Soft Crab Fisheries: Potential for Caribbean Development

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ABSTRACT

Nine species of crabs in the genus *Callinectes* are distributed throughout the Gulf of Mexico and/or Caribbean Sea. Six of these species appear to have potential for soft crab fishery development, based upon size and tolerance to hyposalinities. Identification of potential species, methods of determining pre-molt crabs, harvesting, handling techniques, methods of shedding, and marketing are discussed.

INTRODUCTION

The origin for consumption of soft crabs is lost in antiquity; however, records of the fishery date back to the 1850's. The soft crab industry in the United States has, until recently, been a small part of the blue crab fishery in the Gulf of Mexico and Atlantic waters. In 1984 the National Sea Grant College Program reported approximately 2,300 independent dealers produced soft crabs worth $16 million in the United States. Growth of the fishery can be attributed to technological advances in system design, increased awareness of economic benefits to harvester and producer, and to market demand for the product. While a single species, *Callinectes sapidus*, supports the fishery in the United States, all species of *Callinectes* are edible (Williams, 1974; Norse and Fox-Norse, 1982). With the opening of Asian and European markets, product demand still exceeds supply. The basic unit of the fishery is still the "cottage type" operation (Figure 1a), although design criteria and water quality parameters exist for large scale, highly technical facilities. The range of technologies used in the production of soft crabs allows for the development of this fishery in the Caribbean Basin. Biological, economic, and social factors in the various countries will determine which technological levels can be effectively adopted.

The fishery is dependent upon the capture of premolt, or "peeler" crabs (those that show visible, external signs of molting) by either directed or non-directed fishing activities. Techniques for shedding peeler crabs range from holding crabs in tethered boxes in natural water bodies, to placing crabs in large,

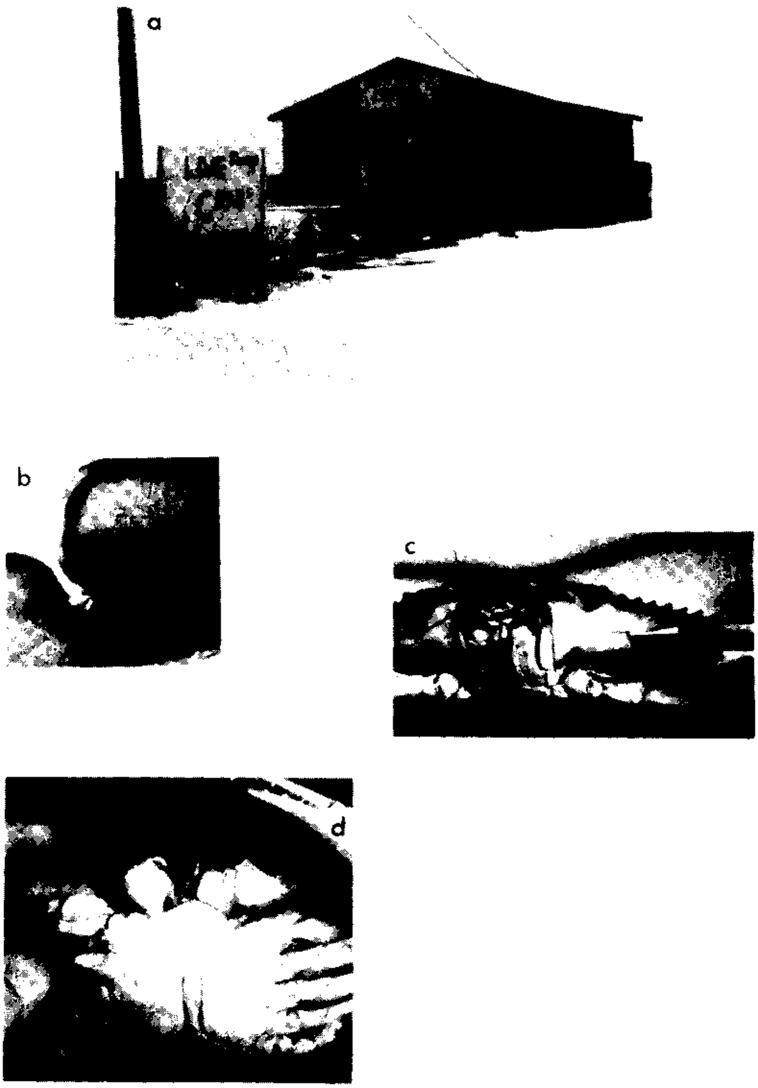

Figure 1. a) shedding house, Irish Bayou, Louisiana b) propodus of swimming leg, white line stage c) suture (epimeral) line (illustration courtesy Steve Otwell) d) limb bud

sophisticated recirculating seawater systems capable of holding several thousand crabs.

Perry *et al.* (1982) and Oesterling (1984) reviewed criteria for recognition of peelers, harvesting techniques, theory of closed recirculating seawater systems, and the various methods of shedding crabs. These authors included in their reviews descriptions of low technology approaches that could be adopted at the household level. Malone and Burden (1988) provided a review of more advanced closed system shedding technology, including water quality requirements, system design, and management. In this paper we identify species potentially available for harvesting, and review appropriate technologies for soft crab fishery development in the Caribbean Basin.

BIOLOGICAL CONSIDERATIONS

Gulf and Caribbean *Callinectes* Species

Of the nine species of *Callinectes* distributed throughout the Gulf of Mexico and/or Caribbean Sea (Table 1), six possess size and distribution characteristics necessary for commercial exploitation (Table 2).

Species with the highest potential for fishery development belong to the "bocourti group." Males in this group have convergent or crossing first gonopods that extend past the suture between the fifth and fourth thoracic sternites (Norse and Fox- Norse, 1982). These species are the most euryhaline of the Gulf and Caribbean *Callinectes*, and have similar salinity distributions and hyposalinity tolerances. They are large crabs, occurring in areas most accessible to fishing activities. Of the four "bocourti" group species in the area of study, two, *C. rathbunae* and *C. maracaiboensis*, are probably isolates of *C. bocourti*. *Callinectes rathbunae* is confined to the western and southwestern Gulf of Mexico, while *C. maracaiboensis* is most abundant in Venezuela in the Lake Maracaibo estuarine system. The remaining two species, *C. bocourti* and *C. sapidus* often occur together in Caribbean estuaries. Of the above species, *C. bocourti* and *C. maracaiboensis* are known to have a life history similar to *C. sapidus*. They are catadromous, maturing and mating in low salinity waters, with spawning and subsequent hatching of eggs in high salinity areas.

Callinectes danae and *C. exasperatus* are also tolerant of low salinities and show wide distribution through the Caribbean. Norse and Fox-Norse (1982) placed them in separate evolutionary groups based on morphology, noting that these groups show less ecophysiological similarities among members than do species in the "bocourti" group. *Callinectes exasperatus*, a member of the "marginatus" group is found in estuaries, river mouths and shoal marine areas, but is predominant in mangrove swamps. Norse and Fox-Norse (1982) noted that *C. exasperatus* lived mainly on heterogenous or three-dimensional bottoms, while *C. danae* ("danae group") is found on mud or sand bottoms with little relief. These species are smaller than those of the "bocourti" group and

Table 1. Distribution of *Callinectes* in the American Mediterranean (from Williams 1974 and Norse and Fox-Norse 1982)

	*C. marginatus**	*C. similis*	*C. ornatus*	*C. danae*	*C. exasperatus*	*C. bocourti***	*C. rathbunae*	*C. maracaiboensis*	*C. sapidus*
Gulf of Mexico (limited distr.)	X(FL)		X(FL)	X(FL)	X(FL)		X(TX)		
Gulf of Mexico (wide distr.)		X							X
Bahamas	X	X	X		X				X
Cuba	X		X	X	X				X
Cayman Islands					X				
Jamaica	X		X	X	X	X		X	X
Hispaniola	X		X	X	X	X			X
Puerto Rico	X		X	X	X	X			X
Virgin Islands	X		X	X	X	X			X
Leeward Islands	X		X	X	X				X
Windward Islands	X		X	X	X	X			
Mexico	X	X	X	X	X		X		X
Guatemala									X
Honduras	X		X	X	X	X			
Costa Rica						X			X
Panama	X			X		X			X
Colombia	X		X	X		X		X	X
Venezuela	X		X	X	X	X		X	X
Trinidad/Tobago	X		X	X	X	X			X
Dutch West Indies	X		X	X	X	X		X	

*Manning and Holthius (1981) suggest that the west Atlantic and east Atlantic populations of *C. marginatus* should be considered separatee species, with *C. marginatus* (A. Milne Edwards, 1861) retained for the east Atlantic species and the name *C. larvatus* Ordway, 1863 assigned to the west Atlantic species.
**Extraterritorial occurrence, Mississippi, Perry (1973)

Table 2. Size comparisons, *Callinectes* (from Williams 1974).

	Largest Specimen (mm cw)		Mean Size (mm cw)/ Standard Deviation	
	Male	Female	Male	Female
C. marginatus	142.0	95.0	93.8 ± 14.7	83.5 ± 8.5
C. similis	122.0	95.0	97.6 ± 13.1	76.9 ± 11.8
*C. ornatus**	130.0	107.0	91.2 ± 16.4	77.7 ± 12.5
*C. danae**	139.0	108.0	108.7 ± 14.7	92.9 ± 9.0
*C. exasperatus**	129.0	124.0	101.6 ± 14.0	97.1 ± 10.6
*C. bocourti**	156.0	146.0	109.3 ± 20.0	106.2 ± 14.0
*C. rathbunae**	134.0	141.0	112.8 ± 13.4	126.6 ± 12.6
*C. maracaiboensis**	159.0	124.0	113.7 ± 16.8	114.3
*C. sapidus**	209.0	204.0	142.8 ± 35.2	131.0 ± 34.3

*Have potential for commercial fishery development.

generally occur in higher, more constant salinities.

Recognition of Premolt Crabs

Commercial production of soft crabs in the United States depends upon the capture and recognition of premolt crabs. Premolt crabs are separated from intermolt or hard crabs and held in floating pens or tanks until they shed (molt). The salable product is a postmolt, "soft-shell" crab. Premolt crabs show definite, recognizable signs of shedding. These signs most often involve coloration changes, which are most visible in the last two segments of the fifth leg or swimming paddle. Although colors may vary from species to species, the space between the old exoskeleton and the new cuticle will be evident (Figure 1b), along with the progression of color changes in the new cuticle. In *C. sapidus*, a white line appears just inside the edge of the paddle indicating that the crab will shed in 7 to 14 days. This line changes to pink in 3 to 6 days from shedding and then to red prior to the actual molt. Based on these coloration changes, a premolt crab is either classified as green (white line) or ripe (pink or red line). An additional color change takes place in the immature female just prior to sexual maturity. Her apron will change from creamy white to reddish-purple as she approaches the pubertal molt.

Other methods of determining premolt condition include the testing of areas where splitting of the exoskeleton occurs at molting (Figure 1c), and limb bud formation (Figure 1d). The possession of a well-developed limb bud identifies a crab approaching a molt. Also, a partial dissolution of the old exoskeleton occurs before shedding through enzymatic digestion. A greater amount of dissolution takes place in certain areas (suture lines) where the exoskeleton will split. Testing the epimeral line under the large lateral spines for a softening of the exoskeleton can be used to identify late premolt crabs. When a split occurs under the lateral line and across the back, the crab is called a "buster." Once the crab has split across the back, it may be two to three hours before the shell is cast off.

PRODUCTION TECHNIQUES

Harvesting and Handling

Harvest of peeler crabs, either by directed or non-directed fishing activities, has been the limiting factor in expansion of the fishery in the United States. Recent improvements in methods of holding and shedding peelers have emphasized the need for selected harvest of premolt crabs. The type of handling a peeler receives in the field will greatly affect the percentage of crabs that successfully complete the molt. Peeler crabs should be culled in the field, placed in shallow boxes, covered with a moist cloth, and be kept out of direct sunlight.

Directed fisheries for peeler crabs are found in very few states, and only in Louisiana and Florida in the Gulf of Mexico. Elsewhere, the supply of premolt crabs is dependent on hard crab fishermen separating peelers from intermolt crabs prior to sale for industrial processing. As there are few developed hard crab fisheries in the Caribbean (Williams, 1974), source of supply of peeler crabs may be a major hindrance to fishery development. A directed fishery technique unique to Louisiana may have application in the Caribbean.

In the Mississippi River delta, an artisanal fishing technique that began in the early 1900's persists today. The use of "bush lines" to attract molting blue crabs is practiced only in the Barataria estuary of Louisiana. Branches from the broad-leaved evergreen shrub, *Myrica cerifera* (southern wax myrtle), are fashioned into bundles and tied onto a stout line to form a bush trotline (Figure 2 a, b). The bundles are tied to a floated line at approximately 5-meter intervals, and the line is usually staked at both ends. The bushes rest just above the bottom. Bush lines attract ripe peelers who hide in the myrtle branches for protection from predators. The lines are run daily from a pirogue (log canoe) or a motorized skiff. Each bush is slowly raised by hand and a dip net slipped under the bundle to catch the crabs that fall out as the bush is shaken (Figure 2c). Bush trotlines function well where estuarine waters are shallow, turbid, and where tidal velocity is low. They are most effective in waters of low to intermediate salinities, areas where maturation and mating occur. Bush lines require little capital investment and are quite efficient under the water conditions described above.

Shedding

Simple production techniques, although labor intensive, are inexpensive to build and maintain. More advanced systems require high initial capital

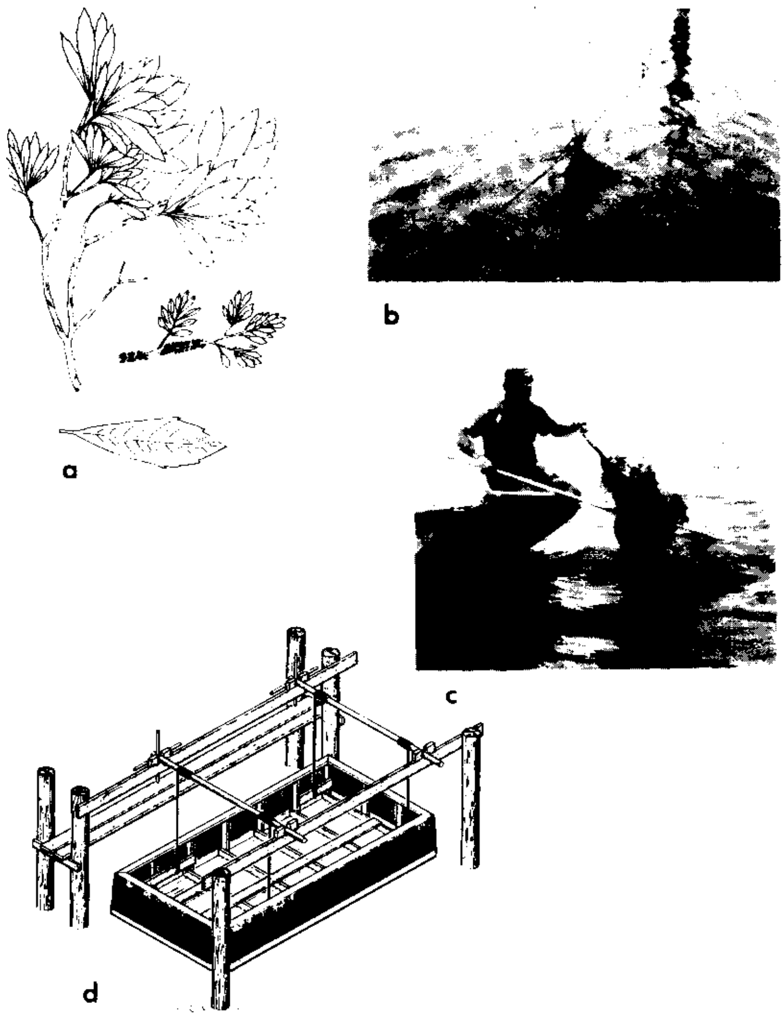

Figure 2. a) southern wax myrtle, *Myrica cerifera* (illustration courtesy, L. Eleuterius) b) bush line, Barataria Bay estuary, Louisiana c) checking bushline for peelers d) live car, used for shedding crabs, Barataria Bay estuary, Louisiana

investment, skilled labor, and appreciable energy costs. Selection of a particular production technique is dependent upon water quality in a given area. Water quality is a prime determinant of shedding success.

The simplest means of holding crabs until they shed is by use of floating boxes tethered nearshore (Figures 2d, 3). Floating boxes evolved in the Chesapeake Bay area in the 1800's. Traditionally, Chesapeake Bay floats were constructed of pine, while in the Gulf of Mexico cypress was used. The Chesapeake float consists of a bottom of closely fitted boards with wooden slats spaced at narrow intervals to form the sides (Figure 3a). A wooden shelf or side wing is added to the outside of the float at mid-depth to give it buoyancy and stability. A lip on the inside of the box prevents the crabs from crawling out. These boxes are not covered. The Gulf of Mexico floats are of variable size and construction and are usually covered (Figure 3 b, c). Although floating boxes are the least expensive method of shedding crabs, they have several limitations. Successful float operations require good water quality in an area where there is moderate wave action or tidal flow. Crabs held in floats are confined to the upper few inches of water and are susceptible to the periodic, often rapid changes in salinity that can occur in surface waters. Siltation and pollution may also plague float operators in some areas.

For these reasons, and for convenience, many operators have turned to shore-based facilities where the water is pumped from the bay or river through a series of tanks and returned overboard (flow-through system), or continually recirculated through a series of tanks and a filter (closed system). In an open system (Figure 4 a, b), the crabs are held onshore in shallow tanks or watertight boxes and water is electrically pumped to, and circulated through, the system. Water is then drained back to the body of water from which it was drawn. An open system, while reducing the labor associated with tending a group of floating boxes, is still dependent upon good quality water in the area where the crabs are held and shed.

In areas where water quality is poor, a closed recirculating seawater system is suggested (Figure 4c). In a closed system, water is recirculated through a series of tanks and biological and mechanical filters to remove dissolved organic material and sediment, respectively. This type of system is more complex and costly than the flow-through system, however, it allows for greater control of the physical, chemical, and biological variations characteristic of natural seawater (temperature, salinity, silt, plankton, pollutants). Monitoring of water quality is essential to successful closed system shedding. Detailed descriptions of open "flow-through" systems and closed recirculating systems are found in Perry *et al.* (1982), Oesterling (1984), and Malone and Burden (1988).

Marketing

Consumption patterns among local populations may determine market

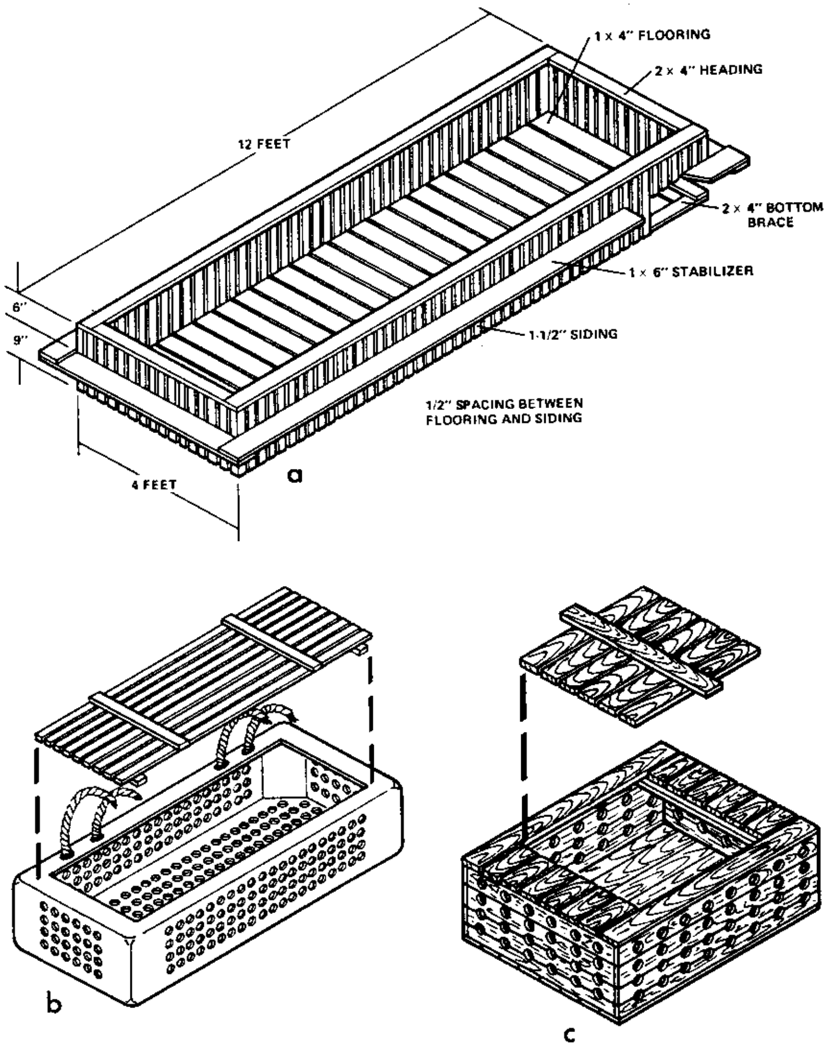

Figure 3. a) shedding box or float, Chesapeake Bay (illustration courtesy Steve Otwell) b) modern float constructed of fiberglass c) traditional southern crab float constructed of cypress

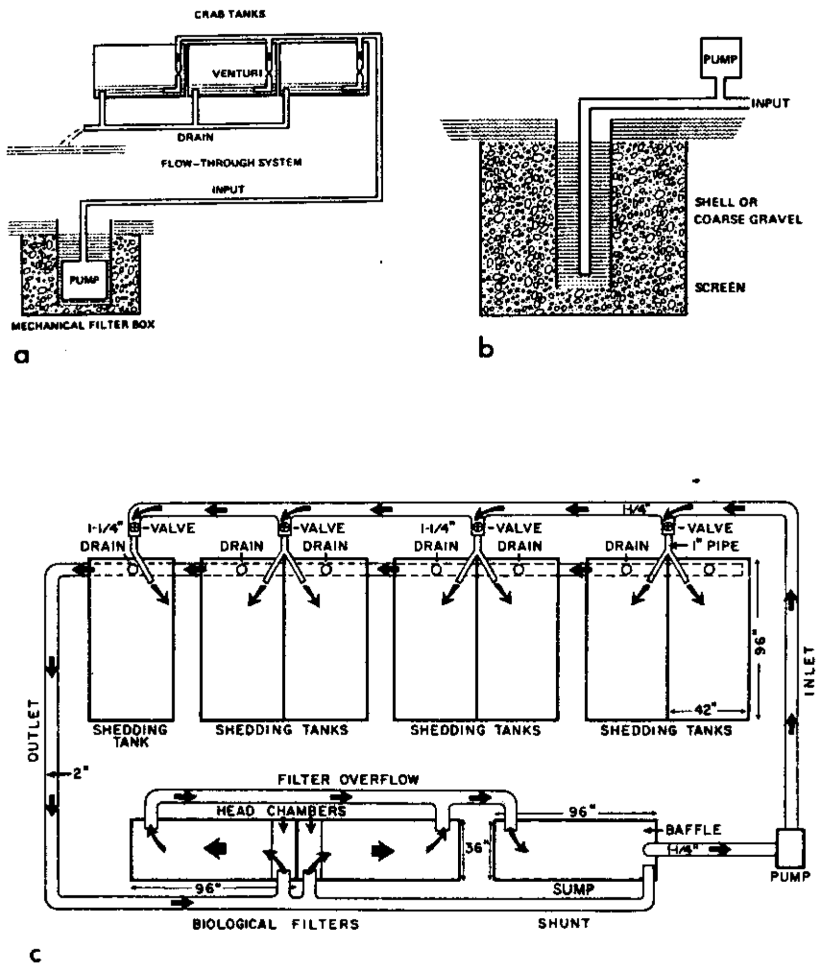

Figure 4. a) flow-through system or open system b) alternate placement of pump, open system c) closed system

channels. Crabs in the United States are either marketed live, refrigerated, or frozen. Most are marketed directly to restaurants or the general public, although in some areas brokers market the product. Highest potential for profit would be in the development of export markets.

DISCUSSION

The goal of soft crab fishery development is the production of a high quality, marketable product. In developing this fishery, consideration must be given to the source of supply of raw crabs, range of technologies that exist for soft crab production, and ability to market the product. Advanced technologies entail large capital investment, high energy requirements, and well-trained technical personnel to design, build, and manage a complex facility. On the other hand, simple holding systems need little capital, negligible energy needs, and unskilled labor. Successful transfer of soft crab production techniques requires understanding of how these technologies can be adopted by the people and countries of the Caribbean Basin, given the local resources and institutions in which this practice will operate. Consideration must be given to how this new technology will mesh with existing fishing patterns, market structures, and social institutions.

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