

# 7

## INAPPROPRIATE MANAGEMENT OF AN APPROPRIATE TECHNOLOGY: A RESTUDY OF MITHRAX CRAB MARICULTURE IN THE DOMINICAN REPUBLIC

Richard W. Stoffle, David B. Halmo, and Brent W. Stoffle

### INTRODUCTION

The developmental change (Gallaher 1968) literature has recently focused on the concept of "sustainable development" (Browder 1989; World Bank 1989; World Commission on Environment and Development 1987a, 1987b).<sup>1</sup> This approach seeks to achieve two goals: conserving the natural environment and sustaining the economy, culture, and society of rural people. The latter goal is achieved by combining local systems of traditional knowledge with economic production plans that involve natural resource utilization, in order to provide food, shelter and income for rural populations. The former is achieved by combining scientific knowledge with traditional local conservation techniques. Natural resources and fragile ecosystems, such as steep, high altitude hillslopes (Ives and Messerli 1989), tropical forests (Browder 1989; Clay 1988; Denslow and Padoch 1988) and coastal areas bounded by coral reefs (Robben 1985), must be conserved through sustainable development because of the intimate interdependency between the local people and their ecosystems. Co-management (Pinkerton 1989) of local natural resources by sharing authority with local people is one strategy for achieving sustainable development.

Many sustainable development interventions involve researching, field testing and transferring "appropriate technology," defined as an innovation that fits local sociocultural and natural environments. McGay (1980:7) points out that the concept of appropriate technology "reflects the received wisdom of applied anthropology (e.g., Niehoff 1966; Arensberg and Niehoff 1964; Foster 1973), including the recognition that effective development may build upon and interact with indigenous knowledge and technology (Arensberg 1967)."

This chapter presents findings from three social assessments of a pilot project intended to demonstrate a

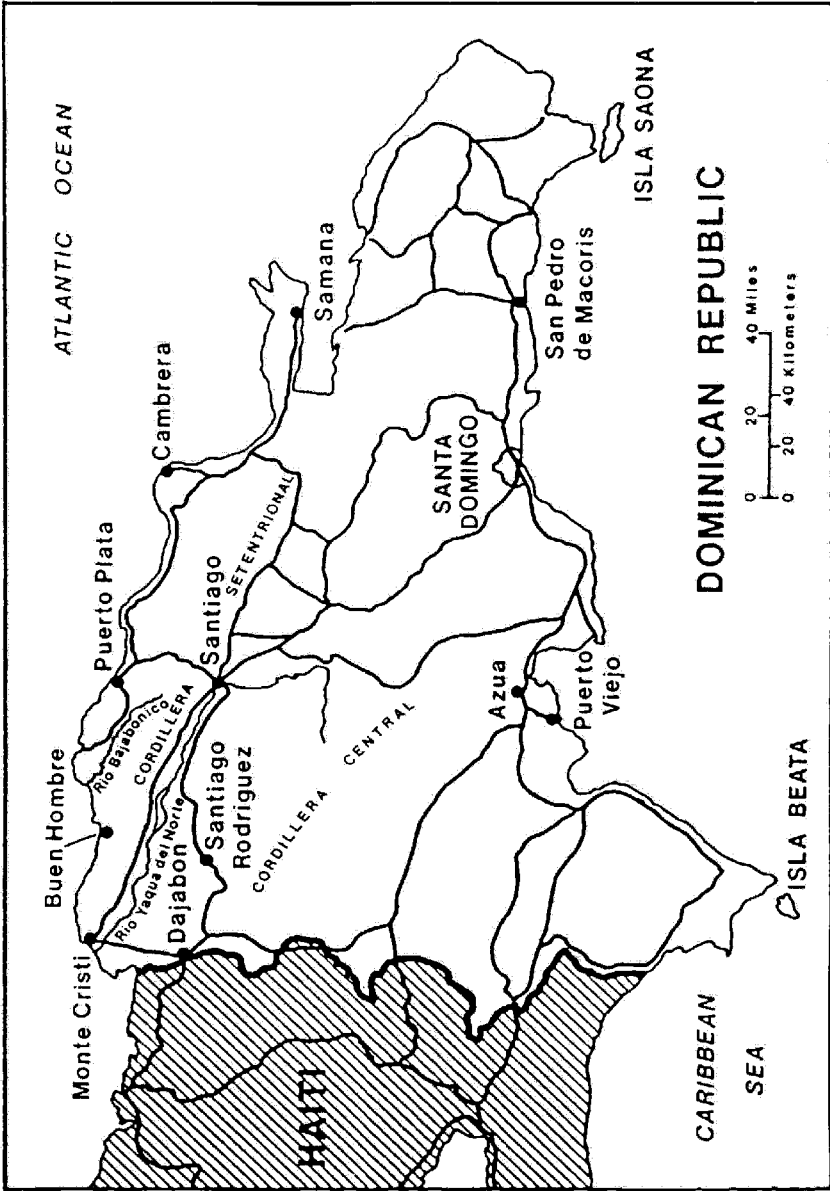


FIGURE 1. Map of the Dominican Republic.

promising food production technology that would, if appropriate, be transferred to coastal fishermen throughout the Third World. The technology involves artificially cultivating algal turfs to serve as food for raising Mithrax spinosissimus, or Caribbean spider crab. The local people are small-scale fishermen who utilize an extensive coral reef ecosystem and live in a community on the arid north coast of the Dominican Republic (Figure 1).

When the pilot project began in 1985, the technology was assessed to be socially and economically feasible because it fit local fishermen's traditional social and economic patterns as well as community desires for locally controlled development (Rubino et al. 1985; Rubino and Stoffle 1989, 1991; Stoffle 1986; Stoffle et al. 1988). Despite efficient and culturally sensitive project management by the Smithsonian Institution's scientific staff, including participation of local fishermen, the mariculture project was terminated and the technology abandoned at this and other pilot project locations in the Caribbean.

This chapter (1) measures the social and ecological impacts of the mariculture project, (2) discusses the factors involved in project termination, (3) assesses the impacts of project termination on local fishermen and their community, and (4) predicts potential long-term impacts on the fragile coral reef and arid coastal mountain ecosystems were the mariculture project not to be re-established.

## METHODOLOGY

Several research methodologies were used during the 1985, 1989 and 1990 social assessment studies. These included key expert interviews, focus group interviews, survey interviews, oral history interviews with community elders, analysis of local records and participant observation. A total of 284 interviews were conducted with local fishermen, farmers, women, former project personnel and government administrators. Additional data derive from analysis of local fish catch records and 174 person days of participant observation.

**KEY EXPERT INTERVIEWS** Key expert interviews were conducted during each of the three studies. In 1985, a number of project personnel, government officials, local fishermen and farmers having special expert knowledge about the project were interviewed (Stoffle 1986:73). During the 1989 study, researchers met with two former members of the Smithsonian Marine Systems Laboratory (MSL), who had served as in-country managers on the pilot project. Through them, the researchers were able to discuss the research with the Director of the Department of Fishery Resources in Dominican Republic, a

lieutenant commander in the military, who provided official support for the research in the form of letters of introduction to local officials. Extended discussions with Smithsonian personnel and Dominican officials provided their perspective on project events that occurred between 1986 and 1989. Government officials and former Smithsonian project managers were consulted in 1990 as well.

**FOCUS GROUP INTERVIEWS** Group discussions, termed here "focus group interviews" (Morgan 1988), were conducted as part of each social assessment study. In 1985, there were three focus group discussions that involved local fisherman's association members, MSL project staff, leaders of Fundacion Natura Dominicana (NATURA) and project social scientists. Issues included who would adopt the technology, who would be hired as project employees, and who would share in decision-making (Stoffle 1986:73).

During the 1989 social assessment, focus group meetings were conducted with members of the fisherman's association, the agricultural association, and an informal association of women. Issues included gaining community understanding and support for the study and recording perceptions of project events and changes since termination.

Six focus group meetings were held with the members of each association during the 1990 study. Three meetings were held with the women's association, two were held with the fishermen's association, and one meeting was held with the farmer's association. Issues discussed during these focus group meetings included the current economic situation and the development needs of the community, including re-establishing the mariculture project.

**SURVEY INTERVIEWS** Survey interviews were conducted in all three social assessment studies. In 1985 a brief survey instrument was administered to all members of the fishermen's association. The 1989 study involved follow-up interviews with all members of the fishermen's association who had worked on the mariculture project and interviews with a random sample of members of the agricultural association. The spouses of fishermen who worked on the project and farmers selected at random were interviewed, so approximately half of the respondents in 1989 were women.

The 1989 survey instrument contained more than 200 variables. Questions addressed the impacts of the mariculture project on traditional fishing, farming, kitchen gardening, and wild resource harvesting. Information was collected on household composition, exchange, food preferences, spending patterns, uses for wild resources, and local classification of fish species. Other questions focused on the impacts of the growing tourism industry and the effects of the new road.

The 1990 survey instrument was revised to include additional questions regarding length of residence in the community, migration history, intercommunity exchange networks, and the current economic situation of the community. The revised instrument addressed a total of 372 variables. Ethnographers interviewed a random sample of five fishermen and their spouses, as well as five farmers and their spouses, for a total of 20 interviews.

The response rate in 1985 was 100%, when 45 persons were surveyed. The response rate in 1989 was 94%, when 33 (31 respondents) persons were surveyed. No one refused to be interviewed, but two fishermen who worked on the mariculture project could not be reached. In 1990, the response rate was 77%, when 26 (20 respondents) persons were surveyed. Again, no one refused to be interviewed; of six farming families selected at random to be interviewed, however, one or both adult heads of household had moved out of the community and could not be contacted.

**ORAL HISTORY INTERVIEWS** Formal, in-depth oral history interviews were conducted as part of the 1990 social assessment study. Five community elders were selected by fisherman, farmer and women's association members during focus group meetings. These individuals were identified as being knowledgeable about the long-term social, economic and environmental history of the community of Buen Hombre from the earliest days of settlement to the present day.

**LOCAL RECORDS** The local fishermen's association purchases and resells the commercial portion of the fish caught by its members. Association records were used to document the type, weight, and commercial value of the fish caught during the same time periods in 1985 and 1989. Catch records were also collected in 1990. Analysis of these records is currently being conducted.

**PARTICIPANT OBSERVATION** During each of the three social assessment studies, ethnographers participated in informal social situations and real events in order to collect additional data, share working hypotheses, and build trust. Social activities included playing on the community baseball teams, visiting in the local cantina, and sitting outside the home of a local fisherman most evenings, talking with persons who dropped-by with a question or a comment. Participating in farming activities was impossible due to the season when the studies were conducted, but on many days in 1989 and 1990, a member of the study team went fishing with a team of local fishermen.

Because analysis of the 1990 survey data has not yet been completed, this chapter focuses on the findings of the 1989

study. In general, however, 1990 interview responses on several issues corroborate those received during 1989. Where 1990 data confirm 1989 study findings, this is mentioned in the appropriate section.

#### AN APPROPRIATE TECHNOLOGY: SMITHSONIAN CRAB MARICULTURE USING CULTIVATED TURF ALGAE

In 1983, Dr. Walter Adey and his research team at the Marine Systems Laboratory (MSL) of the Smithsonian Institution replicated the natural algae colonies that grow and thrive on the surface of reef coral. As many as forty different varieties live together in colonies, called "turfs" by marine scientists. These colonies "...produce dense, lawn-like mats of densely growing vegetation that contribute to make the coral reefs...the most productive of ecosystems in the biosphere" (Adey 1983:9). Adey's new technology, which involved growing algal turfs on fiberglass screens, made it possible to harvest the productivity of the coral reef (Adey and Farrier 1989).

**THE TECHNOLOGY AND ITS USE IN MARICULTURE** Adey sought practical applications for the new technology, believing it could be used to solve many economic and subsistence problems for maritime peoples. MSL field experiments demonstrated that a few hundred screens, cages for raising animals that harvest (consume) algal turf, and the natural movements of ocean currents could be utilized to "farm the sea."

The screens are about the size of an average house window and are made of a wood or plastic frame with fine mesh plastic. MSL scientists found that growth rates varied with the depth of the screen in water and whether it was held upright or flat in the water. The crucial variable was the amount of water flowing over the screen. Increased wave action resulted in increased algal growth.

Cages were utilized to combine the turf algae-laden screens with some type of sea animal such as Mithrax crab placed in the cage. Once the turf is eaten by animals, the clean screens are replaced by ones full of algae. Ideally, the more often the screens are changed, the faster the animals grow.

In the absence of a land-based hatchery, small floating boxes or "baby cages" are used to house gravid females until the release of their eggs. The small rectangular cages are covered with a 2mm polyester monofilament screen. When the babies are released, the mothers are removed from the cages. Babies remain in this protected environment until they are large enough to compete with other animals. Changing the algal turf screens in baby boxes is dangerous because the

screen may contain predators. Only a few closely searched screens can be placed in the box while the babies are growing to juvenile size, a 100-day process. The juveniles are then moved to floating "grow out" boxes where the mesh is larger and screens can be changed with fewer precautions.

A key technology issue is the trade-off between the labor needed to operate the project and the ideal growing conditions. In general there is an inverse relationship between the growth rates of the algae and the caged marine animals. The algae grow better in more active water. The marine animals grow better in calmer water. So from the perspective of growth, the algae should be grown on the outside of the reef system and the animal cages should be located in calm waters near shore. Labor costs and personal risks increase the farther apart the cages are kept from where the algae are grown. So from the perspective of labor costs and risks, the screens and cages should be located next to one another. The trade-off between labor and growth would prove to be a key issue in debates over where to locate pilot projects, as well as where to place cages and screens.

In sum, the technology was estimated to be inexpensive to build, labor intensive to operate, and easy to learn, suggesting that it could be readily transferred to a poor and hungry world. Mariculture technology and its transfer to developing nations came to be termed the "blue revolution" (Bailey 1985; Miller 1985; Rubino and Stoffle 1991). The potential of this new technology was reminiscent of agricultural innovations that characterized the Green Revolution, with all of its potential for economic benefit and concomitant social consequences.

**PRACTICAL APPLICATION OF THE TECHNOLOGY** The Smithsonian submitted a proposal to the United States Agency for International Development (USAID) that outlined the scientific and sustainable development benefits that could derive from its transfer overseas. USAID provided almost two million dollars over three years so MSL scientists could develop a series of pilot projects in the Caribbean.

The first base was established on Grand Turk, Turks and Caicos Islands in 1984, with scheduled expansion to three other Caribbean countries by 1986. MSL scientists selected the Caribbean King Crab (also known as the Caribbean Spider Crab), Mithrax spinosissimus Lamarck, as the target marine species. Local fishermen were chosen as the target adopters, who would privately own and operate the mariculture and market the crabs after the pilot stage was successfully completed.

In 1985 USAID funded social (Stoffle 1986) and economic (Rubino, et al. 1985) assessment studies of the mariculture technology. These assessments focused on two pilot projects--one near the village of Willikies, on the island of

Antigua and one near the community of Buen Hombre on the north coast of the Dominican Republic. The latter is the subject of this analysis.

## MARICULTURE IN THE DOMINICAN REPUBLIC

The Dominican Republic received two pilot project sites, despite the fact that there were financial and management resources for only one site. A dispute between the Smithsonian MSL and the director of the key Dominican government agency, the Programa Nacional del Agroacuicultura (PNA), over where to locate the pilot project was resolved by creating two projects, each with separate but equal management and resources. Parties on both sides of the debate presented strong arguments focused on (1) environmental quality, (2) their knowledge of the site, (3) distance from other sites, (4) number of adopters, (5) types of communities near the project, and (6) proximity to existing offices (c.f. Stoffle 1986:66-72).

The preferred Smithsonian site was Buen Hombre, a village situated along the arid northwest coast of the Dominican Republic, about 60 miles east of the Haitian border (Figure 1). This location had an ideal environment for the mariculture, especially a coral reef system with good wave action and clean water. The MSL staff knew the area because of previous research along the Haitian north coast. The site was near the small village of Buen Hombre from which adopters would be chosen. The site was just south of the existing MSL lab in the Turks and Caicos Islands. The Smithsonian clearly placed most emphasis on demonstrating that the crabs could be grown in the best environment, before addressing the issues of marketing the crabs and transferring the technology to other sites in the Dominican Republic.

The Executive Director of PNA preferred a site near the community of Azua, located along the southern coast just west of Santo Domingo. The site was surrounded by many local fishermen, was close to markets and urban centers, and was near to the capital and the PNA fishery department offices. The PNA recognized that water quality and wave action were not as good as in Buen Hombre, but assessed these environmental conditions to be acceptable. Clearly the PNA placed greatest emphasis upon the southern site because of markets and ease of transference to other adaptors. The PNA also wanted to utilize the project to stimulate developing a hatchery and marine research laboratory.

Because of the dual-site strategy, management and the allocation of financial resources became especially delicate issues. In order to afford both sites, the PNA requested PL-480 funds (i.e. U.S. foreign currency return monies) from



the Dominican Government which would help supplement funds provided by USAID. In order to manage the PL-480 funds and to help coordinate activities at the two sites, the PNA established a semi-independent organization known as Fundacion Natura Dominicana Inc. (NATURA). The United States Peace Corps would provide on-site para-professional aquaculture expertise, while the MSL would provide scientific expertise. The dual site strategy would prove to be a key factor affecting the outcome of both mariculture projects.

#### BUEN HOMBRE: 1985

The people of Buen Hombre look north to the sea and south to the mountains. A 30 km long coral reef system is the community's major natural resource asset. The reef system consists of an inner reef about a quarter-mile off shore, and an outer reef located a quarter mile farther out. The coast is hilly, narrow, and dry because it is on the north flank of the Cordillera Septentrional mountain range. The community is unique in that it lacks potable water. The community is relatively isolated because its only transportation link with interior communities is a poorly maintained dirt road over the rugged mountain range. The road often is impassable to motorized vehicles, so water and other essentials are usually transported by horse.

The village consists of a series of farmsteads organized in a line settlement pattern, extending inland from the small lagoon that serves as the launching location for community fishermen. The village, which was settled in 1890 by a family of 13, had grown to approximately 855 people by 1985 (Stoffle 1986:81).

Families cultivate yuca (cassava), maize, yams, varieties of beans, some fruit trees such as lechosa (papaya), and tobacco as the major cash crop. Fields are comprised of two plots--one adjacent to the homestead and another located on the forested flanks of the mountains. Farming is largely slash and burn. Kitchen gardening, charcoal production and collection of wild resources for fuel, medicine and construction are significant economic activities. People typically rely on more than one economic activity, an adaptive strategy termed "occupational multiplicity" (Comitas 1973), that is common throughout the Caribbean. The majority of homes contain nuclear families, although it is common for these homes to be arranged in extended family clusters. Social networks between relatives and neighbors are horizontal and multistranded (Wolf 1966).

Adult males engage in fishing and farming enterprises for household subsistence and cash income. Women play a significant role in agricultural production at certain

critical times in the farming cycle. A few women occasionally accompany their spouses on fishing trips. When rainfall is adequate, women cultivate mixed kitchen gardens, planting staple tuber and vegetable crops as well as medicinal plants and fruit trees. Women manage most aspects of domestic life.

**SOCIAL ORGANIZATION OF FISHING** Few males who identify themselves as primarily farmers also fish. In contrast, all males who identify themselves as primarily fishermen also farm. Consequently, most fishermen belong to both the community-based fisherman's association and the agricultural association. Most farmers only belong to the community-based agricultural association.

The fisherman's association is composed of men who have risen through the ranks of the developmental cycle of fishing, which involves four distinct stages: (1) apprentice, (2) journeyman, (3) craftsman, and (4) beached (Stoffle 1986:95-100). Fishermen begin their careers as apprentices, which involves extended observation and social interaction with a senior fisherman, who is often the apprentice's father. Apprentices do not belong to the fishermen's association. An apprentice becomes a journeyman when he obtains some of his own equipment and is old enough to become a member of the fishermen's association. Journeymen are not yet members of a fishing crew, so they usually fish alone by swimming out from the beach and snorkel-diving to obtain their catch. When there is a need for another fisherman, a journeyman will be invited to join in a fishing trip.

The highest status achieved by fishermen is that of craftsman crew member. At this point in a fisherman's career, he is usually married, has a family, and has become a full-time member of a fishing crew that is composed of relatives, ritual kinsmen and neighbors. Each crew member owns some pieces of equipment needed to fish, so it is only as a unit that a crew has the means of production. Crew members share expenses for food and gasoline and then divide the catch according to what equipment was contributed by each crew member. Some fish are kept for domestic consumption, but the remainder are sold to the fishermen's association, which keeps the fish on ice and bargains with middlemen for the best price (Stoffle 1986:103).

Beached association members are normally elder fishermen who, because of their age or physical disability, have retired from full-time fishing. Still, they occasionally may fish with crews, and share their years of experience, knowledge and wisdom with younger association members.

Fishing crews usually operate in three "shifts" because of frequent equipment failure, access to boats, or other economic commitments in the system of occupational multiplicity. The first shift is usually worked by the majority of fishermen,

who begin about 8:00 AM and return around noon, depending on weather conditions. In the early morning hours, the sea is at its calmest, allowing easier boat travel to the reefs and beyond. Returning is also easy because fishermen have the prevailing northeast wind at their backs.

The second shift begins after 12 noon. Rowing out to the reefs can be difficult against the strong afternoon winds and rough waters. After four or five hours of fishing, the return trip home is facilitated by the same winds.

Several crews fish at night. Their shift begins around 8:00 PM and lasts throughout the night. Equipped with containers of coffee and rum, a flashlight hooked up to an automobile battery, hand lines and hooks, night fishermen have the advantage of calm waters. Fish are attracted to the light so the largest catches are often at night. Night fishing is, however, the most dangerous because of the risks of running into coral heads, damaging boats and motors, and the possibility of being attacked by barracudas or, on occasion, sharks, should the fisherman decide to snorkel dive. In 1985 a great white shark attacked and killed one of the younger fishermen while he was diving. The night shift is the longest because fishermen have to wait until morning to bring their catch to the market, when someone is there to weigh the fish and put them on ice. Each of the shifts, then, has advantages and disadvantages. Some fishermen will occasionally fish more than one shift, going out in the morning and then making another all-night trip (Stoffle 1986:101-102).

**ADOPTION OF MARICULTURE** The 1985 social and economic assessments concluded that the mariculture technology would fit the social and economic characteristics of the community, especially if the mariculture was incorporated as another occupational component in the local system of multiple economic strategies. Community members also value *Mithrax* crabs (called centolla) as food. Because fishermen were familiar with elements of the technology (e.g., plastic screens and piping), they had the necessary skills and tools to build and maintain the screens and crab cages. Finally, the fishermen were willing to participate in the mariculture project.

Local fishermen expressed the desire that fishing crews from Buen Hombre be the social unit to adopt the mariculture technology. The social assessment study supported this recommendation. A 1985 in-field evaluation by USAID's Assistant Environmental Officer in the Latin American-Caribbean Bureau also recommended that extension and outreach efforts should "[W]ork through existing infrastructure (fishermen's coops and associations...etc.) to stimulate interest in the project and encourage fisherman participation" (Hatziolos 1985:10).

Local fishermen made two arguments for this suggestion. First, the decision would eliminate individuals from interior villages who compete for access to beach, reef and sea resources with fishermen of Buen Hombre. Like most small-scale fishermen (Cordell 1988a, 1988b, 1988c), the people of Buen Hombre perceive the coastal waters as part of their community territory. Second, fishing crews already worked cooperatively to build, operate and maintain boats, fish pots and other equipment. Such crews would logically collaborate to construct, maintain and repair algae screens, baby boxes and grow out cages necessary to cultivate the centolla. Individual fishermen would have a difficult time performing all of the necessary tasks of mariculture in addition to other occupational commitments.

Cooperative "ownership" of the project by other social units like the fishermen's association was neither desired by local fishermen, nor was it suggested by the social assessment study. Instead, it was recommended that the fishermen's association oversee the mariculture project once it was fully adopted by local fishing crews. Fishermen expected that other community members would either join the project following initial commercialization or would share in the profits. An agreement was negotiated with NATURA that a portion of the profits from commercialization would be reinvested in the community, either to start new mariculture projects for other fishermen, or for community welfare projects. The agreement to reinvest mariculture profits in the community helped rationalize the use of national funds (PL 480) for the private benefit of individuals. Through reinvestment, all members of the community would be beneficiaries of the mariculture project (Stoffle 1986:118).

**MONITORING MARICULTURE IMPACTS** The social assessment recommended that USAID fund long-term social monitoring of mariculture impacts on role conflict and reallocation among fishermen's families in the community, worker turnover and the potential emergence of community factionalism. The study also recommended monitoring changes in local marketing of harvested crabs, and the possible conflicts that might emerge between Buen Hombre and interior communities in terms of perceived territoriality or ownership of the coral reef (versus the national legal definition of the ecosystem as a common property resource). Also recommended was monitoring mariculture impacts on the agricultural sector of the local economy. Social monitoring would permit pilot project lessons to be applied when the technology was transferred to other portions of the country, the Caribbean, and the world.

A key social assessment recommendation was that project management decisions be made in consultation with the local fishermen during the pilot stage. When the full adoption

stage began with the transference of title to the fishing crews, then most authority would rest with the crew. During this stage the fishermen's association would oversee the reallocation of mariculture profits and the Dominican government would focus its attention on establishing new projects elsewhere in the country.

#### **BUEN HOMBRE: 1989**

By the summer of 1986 the pilot project was operating smoothly, having some positive effects, and on the threshold of reaching the commercialization stage (Stoffle 1986:126-130). In the latter part of the year, Buen Hombre mariculturalists had "closed the cycle," or achieved the successful reproduction of crabs in captivity (W. Bernard, personal communication), but there were still many unanswered technical issues regarding feed and growth rates. This was the only site where the cycle was closed, according to former Smithsonian managers. Fishing pressure on the coral reef was reduced because some fishermen were employed on the project, new boats and motors provided access to new areas to fish, and funds for new deep water fish pots had been provided by NATURA. Such changes had been predicted by the 1985 study, so the 1989 study attempted to measure the extent of these impacts.

**ANTICIPATED MARICULTURE IMPACTS** The 1985 study predicted a series of impacts that would likely occur as a result of the mariculture project. These predicted changes focused on (1) the social organization of fishing, (2) fishing equipment, (3) social organization of fishing crews, (4) fisherman farming, (5) economic impacts, and (6) project innovations based on local knowledge.

**Social Organization of Fishing** The 1985 study predicted that the mariculture might change the amount of time spent fishing and locations where mariculture workers fish. Thirty-eight per cent of project fishermen interviewed in 1989 reduced the amount of time they spent fishing, so they could concentrate their efforts on growing crabs. Moreover, when they did fish, 25% of the fishermen interviewed in 1989 changed their traditional fishing location. These fishermen shifted from the inner coral reef to the outer coral reef and deep water fishing. This survey finding corroborates the 1986 report of the MSL scientist who visited the community during the late spring of that year and observed intensive use of deep water fish pots. As predicted, fishing pressure on the inner coral reef was reduced as a result of the mariculture project.

**Fishing Equipment** The 1985 study predicted that the mariculture project would change the quantity and types of fishing equipment utilized by fishermen. Survey responses in 1989 indicate that approximately 40% of the fishermen changed their fishing equipment. These changes derive from loans for new fishing equipment provided by the NATURA and from new boats and motors provided to project workers. In general there is a close relationship between fishing equipment available, fishing location catch levels, and catch types.

**Social Organization** The 1985 study predicted that if members of crews were hired, the mariculture could be accomplished without causing a modification of social relationship. Only 13% of fishermen interviewed in 1989 reported a change in crew membership. One person, however, reconstituted his entire social network, becoming close friends and associating on a full-time basis with his "mariculture crew" members.

**Fisherman Farming** The 1985 study predicted that commitments to farming could be reduced due to mariculture work. Twenty-five per cent of the fishermen interviewed in 1989 stopped farming altogether as an economic strategy, to concentrate full-time on crab raising and fishing. They left their fields fallow for two years during the life of the project. In addition, 25% of fishermen who continued to farm during the mariculture project reported that they had changed their schedule of farming activities to accommodate commitments to necessary mariculture tasks.

**Economic Impacts** The 1985 study predicted that wage employment during the pilot phase would increase the purchase of material goods. The 1989 survey did not specifically measure this impact, but interview responses indicate that the cash income of project fishermen was increased. With the additional cash, fishermen purchased deep sea watches, improved their homes, and imported more food products from urban markets. Road improvements, stimulated by the project, caused increased fish, animal, and farm produce sales. The 1989 survey measured a decreasing reliance on gathering wild plants for medicine, suggesting an increase in the purchase of professional health care services. There is no free clinic or doctor in the village.

**Local Knowledge and Project Innovations** Mariculture fishermen suggested innovative ideas for improving the technology. These ideas derived from years of observing the coral reef ecosystem including the behavior of the centolla and the growth of algae. The 1985 study predicted that local fishermen would help improve the technology if they were closely involved in its development and identified with its goals.

The fishermen observed that crabs walk horizontally, but the cages were designed so that newborn and juvenile crabs had to cling vertically to the algal turf screens in order to feed. The fishermen observed damage to fragile legs, claws and developing shells, caused by buffeting from rough wave action. Young crabs were shaken from their screens by rough waters and starved to death because they could not get back on the screens. Mariculturists suggested using horizontal screens inserted in the sides of the cage. The horizontal surface would protect the young crabs from buffeting and the cage could be gently rotated a quarter turn when the screens were changed.

Once crabs reached adult size, mariculturists conceived of a "centolla corral," constructed of poles tied together with plastic screen placed around the interior. The corral would serve as a storage pen for market-sized and reproducing adult crabs and would afford protection from severe storms.

Through long term observation of wild crabs, fishermen learned that the centollas eat more types of algae than those grown on project screens. One fisherman pried open the mouth of an adult crab he had just caught and pointed to the type of algae being consumed. The fisherman then indicated that the back legs and claws were draped with other types of algae. Another mariculturist took the researchers a few miles east of Buen Hombre along the beach, where he entered the shallow water and pulled up four types of algae. He identified one variety as commonly grown on the project screens. The other three were softer in texture and would be ideal for newborn and juvenile crabs to eat. The soft algae were abundant in shallow waters inside the inner coral reef and could be collected by fishermen while they fish. All fishermen agreed that crab growth could be increased by hand feeding algae not grown on screens. The fishermen recognized that hand feeding required much more work for them, but they believed the added effort would contribute to the project's success. Fishermen reiterated these perceptions during the 1990 study.

The fishermen recognized that wave action increased algal growth, but the animals preferred quiet waters. This raised the question of where to put the mariculture components. Even though it involved more work for themselves, the fishermen recommended that the algae screens should be placed on the outside of either the first or second reefs, but the cages should be placed inside the inner reef as close as possible to the mangrove swamp. The cages could be anchored with rock or cement anchors on each of the four corners (in contrast to dual anchors used by the project) and submerged in shallower water. A hole in the top of the cages would allow transfer of individuals crabs and hand feeding. Ideas about placement of the cages were also reiterated during the 1990 study.

The long-term experience (over 20 years in one case)

gained from snorkel-diving for fish, observations of marine life and species behavior, and knowledge of local environmental conditions led to a variety of ideas for improving the mariculture technology because Buen Hombre fishermen perceived their ownership of the project in terms of owning fincas del mar (farms of the sea). Refusal to incorporate these recommendations would prove to be a fatal mistake for the project.

**UNANTICIPATED MARICULTURE IMPACTS** The 1985 study failed to predict three key impacts that seemed to have occurred as either a primary or a secondary impact of the mariculture project. These unanticipated impacts include (1) a new road, (2) newcomer residents, and (3) new tourists. The following analysis suggests a close interrelationship between these impacts.

**The New Road** In 1986, USAID and Dominican Republic development funds were used to improve the road connecting Buen Hombre with the nearest community over the crest of the mountain. The new road permits daily travel by motorized vehicles despite the weather. In general people like the new road; this sentiment was expressed again during the 1990 study, but respondents also felt that the road was in need of further improvement. In addition, road improvement seems to have three secondary impacts that may drastically change the community.

**The Newcomers** The new road apparently has caused Buen Hombre's population to grow. Respondents commented during individual and focus group interviews that the size of the village has grown by as many as 50-150 people. Some of the newcomers were individuals, and some were families. Many of the newcomers were relatives of persons living in the community, so the growth has not resulted in an anti-immigrant response. Some newcomers may have been former residents returning to their natal community. Comments made during focus group meetings also suggest that many newcomers did not establish permanent residence in the community. In general, this was confirmed during focus group meetings conducted in 1990.

The cause of the migration is not certain and could only be partially assessed by the 1989 study. When asked why newcomers came to Buen Hombre, respondents replied that they mostly came to fish. Other respondents noted that some came to farm, which may account for the newly cleared fields high up the slopes of the mountain. Still other newcomers came in anticipation of working for the mariculture project. These pull-explanations probably do not fully account for the migration, because there must have been a variety of reasons



newcomers left communities having better human services than those available in Buen Hombre.

Analyses of road construction and improvement projects (Lisansky 1989; Moran 1989; Schumann and Partridge 1989) document a pattern in which colonists spontaneously migrate from other areas to inhabit new lands along the roadside as a response to population pressure, land exhaustion and the desire to start a new life. The 1989 study could not assess the role of such push factors, but these will be key for understanding future demographic trends in the community. It may be that population movements are stimulated by shifts in environmental and economic conditions, but the issue needs further analysis.

**New Tourists** The number of national and foreign tourists visiting and residing in Buen Hombre has increased since the road was improved. Before the new road only one outsider lived in Buen Hombre. Beach front property and plots along the new road have been sold and six new single and multi-family vacation homes have been constructed. There is a direct connection between the new road and these homes because the tourists who drive for hours to spend a few days at these homes need to leave the village regardless of weather. Day tourists come more often because of the new road, but their numbers and impacts are unknown.

Respondents to the 1989 survey perceive the beginnings of tourism as a positive development and would even welcome a small hotel such as the 28-room hotel that has recently been constructed in the neighboring village of Punta Rucia. Positive attitudes toward tourism were generally expressed again during the 1990 study. Concern was expressed that the scale of tourism remain small, unlike what has occurred in other coastal towns such as Puerto Plata.

## MARICULTURE PROJECT TERMINATION

A report from one of the MSL personnel depicts the operation of the project as going relatively smoothly in May of 1986 (Stoffle 1986:126-129). By June of 1986, eight village fishermen had been hired during the pilot stage of the project. The project had at least 10 large growout cages and more than 1,000 screens. These mariculturists represented four of the ten fishing crews in the community and would be the first to adopt the technology. The outlook was positive. The PNA Director predicted that the first commercial crop of Mithrax crabs, some 140 kilograms, would be harvested by October 1986 (Stoffle 1986:130). The mariculture was on the threshold of being adopted. Things went wrong, however, between July of 1986 and 1987.

In July of 1986, the Executive Director of the PNA reported that the Smithsonian would be withdrawing from full-time participation in the project by the following September, earlier than expected. According to an MSL scientist, politics and differential commitments to the mariculture project led to interagency conflicts. According to one expert, USAID's Latin American/Caribbean Division came under pressure because marketable crabs were not being produced within two to three years following funding for research and development (Rubino, personal communication 1990). Consequently, USAID began to lose interest in continued financial support for the pilot project. Peace Corps Volunteers (PCVs) assigned to the project threatened to quit if Smithsonian personnel were not retained as project managers. Eventually all U.S. agencies withdrew support for the project, leaving both Dominican Republic pilot projects dependent upon Dominican financial and technical support.

When the Smithsonian left the project, the PCVs resigned. This resulted in a project leadership vacuum. After the departure of Smithsonian personnel, USAID turned administrative control of the project over to NATURA, a private Dominican foundation. The director of NATURA petitioned the Office of the Secretary of Agriculture and the PNA to assign a new project supervisor. Because of heavy departmental staff commitments, an agricultural engineer was assigned to the project. Another PCV assigned to Buen Hambre was not interested in mariculture, and so the Peace Corps director permitted him to build a school house with private funds he raised in the United States. The agricultural engineer and the newly assigned PCV served as the project supervisors, filling the leadership vacuum created by the withdrawal of the Smithsonian. They assumed supervisory control of the project, failing to recognize the rights of the mariculturists as eventual owners of the technology. Because of their unfamiliarity with the mariculture project and disregard for the ideas of local fishermen, a series of disastrous decisions was made.

The new supervisors decided not to live in the community, but preferred instead to live on one of the project boats, which was left anchored near the outer coral reef. The agricultural engineer recommended that the mariculture project be moved out to the outer reef from its prior location inside the inner reef. Mariculturists disagreed, pointing out that the new location would not provide an adequate buffer against torrential weather and rough seas. The cages, however, were moved to the outer reef. This information was reconfirmed by fishermen during the 1990 study.

According to local fishermen, the project supervisors spent much of their time on the project boat, not working on the project. Fishermen interviewed in 1990 mentioned that the

Dominican supervisor could not swim and knew little if anything about coastal fishing systems. On occasion, the project boat was rented out to tourists for scenic trips along the northern coastline, presumably to generate revenue in order to maintain operation of the mariculture project.

The Dominican project supervisor exhibited "social discontinuity" (Long 1989) behavior documented for Dominican agricultural extension agents (Box 1989). For a variety of reasons extension workers do not produce the "interface" that is desired between national level scientists with new knowledge and local level adopters (Box 1989:176). The new Dominican supervisor broke the productive interface that had been developed between the mariculturalists and the Smithsonian scientists, and a project that was about to succeed would fail because of this discontinuity.

**THE STORM SURGE** The fishermen's recommendation to keep the project cages inside of the inner coral reef and to use the mangrove as a safety valve stemmed from concerns about severe weather. These concerns became a reality when a storm surge hit the north coast. According to the fishermen, screens were torn, baby boxes broke apart and grow out cages destroyed, releasing the near market-sized crab crop raised from infancy by the mariculturalists. Project participants lost both their produce and means of production.

**THE LOAN** Local fishermen did not have the financial resources to rebuild the pilot mariculture project. It can be argued that it should not have been their responsibility to rebuild because they had not adopted the technology, which was in the pilot stage until the first crabs reached the market. NATURA and the director of the Fisheries Department decided that they would provide PL-480 funds to rebuild the project, but would provide them in the form of loans to mariculture workers. Each mariculturalist was offered a loan of up to \$2,000 pesos to rebuild screens and cages. Fishermen were given a twelve month time period in which to repay the loans.

Confronted with a credit payment as well as daily operations on the project, fishermen intensified their fishing efforts in order to sell their catch for cash. Several fishermen commented that it was a bad time of the year for fishing.

The twelve month repayment deadline passed, with the majority of project workers having to default on their loans. When they could not make payments, the Dominican managers took most of the project boats and motors. Some of the reclaimed boats were sold as scrap. The rest of the equipment was taken to the other project site at Azua, which was soon closed.

**LONG-TERM CONSEQUENCES OF TERMINATION** Termination of the

mariculture project has had effects that may continue to occur over the long-term in Buen Hombre. These are (1) intensification of fishing and (2) loss of economic diversification.

**Intensification of Fishing** The primary impact of project termination is that fishermen have intensified their fishing efforts. Former mariculturists now fish seven days a week. Most of them fish the morning shift, but 1989 observations indicate that others make more than one fishing trip approximately every other day. Some fishermen will go out in the morning every day with their crew and fish until noon. Two or three times a week, they will go out on an all night trip with nets and hand lines. Several of the fishermen have increased the length of the fishing trip.

Fisherman's association fish catch records for the same 11 day period in 1985 and 1989 were compared in order to measure changes in catch rates. This analysis demonstrates that the total weight of seafood sold to the association in 1985 was 331.60 pounds and in 1989 was 819.24 pounds, an increase of 487.64 pounds. The percent increase seems to reflect increased fishing effort because the association's membership remained approximately the same. This figure significantly underestimates the total amount of seafood now being caught, because some percentage of the new immigrants to Buen Hombre are fishing and none belong to the fishermen's association.

The increase in fishing by local fishermen's association members and immigrants is exacerbated by an increase in the number of fishermen from other areas exploiting these reefs. Local fishermen say that these outside fishermen do not respect locally recognized territorial rights. As a consequence of increased fishing pressure, fishermen commented that the fish catches per effort have reached their lowest point in 20 years. This concern was reiterated during the 1990 study. Still, fishermen believe the reefs off Buen Hombre are the best fishing spots around--perhaps one reason neighboring fishermen have begun to exploit the area.

**Loss of Economic Diversification** Among families whose members worked on the project, cash income has declined as a result of its termination. The mariculture project provided economic diversification and another component of the system of occupational multiplicity. Had the project succeeded, profits generated from crab sales would have allowed the community to invest in its own development needs (e.g., a water system, health services, education). The loss of additional income is especially unfortunate because agricultural conditions have worsened due to lack of rainfall.

Inflation in the national currency has also had major negative effects. Commodities purchased outside the community

are more expensive, given the decreased value of the peso over the last five years (the exchange rate changed from DR \$2.00 to US \$1.00 in 1985 to its current rate of over DR \$7.25 to US \$1.00). Residents of Buen Hombre have always had to purchase water for drinking, cooking and other domestic uses. 1989 interview responses indicate that many households spend almost half of their weekly income (and perhaps some savings) to purchase water, delivered by truck in 15 gallon drums at \$5.00 pesos per gallon. Perhaps the most poignant moment during the 1989 fieldwork occurred when one of the more skilled of fishermen returned home early one evening with his afternoon catch. Telling his spouse that he had the night's supper, she replied that there was no water to cook the rice and beans that form the staples of the village diet together with fish. Inquiring as to whether relatives or neighbors had any water to spare were met with negative responses. Everyone had already eaten, and so had used the last of their water for the day (authors' 1989 fieldnotes).

Even when fishing is productive, then, the lack of ready cash prevents the purchase of means by which to prepare harvested food. Some families have taken to collecting rain water in empty drums, buckets and pots. Some individuals were observed bathing in the rain during a thunderstorm.

In addition to the loss of mariculture income, subsistence goods and cash derived from agricultural produce has also declined according to those interviewed. As mentioned, the north coast is arid, comprised of scrub forest vegetation resembling western U.S. deserts. Respondents commented that 1989 had been the driest year of the previous four, which were also very dry. The people of Buen Hombre appear to be experiencing extended drought conditions.

The drought situation was confirmed dramatically during the 1990 study. Comments made by community members and government officials, as well as national newspapers, emphasized the impacts of the severe drought that has affected the entire nation. Millions of dollars in crop and livestock losses have stimulated government relief programs, including crop seedling distribution, to the hardest hit areas.

Lack of adequate rainfall has led women to temporarily abandon kitchen gardening, remarking that nothing survives without water. Ethnographers were repeatedly told that "nothing grows here any longer." Tobacco, the cash crop, remains stacked inside houses and outbuildings because there is no longer a decent price received for it according to agricultural association members. Drastic conditions have begun to stimulate outmigration from Buen Hombre. The community is thus losing population as a result of the drought and poor economic conditions.

Buen Hombre lacks other basic services--adequate education, health care, and sanitation. The village also has

no electricity. As one former project worker summed up the current situation, "Aqui no hay nada" ("here there is nothing"). Community residents are saddened and embittered by their daily struggle for survival. They had counted on the mariculture project as the springboard that would lead to further community development.

The changes brought about by the termination of the mariculture project, the new road, resulting migration and increase in tourism, may have severe social, economic and environmental consequences for the people of Buen Hombre and their local environment, including terrestrial and marine ecozones. Adverse impacts may be exacerbated by the drought situation.

## CONCLUSIONS

These three social assessments have documented that the mariculture technology transferred to local small-scale fishermen in Buen Hombre was feasible and had the potential of being successful. Further success would have been achieved had technical assistance staff listened to the ideas for improvements from knowledgeable, experienced and intelligent local people.

The people of Buen Hombre, like the majority of other potential development beneficiaries (Scudder 1987:190-191), want development, but on their terms and under their control. To illustrate, both managers of the Punta Rucia hotel wrote an official corporate letter of support for re-establishment of the mariculture project at the end of the 1989 and 1990 studies. The Director of the Department of Fishery Resources is interested in implementing fisheries projects in his country. The Smithsonian also has indicated some interest in starting new mariculture efforts. However, as the President of the fisherman's association put it, "...if we cannot manage a new mariculture project ourselves, we do not want it. Do not come back."

Many of the lessons that derive from this case have been known for decades by development anthropologists (e.g., McCay 1980:7; Brokensha et al. 1980; Cernea 1985; Chambers 1983; Eddy and Partridge 1987; Kottak 1985; Partridge 1984; Pillsbury 1986; Scudder 1987). As McCay has noted, the most appropriate technologies will not succeed unless strategies for resource management are included in their transfer. Most programs have failed because, among other factors such as politics, poor science and manipulation by management:

...there is very little appreciation of the socio-cultural realities of the systems being managed and even less

appreciation of the potentials of existing informal or indigenous forms of resource management... Perhaps these, as well as indigenous technologies, might be built upon, resulting in resource management, as well as development, "from below" (McGay 1980:11).

Development planners, policy makers, and project managers in government, national and international agencies must come to grips with adopting a commitment to collaboration with potential beneficiaries, recognizing that local communities have the capacity to manage their own resources and development.

Formulating practical strategies for involving the Buen Hombre fishermen in a new mariculture project will have to entail not only the transfer of the technology, but also the transfer of management and ownership responsibilities. To perceive them as "workers" adopting a new technology does not go far enough. They must become the owners, operators and managers of their own fincas del mar.

#### FOOTNOTES

1. Funds for the field research on which this paper is based were provided by the University of Michigan's Population-Environment Dynamics Project (PEDP) through the United Nations Fund for Population Activities (UNFPA) and the MacArthur Foundation. Grateful thanks is expressed to Professors Gayl D. Ness and William D. Drake, who served as co-directors of the PEDP, for their guidance and assistance throughout the research process. Special thanks is due to Dr. Steven Heeringa of the Sampling Unit at the Institute for Social Research for his assistance in developing the research design and sampling procedure for the study. We are also grateful to Dr. Walter Adey of the Smithsonian Institution for all of his assistance.

In the Dominican Republic, our deep appreciation is expressed to Lt. Com. Rafael Negrette O., Director of the Department of Fishery Resources, for consulting with us, providing letters of introduction, and his overall support of the research. His dedication to pursuing the goal of fisheries development with a sensitivity to the needs and knowledge of local people helped facilitate the research effort.

Special thanks are due to William and Kathy Bernard for

taking time from their busy work schedules to make local arrangements and provide valuable assistance in making government contacts before entering the field. As former project managers for the Smithsonian, they provided valuable insights and first-hand information on the mariculture project history and operation in the field. They also graciously served as reviewers of an earlier version of this paper. Thanks are also due to Sr. Francisco Gerales, former Director of the Department of Fisheries, for his many insights into the project and reviewing the manuscript. Michael Rubino also provided valuable comments on the analysis. Any errors in fact or interpretation in this paper are, however, the sole responsibility of the authors.

The authors would also like to express their thanks to Drs. John Poggie and Richard Pollnac for inviting us to present the findings of this study in their fisheries development session at the American Anthropological Association 1989 annual meeting in Washington, D.C., as well as for all of their efforts in publishing the symposium papers.

Finally, our deepest appreciation is extended to all of the people of Buen Hombre for their generous hospitality, assistance, and for sharing their knowledge about the project and community life with us. We would especially like to thank Tuba, Narciso and their families for all of their kind assistance. Without their participation, this study would not have been possible. A todo de nuestros amigos en Buen Hombre, muchísimas gracias.

## REFERENCES

- Adey, Walter. 1983. Primary Production of Algal Turfs and the 'Caribbean King Crab.' Washington, D.C.: Marine Systems Laboratory, Smithsonian Institution.
- Adey, Walter and Dennis Farrier. 1989. The Biology, Ecology and Mariculture of Mithrax spinosissimus, Utilizing Cultured Algal Turfs. Los Angeles: The Mariculture Institute.
- Arensberg, Conrad. 1967. Upgrading peasant agriculture: is tradition the snag? Columbia Journal of World Business (Jan./Feb.):63-69.
- Arensberg, Conrad and A. H. Niehoff. 1964. Introducing Culture Change: A Manual for Americans Overseas. Chicago: Aldine.



- Bailey, Conner. 1985. The blue revolution: the impact of technological innovation on Third-World fisheries. *The Rural Sociologist* 5(4):259-266.
- Bailey, Conner. 1988. The social consequences of tropical shrimp mariculture development. *Ocean and Shoreline Management* 11:31-44.
- Box, Louk. 1989. Knowledge, networks and cultivators: cassava in the Dominican Republic. *In* Norman Long (ed.) *Encounters at the Interface*. The Netherlands: Wageningen, Agricultural University.
- Brokensha, David, D. M. Warren and O. Werner (eds.). 1980. *Indigenous Knowledge Systems and Development*. Lanham: University Press of America.
- Browder, John O. 1989. *Fragile Lands of Latin America: Strategies for Sustainable Development*. Boulder: Westview Press.
- Cernea, Michael M. (ed.). 1985. *Putting People First: Sociological Variables in Rural Development*. New York: Oxford University Press.
- Chambers, Robert. 1983. *Rural Development: Putting the Last First*. London: Longman.
- Clay, Jason W. 1988. *Indigenous Peoples and Tropical Forests: Models of Land Use and Management from Latin America*. Cambridge: Cultural Survival, Inc.
- Comitas, Lambros. 1973. Occupational multiplicity in rural Jamaica. *In* L. Comitas and D. Lowenthal (eds.) *Work and Family Life: West Indian Perspectives*. New York: Anchor.
- Cordell, John. 1988a. Introduction: sea tenure. *In* J. Cordell (ed.) *A Sea of Small Boats*. Cultural Survival Report No. 26. Cambridge: Cultural Survival, Inc.
- Cordell, John. 1988b. Social marginality and sea tenure in Bahia. *In* J. Cordell (ed.) *A Sea of Small Boats*. Cultural Survival Report No. 26. Cambridge: Cultural Survival, Inc.
- Cordell, John (ed.). 1988c. *A Sea of Small Boats*. Cultural Survival Report No. 26. Cambridge: Cultural Survival, Inc.
- Denslow, Julie and Christine Padoch. 1988. *People of the Tropical Rainforest*. Berkeley: University of California Press.
- Eddy, Elizabeth M. and William L. Partridge (eds.). 1987. *Applied Anthropology in America*. (2nd ed.). New York: Columbia University Press.
- Foster, George. 1973. *Traditional Societies and Technological Change*. New York: Harper and Row.
- Gallaher, Art, Jr. (ed.). 1968. *Perspectives in Developmental Change*. Lexington: University of Kentucky Press.

- Hatzioios, Marea E. 1985. Trip Report--Site Visits to Two Mariculture Operations in the Caribbean: I. Caribbean King Crab (Mithrax spinosissimus) and II. Queen Conch (Strombus gigas). Manuscript.
- Ives, Jack D. and Bruno Messerli. 1989. The Himalayan Dilemma: Reconciling Development and Conservation. London: Routledge for the United Nations University.
- Kottak, Conrad P. 1985. When people don't come first: some sociological lessons from completed projects. In M. Cernea (ed.) Putting People First. New York: Oxford University Press.
- Lisansky, J. 1989. Migrants to Amazonia: Spontaneous Colonization in the Brazilian Frontier. Boulder: Westview Press.
- Long, Norman (ed.). 1989. Encounters at the Interface: A Perspective On Social Discontinuities in Rural Development. Wageningse Sociologische Studies #27. The Netherlands: Wageningen, Agricultural University.
- McCay, Bonnie J. 1980. Appropriate technologies, fisheries, and resource management. APPROTECH 2(4):7-12.
- McCay, Bonnie J. 1981. Development issues in fisheries as agrarian systems. Culture and Agriculture 11:1-8.
- Miller, Julie. 1985. Diet for a blue planet: tasty crabs, sold on the dock for \$4 per pound, are the first edible success of a novel approach to ocean farming. Science News 127:220-222.
- Moran, Emilio F. 1989. Adaptation and Maladaptation in Newly Settled Areas. In D. Schumann and W. Partridge (eds.) The Human Ecology of Tropical Land Settlement in Latin America. Boulder: Westview Press.
- Morgan, David L. 1988. Focus Groups As Qualitative Research. Sage University Paper Series on Qualitative Research Methods, Vol. 16. Beverly Hills, California: Sage Publications.
- Niehoff, Arthur H. 1966. A Casebook of Social Change. Chicago: Aldine.
- Partridge, William L. (ed.). 1984. Training Manual in Development Anthropology. Special Publication No. 17. Washington, D.C.: American Anthropological Association and Society for Applied Anthropology.
- Pillsbury, Barbara. 1986. Making a difference: anthropologists in international development. In W. Goldschmidt (ed.) Anthropology and Public Policy. Special Publication No. 21. Washington, D.C.: American Anthropological Association.
- Pinkerton, Evelyn (ed.). 1989. Co-operative Management of Local Fisheries: New Directions for Improving Management and Community Development. Vancouver: University of British Columbia Press.

- Robben, Antonius C. G. M. 1985. Sea tenure and conservation of coral reef resources in Brazil. *Cultural Survival Quarterly* 9(1):45-47.
- Rubino, Michael, Bruce Epler and Charles Wilson. 1985. Preliminary Economic Feasibility of Mithrax Mariculture (Caribbean King Crab). Report to Marine Systems Laboratory, Smithsonian Institution. Washington, D.C.: Traverse Group, Inc.
- Rubino, Michael and Richard W. Stoffle. 1989. Caribbean Mithrax crab mariculture and traditional seafood distribution. In G.T. Waugh and M.H. Goodwin (eds.) Proceedings of the Thirty-Ninth Annual Gulf and Caribbean Fisheries Institute, (Hamilton, Bermuda), 1986. Charleston, SC: Gulf and Caribbean Fisheries Institute.
- Rubino, Michael and Richard W. Stoffle. 1991. Who will control the blue revolution? economic and social feasibility of Caribbean crab mariculture. Forthcoming in *Human Organization*.
- Schumann, Debra A. and William L. Partridge (eds.). 1989. *The Human Ecology of Tropical Land Settlement in Latin America*. Boulder: Westview Press.
- Scudder, Thayer. 1987. Opportunities, issues, and achievements in development anthropology since the mid-1960s: a personal view. In E. Eddy and W. Partridge (eds.) *Applied Anthropology in America*. (2nd ed.). New York: Columbia University Press.
- Stoffle, Richard W. 1986. Caribbean Fishermen Farmers: A Social Assessment of Smithsonian King Crab Mariculture. Research Report Series, Survey Research Center. Ann Arbor: Institute for Social Research.
- Stoffle, Richard W., Michael Rubino and D.L. Rasch. 1988. Fishermen and crab mariculture in the Caribbean. *Practicing Anthropology* 10(1):10-11, 14.
- Wolf, Eric. 1966. *Peasants*. Englewood Cliffs: Prentice Hall.
- World Bank. 1989. *Striking a Balance: The Environmental Challenge of Development*. Washington, D.C.: The World Bank.
- World Commission on Environment and Development. 1987a. *Food 2000: Global Policies for Sustainable Agriculture*. London: Zed Books.
- World Commission on Environment and Development. 1987b. *Our Common Future*. New York: Oxford University Press.