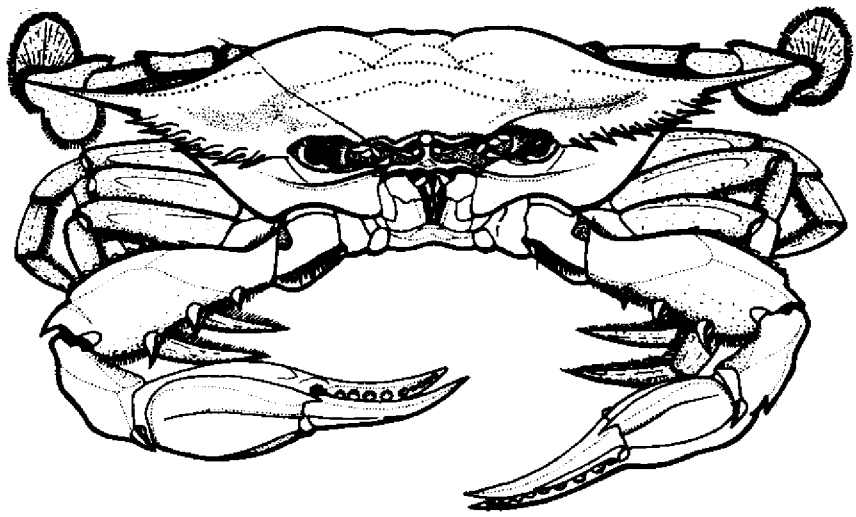
FLORIDA
SEA GRANT COLLEGE

Development of a Soft Crab Fishery in Florida

By
W. Steven Otwell, James C. Cato and Joseph G. Halusky



Report Number 31 January 1980

Marine Research · Education · Advisory Services
A Sea Grant Program for Florida

DEVELOPMENT OF A SOFT CRAB FISHERY IN FLORIDA

by

W. Steven Otwell, James C. Cato
and Joseph G. Halusky

Report Number 31
State University System of Florida
Sea Grant College Program

January 1980

TABLE OF CONTENTS

LIST OF FIGURES

Figure

LIST OF TABLES

Table

DEVELOPMENT OF A SOFT CRAB FISHERY IN FLORIDA[1]

by

W. Steven Otwell, James C. Cato,
and Joseph G. Halusky[2]

INTRODUCTION

The soft-crab is not a separate crab species, but rather the result of the hard shell shedding process (molting) required for growth of most crustaceans. The soft, pliable post-molted blue crab, Callinectes sapidus is a unique culinary delight when batter fried, peppered and sandwiched in fresh bread. Traditionally, most dealers in soft-crabs have been small volume producers because the shedding operation is considered a labor intensive 'art'. Consumer demand for soft blue crabs has always exceeded supply, as evidenced by rapidly increasing prices paid for soft crabs. Soft crabs are so popular, they demand some of the highest prices paid for any seafood on today's market. This situation has prompted a unanimous recommendation for introduction of blue crab shedding operations where they are not presently utilized and show potential (Rhodes and Van Engle, 1978).

In Florida, the current annual harvest of hard shell blue crabs exceeds 17 million pounds. However, the present production of soft blue crabs is almost non-existent and is not closely monitored as a significant state fishery. Thus a Sea Grant immediate response study was designed to investigate the potential for development of soft-crab fisheries in Florida. This initial, small-scale study concentrated on one specific region, the upper reaches of the St. Johns river. Preliminary work included a literature review to provide knowledge of the past and present state of the 'art', a demonstration facility to actually examine the shedding process required for production, and a brief economic analysis of the crabbing and shedding process.

---

[1]Final Report on Florida Sea Grant Immediate Response Project, "Development of a Soft Crab Fishery in Florida" funded from Oct.-Dec. 1978.

[2]W. Steven Otwell is assistant professor in the Department of Food Science and Human Nutrition, James C. Cato is associate professor in the Food and Resource Ecomomics Department, and Joseph G. Halusky is marine agent for Northeast Florida. All authors work with the Florida Sea Grant and Cooperative Extension Service Marine Advisory Program, University of Florida.

REVIEW OF LITERATURE

HISTORICAL SITUATION

Soft crab fisheries in the United States began around the Chesapeake Bay. Credit for initiation of the fishery belongs to some anonymous, brave soul who dreamed of the challenging consumption of a dangling mass of post-molted, whole-fried blue crab legs protruding from two pieces of bread. Although his concoction was not a picture of delight, the rewarding, succulent flavor of the soft-crab was a delightful experience which defied attempts to protect the secret recipe. Thus, a taste for soft-crabs grew in popularity throughout the New Jersey to North Carolina region.

In response to this growing demand, attempts to mass produce soft-blue crabs began in the mid-1800's. Warner (1976) gives a brief, entertaining account of early attempts to shed crabs. Controlled shedding began in the 1850's with wire enclosures (crab pounds) staked in tidal zones. These wire pens were filled with hard crabs which were fed and watched very closely for molting. This method was difficult to manage and numerous crabs were lost to cannibalism and mortality due to variations in water quality.

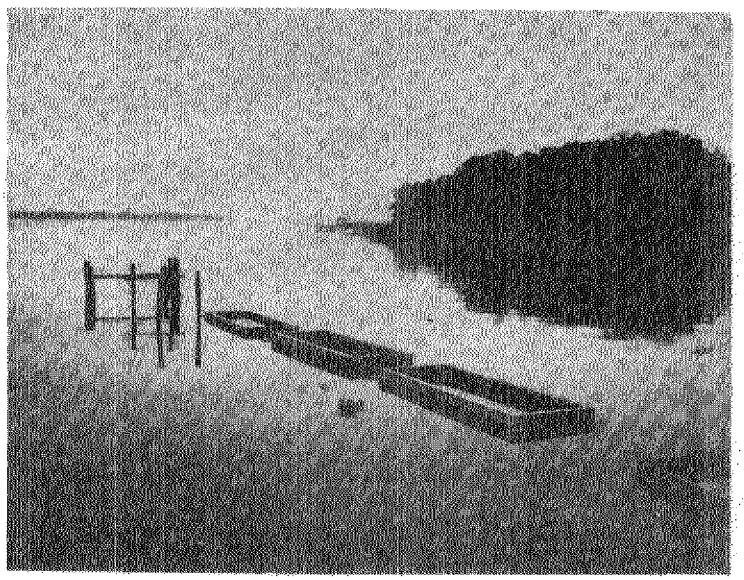
Later, the crab pounds were equipped with floating boxes to house and protect those crabs nearer to molting (Figure 1). Experienced producers had learned to examine hard crabs for unique signs which indicated a pre-molt condition. These floating boxes were successful and were continually modified to suit specific requirements of individual producers. Box size, depth, and location varied with preference.

In time, producers used more floating boxes or cars and became less dependent on crab pounds which required extra care and feeding. Production became more dependent on a selective harvest of peelers, hard crabs displaying pre-molt signs. Dealers who learned the fine 'art' of shedding, began to separate the peelers into a series of floating boxes according to the progressive signs of pre-molting.

Little change occurred until the 1950's when bank floats or shore floats were developed (Figure 2). Shore floats were simply troughs or shallow built shedding tables used to hold running water pumped from an adjacent brackish water supply. The open systems were easier to manage, and they soon evolved into enclosed shedding tables which were housed to provide shade and protection from rain and predators (Figure 3). To prevent cannibalism, some dealers would nick the crab claws. Nicking simply

Figure 1 Typical 'floating boxes' used to hold blue crabs during shedding.

A. Wooden 'box' lined with slats, separated for water circulation.



B. Wooden 'box' lined with plastic coated wire on sides and bottom.

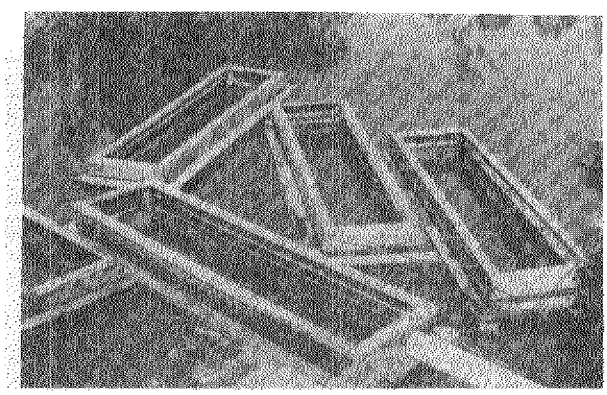


Figure 2 Typical 'bank floats' or 'shore floats' or 'tables' used to shed blue crab on shore. The facility is lighted and supplied with running water.

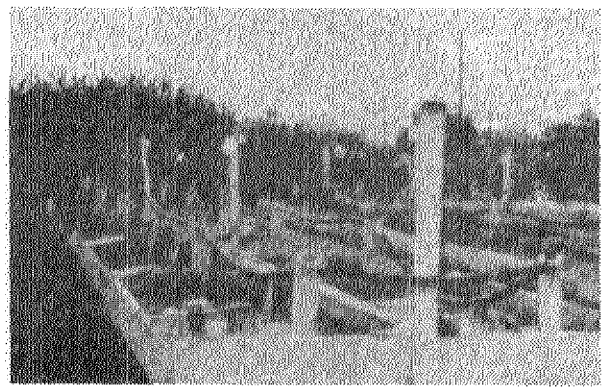
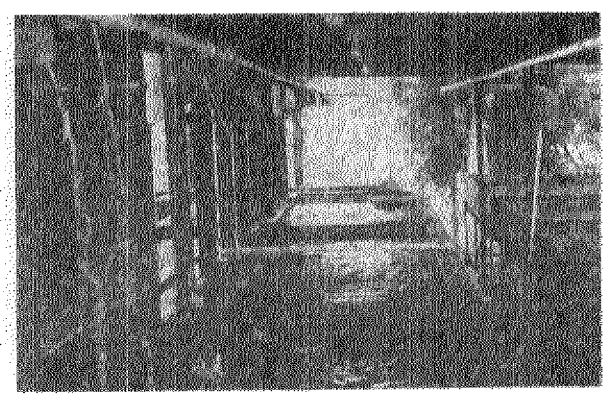


Figure 3 Typical enclosed 'tables' for shedding blue crabs. The facility is lighted and supplied with running water.



broke the moveable finger of the claw, but if done incorrectly, could promote diseases and hinder the molting process. Proper sorting according to pre-molt signs remains the best method to control cannibalism, because most rank peelers (crabs within 24-48 hours of molting) will stop feeding. Feeding ceases because of weakened muscles and inability to grind food, and the eventual loss of the stomach lining at shedding (Van Engel, 1958).

Today, floating boxes are still used, but enclosed shedding tables are more popular. Recent attempts have been made to develop a closed-system of shedding tables which control water quality and could theoretically be used to prolong the shedding season (Haefner & Garten, 1974; Epifano et al, 1973; and Winget et al, 1973). Some researchers (Overstreet & Cook, 1972) have suggested that removing the eye stalks from crabs would enhance shedding because the eyes contain cells with a molt-inhibitory hormone (Knowles and Carlisle, 1956). Removing these hormones would accelerate the shedding process. Unfortunately, experience has shown that this method is not reliable and could promote diseases, death, or hinder shedding.

Some innovaters have tried to introduce methods of soft-crab production without shedding. In 1965 a patent was filed which described a process for chemically softening the hard shells of blue crabs (Gillies, 1975). Whole, alive hard crabs were placed in a 3-5 percent by weight solution of reagent-grade acetic acid (assayed at 95-100 percent acetic acid by weight) at 80°F for 25-30 hours. After the crabs were softened (subjective evaluation) they are rinsed in warm tap water and residual acid was neutralized in a final soak of weak alkaline agent (sodium bicarbonate). The resulting softened crabs were washed, cleaned (undigested foods and gills removed) then batter fried. Presently the lack of any artificially softened-blue crabs could indicate that softened-crabs do not provide the same rewarding flavor and texture commonly associated with the regular soft-crabs. Thus the natural, controlled shedding of blue crabs remains the preferred method for production of soft-crabs.

Regardless of the shedding system used, all methods gradually became more dependent on the selective harvest of pre-molt blue crabs or peelers. Initially, peelers were collected at random. Folk tales recommended soft-crab hunting was best during the light of the full moon when peelers were more visible. Some producers argued that more crabs molt on the dark moon when darkness provided protection from predators. The influence of the moon phase on blue crab molting has not been studied, but the commercial soft-crab 'experts' agree it is a definite part of the soft-crab 'art'.

Crabbers who had learned the signs for the pre-molt condition would sort for peelers caught in their traps or on their trotlines. Crabs caught in traditional crab traps or pots were more difficult to examine and subject to damage which would adversely affect the shedding process. Crabs caught on trotlines (continuous lines of special baits tied at measured intervals) could be individually examined and were in better post-harvest condition. Trotlines were productive and yielded the prefered peeler, but were more labor demanding than the traditional pots.

Jimmie potting was the first, simple attempt at selective harvesting of pre-molting blue crabs. The principle of the system was to use 1 to 3 large male crabs (jimmies) as a live bait to attract female peelers. Female blue crabs, during their last (terminal) molt, will mate with a mature male crab. During the mating process, commonly referred to as 'doubling', the male crab cradles the female for protection during the molt and the soft female can perform copulation. One large jimmie can attract many female peelers. The only problem is that continuous use of the same male will cause starvation, thus enhance cannibalism. For this reason, some crabbers have modified their 'jimmie pots' to separate the male crab from the entering female crabs. Some crabbers use empty, unbaited traps (bare potting) to attract peelers of both sex.

In 1870 a patented crab scrape was invented for towing through shallow grass beds often inhabited by blue crabs in pre-molt conditions (Warner, 1976). The scrape consisted of a rectangular metal frame (approx. 1x4 Square feet) weighing about forty pounds and was equipped with cotton netting to bag the catch and a bridle for towing from a small skiff. The frame would scrape through the grass, cutting well above the root line and capture peelers seeking grassy protection. Some hand operated push scrapes have been equipped with rollers to facilitate the flow through the grass. This gear costs less than one hundred dollars and is still one of the most productive methods of harvesting peelers from the Chesapeake Bay.

Bush lines and peeler pounds have also been used to catch peelers from specific habitats. Bush lines are artificail habitats created by bush cuttings strung in shallow waters. One bush line can consist of over 100 bushes tied in one long row between permanent posts. After the peelers seek the bushes for protection, the line is periodically lifted for harvest. Bush lines made with cuttings from wax myrtles are most popularly

used in Louisiana. Peeler pounds are modeled after the traditional Chesapeake Bay fish pounds. A wire mesh (1 square inch) lead is built perpendicular from the shore, running into the 'heart' shich channels the crabs into the head section (wire mesh 1 square inch). The head (approx. 3x4x5 cubic feet) is situated such that the high tide line does not cover the entire trap. The crabber can harvest the peelers directly from the top of the trap. The selectivity of the peeler pound for pre-molt crabs is not well understood, but location of the pound is critical.

Thus the development of the soft-crab industry has been an evolution of methods designed for convenient mass shedding; and the shedding methods used have always depended on a source of pre-molt crabs. Use of peelers minimizes the holding time in the shedding facility and assures a higher percent shedding. Use of 'green' crabs (non-peelers) would require feeding and monitoring of water quality. Despite the extra care, experience indicates that the extra labor is no assurance that green crabs would survive and shed. Successful soft-crab shedding operations are designed to minimize the work required for this labor intense 'art'.

PRESENT SITUATION

Methods

Currently the most popular and successful method of soft-crab production is with on-shore shedding tables or troughs. These open systems depend on the quality of the water pumped from the natural water supplies and the selective harvest of pre-molt blue crabs. To eliminate the water quality problems, researchers (Haefner and Garten, 1974: Epifano et al, 1973; and Winget et al, 1973) have tried to develop elaborate closed systems which control water temperature, salinity, oxygen, etc... and could theoretically enhance molting and/or prolong the molting season. Overstreet and Cook (1972) described an early attempt at closed system shedding in Mississippi. The first successful and practical closed system of troughs has recently opened in Mississippi (Anon. 1979). This large closed system claims to produce 60 to 90 dozen soft crabs per day during the peak season for peelers. Currently, Louisiana and Maryland crabbers are trying to develop practical closed systems for use near shore and inland. Thus the present trend in soft-crab production is toward closed systems, but production from these systems still depends on a source of pre-molt crabs.

Peelers are harvested by all methods previously discussed, but crab traps remain the most popular source. Despite the damage caused during harvesting and sorting, crab traps are more practical and offer additional income from hard crabs. Peeler production from crab traps depends on the location 'fished' and the ability of the crabber to select true peelers. A recent modification of the typical crab pot, using shading material to inclose the pot as an 'artificial habitat' has been demonstrated as a potential method to harvest peelers in South Carolina (Bishop, 1979).

Research is needed to determine the feasibility of shedding 'green' crabs in a closed system. Possibly, a combination of open systems to hold 'green' crabs prior to the peeler stage, could be used with a simple closed system concept. Utilization of 'green' crabs would definitely boost production of soft-crabs, but the economic practicality of this idea would depend on the extra cost and labor of feeding, holding, and monitoring water quality. An optimal condition would be a controlable environment which enhances shedding.

Terminology

The present language of the soft-crab industry is a unique combination of science, common sense, and descriptive humor (Appendix I). A hard shell adult blue crab can be 'green', 'fat', and a 'jimmie' or a 'sook'. 'Green' describes the condition of crabs between molts, or the non-ripe condition for shedding. Immediately

following a molt, the crab is considered light because the muscle tissues do not completely fill the expanded space of the new shell. Light crabs are called wind-jammers, 'white' crabs, or water galls. In time, after a few meals, the crabs begin to increase in weight and gradually approach the fat condition. In this condition the crab cannot continue to grow in size without molting. The fat crabs, preferred by pickers and eaters, can usually be identified by 'rust' marks on the front portion of the abdomen. These discolored, abrasive marks are caused by the shell being dragged over sand and mud because the fat crab cannot continually support its body weight while walking on the bottom. Most hard, fat crabs soon become cooked crabs.

Certain fat crabs will show signs which indicate the pre-molt condition. A 'white' sign crab, also called snot or hairline crab, will molt within two weeks. The 'white' sign refers to the appearance of a thin white line just inside the outer edge of the last segments of the paddle fin or backfin. This line is the new soft-shell forming below the old hard shell. Gradually, this line turns pink or 'pink' sign which indicates molting within one week. As the pink color darkens, the crab displays the 'red' sign indication a molt within 1 to 3 days. 'Red' sign crabs are true peelers or rank crabs prime for shedding. The common color signs used to identify pre-molt stages are not always evident. Other signs of pre-molting are described in a later section.

The complete molting process requires approximately 1 to 3 hours. The buster stage begins as the carapace separates from the remaining hard shell along the posterior section of the crab. The soft-crab gradually backs out of the old shell, leaving a remaining shed. The emerging soft-crab expands by water intake to its new maximum size within 15 minutes, increasing approximately 25 percent in width (Haefner and Gartner, 1974). The new shell gradually hardens but the hardening process will stop if the crab is removed from water. To obtain the prefered texture, soft-crabs must remain in water for about 15 to 60 minutes depending on temperature and salinity. This critical time, if exceeded, would produce a leathery texture or paper-shell crab with low market value. In water, the paper-shell condition lasts about 12 hours before the shell stiffens into the brittle 'buckram' stage which lasts for an additional 12-24 hours. Total shell hardening requires about 3 full days after molt.

Market Potential

Top value soft-crabs should be large, soft (not paper-shell) and possess all legs and claws. Buffalos

and doorknobs are soft crabs missing legs and/or claws. The largest crabs (whales or slabs) bring the highest wholesale price ($7.50 to $10.00 per dozen; Table 1) but the value of soft-crabs will vary with season and location. Most producers agree that fall water temperatures below 70°F are the lower limit for blue crab molting. Thus best seasonal prices are paid in early spring when freezer inventories are low and production is limited. The first, fresh soft-crabs on the spring market demands the highest price of the year.

Originally, soft-crabs were marketed live, packaged in moist eelgrass and/or paper (Lee & Sanford, 1962). Today most soft-crabs are marketed frozen, pan-ready, and packaged individually in plastic sandwich bags or other suitable clear plastic wrap. After wrapping they are sorted according to size. In certain areas the size categories have special names and color codes (Table 1). Soft-crabs are pan-ready for cooking after the eyes, mouth parts, apron and gills (dead man's fingers) are removed. Some connoisseurs remove the carapace from the larger soft-crabs. No marinating or pre-soaks are required. In the restaurant, one whole soft-crab is thawed, battered, and fried with seasoning.

Production and Value

Average annual production[3] of soft crabs in the United States since 1970 slightly exceeds 2.6 million pounds (Table 2 & Figure 4). This average production represents less than 2 percent of the respective hard blue crab harvest, but the soft crab dollar value averaged greater than 9 percent of the total hard crab value. Present production of soft crabs in the 1970's is at least 38 percent less than averaged in previous decades, but present production is more consistent[4]. Despite fluctuations in production, the dollar value for soft crabs has continuously increased. From 1950 to 1970 the value increased at an annual rate slightly greater than one cent per year, but since 1970 the average annual value has accelerated from $.42 to $1.04 per pound in 1977.

---

[3]Production and landings are synonymous terms in this report.

[4]Standard deviation for production since 1970 is ±181 as compared to ±1123 and ±1091 for the 1950's and the 1960's, respectively.

Table 1. Northern Chesapeake Bay Region wholesale soft crab prices by common market category, 1978.

Grades	Size(inches)[a]	Color Code[b]	Wholesale Value[c]		
			June	July	August
			Dollars per dozen		
Whales(slabs)	> 5.5		10.00	9.50	7.50
Jumbos	5.0-5.5	red	9.00	8.50	6.50
Primes	4.5-5.0	orange	7.00	8.50	4.00
Hotel primes	4.0-4.5	yellow	5.00	4.00	3.00
Mediums	3.5[d]-4.0	green	3.00	2.00	1.50

a. Distance measured between lateral spine tips of carapace.

b. Box color codes used to indicate grade.

c. Wholesale value is direct sales price paid by the handler to the primary producer or operator of the shedding facility. Handlers would normally add from $2.00 to $3.00 for packing and shipping.

d. 3.5 inches is the minimum legal size width for marketing soft-crabs in Maryland.

Source: Personal communication: University of Maryland's Seafood Laboratory in Crisfield, MD.

Table 2. Total United States landings and value of blue crabs, 1950-1978.

Year	Market Form: Hard — Thousands of pounds	Hard — Cents per pound[a]	Soft — Thousands of pounds	Soft — Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1950	119,346	.04	6,727	.16	5.6	22.9
1951	107,807	.04	6,566	.21	6.1	31.9
1952	99,837	.04	4,411	.20	4.4	19.7
1953	105,384	.05	5,155	.18	4.9	19.9
1954	97,750	.04	3,761	.21	3.8	18.2
1955	97,654	.05	3,643	.22	3.7	15.6
1956	94,003	.06	4,334	.21	4.6	16.1
1957	107,978	.06	5,750	.22	5.3	20.0
1958	105,641	.05	5,293	.22	5.0	20.2
1959	112,531	.06	3,957	.28	3.5	15.9
Ten year average	104,.95	.05	4,360	.21	4..	20.0
1960	149,646	.05	5,051	.27	3.4	17.5
1961	147,652	.05	5,106	.28	3.5	20.9
1962	149,347	.05	3,871	.25	2.9	19.3
1963	141,743	.05	3,514	.37	2.5	16.8
1964	152,297	.06	4,795	.39	3.1	20.4
1965	166,996	.07	4,273	.38	2.8	14.3
1966	166,827	.06	3,172	.39	1.9	12.5
1967	145,027	.06	3,649	.40	2.5	16.8
1968	113,619	.10	2,178	.47	1.9	9.1
1969	132,255	.09	4,524	.41	3.4	14.8
Ten year average	146,341	.06	4,213	.36	2.9	16.2
1970	145,410	.07	2,675	.42	1.8	10.8
1971	149,081	.09	2,421	.50	1.6	9.4
1972	147,468	.10	2,610	.50	1.8	8.9
1973	136,516	.13	2,701	.54	2.0	8.2
1974	149,176	.13	2,964	.57	2.0	8.8
1975	130,816	.14	2,622	.75	2.0	10.4
1976	113,152	.20	2,433	.76	2.2	8.0
1977	128,860	.21	2,455	1.04	1.9	9.3
1978	138,230	.20	na	na	na	na
Nine year average	137,643	.14	2,610	.64	1..	9..
Total Average	129,381		4,021		2.3	5.6

a. Value computed from reported total value data.

b. Indicates the total soft crab and peelers landed relative to the total crabs landed. Thus a state which only reports hard crab landings can use this figure to estimate potential soft crab landings.

na.-data not available

Source: Recorded and derived from Fishery Statistics of the U.S. and Annual Landings Reports of the various regions. 1950-1978. U.S. National Marine Fisheries Service.

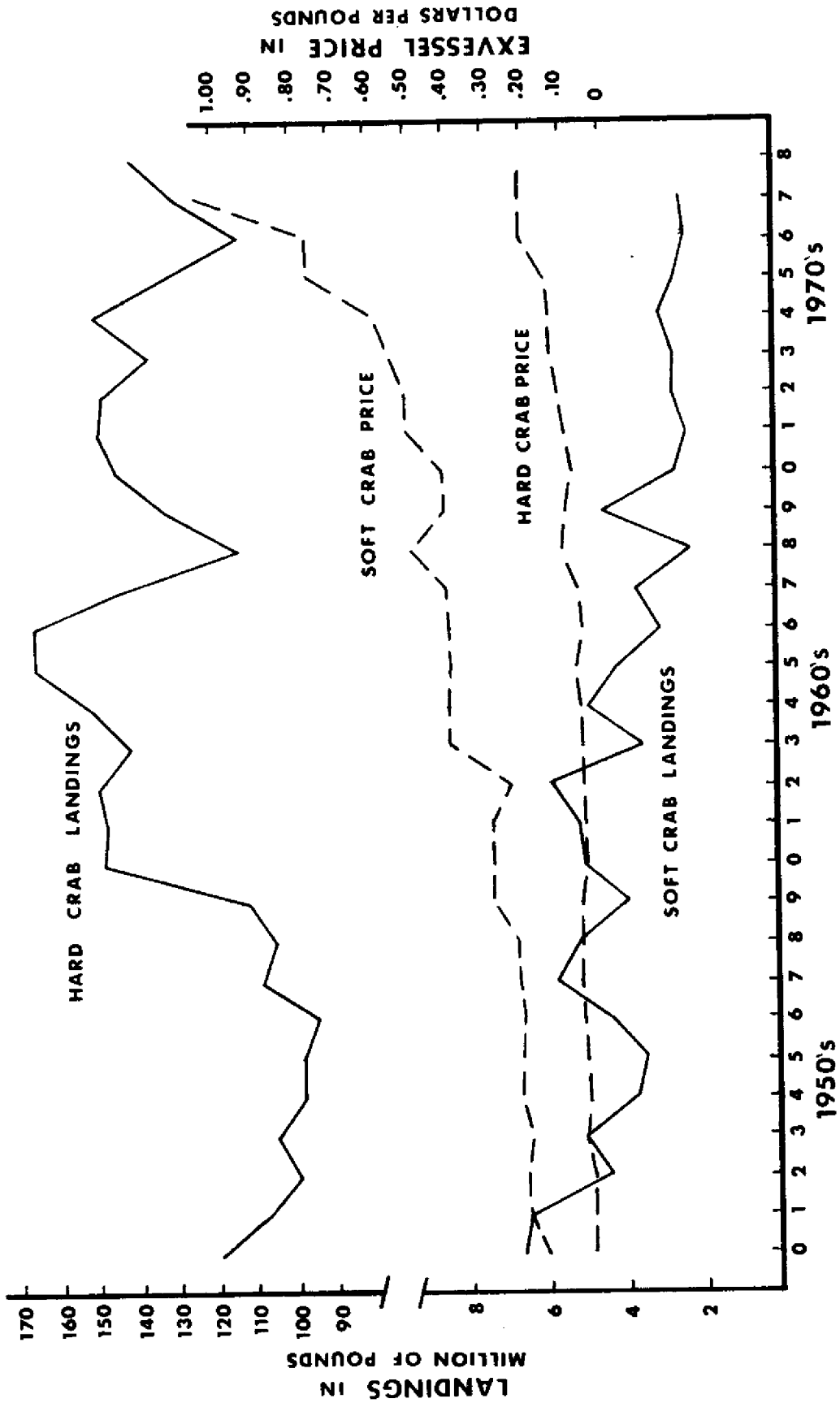


Figure 4. Landings and exvessel price of soft and hard blue crabs in the United States, 1950-1978.

It is apparent that an inverse relationship has existed between hard and soft blue crab landings between 1950 and 1978 (Figure 4). Generally, the overall trend in hard blue crab landings is positive during this period while that of soft blue crab landings is negative. At the same time, soft blue crab prices or values have increased at a much more rapid rate as discussed earlier. The effect of this decline in soft crab landings is probably reflected through the price increases. Even with stable demand, decline in the supply of soft crabs would result in higher prices in the marketplace. Normally, higher prices would encourage the expansion of soft-crab supplies or landings and/or a diversion of hard crabs into the soft crab market. One possible explanation why this has not happened is that soft-crab fishing and shedding is a labor intensive 'art' and those with the adequate knowledge and desire to practice this labor intensive occupation are declining in number.

The use of poundage to express the dollar value of soft crabs is inconsistent with commercial practice and complicates the interpretation of production data. Soft crabs are usually sold by the dozen, and in most regions the crabs are graded by size (width). Fishery statisticians record soft crab sales in dollars per pound using 2.5 pounds per dozen for conversion to the commercial scale (Statistical Branch, NMFS, Easton, MD, personal communication, 1979). Recorded sales are considered transactions at the dock or direct return to the producer. Recorded sales include peelers and soft crabs. These records cannot account for variations in price/grade of dozen, specific price per dozen by region, differences in price and weight of peelers versus equal size soft crabs, etc... Understandably, the small volume of the soft crab industry does not warrant more specific identification, thus more specific interpretation of the records is limited to overall trends and speculation.

Only six states (New Jersey, Delaware, Maryland, Virginia, North Carolina, and Louisiana) record any substantial[5] soft crab production (Table 3). Annual production per state suggests the Chesapeake Bay has always been the major productive region for soft crabs. In the 1970's, Virginia and Maryland accounted for over 90 percent of the total soft crabs produced. Larger volumes of hard crabs were harvested in Virginia, but Maryland produced a larger volume of soft crabs. This may be

---

[5]Greater than 1000 pounds per year.

Table 3. Total annual landings and value of hard and soft blue crabs in states which record a substantial soft crab fishery. (continues)

New Jersey

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	538	.15	18	.24	3.3	5.4
1971	1,153	.16	15	.33	1.3	2.8
1972	1,437	.22	15	.30	1.0	1.4
1973	2,572	.26	23	.67	0.9	2.5
1974	2,745	.24	126	.42	4.6	7.9
1975	2,870	.22	39	.41	1.3	2.5
1976	2,696	.31	90	.44	3.3	4.8
1977	390	.38	5	.53	1.3	1.7
Average 1970-77	1,300		41		2.1	3.6

Delaware

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	na	na	na	na	na	na
1971	1,014	.20	9	.56	0.9	2.5
1972	2,552	.26	10	.80	0.4	1.2
1973	2,373	.26	18	.72	0.8	2.0
1974	2,248	.18	73	.71	3.2	13.0
1975	3,351	.22	34	.71	1.0	3.1
1976	3,365	.30	na	na	na	na
1977	862	.35	na	na	na	na
Average 1970-77	2,309		29		1.5	4.4

Maryland

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	24,935	.08	1,579	.42	6.3	32.1
1971	23,482	.09	1,550	.48	6.9	29.6
1972	23,482	.10	1,575	.48	6.7	31.8
1973	19,539	.14	1,513	.50	7.7	27.4
1974	24,660	.16	1,822	.57	7.4	25.4
1975	24,264	.18	1,654	.55	6.8	20.5
1976	19,429	.24	1,474	.73	7.6	23.4
1977	19,243	.24	1,512	.92	7.9	29.9
Average 1970-77	22,703		1,582		7.0	27.5

Table 3. Continued
Total annual landings and value of hard and soft blue crabs in states which record a substantial soft crab fishery.

Virginia

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	42,416	.06	909	.37	2.1	14.2
1971	47,807	.08	693	.46	1.4	8.7
1972	48,554	.08	858	.48	1.8	10.4
1973	36,746	.11	983	.51	2.7	12.2
1974	40,850	.10	814	.49	2.0	9.5
1975	34,819	.14	754	.51	2.2	7.7
1976	25,761	.20	761	.72	3.0	10.8
1977	37,160	.18	695	.84	1.9	8.7
Average 1970-77	39,254		808		2.1	10.5

North Carolina

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	20,880	.06	59	.39	0.3	1.9
1971	14,476	.08	49	.51	0.3	2.2
1972	13,479	.10	50	.58	0.4	2.2
1973	11,963	.13	45	.62	0.4	1.8
1974	13,164	.10	33	.70	0.3	1.7
1975	11,072	.13	20	.85	0.2	1.2
1976	11,732	.20	20	1.32	0.2	1.1
1977	12,221	.18	16	1.06	0.1	0.8
Average 1970-77	13,373		37		0.3	1.6

Louisiana

	Hard		Soft			
	Thousands of pounds	Cents per pound[a]	Thousands of pounds	Cents per pound[a]	Soft crab landings as percent of hard crab landings[b]	Soft crab landed value as percent of hard crab landed value
1970	19,254	.09	89	.90	0.9	8.6
1971	12,186	.10	127	.99	1.0	10.9
1972	15,083	.12	102	1.07	0.7	6.1
1973	23,080	.12	119	1.11	0.5	4.7
1974	20,640	.13	96	1.32	0.5	4.7
1975	17,144	.15	119	1.30	0.7	6.2
1976	15,211	.20	88	1.65	0.6	4.7
1977	16,154	.23	225	2.53	1.4	15.1
Average 1970-77	16,219		121		0.8	7.5

a. Value computed from reported total value data.

b. Indicates the total soft crab and peelers landed relative to the total crabs landed. Thus a state which only reports hard crab landings can use this fugure to estimate potential soft crab landings.

na-data not available

Source: Recorded and derived from Fishery Statistics of the U.S. and Annual Landings Reports of the various regions. 1950-1978. U.S. National Marine Fisheries Service.

due to the origin of soft crabbing in Maryland and the higher yield of peelers in the abundant grassy shoals of the northern Chesapeake Bay.

Traditionally the southern states have produced the more valuable soft crabs (Table 3 and Figure 5). Louisiana produces the most valuable soft crabs (1977- $2.53 per pound) valued for their larger size (Lee and Sanford, 1962). The recorded 1978 value for soft crabs in North Carolina was $1.91 per pound. All current indications suggest the value of soft crabs is continuing to increase. Some new dealers in the southeast have indicated they are selling non-graded soft crabs at $10-15.00 per dozen (personal communications, 1979). This commercial value, converted to the statisticians scale ($4-6.00 per pound), is inconsistent with previous recorded values and may reflect the high demand for early spring production and/or the inaccuracy of the statistical data.

Despite the limitations of the recorded data, they indicate soft crabbing appears to remain a profitable business. Supply of soft crabs has decreased to a steady state production just above 2.6 million pounds per year, but price has continued to increase. Thus expansion of soft crab fisheries warrants further investigations. Development of this fishery also offers promise for the small-scale fishermen who normally are not able to take advantage of expansion into other more capital intensive fisheries.

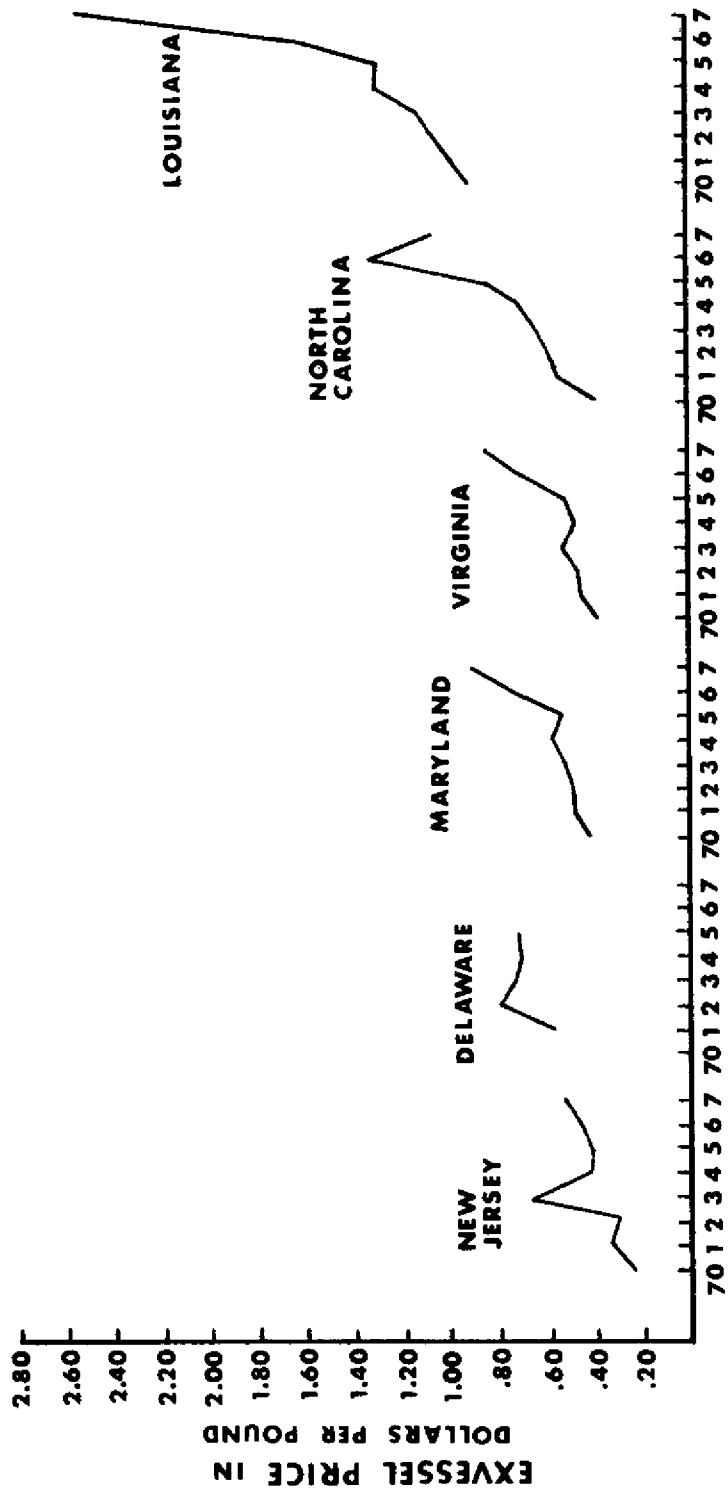


Figure 5. Exvessel price in dollars per pound of soft crabs in New Jersey, Delaware, Maryland, Virginia, North Carolina, and Louisiana, 1970-1977.

POTENTIAL FOR A FLORIDA INDUSTRY

The annual harvest of blue crabs in Florida is usually the third largest in the United States, following Virginia and Maryland, However, there is no substantial soft crab fishery. Meager soft crab production in Florida has been scattered and very inconsistent (Table 4). Recorded landings are so small that conclusions based on these reports are questionable. However, it is evident that the previous production of soft crabs in Florida began to decline drastically in the late 1960's. During this decade average annual soft crab production exceeded 5 thousand pounds, but since 1970 annual production has not averaged over 500 pounds. Areas of most consistent production in Florida have been Duval county, and regions about Tampa Bay and Charlotte Harbor, although the Apalachicola region (Franklin-Wakulla counties) has been the most productive area (Table 5). Since 1960 the Gulf coast has produced over 85 percent of all the recorded soft crab landings in Florida. Records indicate year round production is possible depending on the region, but April-October appears to be the major season for soft crab production in Florida.

The unique nature of the soft crab fishery operattions is the probable cause for the faltering development of Florida's soft crab industry. As previously discussed in this report, all successful soft crab operations depend on a reliable supply of pre-molt or peeler crabs. The availability of peelers in Florida is not well understood. Most Florida crabbers do not know where or how to selectively harvest pre-molt blue crabs, or how to 'read' the pre-molt identification signs.

Most previous productive soft crab operations in Florida have depended on transplanted expertise from the Chesapeake Bay region. Experienced producers consider blue crab shedding an 'art' which requires training and experience, but the tedious preparation and the continuous care required has discouraged many novices. Educational assistance for development of Florida's soft crab fishery has been limited. A preliminary study in 1953 (Young, 1955) was conducted at Punta Gorda, Florida. The results indicated the major problems were a lack of peelers and the rainy location.

Location of a soft crab operation in Florida is a critical factor. Florida's heavy, seasonal rainfalls and tidal fluctuations influence the salinity of coastal regions. The soft crab facility should be located near a water supply with consistent salinity

Table 4. Total annual landings and value of hard and soft blue crabs in Florida, 1960-1976.

	Florida			
	Hard		Soft	
Year	Thousands of pounds	Cents per pound[a]	Total pounds	Cents per pound[a]
1960	25,690	.05	4,550	.50
1961	24,615	.44	5,511	.50
1962	18,225	.05	375	.50
1963	21,744	.05	4,200	.50
1964	21,019	.06	15,063	.48
1965	26,561	.06	12,643	.73
1966	23,870	.06	1,030	.28
1967	23,296	.06	7,487	.63
1968	15,623	.08	325	.40
1969	17,308	.09	504	.37
Ten year average	21,795		5,169	
1970	22,565	.08	451	.55
1971	21,411	.08	35	.40
1972	16,961	.10	152	.97
1973	13,512	.12	0	–
1974	17,605	.13	281	.60
1975	16,992	.13	2,106	.79
1976	16.073	.17	235	.82
Seven year average	17,874		466	

a. Value computed from reported total value data.

Source: Recorded and derived from Fishery Statistics of the U.S. and Annual Landings Reports of the various regions. 1950-1978. U.S. National Marine Fisheries Service.

Table 5 Annual landings and value of soft crabs produced in various counties of Florida from 1960-1976.

EAST COAST

	Duval		Putnam		Brevard		Indian River	
	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]
1960					312	.50		
1961					351	.50		
1962	225	.50						
1963	200	.43						
1964	273	.36			1,755	.35		
1965	323	.40			472	.40	167	.30
1966	217	.40						
1967	219	.40			438	.50		
1968	325	.40						
1969	123	.40						
1970	187	.40						
1971	135	.40						
1972	15	.80						
1973								
1974			135	.12				
1975					410	.80		
1976					235	.82		

WEST COAST

	Monroe-Lee Charlotte		Hillsborough Pinellas		Wakulla Franklin		Citrus Escambia	
	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]	Pounds	Cents per pound[a]
1960	24	.50	2,485	.50			1,729	.50
1961	3,519	.50	1,641	.50				
1962			150	.50				
1963	500	.50	400	.50			3,100	.50
1964	1,915	.50			11,360	.49	30	.50
1965	3,036	.65			4,685	.71	3,960	.90
1966	633	.25	180	.25				
1967	18	.44	12	.50	4,305	.63	2,495	.68
1968								
1969	200	.50					181	.20
1970			264	.66				
1971								
1972	30	.90	107	1.02				
1973								
1974	36	.89	30	1.10				
1975	60	1.32	540	.72				

a. Value computed from reported total value data.

Source: Recorded and derived from Fishery Statistics of the U.S. and Annual Landings Reports of the various regions. 1950-1978. U.S. National Marine Fisheries Service.

and temperature levels. Pre-molt crabs used in the facility should be harvested from waters of similar salinity and temperature. Large fluctuations in water parameters disturb the molting process.

Currently, Florida soft crab operations are located in Citrus County, and around Tampa Bay and Apalachicola Bay. These operations are considered agricultural since the operators are taking an 'aquatic species' for 'commercial' purposes to rear it in a 'controlled environment'. The Aquacultural Policy Act of 1977 states,

> "Aquaculture means the commercial propagation and rearing of aquatic species in controlled environments------(and aquatic species are) finfish, mollusk or crustacean or other aquatic invertebrate, amphibian, or reptile..."

The U.S. Department of Agriculture is the lead agency responsible for all aquaculture activities (Food and Agriculture Act of 1977, PL 95-113).

In Florida, fishery regulations actually encourage the development of soft crab operations. State law 370.135 governing harvest of blue crabs states,

> "Except when authorized by special permit issued by the department (Natural Resources) for the soft-shelled crab or bait trade, it is unlawful for any person to possess for sale blue crabs measuring less than 5 inches from point to point across the carapace in an amount greater than 10 percent of the total number of blue crabs in such person's possession".

This rule provides a special permit (Appendix II) which allows harvest of smaller crabs for sale to soft crab operations. Labor spent in harvesting and sorting smaller crabs could be rewarded by sale to a blue crab shedding operation. This practice would assure a market value greater than that for the small hard crab which would require additional labor and energy for reharvest at a legal size.

Present soft crab producers are paying about 25 cents per crab for crabs displaying the true pre-molt signs. The producer has no assurance the peelers will molt successfully. If they reach the 'buster' stage but fail to completely emerge, the crab is salvaged as a bait item. But if the peeler survives and successfully molts, the producer receives prime soft crab value.

Recent data indicate Florida soft crabs, non-graded,

were valued at $1.93 per pound in 1977.[6] This 1977 value compares second only to the traditionally high value of Louisiana soft crabs (Table 3). Presently, Florida soft crabs are selling in-state as high as $15.00/dozen (price to the producer). Thus market value and demand does not pose any current restrictions on the development of a soft crab fishery in Florida.

---

[6] Florida Landings. Jan.-Mar., 1977. Current Fisheries Statistics, National Marine Fisheries Service.

SOFT CRAB DEMONSTRATION FACILITY: PRELIMINARY INVESTIGATIONS

To support the development of soft crab fisheries in Florida, a preliminary demonstration project was designed to investigate the basic requirements for producing soft crabs. Specific project objectives emphasized the least expensive shedding methods, the determination of unique 'signs' by which to identify pre-molt/peeler crabs, the source of peelers, and the market potential for soft crabs in Florida. The project concentrated on the essential requirements for production, rather than total productivity.

MATERIAL AND METHODS

The project site was located in the upper reaches of the St. Johns River in Putnam county, Florida. Crabs were harvested from waters just south of the major bridge running to Palatka, Florida. Shedding facilities were located at the mouth of Fish Creek which is on the north shore of the St. Johns River in the sharp west-to-east river bend directly north of Palatka (Figure 6). Site selection was determined by the availability of crabs and fishermen interested in a soft crab venture.

The shedding operation was conducted under actual field conditions. A local fisherman, with previous experience from typical Chesapeake Bay soft crab shedding operations, was contracted to operate the shedding facility under the guidance of the project investigators. The shedding facilities consisted of four inexpensive, traditionally designed floating boxes anchored in a row perpendicular to the shore line (Figure 7). Three boxes were used for temporary storage and sorting of crabs. The fourth box, nearest to shore, was designated the 'buster pen' used for holding rank peelers or crabs showing signs which indicated a probable molting within 1 to 3 days. All boxes were examined and periodically cleaned while working from a platform specifically built to float over the row of boxes (Figure 8).

Each box was constructed from inexpensive pine (Figure 9). Wood and hardware cost about $25-30 per box. Wood slats spaced along all sides and the bottom provided necessary water circulation due to tides and wind. The boxes floated in 2 to 4 feet (0.6-1.2 m) of water depending on tide. Wooden side wings helped to stabilize and buoy the boxes at the correct internal depth of 9 inches (23 cm). A 6 inch (15 cm) 'gunnel' with a 2x4 lip prevented crabs from escaping. Proper buoyancy of newly built boxes was maintained with

Figure 6 Location of the project site and shedding facility (x) on the St. Johns River in Florida.

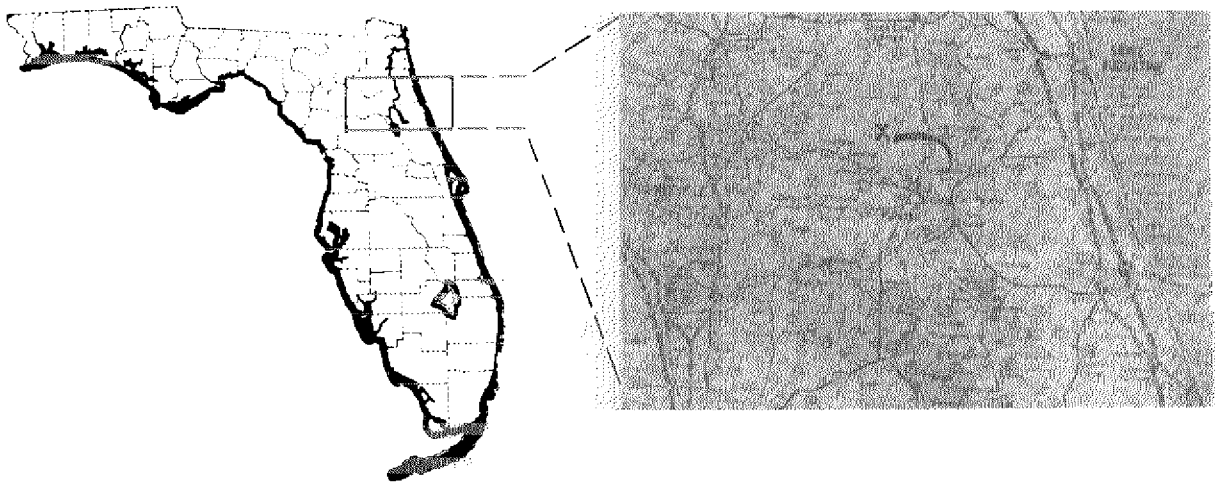


Figure 7 Shedding facility, 4 'floating boxes' anchored in one row perpendicular to the shore.

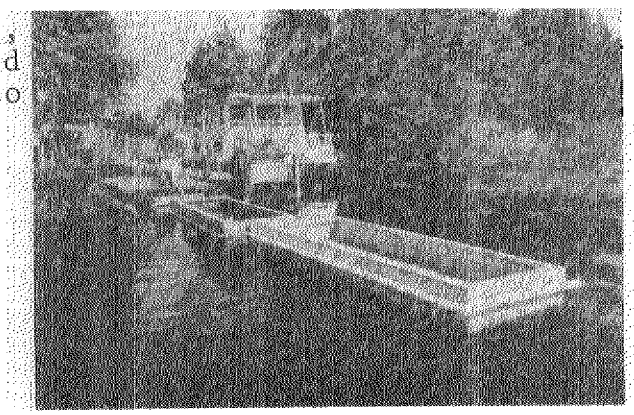
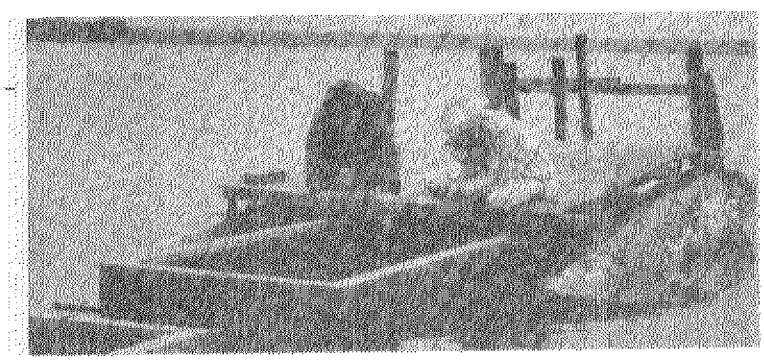


Figure 8 Floating platform built to fit over the 'floating boxes'.



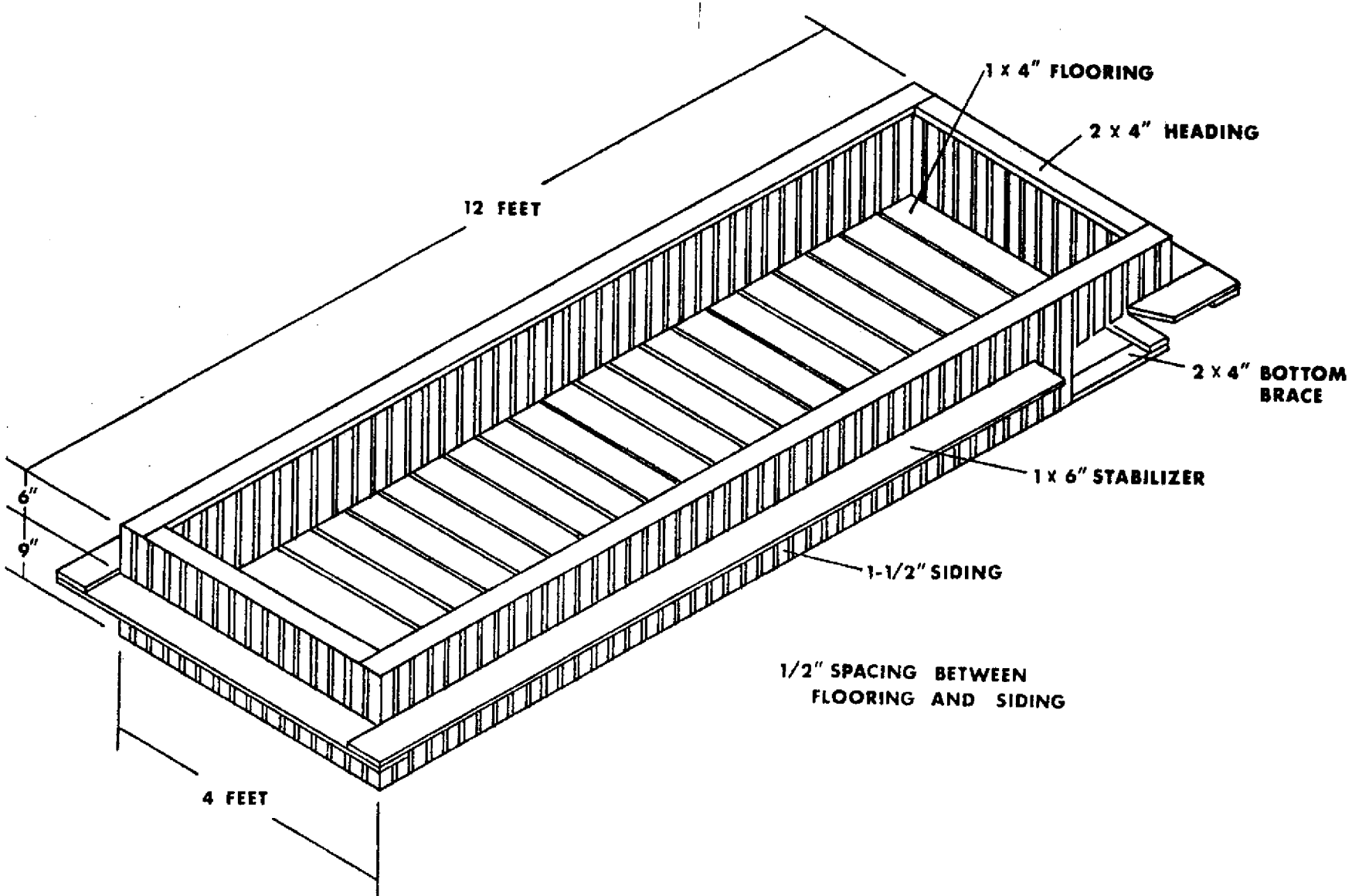


Figure 9. Three dimensional drawing of a floating box used for shedding blue crabs.

cinder blocks placed inside each box. In time, the boxes absorbed water and the blocks were removed. After three months use, the boxes continued to float at the correct depth, but eventually styrofoam would be required on the wings to maintain bouyancy.

After three weeks of building and making arrangements to collect crabs from a local crabber, actual harvest and shedding began in the final week of October, 1978. Crabs were fished from traps in the morning, then immediately returned to the facility for sorting for pre-molt crabs. Likely candidates were placed in the storage boxes prior to resorting 'rank peelers' to the 'buster pen'. The remaining harvest was sold to normal hard crab markets. Crabs held in the storage boxes were fed gizzard shad, Dorosoma cepedianum which were caught as by-catch in the fisherman's gill nets.

The fishermen/operators were instructed to record data pertinent to the shedding operation, i.e., daily water temperature, unusual fluctuations in tides, winds, or rainfall or any unique observations during the shedding process. Arrangements were made with the St. Johns Water Management District to assist in collecting pertinent data. At two week intervals SJWMD personnel measured water temperature, salinity, dissolved oxygen, and pH about the shedding facility.

Soft crabs produced in the facility were individually wrapped in clear plastic sandwich bags and frozen prior to selling. The soft crabs were sold directly to local restaurants. No middleman service was required.

RESULTS AND DISCUSSION

Actual shedding time during the project was from late October through early December 1978. This period represents the least productive season for hard crabs harvested from the St. Johns River (Tagatz, 1965), and was the apparent seasonal limit for natural production of soft crabs. During the six week period only 10 dozen soft crabs were produced, but many unexpected and useful results were recorded. The project essentially ended on December 9 when a cold front caused a sudden drop in water temperature.

Water Parameters

Water temperature was the dominant parameter influencing the shedding operation. Until the December cold front, crabs continued to shed in water above 68°F (20°C), but shedding decreased when the temperature dropped to 62°F (17°C) (Figure 10). At the lower temperatures the crabs remained active and continued to

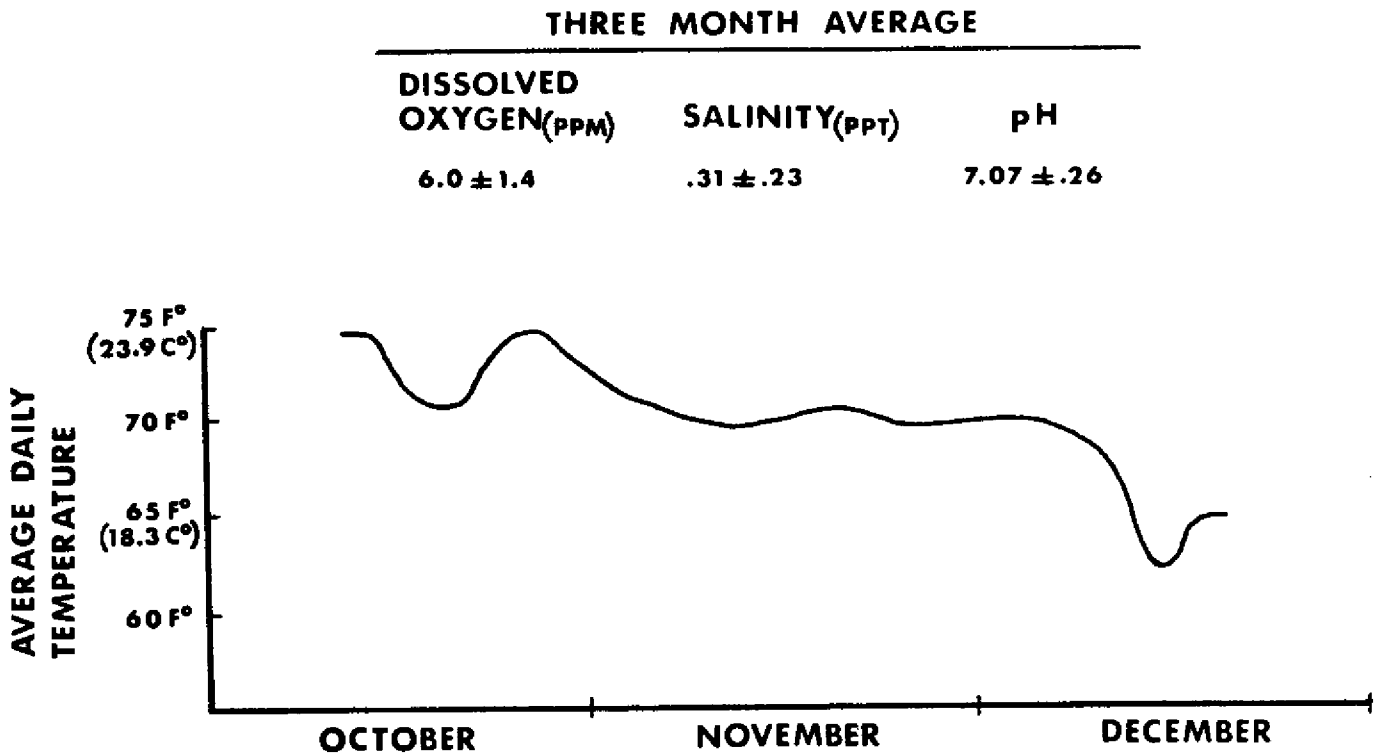


Figure 10. Water parameters (oxygen, salinity, pH and temperature) recorded during the preliminary soft crab operations on the St. Johns River in Florida, 1978.

feed, but molted less frequently. Approximately one soft crab shed every two days during the last three weeks of December when water temperatures ranged from 62-64°F (17-17.8°C). Similarly, Tagatz (1968), who studied molting frequency of blue crabs near Green Cove Springs, Florida, on the St. Johns River, reported longer molting intervals in winter (Dec.-Feb.) than in summer (Mar.-Nov.). He did observe molting at 39°F (3.8°C). Elsewhere in Florida (Punta Gorda), Young (1955) reported blue crabs stop shedding at 68.9°F (20.5°C). Previous lower thermal limits for shedding were thought to be below 60°F (15.5°C) (Churchill, 1919). In the Chesapeake Bay, 72-86°F (22-30°C) is considered the optimum temperatures for blue crab shedding, and although crabs survive and appear active at 68°F (20°C), this is the lower limit for practical shedding operations (Jachowski, 1969; Haefner and Garten, 1974). Most of these previous investigators were primarily concerned with the effect of high water temperatures which depress the survival of the crabs. In colder waters the oxygen concentration is usually not a critical factor, but despite survival, crab molting is obviously depressed below 68°F (20°C).

Dissolved oxygen, pH, and salinity of the water was relatively consistent for the duration of the project and posed no obvious effect on shedding (Figure 10). The oxygen concentration never ranged near the reported critical level, 2.5 parts per million (ppm) (Haefner and Garten, 1974), and the water pH averaged slightly above neutral, within the range of typical brackish water culture systems. Water at the shedding facility and the area of harvest was fresh (less than 1 part per thousand salinity).

Pure freshwater shedding of blue crabs is not common. Most shedding operations are located in brackish water regions (Haefner and Garten, 1974; and Jachowski, 1969). The unique water chemistry (Calcium chloride and Sodium chloride concentrations) in the upper St. Johns River support a variety of marine life (Odum, 1953). The chemical requirements for the molting process are not well understood, but the chemistry of the fresh water in the St. Johns River obviously supports the molting process and a viable, growing blue crab population. The most important fact was that the crabs were shed in the same salinity water as in the harvest area. Large fluctuation in salinity, due to relocating or excessive rainfall, can be detrimental to crab molting and survival.

Pre-molt Signs

The most startling result from this study was difficulty in identifying the traditional color signs indicating the pre-molt condition. Blue crabs harvested from the fresh-

water regions of the St. Johns River did not display discernible 'pink' and/or 'red' signs in the paddle fin (Figure 11) and leg joints which indicate the pre-molt condition. A combination of subtle 'indicators' had to be determined to identify the pre-molt condition.

Certain 'lines' on the hard shell of the crabs became more obvious as the crab reached the pre-molt condition. The epimeral line or hinge line was more prominent in peelers (Figure 12). This line would crack open and act as an opening for the carapace during the buster stage or everging of the new soft crab. Similarly, more prominent lines occurred on the inner segment (merus) of the claw (Figure 13). These claw lines would crack open to form a 'trap-door' to allow the larger, outer segment (propodus) of the new soft claw to be extracted from the old hard shell without becoming lodged in the hard merus.

Discoloration of the abdomen was the only color sign of pre-molting. Pre-molt male crabs had a pale yellowish cast along the segments on the abdomen, and female crabs had a purplish-pink coloring on the triangular apron (Figure 14). Discoloration on the male crab was best observed when comparing the abdomen of a soft crab with the respective empty hard shell. The discoloration on the immature females was more distinct, thus females were easier to detect in the pre-molt condition[7].

Additional pre-molt signs could be felt. The paddle fin would feel soft and filled with fluid (Figure 11), the dorsal surface below the lateral spines would soften, and the crab weight per body size felt heavy (fat crab).

A combination of these various pre-molt signs had to be used to sort for peelers. These signs were less reliable than the traditional color signs on the backfin, and required excessive handling of the crabs. Identification of the pre-molt/peeler crabs improved with practice.

Mortality

Less than 10 percent of the hard crabs died while in the shedding facility. The major cause of death was injuries which occurred during harvest of the crabs with wire crab traps, and during sorting for pre-molt

---

[7]Note: No mature females with semicircular shaped aprons were shed during this project. Shedding from the immature female to the mature female is considered the terminal molt.

Figure 11 Paddle fin of a blue crab displaying all signs of a 'rank peeler', except no 'red' sign evident.

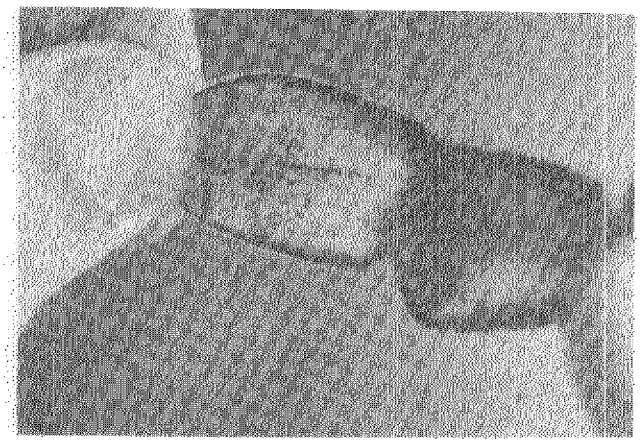


Figure 12 Epimeral line on a blue crab prior to shedding.

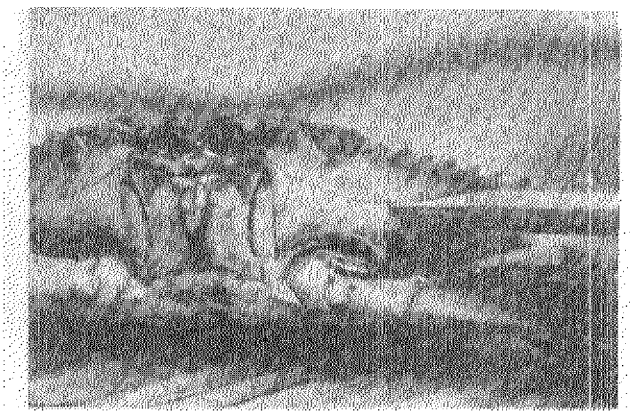
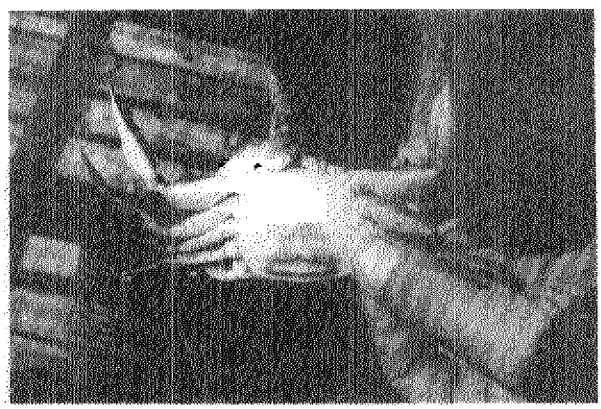
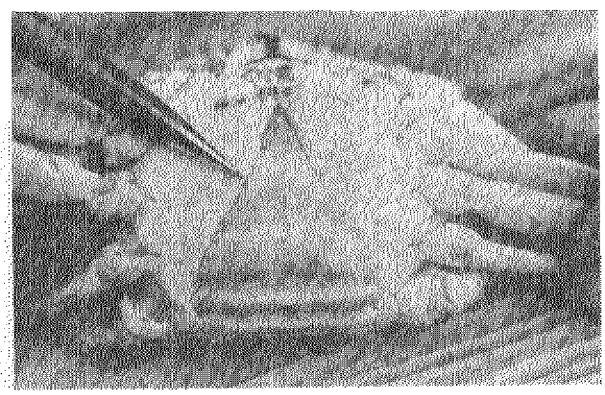


Figure 13 'Claw lines' on the merus segment of a blue crab claw. The 'line' has broken open in preparation for extraction of the larger outer segment, propodus, of the claw.

Figure 14 Two views of the typical pinkish-purple discoloration displayed on the triangular apron of immature female crabs in the pre-molt stage.





crabs at the facility. Injured crabs, with legs missing and/or cracked shells, would die within 24 to 48 hours or fall victim to cannibalism. Cannibalism was not a major problem. Frequent feedings with gizzard shad seem to satisfy appetites. Dividers were constructed in the 'buster pen' to provide protection for individual crab beginning to bust. (Figure 15) Occasionally a 'green' or non-peeler crab was placed in the 'buster pen' by mistake due to misread signs. This crab could travel among the divided compartments and eat the emerging soft crab. A top installed over the 'buster pen' would have prevented this activity. Tops should have been built over all the boxes to provide shade from the sun and outside activities, and prevent predation by birds. Two soft crabs were eaten by the same common egret who realized the value of the operation.

Production

Average size of the soft crabs produced was greater than 5 inches in width and 4.5 ounces (Table 6). This grade of soft crab fits the top dollar grade currently used in the traditional Chesapeake Bay market (Table 1). The average weight is equivalent to 3.4 pounds per dozen which is almost 1 pound greater than the conversion factor (2.5 pounds per dozen) used by fisheries statisticians to relate commercial market scales to reported poundage. Thus the St. Johns soft crabs represent a quality product.

About 67 percent of the hard shell crabs used in the facility were females, and 65 percent of the soft crabs produced were females. Thus sex did not influence the shedding process, except in total production. More small females were available because of their abundance in the freshwater region (Tagatz, 1965), and the larger crabs, mostly males wider than the legal 5 inch size limit, were sold to normal hard crab markets. The average size of all hard crabs used in the shedding facility was 4.6 inches in width and 3.0 ounces (Table 6). Thus the harvesting operation exemplified the fishing practice which is permissible by Florida State law and provides combined income to the crabber.

Size expansion of the soft crabs was dramatic (Figure 16). Average width increased approximately 20 percent and total body weight increased greater than 50 percent (Table 6). Soft crabs remained in water about a half hour after molting, and were frozen before weighing. Percent weight increase was determined with reference to the average weight of subsamples from the hard crabs. The resulting increases were not as large as previously recorded. Studies by Haefner and Garten (1974) in the Chesapeake Bay and Tagatz (1968) using St. Johns

Figure 15 Two views of the wooden dividers built in the 'buster pen' to separate and protect emerging soft crabs.

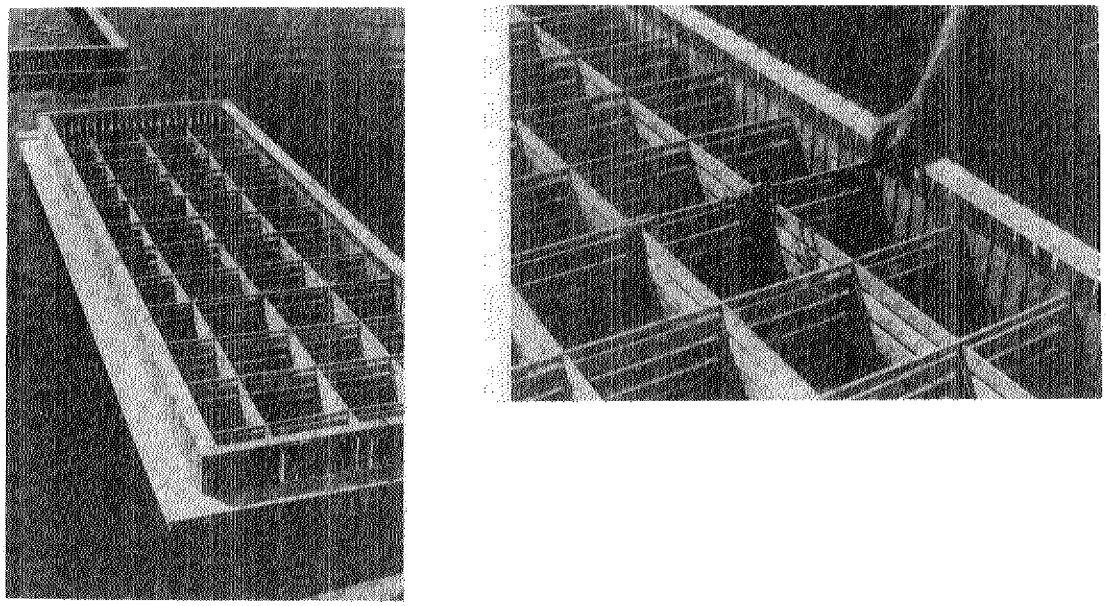


Figure 16 A soft crab (upper) shed from the remaining hard shell (lower).

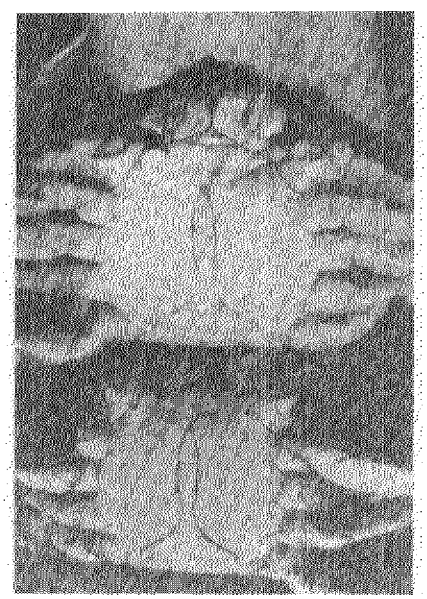


Table 6. Average production data from the soft crab demonstration facility located near Palatka, Florida on the St. Johns River during Oct.-Dec., 1978.

Size[a]	Hard Crabs[b]	Soft Crabs[c]	% Size Increased[d]
width			
inches	4.6	5.4	
centimeters	(11.7 ± 1.7)	(13.8 ± 2.3)	19.5 ± 7.9
length			
inches	2.0	2.4	
centimeters	(5.1 ± 0.7)	(5.0 ± 0.8)	17.9 ± 5.7
weight			
ounces	3.0	4.5	
grams	85.1 ± 22.0	(128.8 ± 53.2)	50.9 ± 19.6

a. All measurements are presented as averages plus or minus one standard deviation about the mean using N-1 weighting.

b. Hard Crabs - refers to random subsamples (n=30) taken from the hard crab/peeler harvest. These crab samples represent the harvest and may or may not have shed.

c. Soft Crab - refers to random subsamples (n=45) taken from the soft crabs produced.

d. Percent increase in width and length was calculated in reference to the original hard shell dimensions, but percent increase in weight was calculated in reference to the average weights from subsamples b&c.

River blue crabs agree that soft crab increase approximately 25 percent in width. Winget et al (1973), shedding Delaware blue crabs in a closed-system at 25°C and 25 ppt, report an average 19.3 percent increase in width and 104 percent in weight. Newcombe et al (1948) estimated weight increases as high as 70 percent after molting. These latter studies did not indicate the method used to determine percent increased weight.

The width to weight relationship for soft crabs was

$$\text{width (cm)} = [19.39 \times \text{weight (gm)}] - 155.64$$

for the random subsample (n=45) of soft crabs produced during this project. The largest soft crab produced was a male, 8.2 inches (20.8 cm) wide and weighed 10.8 ounces (306 gm). This large size converts to 8.1 pounds per dozen. The smallest hard crab to successfully shed was a female 3.0 inches (7.6 cm) wide which yielded a 3.8 inches (9.6 cm) and 1.4 ounces (40 gm) soft crab. This small size converts to 1.1 pounds per dozen.

Market Value

All the soft crabs produced were cleaned (removed eyes, mouth parts, gills, and aprons), packaged in plastic sandwich bags, and frozen. Two dozen 'whales' ($\geq$ 6 1/2 inch width) and two dozen 'hotels' ($\geq$ 5 1/2 width) were sold directly to a local Florida seafood restaurant. The grading scale was larger than traditionally used in Maryland (Table 1). The 'whales' and 'hotels' sold for $21.00 and $18.00 per dozen, respectively. In time, more restaurants called to place orders, but the project was not prepared to supply such a demand. Calls came directly from restaurants in and outside Putnam county. Also, two wholesale firms from out of state expressed interest. Marketing of Florida soft crabs should not restrict the development of soft crab fisheries in Florida.

Food Value

The remaining six dozen soft crabs were used in a taste test. Untrained taste panel members were selected from project investigators and fishermen, members of the St. Johns Water Management District, and various county residents which had expressed an interest in the project. Soft crabs were lightly battered with seasoned cornmeal then fried at 350°F in shallow cooking oil. The taste results were not quantified because all participants agreed the soft crabs taste excellent.

ECONOMIC FEASIBILITY ASSESSMENT

At the individual production level the shedding facility can vary in structure and size. The structure can be as small as a one man system harvesting hard crabs for a baseline income and shedding peelers on a small scale for supplemental income, or as large as a separate shedding operation of variable size depending on a number of crabbers supplying peelers. Crabbers harvesting regular crabs would receive supplemental income for sorted peelers, but crabbers 'fishing' with selective methods would be paid as specialists in peeler harvesting. Numerous combinations of commercial crabbing and/or fishing, and shedding are possible. The following guidelines can be used to calculate the cost incurred and income derived for such operations.

The potential for a soft crab operation is examined in two fashions. First, the potential value of the development of a soft crab industry is estimated for Putnam County where the experimental shedding operation was located. County-wide value potentials are demonstrated and tentative observations are made on the value at the individual crabber and at the shedding level. Second, the potential value of the development of a soft crab industry in Florida is estimated.

COUNTY ASSESSMENT

Total Value

The primary type of fishing that occurs in Putnam County is trapping for eels, catfish and blue crabs. Most eels are landed beginning in September and continuing through the winter months until April. Major landings occur October through February. Virtually no landings occur May through August. The monthly value of landings in Putnam County in 1978 was greater than $40,000 in January and February and again in October through December, 1978.(Table7 and Figure 17). Catfish landings follow the same pattern although landings do occur throughout the year with lowest production coming from April through September (Table 7 and Figure17). Catfish is the most valuable fishery in the County. Value of landings was almost $40,000 or greater from January through March and again from October through December, 1978. Summertime value of landings was lowest in July at $25,000.

In contrast to eel and catfish production, blue crab landings are highest in the summer. Limited production occurs year-round but major production occurs April through October. April value of landings was $11,216. Landings and value increased to the August high of $54,748 and then began the decline as winter approached.

Most fishermen participate in all three fisheries during the year with summer income the lowest during blue crabbing. The soft crab fishery has the potential to supplement incomes during the low income summer months. Development of the soft crab fishery is attractive not only because of its market potential but also because is would supplement incomes of small-scale fishermen in a low capital investment fishery during the low income summer months (Table 7 and Figure 17).

Estimates of the maximum annual value of the development and expansion of a soft crab fishery in Putnam County indicate that $74,050 might have been generated in 1978. A total of $19,747 would have been generated in peeler crab sales to a shedding operation and an additional $54,303 in the sales of soft crabs after shedding (Table 8). These estimates are made using current market information due to uncertainties of data reported in published statistics (see footnotes in Table 8). These estimates would provide a substantial increase to the existing value of hard crab landings of $256,669 in 1978.

Table 7. Estimated monthly landed values of eels, catfish and hard blue crabs and potential values from a soft crab fishery in Putnam County, 1978

	Eels[a]	Catfish[b]	Hard blue crabs[c]	Potential peeler crabs[d]	Potential shedder crabs[e]
	Dollars				
January	63,861	73,871	4,312	0	0
February	46,916	52,753	5,826	0	0
March	24,919	62,844	9,137	0	0
April	12,723	32,990	11,216	968	3,628
May	1,636	35,953	16,042	1,384	5,189
June	571	25,374	24,101	2,079	7,296
July	278	25,019	42,915	3,701	13,880
August	1,076	26,922	54,748	4,722	17,708
September	19,332	28,970	27,746	2,393	8,974
October	49,613	39,947	34,342	2,962	11,107
November	55,205	41,473	17,839	1,538	5,768
December	64,334	43,130	8,444	0	0
Total	340,464	489,246	256,668	19,747	74,050

a. Based on average monthly live weight landings from 1974 to 1976 and 85 cents per pound live weight.

b. Based on average monthly live weight landings from 1974 to 1976 with a dressed yield of 50 percent and 75 cents per pound dressed weight.

c. Based on average monthly live weight landings of 1,283,347 pounds from 1974 to 1976 and 20 cents per pound live weight.

d. Based on 2.3 percent of hard crab landings as derived from Table 2(average from major soft crab producing states), three peeler crabs per pound, and 25 cents per peeler crab. Value is zero in four months since water temperature is too low for crabs to effectively shed and since very little crabbing occurs during winter months.

e. Based on 75 percent shedding rate and $15.00 per dozen. Calculation of net return would require deduction of peeler crab cost and operating expenses.

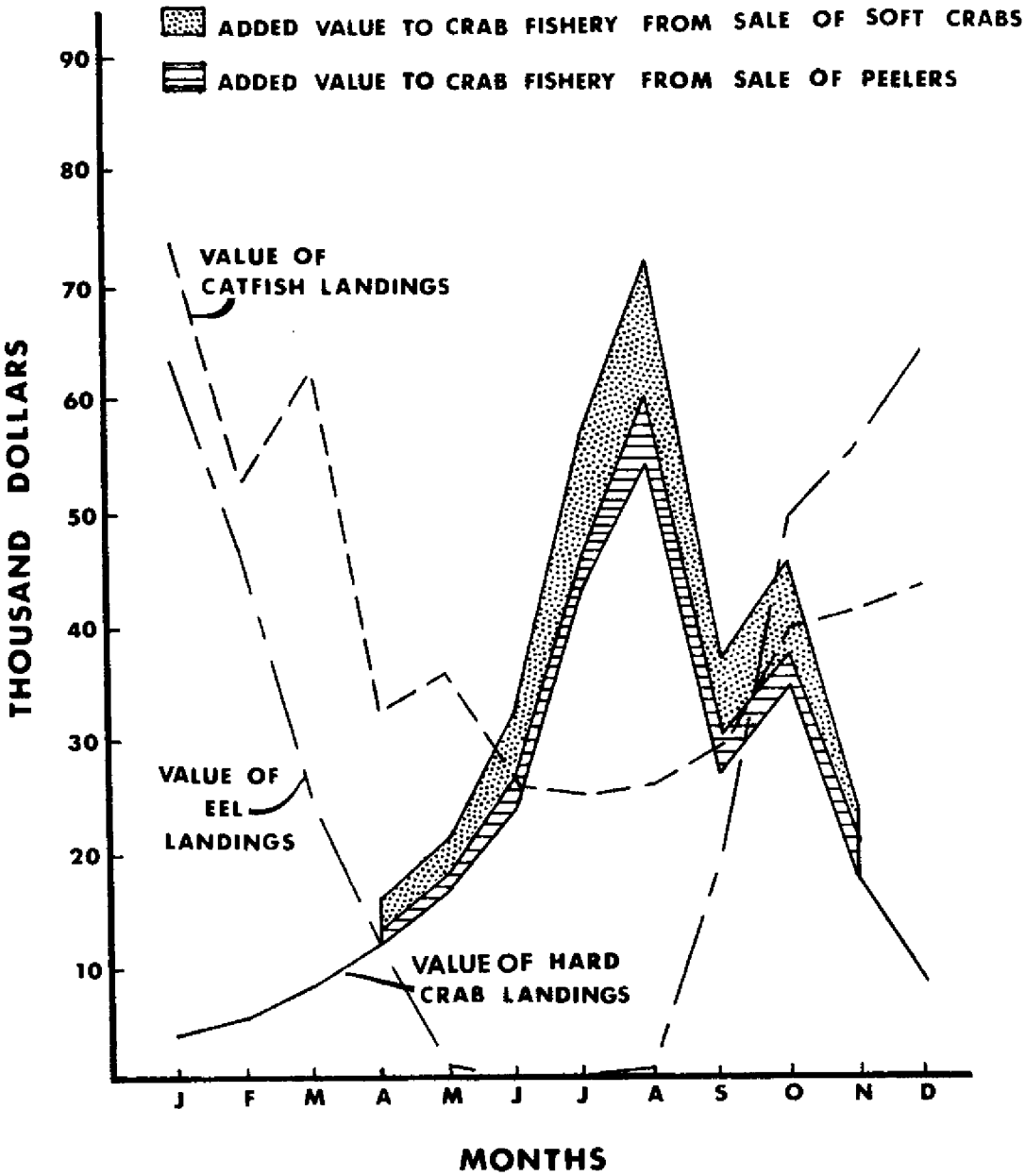


Figure 17 Estimated monthly value of eel, catfish, hard crab landings and potential addition to value of hard crab landings from a soft crab industry in Putnam County, 1978. Potential value of soft crab was determined only from March to November when average daily water temperatures exceed 68°F (20°C) in the St. Johns River near Palatka.

Table 8. Maximum annual potential values of the development and expansion of a soft crab fishery in Putnam County, Florida and in Florida, 1978.

Description	Putnam County		Florida	
	Unit	Dollars	Unit	Dollars
Annual average hard crab landings and value, 1974-1976[a]	1,283,347 pounds	256,669	17,874,000 pounds	3,574,800
Potential soft crab landed production and value by recorded standards[b]	26,329 pounds	50,815	304,215 pounds	587,134
Potential soft crab landed production and value by current market standards[c]	78,987 crabs	19,747	912,645 crabs	228,161
Potential value of crabs sold after shedding[d]	4,937 dozen	74,050	57,040	885,604
Potential gross income from shedding operation after buying peeler crabs[e]	—	54,303	—	657,443

a. Based on Florida Landings, 1974-1976 and current weighted value across all sizes of crabs of 20 cents per pound.

b. Based on 2.3 percent of hard crab landings as derived from Table 2(average from major soft crab producing states) and recorded (1976) commercial value of soft crabs in Florida at $1.93 per pound as derived from Florida Landings, only including production from April through November (Figure17). This value of $1.93 per pound is probably a weighted price and includes some crabs sold to small shedding operations and some crabs sold as soft crab. This diversion from the hard shell landings would be minimal.

c. Based on three peeler crabs per pound and 25 cents per peeler for production from April through November.

d. Based on shedding success rate of 75 percent and current selling price of $15.00 per dozen.

e. Includes deductions for no other costs.

FLORIDA ASSESSMENT

A similar analysis on a state wide basis indicates that the maximum annual value generated by the development and expansion of a soft crab fishery in 1978 would have been $885,604 (Table 8). A total of $228,161 would have been generated in peeler crab sales to a shedding operation and an additional $657,443 from the sales of soft crabs after shedding. This would add considerably to the estimated value of hard crab landings in Florida of $ 3,574,800 in 1978, and would be considered a major expansion in a small scale fishery. This analysis also assumes that this additional volume on the soft crab market would not depress existing prices.

INDIVIDUAL VALUE

Most full-time crabbers in Putnam County use between 100 and 300 traps and, depending on fishing location, catch an estimated 12,000 to 25,000 pounds per year (Martin Dunsen, St. Johns Crab Co., personal communication). Based on these catch rates, the selling of peeler crabs to a shedder would result annually in $207 at the low catch rate and $431 at the high catch rate to an individual crabber (Table 9). These crabs should then result in final sales value after shedding of $780 and $1,620 at the low and high catch rates, respectively (Table 9). At these catch rates, a crabber who also performed the shedding operation would realize an annual basis $780 and $1,620, respectively, while a shedder would realize $573 and $1,189 from crabs bought from each crabber (Table 9).

This leads to two conclusions. Individual crabbers who learn to select peelers and shed soft crabs could generate a good supplemental income of 33 percent over their current value for hard crabs. A shedding operation would have to buy peelers from a number of crabbers to be economically feasible. These income data do not include any costs of running the shedding operation other than the value of the peeler crabs. Virtually no additional costs would be incurred by the crabber in keeping the peeler crabs.

An individual crabber who kept and sold peeler crabs as a supplement to fishing for hard crabs would need no additional equipment (Table 9). A crabber who decided to selectively harvest peeler crabs or shed those peelers caught during hard crabbing would have to use one or more kinds of techniques: peeler pound, trotline, scrape towing, jimmy potting, bush line, push scrape. Some of these would require additional equipment (Table 9). A shedding operation would be done by the floating box, open system or closed system method. This would require some equipment unique to each method plus supplies common to all methods (Table 9).

A complete analysis of the capital and operating costs of the various crabbing and shedding techniques should be made in any further research. This would allow the construction of partial cost and return budgets on the soft crabbing operations and complete budgets on the shedding systems and make available exact estimates on the economic feasibility of each method.

Table 9. Annual added income projections for Putnam County crabber from a soft crab operation.

Type of Crab Operation	Low Catch Rate		High Catch Rate		Equipment Needs & Description
	Unit	Dollars[a]	Unit	Dollars[a]	
Hard crabs	12,000 pounds	2,400	25,000 pounds	5,000	Engine - 35 H.P. engine Boat - 5 ft. boat Traps - wire traps, bait
Peeler crabs[b]	276 pounds or 828 crabs at 25 cents each	207	575 pounds or 1725 crabs at 25 cents each	431	Peeler pound - wire crab pound Trotline - line and minor rigging; bait Scrape- scrape and special rigging Jimele pot - large male crab for bait, traps Bush line - rope, bushes and poles
Shedding[c]	828 peelers at 75% shedding rate (52 dozen) at $ 15.00 per dozen	780	1725 peelers at 75% shedding rate (108 dozen) at $15.00 per dozen	1,620	Floating boxes - wooden frame floating boxes Open system - 'Tables', pumps, and plumbing Closed system - same as open plus biological filter system (Common supplies: refrigeration and/or freezer packaging boxes and wrap, crab food)
Income					
Crabber selling peelers		207		431	
Crabber keeping peelers and shedding		780		1,620	
Shedder buying and shedding		573		1,189	

a. Sold or transferred to shedding operation: the value would be highly dependent on quality. A high quality crab has all legs present and is showing good signs of pre-molt. Rank peelers would be worth 25 to 35 cents and peelers or near peelers, 15 to 25 cents. Capital equipment needs are for selective harvest of peeler crabs.

b. No costs of operation or expenses are shown. These income figures reflect gross revenue, not net revenue.

c. Value is dependent on size and season. Non-graded, seasonal price range in Florida is estimated at $12.00 to $18.00 per dozen or $1.00 to $1.50 per crab. Also assumes waterfront location and onshore housing (at least a roof) is available.

SUMMARY

The soft crab industry originated during the late 1800's in the Chesapeake Bay region and slowly spread to neighboring states. Today only six states (New Jersey, Delaware, Maryland, Virginia, North Carolina, and Louisiana) record a substantial soft crab production, and the Chesapeake Bay remains the dominant production area. Since 1970 the average annual production of soft crabs in the United States exceeds 2.6 million pounds. This productivity is 38 percent lower than recorded for the previous decades of the 1950's and 1960's. But the price for soft crabs continues to increase. This is probably the combined result of increases in demand and a long term decline in the supply of soft crabs. Thus participants in the 1977 meeting of the National Blue Crab Industry Workshop, called for an expansion of soft crab productivity in regions which show potential and are presently underutilized.

Production methods for soft crabs have evolved through a series of open culture systems which house the crabs during their natural molting process. Thus soft crab production has always depended on a source of pre-molting crabs or peelers which require less residence time in the culture system. Prolonged residence in the system would be more labor demanding and expensive. Currently new closed culture systems designed to control water quality are being developed. Theoretically these systems could use 'green' crabs (non-peelers) but they presently remain dependent on a source of true peelers. Todays successful soft-crab shedding operations are designed to minimize the work and expense of this labor intensive 'art'.

In Florida, present soft crab production is almost non-existent. Previous in-state production, although inconsistent and scattered, indicates production potential. If 2.3 percent of the current Florida hard crab landings between March and November could be converted into soft crab production, the potential value to Florida crabbers selling peelers would be greater than a quarter million dollars per year. Shedding operations would expand employment and increase Florida's blue crab landed value greater than $885,000 per year. In Putnam County alone, shedding operations could be valued at $74,000 per year. This value would be a substantial boost to the County's relatively low commercial fisheries value (Mathis et.al., 1978). Present market conditions and state fisheries regulations actually encourage development of a soft crab fishery in Florida

The preliminary demonstration project has investigated the basic requirements for soft crab shedding in the upper reaches of the St. Johns River. During the fall, 1978 this project successfully shed blue crabs in basic, traditional floating boxes anchored in freshwater. Production was dependent on a supply of peeler crabs. New signs for identification of the pre-molt condition or peelers had to be developed because the common color signs on the paddle fin were less evident. Soft crab productivity was seasonally low, but the soft crabs averaged as large as the highest quality crabs graded in the traditional Chesapeake Bay markets. These crabs were sold, in state, at a value per dozen which was greater than or equal to the highest soft crab value typical of the Louisiana markets. Thus the basic methods of soft crab production could be used in Florida to produce top quality, high value soft crabs.

There appears excellent potential for development and expansion of soft crab fisheries in Florida. Market conditions and state fisheries regulations should promote development, but educational assistance is needed to transfer and interpret existing technology from other productive areas to Florida.

RECOMMENDATIONS

Based on this project, several recommendations can be offered that should enable the development of a soft crab industry in Florida. These are delineated into short term and long term recommendations.

Short Term : Extension Activities

Educational and Extension assistance for development of soft crab fisheries in various regions of Florida.

A. Series of state wide workshops to explain and discuss existing technology and needs to suit Florida soft crab production is recommended. They would include a short seminar, slides (and possible film), and handouts:
   Slides - to show typical successful operations in productive states
   - to show actual signs to identify peelers
   - to show economic considerations
   Film - to show actual shedding process from peeler, through buster, to hard crab
   Handout- to explain shedding terminology and methodology
   - to provide blue prints for building floating boxes and tables with piping
   - to provide economic assessment guidelines

B. Follow-up field work for actual 'on-hands' experience with shedding. Scale of operation would depend on commercial participants interest, area, and potential. Extension activities should encourage small scale, preliminary methods for novice, and large scale, advanced methods after preliminary experience.

   Small scale, preliminary - Floating boxes, primary considerations should be identification of 'signs' indicating peelers, and identifying a reliable source and methods of harvest for peelers.

   Large scale, advanced - shedding tables enclosed on-shore and supplied with water pumped from adjacent available water source. Concentrate experience on large volume production.

Long Term: Research

Research to determine potential of advanced, new methods of soft crab production in Florida.

A. Investigate potential for shedding blue crabs in

thermal effluents from power plants.

B. Development of floating boxes and shedding tables in combined systems which use peelers and/or could use 'green' crabs.

C. Development of closed culture systems which use peelers and/or 'green' crabs. Closed systems designed for controlled production and year around production.

D. Basic research to determine methods to control the shedding process so as to decrease the amount of labor required, i.e., slow the shell hardening process thereby permitting longer time in water after shedding, examine shedding frequency versus moon phase, daylight, etc...

E. Basic research to determine methods to promote shedding, i.e. removal of molt inhibitory hormones, use of specific pheromones, control of temperature and light exposure, etc...

Appendix I

Common terminology of the soft-crab industry

Apron - flexible abdomenal section which folds under the crab body; the crab 'tail'.

Backfin - "swimmer" or "paddle fin"; last 'leg' of crab which is flattened for locomotion; reveals color 'signs' of pre-molting.

Bare potting - empty pot; regular crab pot with no bait; catches peelers seeking protection.

Buck and rider - doublers; mating hard crabs.

Buckram - post-molted crab in semi-hard shell condition; shell is brittle and unmarketable as soft-crab.

Buffalo crab - doorknob; soft-crab missing legs or claws.

Buster - first stage of molting; crab beginning to back out of old shell.

Carapace - greenish-blue to brown top shell of the blue crab.

Cars - floating 'boxes' used to hold peelers during shedding

Channeler - large male crabs, jimmies, found in deep channels of the bay, sound, or river.

Dead Man's Fingers - crab gills or 'lungs' found just below the carapace.

Doorknob - buffalo; soft crab missing legs or claws.

Doubler - pair of crabs in mating position, male carries female; buck and rider.

Ecdysis - (ek-di-sis) scientific term for crustacean molting process.

Epimeral line - ridged line running along the 'face' of the crab; below the carapace and on each side of the mouth; acts as a 'hinge' during molting.

Fat crab - full crab; muscle tissue completely fills shell; crab is at maximum weight for existing shell size.

Floats - 'cars'; floating 'boxes' designed to hold peelers during shedding.

Green crab - crab between molts; non-peeler crab; also un-cooked crab.

Hair sign - 'white' sign crab.

Hard crab - crab with hard shell.

Hotels - market size (4-4 1/2 inch width).

Jimmies - larger male blue crabs; jimmie dick or jimmie channeler are largest.

Jimmie potting - jimmies are placed in a crab trap as live bait to attract females looking for a mate.

Jumbos - market size (5-5 1/2 inch width) for soft-crabs.

Lump - large lump of muscle tissue associated with backfin; the selective grade of crab meat.

Lungs - crab gills; dead man's finger below carapace.

Mediums - smallest market size (3 1/2 - 4 inch width) for soft crabs.

Molting - ecdysis; process of shedding old hard shell.

Money - soft-crabs; motivation for soft-crab producers.

Nail polish - red color on claw tips of female blue crabs.

Nicking - breaking the movable 'finger' of the crab claws to prevent cannibalism and damage.

Pan-ready - soft crabs packaged for sale with eyes, mouth parts and gills removed; larger crabs may have soft carapace removed.

Paper-shell - unfavorable leathery condition of the shell on soft-crab beginning to harden.

Peeler - hard crab in pre-molt condition, ideal for shedding operations.

Peeler pound - wire pound net used specifically to harvest peelers in Chesapeake Bay.

Pink sign - pink line of new forming shell visible through the old shell on the backfin about one week from molting.

Prime - market size (4 1/2 - 5 inch width) for soft-crabs.

Rank - peeler crab with true 'red' sign; only a few hours from molting.

Red sign - red line of the new forming shell visible through the old shell on the backfin about 1-3 days before molting.

Rust marks - dark, abrasive marks on the 'chest' or abdomen of fat crabs unable to continually suspend their heavy body; indicators of fat crabs.

Sally crab - she-crab, immature female with triangular apron.

Scrape - small (1 1/2 x 4 foot) bar-type trawl specifically designed for harvesting peelers from grass beds.

Seconds - Pink sink crabs.

She-crab - immature female with triangular apron.

Shedding - process of molting, ecdysis; commonly used to refer to the commercial process.

Shed - empty old hard shell remaining after molting.

Snot crab - 'white' sign crab; snot refers to fluid released from wounds or 'nicks'.

Soft-crab - money; molted blue crab after approximately one hour remaining in water to obtain proper 'soft' texture.

Sook - mature female crab with semicircular shaped apron.

Sponge - female crab carry a large egg mass lodged below the apron; busted sook, orange crab, punk, berried.

Tables - on-shore shedding facilities built to hold peelers in a shallow flow of pumped water.

Terminal molt - last molt for a blue crab; female crab can only mate during the terminal molt; when the female apron shape changes from triangular to half moon.

Trap door - section on the top of the upper segment (merus) of the claws which opens to allow the larger, lower claw section (propodus) to be extracted during molting.

Water gall - windjammer, white crab; hard crab immediately

after molting; muscle tissue does not completely fill shell space; crab is light for the shell size.

Whales - slabs; market size ($\geq$ 5 1/2 inch width) for soft crabs.

White sign - white line of new forming shell visible through the old shell on the backfin about two weeks before molting.

Width - crab size; measured distance between tips of longest lateral spines.

Appendix II: Special application for permit to trap blue crabs in Florida. Note the special provision for harvesting small crabs (less than 5 inches wide) for soft crab operations.

FLORIDA DEPARTMENT OF NATURAL RESOURCES
202 BLOUNT STREET
CROWN BUILDING
TALLAHASSEE, FLORIDA 32301

APPLICATION FOR PERMIT TO TRAP BLUE CRABS

I hereby make application for permit as indicated herein and do declare the following to be true and correct.

NAME AND ADDRESS

This space for address correction or use if label is missing.

PLEASE PRINT YOUR NAME

ADDRESS

CITY OR TOWN

STATE ZIP CODE

COUNTY

Blue crab trap permit number last year:
V_____

Maximum number of traps fished:

Do you fish full-time for blue crabs? That is, is this your only occupation?

YES ☐ NO ☐

Telephone Number:

(Area Code) (Number)

Boat Registration or Documentation number:
FL_____ DO_____

Colors on buoys and boat:

In whose name is boat registered?

Address

Counties where products are landed:

Do you sell small blue crabs (less than 5 inches wide) as:

Bait ☐

Soft Shell Crabs ☐

Neither ☐

I have read the appropriate laws accompanying this form, and understand that a violation of any regulations concerning blue crab trapping may be cause for revocation of the blue crab trapping permit, and that I am to have my permit whenever I am engaged in blue crab trapping.

Signature of Applicant Date

DNR 105 (16)
(Rev. 4/20/79

Bibliography

Anonymous. 1979. Succeed in shedding soft shells in closed commercial holding system. Gulf Coast Research Laboratory, Ocean Springs, Mississippi, Marine Briefs 8(4) p.1-2

Bishop, J. 1979. South Carolina's Soft Shell Crab Program. Presented at 30th Annual Meeting Gulf State Marine Fisheries Commission, Blue Crab Colloquium, Biloxi, Mississippi, October 19 (Proceedings to be published).

Churchill, E.P., Jr. 1919. Life history of the blue crab. Bull. U.S. Bur. Fish. 36: 91-128.

Epifanio, C.E., G. Pruder, M. Hartman, and R. Srna. 1973. An interdisciplinary study on the feasibility of recirculation systems in mariculture. Proc. 4th Annual Workshop World Mariculture Society, Monterey, Mexico. p. 37-52.

Gillies, M.T. 1975. Chemical treatment for porducing soft-shelled crabs. In "Fish and Shellfish Processing", Ed. M.T. Gillies. p. 216-219. Noyes Data Corp. Park Ridge, New Jersey.

Haefner, P.A., Jr. and D. Garter. 1974. Methods of handling and shedding blue crabs, Callinectes sapidus. Virginia Inst. Marine Sci. Marine Resources Advisory Series No. 8, 14p.

Jachowski, R.L. 1969. Observations on blue crabs in shedding tanks during 1968. Natural Resources Inst., Univ. Maryland, Seafood Processing Lab. Crisfield, MD Reference No. 69-24, 15p.

Knowles, F.G.W. and Carlisle, D.B. 1956. Endocrine control in the Crustacea. Biol. Rev. 31(4) 396-473.

Lee, C.F. and F.B. Sanford. 1962. Soft-crab fishery. Commercial Fish. Review 24 (1) 10-12.

Mathis, K., J.C. Cato, R.L. Degner, P.D. Landrum, and F.J. Prochaska. 1978. Commercial fishing activity and facility needs in Florida: Clay, Putnam and St. Johns Counties. Florida Agricultural Market Research Center, Industry Rept. No. 78-3, 26p.

Newcombe, C.L., A.M. Eckstein and F. Campbell. 1949. Southern Fisherman. Annual 9: 153-158, and 371-373.

Odum, H.T. 1953. Factors controlling marine invasion into Florida fresh waters. Bull. Mar. Sci. Gulf Caribbean. 3: 134-156.

Overstreet, R.M. and D.W. Cook. 1972. Soft shelled crabbing. The American Fish Farmer. August, 8: 12-17.

Rhodes, R.J. and W.A. Von Engle. 1978. Report of the National Blue Crab Industry Workshop. South Carolina Marine Resources Center, Special Report No. 185, 75p.

Tagatz, M.E. 1965. The fishery for blue crabs in the St. Johns River, Florida, with special reference to fluctuations in yeild between 1961 and 1962. U.S. Dept. Interior, Spec, Sci. Report - Fish. No. 501, 11p.

Tagatz, M.W. 1968. Growth of juvenile blue crabs, Callinectes sapidus Rathbun, in the St. Johns River. Florida. Fishery Bull. 67(2) 281-288.

Van Engle, W.A. 1958. The blue crab and its fishery in Chesapeake Bay. Commercial Fisheries Review. 20(6) 6-17.

Warner, W.W. 1976. Beautiful Swimmers - Watermen, Crabs and the Chesapeake Bay. Penguin Books, NY,NY, 304 p.

Winget, R.R., D. Maurer, and L. Anderson. 1973. The feasibility of closed system mariculture: Preliminary experiments with crab molting. Proc. Natl. Shellfish. Assoc. 63: 88-92.

Young, R.H. 1955. How to set up a soft shell crab plant in Florida. Univ. Miami Special Service Bull. No. 11, 5p.

ACKNOWLEDGEMENT

The authors wish to express their sincere appreciation for the assistance provided during this project. A special thanks goes to Mr. and Mr. David Fleming and Mr. Junior Scranton for their assistance in harvesting and shedding crabs, and general operation of the shedding facility. We thank the St. Johns Water Management District personnel, and specifically John Martin and Rick Keller for their assistance in monitoring water parameters. Also the assistance of marine agent, Mike Oesterling is greatly appreciated for his advice and knowledge of blue crabs.