YIELD TRIALS FOR RED DRUM IN BRACKISH-WATER PONDS, 1976-1979

WILLIAM C. TRIMBLE[a], Claude Peteet Mariculture Center, Alabama Dept. Conservation and Natural Resources, Gulf Shores, AL 36542

Abstract: In 2 trials during 1976-1979, juvenile red drum (*Sciaenops ocellata*) were reared to marketable size (454 g) in 0.08-ha, brackish-water ponds at the Claude Peteet Mariculture Center. In Trial I, survivors from a nursery pond were stocked in 2 production ponds, fed a commercial feed, and harvested when 394 or 532 days old. Less than 1% of drum from the first harvest were marketable, and yield was 787 kg/ha with 210-g mean weight, 89% survival, and 2.8 feed conversion. Twenty-one percent from the second harvest were marketable, and yield was 1,062 kg/ha with 335-g mean weight, 75% survival, and 4.6 feed conversion. In Trial II, red drum from a second nursery pond were restocked in periodically drained production ponds, fed commercial feeds, then harvested when 715 days old. Standing crop of drum was 2,292 kg/ha during Trial II, and 33% of the drum were marketable at harvest. A 40% protein feed ($0.62/kg) poses an economic barrier in Alabama for mariculture of red drum dock-valued at $0.66 to $0.88/kg. Effect of 25% protein feed ($0.44/kg) on production of red drum was negated by a fungous epizootic.

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Investigations on grow out of red drum were initiated in 1947 and continued intermittently for 20 years in South Carolina ponds tidally stocked with wild fish (Lunz 1951, 1956; Bearden 1967). Red drum portion of harvested crops was only 15 kg/ha/year at maximum, but Bearden (1967) noted that the impounded red drum averaged 860 g when 1 year old. More recently, South Carolina ponds yielded 52 kg/ha/year of red drum with year-old drum averaging 950 g and ranging from 800 - 1,070 g (Theiling and Loyacano 1976).

Fed commercial feed or killed forage fish in Texas ponds, red drum exhibited potential for higher yield and survival during grow out. For example, during a 151-day study in Texas, yield for red drum reached 308 kg/ha with 96% survival and increase in mean weight from 186 g to 641 g (Luebke and Strawn 1973). On the other hand, red drum stocked at a larger size (638 - 1,484 g) did not grow, although supplemental feed was administered (Colura and Hysmith 1975).

Spawning techniques (Colura 1974, Arnold et al. 1977, Roberts et al. 1978a) also enhanced mariculture potential for red drum; however, the fry were not grown to marketable size (454 g). For example, red drum averaging 0.5 g were produced in Texas by rearing 2- to 6-day-old larvae from photoperiod and temperature regimes in ten 0.1-ha ponds for 27 to 60 days with 20% survival and 29.7 kg/ha yield (Colura et al. 1976). In Florida, emphasis likewise was placed on feeding and density relationships for 2- to 16-day-old red drum progeny from photoperiod and temperature regimes (Roberts et al. 1978b).

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[a]Present address: St. Martin Land Company, 311 Toronto Drive, Lafayette, LA 70507

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MATERIALS AND METHODS

General Pond Management

All nursery and production ponds were located at the Claude Peteet Mariculture Center (CPMC) adjacent to the Gulf Intracoastal Waterway at Gulf Shores, Alabama. The ponds were 0.08-ha, rectangular, and equipped with a pivotal standpipe in a concrete catch basin. Because pond bottoms were sandy loams, sandy clay loams, or loamy sands, each pond seeped considerably, about 6.7 cm/day, and averaged 54.1-kl daily replenishment. Prior to entering each pond, brackish water from the waterway was filtered through a nylon encasement sleeve (Domestic Fabrics Corporation, Style ES-8845230).

Temperatures and salinities were usually monitored twice weekly. Temperatures were obtained with maximum/minimum thermometers (Taylor, Model 5458) placed at the deepest portion of ponds. Salinities were measured with an induction salinometer (Beckman Instruments, Inc., Model RS5-3) or refractometer (American Optical Co., Model 10419).

Additional pond management consisted of fertilizing and oiling ponds to promote plankton production and control predacious aquatic insects, respectively. Rate for fertilization was 280-kg chicken manure/ha, and the oiling rate was 2.5-liter motor oil (SAE 30) and 20-liter diesel oil/ha.

All ponds were stocked with hand-counted red drum randomly distributed for experimental designs with replicates. Prior to stocking, a portion of the fish were weighed individually (Mettler, Model P-1000). Similarly, at harvest, the crops were hand-counted, and a portion weighed individually.

Commercial feeds, Purina Trout Chow 40% (Appendix 1) or Purina Experimental Marine Ration 25 (Appendix 2), were administered in two equal portions on weekdays or once daily on weekends. Sizes of the trout chow are presented in Table 1. On windy days, the floating "developer" and "large fingerling" size trout chow were dispensed to each pond's wooden feeding frame (1.2 m^2) which was covered with 1.3-cm hardware cloth.

TABLE 1. Diameters of different sizes of Purina Trout Chow, 40%, administered to ponds at the CPMC.

Size of Feed (Manufacturer's Code)	Sieve Sizes (Tyler Standard)		Diameter of Feed (mm)
	100% Passes	100% Retained	
2	14	20	0.8 - 1.2
3	9	14	1.2 - 2.0
Large Fingerling	4	6	3.4 - 4.7
Developer	3	4	4.7 - 6.7

Nursery Pond Studies

Trial I. Approximately 1,000 juvenile red drum, survivors from part of a spawn induced by temperature and photoperiod regime on 30 August 1976 at the Florida Department of Natural Resources' Marine Research Laboratory (Roberts et al. 1978 a,b), were shipped by air-freight to the CPMC. Upon arrival on 1 October 1976, the juveniles were stocked at

12,500 fish/ha in 1 nursery pond. An unusually severe winter prohibited intensive management of the nursery pond; however, occasionally a commercial feed (Purina Trout Chow, 40% protein, sizes 2 and 3) was administered. Survival was determined when the pond was drained in April 1977.

Trial II. Red drum larvae produced by an experimental temperature and photoperiod regime at Florida's Marine Research Laboratory (FMRL) on 15 June 1977 were air-freighted to the CPMC. Upon arrival on 16 June, approximately 25,000 surviving larvae were transferred from fouled shipping water (28 ppt salinity, 25C) to five 80-liter aquaria containing clean, natural seawater (30 ppt salinity, 25C). Aeration to aquaria was limited to consecutive, single air bubbles to reduce shear mortality of the larvae (D.E. Roberts, Jr.; FMRL; personal communication). Survival of the larvae was noted on 0600 h on 17, 18, and 19 June. Wild plankton was administered to all aquaria on 18 June when the red drum developed eye spots and mouth parts.

To evaluate prospects of transferring the larvae directly to a nursery pond, 20 larval red drum were maintained from 17-19 June in an 80-liter aquarium containing pond water at 10 ppt salinity and ambient air temperature, 26-28C.

After 100% survival was indicated in the direct transfer experiment, approximately 15,000 larval red drum were transported to the nursery pond on 19 June. Thereafter, pond management for the nursery study consisted of monitoring salinity and temperature, fertilizing and eliminating predacious insects on 20 June, and beginning on 16 August 1977 feeding a commercial feed (Purina Trout Chow, 40% protein) twice daily on weekdays and once daily on weekends. A portion of the feed was ground and sieved through 1-mm fiberglass window screening. Feed passing the sieve was administered from 16 August through 1 September at 0.5 kg/pond/day. Crumbles of feed retained by the sieve were fed from 2 September through 19 October at 2.27 kg/pond/day. From 20 October through 7 November, whole, large fingerling size, feed was administered at 2.27 kg/pond/day. At harvest on 8 November survivors were counted, and 240 juveniles were individually weighed and measured for standard (SL) and total length (TL).

Production Pond Studies

Trial I. Two ponds (B-6 and C-3) were filled with filtered brackish water and stocked with surviving red drum from the nursery pond on 29 April 1977. Initial mean weight of drum was 11.5 g, and ponds B-6 and C-3 were stocked with 337 drum (4,213/ha) and 338 drum (4,225/ha), respectively. The commercial feed was administered in sizes increasing from large fingerling (days 0 to 83) to developer (days 84 to termination of studies). Quantity of feed was adjusted at sampling intervals and with feeding activity but ranged from 3 - 20% of estimated biomass of drum, assuming 100% survival. Approximately 30 fish were collectively weighed at sampling intervals. Red drum were inspected for health on 30 May, 9 August, 21 December 1977, and 13 February 1978.

Ponds C-3 and B-6 were harvested on 28 September 1977 (152 days) and 13 February 1978 (290 days), respectively. Weights and standard lengths were obtained for individual fish at harvest for growth, survival, and production computations. Feed conversions were generated by dividing total dry weight of feed administered by the difference of wet weight of whole fish at stocking and harvest. Coefficient of condition (K_{sl}) was calculated using the formula: $K_{sl} = W\ (10^5)/L^3$, where W is weight in g, and L is standard length in mm (Lagler 1956).

Trial II - Phase I. Three days before juvenile red drum in the nursery pond (C-6) were stocked in production ponds, heavy incidences of ciliated protozoans, *Trichodina* spp., were found on the drums' fins, gills, and skin. A 3-day experiment indicated control of the protozoan with a formalin dip (37% formaldehyde at a concentration of 250 mg/liter for 3 minutes); therefore, just prior to stocking the production ponds, all red drum juveniles were treated with formalin.

After the formalin dip on 9 November 1977, 12 ponds were stocked with the 147-day-old juvenile drum which averaged 11.3 g. The fish were randomly stocked to evaluate factorially two densities (2,813 or 6,250 fish/ha) and two commercially available feeds (Purina Experimental Marine Ration 25 or Purina Trout Chow, 40% protein). Initially feed was administered at 10% body weight; however, after 7 December the rate was reduced to 5%. Forty to 50 fish/pond were collectively weighed on 19 December 1977 and 5 January 1978. Microbiological and parasitological examinations were performed on 21 December 1977 and 20 January 1978. The ponds were drained on 23-24 February 1978, and survivors were individually weighed. Hydrodata for Trial II were obtained according to Trial I methods.

Trial II - Phase 2. One pond (C-2) was stocked on 24 February 1978 with 1,328 juvenile red drum (16,600 fish/ha), survivors averaging 13.5 g from Trial II - Phase 1, to investigate potential for grow out during warm months. The feed (Purina Trout Chow, 40% protein; large fingerling size) was administered beginning on 28 February at 5% body weight, and the rate, 0.9 kg/pond/day, was maintained through mid-May 1978. Feeding was stopped in late May, when feeding activity ceased during a massive mortality attributed to an epizootic of the dinoflagellate, *Amyloodinium ocellatum.* When feeding activity returned, the rate was increased to 1.3 kg/pond/day from 1 June through 17 July. Microbiological and parasitological examinations were performed on drum on 19 and 29 May 1978. All fish were counted and 30 fish were weighed individually when the pond was drained on 18 July 1978.

Trial II - Phase 3. On 18 July 1978 one pond (C-1) was stocked at a density of 11,125 fish/ha with surviving red drum averaging 119 g from Trial II - Phase 2. Feed (Purina Trout Chow, 40% protein; developer size) was administered at 2.27 kg/pond/day from 19 July - 14 August and at 2.5 kg/pond/day from 15 August through 27 September 1978. Two fish were sacrificed on 21 July for health examination. The production pond was harvested on 28 September and all fish were counted. One hundred seventy-four randomly selected red drum were weighed individually.

Trial II - Phase 4. On 28 September 1978, 2 ponds (A-3 and C-1) were stocked at a density of 5,238 fish/ha with surviving red drum averaging 206 g from Trial II - Phase 3. The feed (Purina Trout Chow, 40% protein; developer size) was administered at 1.3 kg/pond/day from 29 September 1978 through 22 January 1979 when feeding activity ceased. From 24 February 1979 through 8 April 1979 the feeding rate was 2.0 kg/pond/day then 1.5 kg/pond/day until harvest on 31 May 1979. One drum from each pond was inspected for health on 14 May 1979. All surviving drum were individually weighed at harvest.

RESULTS

Nursery Pond Studies

Trial I. Despite the severe winter, results of the nursery study were encouraging. Survival of juvenile red drum from October 1976 to April 1977 was 82%, and mean weight increased to 11.5 g.

Trial II. Red drum larvae were satisfactorily maintained until 19 June in the 5 aquaria, after an initial mortality of 40% on 17 June. The high initial mortality may have been caused by stocking some stressed and dead larvae from the shipping containers. Food was seen in alimentary canals of the drum, after wild plankton was added to the aquaria. Survival of the 20 larvae transferred directly to aquaria containing pond water was 100%.

From 19 June 1977 to 8 November 1977 (142 days) mean weight of the drum increased to 11.3 g. The random sample indicated a size range of 1.1 g (42 mm SL and 54 mm TL) to 26.1 g (113 mm SL and 139 mm TL). Survival was 31.2%, and production was 662 kg/ha. The feed conversion was 2.7:1. As indicated in Fig. 1, salinity varied from 14–19 ppt and temperature ranged from 17 – 34C during the nursery pond study. Approximately 2.4%

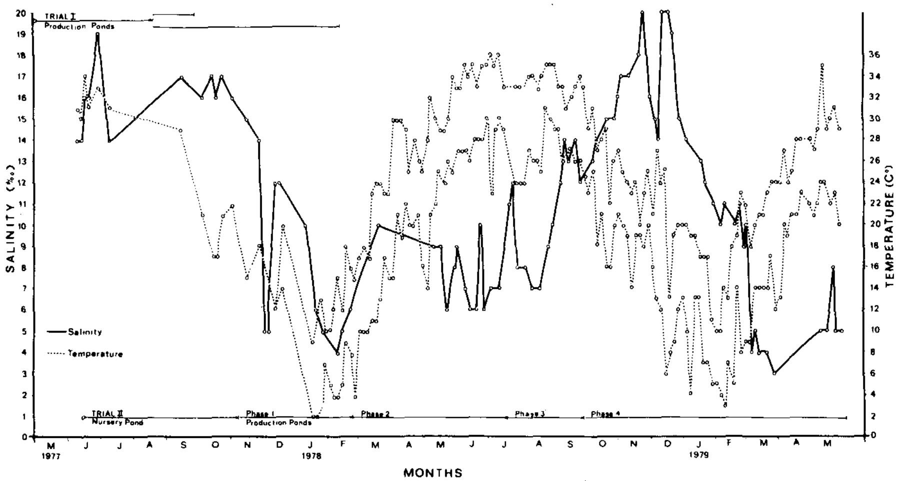

Fig. 1. Salinities and temperatures in ponds during Trial I (29 April 1977 - 13 February 1978) and Trial II (16 June 1977 - 31 May 1979) on grow out of *Sciaenops ocellata* at the Claude Peteet Mariculture Center, Alabama.

of the juveniles were killed during the harvest; the mortality was high for the experienced harvest crew suggesting that juvenile red drum may stress more easily than other juveniles reared at the CPMC.

Production Pond Studies

Trial I. Growth of red drum occurred throughout the seasons, as indicated by sampling data (Fig. 2). As shown in Table 2, mean weight of red drum in ponds C-3 and B-6 increased 18-fold (1.3 g/day during 152 days) and 29-fold (1.1 g/day during 290 days), respectively. At harvest 0.7% of the 394-day-old red drum in pond C-3 and 20.9% of the 532-day-old drum in B-6 were marketable size (Table 3). Mean coefficient of conditions for fish from ponds C-3 and B-6 were 1.9263 (range: 1.0175 to 2.6960) and 1.7891 (range: 1.3318 to 2.6599), respectively. As shown in Table 2, feed conversion for drum in C-3 was 60% less than the conversion for drum in B-6. Yield increased 74% by holding the drum for an additional 138 days, but survival was 14% lower (Table 2).

Pathogens were observed during Trial I, and one chemotherapeutic was administered. Microbiological inspection revealed a bacterium, *Vibrio anquillarium*, on kidney and liver tissue of drum on 30 June 1977 and a bacterium, *Aeromonas hydrophila*, from kidney tissue and a lesion on 13 January 1978. Parasitological examinations indicated moderate incidence of a protozoan, *Tripartiella* (*Paratrichodina*) *obliqua*, on gills on 30 June and 10 October 1977 and light incidence of a protozoan, *Trichodina* sp., on gills, skin, and fins on 9 August 1977. An unidentified fungus was found on gills, skin, and fins of some drum of pond B-6 on 13 February 1978. The only treatment administered was for *V. anguillarium*. Prior to treatment, feeding activity was poor, but normal feeding activity resumed after treatment (2.5 g terramycin/45.4 kg fish/day, administered with feed from 12-22 July 1977).

During the production study, salinity ranged from 4 - 19 ppt and temperature ranged from 2 -34C (Fig. 1). Abrupt changes in salinity occurred in pond B-6 on 2 December when mechanical malfunctions necessitated pumping fresh water instead of brackish water and on 20 January after heavy rainfall.

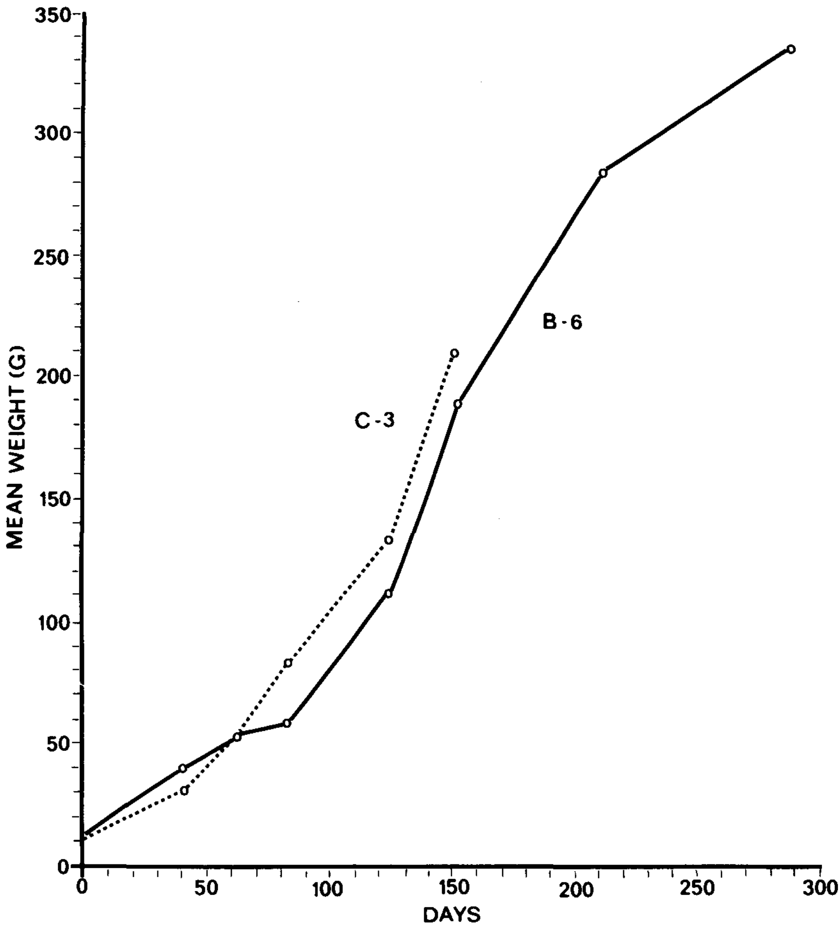

Fig. 2. Growth of *Sciaenops ocellata* during Trial I (29 April 1977 - 13 February 1978) in brackish-water ponds (B-6, C-3) at the Claude Peteet Mariculture Center, Alabama.

Trial II - Phase I. Effects of densities and feeds on production of marketable-size drum were not found during Trial II - Phase I (9 November 1977 to 23-24 February 1978); however, growth, survival, and yield of drum were poor and feed conversions were high (Table 2). For example, during the 106- to 107-day production period, mean weight of drum increased by only 0.5 g (pond B-5) to 2.7 g (ponds B-3 and B-18). Poor growth was indicated as early as 19 December when mean weight was 13.4 g. Likewise, survival rates were low ranging from 10 - 57%. Poor survival was suggested as early as 5 January when 1 drained pond yielded only 234 of 500 stocked drum. Yields for the ponds on 23-24 February were only 8 - 47 kg/ha, and feed conversions ranged from 12.7 - 79.6.

On 19 and 21 December a light-brown, unidentified fungus was seen in lesions on gills and skin of several drum in each pond. The fungus was not found on the drum during sampling on 5 January or during the health inspection on 20 January; however, the fungus was seen on gills and skin of many drum from each pond on 23-24 February. A malachite green dip (0.5 mg/liter for 2 h) did not control the fungus, but infected drum

TABLE 2. Pond studies on grow out of red drum at the Claude Peteet Mariculture Center, 1977-1979.

Trial No.	No.	Stocking Data: Date Stocked	Stocking Data: Mean Weight (g)	Stocking Data: Density (Fish ha)	Prod. Days	Harvest Data: Wt of Drum (g) Mean	Harvest Data: Wt of Drum (g) Range	Harvest Data: Kg/ha	Harvest Data: Survival (%)	Harvest Data: Feed Conv.
I	B-6	29 Apr 1977	11.5	4,213	152	210	59-551	787	89	2.8
	C-3	29 Apr 1977	11.5	4,225	290	335	76-705	1,062	75	4.6
II, 1	B-16[a]	9 Nov 1977	11.3	2,813	106	13.9	2.4-26.8	13	32	22.7
	C-3[a]	9 Nov 1977	11.3	2,813	c	-	-	-	-	-
	C-4[a]	9 Nov 1977	11.3	2,813	c	-	-	-	-	-
	A-3[a]	9 Nov 1977	11.3	6,250	106	12.3	2.3-32.8	32	41	20.1
	A-8[a]	9 Nov 1977	11.3	6,250	106	13.9	3.7-43.3	40	46	15.9
	B-5[a]	9 Nov 1977	11.3	6,250	107	11.8	1.5-27.0	15	21	41.8
	A-5[b]	9 Nov 1977	11.3	2,813	106	13.5	3.5-29.5	22	57	12.7
	B-18[b]	9 Nov 1977	11.3	2,813	106	14.0	3.7-43.1	21	54	13.2
	C-5[b]	9 Nov 1977	11.3	2,813	c	-	-	-	-	-
	A-4[b]	9 Nov 1977	11.3	6,250	107	12.5	2.6-30.6	8	10	79.6
	B-3[b]	9 Nov 1977	11.3	6,250	107	14.0	2.5-34.7	47	54	13.3
	B-7[b]	9 Nov 1977	11.3	6,250	107	13.8	2.7-35.4	42	49	14.8
II, 2	C-2	24 Feb 1978	13.5	16,600	144	119	32-180	1,324	67	1.1
II, 3	C-1	18 Jul 1978	119	11,125	72	206	39-349	2,292	100	1.1
II, 4	A-3	28 Sep 1978	206	5,238	245	377	114-824	1,718	87	5.0
	C-1	28 Sep 1978	206	5,238	245	407	128-880	1,769	83	4.6

[a]Fed low protein ration.
[b]Fed high portein ration.
[c]Replicates terminated due to loss of water caused by pump failure and high seepage rates in 3 ponds.

TABLE 3. Weight-frequencies (%) at 112-g (0.25-lb) intervals for *Sciaenops ocellata* harvested from grow-out ponds at the Claude Peteet Mariculture Center, 1977-1979.

Intervals (g)	Weight frequencies (%): Trial I, Pond C-3	Trial I, Pond B-6	Trial II, 3, Pond-C-1	Trial II, 4, Pond A-3	Trial II, 4, Pond C-1
0 - 112	21.6	5.9	2.3	-	-
113 - 225	34.9	19.0	67.2	13.9	4.3
226 - 339	32.5	27.3	29.9	26.5	24.3
340 - 453	10.3	26.9	0.6	27.7	37.7
454 - 566	0.7	12.6	-	24.0	22.0
567 - 679	-	7.1	-	6.8	7.7
680 - 793	-	1.2	-	0.8	3.1
794 - 907	-	-	-	0.3	0.9

responded well when temperature and salinity were increased from 12 to 20C and 4 to 26 ppt, respectively.

During the study, recurring pump malfunctions resulted in low water levels in many ponds. Three of the ponds (C-3, 4 and 5) with high seepage rates almost dried-up, and all fish were exposed to predation by gulls and terns. During Phase I, temperature varied from 2 - 20C and salinity ranged from 4 - 16 ppt (Fig. 1).

Trial II - Phase 2. Growth, survival, yield, and feed conversions for the drum improved in Phase 2 with an 8-fold weight increase, 67% survival, 1,324 kg/ha yield, and 1.1 feed conversion in 144 days (Table 2). During Phase 2, temperature varied from 4 - 36C and salinity ranged from 6 -10 ppt (Fig. 1).

At least 18% of the mortality was attributed to the outbreak of the dinoflagellate, *A. ocellatum. A. ocellatum* was found at heavy incidence on gills and skin of live and dead drum on 19 - 21 May. Copper sulfate and freshwater controls for *A. ocellatum* (Lawler 1977) were not attempted. Prior experiments at the CPMC indicated that the copper sulfate treatment was not effective for red drum heavily infected with the dinoflagellate. The freshwater treatment was not attempted, because insufficient time and equipment were available to reduce concentration of CO_2 in the freshwater. Nevertheless, *A. ocellatum* was not found on the drum on 29 May. The only treatment attempted between 19 - 29 May was repeated partial draining and refilling of the pond with brackish water.

Formalin (37% formaldehyde at a concentration of 7 mg/liter for an indefinite period) was applied to ponds at the CPMC on 7 July 1978 to reduce densities of ciliated protozoans, including *Ambiphrya* sp., *Tripartiella* (*Paratrichodina*) *obliqua*, and *Trichodina* spp.

Trial II - Phase 3. As shown in Table 2, continued improvement in growth survival, yield, and feed conversion occurred for drum during Phase 3 (18 July through 28 September 1978). For example, the drum almost doubled their weight in 72 days. However, although their growth during Phase 3 was 1.2 g/day, none of the 470-day-old red drum were of marketable size on 28 September (Table 3). Nevertheless, their yield of 2,292 kg/ha and almost 100% survival with 1.1 feed conversion set production records for red drum. The only mortalities were 2 drum sacrificed on 21 July for health examinations. The dinoflagellate, *A. ocellatum*, was not seen on the drum on 21 July. During Phase 3, temperature varied from 24 - 35C and salinity ranged from 7 - 14 ppt (Fig. 1).

Trial II - Phase 4. As shown in Table 3, the drum almost doubled in weight during the 245 days of Phase 4 (28 September 1978 through 31 May 1979). Growth rate was 0.8 g/day during Phase 4, and about 33% of the fish were marketable size at harvest (Table 3). Mean yield, survival, and feed conversion were 1,744 kg/ha, 85%, and 4.8, respectively.

No pathogens were observed on the drum on 14 May 1979; however, livers of the fish were pale (fatty). During Phase 4, temperatures varied from 3 - 35C and salinity ranged from 3 - 20 ppt (Fig. 1). When water temperatures were less than 20C, the drum were not observed feeding on the floating feed.

DISCUSSION

The rapid growth of one-year-old red drum in South Carolina and Texas was not achieved at Alabama's CPMC. Stocking densities may partially explain the differences in growth rates. Trial II - Phase 1, designed to study effects of stocking densities as well as feeds on growth of red drum, was unfortunately terminated because of pump failures and disease problems. These effect should be investigated again when sufficient juvenile drum are available.

Six brackish-water pathogens may have also slowed growth of drum at the CPMC. Five of the pathogens (*Aeromonas hydrophila*, *Ambiphrya* spp., *Trichodina* spp., *Tripartiella* (*Paratrichodina*) *obliqua*, and *Vibrio anguillarium*) can be controlled easily by chemotherapeutics. The exception is *Amyloodinium ocellatum*. Control of this dinoflagellate at the CPMC by simply flushing the pond may have been only fortuitous, and a more assured control may be needed.

Feed may pose a barrier to economic production of red drum. Although feed conversions were as low as 1.1:1, the 40% protein feed's cost ($0.68/kg) approaches the reported dock value of whole red drum ($0.66 to $0.88/kg). Hopefully, as attempted in Trial II's Phase 1, less expensive feeds can be evaluated in future research.

Although red drum are considered eurythermal and euryhaline, the drum's growth rate, survival, and yield were apparently affected by winter conditions in coastal Alabama. In grow-out Trial II - Phase 1, young drum averaging 11.3 g at stocking exhibited little growth (0.5 g - 2.7 g) and poor survival (10% - 57%) during the winter months of 1977 - 1978. Likewise, in grow-out Trial II - Phase 4, older drum averaging 106 g at stocking grew at 67% of the rate for the preceeding period of warmer waters.

In conclusion, efforts at the CPMC to rear larval red drum from spawns induced by temperature and photoperiod manipulations to marketable size in brackish-water, earthen ponds were partially successful. Factors affecting red drum's mariculture potential include at least a 2-year production period, production costs, and effects of winter conditions on growth and survival.

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Appendix 1. Guaranteed analyses and ingredients for Purina Trout Chow 40% administered to ponds, CPMC. Manufactured by Ralston Purina Co., Gen. Offices, St. Louis, MO. 63188.

PURINA TROUT CHOW 40%

Guaranteed Anaysis

Crude protein not less than	40.0%
Crude fat not less than	4.0%
Crude fiber not more than	4.0%
Ash not more than	13.0%
Added minerals not more than	4.0%

INGREDIENTS

Soybean meal, fish meal, ground yellow corn, wheat middlings, meat and bone meal, ground wheat, dried whey, brewers' dried yeast, dried fish solubles, corn distillers' dried grains, animal fat preserved with BHA, vitamin A supplement, D activated animal sterol (source of vitamin D_3), menadione sodium bisulfite (source of vitamin K activity), methionine hydroxy analogue calcium, vitamin E supplement, vitamin B_{12} supplement, ascorbic acid, biotin, choline chloride, folic acid, pyridoxine hydrochloride, thiamin, niacin, calcium panthothenate, riboflavin supplement, calcium carbonate, dicalcium phosphate salt, copper oxide, manganous oxide, calcium iodate, iron oxide, calcium carbonate, cobalt carbonate, zinc oxide.

Appendix 2. Guaranteed analyses and ingredients for Purina Experimental Marine Ration 25 administered to ponds, CPMC. Manufactured by Ralston Purina Co., Gen. Offices, St. Louis, MO 63188.

PURINA EXPERIMENTAL MARINE RATION 25

Guaranteed Analysis

Crude protein not less than	25.0%
Crude fat not less than	10.0%
Crude fiber not more than	5.0%

INGREDIENTS

Fish meal, soybean meal, meat and bone meal, animal fat preserved with BHA, ground yellow corn, ground wheat , wheat middlings, dried whey, soybean oil, vitamin A supplement, D activated animal sterol (source of vitamin D_3), menadione dimenthyl pyrimidinol bisulfite (source of vitamin K activity), methionine, vitamin E supplement, vitamin B_{12} supplement, biotin, dicalcium phosphate, folic acid, pyridoxine hydrochloride, thiamin, niacin, calcium pantothenate, riboflavin supplement, copper oxide, manganous oxide, calcium iodate, iron oxide, calcium carbonate, cobalt carbonate, zinc oxide.