Pond Culture of Shrimp on Grand Terre Island, Louisiana, 1962-1968

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Abstract

Pond culture experiments were started in the spring of 1962 at Grand Terre Island, Louisiana. Brown shrimp, *Penaeus aztecus,* and white shrimp, *Penaeus setiferus,* were cultured in 0.25 acre ponds. Construction details of the ponds used in this study are discussed. Juvenile and postlarval shrimp, obtained from several sources, were stocked at different rates and several types of feeds were used. The shrimp were fed a specific percentage of their body weight daily. A sample of 50 shrimp was taken each week, weighed and returned to the ponds. Feeding rates were adjusted to the increased growth without regard to possible mortalities. The best feeding rates were 5% and 10% at a stocking rate of 20 thousand shrimp per acre. Implications of feeding, including maximum possible feeding rates and amounts, are discussed. Production ranged from 40 to 809 pounds per acre and feed conversion ratios from 1.7 to 9.7. Salinities fluctuated between 16 and 35 ppt while temperatures varied between 8 and 37C during the study periods.

INTRODUCTION

CONSIDERABLE RESEARCH on pond culture of shrimp has been done in this country and abroad (FAO, 1968 and Iverson, 1968). The first significant work in this country was accomplished by Lunz in South Carolina over a period of several years. Lunz used natural stocking by flood tides in his ponds and obtained high rates of shrimp production. However, in the northern Gulf of Mexico tidal range is insufficient to produce high yields with natural stocking. Ponds built in Louisiana (Louisiana Wild Life and Fisheries Commission, 1968) and Texas (Wheeler, 1966), to date, have been used with some form of artificial stocking. These ponds, using various feeds and stocking rates, have produced encouraging results.

Recently, interest in pond culture of shrimp and other commercially important marine animals has increased and additional research ponds have been constructed in Texas, Louisiana and Florida. With these new facilities, much useful knowledge should be gathered.

MATERIALS

Pond construction

A single 0.25 acre pond was constructed in the early spring of 1962 on Grand Terre Island, Louisiana. Grand Terre is a barrier-type island and the surface soil consists of a high percentage of sand. Silty clay is occasionally found near the surface. At the pond site, the soil was mostly sand with a small amount of silt and clay. Three-foot-high levees were built but could not be maintained because of wave action on the inside and tidal action on the outside of the pond. A wooden bulkhead was built on both sides of the levee but proved unsatisfactory as the sand fill washed through the cracks.

Five 0.25-acre ponds, designated A-ponds, were built in 1964 at the same site using corregated asbestos sheets as bulkheads. These bulkheads were 10 feet apart and were supported by 0.25-inch cables strung between 5-inch butt creosote posts. The asbestos sheets (42-inches high and 12 feet long) were laid with the corrugations parallel to the ground and overlapped 1 foot. There were four 10-foot by 5-inch posts for each asbestos sheet.

A 3-foot wide, 8-foot long, and 6-inch deep concrete catch basin was built at the deep end of each pond. The water depth was 3 feet at the deep end and 2.5 feet at the shallow end. The bottom elevation at the catch basin was plus 1 foot MLW. The intake and exhaust pipes were 4-inch polyvinyl chloride. The exhaust was a standpipe in the catch basin and the intake opened directly above. These ponds were completed in 1965 when some were partially destroyed by Hurricane "Betsy." They were rebuilt and ready for use in the spring of 1967. Two undesirable features of these ponds were: (1) the asbestos sheets leaked sand where they were not perfectly fitted and (2) the cables that held the two bulkheads together will rust, requiring replacement.

Sixteen 0.25-acre ponds (D-ponds) were completed in June 1968. These ponds differed from the A-ponds in several ways. There were two layers of asbestos sheets rather than one and they were butted on end rather than overlapped. Square posts were placed where the asbestos sheets butted. In place of cables, 0.75-inch galvanized steel rods were used to hold the bulkhead together. The inside corners of each pond were sealed with hot tar. The concrete catch basins were 6 feet wide, 12 feet long, and 18 inches deep and slots for screens were located near the standpipe. The water depth was 3 feet at the deep end and 2.5 feet at the shallow end. The bottom elevation was plus 2 feet MLW at the deep end to provide adequate drainage head at high tide. The intake water pipes were the same as the A-ponds, but to facilitate quicker drainage, the exhaust was changed to a 6-inch standpipe. The marsh elevation was approximately plus 1 foot MLW before construction and the fill used for the pond bottoms as well as the levees was obtained from a nearby beach. This material proved to be very fine grained, porous and relatively sterile. The pond bottom was gradually sloped towards a 6-inch deep ditch that extended to each side of the pond at the catch basin. The only undesirable feature of these ponds was the porosity of the fill. Excessive percolation under the pond walls necessitated an addition of fill material around the outer wall.

Four concrete-block ponds (C-ponds) of 0.005 acre each were constructed under the laboratory building. They were built on a 6-inch slab floor and the 8-inch thick walls were 40 inches deep. A 1-foot square catch basin with a 2-inch drain was located in one corner.

METHODS

Filling

A 4-inch, deep-well pump was used to fill the ponds. With little variation a 0.25-acre pond could be filled to capacity in 8 hours. No filter was used on the intake until the fall of 1967 and "wild" fish were introduced. In the fall of 1967, intake water was filtered with a saran screen of 50 meshes per inch.

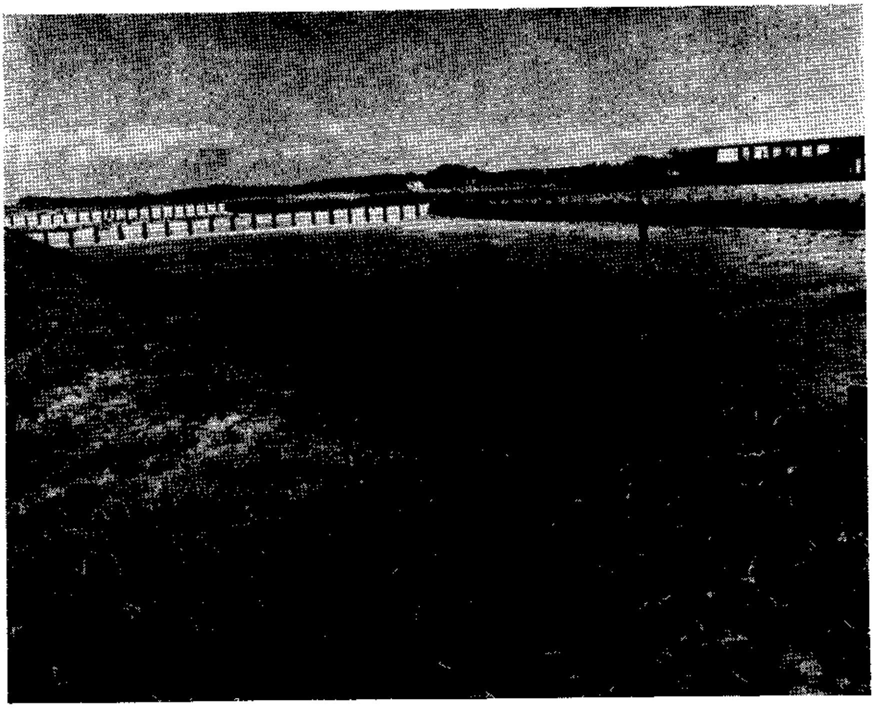

FIG. 1. One of the 0.25-acre (D) ponds constructed in 1968. The sand fill bottom slopes gradually toward the ditch to insure complete draining.

Weekly additions of water, in the quantity of 6 inches in the A-ponds and 12 inches in the D-ponds, were necessary because of percolation and evaporation.

Stock

The brown and white shrimp used in the experiments were obtained in several ways. In early stockings, 6-foot otter trawls were used to catch juvenile shrimp and plastic garbage cans were used to transport them to the pond site. Later, a wooden live box with circulating water was used for transportation. In 1967 and 1968, two 4-foot wide, 4-foot deep and 12-foot long boxes, covered with 0.25-inch mesh hardware cloth and suspended between oil drum supported barges, were used. An outboard motor was attached to one barge and, when a box contained several thousand shrimp, it was brought to the ponds. This satisfactorily reduced the high handling mortality found in the first two methods. In all cases, the juvenile shrimp were held a minimum of 12 hours before stocking. These shrimp had a wide size range, according to what was available. This considerably reduces the confidence in the growth results.

Postlarval shrimp were stocked in 1963. These shrimp were caught with 1 mm mesh beam nets mounted on the sides of an outboard hull. The postlarvae were separated from the catch individually with a teaspoon. This is not a recommended procedure due to the unwarranted amount of time involved in sorting. In 1968, 80 thousand laboratory-spawned postlarval brown shrimp,

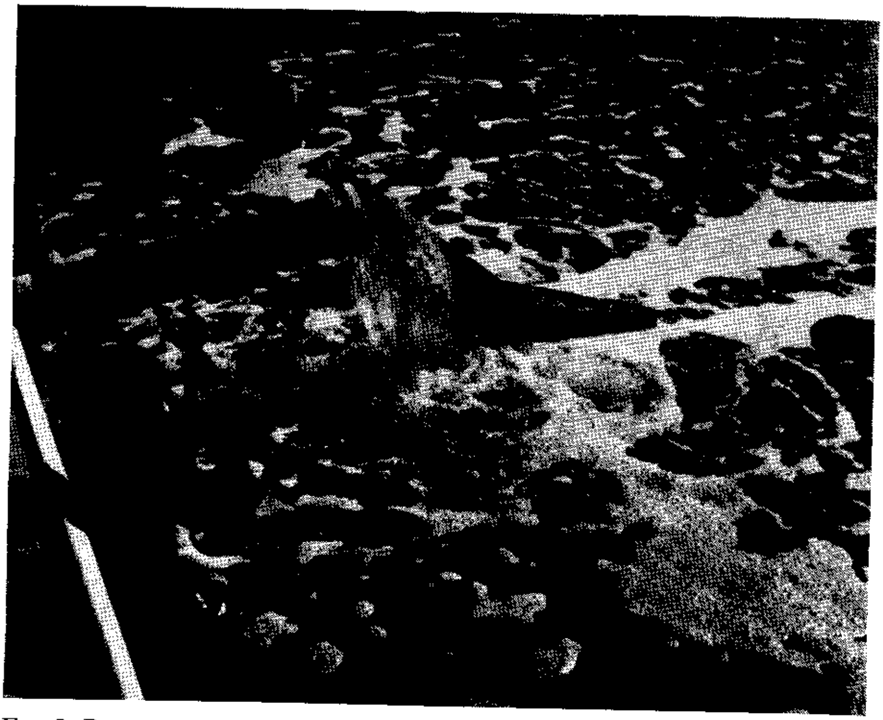

FIG. 2. Bay water was pumped into each pond and filtered with a 50 mesh per inch saran screen. The 6-inch standpipe exhaust is located near the intake pipe.

Penaeus aztecus, were obtained from the U.S. Bureau of Commercial Fisheries' Galveston Laboratory. These shrimp averaged 7 mm when received and were stocked 5 weeks later at an average total length of 24 mm.

During the years of this study, brown shrimp were found near Grand Terre Island in sufficient numbers to pose no stocking problems. However, white shrimp, *Penaeus setiferus,* were often not abundant in the area near the pond site.

Stocking and feeding

In the spring of 1962, juvenile brown shrimp were stocked at a rate of 18 thousand per acre, and juvenile white shrimp were stocked at a rate of 12 thousand per acre in the fall. The pond was drained on each occasion at the end of 2 months. In the spring of 1963, postlarval brown shrimp were stocked at the rate of 20 thousand per acre and the pond drained in 75 days. In July of 1963, postlarvae were caught and stocked at the rate of 12,800 per acre. These shrimp were assumed to be white shrimp. After 62 days, when the pond was drained, it was found to contain only 13% white shrimp; the remainder were brown shrimp. The shrimp in these experiments were not fed.

The 0.005 acre C-ponds were stocked with juvenile white shrimp in 1964 at the rate of 120 thousand per acre. They were fed Purina Fish Chow for 48 days at rates of 3% and 5% of their body weight daily and striped mullet, *Mugil cephalus,* at rates of 3% and 5%. No appreciable amount of natural food was available in these small concrete tanks. In 1965, the C-ponds were stocked with brown shrimp and fed Purina fish chow for 60 days at rates of 5% and 10%.

In 1967, five A-ponds were stocked with juvenile brown shrimp at a rate of 20 thousand per acre. Two of these ponds were fed yellow cornmeal at 10%, two at 5% and one control pond received no feed. Each of these ponds also contained 40 thousands oysters per acre and 2.8 thousand striped mullet per acre. The amount of feed was calculated on the weight of the shrimp only. In the fall of 1967, two A-ponds were stocked with 20 thousand white shrimp per acre. The mullet had been removed from the ponds but the oysters remained. These shrimp were fed cornmeal at rates of 5% and 10%.

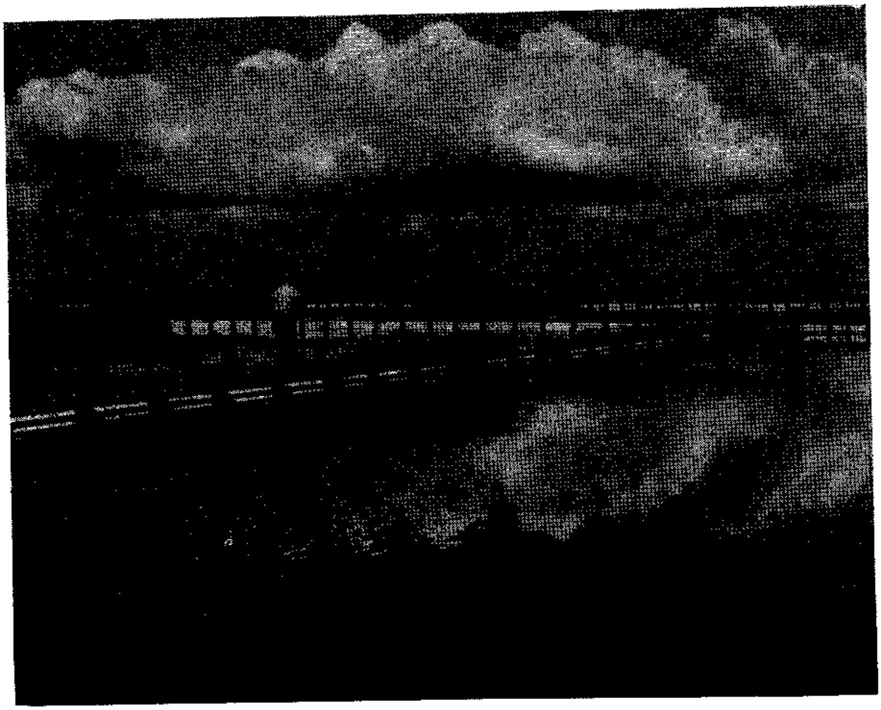

FIG. 3. After stocking the ponds, the shrimp were fed pelleted feeds at various rates.

In the spring of 1968, four A-ponds were stocked with 20 thousand juvenile brown shrimp per acre, and fed Purina Chow at rates of 5%, 10%, a variable rate, and the fourth pond was an unfed control. In the experiment using variable rates of feeding, the shrimp were not fed the first 3 weeks, fed 5% the second 3 weeks, 10% the next 3 weeks and 15% the remainder of the experimental period. In June the postlarvae furnished by the Galveston Laboratory were stocked in four D-ponds as a duplication of the above experiment. In the early fall, four D-ponds were stocked with juvenile white shrimp. Three were stocked at 20 thousand per acre and fed Purina Chow at 5%, 10% and at the variable rates. The fourth control pond was stocked at 12 thousand per acre. An error was made in the variable rate pond and the shrimp were not fed until the fifth week, instead of the fourth week as was planned. Also, in the fall of 1968, four A-ponds were stocked at rates of 20 thousand, 16 thousand, 12 thousand and 8 thousand juvenile brown shrimp per acre. These shrimp were fed Purina Chow at a rate of 3%.

The 0.25 acre ponds were sampled weekly (no samples were made in 1963) with a 6-foot shrimp trawl pulled by hand. Fifty shrimp were removed from each pond, weighed in water and returned to the pond. The following formula was used to calculate the weight for each succeeding week's feed.

Average weight of shrimp in sample	×	Number of shrimp stocked	×	Feeding rate	×	Compensation factor for water in feed	=	Daily feed for the succeeding week

During 1967 and 1968 a recording thermograph was used to record water temperatures in one A and one D pond. A portable salinometer and a portable

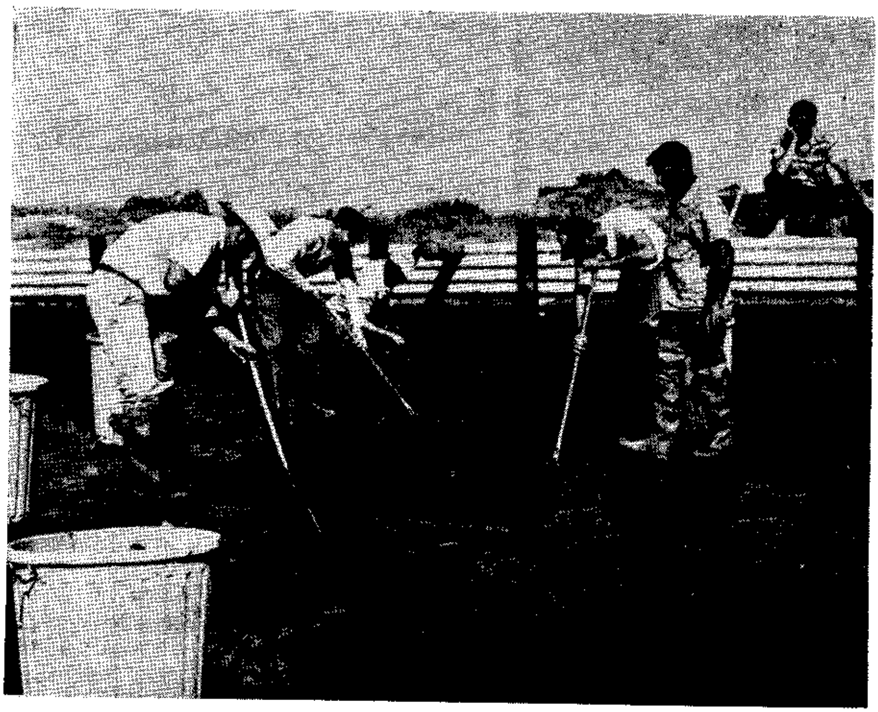

FIG. 4. Most of the shrimp followed the receeding water to the catch basin where they were removed with dip nets. An extra effort was made to recover every shrimp possible.

oxygen meter were used several times weekly for salinity, temperature and oxygen measurements.

Draining

Draining was accomplished by lowering the standpipe drain. A cylinder of 0.25-inch hardware cloth was placed over the end of the pipe to prevent the shrimp from escaping. The A-ponds, because of the 4-inch drain and the bottom elevation, took an average of 24 hours to drain. Often, when the tide was high, pumps were used to remove the last several inches of water remaining in the pond. The D-ponds, with the 6-inch drain pipe, averaged 6 hours to drain. No pumping has been required to date and only a small amount of water has remained in the catch basin at the highest tide observed while draining.

Harvest methods

A small (10- to 20-foot) seine was used to harvest the shrimp in the A-ponds. Harvesting time averaged 24 man-hours in the A-ponds and less than 3 man-hours in the D-ponds. Because of the relatively small catch basin and poor drainage, seining and pumping usually began when 3 to 6 inches of water remained in the A-pond. Often, where pools of water could not be drained, several hundred shrimp had to be picked up by hand. The D-ponds, with their higher elevation and firm bottom drained completely and the shrimp were easily removed from the catch basin with dip nets.

RESULTS

A summary of the results from the 0.25-acre ponds is shown in Table 1 and for the 0.005-acre ponds in Table 2. All data were extrapolated to an acre basis for comparison. Count per pound was the number of shrimp per pound, heads-on. Total mortalities were converted to mortality per month because of the variation in the duration of the experiments. Experiment W 7 (Table 1) was not carried to completion because of a mechanical failure. The data shown in this experiment were estimated from the available sampling results.

Stocking rates

The experimental ponds were stocked at rates from 8 to 120 thousand shrimp per acre during this study. Generally, when high stocking rates were used and early mortalities did not occur, smaller shrimp were recovered when the pond was drained. Few brown shrimp reached the size of 40 per pound, fed or unfed, when stocked at a rate of 20 thousand per acre and with mortalities of less than 10% per month. However, at lower stocking rates a larger size was harvested (B 21 and 23, Table 1). High stocking rates did not necessarily cause high mortalities (W 2-5, 8-10, Tables 1 and 2), but apparently caused some problems in unfed ponds. This problem is discussed later under Growth and Feeding.

White shrimp, when stocked at 20 thousand per acre and fed Purina Catfish Chow, produced shrimp larger than 30 count (W 8-9, Table 1). Experiment W 10 yielded smaller shrimp, but this was probably related to the feeding error previously mentioned.

Handling

Mortalities occurred while catching the stock, sampling and harvesting at the end of each experiment. White shrimp were more difficult to keep alive

Table 1

Summary of Results for 0.25 Acre Ponds

Year	Experiment Number	Stocking Rate-Thousands per Acre	Stocking Weight-Pounds per Acre	Duration-Days	Percent Fed-Daily	Production-Pounds per Acre	Count per Pound-Heads On	Mortality-Percent per Month	Feed Conversion	Gain-Pounds per Acre per Day	Total Amount Fed-Pounds per Acre	Temperature Range-Degrees Centigrade	Salinity Range-Parts per Thousand
1962	B1	18	19.2	60	—	80	166	13	—	1.0	—	23-32	23-26
	W1	12	29.6	63	—	201	54	7	—	2.7	—	13-34	26-35
1963	B2	20	—	75	—	145	62	22	—	1.9	—	15-32	32-35
	B3	12.8	—	62	—	77	B-122 W-55	18	—	1.2	—	26-36	23-35
1967	B8	20	37.5	80	10	381	50	2	6.7	4.3	C2298	19-37	17-30
	B9	20	68.4	80	10	341	45	9	9.7	3.4	C2641	19-37	17-30
	B10	20	70.6	80	5	379	46	5	4.1	3.9	C1265	19-37	17-30
	B11	20	93.7	80	5	234	47	17	9.7	1.8	C1361	19-37	17-30
	B12	20	117.4	80	—	63	97	26	—	—	—	19-37	17-30
	W6	20	109.7	80	5	415	44	4	4.9	3.8	C1509	16-34	21-31
	W7	20	96.0	49	10	412E	44	4E	4.4	6.4	C1406	16-34	21-31
1968	B13	20	18.8	70	V	237	43	13	7.0	3.1	P1537	21-34	16-22
	B14	20	20.0	80	5	464	41	2	2.3	5.6	P1010	21-34	16-22
	B15	20	23.6	68	10	443	38	3	3.8	6.2	P1626	21-34	16-22
	B16	20	25.2	80	—	199	88	5	—	2.2	—	21-34	16-22
1968	B17	20	2.6	100	5	388	47	3	1.7	3.9	P651	24-35	17-22
	B18	20	2.6	100	10	463	34	6	4.1	4.6	P1907	24-35	17-22
	B19	20	2.0	100	V	472	41	1	3.5	4.7	P1655	24-35	17-22
	B20	20	1.1	100	—	120	27	25	—	1.2	—	24-35	17-22
	B21	8	59.4	80	3	150	B-30 W-20	17	4.9	1.1	P448	17-35	16-27
	B22	12	81.4	80	3	190	B-35 W-19	18	6.0	1.4	P653	17-35	16-27
	B23	16	184.8	80	3	173	29	27	—	—	P873	17-35	16-27
	B24	20	128.1	80	3	374	37	12	3.9	3.1	P965	17-35	16-27
	W8	20	69.6	80	5	663	28	2	3.0	7.4	P1780	17-35	16-27
	W9	20	118.9	80	10	809	23	3	3.4	8.6	P2378	17-35	16-27
	W10	20	47.0	80	V	507	36	3	3.9	5.8	P1779	17-35	16-27
	W11	12	36.6	80	—	42	38	33	—	0.1	—	8-35	16-27

B-Brown Shrimp W-White Shrimp
V-Variable rate: No feed 3 weeks, 5% 3 weeks, 10% 3 weeks, 15% 3 weeks
C-Ground cornmeal P-Purina Catfish Chow
E-Estimated: Experiment not completed

FIG. 5. White shrimp, *Penaeus setiferus,* after 80 days of feeding at 5% of their body weight daily. Their average was 28 per pound heads-on and they had increased their total weight almost 10 times since stocking.

than brown shrimp. During stocking, when juveniles were being counted into the ponds, it was found that two to three hundred 2- to 3-inch browns could be held for a short period in 5 gallons of water. Only one hundred white shrimp could be held in the same quantity of water. White shrimp handled early in the day had less mortalities than when stocked later in the day.

Production

Average production values for the 0.25-acre ponds are shown in Table 3. These values are somewhat misleading because the various stocking rates, stocking weights and types of feed are lumped together. They do, however, show production trends and give relative results for different feeding rates.

The size of the shrimp harvested in the unfed ponds was apparently controlled by their density and duration in the ponds. In general, low population densities produced larger shrimp (B 20, Table 1) than high densities (B 16). The shrimp recovered were smaller than 50 per pound, heads-on, when in the ponds for less than 60 days (B 1).

The pounds of shrimp harvested and the gain, in pounds per acre per day, were higher at the higher feeding rates (Table 3), but they also had larger feed conversion which increased the cost of the experiment. It will require an economic study to determine the feasibility of higher production at a greater cost of feed.

The average production values for brown shrimp fed at the rate of 3% of their body weight (Table 3) were misleading. The average size was large but the gain per day and pounds recovered were low. These conflicting data were apparently caused by the high mortalities that occurred in these ponds.

White shrimp production in all experiments was generally better than brown shrimp production when the treatments were the same. More pounds of larger shrimp were produced at a lower conversion rate.

Growth and feeding

The growth curve of brown and white shrimp is typically sigmoid in shape. That is, they grow slowly when small, go through a period of very fast growth and as they approach maturity, begin a reduced rate of growth. This typical growth response takes place when the shrimp are well fed, not overcrowded, not heavily parasitized or diseased and are living in water of suitable quality.

In the unfed ponds, brown and white shrimp over 1.5 grams average size grew rapidly for 3 to 4 weeks when stocked at 20 thousand per acre (B 12, 16 and W 11, Table 1). After this period of fast growth, they apparently reached the carrying capacity of the natural food in the ponds and stopped increasing in weight. They maintained this weight for a period of time and then usually began to lose weight. After this weight loss, the shrimp were not in good condition. Often at the end of the experiment they were flaccid, soft and their antennae were broken which indicated no recent molting.

TABLE 2

SUMMARY OF RESULTS FOR 0.005 ACRE PONDS

Year	Experiment Number	Stocking Rate—Thousands per Acre	Stocking Weight—Pounds per Acre	Duration—Days	Percent Fed—Daily	Production—Pounds per Acre	Count per Pound—Heads On	Mortality—Percent per Month	Feed Conversion	Gain—Pounds per Acre per Day	Total Amount Fed—Pounds per Acre
1964	W2	120	400.7	48	3	574	166	13	5.4	3.6	P934
	W3	120	357.0	31	5	353	278	18	—	—	M976
	W4	120	364.5	48	5	454	231	8	8.6	1.9	P771
	W5	120	384.2	48	3	560	188	8	14.8	3.7	M2611
1965	B4	12	46.3	60	5	96	111	7	4.7	0.8	P235
	B5	12	29.1	60	10	104	103	5	6.5	1.2	P489
	B6	12	48.5	60	5	82	133	4	6.5	0.6	P217
	B7	12	30.4	60	10	84	133	4	6.7	0.9	P360

W-White Shrimp, B-Brown Shrimp, P-Purina Fish Chow, M-Mullet.

TABLE 3

AVERAGE PRODUCTION VALUES FOR 0.25 ACRE PONDS

No. Experiments	Treatment	Gain. lbs/acre/ day	Feed conversion	No/lb. Heads on	Production. lb/acre
		Brown Shrimp			
6	No Feed	1.3	—	94	114
4	5%	3.8	4.5	45	366
4	10%	4.6	6.1	42	407
2	Variable	3.9	5.3	42	355
4	3%	1.4	4.9	33	222
		White Shrimp			
2	No Feed	1.4	—	41	122
2	5%	5.6	4.0	36	539
2	10%	7.5	3.9	34	611
1	Variable	5.8	3.9	36	507

When supplemental feeds were added to the ponds, seldom was the growth better than in the unfed ponds during the first 3 weeks. This would indicate that supplemental feeding was no better than the natural food until the latter had been exhausted.

When very small shrimp were stocked, (B 17-20, Table 1) growth was very slow with all feeding rates until the shrimp were over 2 grams in weight. In the unfed control pond, sampling showed very slow growth for 5 weeks and then a very rapid increase in growth. This indicated that high mortalities had occurred and an abundant supply of natural food was available to the survivors. After the mortalities in the control pond, growth rates exceeded those of the fed ponds.

The feeds used in these experiments were yellow cornmeal, mullet and Purina Fish Chow, which is now called Purina Catfish Chow. Mullet was fed exclusively in the densely stocked 0.005 acre ponds and though no exceptional growth resulted, the shrimp were able to use up to 70 pounds per acre per day without trouble. Both cornmeal and Purina Chow were used in the 0.25-acre experiments, cornmeal in 1967 and Purina in 1968.

In the spring of 1968, oxygen deficiency kills were experienced when Purina Catfish Chow was fed 50 to 60 pounds per acre per day. Thereafter, no ponds were fed more than 45 pounds per day regardless of the amount of feed needed to maintain the projected feeding rate.

Purina Catfish Chow proved to be a better supplemental feed than yellow cornmeal for both species of shrimp, but white shrimp were able to utilize this commercial feed more readily than brown shrimp (Table 4). In most instances, the feed conversion was lower and the gain per day was higher for white shrimp. There was apparently little difference in response between brown and white shrimp to the nutritive value of cornmeal when fed at the same rate. This comparative feeding experiment was not carried out at the 10% level for white shrimp because the cornmeal segment of the experiment (W 7) was not carried to completion. However, that part of the experiment involving a 10% feeding of Purina Catfish Chow did produce the highest yield of all experiments.

TABLE 4
COMPARISON OF FEEDS IN THE 0.25 ACRE PONDS

No. Experi-ments	Feed	Feeding Rate	Ave. Feed conversion	Ave. Gain lbs/day
		Brown Shrimp		
1	Cornmeal	5%	4.1	3.9
2	Purina	5%	2.0	4.8
1	Cornmeal	10%	6.7	4.3
2	Purina	10%	4.0	5.4
		White Shrimp		
1	Cornmeal	5%	4.9	3.8
1	Purina	5%	3.0	7.4
1	Purina	10%	3.4	8.6

Occasionally, when stocking ponds with juvenile brown shrimp in July and August, a few white shrimp were accidentally introduced. This happened several times (Experiment B 3, B 21-22, Table 1). Each time when the experiment was concluded, the white shrimp proved to be larger than the browns. In 1968, Experiments B 21-24 were being conducted at the same time as W 8-11 (August to November). The white shrimp stocked accidentally in the brown shrimp experiments were larger than the white shrimp stocked alone. The higher density in the white shrimp experiments partially explains this size difference.

Mortality

The average monthly mortality rates are shown in Tables 1 and 2. They ranged from 1% to 27% per month. Mortality in the unfed, 0.25-acre ponds averaged 18% per month. Usually these high mortalities occurred near the end of the experimental period when the shrimp had apparently depleted the natural food supply. In this instance, shrimp removed from the pond at the end of the experiment were small. Occasionally, mortalities occurred early in the experimental period (B 20, Table 1) and the shrimp recovered were large.

Usually, higher mortalities occurred when postlarvae, 10-12 mm, were stocked (B 2-3, Table 1) than when very small juveniles, 22-26 mm, (B 17-20, Table 1) or small juveniles, 55-80 mm, (W 8-10, Table 1) were stocked. However, stocking larger shrimp does not insure low mortalities (B 23, Table 1).

High mortalities occurred in 1967 (B 9, 11-12, Table 1) due to an oxygen deficiency. Because fish kills were happening throughout the area at the same time and because the unfed control pond experienced the highest mortality this kill could not be directly attributed to overfeeding. Overfeeding apparently did cause the kill in B 13, in 1968 when 60 pounds of catfish chow per day were being fed. The same amount was being fed later in the year in B 18 and 19 when uneaten spoiled feed was discovered. These two ponds were flushed by pumping without removing the shrimp and the feeding rate reduced to 40 to 45 pounds per day. Apparently, little mortality had taken place.

Predators and competitors were inadvertently introduced into the ponds through the pumping system until water filtration began in the summer of 1967. The quantity of predation and the reduced yield from competition is unknown.

The only animals that passed into the pond after the 50 mesh per inch filter was added were oyster, barnacle and clam larvae.

A microsporidian parasite was noted in W 7 late in 1967 when this pond was not drained and water temperatures were very cold. This parasite had been noticed only occasionally at other times and apparently caused no high mortality. Late in 1968, a high incidence was again noticed in Experiment B 21 in the same pond. This entire series of brown shrimp in the late fall, B 21-24, experienced high mortalities. It was not determined whether the parasite or the unfavorable time of the year caused the mortalities.

Stocking rates, production feeding rates and species of shrimp could not be correlated with mortality.

Hydrography

The average hourly temperatures and average salinities for 1967 and 1968 are shown in Table 5. Recording thermographs in the turning basin at Grand Terre Island and in the experimental ponds were used to record temperature data. These data were removed from the thermograph charts in hourly increments. The turning basin temperatures are representative of the surrounding bay waters. The pond water temperatures were warmer than the turning basin temperature in the spring and fall but not significantly hotter in the summer. This condition would favor ponds over bay waters for growth of shrimp both earlier in the spring and later in the fall.

Salinities shown in Table 5 were fairly typical for this area. The salinity for 1968 is slightly lower than 1967 because of the above average rainfall experienced during spring and summer months.

TABLE 5

AVERAGE SALINITY AND TEMPERATURE OF PONDS

	Temperature-Degrees Centigrade		Salinity Parts per Thousand
Date	Turning Basin	Ponds	Ponds
April 1967	24.7	27.5	20.7
May	26.2	26.8	23.9
June	30.1	29.7	23.6
July	29.2	29.2	25.9
August	28.8	29.5	26.8
September	26.6	27.3	20.3
October	22.1	22.9	—
November	17.8	18.8	—
December	15.9	17.1	—
January 1968	12.2	13.5	—
February	11.2	12.2	—
March	15.8	—	—
April	22.9	24.5	—
May	26.1	27.5	18.6
June	29.6	30.9	19.9
July	29.9	30.4	20.0
August	30.8	30.9	21.7
September	28.6	28.6	23.3
October	27.2	24.8	—

DISCUSSION AND CONCLUSIONS

The recent impetus in pond culture research has added to the feasibility of commercial shrimp culture. When spawning and rearing techniques are further refined, profitable shrimp culture in the estuaries of the Gulf of Mexico will become commonplace.

The data presented here are the results of initial pond culture efforts at Louisiana's Marine Laboratory. As in any preliminary research, many mistakes were made in the planning and execution of the experiments. Therefore, any conclusions stated or implied should be taken as *preliminary results and not as recommendations for commercial shrimp culture.*

Several possibilities for future research were suggested from this study. Water temperatures in ponds are usually suitable for shrimp survival and growth from mid-March through December in the northern Gulf of Mexico. If stock can be obtained early and late in the year, shrimp can be produced when market prices are higher.

The present study emphasized high stocking rates and, therefore, relatively small shrimp were produced. However, several instances of low densities indicated that the growth potential of these shrimp had not been reached. Lower stocking rates and more efficient feeds should produce larger, more valuable shrimp in shorter periods of time.

Some of the more important results of this study are summarized as follows:

1. Labor costs for harvesting shrimp from small ponds can be considerably reduced if the bottom is of a sufficient elevation and sloped in such a manner that the pond drains completely.

2. In unfed ponds, stocking rates as high as 20 thousand shrimp per acre resulted in high mortalities and produced small shrimp of poor quality when the duration of the experiment extended over 60 days. No good stocking rate for unfed ponds was determined. Brown and white shrimp production ranged from 40 to 200 pounds per acre without supplemental feeding.

3. With supplemental feeding, white shrimp can be held for short periods of time at 120 thousand per acre without substantial mortalities.

4. For the first 3 weeks shrimp in unfed ponds grew as fast as those receiving supplemental feeds.

5. Overfeeding may become a problem when rates over 40 pounds per acre per day are used.

6. White shrimp produced more pounds of larger shrimp than brown shrimp when given the same supplemental feed. White shrimp were less tolerant than brown shrimp to low oxygen.

7. Higher mortalities occurred in ponds stocked with postlarvae than in ponds stocked with juvenile shrimp. Higher mortalities occurred in unfed ponds than in ponds receiving supplemental feed.

Louisiana's Marine Laboratory now has adequate research facilities for pond culture of marine and brackish water animals. In 1968, 16 experiments concerning shrimp feeds, feeding rates and stocking rates were successfully completed in the 0.25-acre ponds. Future research will expand these experiments and will also include spawning and maximum population density studies. Hopefully, this work will provide some relationships between natural and cultured shrimp populations. This information should be very helpful to the shrimp fishing industry.

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