legacy of plenty that was left to us by our forefathers.

We would be foolish if we didn't admit that planning for the future is a risky venture. We will probably make mistakes, but by recognizing that our natural resources are finite—I have confidence that we can succeed by utilizing the mistakes of the past to accomplish the goals of the future.

We look forward to the benefits which West Virginia will derive from your pooled knowledge and skills.

With these thoughts, let me wish you success with your deliberations to achieve the goals of this important conference.

STRIPED BASS CULTURE AND MANAGEMENT THEME SESSION MODERATOR'S OPENING COMMENTS

by

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Our purpose today will be to trace the history of striped bass culture and management from its early beginning in the last century, through its major developmental period during the past 15 years, and to try to make realistic comments upon the current state of the art and the direction of the program in the near future. For the record, let me say that in 1966 at the 20th Annual Conference, Southeastern Association of Game and Fish Commissioners, we held the Striped Bass Symposium which helped set the stage for the ensuing striped bass program in the southeast. This session, therefore, is not the first presentation of its kind and, hopefully, it will not be the last.

In-as-much as the program has primarily been devoted to the establishment of striped bass populations in reservoirs, so also will the comments made today be primarily related to reservoir stocking. It should be noted, however, that in recent years at least four estuaries have also been stocked with cultured striped bass. The present investigation on the Hudson River is especially noteworthy. This is a very sophisticated, multi-million dollar study which is generating a data bank of information which should benefit everyone concerned with aquatic resources. A major facet of this investigation is the possibility of using cultured striped bass to mitigate losses of striped bass due to the operation of power plants. The ramifications of this program, especially to the fish culturist, is very exciting. If the stocking of cultured fish proves to be a feasible method for mitigating power plant losses and the projected 1000 new power plants are indeed built by the year 2000, then a needed boost will be given to fish culture and its practitioners.

THE USE OF CIRCULAR TANKS FOR SPAWNING STRIPED BASS (*MORONE SAXATILIS*)

by

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ABSTRACT

During the 1974 spawning season in Tennessee, 17 female striped bass were injected with chorionic gonadotropin and placed in circular tanks to spawn. One or more males, also injected with gonadotropin, were placed in 13 of the tanks with each female. In four of the tanks, treated white bass males (*M. chrysops*) were added in an attempt to produce hybrids.

All 13 of the females, where there were no white bass, successfully spawned producing an estimated 19.3 million eggs. More than 11 million fry hatched.

The four females in tanks containing white bass males ripened but had to be manually stripped.

The tank spawning method requires considerably less handling and imposes much less stress on brood fish than the conventional hormone technique.

INTRODUCTION

The striped bass hormone spawning technique (Stevens, 1966) is probably the first major change in the artificial spawning of striped bass since S. G. Worth (1884) constructed and successfully operated a small hatchery on the Roanoke River at Weldon, N. C. Striped bass fry have been produced in hatcheries intermittently in the Weldon area since that time and regularly since the early 1940's. Prior to the development of the hormone technique, the hatchery at Weldon, operated by the North Carolina Wildlife Resources Commission, was the only hatchery in the world producing striped bass fry.

Other hatcheries throughout the years have tried to produce striped bass fry. Most failed because of an inability to obtain ripe spawn. Apparently the striped bass female completes spawning within an hour after becoming ripe. Ripe females are rarely taken on sport tackle indicating that they feed very little while ripe. The Weldon Hatchery utilized ripe females taken in commercial nets.

Steven's technique opened the door for striped bass culture. Through the use of hormone spawning, the South Carolina Wildlife Resources Department has produced and made available to other agencies hundreds of millions of fry for propagation experiments. The Weldon Hatchery could not have met the demand for striped bass fry.

The hormone technique is well documented by Stevens (1966), and later by Bayless (1972). Briefly, the procedure is as follows:

Brood fish are collected with an electro-fishing unit and placed in a holding pool at the Moncks Corner Hatchery. The females are injected with chorionic gonadotropin to induce ovulation. Approximately 23 hours after the injection, an egg sample is taken from the fish by inserting a small glass catheter tube into an ovary through the urogenital opening. The egg sample is examined microscopically to determine the anticipated spawning time.

The female is placed in a separate holding pen so that she may be checked for ripeness without having to disturb any of the others. Since eggs of striped bass that have been injected with gonadotropin can become overripe within an hour after becoming ripe, the female is generally checked for ripeness 30 minutes prior to predicted ovulation. If not ripe, she is rechecked every 30 to 45 minutes until free-flowing eggs are found.

Ripe females are anesthetized by spraying MS222 or quinaldine on the gills. The eggs are manually stripped, fertilized, and placed in hatching jars.

The hormone spawning technique requires a round-the-clock hatchery crew to check and spawn fish and to regulate the waterflow in egg jars to prevent eggs from floating away. After being handled several times for egg sampling, checking for ripeness, being anesthetized and manually stripped, the survival of brood fish is doubtful. Bayless (1972) stated that "Handling of brood fish, particularly females, should be kept to an absolute minimum. Experience has shown that frequent handling of females not only retards ovulation but also causes increased mortality resulting from stress and various infections".

The tank spawning method evolved from Stevens' hormone technique. In 1972, when the Tennessee Game and Fish Commission (now the Wildlife Resources Agency) first began spawning their own striped bass, circular fiberglass tanks were used to hold injected brood fish. At that time there were only four men assigned to the striped bass project at the Morristown Hatchery. In addition to collecting and spawning brood fish, the crew was responsible for the preparation of fingerling rearing ponds. Consequently, some injected females did not get checked on schedule. However, the females spawned in the tanks and did not hold the eggs until they became overripe. Overripe eggs do not fully expand when water-hardened and the eggs spawned in the tanks expanded very well.

At the end of the season after fry requirements had been met, an additional female was captured and placed in a tank. A ripe male was placed in the tank approximately

eight hours before the estimated spawning time. The female spawned but the eggs did not get fertilized.

During the 1973 season after fry for rearing ponds had been produced by manually stripping eggs, four females were injected and placed in spawning tanks. This time males were also injected in an attempt to overcome any reluctance to perform. Three of the four females spawned and fertilization in the tanks was estimated at 60, 65 and 85 percent. The hatch and survival of fry was equally impressive.

It was obvious from the condition of the three females after spawning that the tank spawning placed much less stress on the brood fish, and the manpower requirements were considerably less than that needed for manual stripping. On the basis of these features plus the success of the three fish that spawned, it was decided that during 1974, the emphasis would be placed on tank spawning so that this technique could be reasonably evaluated.

PROCEDURES

Rigging Tanks:

Circular fiberglass tanks are the only type that have been used for tank spawning. They are rigged with a standpipe to control water depth and a cylindrically-shaped screen to contain eggs and fry.

The tanks each receive a water supply of 8 to 10 gallons per minute, supplied through two 1/2-inch ID tubes under slight pressure. The water supply enters about eight inches from the perimeter of the tank and at an angle of about 15 degrees with the water surface. The end of the tube should be at the water surface. This will create and maintain a circular velocity of from 1/3 to 1/2 foot per second around the perimeter.

Figure 1. Battery of spawning tanks at Morristown Hatchery.

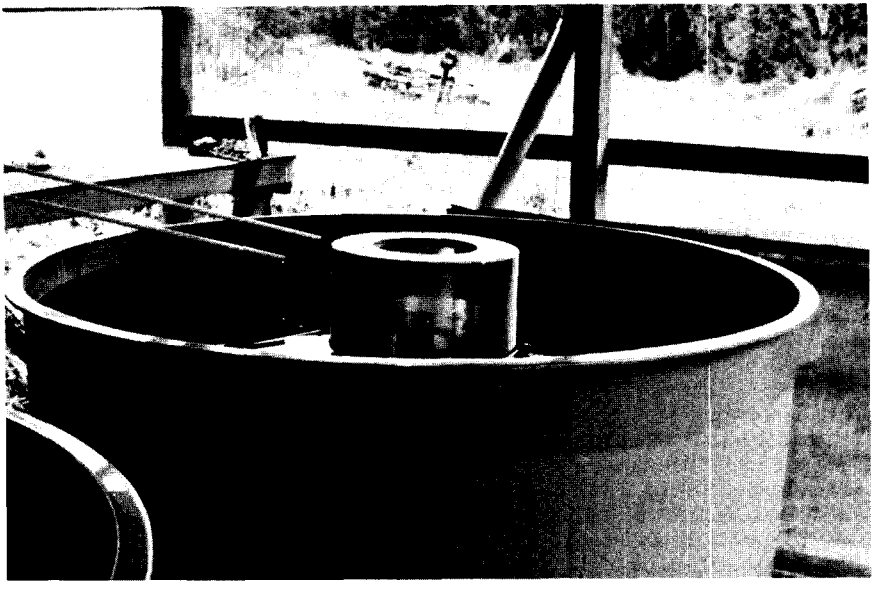

Figure 2. Tank with lowered water level showing water supply tubes and screen.

Three sizes of circular tanks have been used for spawning. These were four, six, and eight foot diameter. The six foot tank with a thirty-inch depth (Frigid Units Model RT630) has proven to be the most desirable. The smaller tank is inadequate for the size fish usually involved in striped bass spawning and the eight foot tank increases the difficulty in removing brood fish, fry, etc. All are medium green colored.

The water level should be at least four inches from the top of the tank. The brood fish are very active after spawning. When removing them from the tank, some in trying to escape the net will swim out of the tank if the water level is close to the top.

The tanks at Morristown Hatchery are set up out-of-doors on a concrete slab. There is a roof over the tanks for protection from direct sunlight and rain, but no surrounding walls. The tanks should be located in an area where the brood fish will not be disturbed.

The tanks are mounted on metal stands that permit installation of drain pipes, if necessary, and leveling. The top of the tank is about 46 inches high.

Screens for the tanks are constructed by cutting two 18-inch diameter discs from three-quarter or one inch exterior grade plywood. A ten inch diameter disc is cut from the center of each of these to allow the screen to fit down over the standpipe, and to permit removal of the standpipe if necessary. The two large discs are connected together with four 2 x 2 x 36 inch pieces of wood placed along the outer edges of the discs forming the frame of a cylinder. This frame is covered with a fine-mesh stainless steel screen (paper mill surplus) having fifty to sixty openings to the inch. A strip of poly-foam approximately one-half inch thick is cemented around the bottom of the tank to provide a seal and prevent fry from escaping under the screen. A hot-melt caulking material applied with an electric glue gun is used to coat seams in the wire screen or rough edges that might cause cuts to personnel or damage eggs.

A perforated air line should be affixed around the base of the cylinder so that air can be bubbled in around the screen to prevent eggs and/or fry from collecting on the screen. One-eight inch ID clear plastic tubing with pin sized holes about two inches apart should be adequate. Some aquarium pumps such as the Silent Giant provide a sufficient volume of air for an individual tank and provide a constant pressure.

Injecting Brood Fish:

To minimize handling, females are injected when first taken with the shocker while still in a tub in the boat or when being transferred from the transport truck to the spawning tank at the hatchery. They can be injected with little effort while in a tub.

The fish are injected at the posterior base of the soft dorsal fin where the needle can be inserted without having to penetrate scales. Injections are intramuscular.

The weights of the fish are estimated. To insure the minimum dosage recommended by Stevens of 127 International Units of chorionic gonadotropin per pound of fish, females in the 12 to 15 pound range are injected with 2,000 IU (2 c.c.) those in the 16 to 22 pound range receive 3,000 IU (3 c.c.) and those over 22 pounds are injected with 4,000 IU (4 c.c.).

Males are injected with a lesser dosage. The minimum dosage required has not been determined because of the small number of males used so far. Most of the males have been injected with 50 to 75 IU of gonadotropin per pound of estimated weight. They are injected approximately 24 hours prior to the anticipated spawning time of the female. Males are injected only once even though they may be used more than once. At Morristown, if a shortage necessitated repeated use of males, they were held in a separate tank and put in with the female about ten hours prior to spawning. If there are enough males to use separate ones for each female, they can be injected and placed in the tanks at the same time the female is put there.

It is important that the brood fish are not disturbed when spawning. The majority of those injected at Morristown spawned during the night. This works very well and some thought should be given to timing injections so that spawning will occur at night.

At the beginning of the season when the river temperature and hatchery temperature are 58° to 60° F., the females have spawned between 55 and 62 hours after being injected. Toward the end of the season when river and hatchery temperatures are from 67° to 69° F., females have spawned as early as 36 hours after injection.

Removing Brood Fish:

At least one brood fish, generally the female, was left in the tank until after the eggs water-hardened. The fish swimming in the tank helps keep the eggs moving while they are still relatively non-buoyant. If the fish spawn during the night, they are left in the tank until the following morning. So far, there has been no evidence that significant egg losses have resulted from leaving the brood fish in the tank during that time.

Except for males that are to be used again, brood fish are placed in a transport truck and taken back to the reservoir when removed from the tank.

Maintenance of Tanks Containing Eggs and Fry:

One of the disadvantages of the tank spawning method is that the dead eggs must remain in the tank with the live ones. At temperatures above 63° F., the dead eggs cause no problems. By the time the live eggs are hatching, the dead ones have broken down and have gone through the screen. At lower temperatures, the eggs do not break down as rapidly and remain in the tank for two or three days after fry have hatched. At 58° the eggs may remain as long as seven days. The eggs become coated with fungus, clump together, and cause some fry mortality as a result of entrapment.

Clumps of dead eggs can be removed from the tanks with a small piece of one-eighth inch mesh screen but it was not practical to keep the tanks picked completely free of fungus. Prophylactic treatments with formalin at varying dosages proved unsuccessful in controlling the fungus.

Dead fry and debris are removed from the bottoms of the tanks with a one-half inch diameter siphon.

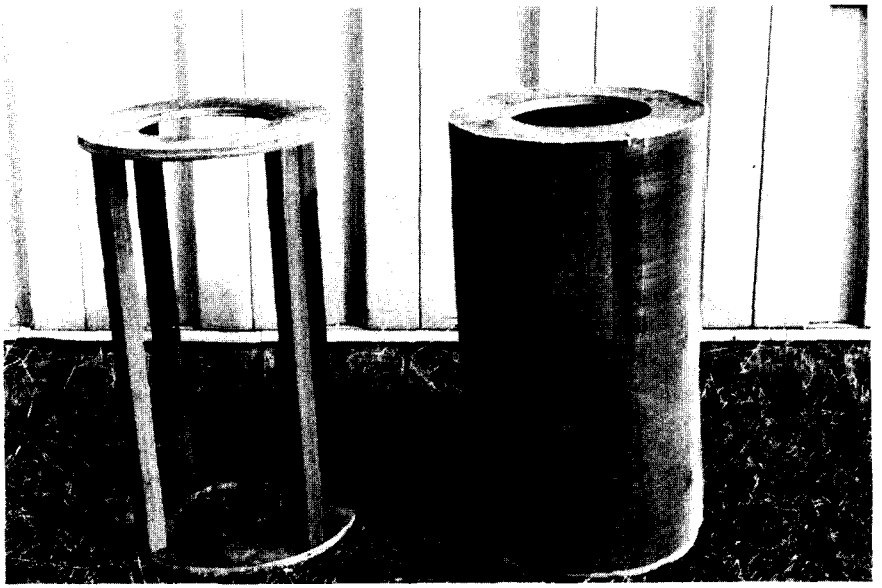

Figure 3. Frame and completed screen for circular tanks.

Figure 4. Fry concentrate around the perimeter of the tank at four to five days of age and can be removed with a scoop.

Collecting and Handling Brood Fish:

Striped bass will not withstand a lot of handling. Therefore, it is extremely important that if brood fish are to be kept alive to be released after spawning, handling must be minimized. It is even more important that when handling is necessary, all possible care be exercised to avoid injury to the brood fish. Since most of the handling in the tank spawning method is done with dip nets, the type of net has a lot to do with the injuries sustained. The following procedure is used by the Morristown crew:

Brood fish are collected with a 220 volt AC shocker. Gill and trammel nets have been used in previous years to collect striped bass but it was difficult to keep the fish alive long enough to ovulate them. Dip nets used with the electro-fishing unit have an eight foot fiberglass handle, a 24 inch diameter hoop and a 1 1/2 inch-bar-mesh knotless nylon bag. The fish are netted head-first if possible and are pulled to the side of the boat. The webbing is grasped in such a way that the fish is cradled on its side. It is then lifted over into a long tub (country bathtub) containing about three inches of water. The net is slipped out from under the fish. Brood striped bass are not lifted from the water while struggling in the net or in such a manner that places the weight of the fish on the tail. Nets with a mesh size large enough for the fish to get their snouts through are not recommended. When possible no more than one fish at a time is handled in a net.

Brood fish are poured from the tub into a transport truck tank. They are transported to the hatchery in a one-percent salt (NaCl) solution. They are transported from the hatchery back to the reservoir in a one-percent salt and 1/2 ppm acriflavine solution. A solution containing one-percent salt and 100 ppm furacin (Stevens, personal communication) was also used during 1974.

Dip nets used at the hatchery for removing fish from the truck or from tanks are constructed with a very shallow bag and small mesh. A one-quarter-inch knotless nylon mesh is recommended. This type of net prevents the fish from "shucking" scales or tearing fins. The mesh size is large enough to let eggs pass through when removing brood fish from the tanks after spawning.

If brood fish are to be moved more than a few feet, they are placed in a long tub with about three inches of water instead of carrying them in a dip net.

Estimating Numbers of Eggs and Fry:

Because of the size of fry and the inability to handle fry and/or eggs out of water without causing excessive mortality, determining the numbers produced within a reasonable percentage has been somewhat difficult. The tank spawning method offers no improvements whatsoever in this area.

Estimated numbers of eggs and fry in tanks are obtained by volumetric sampling. A long glass tube, 1/2 inch inside diameter, is inserted vertically into the tank until it touches bottom. The upper end is sealed by placing a thumb or finger over the end and the tube is lifted from the water. Before the lower end is removed from the water that end is sealed with a finger from the other hand. By holding the tube to the light, the number of live and dead eggs or fry can be counted. The volume within the tube is measured in a graduated container. The procedure is repeated several times at random around the tank and an average is established. By expanding the volumetric sampling to the volume within the tank, an estimate can be determined. This estimate can be compared to fecundity data for fish of the size having spawned to determine whether or not the estimate is reasonable.

The percentages of fertilization and hatch are determined by the same method.

It is recommended that numbers of fry be estimated on the second or third day after hatching while they are somewhat evenly dispersed throughout the tank.

Removing Fry From Tanks:

Because of the small size of striped bass fry and their inability to withstand handling out of water, it is necessary to move them in water. With a large volume of water involved in the circular tanks there is somewhat more difficulty in removing fry from the

tanks than from aquaria normally used with jar hatching. This is especially true for the first three days after the fry hatch because they are pretty evenly distributed throughout the tank.

At four-to-five days of age, depending on water temperature, the fry become concentrated around the perimeter of the tank. By inserting a siphon tube inside the screen and gradually lowering the water level, the fry will concentrate at the water surface around the perimeter and can be easily skimmed off using a scoop. A gallon-size plastic milk jug with the bottom cut out works very well.

All but a small percentage of the fry can be removed by this method and can be concentrated in plastic bags at whatever density is desired for transporting.

During the process of removing the fry, the volume of water supplied to the tank can be reduced. Water supply tubes should be directed more toward the center of the tank so that the action of the incoming water will not prevent the fry from concentrating around the edge. However, it is important that a slow circular current be maintained.

Packaging Fry For Transporting:

Each scoop of fry is gently poured into the bottom of the plastic bag. Fry and water are added until the bag contains about four gallons. Care should be taken to not overcrowd the fry. If the first couple of scoops contain dense concentrations of fry, the remaining scoops should be lightly concentrated to compensate.

It is difficult to even closely approximate the number of fry going into each bag. Usually the number of fry in a tank (or aquarium) is estimated by volumetric sampling and are packaged at a rate of one plastic bag for each 75,000 fry estimated to be in the tank. Stocking rates, time in transport, etc., are factors that determine packaging densities. However, it is generally agreed that the number of fry per bag should not exceed 100,000.

It is extremely important that oxygen or air be bubbled into the bag while fry are being placed into a container. With the density of fry involved, oxygen depletion can result within a couple of minutes.

At least one-half cubic foot of oxygen is placed in a bag. The bag is sealed by twisting the top, doubling it over and wrapping it with plastic tape or rubber bands.

Hybrid Experiments:

Attempts to produce hybrid fry (white bass male x striped bass female) by the tank spawning method were unsuccessful. It appeared that the striper females would not release their eggs in the presence of white bass.

Four females were used in separate attempts to produce hybrids. All four ripened but none would release their eggs and had to be manually stripped. In one of the tanks, an immature female striped bass was placed in with the ripe female and white bass males to determine if the presence of another striped bass would induce her to release the eggs. In another tank an uninjected but ripe male striped bass was placed in with the female striper and white bass. The evidence indicates that, even though the white bass males courted the female stripers very actively, the presence of the white bass was the reason the stripers would not release the eggs.

Egg and Fry Production:

During the 1974 season, 17 females ranging from 12 to 26 pounds in weight were injected with gonadotropin. They spawned an estimated 24.5 million eggs resulting in a hatch of 13,120,000 fry (53.5%).

Eight of the females were permitted to spawn in tanks undisturbed (primarily at night). They produced an estimated 13.3 million eggs and 9,120,000 fry hatched (68.6%).

Five females which were tank spawned late in the season, and were subjected to various disturbances in an attempt to observe and photograph spawning, produced an estimated six million eggs and a hatch of two million fry (33.3%). The percentage of hatch for the five females ranged from approximately five percent to 64.5%. The

quality of the males was not as good as those acquired earlier in the season and could account for part of the lower fertility rate. However, it was obvious that the presence of people around the tanks interrupted spawning.

Of the four females that were in tanks with white bass and would not spawn, two were overripe when stripped. They produced hatches of 16.7 and 25.0%. The other two females produced eggs that expanded very well and resulted in hatches of 43.8 and 87.5%. The majority of the fry produced from those four females were hybrids.

DISCUSSION

Although the number of striped bass ovulated in spawning tanks is still relatively low, the results of the 1974 season at Morristown were very satisfactory. Whether or not this procedure would be applicable to a larger-scale operation such as the one at Moncks Corner, is yet to be determined. However, there are no obvious reasons why it would not be.

There is no question that the brood fish are in better condition after spawning than those that are manually checked and stripped. There has been some mortality of males used in tank spawning, particularly those that are used more than once and held in captivity for several days. There are some indications that the hormone injections might be partially responsible. Additional work needs to be done with other hormones and to determine the minimum dosage of gonadotropin required to induce males to spawn.

The reduction in manpower requirements is significant. During 1973 it required more than twice as many man-days at Morristown Hatchery to produce 5.2 million fry as it did to produce 13 million during 1974. And the tank spawning method does not require personnel with the ability to predict spawning times, except for hybridization.

The percentage of hatch of eggs for the eight females that were permitted to spawn undisturbed ranged from 61.6 to 84.6%. Stevens (1966) reported an overall hatch of 31% for 316 females during 1964. Tatum et al., (1965) reported a 55.7% hatch of eggs taken from 25 hormone injected females and a 70.0% hatch of eggs taken from 41 naturally ripe females. It appears that the hatch of tank spawned eggs will approximate that of naturally ripe eggs. Since the female is releasing the eggs at the proper time it is not unreasonable to expect a higher fertility rate than with eggs that are manually stripped.

Normally two males are used in the tanks with each female to decrease the risk of an unproductive male. However, one male is more than adequate if it is of good quality. Because of a temporary shortage of males, two females weighing about 18 pounds each were placed in an eight foot diameter tank with one male which weighed approximately six pounds. Both females spawned during the night and an estimated 62.5% of the eggs hatched.

Observation of spawning activity was limited to partial spawning of two different females. One swam slowly around the tank expelling eggs with the males alongside. The majority of the eggs appeared to be released in two slugs about five minutes apart. The interruption could have been because of personnel present. The second female spawned more excitedly near the surface of the tank.

Males actively court the female when she is nearing ripeness. They have been observed "butting" at the side of the female and on occasion appeared to bite at the pectoral fins of the female.

Immediately after spawning, the water in some tanks was so "milky" that the fish could not be seen at the bottom of the tank.

Probably the major disadvantages of the tank spawning method are the difficulty incurred if the fry are removed before they concentrate around the edge of the tank and the problem with fungus on dead eggs early in the season.

Another disadvantage in some instances might be the number of tanks and space required for a large scale operation. Six tanks were utilized at Morristown. Optimum fry production would probably be about one million fry per tank per week, depending on the average size of brood fish.

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DEVELOPMENT OF POND CULTURE TECHNIQUES FOR STRIPED BASS *MORONE SAXATILIS* (WALBAUM)

by

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ABSTRACT

The increasing demand for striped bass fingerlings has established a need for improved pond culture techniques for this species. Standard guidelines were developed from methods in use at several production hatcheries. These along with improvements after two production seasons are described.

INTRODUCTION

Artificial propagation of striped bass was attempted in the 1870's with the first published report made by Worth in 1884. The U. S. Fish Commission began experimental striped bass propagation at Weldon, North Carolina, in 1903 and continued this work until 1951 when the hatchery facilities were turned over to the State. Striped bass were being treated as an anadromous species during this period, but with construction of South Carolina's Santee-Cooper Reservoir and the appearance of a landlocked population of striped bass in these waters around 1950, interest began to focus on stripers for inland reservoir management (Fuller, 1968). The increasing demand for striped bass and the lack of natural reproduction in most reservoirs prompted South Carolina to construct its Moncks Corner Hatchery in 1961.

Up to this point essentially all stocking was being done with fry or commercially caught yearlings. In an effort to improve stocking results and increase the availability of larger size stripers, the Edenton NFH began a striped bass rearing project in the spring of 1964 (Anderson, 1966). Approximately 30,000 fingerlings were produced from fry that were provided by the State Hatchery at Weldon. Production techniques have improved over the past 10 years and many other hatcheries, including state, Federal and commercial, have become involved with this work. Federal hatchery production in Region 4 has increased from the 30,000 fingerlings harvested in 1964 to the current level of approximately 4.5 million fingerlings annually. However, the demand for striped bass is much greater than the production capability, and this imbalance is expected to continue for many years. In 1974, the 10 states within the U. S. Fish and Wildlife Service's Southeastern Region requested 8.5 million fingerlings from Federal hatcheries. This was about double the amount we produced.

METHODS

In an attempt to supply the demand for 1- to 2-inch fingerlings and to identify the