POND OVERWINTERING OF TEXAS AND SOUTH CAROLINA RED DRUM JUVENILES

by

Britt W. Bumguardner and Robert L. Colura

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Texas Parks and Wildlife Department
Fisheries Division
4200 Smith School Road
Austin, Texas 78744

ABSTRACT

Survival and growth of Texas and South Carolina red drum (*Sciaenops ocellatus*) ≈ 240 mm total length stocked in separate 0.4 ha ponds at 1,250 fish/ha and fed a commercially prepared diet were compared from November 1986 to April 1987 (142 d). Although no fish survived the test period, South Carolina fish were statistically longer ($P < 0.05$) than Texas fish after 60 days in the ponds. Mean total length was 297 ± 22 mm and 286 ± 20 mm for South Carolina and Texas fish, respectively. No significant difference in standard length or weight of the two groups occurred during the study. Caudal fin length of South Carolina fish was consistently greater than caudal fin length of Texas fish. Bird predation was apparently a major factor contributing to total mortality of both groups.

INTRODUCTION

Red drum (*Sciaenops ocellatus*), a popular sport fish along the Gulf of Mexico and southern Atlantic shorelines (Matlock 1984), suffer periodic winter kills in Texas due to low water temperatures (McEachron et al. 1984). Fish overwintered in South Carolina saltwater ponds survived water temperatures down to 0.8 C (Bearden 1967) suggesting more northerly distributed Atlantic red drum may be less susceptible to low water temperatures than red drum from the Gulf of Mexico (Bearden 1967, Moore 1976). Identification and culture of cold-tolerant red drum could decrease mortality of red drum stocked for population enhancement purposes by the Texas Parks and Wildlife Department (TPWD).

Adult red drum from the Atlantic (South Carolina) and Gulf of Mexico (Texas) are currently maintained by TPWD in controlled tank systems at the Gulf Coast Conservation Association-Central Power and Light Marine Development Center (MDC) at Flour Bluff, Texas. The objective of the present study was to compare survival and growth of juvenile South Carolina and Texas red drum (≈ 240 mm total length (TL)) overwintered in earthen ponds.

MATERIALS AND METHODS

Separate 0.4-ha ponds were stocked with 500 South Carolina red drum juveniles (mean ± SD size, 241 ± 53 mm TL, 161 ± 70 g) or 500 Texas red drum juveniles (mean ± SD size, 242 ± 39 mm TL, 156 ± 70 g) on 18 and 19 November 1986, respectively. Fish were initially fed a 48% protein trout feed (Silver Cup, Murray, Elevators, Murray, Utah) at 1.5% of body weight (BW) daily, five times/week when morning water temperatures were 10-14 C and 2.5% of BW when water temperatures were above 15 C. Fish were not fed when morning water temperatures were below 10 C. Feeding rates were adjusted during the first week in January to 0.5% of BW when temperatures were 10-14 C, 1% of BW when temperatures were 15-18 C, and 2% of BW when temperatures were above 18 C; fish were not consuming all food offered at the previous higher rates.

Fish were sampled at 30-day intervals by seining; standard length (SL), TL and weight of up to 30 fish from each pond were recorded. A parasitic crustacean (tentatively identified as *Argulus* sp.) was controlled using 0.25 mg/l of Trichlorfon ((2,2,2-Trichloro-1-hydroxyethyl)-phosphonic acid dimethyl ester, Fritz Chemical Company, Dallas, Texas) in each pond on 30 December 1986 and 7 January 1987. Water temperature in both ponds was 11 C during chemical application on 30 December, and was 15 C in the Texas pond and 14 C in the South Carolina pond on 7 January. Ponds were drained on 7 April 1987.

Salinity, (salinity-conductivity-temperature meter Model 33, Yellow Springs Instrument Company (YSI) Yellow Springs, Ohio) temperature and dissolved oxygen (dissolved oxygen meter model 58, YSI, Yellow Springs, Ohio) were recorded daily between sunrise and 0900 h.

Mean water temperature, salinity, and dissolved oxygen were compared by students *t*-test. Mean TL, SL, weight, condition factor (Everhart et al. 1975) and caudal fin length of South Carolina and Texas fish at stocking and at sample intervals were also compared by *t*-test. The relationships of SL to TL and log-transformed weight (log WT) to log-transformed SL (log SL) and log-transformed TL (log TL) for both groups of fish were compared using linear regression and analysis of covariance (SAS Institute Incorporated 1986). Statistical tests were performed using the Statistical Analysis System (SAS Institute Incorporated 1985). Significance level for all tests was P = 0.05. All mean values in this paper are reported ± 1 SD.

RESULTS

No fish from either group were recovered at pond harvest. Mean TL of Texas and South Carolina red drum at stocking was not significantly different (Table 1). Approximately 30 days after stocking mean TL of Texas red drum was 267 ± 27 mm (n = 30) and mean TL of South Carolina red drum was 285 ± 24 mm (n = 15); mean TL of South Carolina red drum was significantly greater than mean total length of Texas red drum. Mean TL of Texas (286 ± 20 mm, n = 30) and South Carolina (297 ± 22 mm, n = 30) red drum was also significantly different approximately 64 days after stocking. Mean SL and weight of the two groups was not significantly different; however, mean caudal fin length was significantly different between the groups at all three periods (Table 1). No fish were obtained in samples at 90 and 120 days after stocking or at pond harvest.

Numerous piscivorous birds were observed near the ponds in December and January; 19 dead fish were recovered on the pond banks during these months. Additionally, four cormorants were removed from the ponds in January; each had ingested a red drum. The largest ingested fish was 320 mm TL. Red drum in both ponds were observed schooling and swimming along pond margins in January, occasionally in water so shallow their backs were exposed.

Mean water temperature was 14 ± 3.3 C and 14 ± 3.4 C in Texas and South Carolina red drum ponds respectively; the minimum temperature was 7 C in both ponds. Maximum water temperature decreases of 10 C occurred in both ponds in one 48-h period. Decreases of 10 and 11 C occurred in ponds 13 and 14, respectively, over a 72-h period (Figure 1). Mean dissolved oxygen was 8.7 ± 0.7 mg/l in both ponds; minimum dissolved oxygen was 5.3 mg/l in the Texas pond and 5.1 mg/l in the South Carolina pond. Mean salinity in the Texas red drum pond (17 ± 1.1 o/oo) was statistically less than in the South Carolina red drum pond (18 ± 1.2 o/oo); salinity ranged from 15 to 21 o/oo in the Texas pond and from 16 to 22 o/oo in the South Carolina pond.

Analysis of covariance revealed no differences in the intercepts of the regression models of SL to TL for the two groups; however, the slopes were significantly different (Table 2, Figure 2). Slopes and intercepts of the regression equations for log WT to log SL and log WT to log TL were significantly different for the two groups of fish (Table 2, Figures 3 and 4).

DISCUSSION

Total mortality of both groups of red drum was most likely due to predation by piscivorous birds, as water temperatures did not drop below 7 C (Figure 1) which is at the upper range of lethal temperatures reported for red drum (Simmons and Breuer 1962, Moore 1976). Additionally, no fish remains were observed on the pond bottom when ponds were drained, as would be the case if fish died of low water temperatures, parasite infestation or chemical toxicity.

The cause of shallow water schooling is unknown but may be related to cooler water temperatures, as similar behavior by red drum held in ponds during the fall and winter has been observed at commercial red drum production operations (David Maus, Redfish Unlimited, personal communication). Congregation in shallow water, which due to solar radiation would be the warmest water present in the pond on clear days, may be due to fish actively seeking the highest temperatures available. Fish may also be attempting to instinctively migrate from shallow to deeper water areas with the onset of cooler water temperatures, and the schooling may represent a behavior pattern designed to facilitate egress from a semi-enclosed area. In any event, this behavior made fish susceptible to predation by wading birds. The 19 fish found dead on the pond banks were apparently captured and killed by wading birds, but birds were frightened away before fish could be consumed. While mean salinity for the two ponds was significantly different, the increment between mean values was relatively small (1 o/oo) and should have had little or no effect on survival or behavior as salinities for both ponds were well within tolerated limits for red drum (Weinstein 1981). However, cooler fall water temperatures, possibly combined with the parasite infestation and/or residual treatment chemicals may have made captive red drum more susceptible to avian predators.

It is doubtful that parasites or residual trichlorfon directly caused fish deaths, as the infestation appeared to be moderate and toxicity of trichlorfon decreases as temperatures decrease (Steve Newman, Argent Chemical Company Technical Representative, personal communication). Toxicity of trichlorfon to red drum is unknown, but has previously proven effective in controlling _Argulus_ sp. in black drum (_Pogonias cromis_) X red drum hybrid and red drum culture ponds (Henderson-Arzapalo and Colura 1984, Colura et al. 1990).

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TABLE 1. Mean total length (TL), standard length (SL), caudal fin length (CF), weight (WT) and condition factor (K_{SL}) of Texas (TX) and South Carolina (SC) red drum juveniles at stocking and sampling periods. The number of fish measured is indicated by n, values followed by common upper case letters within columns and periods are not significantly different ($P > 0.05$). Numbers in parentheses represent standard deviations.

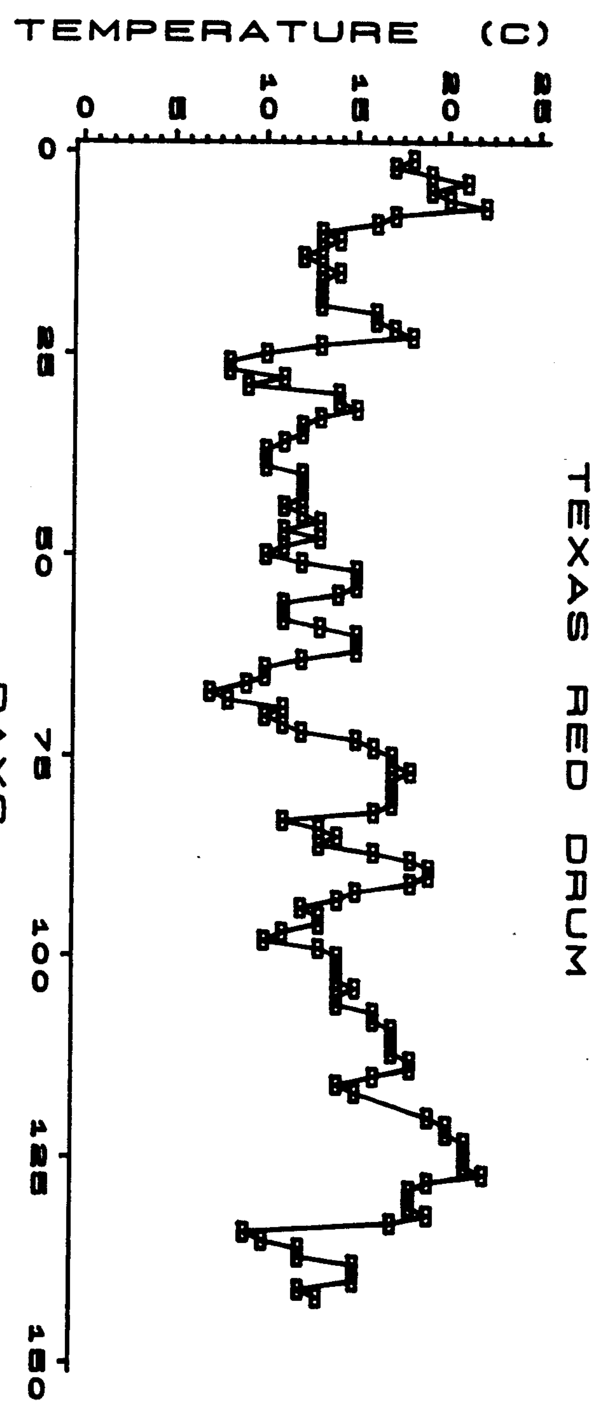
Period	Group	n	SL (mm)	TL (mm)	CF (mm)	WT (g)	K_{SL}[1]
Stocking							
	TX	100	208 A (36)	242 A (39)	34 A (4)	156 A (70)	1.6 A (0.16)
	SC	99	197 A (45)	241 A (53)	43 B (4)	161 A (70)	1.8 B (0.17)
First sample							
28 d	TX	30	236 A (25)	267 A (27)	31 A (4)	202 A (64)	1.5 A (0.10)
31 d	SC	15	245 A (22)	285 B (25)	40 B (4)	231 A (72)	1.5 A (0.11)
Second sample							
63 d	TX	30	248 A (18)	286 A (20)	38 A (4)	232 A (57)	1.5 A (0.07)
65 d	SC	30	254 A (19)	297 B (22)	44 B (3)	239 A (54)	1.4 B (0.05)

[1]K_{SL} = weight X 10^5/standard length X 10^3

TABLE 2. Regression coefficients for relationships between standard length (SL) and total length (TL), log_{10}-transformed weight (LWT) and Log_{10}-transformed SL (LSL) and LWT and Log_{10}-transformed TL (LTL) for Texas (TX) and South Carolina (SC) red drum. Coefficients within columns for each relationship followed by a common upper-case letter are not significantly different ($P > 0.05$).

Relationship	Group	n	Y-intercept	Slope	r^2
SL to TL	TX	160	-11.721718 A	0.911947 A	0.99
	SC	143	-15.079733 A	0.891493 B	0.99
LWT to LSL	TX	160	- 4.529357 A	2.881001 A	0.98
	SC	143	- 4.209498 B	2.759259 B	0.97
LWT to LTL	TX	160	- 5.227731 A	3.095995 A	0.98
	SC	143	- 5.008886 B	2.999513 B	0.98

Figure 1. Temperature in overwintering ponds stocked with Texas and South Carolina red drum, respectively.


TEXAS RED DRUM
TEMPERATURE (C)
0
5
10
15
20
25
DAYS
0
25
50
75
100
125
150

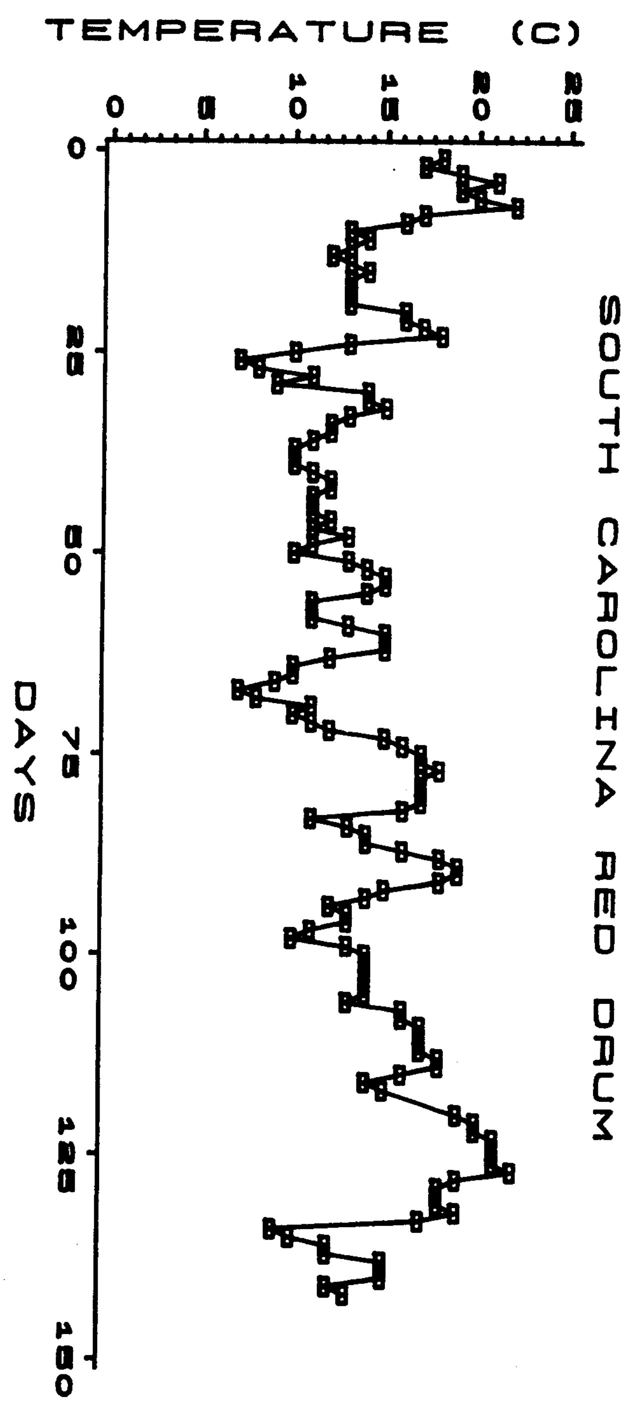

SOUTH CAROLINA RED DRUM
TEMPERATURE (C)
0
5
10
15
20
25
DAYS
0
25
50
75
100
125
150

Figure 2. Relationship of standard length to total length for Texas and South Carolina red drum reared in ponds.

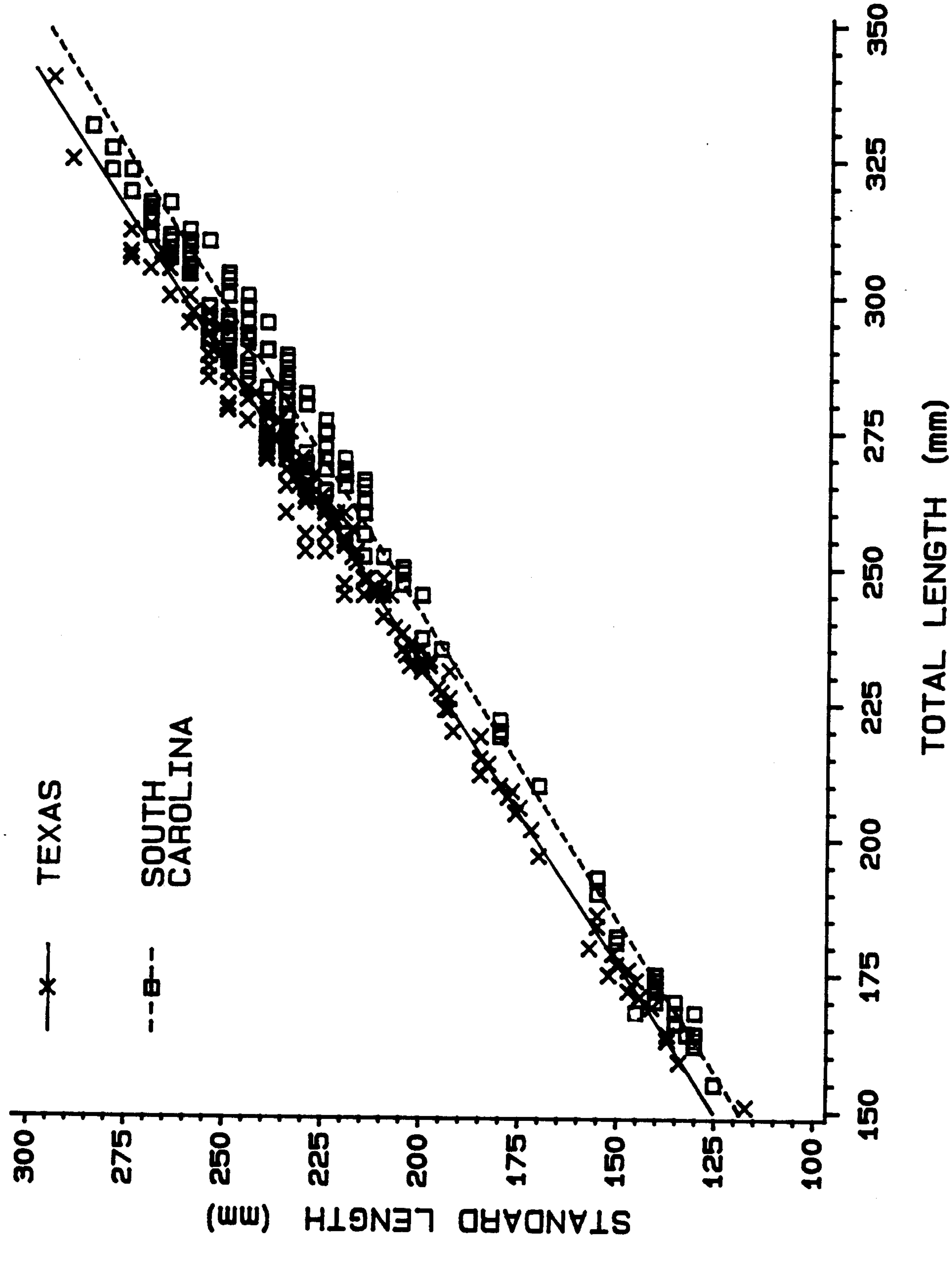

TEXAS
SOUTH CAROLINA
TOTAL LENGTH (mm)
STANDARD LENGTH (mm)
150
175
200
225
250
275
300
325
350
100
125
150
175
200
225
250
275
300

Figure 3. Relationship of log weight to log standard length for Texas and South Carolina red drum reared in ponds.

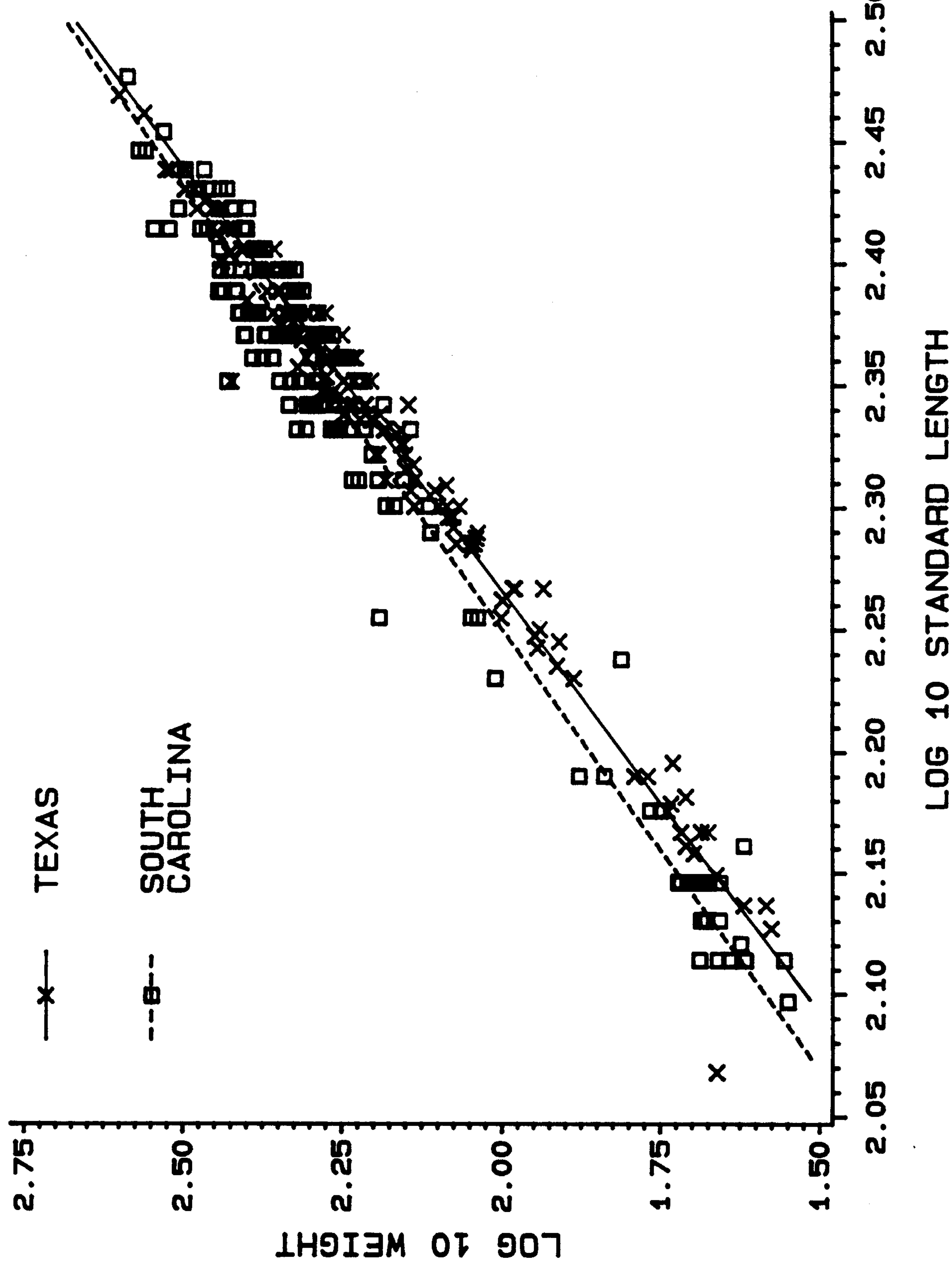
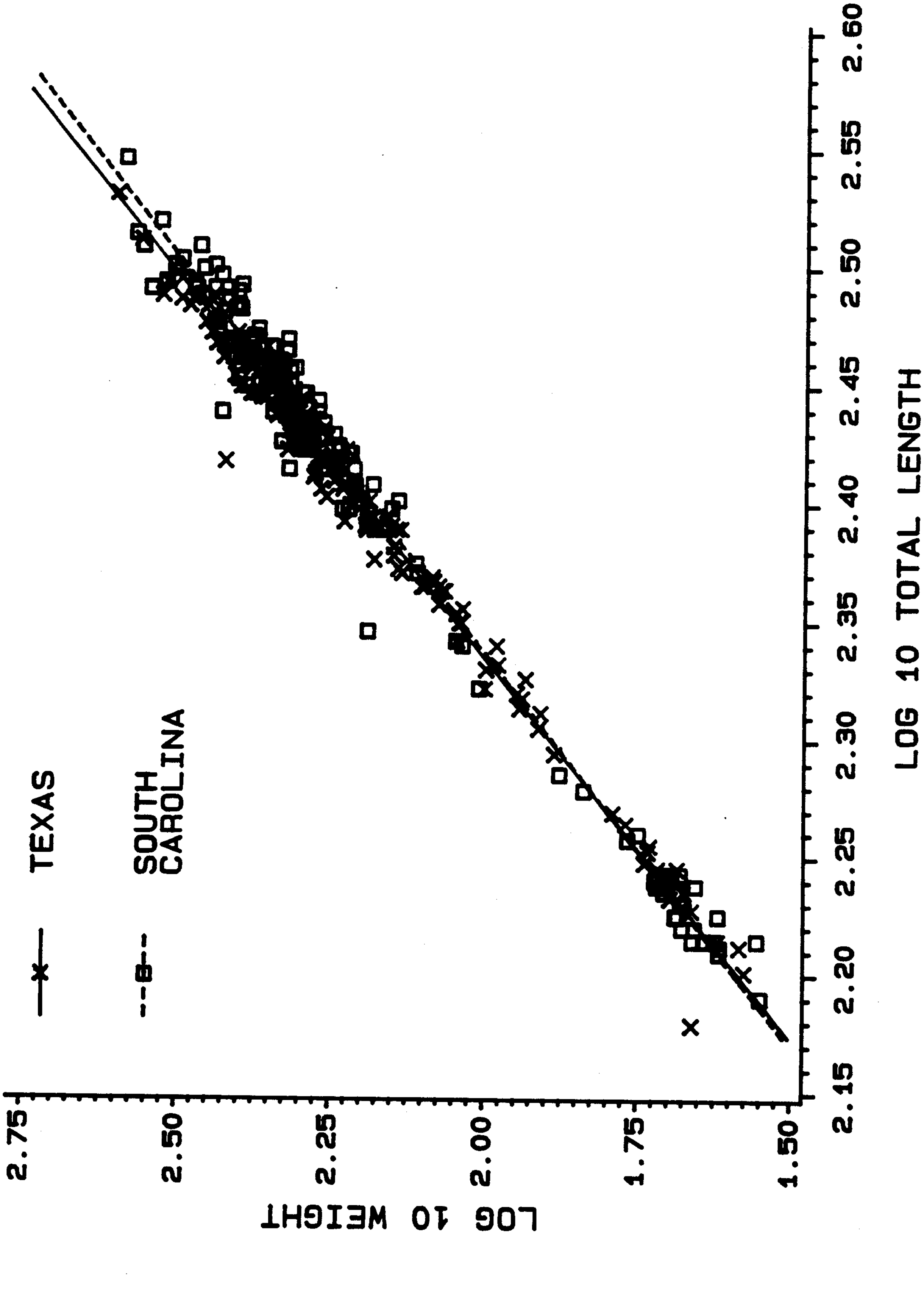

TEXAS
SOUTH CAROLINA
LOG 10 WEIGHT
2.75
2.50
2.25
2.00
1.75
1.50
LOG 10 STANDARD LENGTH
2.05
2.10
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50

Figure 4. Relationship of log weight to log total length for Texas and South Carolina red drum reared in ponds.



TEXAS
SOUTH CAROLINA
LOG 10 WEIGHT
LOG 10 TOTAL LENGTH
2.75
2.50
2.25
2.00
1.75
1.50
2.15
2.20
2.25
2.30
2.35
2.40
2.45
2.50
2.55
2.60

PWD-RP-3400-325-6/90