Producing Juvenile Red Drum

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The internship portion of my degree was fulfilled with the Texas Parks and Wildlife Marine Fisheries Research Station at Palacios, Texas. I was involved in all aspects of maintenance and culture operations at the station. Duties varied as need arose. My primary responsibility was feeding broodstock, monitoring broodstock tanks and biofiltration systems, and monitoring tank water quality. I assisted in egg collection, egg counting, fry counting, fry stocking, and fingerling harvest. After fry were stocked I was directly responsible for pond management: fertilization, filling, and feeding. I was frequently called upon to take pond readings: dissolved oxygen, salinity, and temperature. During the remainder of the time, my activities included minor construction, grounds maintenance, vehicle maintenance, tractor operation, and plumbing.

The red drum project at the Palacios fisheries station was begun in 1977. The state hoped to accomplish several goals with this program. The primary goal was the production of 60,000 red drum fingerlings per acre in one production cycle, for use in bay stocking programs. It was hoped that over-pressured fishing areas can be augmented by stocking.

The red drum is a euryhaline species. The state was investigating the inland sportfish potential of red drum. Experimental stocking programs had been implemented that summer. In west Texas, where ground waters are partially saline, this program appeared to be particularly promising. Additional goals included refinement in control of artificial spawning, improvement of fingerling production techniques, development of a culture program capable of producing fish of commercial size, and nutrition research (emphasizing nutrient requirements of broodstock prior to and during spawning). The following is the procedural format used by the Palacios station project leader, Robert Colura, for mass larval rearing and production of juvenile red drum (*Sciaenops ocellatus*).

Red drum broodstock were maintained in two, 20,000 liter, rectangular, fiberglass tanks. Salinity was maintained between 25-35 g/L. Each tank contained four fish (two males:two females). Toxic nitrogenous wastes were removed by four, shell and gravel biofilters. Biofilter efficiency was determined by checking water samples for nitrites, daily (Hach spectrophotometry). If nitrite levels exceeded 0.1 mg/liter, feeding was discontinued. The fish were fed three percent of their body weight daily. If more than 25% of the feed from the preceding day remained uneaten, food was withheld for one day. The fish were fed shrimp (*Penaeus aztecus*, *Penaeas duorarum*, and *Penaeus setiferus*), mullet (*Mugil cephalus*), and/or gizzard shad (*Dorosoma cepedianum*). Shrimp were headed; fish were headed, gutted and cut into large pieces. Shrimp was fed 60-75% of the time, depending on availability. All food was frozen prior to feeding to prevent the introduction of pathogenic organisms.

To induce spawning in red drum, temperature and photoperiod were manipulated. The fish were placed on an abbreviated yearly cycle. A full year's temperature and photoperiod changes were approximated in 120 days. Each season was completed in a 30 day period. Photoperiod was not matched as closely with all the seasons as was temperature. Temperature appeared to play a greater role in triggering a spawn. The following was the schedule used for the 1980-1981 spawning season which commenced on November 1, 1980. (Only one tank successfully spawned that year.)

<u>Winter:</u>	duration	* 30 days
	photoperiod	* 10 hrs/daily for the entire season
	temperature	* 20°C
<u>Spring:</u>	duration	* 30 days
	photoperiod	* 10 hrs/daily for the entire season
	temperature	* 25°C

Summer:	duration	* 30 days
	photoperiod	* Begins at 15 hrs/daily and drops 15 minutes every 3 days
	temperature	* 30°C
Fall:	duration	* Prolonged until the desired number of eggs is obtained
	photoperiod	* Begins at 12.5 hrs/daily and drops by 15 minutes every 3 days to 10 hrs/daily and then held constant
	temperature	* 25°C

In their natural environment, red drum spawn repeatedly throughout the fall. With a controlled environment, spawning was allowed to continue until the number of eggs desired for the facility had been obtained. The fish were then returned to winter conditions. The Palacios facility required between six and twenty million eggs per year, depending on the number of' production cycles to be completed. A red drum female has the potential to produce in excess of 15,000,000 eggs per year. Spawning data are listed in Table I.

Sexually mature red drum (over four years of age) spawn in the fall. With the beginning of fall tank conditions, the egg collection system was put into place. Just prior to spawning, the males become darker along the back and the females become more aggressive (bumping the males). They appear to spawn only in the evening hours under artificial conditions.

Following their release into the water, the eggs floated to the surface. The eggs then passed into the standpipe drain and on to the biofilter. Water entered the biofilter through perforated PVC pipe. A fine meshed net (500µ mesh) was placed below this inflow. As the eggs passed into the biofilter, they were retained by the net.

The eggs were then collected and placed into a glass aquarium for cleaning and counting. Sediments and particulate matter were allowed to settle out and were then siphoned off. After the eggs were allowed to resettle, their average depth was determined, and the length and width of the aquarium were measured. The total volume of eggs was calculated and multiplied by 1,300 (1,300 eggs occupy 1.0 cc). This determined the total number of eggs for a given spawn. Percentage fertility was then calculated by counting the number of live eggs in a sample of 100. The eggs were placed into aerated 2,000 liter, conical bottom, fiberglass tanks for hatch out. No more than 1.5 million eggs were placed in a tank. Red drum eggs hatch in 24 hours at 23-25ºC. One full volume of water was exchanged in the first 24 hours. Half volumes were exchanged daily thereafter. Salinity had to be maintained at 30 g/L for optimal hatching to occur. Fry were held in the hatch-out tanks until they developed mouth parts. This took approximately 3 days at 23°C.

Fry were collected after mouth parts developed. The conical bottom tank was drained into an 80 liter glass aquarium. The aquarium was equipped with a standpipe drain enclosed by a plankton net sleeve (500µ mesh). The fry became concentrated in the aquarium. The number of fry were then determined. Several samples of a known water volume were taken, and the average number of fry per sample was calculated. The number of fry per milliliter was determined and then multiplied by tank volume. Fry were then measured out by number of fry per liter.

The fry were placed into 11.0 liter, plastic bags. The bags were filled to half volume with salt water (at bay salinity). The remaining volume was filled with compressed oxygen. The bags were sealed with heavy rubber bands. Each bag was filled with 100,000 fry. The bagged fry were allowed to float in the ponds for 30 minutes to acclimate bag temperatures to pond temperatures. After acclimation, the fry were released directly into the ponds. Fry were normally stocked at the rate of 750,000 fry/surface hectare of water.

Red drum fry are plankton feeders. Initially they feed on organisms 50-150µ in diameter. Other researchers were rearing fry in closed, artificial systems. This required the tank culture of algae and zooplankton. Rearing fry that way was labor intensive and often unsuccessful.

The Texas Parks and Wildlife Department employed an extensive technique. This method was capable of producing fingerlings in sufficient quantities for stocking programs and aquaculture. Earthen ponds, fertilized with organic compounds, were used for fingerling production. Recently hatched fry were stocked into ponds as described above. Fry were allowed to graze on pond plankton populations.

In previous studies at the station, it had been noted that fry fed primarily on copepods. Fertilization using inorganic and organic fertilizers had also been evaluated. Organic fertilizers appeared to be more effective in producing zooplankton, in particular, copepods. It was believed that organic fertilizers offered substrate as well as nutrition for zooplankton growth. It takes approximately 7-10 days post-fertilization for peak zooplankton production to occur. Fry were stocked as near to this time as possible.

Alfalfa meal was the organic fertilizer in use at the Palacios station. Alfalfa meal is 17% crude protein and 27% crude fiber by weight. Another commonly used organic fertilizer is cottonseed meal.

Alfalfa meal was applied to the dried pond bottom just prior to filling. It was applied at a rate of 280 kg/ha. Ponds were gradually filled over a three week period. This technique is called "puddling". It was believed that greater light penetration and rapid warming accelerated the production of zooplankton.

Fingerlings were harvested when they attained a length of 35 mm. Approximately four weeks time at 20 -25°C was necessary for growth from a 3-day-old fry to a 35 mm juvenile.

During this time fertilization continued and feeding was started. Alfalfa meal was broadcast over the pond surface by hand three times a week. Twenty-five percent of the initial quantity of fertilizer was applied weekly for four weeks. Prepared feed was offered to the fry at the beginning of the second week. Feed was broadcast over the water surface by hand, at a rate of 5.6 kg/ha/day. Half was fed, twice daily. Fish were fed Silver Cup Salmon Feed. They were given Fry Starter, Number One Starter, and Number Two Starter on the second, third, and fourth weeks, respectively.

Pond harvest was accomplished by draining the ponds into concrete harvest basins. Harvest screens (0.6 cm mesh) were used to prevent fingerlings from being swept into the drainage system. The fingerlings were then removed by dip net and loaded into live transport tanks. Red drum fingerlings were transported at a rate of 35 g/L, which is approximately 75 fingerlings/L. Pond data are listed in Table II (pond size, number stocked, survival, etc.)

All water for filling and replacement was pumped directly from West Matagorda Bay at ambient conditions. Salinity ranged from 6 to 30 g/L (fry survived throughout this range). To prevent the introduction of predatory species, water was passed through plankton net filter bags (500µ mesh) before entering the ponds. At the end of each growing season, ponds were dried and disced.

In their natural environment, red drum attain mean sizes of 33.7 cm and 43.6 cm, at 1.0 year and 1.5 years, respectively (Pearson, 1929). A 33.7 cm fish weighs 0.41 kg; and a 43.6 cm fish weighs 0.86 kg (Harrington, et. al. 1979). It would seem that a fish of commercial size, 0.57 kg, could be produced within one year. Providing an adequate food supply which is nutritionally complete is the first step to successful commercial mariculture. At the time, little was known about the nutrient requirements of red drum. Research in that area was greatly needed.

Producing juvenile red drum was relatively trouble free. The problems that developed, occured during harvest. In several ponds, *Ctenophora* species were introduced with water pumped from the bay. Although they posed little direct threat to the fish, their presence created difficulty in dip netting. They flowed with the current and early in dip netting accounted for over half the net contents. Separating juvenile red drum from *Ctenophora* was quite troublesome.

In the large ponds (1.6 hectares), drainage was more time consuming. If drainage rates were increased, fingerlings became trapped against the harvest screens and suffocated. Drainage proceeded slowly and in summer months water warmed rapidly, particularly in the final stages as depth decreased. The warm water led to low dissolved oxygen and fish losses due to stress and suffocation.

Ctenophora probably passed through the filter nets as microscopic larval organisms while filling ponds. There was little that could be done about this problem because water was pumped directly from the bay. Pond drainage could have been carefully timed to occur over several days, so that most of the final drainage occured during the evening and early morning hours. Prevention of these problems would lie in the planning of future production facilities. Pond size could be limited to 0.8 hectare, and a ground source of good quality saltwater could be located.

In my opinion, there was little to criticize in the state's technique for the production of red drum fingerlings. I would have made two management adjustments. In manipulating photoperiod to induce spawning, I would have used lower intensity lighting. Sport fishermen reported that adult red drum were most commonly, if not exclusively, found offshore at a depth of approximately 20 meters. They were found there all year except during the fall spawning season. At that time, sexually mature red drum moved close to shore to spawn (3-4 m depth). It would seem that only a small fraction of the incident surface light would have reached these depths. Both spawning tanks were subjected to the same light source for photoperiod control. The intensity of light directly over both tanks was 840 watts (total lab illumination is 1,560 watts). In my opinion, 150 watts illumination or less should have been used over each tank. The second adjustment would have been to feed only table quality shrimp to broodstock. On many occasions, shrimp that were no longer fit for human consumption, or, bait shrimp in various stages of degeneration, were fed. Wild red drum forage for live food. When poor quality shrimp was offered, less was consumed. Decomposing shrimp led to deterioration of water quality. Little was accomplished by this practice.

The state's extensive production technique was beautiful in its simplicity. The organic fertilization was particularly efficient. By providing a carbon and nitrogen pool, virtually all of the essential amino acids, vitamins, and essential fatty acids required by red drum larvae could be produced by the biosynthetic activity of bacteria and plankton. The zooplankton populations produced were heterogeneous in nature, offering a diversity of' foods to juvenile red drum. This heterogeneity was more likely to meet the nutritional needs of larval and juvenile fish than any single plankton species produced by artificial means. This technique has potential for many of the species that are presently cultured and many that have not yet been successfully reared.

The potential of organic fertilization for plankton production and larval rearing is far-reaching. Ponds were fertilized with oilseed meals or hays of relatively high protein content. These fertilizers tend to be more costly than the high energy grains (high in carbohydrates, low in proteins). Several of the high energy grain crops (e.g. corn, rice, and wheat) could be used in combination with a nitrogen source, such as urea, to create an inexpensive and highly efficient pond fertilizer. An analogy could be drawn between this type of pond fertilization and the feeding of ruminants. The technique utilizes low protein hays or high energy grains in combination with non-protein nitrogen compounds. The cost of feeding is lowered by reducing the use of high protein grains or meals. The rumen of these animals has a natural bacterial flora that synthesizes vitamins, essential amino acids, and essential fatty acids. These bacterial products can be used by the host animal. To synthesize these compounds, bacteria utilize carbon skeletons derived from the carbohydrates (starch, cellulose, sugars, etc.) in grain feeds and hays. Nitrogen is obtained from urea or feed proteins of low biological value. Organic fertilization could be applied to controlled, artificial aquatic systems to produce heterogeneous plankton populations, simply and efficiently. This could eliminate the troublesome series of plankton monoculture systems used to rear the larvae of many species.

In conclusion, I would like to comment on the Master of Agriculture program. There are few substitutes for practical experience in any given field. Knowledge of mass larval rearing techniques and hatcheries design is best gleaned from appropriate coursework, independent study, and hands-on-experience. A research degree does not always allow students to gain experience in their area of interest and still receive the benefits of graduate study and coursework. I feel that my A&M campus experience and my internship in the field have brought me well within reach of my career goals. I would heartily recommend this program to any interested student.

Table I: 1981 Spawning Data

Spawn #	Date	# Eggs	% Fertilization	# Fry Recovered From Hatch	% Survival
1	3-13-81	772,200	99.9	772,200	100
2	3-14-81	804,375	99.9	804,375	100
3	3-17-81	l,721,362	99.9	l,721,362	100
4	3-20-81	700,000	99.9	700,000	100
5	3-21-81	2,100,000	99.9	2,100,000	100
6	3-22-81	1,400,000	99.9	1,400,000	100
7	3-23-81	1,900,000	99.9	0	0
8	3-31-81	1,500,000	99.9	1,300,000	87
9	4-1-81	2,400,000	99.9	2,000,000	83
10	4-2-81	1,200,000	99.9	700,000	58
11	4-3-81	1,000,000	99:9	600,000	60
12	4-4-81	1,985,500	99.9	1,600,000	81
13	4-5-81	1,400,000	99.9	1,120,000	80
14	4-6-81	800,000	99.9	500,000	63
15	4-7-81	1,000,000	99.9	500,000	50
16	4-8-81	2,200,000	99.9	600,000	27
17	4-9-81	1,900,000	99.9	1,600,000	84
18	4-10-81	1,100,000	99.9	900,000	82
19	4-11-81	1,202,000	99.9	600,000	50
20	4-12-81	800,000	99.9	600,000	75
21	4-15-81	1,800,000	99.9	700,000	39
22	4-16-81	900,000	99.9	900,000	100
	Total	30,585,437	99.9	21,717,937	71

Table II: 1981 Pond Data

Pond #	Pond Size (ha)	Date Filled	Date Stocked	Date Harvested	# Stocked	# Recovered	% Recovered
5	0.1	4-3-81	4-13-81	5-14-81	75, 000	12,000	16. 0
6	0.1	4-3-81	4-13-81	5-14-81	75, 000	300	0.4
13	0.4	3-31-81	4-8-81	5-6-81	300,000	34,000	11.3
14	0.4	3-31-81	4-7 to 4-8-81	5-6-81	300,000	27,300	9.1
18	0.8	3-30-81	4-7-81	5-8-81	600,000	129,000	21.5
19	0.8	3-30-81	4-7-81	5-8-81	600,000	169,000	28.2
20	0.8	3-31-81	4-7-81	5-7-81	600,000	98,700	16.5
21	0.8	4-1-81	4-8-81	5-7-81	600,000	31,300	5.2
15	1.6	4-1-81	4-9 to 4-14-81	5-12-81	4,200,000	623,000	14.8
16	1.6	3-30-81	4-4 to 4-6-81	5-11-81	3,100,000	855,000	27.6

LITERATURE CITED

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