

Additional study of the most promising herbicides included in these experiments is needed to further refine rates of application. New introductions and combinations of accepted herbicides also need to be tested. The use of the screening technique outlined in this paper is suggested as an aid in carrying out this work.

LITERATURE CITED

- Bauman, A. C. 1947. 2,4-D and Some Emergent Aquatics. *Prog. Fish Cult.* 9(2):71-77.
- Eyles, Don E. and J. L. Robertson. 1944. A Guide and Key to the Aquatic Plants of the Southeastern United States. *Pub. Health Bull. No. 286* 151 pp.
- Fassett, Norman C. 1940. A Manual of Aquatic Plants. McGraw-Hill Book Co., Inc., New York. 382 pp.
- Grigsby, B. H., C. H. Reimer and W. A. Curler. 1955. Observations on the Control of Cattail, *Typha spp.* by Chemical Sprays. *Quart. Bull. Mich. Agri. Expt. Sta.* 37(3):400-406.
- Hall, T. F. and A. D. Hess. 1946. Studies on the Use of 2,4-D for the Control of Plants in a Malaria Control Program. *Jour. Nat. Malaria Soc.* 6(2):99-116, June 1947.
- Snow, J. R. 1949. Control of Pondweeds With 2,4-D. *Prog. Fish Cult.* 11(2):105-108.
- Surber, E. W., C. E. Minarik and W. B. Ennis, Jr. 1947. The Control of Aquatic Plants With Phenoxyacetic Compounds. *Prog. Fish Cult.* 9(3):143-150.

PROPAGATION OF CHANNEL CATFISH (*Ictalurus lacustris*) AT STATE FISH HATCHERY

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INTRODUCTION

Requests for channel catfish for stocking purposes have greatly increased during the past few years. The supply of fingerlings from state and private hatcheries has not met the demand for stocking these fish in public and private waters of the state. Channel catfish are an important game and commercial fish (minimum length as a commercial fish is sixteen inches) in Arkansas. Many farmers are requesting channel catfish stocked in their ponds in combination with game fish. In Arkansas, during the past five years, commercial fish farming in the rice belt has grown so that now several thousand acres are under water. The production of fingerling channel catfish by private hatcheries for stocking these areas appears to be a lucrative enterprise.

The demand for edible size channel catfish for the commercial market and home consumption has increased steadily. Retail prices range from forty to sixty cents per pound. The value derived from stocking farm ponds with channel catfish has not been definitely determined, since limited numbers of farm ponds have been stocked with fingerlings from this hatchery and the harvest has not been completely evaluated. However, catch reports from pond owners would indicate that 40 to 60 percent of the fish stocked were caught. These fish ranged in weight from one to three pounds after being in the pond for only one growing season.

During the fall of 1956, in cooperation with the U. S. Soil Conservation Service, 12 choice farm ponds were stocked for experimental purposes. The stocking rate was 50 fingerling catfish per acre. The results of this experimental stocking will not be known until the fall of 1957 and thereafter. It is hoped that continued observation and experimental culture of this type with the channel catfish will (1) furnish farmers with additional meat for their tables and (2) better utilize the resources of their ponds.

Methods used for propagating this species vary from hatchery to hatchery and from state to state. The following pages are devoted to a description of

methods found successful for propagation of the channel catfish at the Centerton State Fish Hatchery.

HATCHERY

The Centerton State Fish Hatchery is located in the extreme northwest corner of Arkansas. This hatchery has been producing fingerling warm water fish for the north and northwest part of the state for over twenty years. The propagation of channel catfish was not introduced until 1947. The demand for this species has increased each year. Presently 80 percent of the fish raised here are channel catfish.

The water supply for this hatchery comes from a large spring with a normal summer flow of approximately 1,000 gallons per minute. The pH of the water varies between 7.0 and 7.4. The temperature of the water stays around 58° F.

The culture ponds range in size from 1 to 4.5 acres. Some of the ponds are constructed to drain individually while others drain in series.

SPAWNING PENS

Channel catfish are spawned in pens at this hatchery. The pens are built in the shallow area of a three-acre pond (Plate I). They have a maximum depth of about 30 inches and the bottom gradually slopes upward to the edge of the pond. The pens range in size from 5 feet to 6 feet in width and 10 feet to 12 feet in length and are constructed of welded wire with a mesh of 1 inch by 1½ inches. The bottom edge of the pens should be securely anchored to prevent the brood fish from working out of the enclosure. During the time the male is compelling the female to deposit her eggs, she will escape from the pen, if it is not properly constructed. A limited amount of fresh water should be allowed to pass through the spawning pond.



PLATE I. Spawning pens for channel catfish. The board fence is needed to prevent wave action from damaging the pens. Note the position of the spawning containers.

SPAWNING CONTAINERS

Nail kegs may be used for the nests, but it has been found that 10 gallon milk cans are more satisfactory. These do not have to be replaced as often as the kegs. The constricted opening of the milk can prevents the fry from work-

ing out of the container. The kegs or milk cans are submerged in at least 24 to 26 inches of water. They should be placed midway on one side of the pen and securely fastened with stakes and wires to prevent them from being tossed about by wave action. If kegs are used they should be submerged in the ground so that the opening of the keg is flush with the bottom. This will prevent the male from working the fry underneath the keg. A good spawning container for large fish can be made from 100 pound grease cans (Plate II). It is important to exclude light from the spawning container.

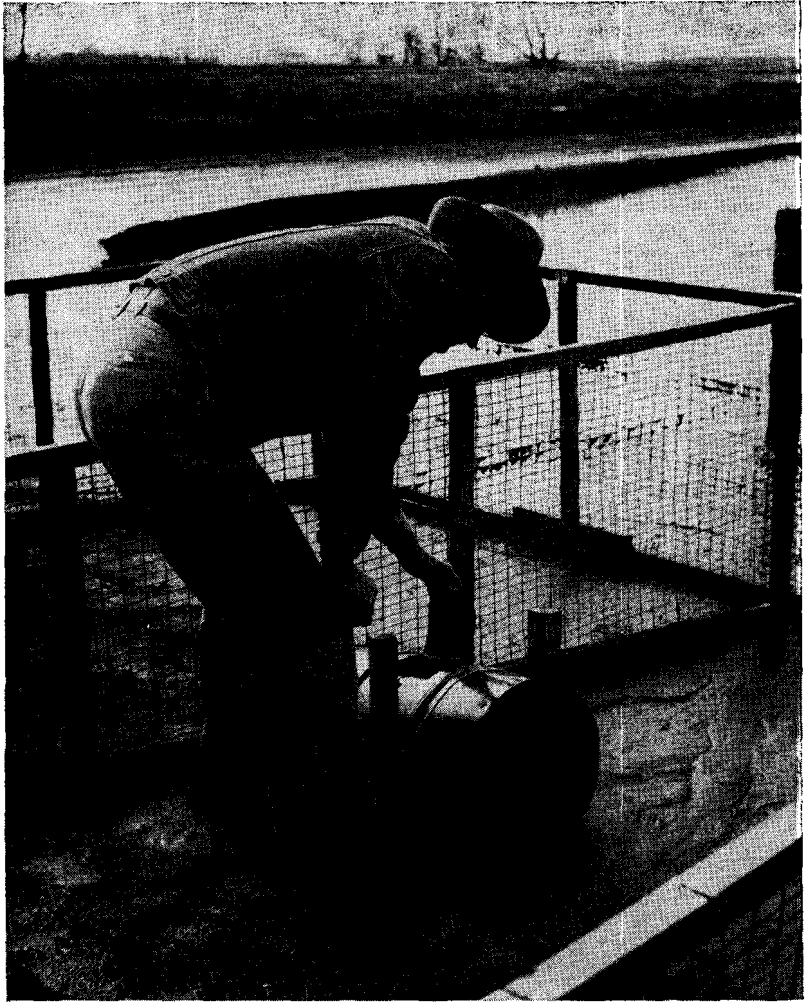


PLATE II. A spawning container made from a grease can. The open end is partly boarded up to exclude light. The window cut in the top enables the fish culturist to more easily inspect for eggs and fry. Note the dead algae on the wire of the spawning pen, which indicates the depth the water is held in the pens.

CARE OF BROOD FISH BETWEEN SPAWNING SEASONS

The adults are distributed throughout all the ponds in the hatchery during the summer months. Their diet consists of natural available pond food, predominately crayfish. When fall distribution starts and the ponds are being

drained, the adult catfish are removed with a one-inch mesh seine and are placed in a pond to themselves. The one-inch mesh seine is used so the fingerling fish can escape. The fingerlings are later removed with a one-fourth inch mesh seine which has been "treated" by dipping in asphaltum varnish. This treatment prevents the serrated spines of the little catfish from hanging in the webbing.

CARE AND CONDITIONING OF BROOD FISH DURING THE WINTER AND SPRING MONTHS

After male and female brood fish have been placed in a pond to themselves, care should be taken in supplying a proper diet. During the months of December, January and February their diet consists of a small portion of cut feed such as golden shiners and carp. A gradual increase in the amount fed is started around March 1 and by April 1 the fish are fed as much as they will consume. This rate of feeding should be continued until time for spawning.

On or about April 15, the brood fish are sexed, placing a male and female in each pen. The balance of the brooders are placed in small ponds (males separated from females). The spawning season is extended over a longer period of time by separating the fish. After the fish are placed in the pens, they are fed twice each week until eggs are found. At this time, feeding is discontinued. If a male is used for a second female, he should receive food between spawns. The brooders that remain in the small holding ponds are also fed twice a week.

HOLDING BROOD STOCK FOR DELAYED SPAWNING

Since the water supply here at the hatchery is derived from a cool spring, we can prolong the spawning over a long period of time.

This year the males and females were sexed and placed in 0.3 acre ponds. The temperature of the water was held at 62° F. to 65° F. during May, June and July. The fish that were selected for spawners were tempered 20 to 30 minutes before being released in the warmer water of the spawning pens. In previous years, our brooders were held in one-acre ponds having a temperature the same as the water temperature in the spawning ponds. The spawning period was extended two weeks this season by holding the brooders in the smaller ponds where a lower water temperature was maintained by passing a large volume of spring water through the ponds.

SELECTING BROOD STOCK

Nice, clean, healthy fish weighing from 3 to 10 pounds should be selected. Any fish larger than 10 pounds would require a very large spawning keg.

All the brood fish do not ripen at the same time. The larger and older of the brooders usually spawn earlier than the smaller and younger ones. The fish most likely to spawn the earliest may be determined by a close examination of the reproductive vent. Therefore, by placing these fish in the pens first, the brooders do not have to remain in the pens for long periods before spawning.

Only one pair of fish should be placed in each pen. More than one pair to the pen would result in fighting between the males and poor production.

HOW TO DISTINGUISH THE SEXES

There are several methods used to distinguish the male catfish from the female catfish:

1. The female is slightly lighter in color than the male fish.
2. The head of the female is slender and long while the head of the male is more blunt and rounded.
3. The sexes can be more accurately distinguished by examination of the external genitalia. The male genital organ comes to a sharp point with its opening toward the tail (Plate III). On the female, the opening of the vent is more slit like. A small flap covers the opening. Near or at spawning time the vent of the female is loose, inflamed, swollen and sometimes pulsating (Plate IV). A lead pencil is a good tool for examining the vent.



PLATE III. The male channel catfish. The external genitalia is slightly raised and pointed with an opening posteriorly. Very little inflammation will be noted. Note how the fish is held. The spines of the channel catfish can inflict a painful wound.

MATING FISH AND PREPARING THE NESTS

In selecting the pairs of fish it is important that the male be slightly larger than the female. Due to his larger size, the female will not disturb the male during his preparation of the nest and his size will give him an advantage in inducing the female to spawn.

It is not necessary to place gravel in the nest. This will only cause extra work for the male, since he thoroughly cleans the inside of the container. After the nest is clean, the male will stay near the female sometimes for as long as a week. In the meantime, he continues his work of keeping the nest clean. After a period of time, the female will enter the keg and deposit a layer of eggs; the male pushes her aside and begins the process of fertilization. When he has finished fertilizing the first layer, the female will deposit another layer. This process is repeated until the female is spent, after which the male compels



PLATE IV. The female channel catfish. The external genitalia is depressed (concave) inflamed, sometimes pulsating, loose looking, and has a ventral opening. Note that the belly of this fish is rounder and fuller than the belly of the male fish shown in Plate III.

her to leave the nest. The male fans and circulates the water and cares for the eggs throughout the incubation period.

It is best to remove the female from the spawning pen as soon as she has deposited her eggs, thus allowing the male to hatch the eggs without any interference from the female as she will continually try to eat the eggs.

CHECKING SPAWNING PENS

Starting around May 1, after the water begins to warm, nests are checked daily. At this time the temperature fluctuates between 65° F. and 72° F. The pens should be numbered so that a record may be kept as to when the fry are to be moved. When the eggs are found and the female removed, the nest should not be disturbed until the ninth day. During the month of May, it will take 9 to 10 days for the eggs to hatch. In June, when the water is warmer, only about 8 to 9 days are required. During the time the male is hatching the eggs

he should not be fed or molested in any way. Slamming of car doors, shooting a gun or any unusual noise, or jar should not be allowed near the pens. Any disturbance might cause the male to eat the eggs or move them from the nest.

The male fish will attack anything attempting to molest the nest of eggs. We find that a heavy wire, three feet long, with a small piece of cloth wrapped around one end is very good for checking the nests. If the male is guarding eggs, he will attack the cloth as soon as it is inserted in the mouth of the spawning container. If this happens you may be sure eggs are present and no further checking is necessary. In event the male leaves the container, very gently insert the cloth end into the container and if eggs are present a soft spongy feeling will be noticed.

ENCOURAGING SPAWNING

Through June and the first part of July the penned fish seem to spawn for a few days then will completely stop. We find that by rapidly raising the water level one or two inches in our spawning pond, we can increase spawning activity immediately. This system was tried five times in June and July of this year and worked successfully each time. The pond immediately above our spawning pond was held six inches above normal in order to have adequate water in sufficient volume for this purpose.

REPLACEMENT OF FISH IN PENS

After the fry have been moved to the rearing ponds or feeding troughs and the proper period of time has elapsed, the container is replaced in the former position and another female is placed in the pen. If the male has done a good job of hatching the first spawn, he should be used again being sure he receives one large ration of feed before starting the second spawning. This practice reduces the number of male fish needed and results in reduced operational costs. Fish that are not good spawners should be eliminated from the brood stock.

In some instances a few of the young catfish might have left the container and failed to be moved with the nest. If the container is immediately replaced, the male will concentrate on fanning the fry back into the container and will continue to care for them. Therefore, the container should not be replaced for a 24-hour period thus allowing time for the fry to work out of the pen into the spawning pond. The spawning container may then be replaced along with another female. This produces quicker spawns with less fighting in the pens.

As previously stated, the male may be used for more than one spawn if he has done a good job with the first nest. This season two males were used for four spawns each. At least half of our males spawned three females. In selecting the female, caution should be taken to be sure she is ready to deposit her eggs or considerable fighting will occur between the two fish. In some cases, if she is not ready to spawn, he will be so ferocious that he leaves her so mangled she is not suitable for spawning. In event this happens she should be replaced with a new female. This same thing might happen if he is guarding a few fry in the container as mentioned in the above paragraph.

CULTURE PONDS AND CARE

The culture ponds vary in size from 1 to 4.5 acres. The ponds should be left dry as long as possible and filled with water only immediately before receiving the fry. This will help prevent insect life from destroying the young fish. After the ponds are filled many kinds of insects will be noticed and most of them will prey on the young catfish. In the event that the ponds are filled weeks before the fry are to be introduced, the practice is to begin treating the water 8 to 10 days in advance and continue the treatment until the fish are at least two inches long. One quart of motor oil to five gallons of kerosene, for a three-acre pond, will kill most insects that are injurious to small catfish. Air breathing insects return to the surface ever so often. The mixture of oil and kerosene will prevent them from breathing. Treatments should be twice a week and on days when there is just enough wind to move the mixture slowly across the pond.

FEEDING TROUGHS

The feeding troughs are constructed of 1" x 12" x 12' pine lumber placed on racks approximately two feet high to prevent snakes and turtles from destroying

the fry (Plate V). Water should flow through the troughs at all times. We allow the full flow of a one-half inch valve with an 18 inch head to pass continuously through each trough.

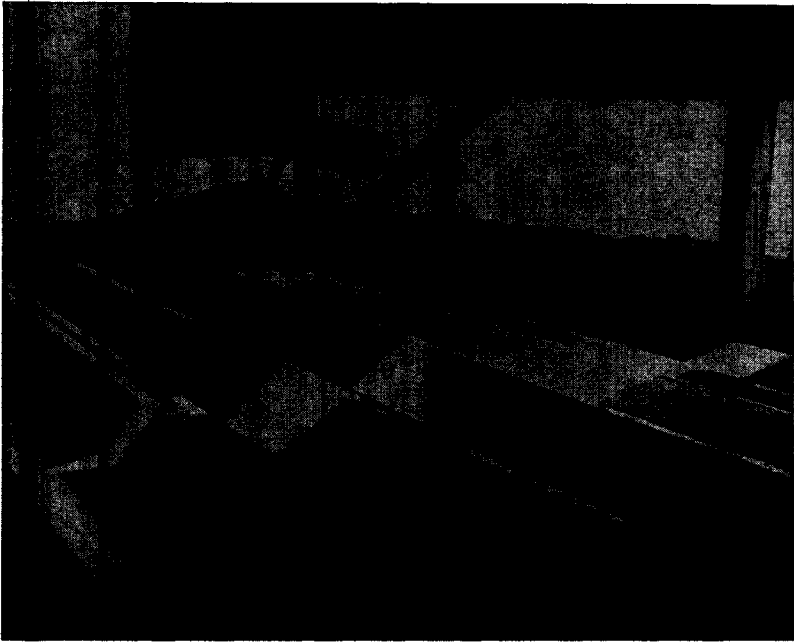


PLATE V. Feeding troughs where the fry channel catfish are held until they absorb their yolk sacks. Here they are protected from predators and can be fed for several days to give them a good start.

REMOVING THE FRY FROM THE SPAWNING CONTAINERS TO THE TROUGHS

A square tub is filled approximately one-fourth full of water and placed in one corner of the pen (floating). Carefully raise the container, slowly empty out part of the water, then empty remaining water with fry into the tub, using your hand to splash water into the container to flush out all the fry while the container is still tilted. It is best to stock only one nest to a trough especially if the nest contains from 10,000 to 20,000 fry. After the fry are placed in the troughs, feeding should not begin until the fourth or fifth day, starting with a small ration for the first few days. We feed once a day. Any food not eaten within two hours should be siphoned out.

A period of mortality was observed in our feeding troughs this season. This would occur when the young fish had reached the twelfth day and would continue to the sixteenth or seventeenth day, after this time mortality rate would stop. Our plan for next season is to feed lighter for the first two weeks. Table I gives the estimated observed and/or expected mortality:

TABLE I

ESTIMATED MORTALITY OF CHANNEL CATFISH FROM SAC FRY TO FINGERLINGS		
Unknown—12 through 16th Day.....	(Fry)	12%
Aquatic Insects.....	(Fry)	10%
Unknown.....	(Fingerlings)	10%
Turtles, Snakes and Crayfish.....	(Fry to Fingerlings)	2%
Handling.....	(Fry to Fingerlings)	1%
TOTAL.....		<u>35%</u>

Fish should be kept in the troughs for at least nine days (longer if troughs are not needed for other fry). When the fry are ready to be moved from troughs to culture ponds, they should be dipped from the trough with a small hand dip and placed in a square tub containing water. The tub is placed in the culture pond after first tempering the water. Stand the tub on one side away from the sun. A small mesh retainer, made of hardware cloth, should be placed around the tub to help prevent predators from destroying the fry. Feeding is started immediately. The longer the fish can be held in or near the tub the better the survival.

REMOVING THE FRY DIRECT FROM THE SPAWNING CONTAINER TO THE CULTURE POND AND FEEDING

Fry may be removed directly from the spawning container to the culture pond, however, we have had less mortality by starting the fry in the feeding troughs.

The tub is placed on one side and encircled with a retainer frame of hardware cloth (Plate VI).

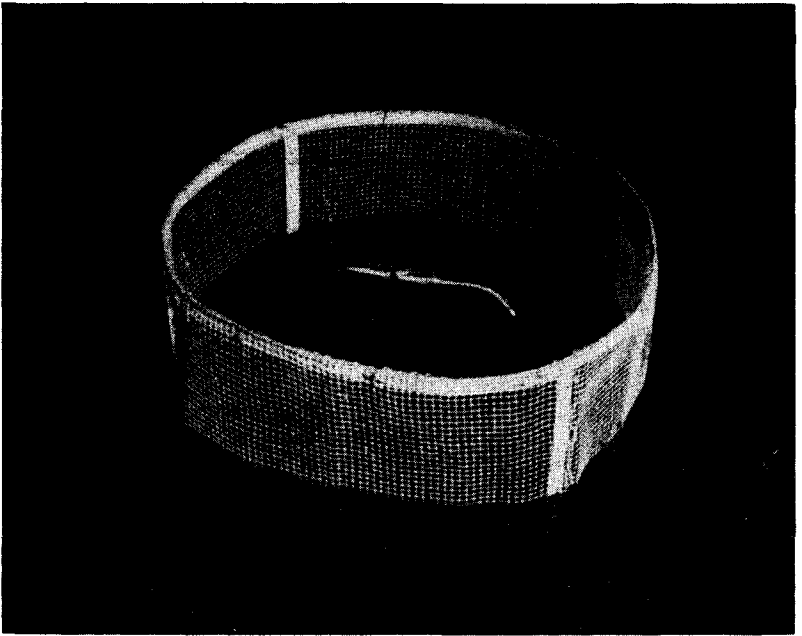


PLATE VI. Retainer frame of hardware cloth. The square tub is stood on edge with the opening away from the sun. The hardware cloth retainer prevents snakes, turtles and other predators from eating the fry channel catfish.

The fry should not be fed until the fourth day or until they absorb the yolk sack. After the fish have used the yolk sack, for the next 3 to 5 days the amount of feed they consume is very little. A good growth is noted although feeding is light. Place the food in the tub. Leave the tub in the pond for at least two weeks. After removing the tub and retainer frame, continue feeding at the same location. At least four feeding stations should be used in a one-acre culture pond. Table II gives the percentages of the various ingredients used in our fry and fingerling catfish feed.

TABLE II

THE PERCENTAGES OF THE INGREDIENTS OF THE FRY AND FINGERLING CHANNEL CATFISH FEED USED SUCCESSFULLY AT THE CENTERTON FISH HATCHERY

<i>Ingredients</i>	<i>Percent</i>
Dried Milk	25.75
Wheat Shorts	7.00
Soy Bean Meal	7.00
Meat Scraps	30.00
Fish Meal	28.00
Vitamin (A) Feeding Oil (15,000 Units Per Gram).....	0.25
Iodized Salt	1.00
Brewers Dried Yeast.....	1.00

Whenever the young fish seem to be off feed, sick, or sluggish terramycin (animal) is added to the feed. We use Terramycin (TM-10) at the rate of 6 ounces per hundred pounds of feed. The use of terramycin is discontinued as soon as the fish perk up and resume normal feeding.

NOTE

In propagating channel catfish we find there are minor problems encountered all of which cannot be covered in this paper. Persons attempting to propagate them will more or less have to learn by experience. One example, placing a pair of catfish in a pen does not always guarantee a spawn. If after a reasonable length of time the male has kept the keg clean and the female does not spawn, then she should be replaced. The same method should apply to the male, *i. e.*, if after a reasonable time he does not clean the nest, then he should be replaced. We have found an average of approximately one pair out of ten are not suited to each other and will not produce a spawn.

In the spring of 1956, eighty-six (86) nests were hatched from 87 spawns. Possibly 250 fish were paired. Approximately 500,000 fingerlings (4" to 6") were distributed this past fall and winter.

In the spring of 1957, one hundred nineteen (119) nests were hatched using approximately the same number of brood fish that were used in 1956. An estimated hatch of 1,500,000 young fish was obtained.

ACKNOWLEDGMENTS

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Question: Was a large male fish used?

Answer: Yes.

Question: Is there any advantage to embedding the can into the embankment?

Answer: No.

Question: What method of feeding was followed?

Answer: This information is covered in the paper.

Question: What is the reason for extending the spawning season?

Answer: To provide pond room to handle the output of young fish.