Cooperative Extension Program

Tank Spawning and Hatching of Golden Shiners

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The majority of golden shiner producers use the egg-transfer method to stock their ponds. Unfortunately, this involves the daily transfer of hundreds of egg-laden mats to rearing ponds. Less than 40 percent of these eggs hatch; the rest are lost to fungus, predators and low dissolved oxygen.

Tank spawning and hatching is now practiced by a major goldfish producer, and has great potential for producers of golden shiners. The main advantages are:

1) Less labor is required to run a hatchery than to move mats.
2) Egg survival is much better and fewer broodstock are needed.
3) Known numbers of fry can be stocked into prepared ponds.
4) Fish can be spawned early or late in the season.

This last advantage shows considerable promise for reducing the need to stunt fish. Broodstock can be brought indoors in March when pond water temperatures are in the lower 40s; they will spawn by the second night. It is also possible to spawn fish during the summer months. In an experiment at the University of Arkansas at Pine Bluff, broodfish that had spent the summer in a hot, shallow pond were brought indoors in mid-August, during a time of very hot weather. Fish were placed in tanks with 79°F well water, and they spawned that night. If fish can be reliably spawned during the late summer, fry could be raised for crappie bait without stunting.

Tank spawning and hatching is a new technology that is rapidly evolving and improving. This fact sheet contains the best current information available on these practices, but it is far from a complete guide. There are a number of areas where additional research and on-farm experience are needed, and farmers are advised that recommendations may change as more information becomes available.

General Hatchery Facilities

An enclosed hatchery building contains broodstock holding tanks, spawning tanks, egg incubation facilities (jars or tanks), fry holding tanks and a table for bagging fry for transport to ponds. Hatcheries used for out-of-season spawning will also require a heating and cooling system

and a water heater. The air will be humid and water will condense on windows and walls, so it is important to use water-resistant materials and lighting fixtures. Noise can be reduced by mounting blowers in the space above an insulated ceiling. Design the hatchery so that broodfish can be moved in and out while minimizing heat loss. For example, one hatchery has a window by each broodstock holding tank. Broodfish can be unloaded from haulers into the tanks by running a plastic pipe through an open window. Allow plenty of space around tanks for ease of harvesting fry. It is important to leave flexibility in the hatchery design for future improvements.

Water quality requirements for golden shiner hatching are similar to those for other fish species. SRAC publication 461 outlines requirements for channel catfish hatchery water quality, and requirements for golden shiners are similar to those of catfish.

Estimating Broodstock Needs and Sizing the Hatchery

The first step in planning a tank spawning and hatching program is to calculate the number of fish that can be sold each year, and then to work backwards to estimate the pounds of broodstock required to produce that number of fish. The broodstock requirement, in turn, gives an idea of the size of necessary hatchery facilities to handle the brooders. Figure 1 shows how to estimate broodfish requirements for each one million fish sold. Based on these assumptions, about 417 pounds of brooders are needed to produce one million marketable fish. However, each producer should make their own calculations based on their particular operation.

Figure 1.
Calculation of Broodstock Requirements for Tank Spawning

For: 1 million salable fish

If: 50 percent survive from peewee size to market size

Need: 2 million peewees (0.5-1.0 pound per 1000 fish)

If: 40 percent survive from fry to peewee

Need: 5 million fry

If: 80 percent survive from egg to fry

Need: 6.25 million eggs

If: average of 750 eggs per female, 25 pounds per 1000 fish and broodstock 50 percent female

Need: 16,666 broodfish or 417 pounds of brooders

Once the amount of broodstock has been calculated, the size of the hatchery can be estimated. For instance, if the goal is to produce 10 million fry within a month, then spawning 100 pound lots of brooders nine times (in three-day cycles) should result in the required number of fry in 27 days. Two holding tanks would be needed, each capable of holding 100 pounds of fish. One tank would be used to hold new brooders, and the other for spent brooders awaiting return to the brood pond. Spawning tank space is needed to hold each batch of broodfish for one or two nights. For each 100 pounds of brooders, two 200 to 250 square foot spawning tanks, each with room for about 40 18 x 30 inch spawning mats (150 square feet) would be needed. Building several smaller spawning tanks instead of one large tank allows for more flexibility. Small batches of fish can be spawned without wasting space and water, and if fish are not producing many eggs, brooders can be concentrated in an area with fewer mats.

If the 100 pounds of brooders are half female, broodfish (25 pounds per 1000) should produce about 3 liters (3/4 gallon) of eggs each cycle (1 1/2 million eggs). Two hatching jars or 10 to 12, 180-gallon hatching tanks would be required to hold this amount of eggs. Twice this number of jars or tanks is needed in the hatchery, as the three-day cycles overlap, and eggs from one batch will still be in the jars or tanks when a second spawn of eggs is collected. Hatching eggs in jars reduces the number of tanks required, but at least two 180-gallon tanks are still needed to hold fry once they hatch.

While there are some advantages to constructing a large hatchery and shortening the spawning period required to stock all ponds, fry production from a large facility may at times exceed the capacity of available ponds. Most farms that have traditionally used the egg-transfer method are accustomed to preparing ponds over much longer periods. Proper timing of fry stocking after the start of pond preparation is so critical to subsequent fry survival that special care must be taken to make sure that ponds are ready to receive fry.

Pond Care of Broodstock

Golden shiners develop their eggs slowly over the winter in ponds; proper care of broodstock during the fall and winter is critical to egg quality. Broodfish should be fed at 2 percent of body weight on warmer days during the winter (when the air temperature is above 45°F). In general, feed on days that the temperature is becoming warmer or staying warm. Shiners can be brought indoors early in the spring and warmed up, and they will spawn. However, if this is done too early, there will be little natural food

available for the fry when moved outdoors to ponds. Shiners can spawn several times during the spawning season. With care, the same brood fish that are tank-spawned one time can be returned to a holding pond, cared for and then spawned again in several weeks.

Broodfish will be a "pond run" mix of males and females. The ratio of males:females in one-year-old fish can sometimes be skewed from 1:1. We have seen populations with many more females than males, but this apparently has not hurt egg production and, in fact, may have helped increase it. While there has not been any research to date on the optimum ratio of female to male fish, it is likely that increasing the proportion of females to males would give higher egg production. However, egg production is reduced by half if there are only 10 percent male fish or less.

When golden shiners are in breeding condition, males can easily be differentiated from females. Males have bright gold pelvic fins, while the females pelvic fins are usually clear or with only a slight tinge of gold on the outer edges. Other fins on the males are brighter gold as well. Males also have a dusky cast to the lower abdomen/vent area and a fine sand-papery feel to the body, especially the lower sides, while the females remain white and smooth. Males are generally smaller than females, but this may not always be the case. When fish are ripe, males will release milt with slight pressure to the lower abdomen.

It is critical to seine brood fish with greater care than is typically used in harvesting fish for sale. Fish must be held more loosely in the seine, dipped in small quantities and handled gently. Fish that are too stressed may not be in the mood to reproduce! Males should be running milt at gentle pressure near the vent, and females should have swollen abdomens. Fish should be transported to the hatchery at a density of less than 0.3 pound per gallon.

Spawning

Broodfish from the pond should be held in a shallow tank and tempered to the indoor water source temperature (usually well water) at a rate of no more than 5°F per hour. Fish can be anesthetized to reduce stress during transfer, and this has been reported to reduce the need for tempering fish. The tempering process is continued when fish are moved from the holding tank to a spawning tank. Spawning tank water temperature should be in the range of 71° to 77°F. In a number of trials, egg production from broodfish held at 72° or 77°F was greater at the warmer temperature early in the season (March) but the difference disappeared as pond temperatures increased (by mid-April). Tank water temperature should be kept below 81°F because fish gonads will regress (shrink) at higher temperatures.

The spawning tank should have two sections, a shallow area for the spawning mats, and a deeper central area where fish can stage before getting up on the mats (Figure 2). Lights over the tank should provide 15 to 16 hours of light, starting at natural sunrise and extending the light period into the night. Females will ovulate at the beginning of the dark period, and spawning should commence shortly thereafter if spawning material is available. The presence of an appropriate spawning material for 12 hours before ovulation has been shown to be one of the factors triggering spawning. Fresh and rising water is also a cue for spawning, but is secondary to the role of temperature, light and spawning material.

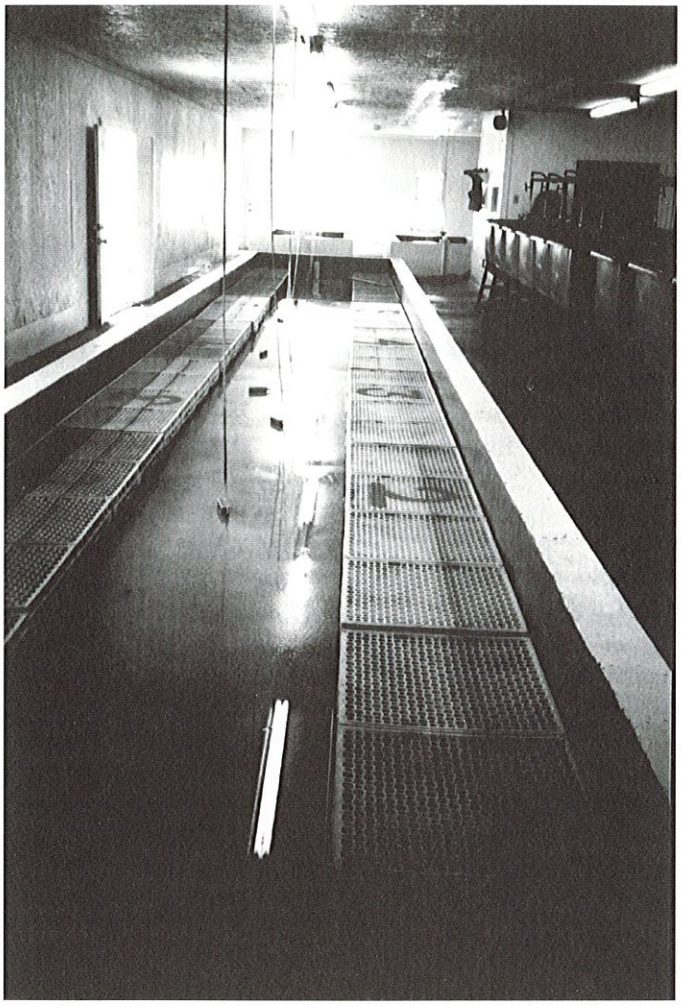

Figure 2. Indoor tank used for spawning goldfish (Pool Fisheries, Inc., Lonoke). Plastic spawning mat supports are numbered to help keep them in sequence, as the supports are different heights to keep mats at a constant depth while compensating for tank slope towards the drain.

Avoid strong aeration or water currents around the spawning mats as the eggs take some seconds before becoming sticky and will wash away. Mats submerged just below the surface receive most eggs. Place mats on platforms that hold them level at a depth of 1 to 1 1/2 inches, and place a few additional mats on the tank floor to catch the scattered eggs.

Broodstock that are brought into the hatchery before 9 to 10 a.m. will usually spawn the first and second nights. Early in the season, if pond temperatures are cooler than 65°F or so, fish may not spawn until the second night in the tanks. If the outside pond temperature is high enough to trigger wild spawning, fish should spawn the first night in the tanks. Once fish are placed in the spawning tank, they should be left undisturbed as much as possible. When fish begin spawning, they should be left alone until spawning ends. After the first night of spawning, fish may also spawn during the day. While water exchange is needed to prevent the buildup of ammonia, leave some of the foamy, hormone-laced water from one spawning episode to trigger rapid spawning of the next batch of fish.

After fish have spawned, check a random sample of fish for eggs. Most females should have spawned, with at most only 10 to 15 percent still with eggs. Egg production per female should be around 500 to 1,000 over the two-night period. After one or two nights, return brood fish to the pond.

Tank spawning provides a ready source of clean egged spawning mats for tank incubation. While mats from brood ponds can be incubated indoors, the silt and algae that typically accumulate will foul drain screens in the hatching facilities. If pond spawning is practiced, use new mats only and place mats on a floating rack, away from the shore, for egg deposition.

Mats with eggs MUST be treated with special care. Egged mats should be transported to the hatchery in a hauling tank, and should be stacked horizontally, taking care to handle the mats by the wire frames only. This is critical to egg survival and to reduce the number of dead eggs that serve as sources of fungus growth.

Hatching

Eggs can be left attached to spawning material and incubated in tanks or they can be removed and the loose eggs incubated in jar incubators. Mats with upwards of 150,000 eggs can be incubated directly in plastic tanks (Figure 3). If there are fewer eggs on a mat, remove eggs with sodium sulfite for jar hatching. Otherwise, too much tank space will be occupied by inferior mats, reducing fry production. Tank hatching eggs attached to mats does not require the additional labor for egg removal. The mat material serves to protect newly-hatched fry and allows sufficient water to be run through the tank to maintain water quality without stressing fry. However, the mats are relatively bulky and numerous tanks must be devoted to egg incubation. Egg removal is quick and easy, and saves water, space and chemicals for fungus treatment.

Figure 3. Semi-square tanks used for hatching eggs on mats (Pool Fisheries, Inc., Lonoke).

Egg Removal and Jar Incubation

To remove eggs, place the mat face-down in a 1.5 percent solution of sodium sulfite and gently shake the mat in the liquid. The tub with the sulfite solution should be lined with a fine mesh screen, 600 to 800 microns in size, to retain and remove the eggs. Eggs will come off the mat material within 15 to 20 seconds. However, eggs should be left in the solution for 2 to 2 1/2 minutes to complete the degumming process. If eggs are removed earlier, they will tend to clump together. Fresh eggs are stickier, as they may still be absorbing water. Do NOT leave the eggs in the sulfite solution for more than 4 to 5 minutes. It contains no oxygen, and eggs will eventually suffocate and die if left too long. Sodium sulfite is used industrially to remove scale from boilers, is quite inexpensive and is available in 50 pound bags. The sulfite solution can be reused for many batches of eggs, but should be replaced periodically.

Remove the screen with the eggs and place upside-down into a tub of fresh water. Good eggs are slightly yellowish in color and sink to the bottom, while dead eggs are white and float. After the eggs settle a minute, pour off excess water, along with dead eggs, and pour the remaining water and eggs into a bucket through a coarser screen (window screen) to remove bits of mat material and other debris. Collect eggs and determine the volume using a graduated cylinder. Each milliliter (ml) contains approximately 450 to 550 eggs, depending on the size of the broodstock.

A small percentage of people have strong allergic reactions to sodium sulfite (which is why it is no longer used on food bars to keep fruits from turning brown). Make sure that this is not a problem for hatchery workers. In any case, gloves, aprons and protective eyewear should be worn when using sodium sulfite.

Detached eggs are incubated in plastic McDonald-style hatching jars. Other types of incubators, such as trays or conical tanks, might be suitable as well, although they have not been tested. Golden shiner eggs are normally attached to vegetation in quiet areas and it would seem advisable to avoid strong agitation of the eggs. Fish eggs in general are particularly susceptible to physical shock in the early stages of development. For golden shiners, this would be the first few hours after eggs are laid, and it would be a wise precaution to be especially careful in handling fresh eggs. In experimental trials, jar incubation using a relatively gentle roll of eggs has yielded good results, with an estimated hatch rate of 80 to 90 percent. Optimum water flow in hatching jars for other fish species is listed at up to 1 gallon per minute (gpm). In trials at UAPB, with small quantities of eggs per jar, a flow of 0.7 gpm was sufficient to roll eggs.

Enough hatching jars are needed to hold eggs for three to four days. Eggs will hatch in two to three days, then fry will stick to the jar walls and take an additional one to two days to absorb their yolk sacs. Just how many golden shiner eggs can be incubated in a single jar is still unknown. A hatching jar can hold up to 50,000 grass carp eggs. As golden shiner eggs (1 mm diameter) are much smaller than Chinese carp eggs (diameter of 5 mm or more), it is likely that up to 250,000 eggs, (2 liters or 1/2 gallon of eggs) could be incubated in a single jar.

Once fry in hatching jars are free-swimming, they can be transferred to tanks. The optimum stocking rate for golden shiner fry in tanks is still undetermined. Based on rates for Chinese carp, with constant water flow (exchanging water every half hour), fry can be held at up to 50,000 per gallon. On the other hand, hybrid striped bass larvae must be held at much lower densities, as the fry crowd together and if the density is too high, they will suffocate. Lower rates (5,000 to 6,000 per gallon) with constant water exchange are indicated until additional research can be conducted.

Tanks with an external drainpipe and a large diameter internal standpipe with cutouts covered with fine mesh (500 to 600 micron) screen are used to exchange water without trapping fry against the screening. One Chinese carp hatchery uses pantyhose as fine mesh screen. A perforated airhose around the base of the inside standpipe will release bubbles and the current helps keep the screens clean. Tanks for golden shiner fry can be modeled after designs for Chinese carp larvae.

Fry are ready to stock in ponds when they are free-swimming. If necessary, hold fry for several days in tanks and feed three to twelve times per day with a 100 to 150 micron feed (shrimp larvae feed, like Zeigler Larval AP100[1]) until they are stocked. Automatic feeders are recommended.

Tank Incubation of Egged Mats

If eggs are left on mats, mats should be set on edge on racks within tanks, with spray nozzles directing fresh water down onto the tank surface. Semi-square 180 gallon plastic tanks have been used successfully, and will hold six to eight standard spawning mats. The mats are an organic material and will use oxygen during the incubation process. Care must be taken to keep dissolved oxygen levels near saturation. Once fry are free-swimming, they can be harvested by slowly dropping the water level below the mats.

Fungus Control

Treat eggs with 1,000 ppm hydrogen peroxide (if using 30 percent active ingredient hydrogen peroxide, add 0.4 fluid ounce per gallon of water) for up to 15 minutes (not longer) after mats are moved to incubation tanks or after eggs are placed in jars or trays. Hydrogen peroxide can be added to the head tank (water supply reservoir) if it is small enough in volume that it will empty in 15 minutes. Alternatively, a small diameter plastic tube can be used to siphon dilute hydrogen peroxide solution from an elevated container into spawning jars. Eggs in jars will float due to bubbles from the treatment, and a fine mesh screen (600 micron or less) should be set in the top of each jar prior to treatment to prevent egg loss. Eggs can also be treated with 500 to 1,000 ppm of formalin for up to 15 minutes (not longer). Eggs should be treated daily for the first two days, but avoid treating older eggs (once eyes are pigmented), as it may lead to premature hatching or fry death.

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[1]Use of trade or manufacturer names does not imply endorsement.

Figure 4. Estimating Fry Numbers by the Volumetric Method

Formula:

$$\text{total fry} = \frac{\text{average number of fry per sample}}{\text{volume of sample (ml)}} \times 1000 \times \text{volume of original container in liters (or its weight in kg)}$$

Example:

Fry are placed in 40 liters of water (almost 10 gallons). Five 20 ml samples are taken and the counts are:

21, 17, 31, 25, 22, for an average of 23.2 fry per 20 ml, or 1.16 fry/ml

There are 1,000 ml per liter, and we have 40 liters, so the estimated number of fry in the container is:

1.16 fry/ml X 1,000 ml/L X 40 L = 46,400 fry/container

Counting and Bagging Fry

Once fry are produced through tank hatching, the number of fry available on a given day must be estimated in order to know how many ponds can be stocked that day. The simplest method to estimate fry numbers is the volumetric method (see Figure 4 for an example). Fry are placed in a known quantity of water. This can be done by either measuring a volume of water or by weighing the water. Place fry in the water, gently mix the fry and take three or more subsamples from the container. For ease of counting, choose an appropriately-sized sampling cup so that there are between 15 to 50 fry per subsample. For example, a 100 ml sample cup can be used for low fry densities and a 10 ml cup for high densities of fry. Samples can be taken using inexpensive 25 ml plastic graduated cylinders or 100 ml specimen cups, cut at various heights. If there are too many fry in a subsample, counting becomes tedious, but if there are too few, the estimate of total fry will be inaccurate. Count the fry in each subsample and use the average number per subsample to estimate the total fry in the original container. This method generally gives an estimate within 10 percent of the actual number.

It is easier to handle fry if they have been anesthetized first so that they swim slowly. Fry may be treated with an approved brand of MS-222 at the recommended dose on the label. Monitor the DO (dissolved oxygen) in the container with the fry to ensure that there is at least 5 ppm. Despite their small size, fry use up much more oxygen per pound than do larger fish.

It is difficult to weigh golden shiner fry to estimate numbers because these fry are so small. The weight of water that clings to fry can be as much as the weight of the fry, and the weight changes as this water evaporates. Newly-hatched goldfish average 1 mg each, while golden shiners are about 0.5 mg. Individual fry weight will vary by up to 30 to 40 percent with differences in egg size.

The optimum stocking rate for golden shiner fry in plastic bags has not been determined. Grass carp fry are added to plastic bags at a rate of 100,000 fry per bag (in two gallons of water). A rate of up to 1 million fry per 8 1/2 gallons of water has been used successfully for transporting goldfish fry short distances.

For more information and assistance in developing a tank spawning, hatching and fry stocking program, contact the UAPB Aquaculture/Fisheries Center Extension specialists at the Lonoke County Extension Service office at (501) 676-3124.

Acknowledgments: We thank Drs. Carole Engle, Andy Goodwin, Joe Maret and Hugh Thomforde for assistance with this fact sheet.

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FSA9081-1M-12-98N