

Growth Rate, Length-weight Relationship and Condition Factor for Saltwater Grown Juvenile Red Drum (*Sciaenops ocellatus*)

WALTER G. DELOACH

*Department of Biological Sciences, Florida International University,
University Park, Miami, FL 33199*

ABSTRACT

A stock enhancement program was begun in 1989 to restock Biscayne Bay, Florida with red drum, *Sciaenops ocellatus*. This bay system had an extensive population of red drum that declined in the 1950s. Fish (41.7 mm SL, 10, 000) were stocked in ten circular fiberglass tanks (1500 l) at 525 fish/m³. Fish were fed daily on a 45 % protein dry ration and were stocked at a mean weight of 1.4g and 41.7 mm standard Length. After eighty-nine days the population mean weight was 33.8g, an increase of 0.36g per day. Standard length increased by an average of 0.96 mm per day. The fish condition factor (weight x 100 / SL³) ranged between 1.65 and 1.78 and averaged 1.72 for the grow out. The length-weight relationship was $\log \text{Weight} = -4.5439 + 2.8867 (\log \text{SL})$. These observations on fish growth demonstrated that red drum can grow rapidly in saltwater tanks (33 ppt). These fish were tagged and released as part of the stock enhancement program in Biscayne Bay, Florida. (Supported by Contract C-6651 from the Florida Department of Environmental Protection).

KEYWORDS: aquaculture, Biscayne Bay, condition, growth, red drum, *Sciaenops ocellatus*.

INTRODUCTION

The red drum (*Sciaenops ocellatus*) is an important commercial and recreational fish in Florida and along the Gulf coast (Peters and McMichael, 1987; Tilmant *et al.*, 1989). They were once described as being abundant in Florida's Biscayne Bay but landings declined rapidly in the 1950s (Yokel, 1966). This decline may be due to both over fishing and habitat loss (Peters and McMichael, 1987). The purpose of this study is to demonstrate that juvenile red drum can grow rapidly in saltwater tanks and to compare the resulting growth characteristics with those from previous studies for this species. Growth data is crucial for management and mariculture programs such as the Biscayne Bay stock enhancement project and many others.

MATERIALS AND METHODS

The Florida International University Marine Lab (FIUML) in Miami, Florida is an open air, flow-through facility that was constructed in 1989 - 1990 with funds from the Florida Department of Natural Resources (FDNR), Fish and Game Unlimited of Homestead Inc., and Florida International University. It is a

small facility of about 220 square meters. Unfiltered sea water from Biscayne Bay is supplied via four 115 volt pumps. Air is provided at 50 psi by two 220 volt regenerative blowers.

In December of 1992, FDNR (now the Florida Department of Environmental Protection) delivered fingerling red drum (25 mm standard length) from their hatchery in Port Manatee, Florida to the FIUML. After a two week acclimation period, 50 juvenile fish were weighed (g) and measured for standard length (SL) in millimeters. One thousand fish were then stocked in each of ten circular fiberglass tanks filled with 1500 l of sea water. Subsequently, a subsample of twenty fish from each tank was measured every two to three weeks. An incomplete data set of 50 fish was taken on day twenty-nine.

During grow out, the fish were fed approximately 5 % of their body weight per day of a commercial feed (Edwards and Roberts, 1989). Purina Trout Chow® # 00 - #2 (50 % protein), #3 and #4 (43 % protein) and #5 (40 % protein) were used. Temperature, salinity, pH and dissolved oxygen were recorded on a daily basis.

A regression model was fit to the weight/length data in the form of $\log W = \log a + b (\log SL)$, where W = weight in grams, SL = standard length in mm, $\log a$ = the y-axis intercept and b = slope. Condition factors were calculated using the formula reported in Wakeman and Ramsey (1985), $K = W (100) / SL^3$, where K = the condition coefficient, W = weight in grams, and SL = standard length in centimeters.

RESULTS

Analysis of variance revealed that there were significant differences in length and in weight among the tanks ($P < .0105$). Therefore, the data among tanks was not pooled. After eighty-nine days, the mean weight of the populations had increased from 1.4 g to 33.8 g (Figure 1), with an average increase of 0.36 g per day. Standard length increased from 41.7 mm to 127.1 mm (Figure 2), an increase of 0.96 mm per day. Regressions for weight (Figure 3) and length (Figure 4) over time were significant ($p = .0001$). The length-weight regression is given in figure five. During grow out, there was a general downward trend in condition (Figure 6). The condition factor at the beginning of the experiment was 1.78 but had dropped to 1.65 eighty-nine days later. Analysis of variance demonstrated that this decline was significant ($p = .0001$). Temperature ranged between 22 and 26°C, salinity between 31 and 36 ppt, pH between 7.5 and 8.2, and dissolved oxygen between 6.0 and 7.1 mg/liter. Total survival during grow out was 40%.

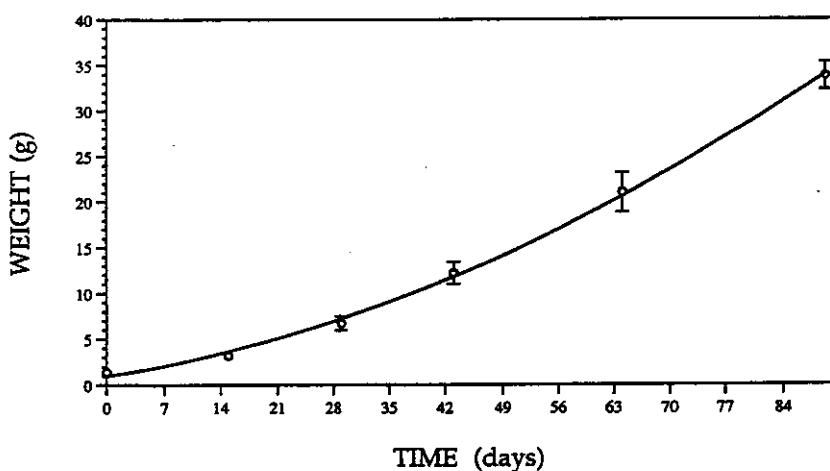


Figure 1. Weight increase of the juvenile red drum grown in saltwater tanks at 525 fish/m³ in the winter of 1992. Error bars indicate ± 2 standard errors. Points are means of ten tanks.

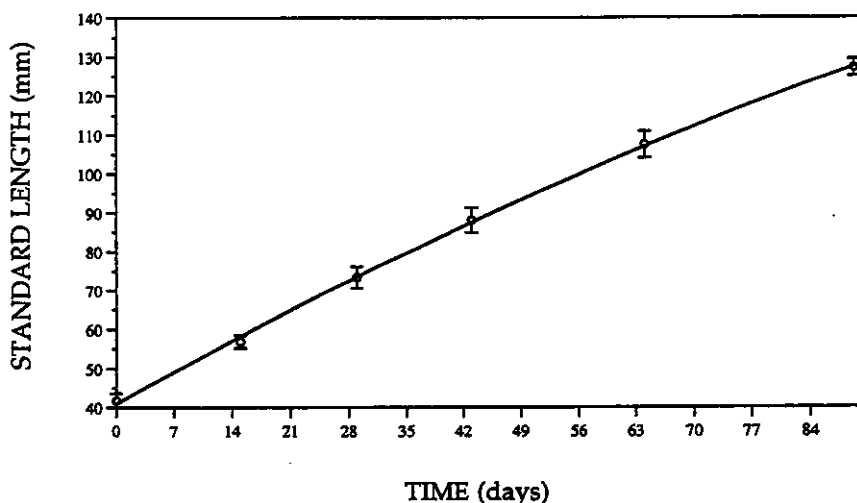


Figure 2. Increase in standard length of the juvenile red drum grown in saltwater tanks at 525 fish/m³ in the winter of 1992. Error bars indicate ± 2 standard errors. Points are means of ten tanks.

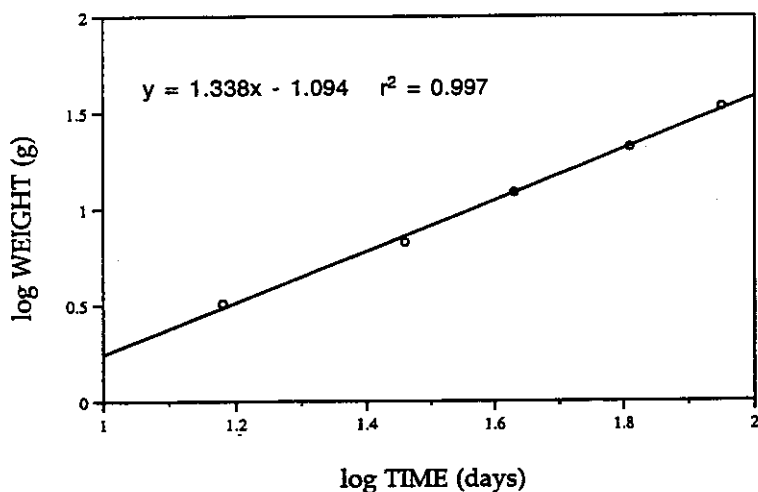


Figure 3. Regression for weight over time for the juvenile red drum grown in saltwater tanks at 525 fish/m³ in the winter of 1992 ($P = .0001$). Error bars indicate ± 2 standard errors. Points are means of ten tanks.

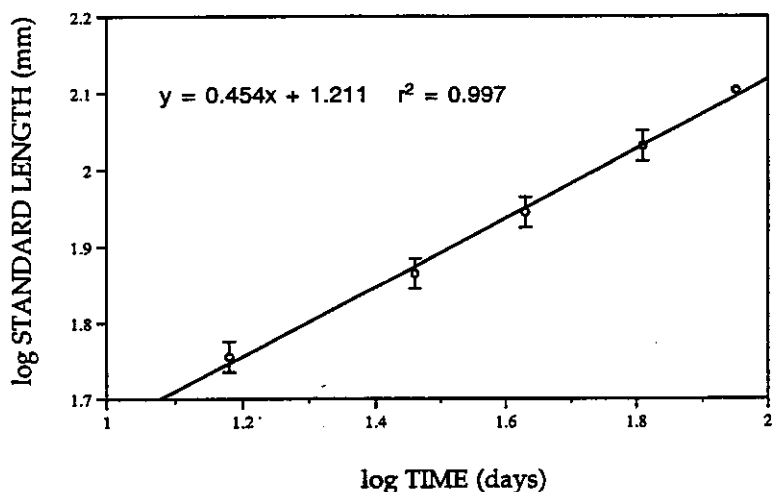


Figure 4. Regression for standard length over time for the juvenile red drum grown in saltwater tanks at 525 fish/m³ in the winter of 1992 ($P = .0001$). Error bars indicate ± 2 standard errors. Points are means of ten tanks.

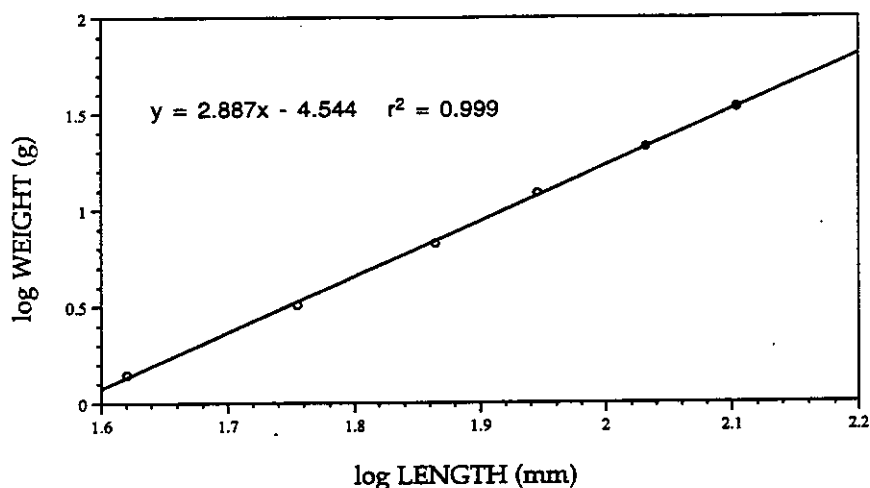


Figure 5. Length-weight regression for the juvenile red drum grown in saltwater tanks at 525 fish/m³ in the winter of 1992 ($P = .0001$). Error bars indicate ± 2 standard errors. Points are means of ten tanks.

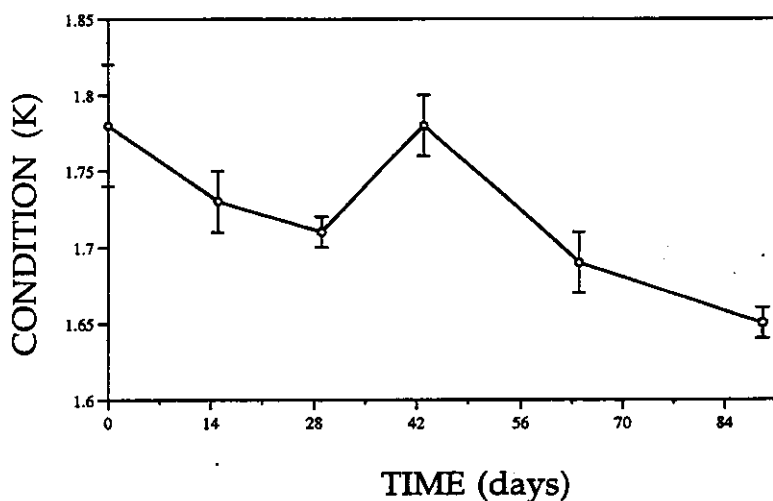


Figure 6. Condition factors for the juvenile red drum grown in saltwater tanks. The grow out was for eighty-nine days in the winter of 1992. Error bars indicate ± 2 standard errors. Points are means of ten tanks.

DISCUSSION

Even though the fish in this study were grown under aquaculture conditions, they grew quickly and maintained condition factors greater than 1.6. Beckman *et al.*, (1988), reported a growth rate of 0.58 mm per day and 4.2 g per day for older juveniles of this species in a Louisiana salt marsh impoundment. Pearson (1929) estimated a 0.54 mm increase per day for fish between one and 1.5 years of age in Texas. These differences in growth however, are primarily due to age differences (*i.e.* Beckman *et al.*, 1988 and Pearson, 1929 reported growth on older, larger fish. A direct comparison of observed growth from our study can be made with Edwards and Roberts (1989). They reported growth of 0.70 mm per day and 0.48 g per day in a forty-three day grow out of fish that had been stocked at 109.2 mm SL and 21.2 grams. On day sixty-four of our study, our fish reached 107.5 mm SL and 21.0 grams. Twenty-five days later they had grown to 127.1 mm SL and 33.8 grams, a growth rate of 0.78 mm per day and 0.51 g per day. These results were similar to those reported by Edwards and Roberts (1989).

The length-weight regression from our study falls within the range of regressions from Overstreet (1983) for this species reported in other studies (Table 1). It is interesting to note the similarities of the regressions even though there were many differences in time and location (conditions), methods, sample sizes and fish sizes. Nevertheless, possible seasonal and sex differences in this relationship may exist (Overstreet, 1983).

The condition factor fluctuated during grow out (Figure 6). There was a temporary rise in K after day twenty-nine (the incomplete data set) but this is thought to be a response to an increase in feed size that was implemented just prior to that day. By day sixty-four K had declined once again and continued to do so through the end of the experiment. This overall decline in condition may be a natural result of growth for this species. Bass and Avault (1975) reported a K of 1.773 - 2.077 for 568 juvenile red drum. Boothby and Avault (1971) reported a range of 1.2 - 1.7 for large juveniles and adults and demonstrated that seasonal variations exist for this parameter. Another possible explanation for this decline is that as the fish grow larger and space becomes more limited, competition due to the high stocking density becomes more intense (Brett, 1979).

These observations confirm that juvenile red drum can be grown in saltwater tanks under aquaculture conditions. In fact, the results from this study were similar to growth characteristics from both wild and captive fish throughout the Southeastern United States.

ACKNOWLEDGMENTS

This project was funded by the Florida Department of Environmental Protection, Florida International University, and Fish and Game Unlimited of

Table 1. A comparison of the length-weight regression from this study to those discussed in Overstreet, 1983. The regressions are organized from highest to lowest slope. Standard length = SL, W = weight in g, TL = total length.

NUMBER OF FISH	SIZE OF FISH	LENGTH-WEIGHT REGRESSION	AUTHOR	LOCATION
568	8-183 mm SL	$\log W = -7.2052 + 4.1913 (\log SL_{mm})$	Bass & Avault, 1975	Louisiana
302	14-1135 mm TL	$\log W = -5.1197 + 3.0523 (\log TL_{mm})$	Hein <i>et al.</i> , 1980	Louisiana
8319	71-970 mm TL	$\log W = -5.085 + 3.041 (\log TL_{mm})$	Harrington <i>et al.</i> , 1979	Texas
480	143-965 mm SL	$\log W = -4.7358 + 3.0053 (\log SL_{mm})$	Overstreet, 1983	Mississippi
47	283-411 mm SL	$\log W = -4.69 + 2.97 (\log SL_{mm})$	Luebke from Parret <i>et al.</i> , 1980	Texas (pond)
10 tanks with 20 Fish each	42-127 mm SL	$\log W = -4.5439 + 2.8867 (\log SL_{mm})$	This Study	Florida (tanks)
286	250-932 mm SL	$\log W = -4.42161 + 2.83232 (\log SL_{mm})$	Boothby & Avault, 1971	Louisiana
88	?	$\log W = -1.29596 + 2.74031 (\log SL_{cm})$	Thelling & Loyacano, 1976	South Carolina (marsh)

Homestead Incorporated. I would like to thank Dr. L.S. Quackenbush for his patience and support, and for making this project possible. Thanks also to Dr. Joel Trexler, Dr. Walter Goldberg, Dr. Ron Jones, Tom Frese, Donna Palchick, my family, and all of my friends at FIU who made this paper possible.

LITERATURE CITED

- Bass, R. J. and J. W. Avault, Jr. 1975. Food habits, length-weight relationship, condition factor, and growth of juvenile red drum, *Sciaenops ocellata*. Louisiana. Trans. Amer. Fish. Soc. 1: 35-45.
- Beckman, D.W., G.R. Fitzhugh, and C.A. Wilson. 1988. Growth rates and validation of age estimates of red drum, *Sciaenops ocellatus*, in a Louisiana salt marsh impoundment. Contrib. Mar. Sci. 30: 93-98.
- Boothby, R.N. and J.W. Avault. 1971. Food habits, length-weight relationship, and condition factor of the red drum, *Sciaenops ocellata*, in Southern Louisiana. Trans. Amer. Fish. Soc. 100(2): 290-295.
- Brett, J.R. 1979. Environmental factors and growth. Pages 599-699 in W.S. Hoar and D.J. Randall, ed. *Fish Physiology*, Vol. VIII. Academic Press, Inc., Orlando.
- Edwards, R.E. and D.E. Roberts. 1989. Inland aquaculture of red drum in fresh water from the Floridian aquifer: a feasibility/demonstration project. Aquaculture Report Series. 1989.
- Harrington, R.A., G.C. Matlock, and J.E. Weaver. 1979. Standard-total length, total length-whole weight and dressed whole weight relationships for selected species from Texas Bays. Tex. Parks Wildl. Dep. Tech. Ser. No. 26. 6pp.
- Hein, S., C. Dugas and J. Shepard. 1980. Total length-standard length and length-weight regressions for spotted seatrout, *Cynoscion nebulosus*; red drum, *Sciaenops ocellata*; and black drum, *Pogonias cromis*, in south-central Louisiana. La. Dept. Wildl. Fish., Contib. Mar. Res. Lab., Tech. Bull. 31: 41-48.
- Osburn, H. R., G. C. Matlock and A. W. Green. 1982. Red drum (*Sciaenops ocellatus*) movement in Texas bays. Contrib. Mar. Sci. 25: 85-97.
- Overstreet, R.M., 1983. Aspects of the biology of the red drum *Sciaenops ocellatus*, in Mississippi. Gulf Res. Rep. suppl. 1: 45-68.
- Parrett, W.S., J.E. Weaver, R.D. Williams, P.L. Johansen, T.D. McIlwain, R.C. Raulerson and W.M. Tatum. 1980. Fishery profiles of red drum and spotted sea trout. Gulf States Marine Fisheries Commission, Publication No. 6. 60pp.
- Pearson, J.C., 1929. Natural history and conservation of the redfish and other commercial sciaenids on the Texas coast. Bull. U.S. Bur. of Fish. 44: 129-214.

- Peters, K.M. and R.H. McMichael Jr. 1987. Early life history of the red drum *Sciaenops ocellatus* (Pisces: Sciaenidae), in Tampa Bay Florida. *Estuaries*. 10(2): 92-107.
- Theiling, D.L. and A. Loyacano Jr. 1976. Age and growth of red drum from a saltwater marsh impoundment in South Carolina. *Trans. Amer. Fish. Soc.* 105: 41-44.
- Tilmant, J.T., Rutherford, E.S. and E.B. Thue, 1989. Fishery harvest and population dynamics of red drum (*Sciaenops ocellatus*) from Florida Bay and adjacent waters. *Bull. Mar. Sci.* 44(1): 126-138.
- Wakeman, J.M., and Ramsey, P.R. 1985. A survey of population characteristics for red drum and spotted sea trout in Louisiana. *Gulf Res. Rep.* 8(1): 1-8.
- Yokel, B.J., 1966. A contribution to the biology and distribution of the red drum *Sciaenops ocellata*. M.S. Thesis. Univ. of Miami, Coral Gables Fla. 166pp.