

Longnose suckers spawn earlier in the spring than white suckers. Spawning activity and rearing methods are similar for both suckers, therefore, refer to the section on white suckers for more information.



RAINBOW SMELT *(Osmerus mordax)*

DESCRIPTION

Rainbow smelt are a small, slender, laterally compressed fish with a large mouth and prominent teeth. The lower jaw protrudes past the upper jaw. The dorsal fin is at the middle of the body, the tail deeply forked, and the anal fin long relative to other fins. There is a well developed adipose fin, and the scales are relatively large. Smelt are a silvery color, occasionally darker on the back, fading to silver-white on the belly.

HABITAT AND RANGE IN MAINE

Rainbow smelt are found in both fresh and salt water. In fresh water, smelt are found in the open, middle depths of lakes and reservoirs in the summer. In spring and fall, they are found in shallower water close to shore or in inlet streams. During the winter they can be caught over deep water at all depths. Smelt are found in 468 waters in Maine, evenly distributed throughout the state.

GROWTH RATE

Adult rainbow smelt are usually 6 to 8 inches in length, although smelt longer than 10 inches are common in some lakes. Growth rate of young smelt will vary with the availability of food. From hatch in early June to time of ice formation in late November, smelt can reach baitfish size of 3 to 3.5 inches if they have an abundant food supply. Sea-run smelt are generally larger than landlocked smelt.

SPAWNING

Rainbow smelt reach sexual maturity at one or two years of age. Sea-run populations of rainbow smelt begin to spawn in March in southern Maine, extending into early June in northeastern Maine. Sea-run smelt spawn in coastal streams; landlocked smelt spawn in tributaries of lakes or in shallow areas of lakes. In streams, the adhesive eggs are deposited in shallow riffle areas. Larvae hatch in 12 to 27 days, depending on water temperature, and are carried downstream to estuaries, the open ocean, or deeper areas of lakes.

CULTURE

Rearing rainbow smelt is still more of an art than a science. Eggs can be collected from wild fish, hatched in a raceway, and the young reared in a small pond. Growth is good and marketable fish can be reared in one year. However, the very specific food requirements of various life stages of smelt result in low survival from egg to market size and hence rearing costs are very high. Recommended reading are the articles listed in Appendix 6 by Akielaszek et al. (1985) and Moring (1985). With the information in these articles, some persistent experimentation, and a lot of luck, someone may yet develop a reliable method of culturing smelt. When this happens the baitfish industry will beat a path to the hatchery door and great wealth will follow.

MANAGING WATER QUALITY

Water is made up of many components besides the H_2O we all learned about in our early years of education. Being an excellent solvent, water, as it is available in nature, will also contain minerals, gasses (such as oxygen, carbon dioxide, and ammonia), and, perhaps, toxic chemicals. These extra ingredients all have an effect on the fish that live in the water.

DISSOLVED OXYGEN

Dissolved oxygen (DO) is necessary for fish to live. DO should be measured at sunrise, when it is at its lowest level. At least five parts per million (ppm) of DO is required for most species to remain healthy. When the amount of DO falls below this level, fish become stressed, which may make them vulnerable to disease or parasite attack, and may eventually cause death.

CARBON DIOXIDE

Carbon dioxide (CO_2) is a by-product of respiration and must be kept below certain levels in the water. High levels of CO_2 will contribute to wide fluctuations in pH. This, in turn, may cause stress. Carbon dioxide levels below 2 ppm will not present any problems to minnows if the DO is at saturation level. If, however, DO falls significantly below saturation and CO_2 rises above 5 to 15 ppm, the fish will have difficulty acquiring oxygen from the water and they will become stressed.

AMMONIA

Ammonia is one of the by-products of fish digestion and will lead to stress if allowed to accumulate. Under normal conditions, ammonia concentrations are not a problem in water because of the low numbers of fish present, neutral or slightly acid pH levels, and low algae levels. However, in aquaculture systems the number of fish maintained usually exceeds what a wild population would be and the pH is usually higher because of plankton blooms that are encouraged to provide fish forage. Ammonia can be very toxic to fish at low concentrations and every effort should be made to control it. Water test kits can be obtained for ammonia determinations and their use is encouraged. Aeration and frequent water changes will help control ammonia build-up and encourage moderate, instead of intense, plankton blooms. This will also help control pH fluctuations that, in turn, will help control ammonia accumulation.

AERATION

Aeration (USDA 1984) will cure many potential water quality problems by adding oxygen to the water, and removing $C0_2$ and other gasses. Commercially available aerators (Figure 6) can be used, or water can be agitated as it moves from one pond to another by letting it splash over a series of steps.

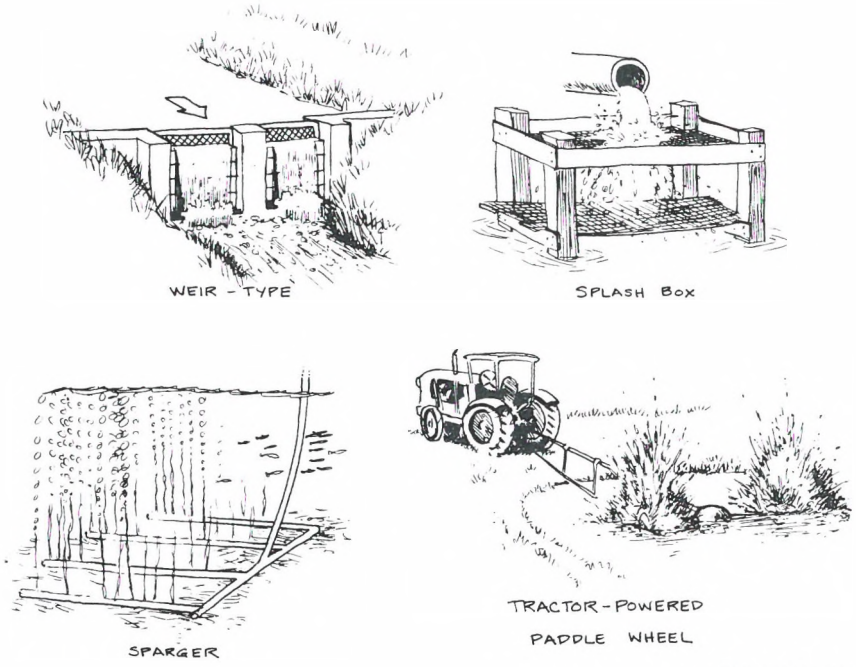


Figure 6. Aerators.

MINERALS

Minerals that are dissolved in the water contribute to its pH (potential hydrogen) or acidity, its color, and its ability to conduct electrical current (conductivity). Excessive or inadequate amounts of any mineral can be troublesome for aquaculturists.

pH

The ideal pH for baitfish is between 7.0 and 8.0, although some fish will grow better at higher pH levels. Readings should be taken in the morning and in the afternoon, and both should be between 7.0 and 8.0. Levels of pH below 6.5 can be increased by adding agricultural lime to the pond. You may wish to experiment with different levels to determine what works best in each situation. In general, one ton of common agricultural limestone per surface acre of water, in a pond without flow through, will increase the pH approximately one pH unit.

WATER QUALITY: WINTER AND SUMMER

Water is the most vital ingredient in any fish rearing operation. There are two seasons in Maine when water quality may be a limiting factor for fish living in a pond: winter and summer.

In winter, when ice and snow can cover ponds with several feet of accumulation, fish must survive on the dissolved oxygen already in the water before freeze-up. If the pond is deep enough, and the number of fish is not too large, there should be no problem. However, if you try to overwinter too many fish, or if there is too much aquatic vegetation (the decay of which will use up oxygen),

then the fish will suffocate (Figure 7). Winter-kill can be avoided by providing: (1) a flowing water source that continually adds oxygen-rich water; (2) aeration of the pond by mechanical means; or (3) air or oxygen injected through hoses and pumps into the bottom of the pond. Another method of providing adequate oxygen levels in winter, is to keep the pond free of snow. Plant growth ceases in the winter because sunlight cannot penetrate heavy ice and snow cover. Removing the snow will allow light penetration, thus keeping the plants alive and producing oxygen. These procedures add to the cost of rearing bait, but the additional profits realized by having more fish available may offset the added expense. In addition to clearing off the snow, drilling 20-30 holes per surface acre will allow the escape of excess methane, CO_2, and other gasses.

During summer, high temperatures, algae caused by overfertilization, and low oxygen levels can all pose problems. Again, a reliable source of well oxygenated water coming into a pond and agitation of the water surface to add oxygen, are invaluable aides. A deep pond will also have fewer problems caused by high temperatures, than will a shallow pond.

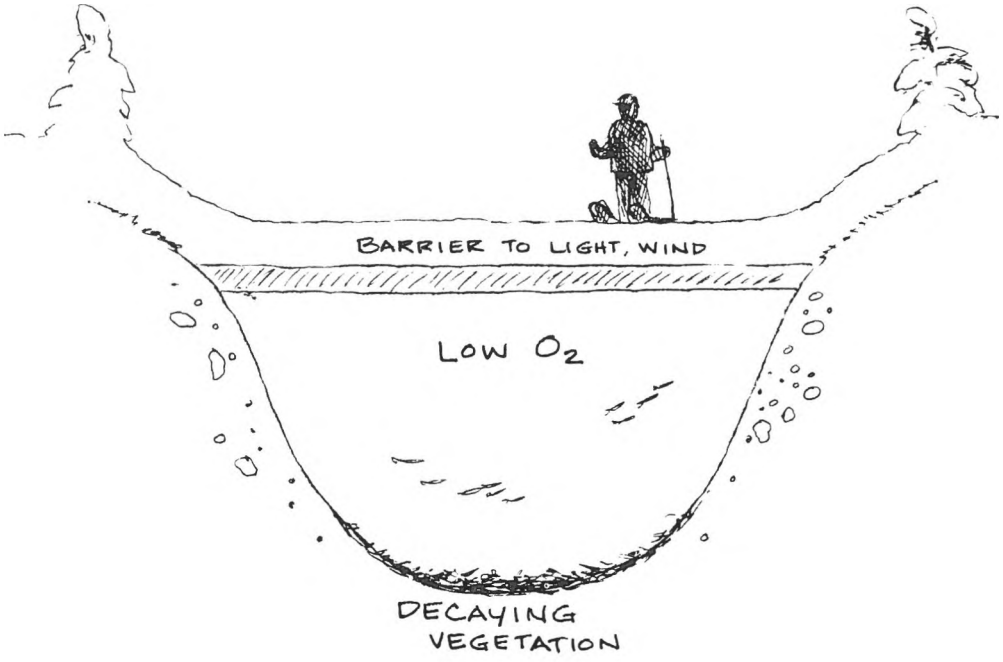


Figure 7. Cross-section of pond in winter.

TESTING WATER QUALITY

Most waters in Maine contain no chemicals that are harmful to fish. A one-time examination for pH, alkalinity, and conductivity should be sufficient unless a problem is detected. It may, however, be desirable to be able to routinely test for dissolved oxygen. Do- it-yourself test kits (Figure 8) are available from some of the suppliers listed in Appendix 8.

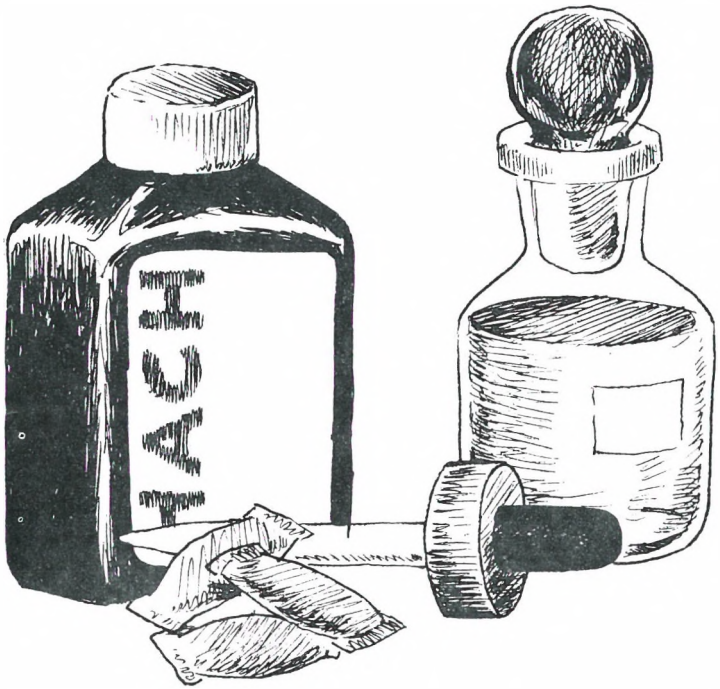


Figure 8. Water quality test kits.

HOLDING AND REARING FACILITIES FOR LIVE BAIT

There are a number of options for holding baitfish until they are needed for sale. Ponds, both artificial and natural, are most common, but cages and raceways are also used. Each method has advantages and disadvantages as will be discussed in the following sections. Prime factors to consider in deciding how to rear baitfish are the species of fish you want to raise and their biological requirements. The needs of a particular fish species for oxygen, temperature, and pH, and how well you are able to monitor and control these conditions, will influence your success.

POND CULTURE

Several bait species are well suited to small pond culture. The golden shiner is a prime example. In 1987, 90 percent of Maine live bait dealers carried golden shiners in their inventory and many sold this species exclusively. Golden shiners, fathead minnows, and common suckers, perform very well in small ponds.

How you manage your ponds will depend on whether you capture wild stock each year, or rear brood stock. Your ability to manipulate water levels within your ponds will depend on whether the pond is natural or artificial.

POND LOCATION

As in any business, an analysis of the potential market should be done before investing in a new venture. It does not make good sense to build your bait pond in an area where anglers don't use live fish for bait or where there is already a well-established bait business. Close proximity to the market area will simplify transportation and storage, and allow easy customer access.

After the geographic area of your bait business is determined, you need to find the best site for your pond. The most important thing to consider is water: where does it come from, how suitable is it, how much is available, how much is needed, and where will it go?

Water can be obtained from ground water, surface run-off, nearby streams, or a combination of these. All potential sources of water should be tested for dissolved minerals, pH, and dissolved oxygen. Appendix 4 lists several places in Maine where water quality analysis may be obtained. Treatment to improve water of poor quality is possible but usually very expensive.

Ground water, in the form of wells or springs, is often excellent quality water but can be expensive and unreliable if it needs to be pumped. Ground water is also low in dissolved oxygen and may need to be aerated before use.

A water supply from surface run-off is dependent upon adequate precipitation, and as such it should never be the sole source of water for a fish pond. Surface run-off is also more likely to be contaminated with agricultural fertilizers, sprays, or animal manure, all of which may cause problems with fish rearing.

Lakes, ponds, and streams often provide the best source of water for an aquaculture operation. The amount and quality of this water is usually constant because the sources are a mixture of ground water, precipitation, and run-off. Water from lakes, ponds, and streams usually has a slightly acidic pH, adequate

dissolved oxygen, and a low to moderate natural fertility. These qualities may vary if the watershed includes active farmlands, old dumps, industry, or communities without adequate sewage treatment. A notched weir can be used to measure the flow of water in a stream to determine if it is adequate for your needs (Appendix 5).

Soil type will also have a major effect on the suitability of your property for pond construction. A gravel or sandy soil may not hold water, and you may end up with a dry hole or greatly fluctuating water levels if you try to put a pond in such soil. A good pond usually has a clay-loam, silt-loam, or sandy-loam soil and a high water table. Ponds on sandy soils can be made to hold water with a plastic liner, but this is very expensive and the pay-back time may be excessive. More information on soil suitability for pond construction, sealing leaking ponds, and other topics can be obtained from your local SCS office (Appendix 4).

The ease of maintaining water quality is also an important consideration in choosing a site for your pond. Avoid areas that receive contaminated run-off from highways or agricultural lands, and areas that are adjacent to crops that are sprayed with fertilizer or pesticides that may drift into the water.

A final factor to be evaluated may be the presence of potential predators, such as fish-eating birds, turtles, and mammals, including people.

POND SIZE

The size of the pond you build will also depend upon a number of factors. If this is a new venture and you are unsure of how much to invest until you try it out, then a small pond, constructed with room for expansion, is a smart way to begin. Obviously, a larger pond will hold more fish but large ponds also can be difficult to manage. Several small ponds (or raceways, or pools) are easier to control. It is easier to grade fish by size, harvest the fish, control water levels, treat disease problems, and manage feeding and fertilizing programs in smaller ponds. More ponds will require a higher initial investment (water control devices, inlet pipes, and other equipment) but in the long run will prove to be more satisfactory than one large pond.

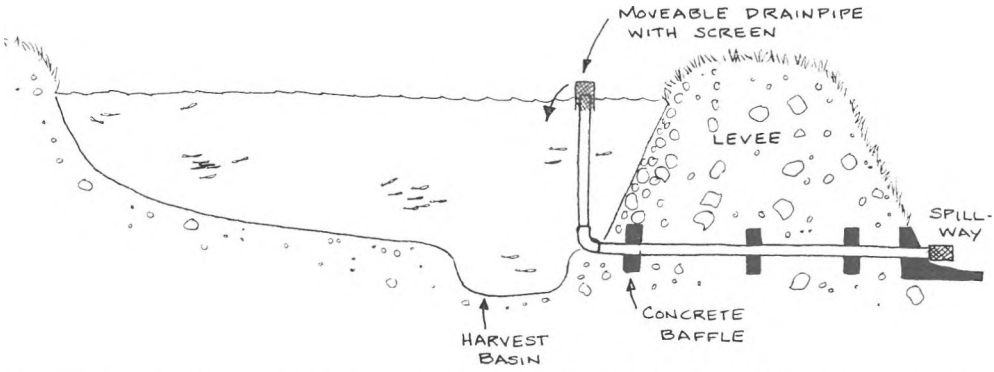


Figure 9. Cross-section of pond showing harvest basin, moveable drainpipe, and outlet pipe baffle.

The ponds should six to eight feet deep. Ponds that are circular or rectangular, and have a smooth bottom, are easier to work in and around than ponds with irregular shapes. The sides of the pond should have a 2:1 to 3:1 slope. Steep sides discourage the growth of aquatic vegetation that can take over a pond. Vegetation can deplete a pond of needed fertility, and it can also offer hiding places for predators such as mink, raccoon, and otter. Diving beetles, which can prey on small fish, also use vegetation for hiding cover and reproduction. During the winter, decaying vegetation can rapidly deplete dissolved oxygen and lead to winter-kill of your fish.

WATER LEVEL CONTROL

To adequately manage your fish pond, you must be able to adjust the water level. Ideally, you should be able to remove all or most of the water when it is necessary to take fish out or to clean the pond bottom. In an artificial pond, a drawdown mechanism can be built into the dam or dike. This can take the form of a pipe or series of planks that, when adjusted, raise or lower the water level. The pond bottom should slope toward this outlet so that, when fully drained, the pond has only a small area of water remaining , in front of the dam, where the fish will collect (Figure 9). The pond should have a well engineered spillway to carry off unusually high water so that the main dam is protected from washout. The pipe that goes through the dam should have a large baffle fastened to it to prevent water from passing outside the pipe and causing a washout along the pipe. The Soil Conservation Service (Appendix 4) has plans for several different methods of pond construction and water level management. Anyone contemplating such a project should get in touch with their SCS representative.

EXISTING PONDS

If you already have a pond on your property that you wish to use to rear bait, you may have a different set of problems with which to deal. It may not be feasible to drain a natural pond, so you will have to devise other methods of harvesting your fish (see section on methods of capturing wild bait). You may also have shallow areas that will need dredging to remove vegetation, dead

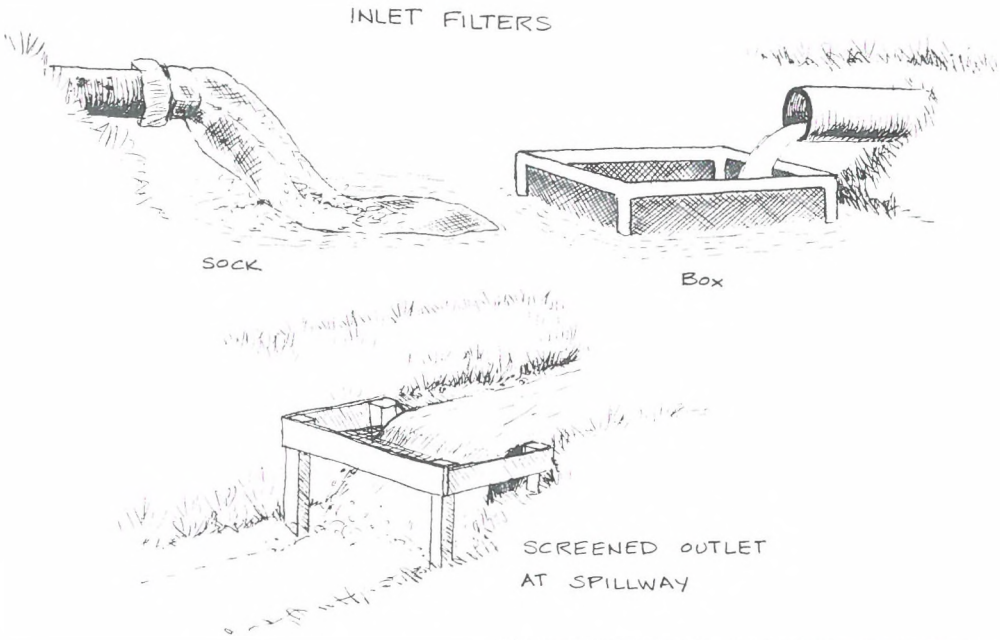


Figure 10. Inlet/outlet pipes with screens/filters.

timber, or stumps. However, with a natural pond you can eliminate many of the costs associated with new pond construction, and this may well offset the disadvantages already mentioned.

It will be necessary to remove all existing fish from your natural pond before you put any baitfish into it. This may be done by draining the pond or if that is not possible, by killing the resident fish with rotenone. Rotenone is very effective when used correctly, but be sure you contact the Maine Department of Environmental Protection before you proceed. When using any chemical in a private pond, great care must be taken to ensure that none escapes into other waters. Rotenone remains toxic for varying lengths of time depending on water chemistry and temperature. It generally would not be considered safe to discharge treated water into public waters for several months after using this chemical.

You will also need a permit from the Maine Department of Inland Fisheries and Wildlife if you are stocking your natural pond with a fish species not native to the drainage in which the pond is located. You also need to install fish screens (Figure 10) on any pipes or ditches leading to and from your ponds so that fish cannot pass in either direction into public waters.

CAGE CULTURE

Many aquaculture operations are now using cage culture to rear salmon and trout, especially in salt water. These cages are usually made of nylon netting and are attached to floating rafts in deep water. For baitfish, cages are most often used for holding the fish, but can also be used for rearing (Figure 11). Cages eliminate the problem of recapturing your fish from the pond, reduce feeding costs (because less food is wasted), reduce predator losses, simplify disease control

and treatment, and eliminate the need for water level control. However, cage culture also has its disadvantages. The small size of most baitfish requires fine mesh netting that may need frequent cleaning to remove algae and fish wastes. Cages also crowd fish, making them more susceptible to stress and disease, and constant monitoring is needed to deal with losses as soon as they occur. Such high intensity rearing, in standing water, can rapidly deplete dissolved oxygen levels, and result in die-offs of fish. Fish wastes and uneaten food may accumulate in the vicinity of such cages, and a waste treatment program may have to be developed.

Cages can be of different sizes depending upon their intended use. A large floating cage, six to eight feet on a side, can be used to hold many hundreds of fish without undue crowding. Smaller cages, about three feet on a side, can be used during the retail season so that fish can be quickly obtained for customers as needed.

Cages can be made of nylon net (inexpensive but tears easily), or plastic wire mesh (moderate cost and good durability). Galvanized wire is not recommended because of possible problems with zinc toxicity and abrasion.

Winter conditions can offer special problems in cage culture. Either the water must be kept open, or the cages removed from the pond for the winter. Some fish culturists allow the cages to freeze into the pond and then, when the ice is thick enough, build a small shelter over the door in the top of the cage so that fish can be removed as they are needed. Each situation will require its own solution to winter problems.

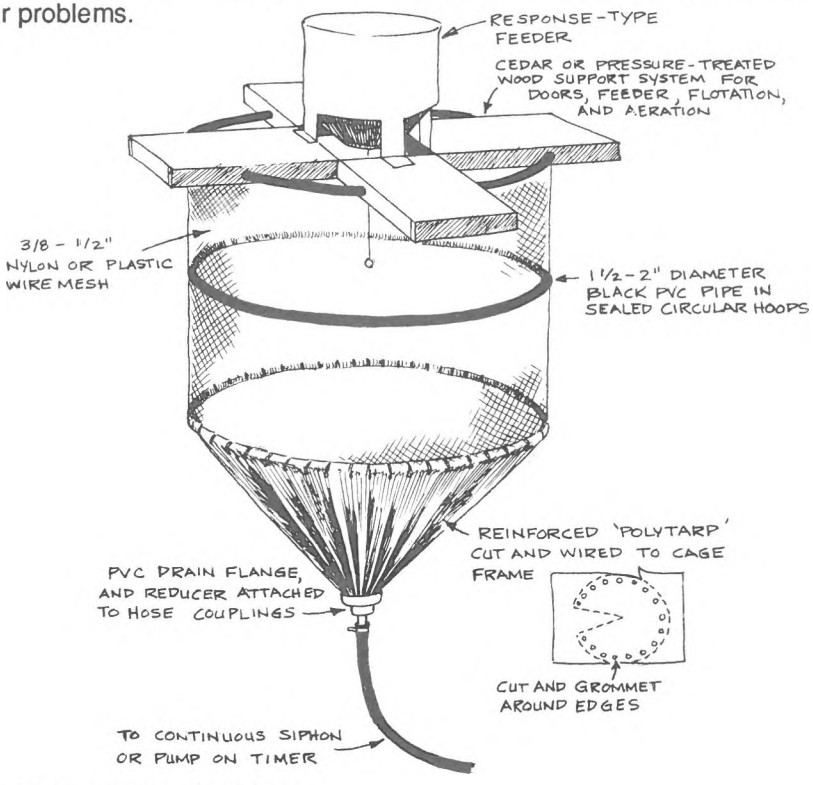


Figure 11. An example of a fish cage.

RACEWAYS AND POOLS

Raceways (Figure 12) may be circular or rectangular pools constructed of earth, wood, concrete, metal, plastic, or fiberglass; temporary raceways can be made out of sheet plastic. Plastic or fiberglass swimming pools can be a cost-effective alternative for holding and rearing baitfish, but use caution with new pools because some plastics need to be stabilized, aired, or aged to eliminated toxic effects.

Usually, water flows into one end of the raceway or pool and out the other, but recirculation systems can be designed as a practical alternative, especially in pools. Sometimes several raceways may be arranged end-to-end so that the same water can be used many times over. Raceways can be set up outside and left uncovered (but predation may be a significant problem), outside with a roof and screened sides, or inside a building. Indoor raceways are more easily managed in all types of weather but building construction may be very expensive. Greenhouses are an excellent alternative.

Most commonly used in trout and salmon culture, raceways can be adapted to holding baitfish where a pond would not be feasible or where easy access to the fish is desirable. If this method appeals to you, you should consult a hatchery expert for advice on size and shape of the raceways, required water volume and rate of flow, and waste management techniques (see Appendix 4).

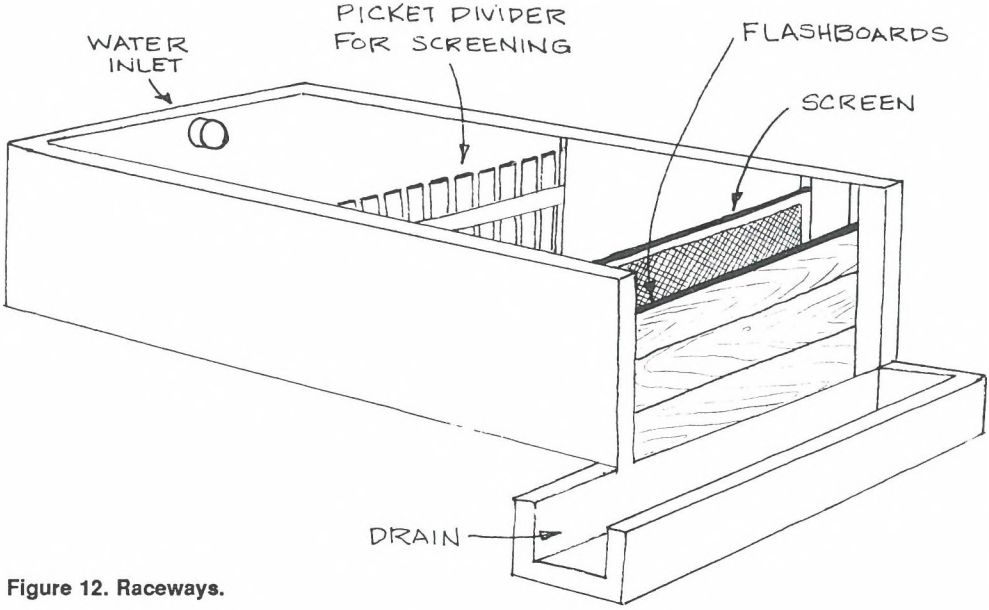


Figure 12. Raceways.

GRADING FISH

CONCRETE RACEWAY

Whatever type of rearing or holding system appeals to you, you should be prepared to grade (sort by size) your fish. They will perform better, and sell better, if they are kept in at least three separate size groups; small, medium, and large.

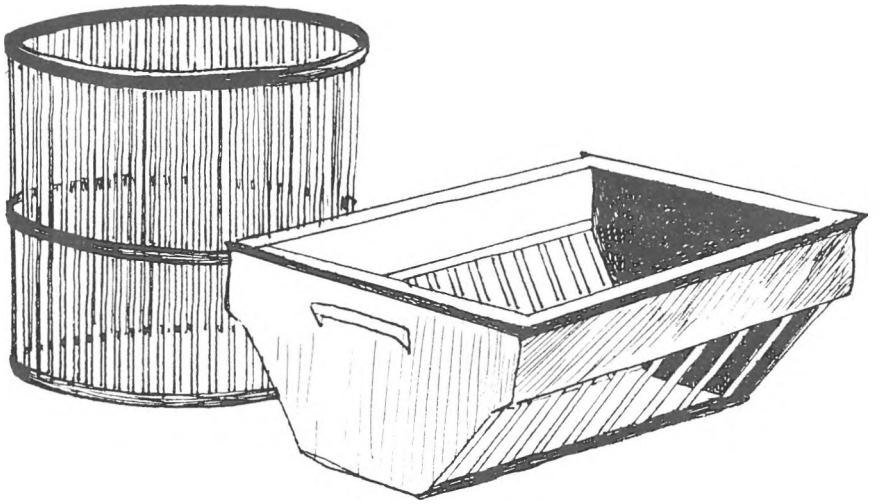


Figure 13. Graders.

There are a number of ways to grade fish but they all consist of an arrangement of evenly spaced bars that allow fish of a certain size to swim through while larger ones are held back (Figure 13). The bars can be formed into a basket into which all the fish are placed, the small ones swim out through the sides, and the large ones are retained in the basket. The bars can be made into a screen that is placed across a raceway; the small fish will swim toward the head of the pool and larger ones will be retained behind the screen.

MAINTENANCE AND STORAGE OF SUPPLIES AND EQUIPMENT

Some type of building for storage of feed and equipment is essential to all operations. The building need not be elaborate but it should provide a dry, rodent-free place for the feed, and it should be large enough for all the seines, buckets, aerators, boots, dip nets, and other equipment that you will accumulate. You should have separate nets for each of the ponds in your business. This will reduce the likelihood of moving diseases or parasites from one place to another. If your operation depends on electricity (to run pumps, aerators, or other essential equipment), you may want to consider having a generator on hand in case of electrical failure.

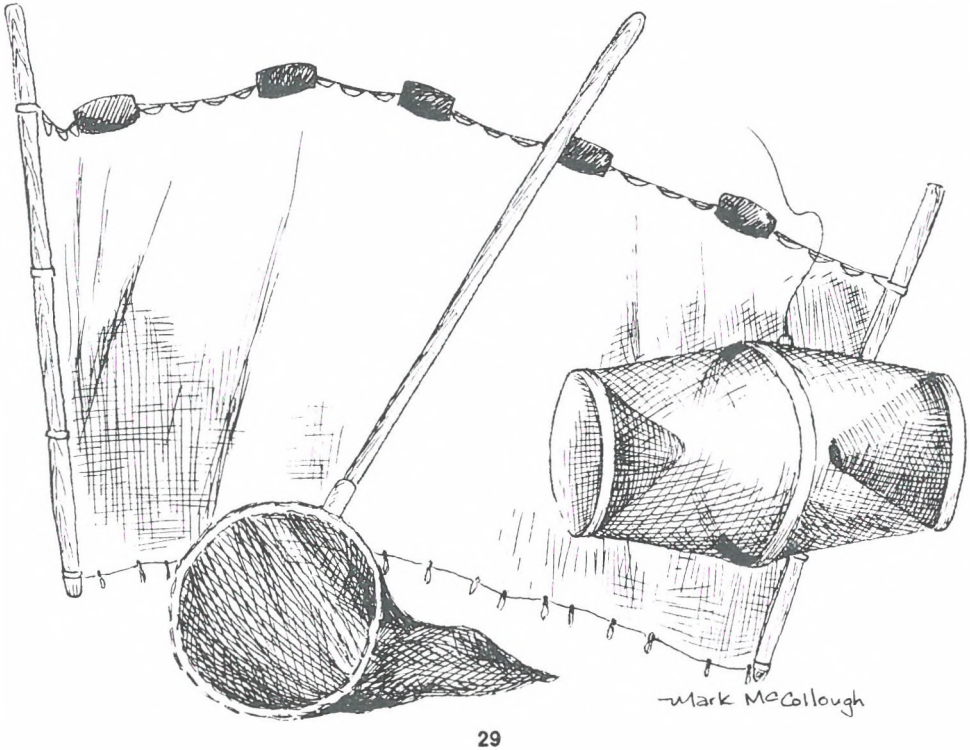
You should also have spares of essential equipment so that a mechanical failure will not put you out of business.

METHODS OF CAPTURING WILD BAIT

The baitfish farmer may want to capture wild bait for two reasons: (1) to obtain brood stock for production purposes; or (2) to obtain a supply of bait to be held until it can be sold. In the first instance, trapping should be done in the spring before the fish have spawned in the wild. In the second, trapping is best done in the fall, when the wild-produced fish have grown to bait size and the water has begun to cool, but before freeze-up. Smelt dealers usually net or angle their bait through the ice on winter evenings during the ice fishing season. They may also angle for smelts or net them on the spring spawning runs for use during the open water season.

Baitfish, by law, may be captured with a seine no larger than 1,200 square feet, a baitfish trap no larger than 50 cubic feet, a dip net, a drop net, a bag net, or by hook-and-line. Smelt dealers may use any of these methods except a seine.

The best method to use depends on the area to be harvested, the availability of equipment, and the operator's own personal experience and preference. No matter what method is used to capture bait, great care should be taken to avoid injury and stress to the fish, both to those kept for bait and to those not wanted and released. It is illegal to kill unwanted fish as part of a bait-taking operation. Although a state law prohibits the placement of bait or food into the water to attract sportfish, it is permissible to use such methods to attract baitfish into a trap or into an area to be netted. Some people use bread, pet food, egg shells, meat scraps, or their own "secret" recipe to attract fish into their nets. Baitfish can also be taken in unbaited wire traps in some situations. All of these methods have merit, and experimentation will tell you which is best for you.



If the fish are netted, they should be very carefully transferred from the net to holding or transport tanks; they should not be smothered by overcrowding or debris in the nets, or be held out of the water any longer than necessary. Poor handling, and the resulting stress and diseases problems, may be the biggest cause of baitfish loss. It is also very important to sort wild-caught fish to make certain that any non-bait species are released and not taken back to the place of business where they may become predators on the bait. Possession of non-baitfish in a bait business may result in a fine.

TRANSPORTING BAITFISH

During transport, tanks used to hold fish must be aerated or supplied with oxygen to avoid suffocating the fish (Figure 14). The tanks should also be covered to prevent loss of water and fish from spillage, and in warm weather it may be necessary to add ice to avoid overheating. The addition of salt to the water will reduce ammonia build-up during transport.

When moving fish from one area to another, care should be taken to avoid any sudden change in water temperature. If a pond is at 50°F when the fish are caught, the transport tanks and the ultimate home for the fish should also be at 50°F. If the recipient water is at 60°F, then the fish should very slowly be brought up to the same temperature by the gradual addition of warm water to the transport tanks before being transferred. If, during transport, it becomes necessary to change the water in the transport tanks, great care should be taken to avoid placing fish or fish eggs into any public water.

If captive bait are to be moved from one pond to another, or if they are to be moved from a rearing area to a retail site, they should be deprived of food for at least 24 hours before handling. This will decrease the amount of excrement, ammonia, and $C0_2$ in the transport tanks, thus lowering the amount of stress on the fish. After bringing bait into your facility, they should be allowed to acclimate for about 24 hours before you grade or otherwise handle them. They will be easier to handle and less susceptible to stress after this breaking-in period.

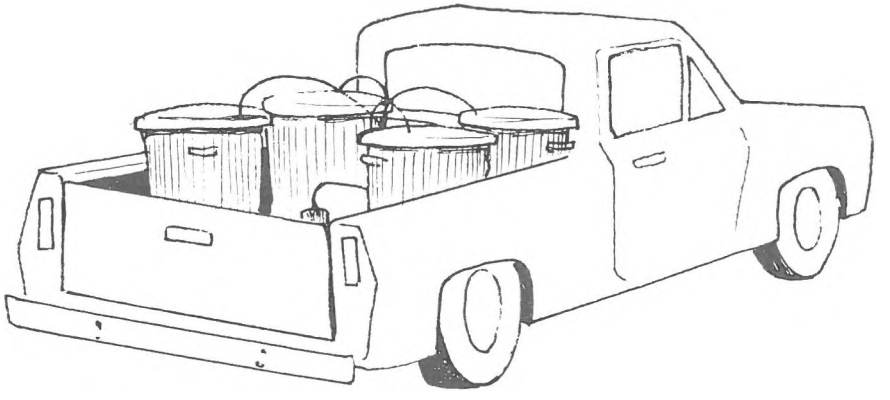


Figure 14. Truck with aerated barrels.

Before putting newly captured live fish into your bait operation it makes sense to give them a prophylactic disease treatment to prevent the introduction of disease into a healthy fish population. Exercise great care with this, however, because you don't want to stress the fish any more than necessary or kill them with an improper dosage. Refer to the section on disease prevention for more information. Wild baitfish can survive a very long time in captivity without feeding. However, if captured early in the fall and held in warm water, they may require some feeding to keep them from using up their reserves. Feed baitfish commercially prepared food (Appendix 8) as long as they will eat it. Do not over-feed because this is wasteful and may cause water quality deterioration.

UNDER-ICE HARVEST

It is very difficult to capture baitfish in the winter in Maine. Most waterways are frozen, and cold air temperatures are stressful when fish are transferred from the water to a truck or bait pail.

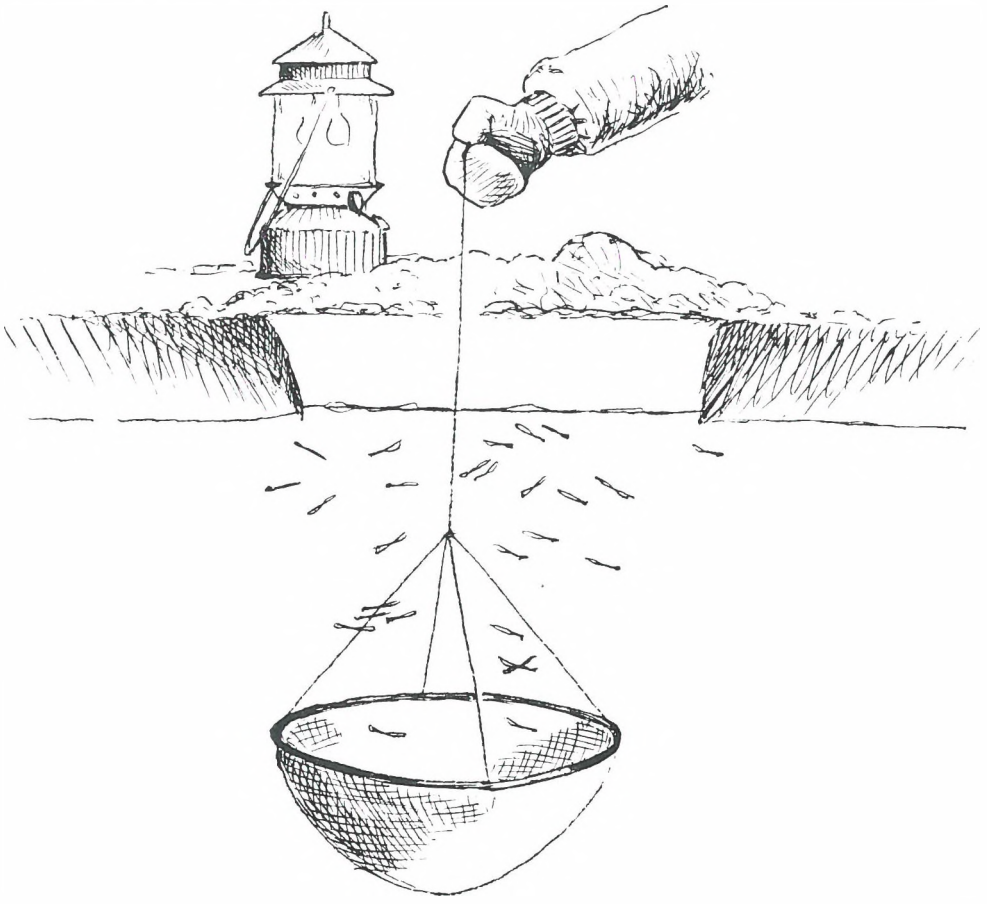


Figure 15. Drop net for capturing baitfish under ice.

Much of the live bait harvested in Maine is captured in the fall, when many minnow species congregate into overwintering schools. If a place where the fish concentrate can be located, it is fairly easy to trap or seine a supply of bait. If it is necessary to replenish low reserves during the winter, large, baited minnow traps can be lowered through the ice. These can be suspended at different levels under the ice until the depth at which the fish are congregating is located. Sometimes it is best to place the traps right on the bottom, but as winter progresses, the deeper areas of the pond may become low in dissolved oxygen forcing the fish to move nearer the surface.

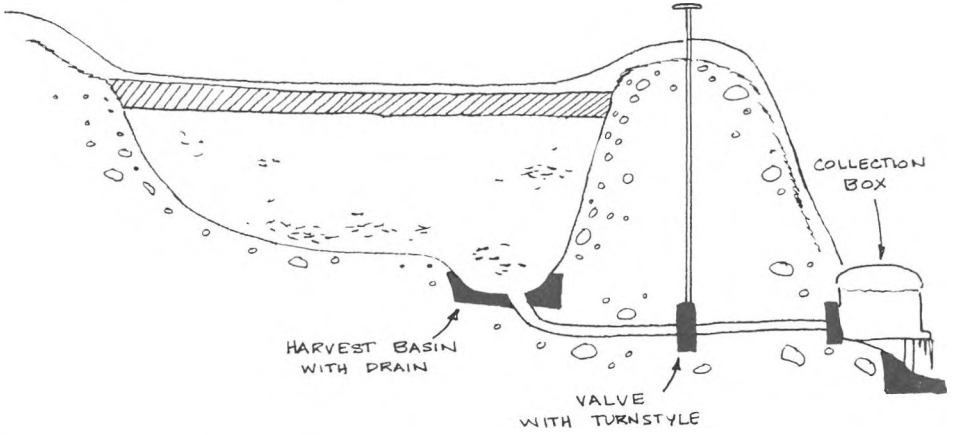


Figure 16. Drain and collection box outside of pond.

Baitfish can also be taken through the ice with drop nets (Figure 15). These nets are usually circular and constructed of a rigid, or semi-rigid, hoop covered with small mesh netting. A rope bridle completes the net that is lowered through the ice below the depth where bait fish are thought to be. The fish are then attracted to the area with a lure (a bright light, pet food, egg shells, or other bait, etc.) and the net rapidly retrieved when the fish are congregated over it.

It is possible, though difficult and not often productive, to pull a seine under the ice if you have a small shallow pond with a smooth bottom. Another solution would be to construct a pond drain system that would flush fish out from under the ice into a collection box downstream (Figure 16).

POND FERTILIZATION, FEEDS, AND FEEDING

In Maine, especially in newly constructed ponds, fertilization may not be necessary. Location, soil type, and intensity of management will affect the need to fertilize. If fertilization is found to be necessary, the following information can be used as a guide.

GOLDEN SHINER AND FATHEAD MINNOW

FERTILIZATION

The objective of fertilizing a pond is to establish a bloom of phytoplankton (minute floating plants) to provide natural foods for shiners and minnows, and to shade out aquatic weeds. The initial bloom should be dense enough to obscure a Secchi disk (Figure 17) held at 12 to 15 inches below the water surface. When the bloom begins to fade, more fertilizer can be added or, if there is a pond nearby with a good bloom, water can be pumped over to "seed" a bloom. Care must be taken to avoid transferring fish while pumping water from one pond to another; if diseases, parasites, or undesirable fish are present, seeding should not be done. This degree of bloom should be maintained until the fish are one inch long and be discontinued during hot weather. The bloom should then be allowed to fade to a Secchi disc reading of 24 inches by adding fresh water and reducing the amount of fertilizer. This 24-inch reading should be maintained throughout the growing season. Be careful not to lower the DO by over-fertilizing. Constant monitoring should be done until conditions stabalize.

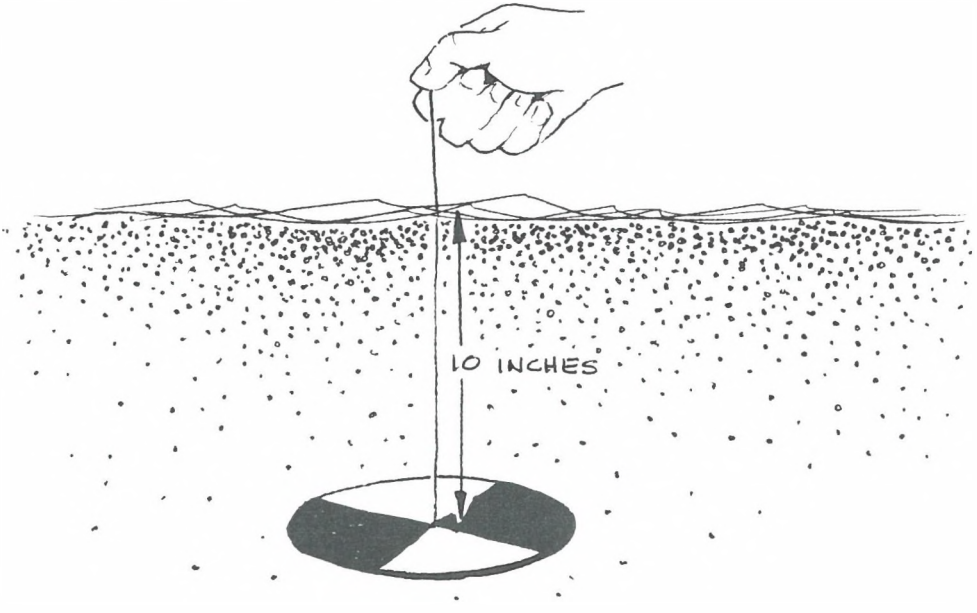


Figure 17. Secchi disk.

A combination of organic and inorganic fertilizers can produce good fertilization at less cost than inorganic fertilizer alone. Organic materials such as barnyard or poultry manure, dried hay, or corn meal can be used. Depending on the rate of water flow through, organic materials should be applied at 400 to 1,000 pounds per surface acre along with 100 pounds per surface acre of 16-20-0 or 10-20-0 inorganic fertilizer. If inorganic fertilizer is used alone, about 200 pounds per surface acre of 16-20-0 is required to produce a bloom. Some researchers and producers have obtained good results by spraying liquid fertilizer on the pond surface. This results in more phosphorus becoming available to pond organisms, rather than being retained by bottom soil.

STARTER FEED

Starter feeds generally have more protein, are more complete in nutrients, and are smaller in diameter than grower feeds. They should be ground flour-fine (may require double milling), made into a slurry, and fed on all sides of the pond to ensure that all fish receive food. Initially, the fish are overfed and the excess feed serves as fertilizer to produce natural food organisms. After about three weeks, the fish should be switched to grower or larger-sized feed.

GROWER FEED

Grower feed is more coarsely ground, has a lower protein content, and is fed by throwing dry feed along the upwind side of the pond (Figure 18). When formulated as a meal, extra animal fat must be added to hold the meal together and make it float. Extra fat is not required in pelleted feed.

Figure 18. Feeding fish by hand.

Research on the use of heat-treated full-fat soybeans in minnow feed shows promise. The soybeans are heated for four minutes at 375°F to 400°F to destroy growth inhibitors. Whole soybeans contain 38 percent protein and 18 percent fat, and the fats contain essential fatty acids and serve as an energy source. No additional fat is needed to make it float. Commercially prepared fish food can be purchased from several sources; a partial list of these is presented in Appendix 8.

INTENSIVE CULTURE OF GOLDEN SHINERS

Two hours after feeding, the downwind side of the pond should be examined for uneaten food. The amount of food given should be adjusted to that which can be eaten in two hours. Leftover food will decay and may cause problems with low oxygen levels and excessive algal blooms.

As the shiners grow, increase the amount of food. By feeding smaller amounts, several times a day, the food will be more completely utilized and the growth rate of the fish may increase. A heavily stocked pond with an adequate water supply may use 40 pounds of feed per acre per day.

If feed formulas are changed, mix the old and the new together for a few days until the fish become accustomed to the new formula.

INTENSIVE CULTURE OF FATHEAD MINNOWS

Start feeding the fry while they are still in the brood pond. A combination of starter feed (for the fry) and grower feed (for the brood fish) can be used to ensure that all fish obtain adequate food. After transfer to rearing ponds, continue to give starter feed until the fry are about 0.75 inches long. Change to pelleted grower feed by mixing four parts pellets to one part starter until you observe the fry eating the pellets, then use only pellets.

Pellets are not eaten whole but are nibbled on by the minnows. Place them in little piles, near shore, on all sides of the pond and adjust the amount of food given according to what is eaten in two hours.

WHITE AND LONGNOSE SUCKER

FERTILIZATION

Most natural ponds will produce enough water fleas to provide food for all the suckers in a pond, making fertilization unnecessary. When chironomid-fly larvae are their main food, suckers appear to grow faster and more consistently. Fertilization with barnyard manure or dried sheep manure will increase the number of chironomids in the bottom mud. Commercial, inorganic fertilizers should be used sparingly because the phosphorus tends to produce algal blooms that may result in oxygen depletion and fish mortality.

ARTIFICIAL FOODS

During the summer, you can use artificial foods such as dry soybean meal to increase the growth rate of suckers. Broadcast the meal into shallow water along

the upwind side of the pond. Feeding will occur after the meal sinks to the bottom. Feeding should begin in June, three to four weeks after stocking the fry. The amount of food eaten will vary with the type of pond and the weather. In farm ponds, supply a maximum of five pounds of feed per acre per day. In hatchery ponds, supply up to 10 pounds per acre per day in June and July, and 20 pounds per acre per day in August. During the hot months, there is a danger of oxygen depletion, sometimes detected by observing fish swimming near the surface in early morning. If this occurs, flush the pond with fresh water and stop feeding until normal behavior resumes.

RAINBOW SMELT

Rainbow smelt have been fed on artificial diets, but they must have natural foods for at least the first month of life. These foods may occur naturally in the pond or may be obtained from a lake or pond and added to the raceways or tanks.

(See section on culture of rainbow smelt)

Figure 19. Removing weeds from pond.

AQUATIC WEED CONTROL

Although it may be aesthetically pleasing to have a few cattails on the edge of your pond, it is undesirable to have vegetation in a pond geared for maximum fish production, except as noted in the section on golden shiner spawning. Pond weeds can contribute to overwinter mortality because dead plants, decaying on the pond bottom, use up oxygen that fish require for respiration. In hot summer months, excessive plant life can also contribute to fish kills because, during the night, plants use, rather than produce, oxygen. If the pond is shallow and warm, the activities of plant respiration can lead to critically low oxygen levels in the early morning hours before dawn. Aquatic vegetation can also reduce fish production by using nutrients required for production of fish flesh. Plants can affect fish harvesting efforts by blocking pond drainage systems and interfering with seining operations. Finally, plants offer breeding and hiding places for predaceous aquatic insects and other predators that may feed upon or compete with your fish.

Control of aquatic vegetation must begin at the start of a pond construction project. Plants may become established from seeds or parts brought in with run-off or inflow from streams. The sides of the pond should be very steep with a depth of at least two to three feet close to shore. Aquatic plants have difficulty taking root in water deeper than three feet.

If plants become established, you can control them by pulling or raking, either by hand or with a drag line (Figure 19). If the pond is suitably constructed, the water level can be lowered during the fall, plant remains removed, and the pond bottom left exposed over winter.

Cattails can be controlled by increasing the depth of the water and cutting the plants off below the water surface every two to three weeks. This will starve the root systems and, if done consistently, can eliminate cattails in one growing season.

The use of aquatic herbicides is not recommended. They are often difficult to use and can be dangerous to both the applicator and to the fish. If a decision is made to use herbicides, it may be necessary to get an application permit from the Maine Department of Environmental Protection and to obtain an applicator's license from the Pesticide Control Board. You should remember that if you kill vegetation in a pond, and that vegetation remains in the pond to decay, the decay process will use dissolved oxygen in the water and may contribute to a fish kill. The use of aquatic herbicides must be considered a stop-gap measure, the vegetation will usually quickly reappear and another treatment will be required.

DISEASES AND PARASITES OF BAITFISH

Prevention is the best approach to disease and parasite control in your baitfish operation. In nature, disease organisms are common but fish showing symptoms are rare. Fish in captivity are more susceptible to disease and parasites because they are subject to stresses, such as crowding, that make them more vulnerable to infection.

Early detection and prompt treatment of a problem are important to increase chances of recovery. Sick fish (Figure 20) weaken rapidly and a treatment that is successful one day may not be effective the next. Treatments that depend on using medicated foods must be started early because sick fish often stop feeding and become difficult to medicate. Illness may be caused by disease or parasites, poor water quality, injury, or poor nutrition. There are a number of behavioral symptoms that can signal problems:

- refusal to eat,
- scratching or rubbing against objects in the pool,
- swimming weakly, lazily, erratically, or in spirals,
- twitching, darting, or convulsions,
- failure to flee when frightened,
- crowding together or gathering in vegetation, shallow water, or at water inflow site,
- hiding from light,
- "gasping" at water surface or floating head-up.

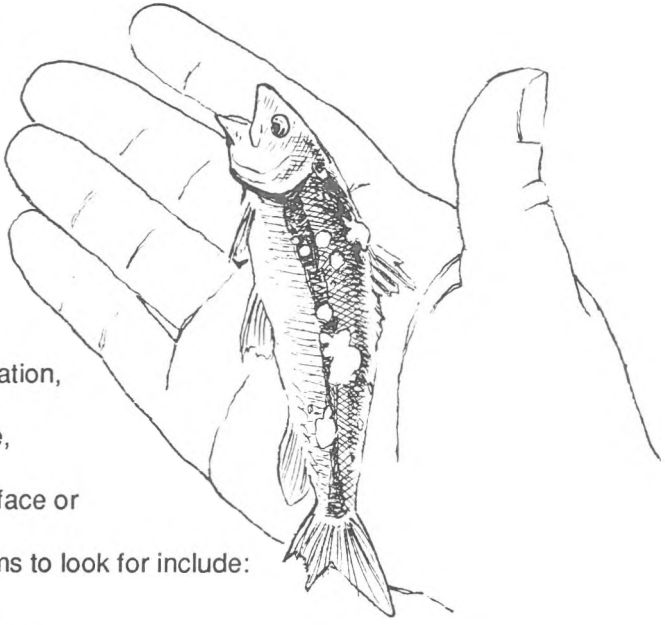


Figure 20. Example of a sick fish.

Some physical symptoms to look for include:

- dead or dying fish,
- open lesions or sores,
- bloody or reddened areas,
- gaping mouth,
- scale loss,
- gills pale, eroded, puffy, bloody, or brown,
- gill covers flared,
- pale skin color,
- bulging eye balls (popeye),
- white spots, nodules, or pustules,
- white patches,
- frayed or eroded fins or tail.

If you detect any of these symptoms, start looking for causes. Examine fish for obvious lesions, discoloration, or growths. Examine pond, pool, or trough water for siltation, temperature, or chemical problems. If this doesn't yield clues,

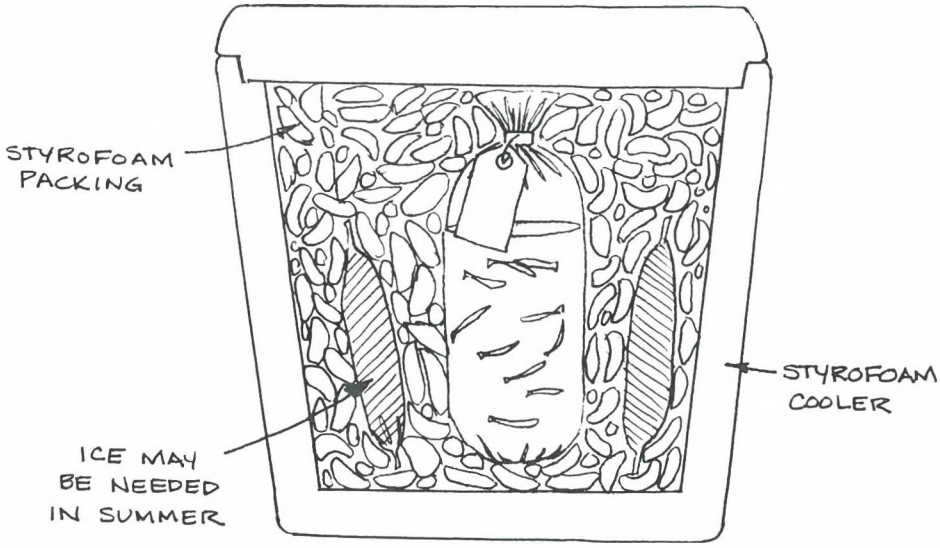


Figure 21. Packing fish for transport to lab.

examine fish for microscopic lesions and parasites. Some diseases and parasites can be readily identified by the lay person, but for many it will be necessary to take or send a sample of fish to a pathologist (see Appendix 4) for diagnosis.

When submitting a sample of fish for diagnosis, include about 10 fish, some apparently healthy, some just beginning to show symptoms, and some with the most obvious symptoms. Live fish are preferred because dead fish are very difficult to diagnose. Transport them in containers of sufficient size to provide good water quality and abundant oxygen. Check with the diagnostic lab for their suggestions on recommended shipping methods (Figure 21). Include your name, address, phone number, and information on:

- species, number, and age of fish submitted,
- description of behavioral and physical symptoms,
- number of fish with symptoms, and rate and duration of die-off,
- water source, temperature, pH, dissolved oxygen concentration, condition of algal bloom, fertilization history, and ammonia, nitrate, and nitrite concentrations
- area and depth of pond or tank, and recent management history,
- type of feed used, frequency of feeding, feeding response of the fish,
- previous diseases and treatment,
- pesticide or herbicide use in the area,
- recent or excessive stresses, such as handling, shipping, or changes in water quality.

PREVENTING DISEASE AND PARASITE INFECTIONS

When moving fish, adequate oxygen, proper temperature, careful handling, and prompt release (after balancing temperature and pH) will help reduce fish

loss. Keep your fish healthy by maintaining water quality and ensuring adequate nutrition.

Temperature, dissolved oxygen, and ammonia concentration are three water quality considerations. Careful and continuous monitoring of water quality not only helps prevent problems but can give you clues to the cause of problems that do occur.

Nutritional deficiencies are relatively rare when good quality, properly stored feed is used.

Overcrowding and handling are two sources of stress that can be controlled to minimize adverse effects on your fish. Bacterial gill disease is one of several baitfish problems that can be brought on by stress. Although density of fish in the pond, pool, or tank will depend on biological and economical considerations, in general, lower densities mean fewer problems (Figure 22). Avoid handling your fish whenever possible, but when you have to, do so gently and efficiently. During summer months, hot weather is particularly dangerous, so if you must handle the fish do so in early morning, late evening, or on cool and cloudy days. Fin diseases are particularly troublesome in warm weather.

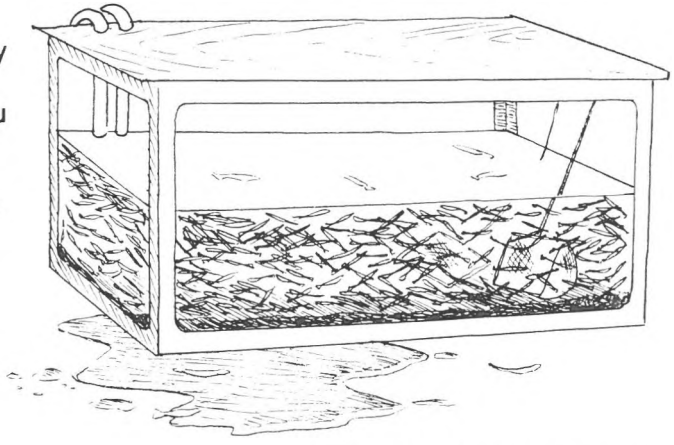


Figure 22. Tank overstocked with fish.

Disinfecting ponds, troughs, and equipment will help to prevent the spread of disease and parasites from one body of water to another, and prevent the build-up of disease organisms. Nets should be cleaned, using a disinfectant such as chlorine bleach, lime water, or dilute formalin, and sun-dried after use. Washing with soap and water is generally adequate for food and fish containers, equipment for testing water quality, and hands and clothing of workers. Separate sets of gear for each area of your operation will help prevent the spread of contamination among rearing facilities.

When designing your baitfish operation, you may want to incorporate features that will assist you if you have to treat your fish or control disease organisms. Being able to drain ponds and shut off the inflow and outflow of water will make treatment easier and more effective.

METHODS OF TREATMENT

There are four basic treatment methods used to prevent and control disease organisms in captive fish; each is described briefly. The references listed in Appendix 6 and the advice of a fisheries pathologist (Appendix 4) are recommended for more specific instructions. Note that many of the chemicals used to treat baitfish cannot be used to treat food fish. Seek the advice of a professional before chemically treating a disease problem.

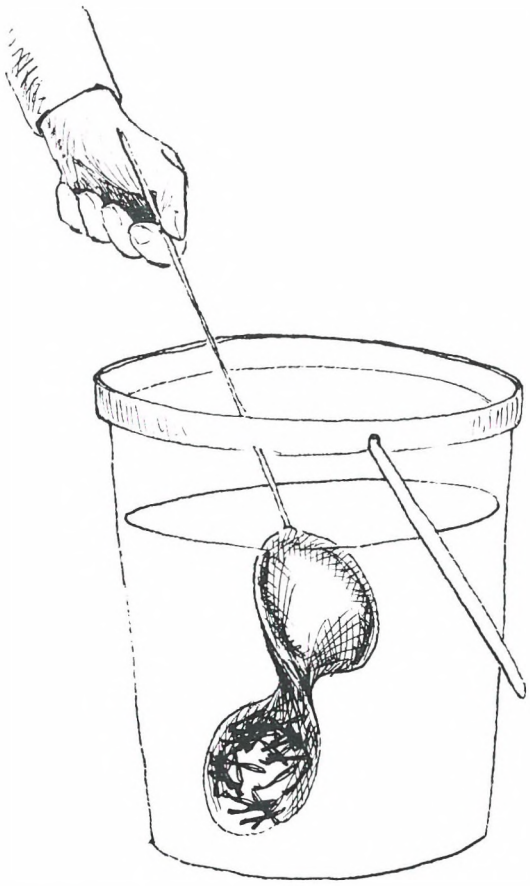


Figure 23. Treating fish by dipping

FLUSHING

This treatment method is most efficiently applied in troughs or raceways.
A drug of known strength is added to the upper (inflow) end of the trough and allowed to flow to the lower (outflow) end. The rate of replacement with fresh water will vary depending on the treatment solution and the length of time the fish need to be exposed to the chemical.

DIPPING

Dipping involves capturing the fish, immersing them in a concentrated solution of the treatment chemical, and then releasing them to clean water (Figure 23). Care needs to be taken to avoid overexposure to the treatment solution, to maintain adequate oxygen levels, and to maintain the temperature of the treatment solution to within 4°F of that of the water in which the fish are being held.

An example of this type of treatment is the use of salt as a preventative measure or as a treatment to control certain external parasites and fungi. The first step is to prepare a three percent solution of salt in a large container of water (see Appendix 9). Using a dip net, treat a few fish at a time by immersing them in the salt solution for two or three minutes. Release them into clean, fresh water immediately after treatment. This quick, simple, and economical treatment may be repeated two or three times at 24-hour intervals, if needed.

PROLONGED TREATMENT

Prolonged treatment involves a longer exposure time to a more dilute solution of the treatment chemical. The fish do not have to be handled, thus reducing stress and the chances of overexposure to the chemical. Application of this method is basically the same as dipping. The volume of water in the pond, pool, or trough must be known. The correct amount of chemical is mixed with a small amount of water and then added to the water containing the fish. A pump can be used to aerate the water by pumping it from the lower end of the pond to the upper end without adding any additional water that would result in diluting the

treatment solution. At the end of the treatment time, which will vary with the disease problem and the chosen chemical, fresh water is added to the system to flush out the chemical.

INTERNAL TREATMENT

Some diseases and internal parasites must be treated by requiring the fish to ingest the drug; most often this is done by mixing the drug with food. The food used to administer a drug must be readily taken by the fish and be of good cohesion to prevent leaching of the drug into the water; medicated pellets can also be used. The drug must be well mixed with the food so that the amount taken is proportional to the amount of food taken. The amount of food given must be adjusted so that each fish gets the required dose. Giving too much is a waste of food and medication, and giving too little may result in the weakest fish not getting enough.

FUNGUS

Fungal infections can affect both eggs and fish. They generally appear as fuzzy, grayish-white to white patches on the body. Death is caused by invasion of the fungus into the body and internal organs. Fish that are in poor condition, have been injured by handling, or are being held in poor quality water are most susceptible. Chemical treatment is possible in tanks, troughs, and raceways, but is usually impractical in ponds. Maintaining a clean environment is the best prevention, and disinfecting can prevent outbreaks.

BACTERIA

Bacteria are microscopic organisms that are present everywhere in nature. In most instances they are not harmful, indeed some bacteria are very beneficial, but in the unnatural conditions of a baitfish culture operation outbreaks of bacterial diseases can occur. Fish that are under stress from poor water quality, handling, and other disease organisms are more likely to develop bacterial diseases. Avoiding or minimizing stress can help prevent outbreaks, and is easier and less expensive than treating diseased fish.

If you suspect a bacterial infection, consult an expert for an accurate diagnosis and prescribed treatment. The characteristics of the more common bacterial diseases are described in the following paragraphs to help you make an initial diagnosis.

FIN ROT

Fin rot is caused by several bacteria, and is characterized by the progressive degeneration of one or more fins, particularly the tail. Infection starts at the free end of the fin. The infected tissue is separated from the healthy tissue by a white line.

FURUNCULOSIS

This is a disease of salmon and trout, but it will infect minnows if they are kept in water flowing from areas with infected trout or salmon. The symptoms are variable but are characterized by swellings on the outside of the fish that are filled with blood and pus, and bloodshot fins. Death may occur without any apparent symptoms.

COLUMNARIS

This infection is similar in appearance to fungus disease but the spots do not look fuzzy. Grayish-white spots appear on the head, gills, fins, or some other part of the body. The spots are surrounded by a ring with a reddish tinge. Infection is most common in warmer water (75°F to 85°F), and as a result of injures during handling.

PARASITES

Most of the parasites that attack baitfish are microscopic, although a few can been seen by a knowledgeable eye. Infestation by parasites can progress very rapidly, and can result in major die-offs. Prevention is the best cure. Disinfect tanks and troughs between batches of fish to prevent a build-up of parasites. If possible, dry out and rototill or disk harrow ponds before putting in new fish. New fish may bring parasites with them, but this can be controlled by quarantining them for two or three weeks. Quarantine is particularly useful for controlling outbreaks in brood stock, but may not be feasible for retailers with a rapid turnover in their stock. The following are some of the more common parasites of baitfish and their symptoms of infection. If you suspect parasitic disease, consult an expert to obtain an accurate diagnosis and prescribed treatment.

WHITE SPOT

This very common disease is caused by a protozoan called Ichthyophthirius, or "Ich." It becomes evident in its feeding stage as white spots under the skin. Chemicals can be used to kill the parasite after it leaves the fish, but are ineffective on the parasites in the fish.

BLACK SPOT

This disease is caused by the larva of a flatworm. Black spots appear on the skin of the fish and in the flesh. Unless severe infections occur, black spot does not usually cause death but can reduce the salability of the fish. The intermediate host of this parasite is a snail, so control of the snail population in your ponds may be indicated if you have a black spot outbreak.

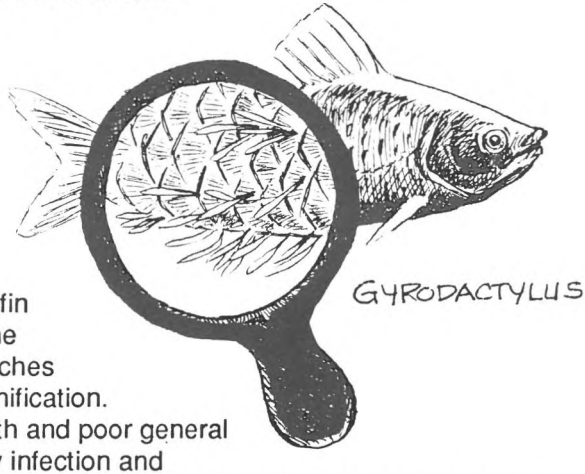
ANCHOR WORM *(Lernaea)*

This parasite is visible as an adult and appears as a small white worm with its head buried in the fish. If the fish are seen twitching or flashing, and red spots are seen near the bases of the fins, the larval stage of this parasite may be present. A large fish can carry several anchor worms without ill effects, but a single worm may kill a minnow, or secondary infections may enter the minnow at the attachment site. Control is difficult, but some drugs may be effective if used properly.

TAPEWORM

Fish infested with tapeworms are easily identified by their swollen bellies, caused by the larval stage present in the body cavity. Several species of tapeworm infect baitfish, and are easily spread by waterbirds. Complete eradication is not likely, but may be reduced by drying and freezing the pond bottom. Heavy infestations of tapeworms can cause sterility, so treatment of brood stock may be necessary. Consult an expert for prescribed treatment.

GYRODACTYLUS



Gyrodactylus is often found on Maine baitfish. It attaches to the gills, fins, and skin of the fish, and feeds on epidermal cells. Heavily infected fish may have a bluish-white film and reddened, inflamed areas on their body, and fin membranes may be destroyed. The parasite is small (less than 0.06 inches long) but may be seen under magnification. Heavy infections cause poor growth and poor general health, and may lead to secondary infection and ultimately death.Gyrodactylus infections can be treated with a five percent salt solution for five minutes. These infections are almost always the result of keeping fish in poor, unsanitary conditions. Adequate amounts of clean, fresh water will help avoid this problem. Gyrodactylus leaves the bodies of fish almost immediately after death, so if you suspect this parasite you must examine live fish.

OTHER EXTERNAL PARASITES

Parasites that live on the surface of the fish can often be prevented by sanitation and controlled by dipping in treatment solutions. For specific recommendations, refer to the sources listed in Appendices 4 and 6.

CAUTION - If an outbreak of disease or parasites makes it necessary to remove infected fish from your hatchery, these fish should be killed and buried. DO NOT RELEASE INTO THE WILD. Such a release is illegal and would spread the infection to wild fish.

CONTROL OF PESTS AND PREDATORS

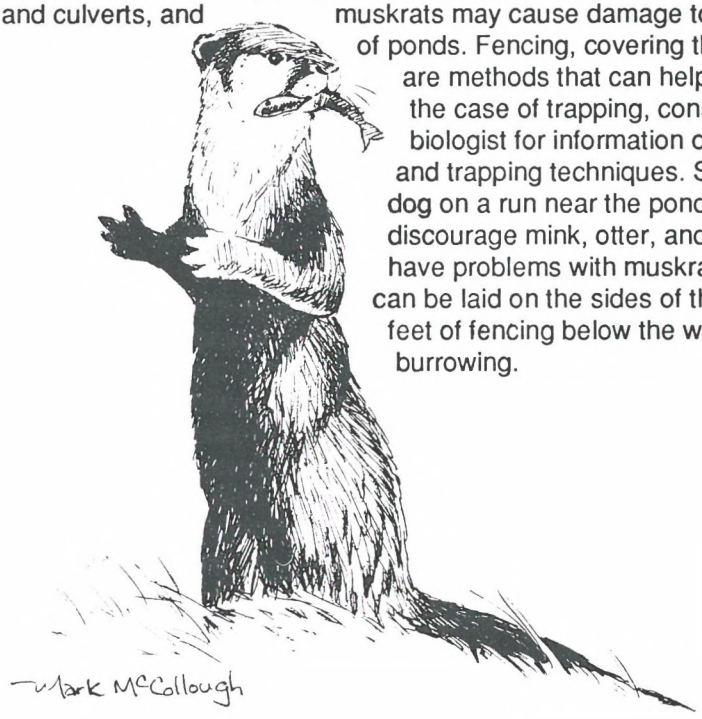
There are a number of organisms, including birds, mammals, fish, reptiles, and insects, that may cause problems in your baitfish ponds by eating your fish or damaging your property. Each is dealt with briefly, but because specific problems usually require specific solutions, details are avoided.

FISH

Predatory fish species and adults of cannibalistic species can greatly reduce the spawning success and population size of baitfish in your ponds. Intake pipes should be filtered to prevent unwanted fish from entering your system. If you suspect fish predation to be the cause of losses in your pond, draining and allowing the pond to remain dry for several days will eliminate unwanted fish. Alternatively, an application of rotenone will kill all of the fish in a pond. A permit may be required from the Maine Department of Environmental Protection before using this chemical.

MAMMALS

Otter and mink may prey on your baitfish, beavers may dam ponds, ditches, and culverts, and muskrats may cause damage to the banks or dikes of ponds. Fencing, covering the pond, and trapping are methods that can help reduce problems. In the case of trapping, consult your local wildlife biologist for information on required permits and trapping techniques. Simply keeping your dog on a run near the pond may be sufficient to discourage mink, otter, and raccoons. If you have problems with muskrat, chain link fencing can be laid on the sides of the pond, with three feet of fencing below the waterline to prevent burrowing.



BIRDS

Great blue herons, kingfishers, cormorants, and seagulls are the birds most likely to cause significant damage to baitfish populations. All are protected species, so shooting and trapping are not possible solutions.

Herons usually alight on the bank and then wade into the pond to hunt. A low chicken-wire fence, close to the edge of the pond, or very steep banks at the edge of the pond, will discourage these birds.

Kingfishers hunt from lookout perches along the edges of waterways. Removing all posts and trees from the immediate vicinity of the pond will usually reduce this problem.

Cormorants and seagulls, as well as eagles, osprey, and mergansers, can be discouraged by stringing 12 to 20 pound monofilament line in a criss-cross pattern, from the tops of eight foot poles placed six to eight feet apart, along the length and width of the pond.

Floating an inflatable rubber snake on the water has also been successful at discouraging avian predators.

SNAKES

Garter snakes and water snakes will feed on fish if there is suitable habitat for them around your pond. Keeping the grass and weeds at the edge of the pond cut short at all times, and removing logs, tree roots, and boulders from the immediate vicinity should discourage snakes by removing protective cover.

TURTLES

Snapping turtles are the species most likely to cause problems in baitfish ponds. Any turtles seen should be trapped (Figure 24) and transported elsewhere. Fencing can be used to keep turtles out.

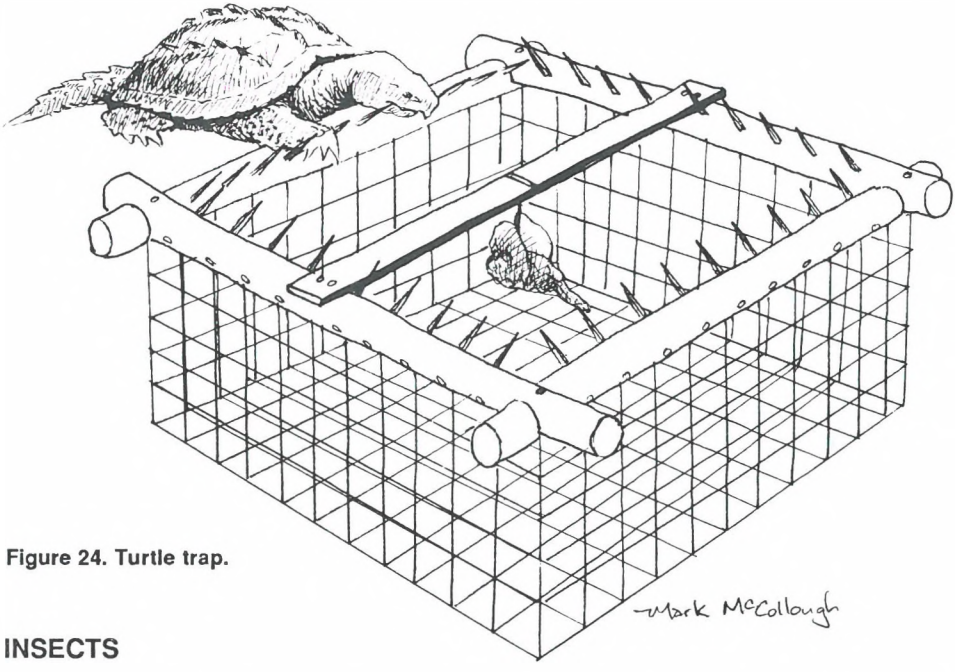


Figure 24. Turtle trap.

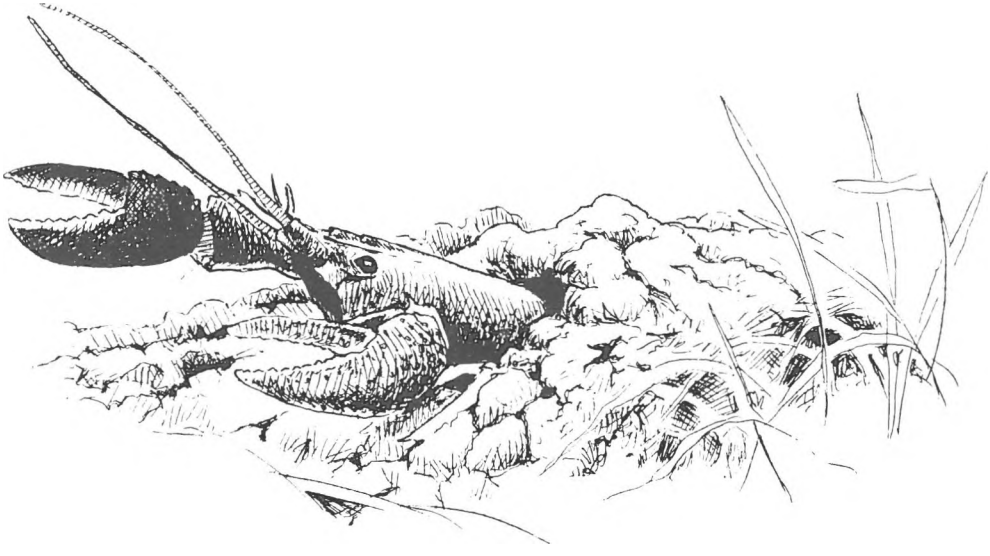
INSECTS

Insects most likely to prey on young baitfish are the backswimmer, giant water bug, water tiger (larval form of predaceous diving beetles), and dragonfly larvae. Individuals can be netted and removed from the pond. Control of aquatic plants will help reduce predaceous insect populations by removing hiding cover.

In instances where insects have become a severe problem, a mixture of one part oil (fish oil, No. 2 fuel oil, or cod-liver oil), two parts gasoline, and 10 parts kerosene can be applied to form a film on the water surface. This will cut-off the supply of air to the insects when they come to the surface to breathe. As with the addition of any chemical to water, consult the Maine Department of Environmental Protection before proceeding.

CRAYFISH

Large burrowing crayfish are not native to Maine but they are common in bait rearing states in the south. Some of these crayfish have become established in parts of Maine where illegal shipments of live bait have been brought in. Crayfish can become a problem in ponds that depend on dams to hold in the water. These animals dig extensive burrows in the sides of the dams, below water level. The dams become weakened, leak, and eventually fail. After becoming established, crayfish can be difficult to eliminate. Their numbers can be kept down by trapping with baited minnow traps or by conducting winter drawdowns.



MARKETING TIPS FOR RETAILERS

The bottom line for raising and selling live bait requires that the product be sold as efficiently and as profitably as possible. There are numerous retailing tips applicable to any business, but there are some that are important for sellers of live bait to remember (Figure 25).

Never forget that you are selling a living animal that needs favorable temperatures, clean water, and plenty of oxygen to keep it healthy. When the fish are in a display tank awaiting sale, feeding is not required, but waste products must be removed. A healthy bait fish will be lively, and a lively bait fish will sell more easily than one that is lethargic.

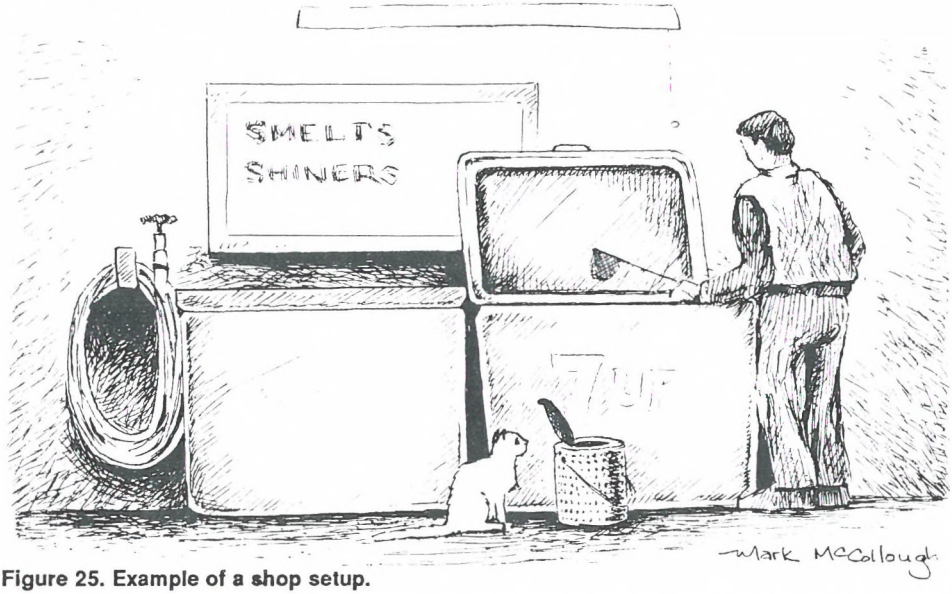


Figure 25. Example of a shop setup.

If baitfish are to be sold in a shop used just for that purpose, a more elaborate, permanent setup can be constructed. If selling bait is a small portion of a business, then a seasonal or temporary setup may be desirable. Any system should consist of several fish tanks so that fish can be separated by species and size. These tanks should be at waist level and 12 inches to 18 inches deep so that the fish can be easily seen and removed. The water should be changed frequently so that algae does not accumulate, and all dead fish removed immediately as they can discourage prospective buyers. Dead fish also contribute to degradation of water quality and encourage fungal growth, both of which can endanger the health of the remaining fish.

In Maine, more baitfish are sold during the winter months than in the rest of the year. The baitfish market is active beginning in December, when people start pickerel fishing, peaks in January and February, and tapers off during March, when the ice fishing season ends. There is an April through early-June smelt market for anglers who prefer them for spring salmon fishing, and a smaller summer market for smelts and shiners for people who like to use live bait year-round. About 90 percent of the sales of baitfish in Maine occur from December through March.

This winter season market requires the retailer to have bait supplies available when harvest conditions are the most difficult. Water in holding tanks must be kept cool to prevent thermal shock to baitfish when anglers take them into cold outdoor temperatures. Many people have had satisfactory results holding bait in old bathtubs or in beverage coolers. These coolers are desirable because they have refrigeration systems that can be adjusted to keep the contents at a uniformly cool temperature (35°F to 50°F would be ideal for winter storage). Any sturdy, water-tight container will prove satisfactory for bait storage if a bathtub or a cooler is not available. If a cooling system is not possible, then the bait storage area should be in an unheated room, or as far as possible from a source of heat. Some bait dealers use coils of metal tubing to circulate their tank water outside their building, thus using the cold outside air temperature to cool their tanks.

The retail area should be well lighted, spacious, clean, and have prices clearly displayed. A spigot for filling bait buckets should be located nearby, and small dip nets kept by each tank. Each tank should have its own net to help prevent the transfer of diseases among fish tanks.

If your bait operation requires the use of flexible hoses to fill tanks or wash out raceways, remember to use non-toxic hoses. Many plastic garden hoses are made from chemicals that may be fatal to fish. Chemically inert hoses may be obtained from hardware stores, animal supply stores, or recreational vehicle suppliers.

SELLING STRATEGIES

Anglers usually prefer a particular size bait for the type of fishing they intend to do. Pickerel anglers want shiners 2.5 to 4 inches long, perch anglers want 1.5 to 2 inch bait, and salmon anglers often desire 3 to 4 inch smelt. As a bait seller, you should be prepared to offer bait by size group. This will require that you grade your fish and keep them in separate containers.

A price list should be posted in a conspicuous place in the shop. This should include each species and each size group, if they sell for different amounts. Most people in Maine prefer to buy their live bait by the dozen, so price lists for bait by the pound or by the hundred should be avoided.

Many anglers travel long distances to their favorite fishing places and start out early. These early starts mean customers at hours earlier than normal working hours. As a service to these people, a retailer may make bait available on an honorary, "serve yourself and leave your money," basis (Figure 26). Generally, people are honest enough to be fair about this arrangement, and the amount of lost revenue because of unscrupulous or forgetful people may be offset by avoiding the costs of staffing the shop early and late in the day.

SANITATION

Just as baitfish reared in ponds and raceways require abundant clean water, the same fish will require certain conditions to survive in a retail display situation. Temperature has already been discussed, but it is also necessary to keep the oxygen level high (at least 5 ppm) and to eliminate chlorine, which is present in many domestic water sources. Oxygen can be kept at adequate levels by using

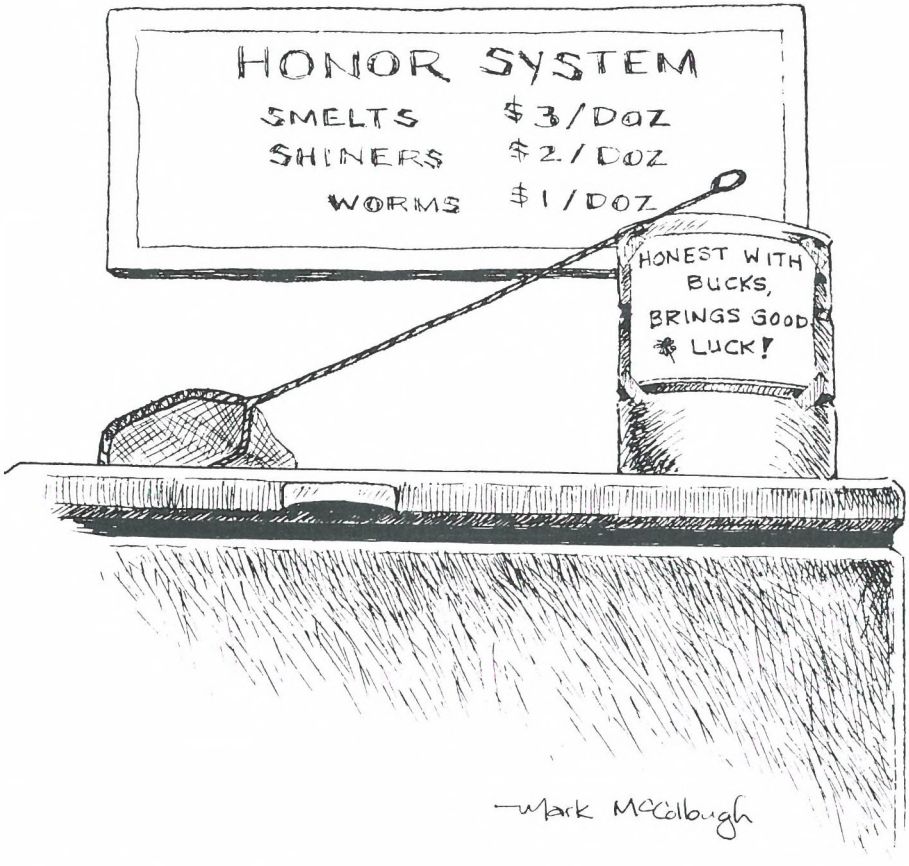


Figure 26. Self-service setup.

an aquarium-type bubbler system or by surface agitation. Both of these systems add air to the water, and the action of the bubblers and the agitation helps rid the water of waste gasses. Oxygen can also be purchased in large cylinders and added to the water through a bubbler system.

Ammonia accumulates in fish tanks from fish feces and urine, and from decomposition of dead fish. Ammonia can be lethal to fish, so this gas must be removed. Frequent water changes are the best way to accomplish this; if part of the tank of water is replaced each day then ammonia accumulation should not cause difficulties. The amount of chlorine usually found in city water supplies can be lethal to fish, and it must be neutralized before new water is added to the fish tanks. Chlorine can be removed by charcoal filtration (which is expensive) or by the addition of a small amount, usually one drop per gallon of water, of sodium thiosulfate (photographic "hypo") to the water. Sodium thiosulfate is available from photographic supply outlets, aquarium supply stores, or some of the suppliers listed in Appendix 8. It is inexpensive and easy to use. It is not enough to let tap water sit overnight to dissipate chlorine before adding it to the fish tank. Enough chlorine may remain to kill your fish before you realize what is happening.

There are companies that sell water chemistry test kits to measure pH, ammonia, and dissolved oxygen, and there are companies that specialize in selling water treatment chemicals that can be used to modify the composition of your water or treat fish diseases.

Some of these sources are also listed in Appendix 8.

ADVERTISING YOUR BUSINESS

If you live in a well traveled area near a popular fishing spot, it may be enough to put a "Bait for Sale" sign in front of your bait shop to attract all the customers you can supply. Such a sign will be more effective if it includes a list of hours that you are open, a general description of the type of bait you offer (e.g., smelts, shiners, worms) and your prices.

After you have been in business for a while, you may be able to survive on word-of-mouth advertising, but if not, there are several other avenues to explore. Newspaper and local magazine advertisements are generally reasonable priced and will reach a number of potential customers. The telephone book Yellow Pages will give you year-round advertising that will reach local people, as well as travelers. Large signs posted in sporting goods stores, boat launching sites, tourist information booths, and grocery stores near fishing spots will be a big help in attracting new customers.

DISPOSAL OF UNUSED BAITFISH

Because the greatest demand for live bait is during late December through March, many suppliers are faced with the problem of end-of-the-season surplus. In situations where the dealership has its own ponds the solution is simple: keep the surplus bait in the pond until next season. Care should be taken to avoid over-stocking and to be prepared for summer feeding.

When a private pond is not available, **leftover fish should not be returned to the wild**. A state-issued permit is required to stock any fish into state waters, and these permits generally are not issued for releasing baitfish into the wild. If a private pond cannot be found to store baitfish throughout the off-season, then the fish should be destroyed. This may seem wasteful, but it is preferable to the risk of releasing fish, and possibly parasites and diseases, into waters where they do not naturally occur.

RECORD-KEEPING SUGGESTIONS

As in any business, large or small, it is important that you keep good financial records. These records will help you:

- assess how your business is doing, and where it is going,
- determine specific aspects of the business where performance could be improved, and
- maintain complete and accurate income tax data.

Basically, at least for tax purposes, the amount you receive in sales, minus what it costs you to purchase, produce, and retail the fish, is your profit. The bookkeeping system you use can be a very simple one, or it may be fairly complex. Either way, it should be flexible enough to expand as your business grows, and you must keep it up-to-date and accurate.

The expenses you incur will vary with the type of business you are operating, the size of your operation, and the stage you are at in developing your business. If you are simply selling baitfish that you purchase from a wholesaler, your equipment needs and other expenses will be fairly straight forward. If you are building ponds, raising your own bait, wholesaling, and retailing, your record keeping needs will be more comprehensive.

The simplest system is to use your business checking account. All transactions, both income and expenses, must go through this account. This system is suitable only if you have very few transactions each month.

A more complete system is the single-entry system that uses two journals: cash receipts and cash disbursements. Every transaction is recorded in one of the two journals. The cash receipts journal (Figure 27) is for all incoming funds, i.e., income. Each entry is on a separate line and includes the date, source of the cash, the total amount, and the category or type of receipt. The columns for various categories of receipts, such as types of merchandise, or types of service, can be chosen to best suit your needs.

The cash disbursements journal (Figure 28) is for all outgoing funds (expenses). Each entry has its own line with the date, check number, payee, description of the expense, and total amount. Column categories, such as merchandise for resale, supplies, rental costs, and labor, are chosen to suit your needs.

The columns in both journals should be totaled at the end of each month, and a "year-to-date" total kept. You can then determine your financial status each month to make your annual income statement. The New England Farm Account Book, available from University of Maine Cooperative Extension offices, is an example of a good single entry system (see Appendix 6).

There are other more complex bookkeeping systems, such as the double-entry system, that are suited to businesses with significant accounts receivable, accounts payable, depreciable equipment, or inventory.

It is usually helpful to consult an accountant before setting up your bookkeeping system, and in some instances to keep your books for you. You can also consult your local office of the University of Maine Cooperative Extension (Appendix 4) for information and assistance in small business management and record keeping. Some of the publications available from UMCE are listed in Appendix 6.

My Bait Business
Cash Receipts Journal

DATE		SOURCE	TOTAL RECEIPTS	MERCHANDISE SALES	SERVICE SALES	MISC.
1	1	Capital invested from me	$1500			$1500
1	15	Sam Owens - product sales	210	$210		
1	17	Dave Jones - service & repairs	75		$75	
1	26	Bob Smith - Down payment	56	56		
		TOTAL for JANUARY	$1841	$266	$75	$1500
2	1	Mary Davis - product sales	$219	$219		
2	6	Bank loan proceeds	500			$500
2	7	Bob Smith - paid on account	144	144		
2	21	Sam Owens - sales & service	290	170	$120	
2	27	John James - service & repairs	75		75	
		TOTAL for FEBRUARY	$1228	$533	$195	$500
		YEAR TO DATE	$3069	$799	$270	$2000

Figure 27. Cash receipts journal.

My Bait Business
Cash Disbursements Journal

DATE	CHECK NO	PAYEE – DESCRIPTION	TOTAL PAID	INVENTORY FOR RESALE	SUPPLIES	MISC.
1/7	001	XYZ Wholesale - purchase inventory	$460	$460		
1/8	002	ABC Supply Co - service supplies	180		$180	
1/9	003	Trade magazine - 1 yr. subscription	15			$15
1/29	004	Local Newspaper - advertising	45			45
		TOTAL for JANUARY	$700	$460	$180	$60
2/5	005	XYZ Wholesale - purchase inventory	$250	$250		
2/10	006	ABC Supply Co - service supplies	65		$65	
2/20	007	Commercial Bank - loan repymt + int.	261			261
2/27	008	Local Newspaper - advertising	56			56
		TOTAL for FEBRUARY	$632	$250	$65	$317
		YEAR TO DATE	$1332	$710	$245	$377

Figure 28. Cash disbursements journal.

SOME FINAL THOUGHTS

Anyone who has read through to this point is aware that there is much information about baitfish, their rearing and handling, that has not been included in this text. We hope that we have provided a logical framework upon which you can build a successful baitfish enterprise, and a useful guide to sources of further information. Expert advise will be needed, and should be sought, during all phases of developing a baitfish business. We have tried to provide a wide variety of sources for this advice, but we also encourage you to make use of any source that becomes available to you. Often one source of information will lead to others, and there is no such thing as too much information when you are contemplating such a large investment of time and money.

In the final analysis, however, any person entering into the bait business will learn as much, or more, from experience as from outside sources. Consequently, our final piece of advise is to learn as much as you can, from as many sources as you can, before you start, then start small, pay attention to what you see happening in your situation, and build upon what works for you.

LITERATURE CITED

Akielaszek, J.J., J.R. Moring, S.R. Chapman, and J.H. Dearborn. 1985. Experimental culture of young rainbow smelt *Osmerus mordax*. Transactions of the American Fisheries Society 114(4):597-603.

Buss, K. 1959. Jar culture of trout eggs. The Progressive Fish-Culturist 21(1): 26-29.

Dobie, J., O.L. Meehean, S.F. Snieszko, and G.N. Washburn. 1956. Raising bait fishes. USDI Fish and Wildlife Service, Circular 35. 124 pp.

Moring, J.R. 1985. Smelt culture...a new business for Maine? Maine Fish and Wildlife 27(2):13-15.

USDA. 1984. Aeration of ponds used in aquaculture. USDA Soil Conservation Service, Agriculture Engineering Note 3. 16 pp.

APPENDIX 1

MAINE LAWS THAT REGULATE THE TAKING, SELLING, AND USING OF LIVE BAIT

State of Maine Inland Fisheries and Wildlife Laws, 12 MRSA Part 10, Chapters 701 to 721 (effective September 29, 1987).
These laws are subject to change by the legislature and interested persons should examine current revisions to be fully informed.

Chapter 701, section 7001, sub-sections 1-A and 1-B.
This law, which went into effect on January 1, 1987, defines which fish are considered to be legal baitfish in Maine (See Appendix 2).

Chapter 707, subchapter V.
This law defines the fees and limitations of a live bait dealer's license, a live smelt dealer's license, and the permit system for taking live bait from closed waters.

Chapter 707, subchapter VI.
This law allows people to culture live fish, including baitfish, and to sell these fish in Maine. It does not allow for the importation of live fish nor does it allow a person to capture live fish for sale.

Chapter 710, subchapter III, section 7606 and 7606-A.
This law discusses the use of illegal baitfish, the labeling of fish traps and holding boxes, and the disturbing of these boxes.

Chapter 710, subchapter III, section 7613.
This law prohibits the importation of baitfish and smelt.

Chapter 710, subchapter III, section 7608 and 7622.
These sections define baitfish traps and the use of food in the traps to attract baitfish.

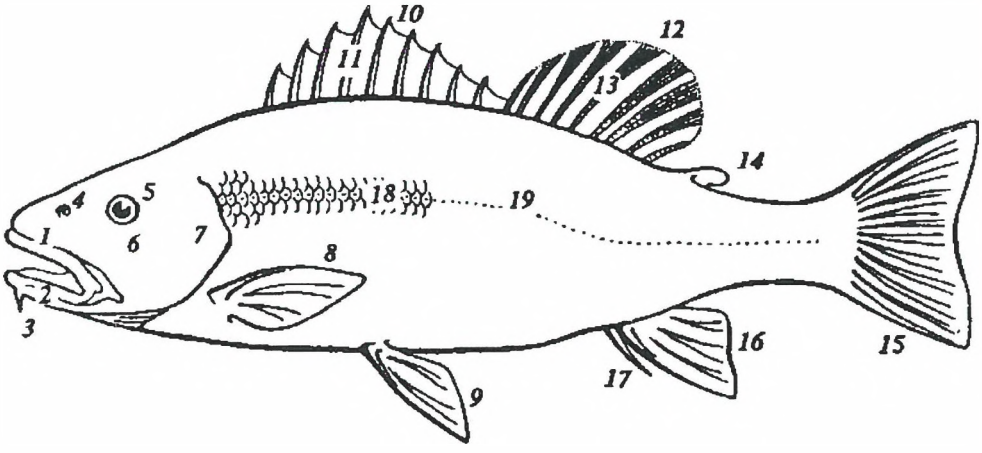
APPENDIX 2

LEGAL MAINE BAITFISH

Banded killifish	*Fundulus diaphanus*
Blacknose dace	*Rhinichthys atratulus*
Blacknose shiner	*Notropis heterolepis*
Bridle shiner	*Notropis bifrenatus*
Common shiner	*Notropis cornutus*
Creek chub	*Semotilus atromaculatus*
Creek chubsucker	*Erimyzon oblongus*
Emerald shiner	*Notropis atherinoides*
Fallfish	*Semotilus corporalis*
Fathead minnow	*Pimephales promelas*
Finescale dace	*Phoxinus neogaeus*
Golden shiner	*Notemigonus chrysoleucas*
Lake chub	*Couesius plumbeus*
Longnose dace	*Rhinichthys cataractae*
Longnose sucker	*Catastomus catostomus*
Mummichog	*Fundulus heteroclitus*
Northern redbelly dace	*Phoxinus eos*
Pearl dace	*Semotilus margarita*
Rainbow smelt	*Osmerus mordax*
Silvery minnow	*Hybognathus nuchalis*
Spottail shiner	*Notropis hudsonius*
White sucker	*Catostomus commersoni*

APPENDIX 3

GENERAL CHARACTERISTICS USED TO IDENTIFY FISH



1. Upper jaw (premaxillary and maxillary bones)
2. Lower jaw (dentary bone)
3. Barbel
4. Nostril
5. Eye
6. Cheek
7. Gill cover
8. Pectoral fin
9. Pelvic fin
10. Spiny dorsal fin
11. Fine spine
12. Soft dorsal fin
13. Fin ray
14. Adipose fin
15. Caudal fin
16. Anal fin
17. Anal spine
18. Lateral line scales
19. Lateral line

APPENDIX 4

AGENCIES IN MAINE THAT CAN HELP YOU WITH YOUR QUESTIONS

MAINE DEPARTMENT OF INLAND FISHERIES AND WILDLIFE

Main Office: State House Station #41
284 State St.
Augusta, ME 04333

Fisheries & Hatcheries Division	289-5261
Licensing Division	289-2043
Public Information	289-2871
Regulations Division	289-3371
Fishery Pathologist	289-2917

Regional Fisheries Offices:

Region A
RR 1, 328 Shaker Rd.
Gray, ME 04039
289-3849 or 657-2345
1-800-322-1333

Region B
8 Federal St.
Augusta, ME 04333
289-2535
1-800-322-3606

Region C
68 Water St.
Machias, ME 04654
255-3266

Region D
RFD 3, Box 3770
Farmington, ME 04938
778-3322

Region E
Box 551
Greenville, ME 04441
695-3756
1-800-322-9844

Region F
Box 66
Enfield, ME 04433
732-4131

Region G
P.O. Box 416
Ashland, ME 04732
435-3231
1-800-322-4011

Research Office:
P.O. Box 1298
Bangor, ME 04401
941-4449
1-800-322-2033

MAINE DEPARTMENT OF ENVIRONMENTAL PROTECTION

Main Office: State House Station 17
Augusta, ME 04333

Land Bureau 289-2111
Water Bureau 289-3901

Regional Offices:

106 Hogan Rd.
Bangor, ME 04401
941-4570

528 Central Drive
Skyway Park
Presque Isle, ME 04769
764-2044

21 Vocational Drive
South Portland, ME 04106
767-4761

MAINE DEPARTMENT OF AGRICULTURE

Pesticide Control Board
State House Station 28
Augusta, ME 04333
289-2731

UNIVERSITY OF MAINE COOPERATIVE EXTENSION

Androscoggin-Sagadahoc County
277 Minot Ave.
Auburn, ME 04210
786-0376

Aroostook County
13 Hall St.
Fort Kent, ME 04743
834-3905

Aroostook County
Houlton Rd.
P.O. Box 727
Presque Isle, ME 04769
764-336

Aroostook County
Central Building
P.O. Box 8
Houlton, ME 04730
532-6548

Cumberland County
96 Falmouth St.
Portland, ME 04103
780-4205

Franklin County
78 Main St.
P.O. Box 670
Farmington, ME 04938
778-4650

Hancock County
RFD #5, Boggy Brook Rd.
Ellsworth, ME 04605
667-8212

Kennebec County
125 State Street
Augusta, ME 04330
622-7546

Knox-Lincoln County
375 Main St.
Rockland, ME 04841
594-2104

Oxford County
RFD 2, Box 1735
South Paris, ME 04281
743-6329

Penobscot County
Court House Annex
Bangor, ME 04401
942-7396

Piscataquis County
Court House Complex
Dover-Foxcroft, ME 04426
564-3301

Somerset County
Norridgewock Avenue
P.O. Box 98
Skowhegan, ME 04976
474-9622

Waldo County
RFD #2, Box #641
Belfast, ME 04915
342-5971 or 342-5972

Washington County
11 Water Street
Machias, ME 04654
255-3345

York County
P.O. Box 347
Alfred, ME 04002
324-2814

UNIVERSITY OF MAINE

Aquatic Animal Health Laboratory
187 Hitchner Hall
University of Maine
Orono, Maine 04469 581-2810

Cooperative Fish and Wildlife Research Unit
240 Nutting Hall
Orono, ME 04469

Leader	581-2870
Assistant Leader for Fisheries	581-2580
Assistant Leader for Wildlife	581-2895

SOIL AND WATER CONSERVATION DISTRICT (SWCD) AND SOIL CONSERVATION SERVICE (SCS) OFFICES

Androscoggin Valley SWCD/SCS
27 Westmimster St.
Lewiston, ME 04240
783-9196

Central Aroostook SWCD/SCS
Agricultural Center Building
744 Main Street
Presque Isle, ME 04769
764-4153 or 764-4154

Cumberland County SWCD/SCS
14 Karen Dr.
Westbrook, ME 04092
871-9247

Franklin County SWCD/SCS
2 Park St.
Farmington, ME 04938-1912
778-4767

Hancock County SWCD/SCS
Federal Building
41 Main St.
Ellsworth, ME 04605
667-8663

Kennebec County SWCD/SCS
Federal Building & P.O.
Western Ave.
Augusta, ME 04330
622-8289

Knox-Lincoln County SWCD/SCS
RR 1, Box 15
Waldoboro, ME 04572
832-4292

Main Office SWCD/SCS
202 USDA Building
University of Maine
Orono, ME 04469
581-3446

Oxford County SWCD/SCS
1 Main St.
South Paris, ME 04281
743-7019

Penobscot County SWCD/SCS
970 Illinois Ave.
Bangor, ME 04401
947-6622

Piscataquis County SWCD/SCS
Rt. 15, Dover-Foxcroft Plaza
Dover-Foxcroft, ME 04426
564-2321

St. Johns Valley SWCD/SCS
96 Market St.
Fort Kent, ME 04743
834-3311

Somerset County SWCD/SCS
7 High St
Skowhegan, ME 04976
474-8324

Southern Aroostook SWCD/SCS
RR 3, Box 45
Houlton, ME 04730
532-2087

Waldo County SWCD/SCS
69 Northport Ave.
Belfast, ME 04915
338-2320

Washington County SWCD/SCS
Federal Building & P.O.
49 Court St., P.O. Box 121
Machias, ME 04654
255-3995

York County SWCD/SCS
160 Cottage St.
Sanford, ME 04073
324-7015

U.S. ARMY CORPS OF ENGINEERS

Augusta Field Office
Federal Building
40 Western Ave.
Augusta, ME 04333
622-8246

New England Regional Office
424 Trapelo Rd.
Waltham, MA 02254
(617) 647-8138

FARMER'S HOME ADMINISTRATION

- contact for information on loans available for aquaculture operations

Androscoggin County
27 Westminster St.
P.O. Box 1938
Lewiston, ME 04241
783-9191, 783-9192,
or 783-9193

Aroostook County
Parent Building
100 Main St.
Van Buren, ME 04785
868-5471 or 868-5472

Aroostook County
373 South Main St.
P.O. Box 777
Caribou, ME 04736
498-2591

Aroostook County
Agricultural Center Building
744 Main St.
Presque Isle, ME 04769
764-4155

Aroostook County
Theatre Block Building
128-140 Main St.
P.O. Box 227
Fort Fairfield, ME 04742
472-3761

Aroostook County
North Rd.
RFD 3, Box 44
Houlton, ME 04730
532-2203 or 532-2204

Aroostook County
94 Market St.
Fort Kent, ME 04743
834-3946 or 834-3947

Aroostook County
Lougee Office Building
Houlton St.
Island Falls, ME 04747
463-2293 or 463-2294

Cumberland County
14 Karen Dr.
P.O. Box 1247
Westbrook, ME 04092
871-9055, 871-9070,
or 871-9228

Cumberland County
Bridgetown Common
Route 17
P.O. Box 220
Bridgton, ME 04009
647-5611 or 647-5612

Franklin County
2 Park St.
P.O. Box 271
Farmington, ME 04938
778-6531 or 778-6532

Hancock County
P.O. Box 369
Bucksport, ME 04416
469-7366 or 469-7367

Hancock County
Federal Building
41 Main St.
P.O. Box 654
Ellsworth, ME 04605
667-7196 or 667-7197

Kennebec County
Federal Building
Room 412A
Western Ave.
Augusta, ME 04330
622-8215

Kennebec County
Federal Building
33 College Ave.
P.O. Box 725
Waterville, ME 04901
873-0617 or 873-0618

Knox County
Federal Building
21 Limerock St.
Rockland, ME 04841
594-2149 or 594-2149

Lincoln County
Business Route 1A
P.O. Box 310
Damariscotta, ME 04543
563-3124

Oxford County
1 Main St.
P.O. Box 217
South Paris, ME 04281
743-7017 or 743-7018

Penobscot County
29 Main St.
P.O. Box 10
Newport, ME 04953
368-4346 or 368-4347

Penobscot County
970 Illinois Ave.
Suite 3
Bangor, ME 04401
947-0334 or 947-0335

Penobscot County
15 Mechanic St .
Lincoln, ME 04457
794-6734 or 794-6735

Piscataquis County
Dover-Foxcroft Plaza
P.O. Box 218
Dover-Foxcroft, ME 04426

Sagadahoc County
97 Commercial St.
P.O. Box 701
Bath, ME 04530
474-8321 or 474-8322

Somerset County
7 High St.
P.O. Box 70
Skowhegan, ME 04976

Waldo County
69 Northport Ave.
Belfast, ME 04915
338-4160

Washington County
Route 182
P.O. Box 210
Cherryfield, ME 0462
546-2305

Washington County
Federal Building
Court St.
P.O. Box 138
Machias, ME 04654
255-3601 or 255-8370

Washington County
P.O. Box 929
Calais, ME 04619
454-7186 or 454-7187

York County
160 Cottage St.
P.O. Box 233 w
Sanford, ME 04073
324-7012, 324-7013,
or 324-7014

BUSINESS TAXES AND PERMITS

Department of Finance
State House Station 78
Augusta, ME 04333
1-800-452-1983 (in-state number for individuals with tax questions)
1-800-338-5811 (in-state number to order forms)

- the Department of Finance includes the Bureaus of the Budget, Accounts & Control, Taxation, Alcoholic Beverates, and the Lottery
- contact for information on corporate income taxes, individual income taxes, sales and use taxes, and payroll taxes

Small Business Administration
40 Western Ave.
Federal Building
Augusta, ME 04330
(207) 622-8378 or 622-8242

- contact for information on SBA guaranteed loans, and special loan programs for women and minorities

Internal Revenue Service
68 Sewall St.
Augusta, ME 04333
1-800-424-1040

- contact for information on federal income tax withholding, payroll taxes, home-based business deductions, and applications for an Employer Identification Number

Department of Labor
State House Station 54
Augusta, ME 04333
(207) 289-3788

Bureau of Employment Security

- contact the Unemployment Compensation Division (207-289-2316) for information on unemployment insurance

Bureau of Labor Standards

- contact the Division of Minimum Wage, Child Labor (207-289-6410) for information on wages and labor laws
- contact the Industrial Safety Division (207-289-2591) for information on no-fee, no-penalty safety inspections, on-site training programs in occupational health and safety, and low interest loan programs to businesses for the purchase of safety equipment

Worker's Compensation
AMHI
Deering Building
Augusta, ME 04333
(207) 289-3751

- contact for information on worker's compensation insurance

Maine Department of Inland Fisheries and Wildlife
State House Station 41
Augusta, ME 04333
(207) 289-3371

- contact the Licensing and Registration Division (207-289-2571) for information on licenses for Live Bait Retail Dealer, Live Bait Wholesale Dealer, Live Smelt Bait Dealer, and Inland Fish Sales
- contact the Fisheries Division (207-289-3651) for information about private ponds, fish cultivation, or fish harvest

WATER QUALITY TESTS

A & L Laboratory
Goldthwaite Rd.
Auburn, ME 04210
784-5354

E. C. Jordan Company
261 Commercial St.
Portland, ME 04112
775-5401

Maine Department of Environmental Protection
State House Station 17
Augusta, ME 04333
289-2811

Maine Department of Human Services
Public Health Laboratory
221 State St.
Augusta, ME 04333
289-2727

McFarland Associates, Inc.
Rt. 115
North Windham, ME 04062
892-4485

Northeast Laboratory Services
China Rd.
Winslow, ME 04901
873-7711

FISH HEALTH PROBLEMS

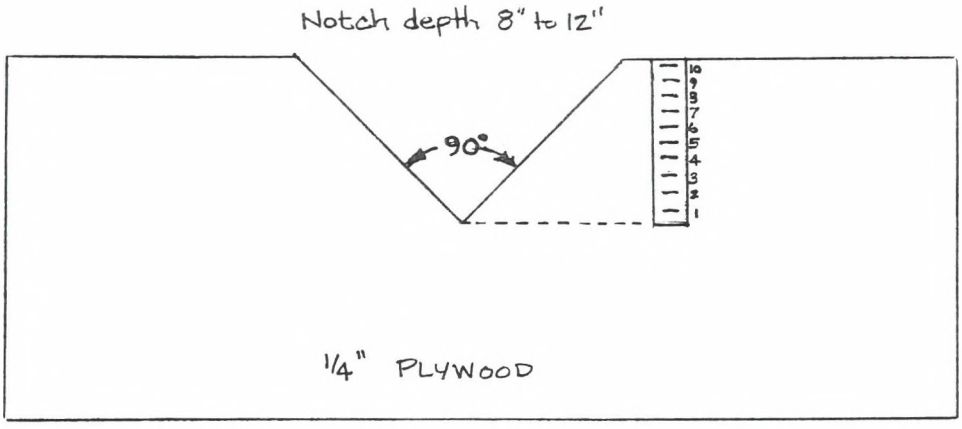
University of Maine
Aquatic Animal Health Laboratory
187 Hitchner Hall
Orono, ME 04469
581-2810

Roger Dexter
Fish Pathologist
Box 12
East Orland, ME 04431
469-2601

Maine Department of Inland Fisheries and Wildlife
Fish Pathologist
8 Federal St.
Augusta, ME 04333
289-2917

APPENDIX 5

HOW TO MEASURE THE FLOW OF WATER IN YOUR STREAM*



NOTCH WEIR

A notch weir made of plywood can be used to measure the flow of water from a small stream or spring.

The weir is placed across the stream or spring. You will have to be sure all of the water flows through the notch (don't let water escape around the sides or under the weir). Also, be sure the bottom of the notch is above the water on the downstream side of the weir.

Measure the depth of the flow (head) on the scale to one side the notch, and then refer to Table 5.1 for the stream or spring flow in gallons per minute.

Table 5-1. Discharge table for 90-degree triangular notch.

Head in inches	Dis-charge (GPM)	Head in inches	Dis charge (GPM)	Head in inches	Dis charge (GPM)	Head in inches	Dis charge (GPM)
2-3/8	21	4-13/16	115	7-3/16	314	9-5/8	641
2-1/2	23	4-15/16	122	7-5/16	327	9-3/4	663
2-5/8	26	5-1/16	130	7-7/16	341	9-13/16	681
2-3/4	29	5-3/16	137	7-9/16	354	9-15/16	705
2-7/8	32	5-1/4	145	7-11/16	369	10-1/16	722
3	36	5-3/8	154	7-13/16	383	10-3/16	744
3-1/8	39	5-1/2	162	7-15/16	398	10-5/16	767
3-1/4	43	5-5/8	171	8-1/16	413	10-7/16	790
3-3/8	47	5-3/4	181	8-3/16	428	10-9/16	812
3-1/2	52	5-7/8	190	8-1/4	444	10-11/16	834
3-5/8	56	6	200	8-3/8	462	10-13/16	861
3-3/4	61	6-1/8	210	8-1/2	475	10-15/16	883
3-13/16	66	6-1/4	220	8-5/8	493	11-1/16	907
3-15/16	71	6-3/8	231	8-3/4	511	11-3/16	934
4-1/16	77	6-1/2	242	8-7/8	529	11-1/4	956
4-3/16	83	6-5/8	253	9	547	11-3/8	982
4-5/16	88	6-3/4	265	9-1/8	565	11-1/2	1010
4-7/16	94	6-3/16	277	9-1/4	583	11-5/8	1037
4-9/16	101	6-15/16	289	9-3/8	601	11-3/4	1064
4-11/16	108	7-1/16	301	9-1/2	623	11-7/8	1090
						12	1118

* Taken, with permission, from Marek and LaBar (1980).

APPENDIX 6

LIST OF PUBLICATIONS

The following list of publications is provided to help you find additional information as needed. This is not a complete list. You will find that, depending on your knowledge and questions, some will serve you better than others.

BAITFISH REARING

Akielaszek, J.J., J.R. Moring, S.R. Chapman, and J.H. Dearborn. 1985. Experimental culture of young rainbow smelt *Osmerus mordax*. Transaction of the American Fisheries Society. 114(4):597-603.

Brown, E.E. and J.B. Gratzek. 1980. Fish farming handbook: food, bait, tropicals, and goldfish. AVI Publishing Company, Inc., Westport, Connecticut. 391 pp.

Buss, K. 1959. Jar culture of trout eggs. The Progressive Fish-Culturist 21(1):26-29.

Crance, J. 1969. Alabama fish ponds. Dept. of Conservation, Montgomery, Alabama 36104. 43 pp.

Dobie, J. 1972. Rearing suckers for bait in Minnesota. Minnesota Department of Natural Resources. Investigational Report No. 256. 34 pp.

Dobie, J., O.L. Meehean, S.F. Snieszko, and G.N. Washburn. 1956. Raising bait fishes. USDI, Fish and Wildlife Service, Circular 35. 124 pp.

Dupree, H.K. and J.V. Huner, ed. 1984. Third report to the fish farmers. U.S. Fish and Wildlife Service, Washington, D.C. 270 pp.

Eipper, A.W. and H.A. Regier. 1983. Fish management in New York ponds. Bulletin 116. Cornell University, Ithaca, New York 14850. 20 pp.

Forney, J.L. 1968. Raising baitfish and crayfish in New York ponds. Bulletin 986. Cornell University, Ithaca, New York 14850. 31 pp.

Flickinger, S.A. 1971. Pond culture of bait fishes. Cooperative Extension Service, Colorado State University, Fort Collins, Colorado. Bulletin 478A. 39 pp.

Giudice, J.J., D.L. Gray, and J.M. Martin. No date. Manual for baitfish culture in the south. University of Arkansas Cooperative Extension Service, Little Rock, Arkansas 72203. 49 pp.

Johnson, S.K. 1978. Maintaining minnows, a guide for retailers. Bulletin 1365. Texas Agricultural Extension Service, College Station, TX 77843. 19 pp.

Marek, L.G. and G.W. LaBar. 1980. Fish farming in Vermont. University of Vermont. Burlington, Vermont. 55 pp.

McLarney, W. 1984. The freshwater aquaculture book: a handbook for small scale fish culture in North America. Hartley & Marks, Publishers, Point Roberts, Washington. 583 pp.

Meyer, F.F. and G.L. Hoffman. 1976. Parasites and diseases of warmwater fishes. Fish Farming Experiment Station, Resource Publication 127. Stuttgart, Arkansas 72160.

Mitchell, A.J. and F.P. Meyer. 1989. Treatment Tips for Fish Producers. U.S. Fish and Wildlife Service, Washington, D.C., Leaflet 15. 10 pp.

Moring, J.R. 1985. Smelt culture...a new business for Maine? Maine Fish and Wildlife 27(2):13-15.

USDA. 1984. Aeration of ponds used in aquaculture. USDA Soil Conservation Service, Agriculture Engineering Note 3. 16 pp.

FISH IDENTIFICATION

Decker, D.J., R.A. Howard, Jr., W.H. Everhart, and J.W. Kelley. 1985. Guide to Freshwater Fishes of New York. Cornell University, Ithaca, NY 14850. 140 pp.

Everhart, W.H. 1976. Fishes of Maine. Maine Dept. Inland Fisheries and Wildlife, Augusta, Maine 04333.

Hubbs, C.L. and K.F. Lagler. 1964. Fishes of the Great Lakes Region. University of Michigan Press. Ann Arbor, Michigan.

Scarola, J.F. 1973. Freshwater fishes of New Hampshire. N.H. Fish and Game Dept. Concord, N.H. 03301.

Scott, W.B. and E.J. Crossman. 1973. Freshwater fishes of Canada. Fisheries Research Board of Canada, Bulletin 184. Information Canada, Ottawa, Canada K1A 0S9.

Smith, C.L. 1985. The inland fishes of New York State. N.Y. Dept. of Environmental Conservation, 50 Wolf Road, Albany, N.Y. 12233.

Woodling, J. 1985. Colorado's little fish. Colorado Division of Wildlife. 6060 Broadway, Denver, Colorado 80216.

MAGAZINES AND JOURNALS

Aquaculture Magazine
P.O. Box 2329
Asheville, NC 28802

Canadian Aquaculture
4611 William Head Rd.
Victoria, B.C.
Canada V8X 3W9
(604) 478-9209

Fish Farmer
IPC Business Press Ltd.
205 East 42nd St.
New York, NY 10017
(7 issues/year)

Fish Farming International
Arthur J. Heighway Publ. Ltd.
4 Kildare Close
Eastcote, Ruislip, Middlesex
HA4 9XB England
(monthly)

Progressive Fish-Culturist
American Fisheries Society
5410 Grosvenor Ln.
Bethesda, MD 20814
(quarterly)

SMALL BUSINESS MANAGEMENT AND RECORD KEEPING

These publications are available from local offices of the University of Maine Cooperative Extension:

1. Getting Organized - Personal and Financial Records. Bulletin 658.

2. New England Farm Account Book Number 1. (can be easily adapted to a baitfish operation)

3. A series of pamphlets on home based businesses titled:
   - Is It For Me?
   - So You're in Sales
   - Estimating Retail Market Potential
   - Starting a Home Business
   - How to Organize Your Business
   - Record Keeping for Profit
   - Capital Sources for New Business
   - How to Insure Your Business
   - Taxes and Permits

4. SBRD Section II: Licenses, Permits, and Regulations
   - A) Federal
   - B) State

APPENDIX 7

BAIT PRODUCER AND DEALER CHECKLIST

This checklist is intended to help you consider what is involved in running a baitfish operation before you invest. Some of the questions may not apply to you, and you may think of others as you go along. The time you spend finding the answers will be time well spent. Establishing and operating a baitfish business can be expensive, and it is hard work, but it can also be very rewarding. This list is an adaptation of that presented by J. V. Huner and H. K. Dupree (1984) in Third Report to the Fish Farmers, U.S. Fish and Wildlife Service.

INFORMATION SOURCES

1. Federal and state agencies - personnel and publications
2. Universities and colleges - personnel and publications
3. Fish farming associations - state and national
4. Professional consultants, bait dealers, fish farmers
5. Feed company research departments
6. Industry journals and magazines
7. Popular and professional books and pamphlets
8. Research reports

LAWS AND REGULATIONS

1. Decide whether you wish to operate as a sole proprietorship, partnership, or corporation.
2. If you decide to incorporate, obtain incorporation papers from the Maine Secretary of State, Bureau of Corporations, State House Station 29, Augusta, ME 04333. If already incorporated in another state, obtain an application to do business in Maine as a foreighn corporation from the same office.
3. Obtain a federal employer identification number from the nearest Internal Revenue Service Office.
4. Obtain an unemployment insurance identification number from the Unemployment Compensation Division, Maine Department of Labor.
5. Determine necessary compliance with the Workers' Compensation Act by contacting the Maine Worker's Compensation Commission.
6. Contact the Maine Department of Labor, Bureau of Labor Standards to determine compliance with the Occupational Safety and Health Act.
7. Obtain a State Sales Tax Number from the Maine Department of Finance, Bureau of Taxation, State House Station 78, Augusta, ME 04333.
8. Call the local municipal office (town or city clerk or manager) to fufill any licensing or registering requirements (not all municipatities require this).
9. If your business is operated in your home, check with the local code enforcement officer to ensure you are not in violation of any local codes.
10. What other laws and regulations apply to the type of business and species of fish you are interested in?

11. What permits and licenses are you required to have?
12. What laws and regulations apply to your use and discharge of water, pond construction, and alteration of existing ponds, wetlands, or streams?

CAPITALIZATION AND OPERATING COSTS

1. Develop a business prospectus detailing land or space costs, capital expenditures (fish stock, equipment, buildings, pond construction), operating capital, labor, financing costs, production, harvesting, marketing costs, depreciation, and a profit and loss estimate. This prospectus is often necessary to obtain financing, but also forces you to take a hard look at the economics of the venture.
2. Do you have, or can you obtain, financing for capital and operating expenses for at least the first year, possibly more?
3. Are you prepared, psychologically and financially, to only break even, or maybe take a loss, your first year of operation?
4. Have you considered overhead as well as operating costs?
5. Have you included fringe benefit costs in calculating labor expenses?

MANAGEMENT OF PERSONNEL, FACILITIES, AND EQUIPMENT

1. Do you have the technical training necessary to run your business efficiently? Or have you made arrangements to consult with or hire a professional?
2. Do you have the biological expertise to diagnose and treat diseases, parasites, etc.? Or have you made contact with a biologist or pathologist who is willing to help?
3. Do you have adequate skilled help available when needed, on a regular basis and in the case of an emergency?
4. Are your facilities (ponds, raceways, storage sheds, retail shop, etc.) arranged so as to make efficient use of time and labor? Are they accessible inadverse weather conditions?
5. Have you considered future expansion in the design and layout of your facilities?
6. Do you have or can you arrange for quarantine facilities for incoming stock or diseased stock?
7. Do you have adequate and dependable sources of electrical power, potable water, and sewage disposal? Do you have an emergency source of power?
8. Do you have equipment for testing water quality (DO, pH, ammonia, etc.) or for diagnosing and treating diseases?
9. Do you have the necessary equipment for aeration or oxygenation of water, both on a regular basis and in an emergency?
10. Do you have, or know who to contact to obtain, special permits from state and federal wildlife agencies to control predators?

SITE LOCATION AND WATER SUPPLY

1. Can each pond be drained independently and completely?
2. Have you had your soil tested for water retention capability?
3. Are adjacent lands sprayed for insect or weed control? What are the chances of drift into your ponds?
4. If your land may have been sprayed in the past, have you had the soil tested for residual chemicals?
5. Is the site well above the high water line during flood season?
6. Where is your discharge water going to go? Do you need permits for it?
7. Can you make or take delivery of fish regardless of weather conditions?
8. What is the source of your water supply? Is it adequate for present and future needs? Is it adequate to meet losses to evaporation and seepage? Is there an alternate emergency source of water available?
9. What are the temperature variations of the water supply?
10. If you are using surface waters, can you control predators and unwanted fish species in the water supply?

SOURCE OF BROOD STOCK AND SPAWNING

1. If you are going to purchase brood stock, how many of each sex do you need, what size and age?
2. If you are going to capture wild fish for brood stock, what type of trap and bait will you use, where will you go, at what time of year, and how will you transport them back to your ponds?
3. During transport, how will you ensure proper temperature and oxygen supply?
4. How long do the fish need to acclimatize to their new home before the spawning season?
5. What water temperature is best for spawning?
6. Do you need to supply spawning mats or boards?
7. Are the eggs going to be artificially incubated? What types of equipment will you need? What are the particular water requirements for temperature, chemistry, and flow rate?
8. How are you going to handle the fry? Are the adults cannibalistic?
9. To what diseases are fry susceptible and how are they treated?
10. Are you going to use natural or artificial foods for the fish?
11. Can you produce and maintain an adequate supply of natural foods? What kinds and amounts of fertilizers are you going to use? Are you prepared to supply supplemental food if natural food supplies are inadequate?
12. What type of artificial food are you going to use? Do you have a supplier?
13. How will you determine daily feeding rates? How will feeding rate vary with growth rate of the fish, water temperature, and time of year?
14. How will you supply the food to the fish? How often, what time of day, and in what depth of water?
15. How will you check on food consumption rate?

SOURCE OF FINGERLINGS OR READY-TO-SELL BAITFISH

1. What size fingerlings can you economically raise to commercial size? How many do you need?
2. What is the wholesaler's reputation for producing quality, disease-free fish? Have you visited the facility? Will you inspect the fish prior to or upon delivery to you?
3. Do you have alternate sources?
4. Will you need to treat the fish for disease control prior to release into your ponds? What do you have to do to prepare the water prior to release?
5. How far in advance do you have to place you order for stock?
6. If you are going to sell wild-caught bait, what type of trap or seine will you use? How many will you need?
7. How will you transport the fish from the field to your place of business? Do you have a source of aeration or oxygen?

HARVESTING AND TRANSPORTING

1. How are you going to harvest fish from your pond? Are your ponds constructed to facilitate removal of fish?
2. What equipment will you need for handling and transporting your fish?
3. Will you need special holding facilities or tanks to keep fish ready for sale or delivery?
4. How will you keep water cool during transport? Ice, refrigeration?
5. How will you supply sufficient oxygen to the fish during transport? Aeration, oxygen tanks?

MARKETING

1. Have you studied your market or potential market?
    - where is your market, how large is it, and what is its growth potential?
    - what species and size of fish are most in demand?
    - what time of year?
    - how many fish can you sell in a season?
    - how many can you produce or obtain from a wholesaler
    - how are prices determined?
    - who are your competitors, what are their strengths and weaknesses, and what advantages will you and your business have?
2. What methods of advertising are you going to use?
    - sign in front of your store?
    - signs posted in other stores, information bureaus, etc.?
    - Yellow Pages listing?
    - what are the costs of different types of advertising?
3. Have you arranged your retail area to be attractive, clean, and well-lit? Have you posted your prices?
4. Do you have dip nets, plastic bags, bait pails, etc. available? Do you have a source of water for your customers to fill their own bait pails?
5. What equipment will you need for cleaning, aerating, and replacing water in the holding tanks?

APPENDIX 8

SOURCES OF SUPPLIES AND EQUIPMENT

An attempt was made to make this list as complete as possible. Listing here does not imply endorsement. See Aquaculture Magazine's Annual Buyer's Guide for a comprehensive list of suppliers.

NETS AND HATCHERY EQUIPMENT

ADPI
3621 "B" St.
Philadelphia, PA 19134
(plastic netting)

Anderson's Bait Distributors
Lonoke, AR 72086
(501) 676-3166

Aquacenter, Inc.
P.O. Box 4877
Greenville, MS 38704
(601) 686-2324

Aquaresearch Ltd.
Karl Ehrlich
C.P. 208
North Hadley, Quebec
J0B 2C0

Aquatic Eco-systems, Inc.
Box 1446
Apopka, FL 32704
(305) 886-3939

Carolina Fiberglass Products
510 East Jones St.
Wilson, NC 27894
(fish tanks)

Frigid Units, Inc.
3214 Sylvania Ave.
Toledo, OH 43613
(aquarium units)

Halvin Products Co., Inc.
1916 McDonald Ave.
Brooklin, NY 11223
(hatchery filters)

Hamilton Marine, Inc.
Searsport, ME 04975
(207) 548-6302
(hatchery equipment)

Heath/Tecna
19819 84th Ave. S.
Kent, WA 98031

Internet, Inc
2730 Nevada Ave. N
Minneapolis, MN 55427
(plastic netting)

Johnson's Fiberglass Net Hoop
Route 4, Box 190
Cabot, AR 72023
(501) 843-3119

Memphis Net & Twine Co.
2481 Matthews Ave.
P.O. Box 8331
Memphis, TN 38109
1-800-238-6380

Naltex
Nalle Plastics, Inc.
203 Colorado St.
Austin, TX 78701-3998
1-800-531-5112
(plastic netting)

Neilson Hatchery Equipment
3501 Portland Rd., N.E.
Salem, OR 97303
(618) 876-7700

Nichols Net & Twine Co., Inc
R.R. 3, Bend Rd.
East St. Louis, IL 62201

Nylon Net Company
P.O. Box 592
Memphis, TN 38101
1-800-238-7529 (fish tanks)

Rainbow's End Productions
Rainbow's End Farm
P.O. Box 203, Route 176
South Brooksville, Maine 04617
(207) 326-9038
(fish tank coolers and consultants)

Red Ewald, Inc.
P.O. Box 519
Karnes City, TX 78118

Research Nets, Inc.
P.O. Box 248
Bothell, WA 98041
(206) 821-7345

Sterling Marine Products
18 Label St.
Montclair, NJ 07042
(201) 783-9800

FISH FEED

Agway, Inc.
P.O. Box 1333
Syracuse, NY 13201
(503) 861-2256

Bioproducts, Inc.
P.O. Box 429
Warrington, OR 97146

Murray Elevator
118 West 4800 South
P.O. Box 7428
Murray, UT 84107
1-800-521-9092

Rangen, Inc.
P.O. Box 706
Buhl, ID 83316

Zeigler Brothers, Inc.
P.O. Box 95
Gardners, PA 17324-0095
1-800-841-6800

CHEMICALS AND WATER TESTING EQUIPMENT

Argent Chemical Laboratories
8702 152nd Ave., N.E.
Redmond, WA 98052
1-800-426-6258

Ben Meadows
3589 Broad St.
P.O. Box 80549
Atlanta (Chamblee), GA 30366
1-800-241-6401

Carolina Biological Supply Co.
2700 York Rd.
Burlington, NC 27215

Chemetrics, Ind.
Mill Run Dr.
Warrenton, VA 22186

Crescent Research Chemicals
4331 East Western Star Blvd.
Phoenix, AR 85044
(602) 945-4733

Forestry Suppliers, Inc.
P.O. Box 8397
Jackson, MS 39284-8397
1-800-647-5368

Engineered Systems and Designs
3 South Tatnall St.
Wilmington, DE 19801
1-800-742-4325 (U.S.)
1-800-638-3779 (Canada)
(pH meters and oxygen analyzer)

Hach Chemical Company
P.O. Box 389
Loveland, CO 80539
1-800-227-4224

Jungle Laboratories Corp.
Box 1630
Cibolo, TX 78108-0630
1-800-327-2200

LaMontte Chemical
P.O. Box 329
Chestertown, MD 21620
1-800-344-3100

Orbeco-Hellige
185 Marine St.
Farmingdale, NY 11735
1-800-922-5242

TSI Company
P.O. Box 151
Flanders, NJ 07836
1-800-631-9690

WildCo
Wildlife Supply Company
301 Cass St.
Saginaw, MI 48602
(517) 799-8100

APPENDIX 9

CONVERSION TABLES

VOLUME AND WEIGHT

1 cubic yard	= 0.764 cubic meter	
1 cubic foot	= 7.48 gallons	= 28,355 grams
	= 62.4 pounds	= 1,723 cubic inches
	= 0.0283 cubic meters	
1 cubic inch	= 0.004 gallons	= 16.4 cubic centimeters
	= 0.016 liters	= 16.4 grams
1 cubic meter	= 35.31 cubic feet	= 1.31 cubic yard
1 cubic centimeter	= 0.610 cubic inches	
1 cubic millimeter	= 0.00006 cubic inches	
1 acre foot	= 43,560 cubic feet	= 12 acre inches
	= 325,850 gallons	
1 million gallons	= 3.0689 acre feet	
1 gallon	= 8.34 pounds	= 3.785 liters
	= 3,786 grams	= 231 cubic inches
	= 0.13 cubic feet	
1 quart	= 32 ounces	= 0.94633 liters
1 pound	= 16 ounces	= 453.6 grams
1 ounce	= 28.35 grams	= 437.5 grains
	= 16 drams	= 29.6 milliliters
1 teaspoon	= 1 1/3 drams	= 36.4 grains
	= 1/6 ounce	= 1/3 tablespoon
1 liter	= 61.023 cubic inches	= 0.035 cubic feet
	= 1.057 quarts	= 0.264 gallons
	= 1,000 cubic centimeters	
1 milliliter	= 0.03382 ounces	= 0.2705 drams

1 dram	= 3.697 milliliters = 1.77 grams	= 27.3 grains
1 gram	= 15.43 grains	= 0.035 ounces
1 grain	= 0.065 grams	

To calculate volume:

$$\text{\# acre feet} = \frac{\text{length (feet) x width (feet) x average depth (feet)}}{43{,}560}$$

\# million gallons = # acre feet x 0.3

RATIOS AND RATES

1 part per million (ppm)	= 0.0038 grams per gallon = 0.028 grams per cubic foot = 0.059 grains per gallon = 8.33 pounds per million gallons of water
1 gallon per minute (gpm)	= 0.00223 cubic feet per second = 1,440 gallons per day (24 hr.)
1 million gallons per day (gpd)	= 695 gallons per minute = 1,547 cubic feet per second
1 cubic foot per second (cfs)	= 7.48 gallons per second = 646,272 gallons per day = 0.992 acre inch per hour = 1,983 acre feet per day

AREA

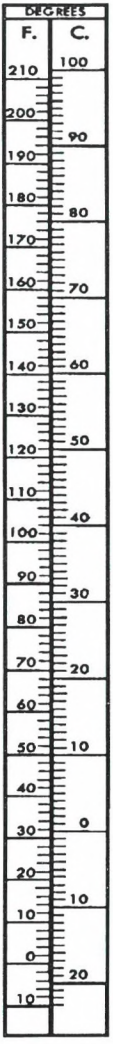
1 acre	= 4047 square meters = 4840 square yards	= 0.4047 hectares
1 square yard	= 0.836 square meters	
1 square foot	= 0.0929 square meters	
1 square inch	= 546.16 square millimeters	
1 hectare	= 10,000 square meters	= 2,47 acres
1 square meter	= 10.73 square feet	= 1.196 square yards

SALT SOLUTION

A three percent salt solution can be obtained by using:

1 ounce of salt per 60 cubic inches of water
4 ounces of salt per 1 gallon of water
30 ounces of salt per 1 cubic foot of water
30 grams of salt per 1 liter of water

TEMPERATURE



APPENDIX 10

GLOSSARY

ACRE-FOOT: One acre of water, one foot deep; 43,560 cubic feet of water.

ANADROMOUS: A fish that spawns in fresh water but spends its adult life at sea.

BAITFISH: In Maine, this refers to small fish that are used as bait to catch larger game fish. A list of legal baitfish may be found in Appendix 2.

BLOOM: A proliferation of algae or plankton that can occur in a nutrient-rich environment. The nutrients may be the result of fertilization, pollution, or the accumulation of fish foods or waste.

BROOD FISH: Sexually mature fish of any species that are used to supply fertilized eggs for aquaculture purposes.

CARRYING CAPACITY: The total number, or number of pounds, of fish that can be held in a pond or raceway without undue stress or mortality.

DISSOLVED OXYGEN (DO): Oxygen that is dissolved in water and that the fish obtain by passing the water over their gills. Cold water is capable of holding more oxygen than warm water. At least 5 ppm DO is required by fish for stress-free survival.

FRY: The next size larger fish than sac-fry. These small fish are beginning to feed on organisms in the water and cease to depend on their yolk-sac. This developmental period is one in which many fish may die if proper food is not provided.

GROWTH RATE: The amount of size increase in a fish in a given amount of time: e.g., a 3 inch increase in length in one year.

LIVE BAIT: See baitfish

pH: A unit of measure for expressing the degree of acidity in water. On a scale of one to 14, seven is neutral; higher numbers are basic and lower number are acidic.

PPM (PARTS PER MILLION): The term usually used to represent a proportion of a substance to a given amount of water. For example, one ounce of chemical per one million ounces of pond water equals one ppm.

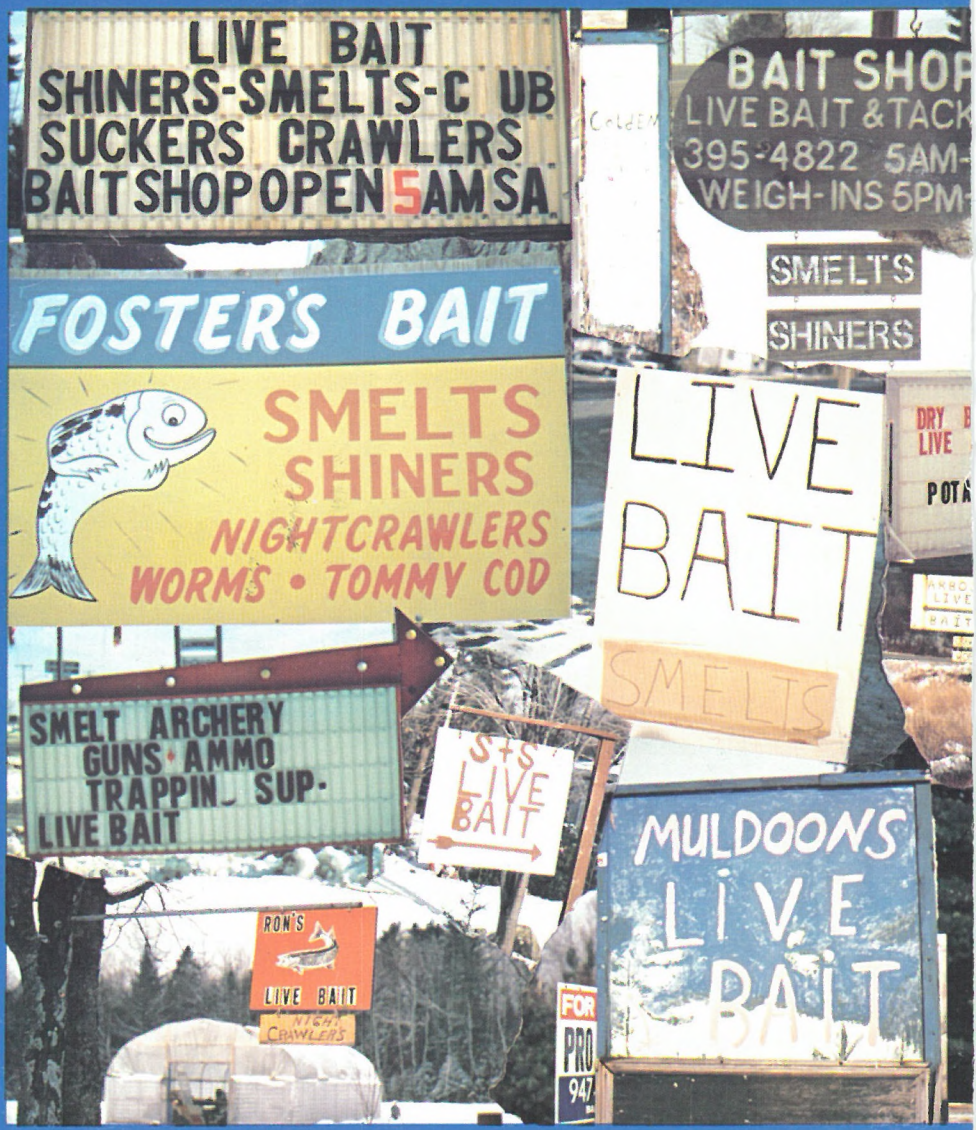
SAC-FRY: Recently hatched young fish that still have their yolk sac attached to their abdomen. They will feed off this yolk fo the first few days or weeks after hatching.

SATURATION: A state of equilibrium where, at a given temperature, water contains all of the dissolved gasses that it is capable of holding. Less gas can be dissolved in water at higher temperatures; more gas at lower temperatures.

SECCHI DISK: A disc about 8 inches in diameter, painted in black and white quadrants; used to measure water transparency.

SPINY-RAYED FISH: Fish that have rigid, pointed spines in one or more of their fins.

STOCKING DENSITY: The number of fish, or the pounds of fish, stocked per unit area or volume of water: e.g., 1,000 fish per acre or 5,000 fish per five acre feet.


LIVE BAIT
SHINERS-SMELTS-C UB
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SMELTS
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GUNS • AMMO
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LIVE BAIT
NIGHT CRAWLERS
MULDOONS
LIVE
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