

# Caribbean *Mithrax* Crab Mariculture and Traditional Seafood Distribution

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## ABSTRACT

This paper examines the potential changes in traditional seafood distribution due to the culture and sale of *Mithrax spinosissimus* crab by fishermen in Caribbean countries. The Smithsonian Institution developed a new technology for growing algae in the sea and feeding the algae to *Mithrax* raised in cage culture. Fishermen and fishermen groups have participated in pilot projects and are likely to adopt the technology and implement small-scale commercial operations. The authors conducted two independent studies of the economic and social feasibility of fishermen adoption of *Mithrax* culture during July-August 1985 in two villages near Smithsonian research sites: Willikies in Antigua and Buen Hombre on the north coast of the Dominican Republic.

Fishermen in both villages catch and distribute three classes of fish and spiny lobster. The fish is currently 1) exchanged for services or goods in the fishermen's extended families and village, or 2) sold for cash either to a variety of middlemen or directly to consumers. The findings outlined in this paper indicate that the shift of some fishermen into crab farming may change the amount and types of fish caught and distributed, the availability of subsistence or third class fish, and the structure of the local seafood market.

## INTRODUCTION

The Marine Systems Laboratory (MSL) of the Smithsonian Institution has been developing a new technology for growing algae in the sea and feeding the algae to *Mithrax spinosissimus*, a large Caribbean spider crab, or "king crab", raised in cage culture (Adey, 1983; Miller, 1985). The Smithsonian and the United States Agency for International Development requested and funded two independent studies of the economic and social feasibility of fishermen adoption of *Mithrax* culture (Rubino *et al.*, 1985; Stoffle, 1986). The authors conducted site visits during July—August 1985 in two villages near Smithsonian research sites: Willikies in Antigua and Buen Hombre on the north coast of the Dominican Republic. These initial studies concluded that small-scale crab mariculture by fishermen groups living near two Smithsonian mariculture sites is feasible based on economic feasibility (Rubino *et al.*, 1985) and social soundness (Stoffle, 1986) criteria. A demonstration that the technology is feasible and that start-up loans or financial incentives for fishermen crab farmers are available are among the steps that will likely be required for fishing groups to actually adopt the technology (Rubino, 1986). In addition, fishermen are

likely to adopt the technology if they can adapt it to their existing patterns of fishing and other social obligations (Stoffle, 1986).

This paper examines the potential changes in traditional seafood distribution due to the culture and sale of *Mithrax* by fishermen groups in Caribbean Countries. The findings outlined in this paper indicate that the shift of some fishermen into crab farming may change:

1. The amount and types of fish caught and distributed.
2. The availability of subsistence and third class fish.
3. The structure of and the roles of the participants in the local seafood market.

#### ECONOMIC AND SOCIAL FEASIBILITY STUDIES: BACKGROUND AND RESEARCH METHODOLOGY

At the time economic and social feasibility studies were initiated in July 1985, the Smithsonian had worked on *Mithrax* culture for three years in the Turks and Caicos and had recently started new research projects on the east coast of Antigua near the village of Willikies and on the north coast of the Dominican Republic near the village of Buen Hombre. The Smithsonian was also involved with plans for projects at Azua in the Dominican Republic, in Carriacou (Grenada), and elsewhere in the Caribbean. The authors' visits to the Smithsonian research sites and adjacent fishing villages in Antigua and the Dominican Republic overlapped and they shared data and some interviews in the field. Their analyses and reports however, independently arrived at similar conclusions.

#### **Economic Study**

The economic study included a financial analysis of small-scale, 20 grow-out cage fishermen operations, a review of market potential, and an analysis of economic constraints and incentives associated with fishermen adoption. Variations in crab production, survival rates, growout time, and sale price and project costs on the cash flow (gross and net revenues) and financial indicators (e.g., rates of return, breakeven price, and profit margins) of a fishermen's crab farm were examined. Estimated crab project revenues were compared to estimates of fishermen income. To gather the cost, market, and fishermen production and income data, over 200 interviews were conducted in both countries with fishermen, middlemen, equipment suppliers, hoteliers, operators of processing and export companies, government officials, and others.

#### **Social Study**

The social feasibility study collected data using ethnographic methods, especially key informant interviews and participant observation. Primary documents such as fishermen's records were used when available. In Antigua more than 100 interviews were conducted with fishermen, marketers, local village residents, and government officials. One three man crew in Willikies was interviewed in depth and their fishing and marketing activities were observed over a three week period. Almost 200 interviews were conducted in the Dominican Republic. In addition, after two weeks of interviewing in Buen Hombre, an interview schedule was designed and administered to 33 of the 42 members of the Buen Hombre fishermen's association.

### Key Findings

Based on the economic and social feasibility analyses, *Mithrax* mariculture appears to be an "appropriate technology" in the fullest sense of that commonly used development term. Fishermen at both sites conveyed a positive attitude toward the idea of mariculture and seemed ready to give it a try as soon as the demonstration stage is completed and the adoption stage in the transference process is reached. Fishermen currently have many of the values, skills, understandings, experiences, and market connections required for the successful transference of the mariculture technology. The prime unit of adoption appears to be existing fishing crews, but a variety of potential adoption units exist. Fishermen understand, participate in, and partially control a seafood marketing system that can be utilized for the local and regional distribution of mariculture crabs. Many fishermen, especially in Buen Hombre, lack the startup capital for cages and screens and the income reserves to cover the one to two year period before the first crab harvest. However, both the Government of Antigua and Barbuda and the Government of the Dominican Republic indicated a willingness to design credit and incentive programs for potential crab farmers. In other words, based on social and economic variables, *Mithrax* mariculture appears to be very possible for these Caribbean sites.

### RESEARCH SITES AND CURRENT FISHING ACTIVITIES

The physical, economic, and social characteristics of the two sites differed, but the structure and function of fishing crews, the multiple occupations of fishermen, the types of fish caught, and the seafood distribution patterns were similar in many ways for both villages. In addition, both villages are located near or on bays protected by offshore coral reefs within which the Smithsonian research projects were ongoing. The following brief description of the sites and current fishermen activities provides some of the baseline data and context for projecting seafood distribution impacts of crab mariculture.

#### Site Specific Characteristics

Due to the small size of Antigua, the fishermen of Willikies are close to their market: the fish market in the city of St. John's, tourist hotels, and exporters. Fishing crews of 2—4 men operate 4—8 m boats with 40 horsepower outboard motors. Most boats have ice chests and some are equipped with sails. Fishing is conducted nearshore and up to several miles offshore by means of fish pots, long lines, and diving. The village of Willikies appears to have participated in the economic development and increased income associated with Caribbean tourism. Fishermen live in wood frame or cinderblock homes, many of which are being expanded and improved, and possess electric appliances. Some own motorbikes and automobiles.

Buen Hombre is a remote fishing village of about 855 people on the north coast of the Dominican Republic geographically isolated from other communities. Relative to other villages in the country and the Caribbean, this is an economically poor village in terms of housing and material possessions. Water is imported by truck or donkey, houses are of wood and mud construction, there is no electricity, and the dirt roads are periodically impassible. However, from the standpoint of diet, health, community stability, and public safety, the people of Buen Hombre appear to have a higher quality of life than other poor areas observed in the country. Many foods including fish

and many farm products are readily available locally, although rice, a staple, is trucked to the village. Ten fishing crews operate out of the village. Between them they possess 8 boats (4—7 m) with sails and 4 motors in various states of repair. Most fishing at the time of the study was either nearshore or reef fishing using lines, nets, and diving.

### Mixed Fishermen Crews

At both sites the men identified as “fishermen” by villagers conducted their fishing as members of 2—4 man crews who work together on a regular basis. These fishermen can be termed “mixed fishermen” oriented toward both subsistence fishing and the commercial market (Stoffle, 1986:36). Mixed fishermen are distinguished from large-boat (over 10 m) full-time fishermen who fish solely for the commercial market and subsistence or part-time/occasional fishermen. The mixed fishermen crews fish 3—5 times per week. Bad weather, repairs, and other commitments most likely limit fishing to 150—200 days per year. Of the 850—1,200 fishermen in Antigua, 43% are mixed fishermen, 43% subsistence, and 14% are large-boat commercial fishermen (Joseph, 1984). The primary fishing crews in Willikies are of the mixed type. In Buen Hombre, there are 46 members of a fishermen’s association which includes ten 1—4 man “craftsman” crews (the fishermen’s terminology) of the mixed type. Other fishermen in the association are categorized as “apprentice”, “journeyman”, and “beached” (older) fishermen.

The economic and social feasibility studies found that “mixed fishermen” is the fisherman type most likely to be successful if they adopt small-scale crab farming. “Mixed fishermen” crews are proven economic units and have other characteristics that make them suitable for undertaking mariculture: they have corporate resources and responsibilities, mechanisms for replacing members, trust among members and legitimacy in their villages, and territorial rights over local fishing grounds (Stoffle, 1986:43—47; Rubino *et al.*, 1985:51—59).

### Occupational Multiplicity

At both sites, long term adaptation to the physical and economic environment has created functionally integrated family, crew, and village activities and commitments (Stoffle, 1986:43—46). Most Caribbean mixed fishermen are involved in a web of commercial and subsistence commitments that provide them economic and social stability in a marginal economic environment where any single occupational strategy might fail unexpectedly. The multiple occupations conducted by fishermen have been termed “occupational multiplicity” (Comitas, 1973). Mixed fishermen engage in part-time farming (crops and domestic animals), charcoal making, gardening, wage labor, automobile and equipment repair, and taxi driving. Occupational multiplicity contrasts with single full-time occupation/employment commitments which can leave people vulnerable in countries that do not have national or society-wide social security programs. Fishermen *Mithrax* farming can either be integrated into or can be a replacement for the system of multiple occupations.

### Types of Fish Caught

Fishermen at both sites catch lobster and three classes of fish. Lobster, a first class fish, first and some second class fish is destined for hotel, restaurant,

and upper income markets. Third class fish is largely consumed by low-income people for whom it is an important source of protein in both villages and cities. Fishermen retain fish of all classes for family and village subsistence needs and commitments.

### Current Fish Distribution

The pattern of fish distribution to family, village, and market consumers follows a similar pattern in Willikies in Angigua and Buen Hombre in the Dominican Republic (Rubino *et al.*, 1985:48—60; Stoffle, 1986: 36, 88—90). Fish are exchanged for:

1. Goods and services among family and neighbors.
2. For cash through direct sale to consumers or to a variety of middlemen or wholesalers.

The middlemen in turn market the fish to other middlemen, exporters, or consumers.

### Subsistence Distribution

One Willikies crew contributed about 20% of its catch to subsistence and sold the other 80% mostly to middlemen. Average catch for a fishing trip was 45—50 kg. The subsistence portion was consumed by the fishermen's families or given to village neighbors in exchange for other goods or services.

In Buen Hombre, it is customary for each crew member to keep about 3 kg of seafood per trip to distribute to members of his family. Three kg is 19% of the 16-17 kg caught per fishermen per trip. There is an important relationship between the amount of the catch given to the family and the size of the total catch. It appears that even if the catch is small, the same number of kilograms will be distributed to family members. This suggests that meeting perceived basic needs may be more important than meeting cash demands.

### The Cash Market

Willikies and other Antiguan mixed fishermen occasionally bypass middlemen and sell lobster directly to hotels and restaurants. Several smaller hotels indicated a preference for dealing directly with fishermen for lobsters to gain a price lower than that offered by middlemen. However, most fish and lobsters reach the commercial market via a variety of middlemen. Much of the lobster and first class fish landed are eventually purchased by three or four major Antiguan middlemen/exporters even if intermediate middlemen deal directly with the fishermen. Most intermediate middlemen or middlemen handling second and third class fish are women called "hawkers". The Willikies fishing crew, for example, targeted red-colored fish on two days of every week. They used longlines to catch only red colored fish and would bring in 40—45 kg of such fish each time they went out. All the fish were iced and sent to St. John's via a crew member to be sold to an exporter. The fish were then packaged for transport to the French Antilles and Puerto Rico. Second and third class fish caught by the crew were sold by women "hawkers" directly to consumers in the St. John's public market.

After off-the-top subsistence commitments are met in Buen Hombre, the catch is sold with the assistance of the fishermen's association (Rubino *et al.*, 1985:56; Stoffle, 1986:92—100). Most of the fishermen in Buen Hombre

belong to a fishermen's association that began operating in 1984. The association has a number of organizational and market functions:

1. Works to set the local market price for seafood.
2. Provides storage for fishermen's equipment.
3. Provides ice for keeping the catch until marketers arrive.
4. Records each fisherman's or crew's daily catch by type of fish and weight.

A member of the association who also serves a village middleman role, purchases the lobsters, keeps them in cages, and feeds them until a sale is made to a truck middleman. The association neither owns the means of production nor has the authority to regulate the fishermen or their activities. Therefore, it cannot be considered a cooperative (Stoffle, 1986:93).

Middlemen serving Buen Hombre have segmented the market into groups reflecting consumer purchasing power (Rubino *et al.*, 1985:56—7; Stoffle, 1986:102—104). Third class fish purchasers (4 on Saturday, 2 during the week) use motorbikes to transport fish from Buen Hombre to retailers catering to lower income groups in larger villages and cities in the region. A small pickup truck is used by the only mixed second and first class fish marketer who comes once or twice a week to purchase fish for the middle and upper-class urban people living in nearby towns. Lobster are purchased by one fish marketer almost every Saturday. The lobster marketer visits a number of villages along the north coast to make enough purchases to fill his truck. He then drives directly to Santa Domingo, the capital, to sell the lobsters to hotels or exporters. Price markups from exvessel sale through middleman to large town wholesaler were recorded as 100% for first class fish, 150% for second class fish, and 70% for lobsters (Rubino *et al.*, 1985:57).

### ECONOMIC AND PRODUCTION FACTORS THAT MAY INFLUENCE *MITHRAX* MARKETING AND DISTRIBUTION

If *Mithrax* mariculture proves to be feasible and is adopted by crews in Willikies and Buen Hombre, several economic and production characteristics will influence *Mithrax* marketing and distribution and will affect the distribution of other seafoods.

#### Current and Potential *Mithrax* Markets

*Mithrax* is likely to be directed to a high value cash market of gourmet, high income, and tourist consumers (Rubino *et al.*, 1985). King crab and similar species are in high demand around the world. However, *Mithrax* is currently not sold in Antigua because fishermen do not catch a sufficient quantity of the crab to supply a market. The occasional "sea crab" trapped in fish pots is used for bait or consumed by fishermen's families. In the Dominican Republic, *Mithrax* is served in several restaurants, but it is not an established gourmet food item. Known as centolla, *Mithrax* is not considered a first class fish and sells for a low price relative to lobster (fisherman sale prices of 1.50 pesos per kg for centolla versus 5.00 pesos per kg for lobster) (Rubino *et al.*: 1985:57; Stoffle, 1986:89). This is due to the low volume, poor quality, and irregular supply of the crab. The crab is cooked and picked in the restaurants.

#### Economic Returns and Labor Commitment

Various scales of crab operation could be conducted by mixed fishermen crews. The number of crab farmers and the number of crabs produced will

affect the viability of a crab market and the impacts of crab production on the seafood market.

The small-scale production scenario considered in the economic feasibility study used Smithsonian estimates of a 20 cage, 1,000 screen operation which would produce 900—1,300 kg of crab per year and require 5 man hours of labor per day to operate. Using likely fishermen sale prices and Smithsonian production figures for *Mithrax*, the net income realized from a 20 cage crab operation is estimated to be similar to the current income (including subsistence fish) realized by fishing 150—180 days at either site (i.e., US \$3,000 per year in Antigua and US \$2,000 in Buen Hombre) (Rubino *et al.*, 1985). Likely fishermen crab sale prices used in the calculation are (in US\$ equivalents) US \$5.50 per kg in Antigua and US \$4.40 per kg in Buen Hombre.

The economic feasibility study also reported that crab farming profitability is very sensitive to changes in yield (of crab per cage) and sales price. Obtaining sale prices of at least US \$4.40 per kg and careful management to obtain high yields will be critical to successful fishermen crab farming.

Because *Mithrax* will require about two years to reach market size in mariculture, a transition period of two or three years during which fishermen support themselves by their current activities and/or receive startup loans, grants, or subsidies will be required. The availability and type of economic incentives offered may therefore affect fisherman adoption of crab culture, the changes fishermen make in their fishing and other occupational activities to adopt crab culture, and the distribution of seafood.

#### POTENTIAL IMPACTS OF CRAB MARICULTURE ON SEAFOOD DISTRIBUTION

Due to the uncertainties and risks of a new technology and occupation, mixed fishermen adoptors of crab farming are likely to continue to conduct their current primary activity: fishing for subsistence and cash needs. However, the catch volumes, types, and distribution may change. In addition, crab farming will produce a new seafood product that may alter relationships between fishermen, middlemen, and consumers. The authors' economic and social feasibility analyses point to several potential impacts of crab mariculture on seafood distribution in Willikies and in Buen Hombre. Further research is required to better define the likelihood and magnitude of these impacts.

#### ***Mithrax* Marketing and Distribution**

Cultured *Mithrax* can be marketed differently from most wild caught seafoods because a crab fishermen-farmer need not sell his product immediately after catch like a fisherman. Crab farming may allow fishermen to time and stagger crab production cycles and the sale of crabs to maximize their economic returns. Sales could be timed to coincide with the influx of tourists during the winter months. Or crabs could be sold to the United States or European export market during the summer months when lower local demand for fish leads to a glut on the local Caribbean markets and low fish sale prices. The ability to decide when to sell crabs may provide fishermen with greater market and price setting power vis-a-vis middlemen and consumers than they currently have with fish and lobsters.

*Mithrax* could and may initially be handled by the market system that currently purchases and distributes Caribbean spiny lobster. Fishermen at both

sites catch lobsters and keep them alive in cages to sell them periodically to middlemen. The middlemen sell the lobsters to high income markets. In Buen Hombre and perhaps in Willikies, the lobster and first class middlemen will play a more important role than before relative to other middlemen as crab is added to increase the volume of first class fish marketed.

The fish and lobster market reaching Buen Hombre has the potential to collect, distribute, and market additional high value seafood including *Mithrax*. Fishermen crab farmers will most likely have to rely on a marketer with a truck and high income market connections to deliver crabs to high value markets.

In Antigua, where fishermen are not isolated from their markets, two or more crab market scenarios are possible. The ability to sell a particular volume of crab on pre-arranged days may allow fishermen to market crabs directly to end consumers such as hotels and restaurants. Fishermen currently attempt to bypass middlemen and sell lobsters directly to hotels and restaurants; some are successful. The necessity of getting as high a price as possible to make crab farming financially feasible may give crab farmers an incentive to market directly to end consumers and capture all or a portion of a middleman's markup.

Such a direct market connection for crab could be followed by direct sales of lobster and first class fish by fishermen to consumers, creating increased competition between fishermen and middlemen.

During the initial commercialization/adoption stage, the Government of Antigua and Barbuda may encourage or negotiate for the fishermen crab farmers to sell their crabs directly and exclusively to two or three hotels (Rubino *et al.*, 1985). Such an arrangement may be required to insure that the hotels receive an adequate supply of *Mithrax* to justify putting it on their menus. Once crab farming becomes established, such a direct link between crab farmers and hotels may continue.

Another possible scenario in Antigua retains a role for middlemen. Middlemen provide market outlets, transport, knowledge of wholesalers, hotels, and consumers, and assume and spread the economic risks of marketing. These services may continue to be valuable to crab farmers. Middlemen may also be a source of financing for the startup costs of crab farming.

### **Changes in Occupational Mix that Affect Seafood Distribution**

If a fishing crew adopts crab mariculture, the members of the crew will need to change their mix of multiple occupations or exchange multiple occupations for full-time crab farming. Their decisions will affect a series of interrelated family, village, fishing, and market commitments. The small-scale farm size suggested by the Smithsonian is a 20 cage operation requiring a minimum 5 man-hour per day labor commitment. Such a 20 cage fisherman farm operated by a fishing crew would leave the crew time to continue some but not all of their current fishing and other activities. Certain family and village commitments may have to be renegotiated to make room for crab farming. Another possibility is that part-time, substitute, or apprentice fishermen might become full-time members of an expanded crew and take on tasks in crab farming and fishing. This would leave the key members of the crew time to continue fishing activities. Children, apprentices, and older fishermen could watch over and repair the crab cages and conduct less physically demanding tasks of crab farming.



### Full-Time Adoption of Crab Farming

The full-time adoption of crab farming is also possible for several reasons: crab farming may require much more than 5 man-hours per day of labor and government and international aid organizations may provide economic incentives or wage income to encourage fishermen to get started in crab farming (Rubino *et al.*, 1985; Stoffle, 1986). In Buen Hombre, the Smithsonian intended to hire 5—15 fishermen on a full-time 40 hours per week basis to participate in a pilot program. Eight fishermen have been hired, but in practice they work 20 hours a week each on the crab project, engage in fishing and other activities the remainder of the time, and have evolved a mutual support system (which includes other members of the community) to assist each other in crab farming (Stoffle, 1986:125—130).

If fishermen are hired for or engage in full-time crab farming, it will be difficult for other villagers to replace them as fishermen. The professional skills and knowledge acquired by mixed or craftsmen fishermen require years to develop. The withdrawal of key fishermen and crews from fishing can cause the collapse of a village's fish marketing connections (Stoffle, 1986:104).

### Impacts of Decline in Volume of Fish Marketed

A fishing crew or fishing village may need a critical amount of lobster, first, and second class fish to maintain commercial market commitments and connections. Crab farming might result in a decrease in fishing effort by the adoptor crews and a decline in the volume of fish marketed. If the supply of marketable fish falls below a critical threshold, the middlemen may go elsewhere for their supply thereby eliminating the fishermen's or village's market connection. Buen Hombre, in particular, could lose the goods regularly brought to the village by the middlemen if the market connections were severed. The possible existence and indicators of such a threshold require further study.

The most likely decrease in fished species would be third class fish, fish with the lowest commercial cash value to fishermen. If crab production precludes sufficient production of third class fish, it is expected that this portion of the fishermen's or village's market will be curtailed or eliminated and the poor will have to find alternative sources of inexpensive protein (Stoffle, 1986:104). The third class middlemen may be forced out of business or to seek other sources of supply.

Research on the interactions between "subsistence" and "commercial" markets and between fishermen and middlemen at other sites indicates precedents that may be applicable to *Mithrax* marketing. For example, Forman and Riegelhaupt (1970:189) identified several stages of transition and adverse impacts on the supply of food staples that occur in Brazil when a highly capitalized national commercial market system "takes over" the local peasant marketing system. Polnac's analysis in Costa Rica (1982:233) suggests that rural fishermen place a high value on a middleman's personal services and cultural sensitivity.

### Crab Farming and Potential Increases in Total Seafood

There is evidence that overfishing of traditional stocks of fish currently limits both the catch and the time fishermen devote to fishing and the number of fishermen that Caribbean fisheries resources can sustain (Simon, 1983; Joseph, 1984; Goodwin, 1985). If this is the case, fishermen might be able to maintain

their current level of fishing and engage in crab farming depending upon the man-hours required for mariculture. In addition, increased seafood/fishing sector employment opportunities may be created by crab farming: marginally or underemployed villagers could work in crab farming, join expanded fishing crews, or replace fishermen who choose to engage in crab farming. Sons of fishermen and younger people who might otherwise leave villages for wage employment may find job opportunities created in the fishing sector. A possible net result could be an increase in the overall supply of seafood.

### **Changes in the Means of Production in Buen Hombre**

In Buen Hombre, the credit, subsidy, and development programs that may be required to encourage fishing crews to adopt crab mariculture are likely to provide fishermen with increased means of production. As an example, the Smithsonian project supplied boats and motors for use by fishermen participating in the project. These are now also used for fishing (Stoffle, 1986:128). This has doubled the means of production--boats and motors--in the village. Fishermen using the new boats are fishing further from shore and have added pots or traps to their repertoire of techniques. A greater percentage of first and second class fish and lobsters may be caught with pots than was possible in the overfished nearshore areas.

### **Buen Hombre Fishermen's Association**

The fishermen organization in Buen Hombre could expand its current functions to include crab mariculture by negotiating with crab market middlemen, helping in storage of equipment, and providing collective protection for crab cages. Corporate functions should only be added to this association with caution, given the community's expressions of distrust of cooperatives (Stoffle, 1986:93). The fishermen's association has already been active in the design and operation of the Smithsonian research/pilot project: the association decided that at least one member of each crew should participate in the Smithsonian program (which includes a stipend for participation) and that only members of the association would be able to participate in crab mariculture activities.

### **Antigua Market**

Although *Mithrax* is not sold in the Eastern Caribbean due to lack of supply, a gourmet food market for Caribbean king crab could be developed targeting restaurants that specialize in seafood and local cuisine. Hotels import fish and lobsters during the high demand winter tourist season. During the tourist off-season crab may compete with lobster and first class fish.

If *Mithrax* production exceeds the local market demand for whole live crab, crab processing into meat and sections may be required to satisfy *Mithrax* export markets and large, local hotels that cannot afford the labor costs of processing in their kitchens (Rubino *et al.*, 1985:61). Their extremely hard shell necessitate some form of processing before *Mithrax* can be served in a restaurant. The need for processing may create entirely different relationships between producer, middleman, wholesaler, and exporter that those required for whole live crab.

### Dominican Republic Market

Mariculture production of crab may lead to an upgrading of the crab market in the Dominican Republic. Farming allows the crabs to be delivered from water to table in a matter of hours by fishermen working with transport middlemen. The improved quality reaching the market could push cultured *Mithrax* into the ranks of first class fish and lobsters according to wholesalers and hoteliers interviewed (Rubino *et al.*, 1985:62).

### CONCLUSION

This paper focuses on the potential impacts of crab mariculture on seafood distribution. Fishermen adoption of crab mariculture raises many other important economic and social issues:

1. Village income and cash distribution.
2. Potential changes in the hierarchy of a fishing village that could affect community cohesion.
3. Territoriality.
4. The realignment of fishermen and other villagers' multiple occupations and changes in village production.

The seafood distribution issues alone raise significant economic and social impact questions that should be analyzed and addressed in formulating a program for transferring *Mithrax* technology to fishermen crews in the Caribbean.

Based on the authors' economic and social feasibility studies of *Mithrax* mariculture and on other fisheries studies, a number of actions can be taken by Caribbean governments to address the impacts of crab farming on seafood distribution:

1. Include economic and social variables in the design of a crab mariculture program alongside production and technical issues.
2. Identify the potential economic and social benefits and costs of crab farming that affect fishermen seafood distribution.
3. Inform potential fishermen adoptors of these costs and benefits.
4. Include potential fishermen adoptors in the design and operation of demonstration stage projects that occur between the research and the full adoption stage.

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