PRELIMINARY EXPERIMENT ON THE CULTURE OF RED SWAMP CRAWFISH, Procambarus clarki, IN BRACKISH WATER PONDS

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ABSTRACT

This paper reports upon brackish water impoundment studies conducted in the coastal marshes of Southwest Louisiana with a valued Louisiana delicacy, the red swamp crawfish, *Procambarus clarki*. Survival, growth and reproduction were recorded in an attempt to better evaluate the potential of Louisiana's brackish coastal areas for crawfish culture.

The initial field experiments were begun in 1967, with the stocking and management of an experimental 5.6 acre pond at the Rockefeller Wildlife Refuge using the commonly accepted management techniques. Crawfish samples were taken and recorded from the study area throughout the season. Records were maintained of water pH, temperature and salinity. Soil and water analyses were made prior to draining in 1969. Vegetation types were identified and recorded before inundation and approximately two weeks after draining in an effort to determine the types of food and cover available.

The results of this study proved very promising for the crawfish farming potential of thousands of acres of our less saline coastal wetlands.

INTRODUCTION

Crawfish are utilized as a food and recreational resource in Louisiana to a much greater degree than in any other state. The crawfish harvest in Louisiana varies from six to 10 million pounds annually. This variation is caused principally by erratic water fluctuation in the Atchafalaya River Floodway, which produces more than 50 percent of the annual crawfish crop. The supply of crawfish has not met the demand since the bumper crop of 1964-65.

Since 1965, interest in crawfish farming has significantly increased. Crawfish farmers are able to control water levels and produce satisfactory crops with less annual variation than that experienced in natural areas. Generally, crawfish farmers produce earlier crops which command higher prices. Many crawfish farmers have realized per-acre net profits greater than those realized on more common field crops. There are approximately 12,000 acres of crawfish farms located mainly in the southeastern portion of Louisiana.

The availability of land suitable for economically feasible crawfish farming is limited. Generally, the land must be flat, to the extent that 12-30 inches of water may be retained without the construction of terrace or interior levees within the main levee. Adequate water must be available for flooding during specific periods—most crawfish farmers use surface water as the cost of drilling large-bore wells is prohibitive. The area must be capable of producing certain types of aquatic plants, which provide food and cover for crawfish.

A recent survey of coastal Louisiana revealed that a minimum of a half million acres of freshwater marshland met the above criteria,

excluding areas where available waters occasionally contained salinity concentrations thought to be detrimental.

The purpose of this preliminary study was to obtain further information on the tolerance of the red swamp crawfish (*Procambarus clarki*) to brackish water of known salinities under conditions approximating those found on commercial crawfish farms.

Specifically, the primary objective of this study was to determine if the red swamp crawfish could survive and reproduce in a brackish situation. After survival and reproduction were realized, an estimate of production was determined.

DESCRIPTION OF STUDY AREA

Location

This study was conducted in the coastal prairie marshes of Southwest Louisiana on Rockefeller Wildlife Refuge. The 85,000 acre state-owned and managed refuge is situated in southeastern Cameron and southwestern Vermilion Parishes, between the beach ridge complex of Pecan Island and Grand Chenier and the northern Gulf of Mexico. The refuge marshlands are high in organic matter and exhibit a typical brackish to salt marsh flora. Some of the major plants present are salt grass, *Distichlis spicata*, wiregrass, *Spartina patens*, wild millet, *Echinochloa walteri*, leafy three-cornered grass, *Scirpus robustus*, and widgeon grass, *Ruppia maritima*.

History and Description of Study Pond

The crawfish culture experiments were conducted in a 5.6 acre pond created in 1956. A freshwater irrigation canal marking much of the northern boundary of the refuge is located on the pond's west and south ends. A saline Gulf access canal borders the pond on the north and east sides.

In 1959, the late Percy Viosca attempted to use the pond for shrimp culture by placing a low-lift pump into the Gulf access canal and pumped water containing postlarval shrimp into the pond. The project was abandoned after its first unsuccessful year (R. Chabreck, personal communication). The pond, left idle since the 1959 experiment, was drained and cleared of all undesirable underbrush in the spring of 1967.

The levees were originally four to five feet high. However, shrinkage resulted in levees of approximately three feet due to a loss of the tremendous moisture content of the marsh soils. The pond was constructed at a higher elevation than the surrounding marsh, prohibiting unwanted salt water intrusions from high tides. The slope of the pond bottom was such that water depths varied from one to three and one half feet, approximating depths found on the commercial crawfish farms. Ninety-five percent of the pond floor, characteristic of prairie marshes which are dried annually, was quite firm.

Composite samples of top soil, one to six inches deep, were taken from five locations for chemical analyses. Phosphorus, potassium, calcium, magnesium and pH of the air dried soil samples were determined by the Louisiana Agricultural Experiment Station Soil Testing Laboratory and had the following characteristics:

Phosphorus	166 ppm
Potassium	455+ ppm
Calcium	1,650 ppm
Magnesium	1,000+ ppm
Organic material	4.96 %
pH	6.4

The dominant vegetation present in the crawfish pond prior to renovation was oyster grass, *Spartina alterniflora*, indicating a highly brackish area (T. Joanen, personal communication). Upon pond flooding in September, 1968, vegetative types were identified and recorded as to percent

occurrence (Table I). At this time the pond, which had remained dry since June, 1968, had a luxuriant stand of sprangletop, *Leptochloa fascicularis*, which covered approximately 80 percent of the pond. Wild millet, *Echinochloa walteri*, was second in abundance with 10 percent recorded. The presence of oyster grass in this sample revealed the area still to be brackish.

In July, 1969, after the water was pumped from the pond, vegetation occurrence was again recorded. At this time approximately 80 percent of the pond bottom appeared to be bare, but closer observation revealed the presence of approximately 40 percent young millet, 30 percent sprangletop, 20 percent sea purselane, *Sesuvium portulacastrum*, 12 percent lake grass, *Paspalum sp.*, and 1 percent leafy three-cornered grass, *Scirpus robustus*.

The plant occurrence was again analyzed in August, 1969. Sprangletop was again dominant, making up 40 percent of the plants present. Sea purselane made up 20 percent, wild millet 15 percent and lake grass 10 percent of the plants recorded. Alligator grass, *Alternanthera philoxeroides*, a choice crawfish food and cover plant, was introduced into the pond in July, 1967.

Without observing water salinity data or soil chemistry one would conclude this to be a slightly brackish-to-fresh marsh pond from vegetation types present. *Sesuvium* and *Scirpus* are strong indicators of brackish situations. Also, *Eleocharis parvula*, dwarf spike rush, recorded in August, 1969, occurs in brackish areas.

TABLE I. Per cent vegetative composition of crawfish research pond, Rockefeller Wildlife Refuge.

Common Name	Scientific Name	9/21/68	7/17/69	8/12/69
Sprangletop	*Leptochloa fascicularis*	80	30	40
Sea purslane	*Sesuvium portulacastrum*	..	20	20
Wild millet	*Echinochloa walteri*	10	40	15
Lake grass	*Paspalum sp.*	Tr.*	12	10
Leafy three-cornered grass	*Scirpus robustus*	..	1	8
Dwarf spike rush	*Eleocharis parvula*	Tr.	Tr.	5
Rattle box	*Daubentonia sp.*	Tr.	Tr.	2
Oyster grass	*Spartina alterniflora*	2	..	..
Bermuda grass	*Cynodon dactylon*	Tr.	Tr.	Tr.
Alligator grass	*Alternanthera philoxeroides*	Tr.	Tr.	Tr.
Water hemp	*Acnida sp.*	Tr.	Tr.	Tr.
Water-hyssops	*Bacopa monnieria*	2	..	Tr.
Buck brush	*Baccharis halimifolia*	Tr.	..	..
Fall panicum	*Panicum dichotomiflorum*	Tr.	..	..
Giant foxtail	*Setaria magna*	Tr.	..	..
Marsh elder	*Iva frutescens*	Tr.	..	..
Roseau	*Pharagmites communis*	Tr.	..	..
Wire grass	*Spartina patens*	Tr.	..	..
Nut grass	*Cyperus sp.*	Tr.	..	..

MATERIALS AND METHODS

Records

Initially, water temperatures were recorded by placing a submersible Ryan Model D temperature recorder 3.5 feet below the surface of a similar pond nearby in which another study was being conducted. This

* Trace—less than one per cent.

was replaced during the course of the study by a Taylor Model 76J two-probe recorder which recorded both water and atmospheric temperatures.

Salinity data was determined through December, 1968, by the use of the Mohr method in which water samples were titrated with a standard silver nitrate solution (American Public Health Association, 1960). For the duration of the study a battery-operated, Model R-S-5, Beckman salinity meter was used. This electrodeless induction-type meter gave readings of conductivity, salinity and temperature with conversion.

Pond pH values were measured throughout the study using the Hach Portable Colorimetric pH Test Kits, Model Nos. 17N and 17H and a standard secchi disc was used to determine turbidity. Water samples were collected in June, 1969, and submitted to the Soil Testing Laboratory, Louisiana Agricultural Experiment Station for chemical analysis.

In the 1967-68 season, samples of crawfish were taken with baited screen wire traps, baited single funnel ¾-inch wire mesh traps and dip nets.

Samples were also taken in November, 1968, and in June, 1969, by the use of baited ¼-inch hardware cloth traps. These single throated traps, recently designed for the analysis of populations by LaCaze, measured 10″ × 10″ × 24″, with funnel openings of ½″ × ¾″ and 3″ × 2½″. These traps were used since it was found that small crawfish usually will not enter or remain in traps when larger crawfish are present.

In order to get a comparison of the 1968-1969 production of marketable size crawfish with that of commercial freshwater crawfish farms, 16 ¾-inch mesh single-funnel traps were fished periodically until the pond was drained. Baits utilized consisted of beef melt (pancreas), fish scraps and gizzard shad. The catch was recorded and weighed to the nearest half pound using a Hanson Model 60 dairy scale.

Procedure

In farming crawfish profitably, one must establish, maintain and harvest the highest number of market size crawfish. This requires the stocking or "seeding" of crawfish, proper control of water, encouragement of food and cover in the form of aquatic vegetation and intensive harvesting.

The 5.6 acre pond was renovated in May, 1967 and managed using the commonly accepted techniques as described by LaCaze (1966). The water that could not be pumped out was treated with 3 ppm of Noxfish (rotenone, 5.0 percent). On June 21, 1967, 410 pounds of red swamp crawfish were purchased from a freshwater area just south of Plaquemine, Louisiana. These adult crawfish, exceeding 10 centimeters in total length, were transported 195 miles and stocked in the refuge pond which contained approximately 18 inches of water. The slightly high stocking rate was selected because of the absence of natural stock, vegetation and because of expected predation. The stock was made up of two species, 98 percent were the red swamp variety and 2 percent were white river crawfish, *Procambarus blandingi acutus*. Males made up 60 percent of the crawfish stocked.

In mid-July a 4-inch mobile pump was used to slowly dewater the pond. After approximately 10 days, the crawfish had burrowed and the pond was dry. At this time the crawfish were assumed to have bred since it is believed that mating occurs in open water in late May and early June. The sperm remain in an annulus on the female until the eggs are laid in September or early October.

Mortality was high during the period of burrowing as a result of poor cover. Raccoons, wading birds, snakes and bullfrogs were probably the major predators. The bare pond bottom was approximately 65 percent vegetated when water was again pumped in, October 1, 1967. An assumption was made at this time that the young crawfish had hatched and after the pond was reflooded could range from the burrows and feed. At

least 24 inches of water covered the pond throughout the winter months. After the 1967-68 growing season the pond was drained again by June 1, 1968. Numerous burrows were observed.

Annual grasses began to appear shortly after the pond bottom was exposed and by the time of the fall flooding, approximately 65 percent of the bottom was vegetated. The impoundment was filled by September 11, 1968. In order to compare the pond's production during the 1968-69 season to commercial freshwater crawfish farms, samples were taken through June 24, 1969, at which time the pond was drained.

RESULTS AND DISCUSSIONS

Hydrography

The water temperature in the relatively shallow pond tended to fluctuate rather closely with atmospheric temperatures. The 1968-1969 monthly ranges of water temperatures were always above 41°F. A maximum of 96°F was recorded just before draining in June (Figure 1). The 1967-1968 temperatures followed the pattern very closely with the exception of a slightly cooler spring (Figure 2).

Pond water analyzed by the Soil Testing Laboratory contained the following:

Nitrogen	0.2%
Phosphorus	0.8 ppm
Potassium	200.0 ppm
Calcium	51.0 ppm
Magnesium	275.0 ppm
Salinity	1.6 ppt
pH	9.3

A variation in pH of 7.2 to 9.5 was experienced with the majority of readings ranging from 7.5 to 8.0. The secchi disc readings ranged from 24 to 30 inches during the 1967-68 season. The water during the 1968-69 period was more turbid with secchi readings from 4 to 18 inches.

The salinity of the pond was 7.9 ppt when the crawfish were stocked June 21, 1967 (Figure 3). After the pond was flooded in September, 1967, a salinity of 4.4 ppt was present. This rose to a high for the year of 7.8 ppt in November and steadily declined to 3.1 ppt at draining.

The 1968-69 salinity reading was 7.9 ppt immediately after flooding in September and remained fairly constant until the November rains diluted it to 6.6 ppt.

Reproduction

Samples taken in the winters of 1967 and 1968 revealed the crawfish to be present. Many young of the year (1 to 4 cm.) were collected with baited screen-wire funnel traps and dip nets and thus reproduction was evident in the saline waters both years. A sample of the market sized crawfish (over 7.6 cm.) present was taken May 30, 1968. The catch of the standard ¾-inch mesh single-funnel traps averaged 2.7 pounds per trap over a 24 hour period.

The pond was not intensively harvested during its first fishing season as it was felt that the initial lack of cover exposed a great number of crawfish to predators. This could be circumvented by a prospective crawfish farmer through the selection of areas containing a heavier vegetative cover prior to pond construction.

Production

Intensive trapping was begun on April 4, 1969, and terminated on June 6, in an effort to estimate the total pounds of harvestable crawfish produced by this brackish water pond. Traps used were essentially of the same type as those used by commercial crawfishermen and were emptied and rebaited on a 24 hour schedule. Crawfish farms are normally harvested intensively from about December 1 to June 15. Though crawfish were present in the research pond in harvestable numbers, other commitments prohibited intensive harvesting during this entire period.

Figure 1. Monthly minimum-maximum range of temperatures recorded 3 1/2 feet below the surface of Rockefeller Research Pond, 1968-69 season.

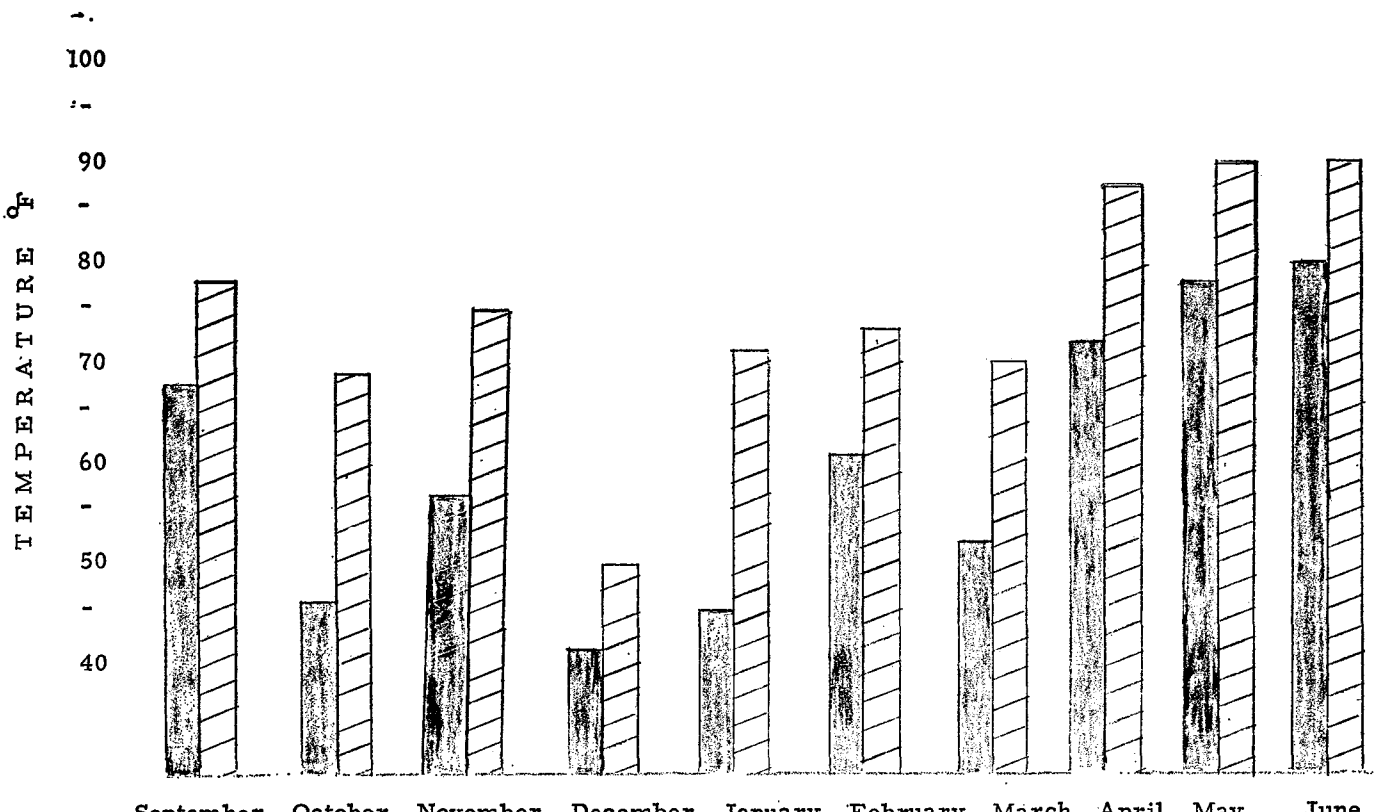


Figure 2. Monthly minimum-maximum range of temperatures recorded 3 1/2 feet below the surface of Rockefeller Research Pond, 1967-68 season.

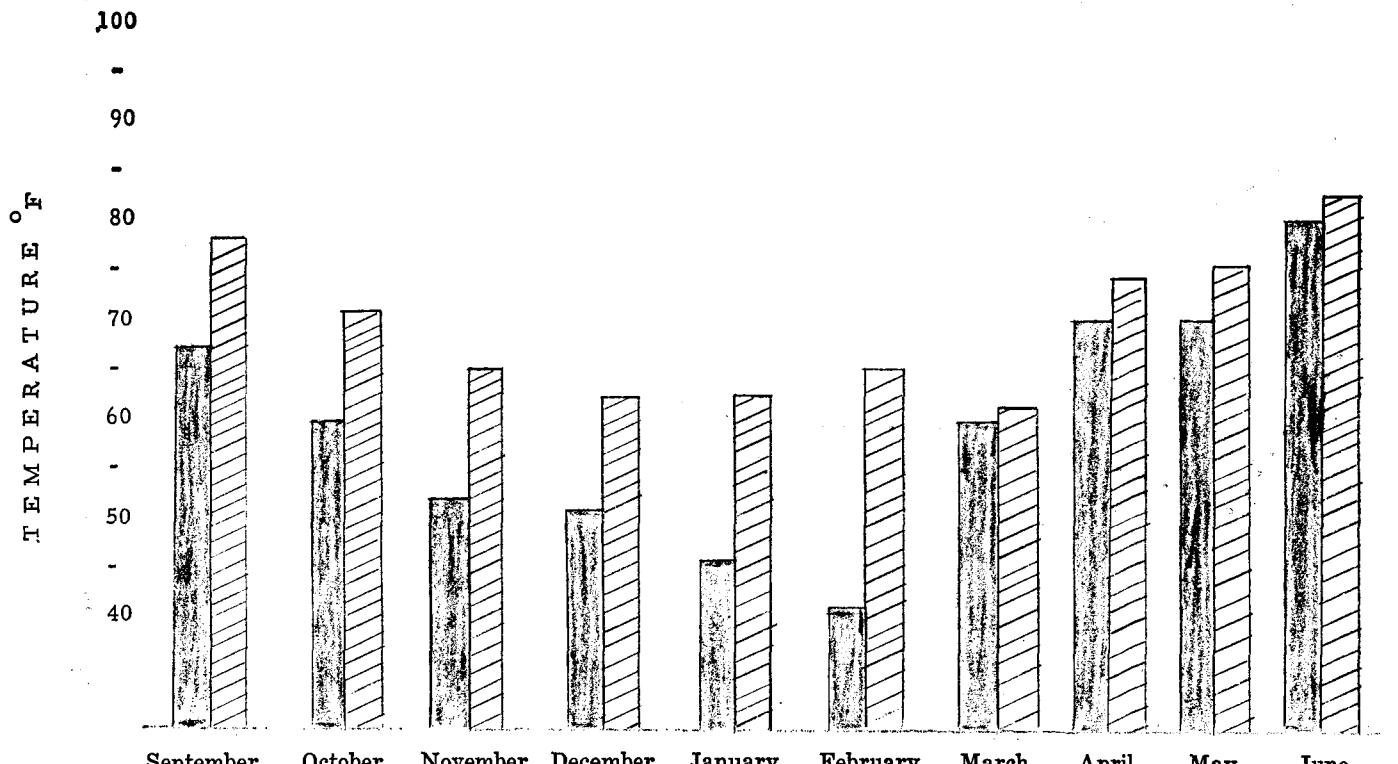
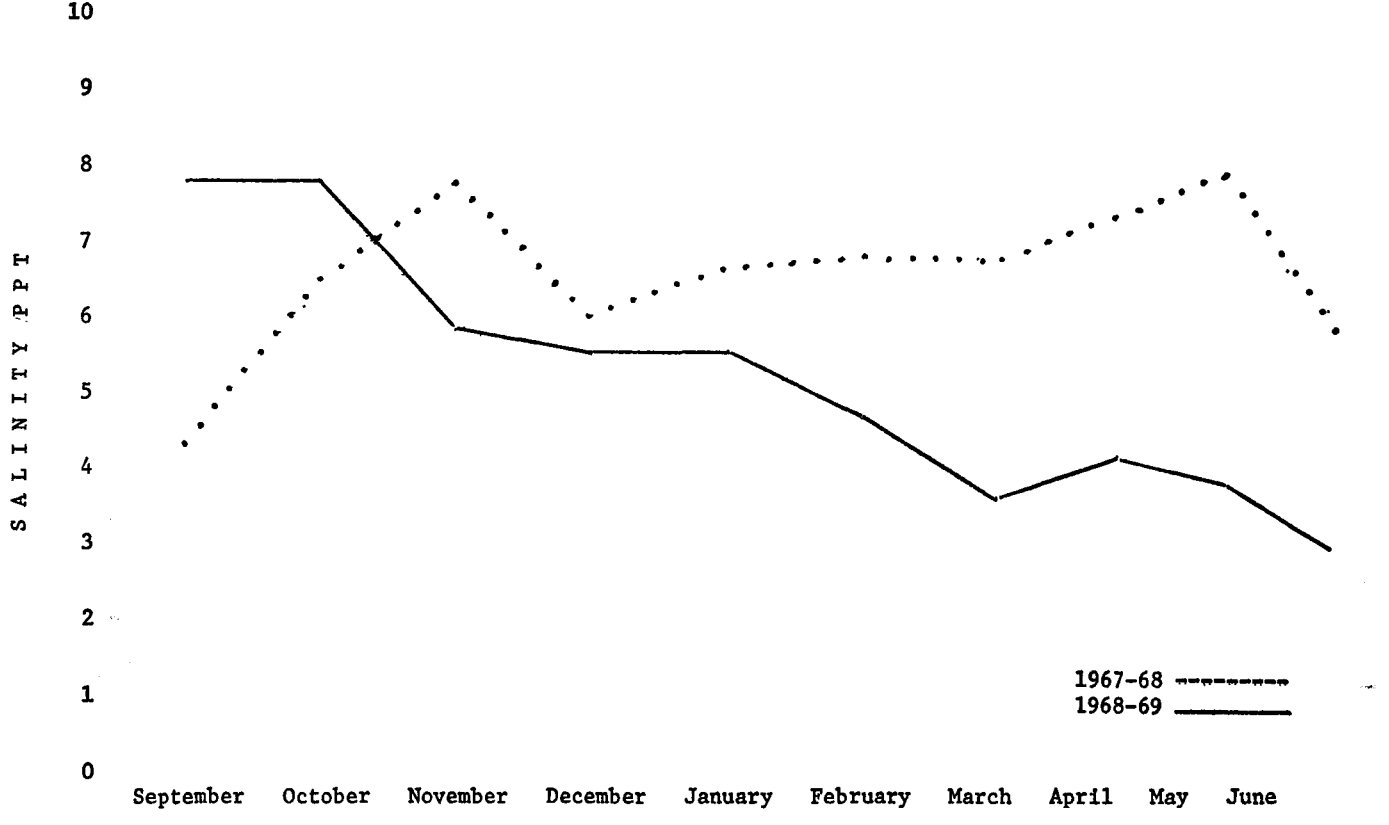


Figure 3. A two year comparison of monthly salinities of the crawfish research pond, Rockefeller Wildlife Refuge, 1967-1968 and 1968-1969.



Total production figures were adjusted according to the average number of traps used per acre (Table II). Crawfish farms use an average of six traps per acre since it has been found that effort expended combined with catch per trap prohibits the use of more than 10 traps per acre. Total possible catch figures were calculated by assuming that six traps per acre were used rather than the 2.3-2.9 traps per acre actually used. The 1,525.0 pounds or 272.3 pounds per acre were considered to be minimal.

TABLE II. Red swamp crawfish harvested in the 5.6 acre brackish pond at Rockefeller Wildlife Refuge. Complete data after April 4, 1969.

Date	Pounds Caught	Number of traps	Pounds per trap	Traps per acre	Possible Catch*
All samples prior to					
4/10/69	90.0	..	..	..	90.0
4/10/69	15.0	16	0.9	2.9	31.0
4/30/69	22.0	16	1.4	2.9	45.5
5/01/69	22.0	16	1.4	2.9	45.5
5/02/69	36.5	16	2.3	2.9	75.5
5/03/69	44.5	16	2.8	2.9	92.1
5/05/69	15.0	16	0.9	2.9	31.0
5/06/69	57.0	16	3.6	2.9	117.9
5/07/69	30.0	16	1.9	2.9	62.1
5/08/69	38.5	16	2.4	2.9	79.7
5/09/69	35.0	16	2.2	2.9	72.4
5/15/69	17.0	13	1.3	2.3	44.3
5/16/69	37.5	13	2.9	2.3	97.8
5/19/69	13.0	4	3.3	0.7	111.4
5/20/69	33.0	13	2.5	2.3	86.1
5/21/69	39.0	16	2.4	2.9	80.7
5/22/69	41.0	16	2.6	2.9	84.8
5/23/69	48.0	16	3.0	2.9	99.3
5/28/69	38.0	16	2.4	2.9	78.6
5/29/69	23.0	16	1.4	2.9	47.6
6/06/69	25.0	16	1.6	2.9	51.7
TOTAL	720.0				1525.0

It has been determined that a crawfish farm must be fished intensively during the above period if maximum yields are to be realized. Many adult crawfish are caught by predators or reach the end of their life spans, particularly during the December—March period.

Data is still not complete enough to make any definite statements regarding the maximum salinities in which the red swamp crawfish can be successfully farmed. It was concluded from field data collected over a two year interval that between the dates of September 15 to October 15 egg laying and hatching occurred at salinities ranging from 4.4 to 7.9 ppt. The harvest period, including the growing and breeding stages which extends from October 15 to draining, had salinities ranging from 3.1 to 8.0 ppt. Our findings during this period are in agreement with Loyacano's (1967) laboratory experiments on the tolerance of newly hatched, intermediate and adult crawfish to salinities in this range. He stated that crawfish in some experiments seemed to grow faster in concentrations up to 10 ppt, possibly because of the increased essential minerals in the more saline water. He further stated that this may be the maximum salt water concentration that crawfish could tolerate osmotically. However, his test did not include the actual breeding and reproductive cycles.

* Projected to six traps per acre.

It is suggested, however, that crawfish subjected to a sudden increase or decrease in salinity concentrations may totally or partially fail to complete its reproductive processes if the gradient is sufficient. Further experiments in this area will be conducted with procedures approximating those used in commercial freshwater crawfish ponds.

White crawfish were not observed or harvested during the two year period of sampling. Definite conclusions have not been made due to the small percentage of this species in the initial stock.

SUMMARY

Red swamp crawfish were obtained from freshwaters and stocked in a brackish water impoundment in Southwest Louisiana to determine if these freshwater animals could be grown in saline waters. The crawfish were stocked at a rate of 89 pounds per acre and the pond was managed using the commonly accepted techniques of commercial crawfish farmers.

Records were taken and maintained for water temperature, salinity, pH and for the presence of crawfish throughout the growing periods.

After survival and reproduction was realized production was determined. Population samples taken in the fall of 1967 and the fall of 1968 correlated with the monthly salinities recorded during the study indicated the following:

(1) The crawfish apparently bred in waters containing maximum salinity concentrations ranging from 6.0 to 8.0 ppt.

(2) The hatching of eggs took place in maximum salinity concentrations ranging from 6.0 to 7.9 ppt.

(3) Crawfish growth was evident in waters in which monthly salinities ranged up to 8.0 ppt.

(4) Projected possible catch figures calculated by assuming that six traps per acre were used rather than the 2.3-2.9 traps per acre actually used resulted in a total possible harvest projection of 1,525.0 pounds or 272.3 pounds per acre which is considered minimal.

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