LITERATURE CITED

Butler, P. A. 1962. Reaction of some estuarine mollusks to environmental factors. In: Biological problems in water pollution. Third Seminar. U. S. Public Health Serv. Publ. No. 999-wp-25, 1965: 92-104.

Davis, H. C. and H. Hidu. 1969. Effects of pesticides on embryonic development of clams and oysters and on survival and growth of the larvae. U. S. Fish and Wildl. Serv. Fish. Bull. 67(2):393-404.

Eisler, R. 1969. Acute toxicities of insecticide to marine decapod crustaceans. Crustaceana 16:302-310.

______ and P. H. Edmunds. 1966. Effects of endrin on blood and tissue chemistry of a marine fish. Trans. Am. Fish. Soc. 95(2):153-159.

Hansen, David J., P. R. Parrish and J. Forester. 1974. Aroclor® 1016: Toxicity to and uptake by Estuarine Animals. Environ. Res. (In Press)

Johnson, Howard Ernest, 1967. The effects of endrin on the reproduction of a fresh water fish (*Oryzias latipes*). Ph.D. thesis, Univ. Wash. Wash.

Katz, M. 1961. Acute toxicity of some organic insecticides to three species of salmonids and to the threespine stickleback. Trans. Am. Fish. Soc. 90(3):264-268.

______ and G. C. Chadwick, 1961. Toxicity of endrin to some Pacific Northwest fishes. Trans. Am. Fish. Soc. 90(4):394-397.

Litchfield, J. T., Jr. and F. Wilcoxon. 1949. A simplified method of evaluating dose-effect experiments. J. Pharmacol. Exp. Ther. 96(2):99-113.

Lowe, J. I., P. R. Parrish, J. M. Patrick, Jr. and J. Forester. 1972. Effects of the polychlorinated byphenyl Aroclor® 1254 on the American oyster, *Crassostrea virginica*. Mar. Biol. (Berl.) 17:209-214.

Malone, C. R. and Blaylock, B. G. 1970. Toxicity of insecticide formulations to carp embryos reared in vitro. J. Wildl. Manage. 34(2):460-463.

Mount, Donald I. and William A. Brungs. 1967. A simplified dosing apparatus for fish toxicology studies. Water Res. 1:21-29.

Schimmel, Steven C., Hansen, David J. and Jerrold Forester. 1974. Effects of Aroclor® 1254 on laboratory-reared embryos and fry of sheepshead minnows (*Cyprinodon variegatus*). Trans. Am. Fish Soc. 103(3):582-586.

Strickland, J. D. H. and Parsons, T. R. 1968. A practical handbook of seawater analysis. Fish. Res. Board Can. Bull. 167:21-26.

U. S. Food and Drug Administration, 1970. Pesticide Analytical Manual. Sect. H212. U. S. Dep. Health, Educ., Welfare, Wash., D. C.

EFFECT OF TWO FEEDING RATES ON PRODUCTION OF ADVANCED FINGERLING STRIPED BASS

by

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ABSTRACT

An investigation of the effect of two feeding rates on pond production of advanced fingerling striped bass was studied at the Auburn University Fisheries Research Unit from June 27 to November 24, 1972. The mean survival for fingerlings fed a high feeding rate was 71.87% as opposed to 70.13% for fingerlings fed a low feeding rate. Mean production for fingerlings fed a high and low feeding rate was 266.44 kg/ha and 293.68 kg/ha, respectively. Food conversion for fingerlings fed a high feeding rate was 3.74 as compared to 2.51 for fingerlings fed a low feeding rate.

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INTRODUCTION

Striped bass, *Morone saxatilis* (Walbaum), stocking programs using 125 to 200 mm fingerlings are thought to afford higher survival and therefore prove more successful than programs using 30 to 80 mm fingerlings. For most state agencies this type of stocking program is impractical because of the high cost involved in producing substantial numbers of advanced fingerlings.

Results from advanced fingerling production have varied greatly among researchers. Survival percentages and S-values (kg feed fed/total kg fish produced by natural plus added feed) ranged from 29.75% to 57.30% and 1.49 to 28.29, respectively (Regan, Wellborn and Bowker, 1968; Annual Report, 1969; Ray and Wirtanen, 1970; Wirtanen and Ray, 1971; and Reeves, 1972).

The objective of this research was to determine the effect of a high and a low feeding rate on survival and production of advanced fingerling striped bass. Emphasis was placed on increasing survival and lowering S-values.

MATERIALS AND METHODS

Research was conducted in six 0.04-ha earthen ponds located at the Fisheries Research Unit of the Auburn University Agricultural Experiment Station. The ponds were filled with creek water just prior to stocking.

Small fingerling striped bass (26 to 89 mm in total length) were obtained from rearing ponds at the Fisheries Research Unit. These fingerlings were originally obtained as fry from the Wildlife Resources Department Hatchery located near Moncks Corner, South Carolina. Production ponds were stocked June 27 to July 7, 1972 with approximately 17,290 fish/ha.

Each pond was equipped with one Neilson automatic fish feeder. The feeders were set to feed at three-hour intervals from 0600 to 1800 hours (5 feedings/day). The feeders were used July 7 to August 16, 1972. From August 17 until November 1, 1972 the fish were fed twice daily by hand at sunrise and sunset. Purina Trout Chow No. 4 and Purina Trout Chow Large Fingerling were fed in all ponds.

Two feeding rates, a high and a low, were tested in this experiment. The high rate consisted of feeding at 10% body weight per day from July 7 to July 31, 1972; 7% body weight per day from August 1 to August 31, 1972; 6% body weight per day from September 1 to September 30, 1972; and 5% body weight per day from October 1 to October 31, 1972. The low rate consisted of feeding at 10% body weight per day from July 7 to July 31, 1972; 4% body weight per day from August 1 to August 31, 1972; 3% body weight per day from September 1 to September 30, 1972; and 2% body weight per day from October 1 to October 31, 1972.

Low surface water temperature in November affected the feeding response of the fish. The best response to feeding was obtained when the surface water temperature was above 10 C. Therefore, from November 1 until the ponds were drained the sole criterion for determining the feeding rate was the ability of the fish to utilize the food.

Each feeding rate was applied to three ponds chosen at random. The amount of feed fed was based on feeding rate and weight of fish in each pond. Each month during the experiment 20 fish were chosen at random from one seine haul, anesthetized with quinaldine, weighed and returned to the pond. This sample weight was expanded to give an estimate of the total weight of fish in each pond.

Special emphasis was placed on keeping the fingerlings healthy and in so doing all fingerlings were given feed treated with Terramycin at 3 g active ingredients per 45.5 kg of fish per day for 10 days of each month. Monthly sampling for weight determinations followed the Terramycin feeding periods.

Control of filamentous algae was attempted by several methods. Triple superphosphate fertilizer was applied at 19.1 kg/ha as deemed necessary to maintain a surface water visibility of 30 to 37 cm. Ponds were also treated with Diquat as recommended by Lasrence (1968). Floating mats of algae were periodically seined from the ponds using a minnow seine. Finally, Chinese grass carp, *Ctenopharyngodon idellus* Valenciennes, were stocked in each pond September 1, 1972 at 99 fish/ha.

Daily maximum surface water temperature was recorded in late afternoon with the use of an Airguide maximum-minimum thermometer. Surface dissolved oxygen concentrations were measured with a YSI oxygen meter (Model 51) as often as deemed necessary.

All ponds were drained November 22 to November 24, 1972. After draining, the fish were anesthetized, weighed (g) and measured (total length in mm).

RESULTS AND DISCUSSION

Survival of fish in five of six ponds was high; averaging 71.00%. Mean survival for high and low feeding rates was 71.87% and 70.13%, respectively (Table 1).

Table 1. Survival from five 0.04-ha striped bass production ponds.

Feeding Rate	No. Fingerlings Stocked	No. Fingerlings Recovered	% Survival	Mean Survival	Days in Experiment
High	695	432	62.16		139
High	700	557	79.57		139
High	720	532	73.89		139
				71.87	
Low	702	529	75.36		139
Low	695	451	64.89		141
				70.13	

In prior research at the Auburn University Fisheries Research Unit, epizootics of *Chondrococcus columnaris* have significantly lowered survival of striped bass. The epizootics were generally correlated with monthly seine sampling of the fish for weight determinations.

During this experiment there was not an identified epizootic of *C. columnaris* and this was thought to have contributed to the high survival. *Trichodina* sp. was the only parasite identified as causing mortality. Pond treatments of 2 mg/l potassium permanganate were effective in controlling the parasite. Observed mortality due to *Trichodina* was estimated to be less than 2%.

The major factor affecting survival in the experiment was dissolved oxygen. Low dissolved oxygen concentrations (below 3 mg/l) were recorded for two ponds. The first critical oxygen concentration was the indirect result of a Diquat treatment and resulted in a partial fish kill in one pond. A total fish kill was experienced in another pond and was due to a phytoplankton die-off. After experiencing a partial and complete kill, pond fertilization was discontinued and dissolved oxygen readings were taken in late afternoon. When oxygen concentrations were dropping to critical levels (6 mg/l) an Air-o-lator (Model No. AF-11) was placed in the pond and operated until the following morning. The Air-o-lator sprays water with force against the surface of the water and was effective for maintaining dissolved oxygen concentrations above 8 mg/l. Phytoplankton die-offs in August and September were the major cause of low oxygen concentrations.

Table 2. Production of advanced striped bass fingerlings from five 0.04-ha ponds.

Feeding Rate	Stocking Wt. (kg)	Recovery Wt. (kg)	Mean Production (kg/ha)	Average Wt. (g)	Feed Fed (kg)	S-Conversion	Mean S Conversion	Range in Total Length (mm)
High	1.50	10.62		24.59	40.73	4.47		91-224
High	0.80	10.32		18.53	30.09	3.16		73-205
High	0.92	14.64		27.52	49.30	3.59		72-205
			266.44				3.74	
Low	1.62	13.20		24.95	30.95	2.67		86-210
Low	0.87	13.07		28.97	28.66	2.35		92-210
			293.68				2.51	

The number of advanced fingerlings produced was low with only 44.82% of the produced fingerlings reaching the minimum desired total length of 125 mm. Mean production of advanced fingerlings for the high and low feeding rates was 266.44 kg/ha and 293.68 kg/ha, respectively (Table 2).

The average weights of fish from five ponds ranged from 18.53 g to 28.97 g. Reeves (1972) reported average weights of Cooper River advanced fingerling striped bass ranged from 63.86 g to 80.18 g. Reeves used a 32,500 fish/ha stocking rate as compared to 17,290 fish/ha in this experiment. It was thought that the stocking rate used in this experiment was too low and allowed an abundance of natural food organisms to exist in the ponds for a longer period of time. With a natural food supply upon which to feed, the fingerlings would require more time to make the transition to the artificial diet. A stocking rate of 25,000 fish/ha would probably increase the average weight and length of the fingerlings as well as increase production.

Food conversions in this experiment were consistently lower than in previous research (Table 2). A mean S-value of 3.74 was obtained for the high feeding rate as compared to 2.51 for the low feeding rate. The high feeding rate resulted in more food than the fish would utilize and portion of the feed was wasted.

Differences in survival and production between high and low feeding rates were non-significant. Therefore, it was thought that the low feeding rate used in conjunction with the recommended stocking rate of 25,000 fish/ha would economically produce substantial numbers of advanced fingerlings.

The most troublesome forms of algae during the experiment were *Hydrodictyon* sp., *Spirogyra* sp., and *Chara* sp. Fertilization was not effective in control of algae and Diquat was only temporarily effective. Seining was as effective as any of the methods used to control the floating mats of filamentous algae. Grass carp were effective in controlling *Chara*.

The automatic feeders were a problem during the experiment. When floating mats of algae were present the feed was caught and not available to the fish. The feeders, as stated earlier, were set to feed from 0600 to 1800 hours. It was soon apparent that the fingerlings fed best at sunrise and sunset. Therefore, a large portion of the feed fed during the day was wasted. Hand feeding daily at sunrise and sunset eliminated these problems.

Monthly sampling data collected from 20 fish resulted in a fair estimate of weight. A better estimate would have been made had additional seine hauls been taken and more fish weighed, but it was thought best in this experiment not to stress the fish with additional sampling.

Surface water temperature at draining was 6 C. The fish were transported and held in 1% sodium chloride solution with mortality at 0.88%.

LITERATURE CITED

Annual Report. Auburn University, Alabama Agricultural Experiment Station. Dept. of Fisheries and Allied Aquacultures, 1969.

Lawrence, J. M. 1968. Aquatic weed control in fish ponds. World symp. on warm-water pond fish culture, (1966). FAO Fish Report 5(44):VII/E-1:76-91.

Ray, R. H. and L. J. Wirtanen. 1970. Striped bass, *Morone saxatilis* (Walbaum): 1969 Report on the development of essential requirements for production. U.S. D.I., Div. of Fish Hatcheries, Atlanta, Ga. 46 pp.

Reeves, W. C. 1972. The effects of increased water hardness, source of fry, and age at stocking on the survival of striped bass, *Morone saxatilis* (Walbaum), fry and effects of two feeding regimes and source of fingerlings on survival and production of advanced fingerling striped bass in ponds. M.S. Thesis, Auburn University. 58 pp.

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Regan, D. M., T. L. Wellborn, Jr., and R. G. Bowker. 1968. Striped bass, *Roccus saxatilis* (Walbaum): 1967 Report on the development of essential requirements for production. U.S.D.I., Div. of Fish Hatcheries, Atlanta, Ga. 133 pp.
Wirtanen, L. J. and R. H. Ray. 1971. Striped bass, *Morone saxatilis* (Walbaum): 1970 Report on the development of essential requirements for production. U.S. D.I., Div. of Fish Hatcheries, Atlanta, Ga. 37 pp.

THE EFFECTS OF ADDED HARDNESS, SALINITY, AND SOURCE OF FRY ON THE SURVIVAL AND GROWTH OF STRIPED BASS FRY IN HATCHING JARS[1]

by

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ABSTRACT

The effects of increased water hardness, salinity, and source of fry on the survival and growth of striped bass fry from three females from the Cooper River, South Carolina, and two females from the Savannah River, Georgia, were studied at the Fisheries Research Unit, Auburn University, from 6 April to 11 June, 1971. Fry were stocked in one of three water treatments: control with a total hardness of 30 to 40 ppm; added hardness, 125 to 175 ppm; and added salinity, (chlorides) 1,100 to 1,500 ppm. Variance tests for homogeneity and contingency tables were employed for data analysis. Survival of striped bass fry was increased in the added salinity treatment. Fry survival in the control and added hardness treatments appeared to be dependent on the fry groups rather than the effects of the treatments. The survival of Cooper River fry appeared to be more variable in water with added hardness; Savannah River fry survival was more variable in the control treatment. The effects of added hardness and added salinity treatments on Savannah River fry survival were similar. Growth of fry in the added hardness and added salinity treatments was slightly greater than growth of fry in the control. The cause of the growth increase was not known.

INTRODUCTION

Research on the intensive culture of striped bass, *Morone saxatilis* (Walbaum), fry has been conducted at the Fisheries Research Unit, Auburn University, since 1966. During the period 1966 to 1969, 15 groups of striped bass fry were utilized in intensive culture experiments. All fry of 11 of these groups died at or before 29 days of age (Kelly, 1969). Intensive culture experiments performed in 1970 were hindered by 98% mortality of fry before 25 days of age (Powell, 1970).

Factors believed to contribute to the low survival of striped bass fry during the early stages of development have been cited by Regan, Wellborn and Bowker (1968), Hughes (1968), Kelley (1969), and Powell (1970). Two factors have been cited which apparently enhance the survival of striped bass fry. Albrecht (1964) indicated that water of low and moderate salinity (containing chlorides of 920 to 948 and 4,595 to 4,740 ppm, respectively) contributed to fry survival. Powell (1970) suggested that the survival of striped bass fry was enhanced in water with increased total hardness (150 to 500 ppm).

The objectives of this experiment were: to determine if increasing the total hardness or the salinity of water flowing through hatching jars would result in increased survival of striped bass fry; to compare survival rates of fry from Cooper River, South Carolina, and Savannah River, Georgia; and, to determine if water hardness and salinity have an effect on the growth of fry in hatching jars.

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