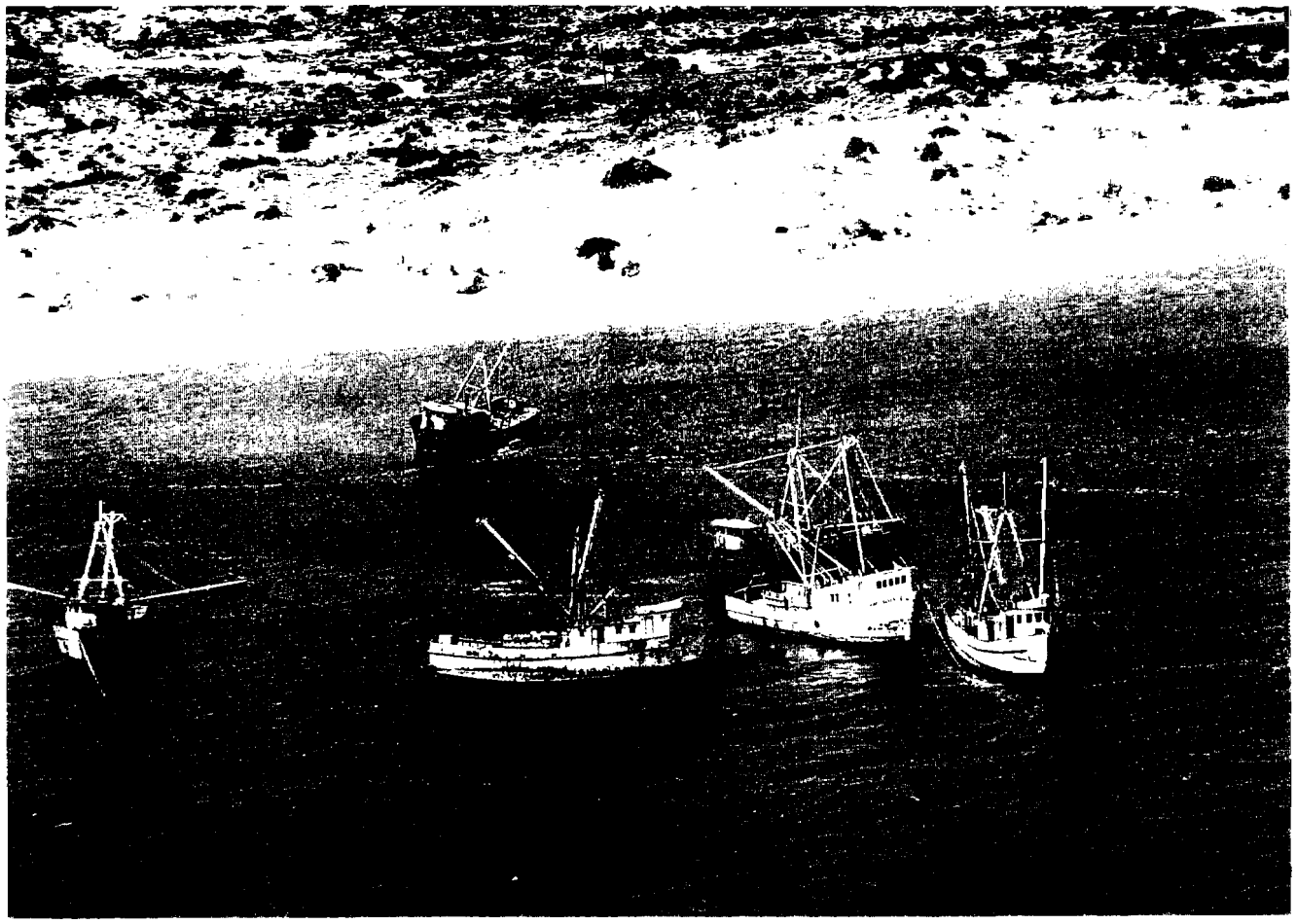
Maritime Community and Biosphere Reserve: Crisis and Response in the Upper Gulf of California

Thomas R. McGuire and James B. Greenberg
Editors



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Cover photo: a portion of the trawler fleet from El Golfo de Santa Clara, at anchor during the *veda*, 1992; photo by Tom McGuire

Second Edition

Acknowledgments

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Authorship of the following chapters is attributed to those of our research staff who had primary writing responsibilities. This does not in any way belittle the immense contributions of the rest of the team. Terry Sprouse had primary field responsibility in San Felipe. Gloria Ciria Valdez and David Halmo were responsible for the quantitative data collection and ethnographic work in El Golfo, and Gerardo Bernache oversaw the preparation of the household questionnaire. Although they all remain hidden in these chapters, such was not the case during the conduct of research. Two of the maps prepared for this report by M. Nieves Zedeño are based in part on bathymetric charts contained in the dissertation by R.W. Thompson (University of California, San Diego, 1965).

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We have not attempted to standardize the reporting of monetary data in this report, preferring simply to use the idiom in which the various currencies were reported to us. During our fieldwork, the exchange rate was 3,100 old pesos to 3.1 new pesos to US $1.00, more or less.

T.R.M.

J.B.G.

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ico D.F., 1992), and *Lazos de Confianza: Los Sistemas Culturales de Asociaciones Rotativas de Crédito entre Mexicanos y Chicanos Urbanos* (Fondo de Cultura Económica, México D.F., forthcoming).

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Chapter 1

Introduction: Crises and Opportunities

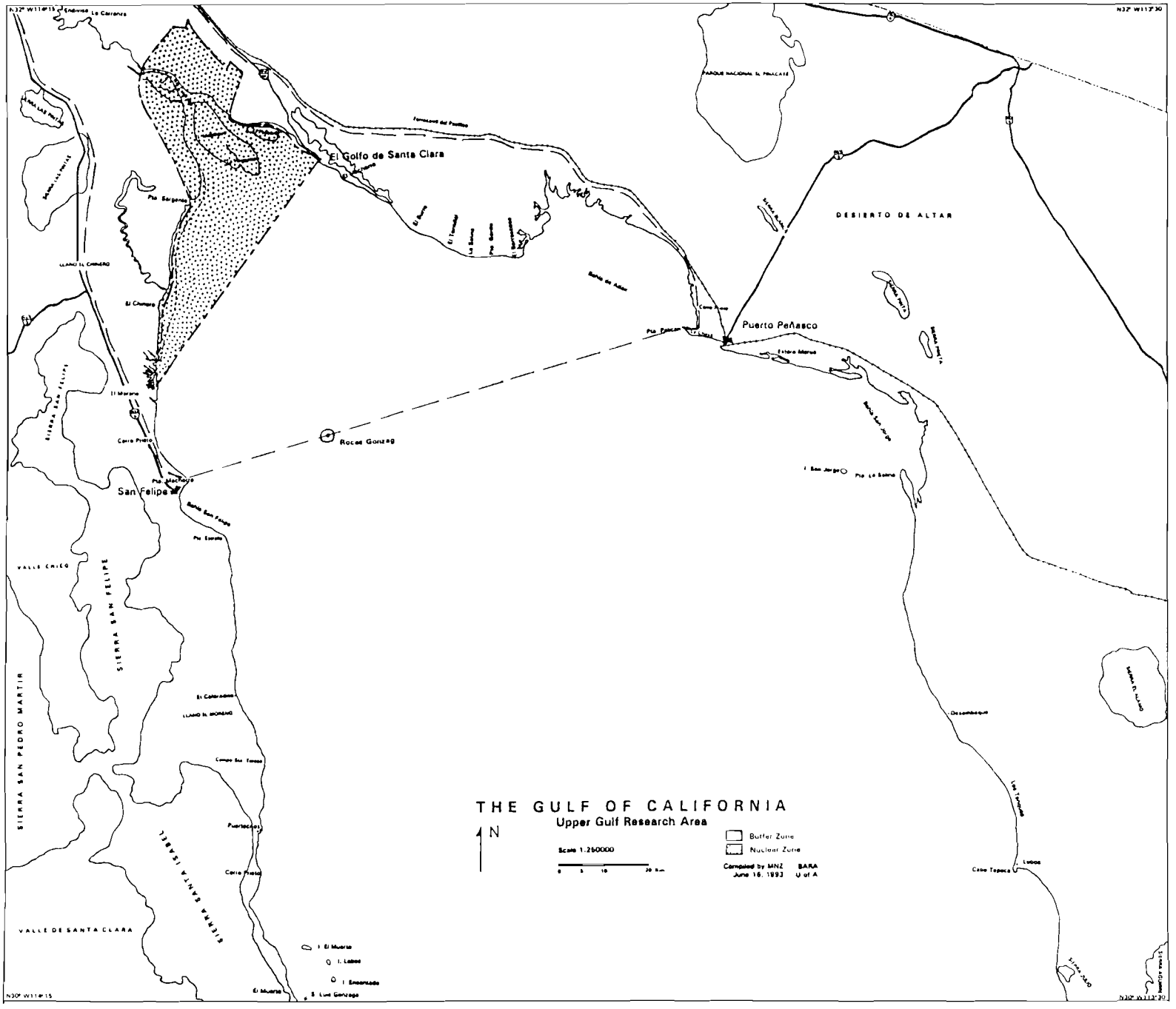
Thomas R. McGuire

By Presidential Decree, the "Reserva de la Biósfera Alto Golfo de California y Delta del Río Colorado" was established on June 10, 1993. The explicit objectives of the reserve are (1) to conserve the ecosystems of the Sonoran Desert, the upper Gulf of California, and the Delta of the Río Colorado; (2) to grant permanent protection to unique species such as the totoaba, the vaquita, the desert pupfish, and various bird species; (3) to regulate productive activities to safeguard natural resources; (4) to promote alternative economic activities that will raise the quality of life of resident peoples; (5) to conduct scientific investigations and environmental education in the region; and (6) to recuperate and preserve the flora and fauna and environmental quality (Diario Oficial 1993).

Our primary concern, as social scientists, is with the culture, society, and economy of residents and users of the upper Gulf. We attempt to predict how the status and concept of a biosphere reserve will affect the lives and livelihoods of those residents and resource users. We do not, however, present a formal "social impact assessment" of the biosphere reserve, for the simple reason that the "action" has already been taken. Social impact assessment methodology, through which alternative proposed actions are evaluated against one another, is thus no longer appropriate. We do, however, work on the presumption that the implementation and management programs of the biosphere reserve are still to be defined, so our set of recommendations will address these processes, not the declaration of the reserve itself.

Crises and opportunities

The boundaries of the biosphere reserve delíneate a region in crisis, a crisis that has ecological, economic, social, and historical dimensions. Some of these dimensions are highlighted in recent commercial fisheries statistics from the community of El Golfo de Santa Clara, near the old mouth of the Colorado River. Reported landings of shrimp for the 1987-1988 season amounted to 275,043 kg, 242,211 kg the following year, and 162,965 kg for 1989-1990. For the season of 1990-1991, landings fell to 33,623 kg, although the same number of shrimp trawler trips were undertaken. Catches rose somewhat in 1991-1992,



Map 1. The Biosphere Reserve of the Upper Gulf of California and the Delta of the Colorado River

to 45,582 kg, with half the fishing effort of the previous year. In a desperate effort to compensate for the collapse of the shrimp stock, fishermen turned to the exploitation of *chano*, a low-priced finfish destined for the Asian manufacture of *surimi*: 708,276 kg of finfish, largely chano, were caught in 1992, the first year that there were buyers for that species. Prices received by fishermen for shrimp are roughly 10 times that received for chano, so the Santa Clara fishery would have to capture some 2,000,000 kg of chano to match the income levels from shrimp stocks in the late 1980s.

The data are crude, as are most fisheries statistics throughout the world. But they nonetheless hint at the intertwined crises of the upper Gulf of California. Quite simply, shrimp stocks are not able to sustain the decades of heavy exploitation in the region, and fishermen, at least those in Santa Clara, are turning their effort to other species, out of economic necessity and cultural survival. Many fishermen, as well, are simply out of work.

The causes of the crisis are multifaceted. Shrimp trawler fleets throughout the Gulf and Pacific littoral grew markedly in the 1970s, despite warnings as early as 1971 of "una posible crisis" of overcapacity and diminished yields (Chávez and Lluch 1971:141; see also Lozano 1972).

Efforts were made in the early 1980s to curtail this expansion and return the fleet to cooperative ownership after a period of private investment in the 1970s, but the capacity was still in excess of economically profitable numbers. One study estimated an annual loss per trawler of $30,000 US (Rodríguez de la Cruz 1987:50). This loss compounded a debt problem for most cooperatives dating to the 1982 transition, when coops were required to purchase their equipment and boats from private owners, often at inflated costs (Miller 1991). By the end of the decade, the economic crisis in the industry came to a head: cooperatives were on the verge of bankruptcy, the state-controlled BanPesca, which had been providing loans at relatively benign interest rates, was closed down, and, it appears, the shrimp stock itself collapsed.

Into the 1990s, the problems continued. Active trawler fleet size was reduced to some 40 percent of its level during the 1980s. Cooperatives have closed, their boats repossessed by private banks and sold, frequently well below value, to private investors. There has been a corresponding demise in employment and output of fisheries-related industries -- boat yards, processing plants, and outfitters.The small-boat sector, a multi-species, multi-gear fishery, has shown more resiliency through the crisis. But it, too, has suffered from uncontrolled expansion, overcapacity, lack of shrimp, and lack of markets for other species.

The economic crisis in the fisheries of the upper Gulf has both ecological causes and ecological effects. In addition to overcapacity and overexploitation, a number of other factors have been noted as possible contributing causes to the

decline in stocks. The cessation of river flow is a favorite factor among local fishermen as well as some scientists -- the effects being felt through reduced estuarine habitat for nursery grounds and higher salinities, less conducive to growth. A series of warm oscillations through the 1980s ("El Niño"), perhaps associated with "red tides," may have caused shock waves throughout the ecosystem. Other potential culprits, anthropogenic in nature, include habitat destruction, port pollution, the inadvertent introduction of virus-carrying shrimp from aquacultural operations into the natural environment, and the harvest of wild postlarvae to stock shrimp ponds. And there are likely ecological consequences, whose magnitude is similarly unknown at this point, of the economic crisis in the fisheries. One, noted above, is the shifting of effort to heretofore lightly exploited stocks. Others include the potential environmental impacts of alternatives to commercial fishing: habitat degradation through tourist infrastructure development and the possibility of increased water pollution due to the expansion of port facilities and aquaculture.

In this dim picture of the upper Gulf of California, we see opportunity. Virtually no one in the upper Gulf is willing to conduct business as usual. And the Presidential Decree affirms that business will not be conducted as it has since the 1970s. The economic plight of the fishery, for which the fishermen themselves need shoulder only part of the blame, affords the opportunity, in essence, to start over. What we attempt to develop in this report are some reasonable ways of going about that task.

The nature of biosphere reserves and "ecodevelopment"

As one of a dozen technical categories recognized by the International Union for the Conservation of Nature and Natural Resources (IUCN, now World Conservation Union) for the management of the world's protected areas, "biosphere reserve" promotes at once the conservation of resources and the planned use of resources by resident peoples (Brechin, West, Harmon, and Kutay 1991:7). The category thus differs significantly from the national park model -- based largely on the evolution of the system in the United States -- in which "the idea that people should not live in protected areas or consume their resources are virtually synonymous with the national park ideal" (Ibid.:10). But bioreserves differ as well from multiple-use management areas, another of IUCN's categories, likewise modeled on US experience:

> National Forests in the United States provide an example where multiple-use principles allow exploitation of timber, forage, and wildlife, as well as host recreation, which may substantially alter the natural ecosystem (Ibid.:7).

Thus situated, the category of bioreserve seemingly encompasses a range of options for balancing conservation with development. Yet what appears

unique about the bioreserve concept is that there need not be a trade-off between conservation and development (see Stone 1992). Reporting on the general consensus reached at the United Nations Conference on the Human Environment in 1972, Raymond Dasmann offers a working notion of what is now called "ecodevelopment" or "sustainable development":

> For a long time it has been said that economic development must lead to sustainable ways of life. For an equally long time it has been agreed that nature conservation cannot succeed unless the needs of people are taken into account; you cannot have lasting conservation in the midst of human poverty and suffering. Similarly, it has been agreed that conservation and development must go forward together; development will not lead to a sustainable way of life if conservation principles are ignored (1988:487).

We take this as the fundamental premise for the concept of bioreserve, a premise which appears to be embodied as well in the two "objectivos de la unidad de conservación" of the proposal for the upper Gulf bioreserve, specifically: "Conservar los valores biológicos" and "Mantener y fortalecer las actividades económicas de la región, mediante el Uso Sustentable de los Recursos Naturales" (Anon. 1993:55).

However, we do not, *a priori*, assume a fixed definition of "sustainability." Applied to resource exploitation, there are three underlying dichotomies to the concept of sustainability. In terms of technology, the distinction is one of traditional gears and industrial gears. In terms of resource exploitation rates, it is between "sustainable" exploitation and overexploitation. Finally, in terms of the destination of natural resources, the contrast is between subsistence use and commercial markets. Now, the predominant definition of sustainablity in the conservation literature joins traditional technology, sustainable rates of exploitation, and subsistence or home consumption. This is a limiting definition. There are abundant examples of overexploitation by traditional technologies, of industrial technology producing for home consumption, and of inadequate commercial market channels fueling overexploitation (West and Brechin 1991).

In the area of fisheries stock assessment, the concept of a sustainable rate of exploitation has proven to be particularly troublesome. In theory, the concept is simple:

> The catch obtained from a level of effort and its corresponding equilibrium population is called a sustainable, or sustained, yield. It is sustainable because population size will not be affected by fishing, since catch is replaced by natural increase. Therefore, the same level of effort will yield the same catch in the next period (Anderson 1977:26).
>
> In practice it has proven to be biologically and economically disastrous.

Typically, fishing up to levels of "maximum sustainable yield" (MSY) produces excessive capacity, overcapitalization, reduced landings and earnings per vessel, and may induce stock collapses, particularly in the face of unanticipated environmental and climatic perturbations (Nielsen 1976; Hilborn and Sibert 1988; McGuire 1991).

Moreover, the entire concept of sustainable yield has recently been called into question, due to the operation of "chaos" in marine ecosystems. As Wilson and Kleban briefly explain,

> ...what we mean by a chaotic fishery is one in which the time path of abundance of individual species has no equilibrium tendency but varies unpredictably within certain limits (1992:67).

They go on to suggest that the fishermen themselves may have learned what these limits are:

> Our basic argument is that the practical management of chaotic fisheries rests upon information and knowledge about the relatively stable ecological parameters of the fishery. This is the kind of knowledge that fishermen can be expected to acquire through observation and experience...Management based on this kind of knowledge may be not only the most effective way to conserve our fisheries resources, as argued here, but it is also likely to be a management approach that is credible (1992:72).

While we by no means equate current fishing practices in the upper Gulf with "sustainability," we do listen carefully to this local knowledge. Sustainability -- the reasonable mix of technologies, uses, and rates of exploitation -- is an empirical issue, to which our research is addressed.

Ecodevelopment or sustainable development also raises the question: for whom? The establishment of the bioreserve and the ensuing implementation and management regimes will have negative and beneficial consequences for resource users in the upper Gulf. It is our premise, as anthropologists, that those who are called upon to sacrifice should also be among the beneficiaries. In addition, to the extent that resources are redistributed, it is our contention that the redistribution should be in the direction of (1) those with legitimate historic claims to those resources and (2) those with the most pressing economic needs.

Units of analysis

It should be emphasized at the outset that our study area is not coterminous with the boundaries of the biosphere reserve, boundaries which were drawn after our study had been conceptualized, designed and funded. Rather, our primary unit of analysis may be defined as the group of users of marine resources in the upper Gulf. This unit has both human and spatial components. First, it is com-

prised of four "communities," the towns of San Felipe, El Golfo de Santa Clara, and Puerto Peñasco, and the group of "outsiders" who utilize the marine resources of the upper Gulf. The spatial component, again, it not set by the lines of the reserve. We are concerned with activities carried out by our human users within the reserve, but we are also concerned with marine and coastal areas outside the reserve which may be affected by regulations established for the use of the reserve.

Overview of report

The political ecology of the upper gulf

Part I of the report is a descriptive and analytical discussion of the communities of marine resource users in the upper Gulf. We approach this from the theoretical perspective of "political ecology." Through this approach, we attempt to define the forces driving behaviors in the region -- driving what is indeed an ecological and economic crisis. Many of these forces are external to the region: market demands, monetary policies, fisheries management policies and practices, historic patterns of technological growth and change in the fishing industry. And we attempt to understand how these forces play themselves out on the ground -- in the communities of the upper Gulf and in the marine environment. As a whole, then, Part I is a "baseline" study of how the communities work, now and in the recent past.

Assessment, implementation, and management

Part II draws upon the analyses offered in Part I to evaluate the potential impacts of the resource management and land use changes that will result from the establishment of the biosphere reserve in the upper Gulf. In this section, we also propose and evaluate alternative fisheries management options as well as alternative occupational options for the region. Finally, we suggest ways and means by which the reserve may be implemented and managed to reduce the negative impacts and assure the beneficial impacts will accrue to the appropriate segments of the population.

Chapter 2

Methods of Investigation

James B. Greenberg

In carrying out this research, we have employed rapid appraisal (RA) methods (See Conway and McCracken 1990, Chambers 1985, Rhoades 1985). This approach maximizes the quality of information that may be gathered given limited resources and time. These RA techniques use a mixed methodology that begins with review of secondary literature, followed by short fieldtrips to identify the important variables and segments of the population that require study. This initial phase is then followed by intensive fieldwork which targets these groups using a variety of ethnographic techniques to collect data such as participant observation, in-depth interviews, focus group interviews, and formal surveys. To assemble the information required we divided our efforts into a number of components: review the existing literature and analysis of secondary sources of data; rapid assessment visits to the region; intensive ethnographic fieldwork in the communities which included household and business surveys as well as ethnographic studies of fishing. Between January 6th and May 14th of 1993, team members conducted 60 man-days of actual fieldwork in El Golfo de Santa Clara, 73 days in San Felipe, 86 days in Guaymas, and 132 days in Puerto Peñasco.

Review of the literature and analysis of secondary data sources

In order to assess the infrastructure of the various communities in the region, prior to beginning fieldwork, we searched and reviewed of the existing literature on Sonora, Baja California, and the upper Gulf. In addition to these sources, we also examined the literature on Mexico's fisheries, marine ecology of the upper Gulf, shrimp, studies of marine and coastal reserves designed for habitat protection, evaluations of sanctuaries and area closures promulgated for the enhancement of exploited fish stocks, case studies of the impact of tourism and ecotourism on coastal communities, evaluations of gear and effort restrictions in fisheries, studies of aquaculture, the literature on *maquiladoras*, and models and empirical studies of the costs, benefits, and difficulties of enforcing marine resource regulations in other areas. This literature was used both to establish baseline profiles of the region and to facilitate comparisons with similar data from other regions. As fieldwork progressed we continued to search for additional materials to incorporate in our analysis. For instance, in addition to the

review of existing literature, as part of this investigation we have also analyzed secondary data from special local-level and census track runs done for us by the Instituto Nacional de Estadistica, Geografia, e Informatica on the1990 census. Similar data obtained from the SEPESCA census on fishing in the upper Gulf of California were also analyzed.

Rapid assessment visits to the region

Following this preparatory phase, research teams were sent to Puerto Peñasco and El Golfo de Santa Clara in Sonora, and to San Felipe in Baja California. Because shrimp trawlers from other ports fish the waters of the upper Gulf, in addition to these three communities we decided to examine the activities of the Guaymas fleet. These initial visits help us identify the different economic sectors within each community that need to be studied. These sectors, for instance, included among others fishing, secondary industries and businesses dependant upon fishing, tourism, and government. Within each sector, the rapid assessment also distinguished the major variables that needed to be taken into consideration. For example, the fishing sector has both independent fishermen and those working in cooperatives; in both cases there is an inshore sector of *pangas* (small boats) engaged primarily in shrimping and commercial fishing, and an offshore sector of shrimp trawlers as well as Korean factory ships. As well, there is a segment of fishermen catering to a growing tourist industry. Fishermen in Puerto Peñasco and San Felipe not only take tourist sports fishing in pangas, but in San Felipe, there is a fleet of large tourist boats that takes 18 to 30 passengers on seven day fishing cruises. This type of information was then used to decide not only who should be interviewed within each sector, and what we needed to ask them, but which of a range of techniques we would use to gather the data required. This grounded approach allowed us to incorporate new variables into the research design as they were discovered, and to refine the questions for which we sought answers throughout the fieldwork. These rapid visits also provided the background community-level information necessary to develop sampling strategies and to design questionnaires for use in the formal surveys in the three communities.

Ethnographic fieldwork

Because human pressures on the upper Gulf's biotic resources are a direct outgrowth of the degree to which these populations are dependent for their livelihood upon the sea, community studies are not just vital to understanding these pressures on the local ecosystem, but to the success of any policy or interventions that may be contemplated. Community ethnographies attempt to place the human pressures on the ecosystem of the upper Gulf into political and economic perspective. Using ethnographic techniques, we have tried to determine not only how the mix of sectors varies from community to community, but also how the

economic difficulties that the commercial fishing sector has experienced of late has affected various sectors within them. Ethnographic work was done not only to collect information on the organization and management of the fishery, but also on central aspects of community life that may be affected by the proposed plans, such as household economics, patterns of employment, entrepreneurial activities, tourism, land tenure, aquaculture, farming, maquiladoras, and out-migration.

These ethnographic efforts relied on standard methods of participant observation as well as interviews of various kinds-- informal conversations, formal sessions with carefully chosen people in different sectors, and focus group interviews in which invited participants were asked questions and discussed relevant issues. During the process of fieldwork in each community a number people who during interviews had revealed an unusual depth of knowledge and willingness to talk about local matters were selected for in-depth interviews. Some of these local experts were not only interviewed repeatedly, but were enlisted in our investigation as co-workers. Their insights not only took us down unexplored avenues leading us to the crux of many issues, but their social networks opened many doors which without their assistance might have been overlooked or have remained locked.

Household and business studies

The pressure on the fisheries is not just a question of numbers of fisherman or value of their catch. How many fisherman will put to sea is largely determined by the complex relations formed between households and local enterprises. Thus, studies of household economy and local businesses were done in order to examine the impacts new regulations limiting fishing might have on them. As a result of the rapid visits to the region, two questionnaires were designed. One focusing on households, another on business enterprises (see Appendix A). These were administered during subsequent fieldwork sessions. Because of limitations of time and money, we could only afford to draw a representative random sample of households in the El Golfo de Santa Clara. A sample of 32 households (approximately 10 percent of the community) was drawn from a census of residents carried out by the local school system in October of 1992. The decision to sample Santa Clara rather than the other communities was predicated on three factors: (1) of the three communities around the upper Gulf, Santa Clara had the highest percentage of households dependant on fishing; (2) because of its location at the mouth of the Colorado River, it was also most likely to be the most severely affected by any policies which would limit fishing activities in the upper Gulf; (3) much less secondary data was available for this community than for the others. However, so as to collect similar data on fishermen in Puerto Peñasco and San Felipe, snowball samples were drawn using local social networks to identify fishermen. In Puerto Peñasco and San Felipe the households of 20 and

25 fishermen were interviewed respectively. Although the data from Santa Clara were statistically analyzed, because of the nature of the snowball samples, the interviews from the other communities were treated qualitatively rather than quantitatively, and used primarily to compare specific types of fishermen (panga boat owners versus panga crew members; trawler captains, motormen, cooks, crewmen, etc.) with the profiles of fishermen drawn from Santa Clara. In all three communities, these questionnaires usually led into lengthy discussions with fishermen ranging across a wide series of topics. Careful fieldnotes, and in some cases tape recordings, were made of these discussions, and these have been used to further enrich the ethnography.

As part of the community ethnography, interviews were also done with local businessmen. In Santa Clara a business census was done that included nearly all enterprises in the village from formal businesses to informal enterprises-- such as people who sold fish out of their houses. A simple questionnaire was administered in each. Although the size and complexity of Puerto Peñasco and San Felipe made a comparable census impossible given the limited time available, the business questionnaire was administered to an opportunity sample of enterprises in San Felipe. However, because of the nature of the sample, no attempt was made to treat the data from San Felipe statistically; rather these data were used to supplement the ethnographic description.

The ethnography of fishing

In addition to the formal survey and interviews done Puerto Peñasco, Santa Clara del Golfo, and San Felipe, an ethnographic approach was employed to collect information on current fishing organization and management including fishing technologies and practice, processing and marketing, and perceptions of ecological problems in the upper Gulf. Formal interviews were also done with key experts who represented important sectors of the local economy or community, such as fishermen working on shrimp trawlers, pangas and sports fishing boats, members of fishing cooperatives, SEPESCA as well as other local, state, and federal officials, businesses dependent on fishing such processors, buyers and marketeers of sea food, marine suppliers, outfitters and repairmen, people involved in aquaculture, businesses dependent on tourism including developers, hotels, restaurants and curio shop owners, and so on. These key experts were chosen based on standard criteria for selecting key informants: each (1) had long experience in an activity, (2) was currently involved in it, and (3) was capable of conveying an accurate account of their activities (van Willigen and DeWalt 1985:69).

The basic ethnographic interviews that were conducted focused on patterns of fishing, marine ecology, and economic issues. These experts provided detailed descriptions of the impact of fishing patterns on the ecosystem as well as how changes in the ecosystem affected the local economy. General interviews and

site-specific interviews conducted with local experts elicited their knowledge of marine ecology with respect to seasonality, river flows, species behavior and reproductive cycles. These interviews also elicited their perspectives on the impacts of human activities, including patterns of fishing and the use of various fishing technologies on the biological status of the upper Gulf and its fishery. Interviews were also conducted with government officials responsible for the upper Gulf fishery and associated natural resources. As part of this exercise, in order to identify those areas of the upper Gulf that are crucial to the ecosystem, and to assess the human impact in these areas, fishermen were asked to locate and identify sites of significant ecological, social and economic activities. The temporal-spacial data they provided on patterns of exploitation were then mapped. Less formal group discussions, termed here "focus group interviews" (Morgan 1988), were also conducted with members of the community. The focus group discussions focused on the productive careers and developmental cycle of fishermen, access to fishing equipment and other services, the types of fishing equipment used by local and other fishermen, the climatic, economic and ecological constraints and incentives on fishing, and on values associated with being a fishermen. Questions about how these factors affect the health and well-being of the local fishermen and their families were also asked. Investigators also used techniques of participant observations to immerse themselves in the daily activities of the local people and record both their own observations and information provided by local residents.

While the household and community studies examine the role of diverse fishing activities in the regional economy, the critical importance of the shrimp fishery in the upper Gulf cannot be denied. Because an adequate understanding of the behavior of both shrimp and shrimpers is fundamental to comprehending the fragile environment of the region, the ethnography of fishing also focused on the biological parameters of the shrimp stock, economic costs and returns of production, as well as the economics of marketing shrimp. Much of the data necessary for the economic analyses were acquired in the process of ethnographic fieldwork, through interviews with regulatory officials, boat owners, and processing and marketing representatives. To obtain the necessary data on the offshore sector, a team member spent 30 days on the trawlers, recording a log for each trip that indicated location, depth, species composition, and size of catch taken in upper Gulf waters for economic analysis. Additional records required by SEPESCA were also obtained from captains that recorded similar information for four trips. For the inshore sector, we utilized more traditional ethnographic methods. Small-boat fishermen from each port were intensively interviewed to elicit information on costs and returns, on the disposition of catches, and on gear characteristics (Appendix B).

Chapter 3

Community Dynamics in a Time of Crisis: An Ethnographic Overview of the Upper Gulf

James B. Greenberg and Carlos Vélez-Ibáñez

Economic structure of communities in the upper Gulf

The communities of El Golfo de Santa Clara, Puerto Peñasco, and San Felipe are marine dependent to varying degrees. Their historical existence stems from the same basic source, as fishing camps begun in the 1920s. However, for structural reasons each community varies in the manner in which it utilizes the regional marine environment and the manner in which such use partially defines its organization. As well, the American market, and its attendent technological penetration of the region, defines the regional economy of the land and the marine life of the Gulf of California. However, what is of great significance is that each community represents a difference in developmental scale in which San Felipe is the most "developed" in terms of its institutional and economic structures, Puerto Peñasco less so, and El Golfo de Santa Clara the least. This "development" is expressed by the scale of economic activity focused on commercial activities and the production of non-marine resources. For analytical purposes, each of the communities should be understood along a continuum of structural development according to the scale described above. Another way, however, to describe the same continuum is to ascribe to each community its degree of integration into an international capitalist market. The greater the "integration" the greater the need for complex governing mechanisms, sophisticated coordination of capital formation and use, and control of social stratification. This "integration" makes these communities doubly vulnerable: they are at the mercy of changes in political policies and fluctuations of the market, and they are at the mercy of the sea.

The recent collapse of shrimping in the upper Gulf of California has affected fishermen profoundly. Economic problems in the shrimp industry have bankrupted coops and led to their boats being impounded or sold. The trawler fleet in the upper Gulf has decreased substantially. In 1990, there were some 226 trawlers in Puerto Peñasco, 40 in San Felipe, and 15 in El Golfo de Santa Clara.

In 1993, 120 remained in Puerto Peñasco, 23 in San Felipe, and eight in El Golfo de Santa Clara. Panga fishermen have fared a little better; nevertheless, panga coops also have had boats seized for debts. Fishermen, however, are not the only ones affected by this collapse; its impact has been felt by other economic sectors in these communities to varying degrees. In addition to the damage done to fishermen, the scarcity of product has harmed seafood buyers, processing and ice plants, ship yards, and marine suppliers, among others, whose livelihoods are directly linked to shrimping. Indirectly, many others have been hurt as well. As the income of fishermen has dropped markedly (on the order of 80 percent since 1989), so to has their purchasing power, and local businesses have suffered. Even people who believed that their livelihoods were unrelated to fishing have experienced the pain. As one brick layer in Puerto Peñasco put it, "I used to think that being a brick layer had nothing to do with the sea, but I've learned that I'm a fishermen's brick layer. If they don't eat, I don't eat." However, the economic problems the communities of the upper Gulf face are, for somewhat more complex reasons, also due to a decline in tourism. The drop in tourism particularly has affected San Felipe and Puerto Peñasco.

If we compare their economic structures, the impact of these downturns in the economy on these communities becomes clearer. To facilitate comparisons we shall use the categories employed in the Mexican census (INEGI 1990a, 1990 b). The census defines three categories of workers-- primary, secondary, and tertiary sector workers. The primary sector includes economic activities related to agriculture, ranching, hunting, orchards, and fishing. In our samples, fishing and related activities were the only ones that belonged to this category. The secondary sector includes mining, oil and gas extraction, manufacturing, construction, and electric and water workers. The tertiary sector comprises activities related to commerce, transportation, communications, and services. In San Felipe, which according to the 1990 census has a population 9,263 inhabitants,[1] 25 percent of the economically active population are in the primary fishing sector,[2] 17 percent are in the secondary sector; and 58 percent are in the tertiary sector. Although Puerto Peñasco has a larger population, 26,625 persons, its economic structure is very similar: 23 percent in the primary fishing sector, 19 percent in the secondary, and 58 percent in the tertiary. While El Golfo de Santa Clara is the smallest of these communities with a population of only 1506 residents, it is also the community most dependant upon fishing: 76 percent of the economically active population are in the primary fishing sector. The secondary sector accounts for only 3 percent, and the tertiary sector makes up the remaining 21 percent. What these

1. According to Rojas Caldelas et al. (1991:62), the actual figure is 13,270 and according to Rodriguez (1989:13) the population is 18,200.

2. According to figures in. Rojas Caldelas et al. 1991, there are 30 percent in the primary sector.

figures indicate is that although problems in the fishing sector numerically affect more people in Puerto Peñasco and San Felipe, because of the almost exclusive dependence in Santa Clara on fishing, the effects on the population are likely to be much more profound. This is not to downplay the seriousness of the problems faced by the other communities. Some history of these communities, however, may help put these problems in perspective.

Puerto Peñasco, Sonora

Puerto Peñasco or "Rocky Point" began as a fishing camp in the 1920s. Like both San Felipe and El Golfo de Santa Clara, Puerto Peñasco concentrated its earliest fishing efforts on the totoaba. At the time, there was a market for the totoaba's "*buche*" that Chinese restaurants in Mexicali, Los Angeles, and San Francisco used to make soup. Fishermen also supplied shark fin for this same market. Fishermen went to sea in canoes and wooden sail boats and initially used some very crude fishing techniques. Until the 1940s, fishermen used dynamite to fish for totoaba;[1] later efforts shifted to the use of nets. As totoaba catches declined in the 1940s,[2] increasing efforts were directed toward shrimping. By the time Puerto Peñasco was incorporated as a municipality in 1952, it had already begun to concentrate its local and commercial fishing activities on shrimp.

In 1936, the first cooperative was formed in Puerto Peñasco, and was officially recognized by the Mexican government in 1940-41. The organization of shrimping cooperatives was part of a national effort to increase shrimp production. Government credit helped underwrite the rapid expansion of the shrimp industry. Nationally, shrimp production increased from 690 tons in 1930, to 5,102 tons in 1940, to 20,373 tons in 1950, to 39,776 tons in 1960, 42,872 tons in 1970, to 51,726 tons in 1980 (INEGI 1990c Tomo I:425-431). Although cooperatives began with small wooden shrimp boats with capacities of 11 tons, beginning in 1970s shrimp began to fetch record prices on the world market, and the size of boats increased rapidly. By the mid 1970s, they were operating steel boats of 60 to 70 tons and larger. This boom in shrimp markets between 1970 and the late 1980s, led the government not only to undertake massive projects to provide the harbor with piers, dry docks, breakwaters, light houses, and navigational buoys, but as elsewhere to encourage cooperatives to expand their fleet. By 1989, Puerto Peñasco had a trawler fleet of 226 boats.

In addition to the offshore sector, the boom in the shrimp industry stimu-

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1. Some old men still may be found who lost hands this way.

2. Totoaba continued to be fished commercially until the late 1950s. The Secretaría de Pesca, to protect it from extinction, banned fishing totoaba in 1975. Poaching, however, continues to be a problem.

lated the growth of an inshore sector of small boats, "pangas." Although there have been pangas from the beginning, since the mid-1970s there has been a sharp increase in the numbers. Beginning during Echeverría's administration (1970-76), government policies encouraged the expansion of the inshore sector. Panga cooperatives were formed. By the late 1980s, there were 120 pangas registered in Puerto Peñasco, of which 80 were operated by cooperatives, and 40 more by private owners. The growth of the shrimp industry in turned spawned related industries such as processing plants and ship yards. By the mid 1980s, Puerto Peñasco had eight packing and freezing plants and two fish meal plants. There were also 10 ship yards in Puerto Peñasco.

Because Puerto Peñasco's shrimp catch placed it first among producers nationally, its population, which had been less than 200 in 1940, had grown rapidly to almost 18,000 by 1980, and to 26,625 by 1990. As a result, a great number of businesses of distinct types grew up to satisfy the needs of its rapidly growing population. The growth of Puerto Peñasco's population, however, cannot be attributed to the growth of the fishing sector alone--tourism also played an important role in Puerto Peñasco's development almost from the beginning. During Prohibition a North American, John Stone, built a hotel in Puerto Peñasco with a casino and bar. At the end of Prohibition in 1933, there was little to attract tourists to a hotel that could only be reached by railroad or boat, and it was abandoned and soon burnt down. In 1941-42, a road to Puerto Peñasco was built by the U.S. government as part of regional defense plans for World War II.

Easy access by paved highway, especially to Arizona, created a very tight symbiotic economic relation with both Tucson and Phoenix-- principally in the export of shrimp and fresh fish to consumer markets in those two urban centers. The road also opened Puerto Peñasco to tourism, attracting visitors from southern Arizona especially on weekends and holidays. Americans began to come to Puerto Peñasco in the 1950s, and soon established an American colony in Choya Bay. Initially its residents were primarily sport fishermen, but now the recreationalists predominate (i.e., 3-wheelers, divers). Choya Bay currently has 960 units, including houses and boathouses. A number of these are little more than shacks, but there are some substantial homes. Until the early 1980s, this was predominantly a weekend crowd. However when two North Americans acquired the bar (now J. J.'s) and got a TV hookup, some people started to stay through the week, even through the summer, despite not having electricity to run coolers. During the 1980s North Americans and rich Mexicans also began to build substantial vacation homes along the beach south of Puerto Peñasco.

The town itself, however, had few facilities for tourists before the early 1980s. Although it now has more than 500 hotel rooms, as late as 1960 there were only 10 hotel rooms in town. Visitors either camped on the beach or rented in Choya Bay. A small sports fishing sector existed in the 1960s that had two big charter boats for tourists, as well as eight smaller pangas. However, the price of

shrimp began to skyrocket in the 1970s. As one resident put it, "when the fever of shrimp came along, everyone forgot tourism." In the 1980s, when the peso was devalued, and vacations in Mexico became a real bargain for North Americans, tourism resurged. According to the *Plan Municipal de Desarrollo*, Puerto Peñasco now receives 254,500 visitors a year. As a result, Puerto Peñasco again became increasingly dependent on tourism, and an increasing percentage of individual income derives from tourist oriented services such as hotels, restaurants, and specialty marine recreational stores. In 1991, this sector employed 881 persons.

Puerto Peñasco's principal economic activities are commerce, fishing and tourism. Puerto Peñasco's occupational structure is roughly distributed as follows: 30.8 percent in commerce; 34.7 percent in fishing, 11.2 percent in tourism, 6.2 percent in agriculture and 17 percent in government. Beginning in the late 1980s, however, shrimp catches began to fall alarmingly. From the 1985-86 season to the 1991-92 season, there has been a 91 percent drop in production. As a result, although there are 20 trawler cooperatives with 2,050 members, in 1992 only 1,000 members were employed. In 1985, there were eight freezing and packing plants in operation (concentrating primarily on shrimp). These plants employed 580 people. In 1992, only four remained in operation, and employed only 120 workers, a 79 percent decline. (Zepeda Munro 1992:4-10). Similarly, the shipyards that in 1986 had built 15 boats, repaired 38 more, and employed 138 people, built no boats in 1991, repaired only 16, and employed only 59 people, a 57 percent decline in the level of employment. Between 1986 and 1991, employment in the construction industry has likewise declined from 116 employees in 1986 to 71 in 1991, a drop of 39 percent. (Zepeda Munro 1992:C1-2). The commercial sector has also suffered losses year by year. Of 519 members that the Chamber of Commerce had in 1987, only 275 remained in 1991, a drop of 47.01 percent. Notably the biggest drops in the commercial sector between 1987 and 1991 were in workshops (78 percent), curio shops (72 percent), marine supply stores (69 percent), and restaurants (64 percent; Zepeda Munro 1992:12-13). These figures show that only part of these losses can be attributed to the declining shrimp industry. Tourist related businesses have suffered nearly as badly as has the fishing sector as inflation has wiped out the bargain prices that followed the peso's devaluation. Tourism has declined sharply.

These economic losses have begun to leave visible signs on the community. Shrimp trawlers sit idle and rusting in the harbor. Processing plants are closed. Commercial buildings scattered throughout the center of town are empty.

San Felipe, Baja California

San Felipe, the oldest of these communities, was founded in 1914 by Chinese. Its history is importantly linked to efforts to fish totoaba in the early twenties exclusively for the export of buche. Begun as a fishing camp to take

advantage of the depletion of the stock in the Guaymas region, San Felipe became a site for American truckers who made serious inroads as exporters by 1924 and in so doing, San Felipe became linked to the American market and later became a recreational site for American and Mexican tourists. The community is strategically placed for both economies since it is easily accessible by paved highway to the principal cities of Baja California and Southern California and the state of Arizona. As one resident recounted,

> My father was among the first to settle in San Felipe; he came by row boat from Sonora. At the time, San Felipe was a fishing camp of a few Chinese. They settled San Felipe simply because the boats that smuggled them into Baja California landed them there. At the time, there were no roads to San Felipe. The first dirt road was opened to San Felipe in 1923. I was born in Guaymas. My father brought us to San Felipe when I was three years old, in 1926. When I started school in 1930, there was only one school that went from the first to third grades. So I left school after the third grade. The sea was teaming with fish. People fished totoaba, using dynamite. The beaches would be covered by thousands of totoaba. As kids, we would help cut off the heads, and take the buche which was what sold, especially to the Chinese in Mexicali. In 1930 the first fishing cooperative, the San Felipe, was formed. It was renamed Felipe Angeles later. By the 1940s there was some tourism, and the first hotel was built. Tourism, however, really took off after the road was paved in 1950. That's when the pueblo really began to develop.

The demographic history of San Felipe bears out this account. In 1920, the census shows San Felipe as a fishing camp with a population of 100. By 1930, the population had grown to 287. In 1950, the year the road was being paved, it had a population of 995. Ten years later its population had doubled to 2,073. By 1970, its population had more than doubled again, to 4,489. In 1980 its population stood at 6,197. By 1990, according to the census its official population, although many estimates put it higher, (Zepeda et al. 1992:2,5) was 9,263 (INEGI 1990a: 22, 24, 40, 42).

Like Puerto Peñasco, San Felipe's rapid growth is closely linked to the development of fishing and tourism. During the 1930s and 1940s, shrimp cooperatives began to be organized, and eventually seven cooperatives would be created. As totoaba catches declined during the 1940s and 1950s, shrimping took on growing importance. As the shrimp industry expanded during the 1970s, as in Puerto Peñasco, massive government projects were undertaken, such as building a protected harbor and piers, to improve the port's infrastructure. By 1987, San Felipe's trawler fleet had 31 boats, and was still increasing. By 1989, there were 40 boats. The inshore sector of pangas has also grown significantly in recent years. In 1990, the Governor of Baja California decided to allow panga fishermen to fish for shrimp. Soon, there were fourteen panga cooperatives and 575 pangas registered in San Felipe and its fishing camps. (Rojas Caldelas et al.

1991: 64)The expansion of the tourist sector has likewise been dramatic. By the early 1950s, there were a few hotels, but the streets were not paved, nor was there electricity, potable water, or sewers. After the paving of the road to Mexicali, the infrastructure of the town began to improve. In the late 1950s, the town was electrified. As a result, more hotels were built. As the town began to have facilities for tourists, more restaurants, bars, and curio shops catering to tourists opened. In the mid-1970s, developers began to build residential communities for tourists, and sell land and houses to North Americans. As a community San Felipe has become increasingly dependent on tourism as a mounting percentage of the income for individuals is generated by an increasing demand for tourist oriented services such as hotels, restaurants, and specialty marine recreational stores. By 1992, San Felipe had 9 hotels and 661 hotel rooms, 90 R.V. parks with 1461 spaces, and 16 restaurants catering to tourists.

Its occupational structure is roughly distributed along the following lines: 35 percent in commerce, 30 percent in fishing, 20 percent in other services, and 10 percent in government. Commercial and service occupations and activities are closely linked to tourism. However, in terms of occupational statuses, 60 percent of the active labor force are self-employed, the rest are salaried workers. Of the self-employed workers, some 60 percent are fisherman.

As in Puerto Peñasco, the crisis in the shrimping industry and the drop in tourism have had tremendous impacts on the community. Many trawler cooperatives have ceased to exist due to the decline in fishing, lack of credit, debt, and poor management. In 1989, there were seven offshore cooperatives, in 1993, only three were a still functioning, and they were in economic trouble. For example, The Bahia de los Angeles is a cooperative of shrimp boats. Before the problems started five years ago, the Bahia had 68 members. The cooperative also had 9 boats. Because of debts it owed to banks, it has had to sell three boats and is down to 30 members. As a result, San Felipe's trawler fleet, which had numbered 40, has been reduced to 23 boats, a 60 percent decline. Similarly there used to be 14 inshore cooperatives. When the panga cooperatives started, the government offered easy credit, and the panga fleet expanded to over 500 boats. Because the cooperatives were the permisionarios, fishermen who had pangas were forced to register their boats and motors as property of the coop, in order to fish, and to obtain credit. As fishing yields declined, coops were unable to repay their loans. The result has been that the coops' pangas have been embargoed, and their property (buildings) which had been mortgaged, was seized. By 1993, only two panga coops with 100 pangas remained active.

While we do not have data comparable to those in Puerto Peñasco for the impact on other sectors, our interviews suggest that the tourist and commercial sectors have experienced a similar decline over the past four years. For example, one restaurant owner estimated that in 1990-91 his business dropped 5 to 8 percent. In 1991-92, it fell another 21percent. In 1992-93, it fell again by 18 to 20

percent. In total, business is off from 45 to 48 percent. To break even, he needs to sell 1,100,000 pesos a day in food and drinks, but he does not. He figures he has lost 175,000 dollars in the last 3 years, and may go under soon if things do not turn around. A marine supply and hardware store owner was experiencing similar problems. He estimates that his business has experienced a 70 percent decline over the past five years. The manager of a fish processing plant estimated that his business is off 40 percent from five years ago. An R.V. park owner estimated that his business has declined by 30 to 40 percent in the past three years. And 1993 has been the worst year he can remember since opening business in the 1950s.

El Golfo de Santa Clara, Sonora

El Golfo de Santa Clara, like the other communities described, began as a fishing camp in the 1920s. Like San Felipe and Puerto Peñasco, El Golfo de Santa Clara concentrated its earliest fishing efforts on the totoaba. In 1945, the Cooperative V. Carranza was organized by a group of 45 fisherman, and was given official federal recognition in 1953. By the 1950s, shrimp became the primary fishery of choice. Unlike the other communities, however, the government never invested massively in the port's infrastructure. As a result, El Golfo de Santa Clara has no piers or breakwaters, no marina or harbor, nor any ship repair yards. Tourism, perhaps because of location, and certainly because of lack of facilities, never developed to the degree that it did in the other communities of the upper Gulf. Until the 1950s, the only road into the area was a dirt path across the sand dunes. There was, however, a railroad stop near town. Even as late as 1959, the town had no mail service. It still only has one telephone. Unlike Puerto Peñasco or San Felipe, Santa Clara's population has grown only slowly and modestly. Until the late 1980s, most of the families in Santa Clara were descended from pioneers who founded the village in the 1920s and were intermarried. About this time a group people from Guanajuato settled in Santa Clara-- they tend to be the poorest of the poor, living in shanties at the edge of town. By 1990 the population had grown to 1,506 persons (INEGI 1990b). Because El Golfo de Santa Clara remains a small community, it is classified politically as an *agencia* of the municipality of San Luis Río Colorado, and is represented by a *delegado* who reports to that municipality. It has access by paved highway to San Luis Río Colorado and Arizona and San Luis especially serves as the locus for temporary employment, purchase of major goods, and for political control.

El Golfo de Santa Clara is almost exclusively dependent on the external market with a very small sector of tourism as a basis of economic stability. Its shrimp market is largely for export to the U.S. while fish and shellfish serve a dual domestic and export market function. "Chano," for example is primarily extracted to be processed as fish meal for export to the Orient while clams are primarily for the domestic Mexican market, for San Luis Río Colorado, and the small tourist flow. Occupationally, 76 percent of the work force is in the primary

labor sector, engaged in fishing; most of the rest are employed in the tertiary sector in services and commerce, with some employment in aquaculture (5 percent). From our own sample of 32 households, fishing and aquaculture account for 56 percent of the occupational activities in which household members are engaged while 41 percent are in largely service employment.

Like the other communities, Santa Clara in the past five years has suffered in its economic stability due to a decline in shrimp catches. Santa Clara had a trawler fleet of 15 boats, but as of 1993, only 8 remained in operation. The dimensions of the crises may be understood by looking at what has happened to the trawler cooperative Venustiano Carranza. Up until 1989, the cooperative had functioned well. It had 10 boats, refrigerated trucks, a freezing plant, warehouses, and a fully equipped ice factory. In fact, it was one of the richest cooperatives in Mexico, having a surplus of 280 million pesos. In 1990, production fell and the coop was unable to repay credit advanced-- and the banks placed liens on its boats. Since then 6 of its trawlers have been embargoed, and the cooperative has had to sell off its properties, ice factory, freezing plant, boats, and trucks. Despite these sales, in 1993 the cooperative still owed 440 million pesos. The inshore sector has likewise suffered setbacks. For example, when the panga cooperative El Tornillal was organized panga owners were required to register their pangas in the cooperative's name. Thus when the cooperative fell into economic difficulties, pangas were embargoed along with other property.

Tourism, according to the owner of the town's only hotel, has also declined, especially over the last several years. There was another hotel (in fact a fancier one), but it closed due to a lack of business. There are perhaps a dozen restaurants in town; however, only one or two would be attractive to North American tourists. In our sample of 17 businesses in the community, 65 percent reported that business was down in comparison to five years ago. Of those reporting declines in business, the range went from 20 to 80 percent, and averaged 50 percent. In fact, of the three communities, because of its almost total dependence on marine exploitation, it is the one at greatest economic risk (See Map 2). As a community, El Golfo de Santa Clara remains highly dependent on fishing as a source of income for individuals, but the scarcity of product and the decline in tourism has placed the community in the most dire of economic circumstances. Because of the decline in shrimp production over the past five years, most households must combine fishing, commerce, and service to survive. In effect, their survival depends on each sector subsidizing at times the operation of the other, so that while at one moment profits from fishing may be poured into a family business, when fishing is poor the domestic sector may be subsidized by the household's enterprise.

There is no doubt that from fieldwork conducted and the census figures discussed, this community is in the most fragile of economic conditions if fishing circumstances further reduce the ability of this community to extract marine life.

Map 2. Spatial Distribution of Businesses in El Golfo de Santa Clara

A discussion and comparison of household economy dynamics will further elaborate this contention.

A comparison of household dynamics

Introduction

The household data for this discussion for Santa Clara was taken from a random sample of 32 households of the community, of which 23 were primarily dependent on fishing. For the purposes of this report we will discuss fishing households only since the household samples taken from the other two communities were opportunistic samples of fishing households only. Thus while fishing households in San Felipe (23 households) and Puerto Peñasco (20 households) are not representative in a statistical sense, they do represent those engaged in fishing and may be compared to fishermen in Santa Clara. These latter samples reflect the general structure of each community when compared to census data, and do verify the structural arguments set forth in the initial discussion of this chapter. Each sample is internally stratified according to "patrones," and "trabajadores" as primary sector participants. The secondary fishing sector is made up of panga owners and other marine life extractors such as clam and oyster fishermen.

The collapse of shrimping and economic crisis

The near collapse of shrimping in the upper Gulf directly affected not only fishermen and those working in associated industries, such as processing plants and marine suppliers, but as their incomes have fallen, indirectly every sector of the local economy has felt the impact. These problems have literally thrown hundreds of fishermen in these communities out of work. For Santa Clara fishing households, the average unemployment period during the year is 5.7 months and at the time of the study, 46 percent of the fishermen were unemployed. According to these respondents, 43 percent are semipermanently or permanently unemployed, with the months of December-February the period in which almost a third of the fishermen are unemployed. For Puerto Peñasco, the average unemployment period was 4.6 months and, at the time of the study, 50 percent were unemployed and 20 percent considered themselves semipermanently or permanently unemployed. Unemployment, for these fishermen, occurs primarily during the winter (30 percent) and 10 percent in the summer. In San Felipe, the average period of yearly unemployment was 2.5 months, and 43 percent were unemployed, but none considered themselves semipermanently or permanently unemployed. Unemployment for these fishermen largely occurs during the summer veda (50 percent), 20 percent in the winter, and the rest distributed sporadically during winter and summer.

The crisis in the shrimp fishing industry has meant not just the loss of jobs, but even for those who continue to work as fishermen, the low catches of shrimp translate into drastically reduced wages and income. Until 1987-88, fishermen made good money. As a trawler captain's wife from El Golfo de Santa Clara observed, "my husband used to make 15 to 20 million pesos a month. We used to go to San Luis Río Colorado, to Mexicali and Yuma to eat out and enjoy ourselves. We'd buy a new car every year. We would spend freely, as practically everyone here did. No one gave a thought to the future, or to the possibility that shrimp might become scarce." By 1991-92 shrimp production had fallen by between 80-90 percent, and household incomes mirrored this drop. Our household survey data show that in 1992, 66 percent of the households in El Golfo de Santa Clara made less than 12 million pesos a year; 25 percent earned between 12 and 20 million pesos; and only 9 percent had household incomes of more than 20 million. In Puerto Peñasco, 80 percent of the fishermen interviewed had made less than 12 million pesos a year. Ten percent had earned between 12 and 20 million; and 10 percent had made more than 20 million. In San Felipe, we found that 70 percent earned less than 12 million pesos per year; 22 percent gained between 12 and 20 million; and 8 percent made more than 20 million. When asked how their present economic situation compared with their status five years ago in El Golfo de Santa Clara, 59 percent claimed they were in worse shape; in Puerto Peñasco 70 percent of the fishermen said things were worse; and in San Felipe the figure was 91 percent.

Household strategies for coping with economic crisis

A comparison of the households of the three communities shows that the Santa Clara "panga" households are in extreme economic distress. When monthly income and expense figures are compared, the ratio is 0.67, meaning that they can only cover 2/3 of their expenses with their reported income. While admittedly because these monthly figures are for the spring, and represent a period of low income during the year, they are good indications of the duress households face during these periods. The situation of trawler fishermen (both patrones and socios) is even more dramatic. They can only cover 1/5 of their expenses from their derived income. Even for patrones, the mean calculated for their expenses was almost 1.5 million pesos while their reported income was 805,000 pesos. However, for Puerto Peñasco, at least two thirds of all fishermen in all categories are able to cover 75 percent of their expenses from derived fishing income. For both categories of patrones and trabajadores there was an almost even ratio between income and expenses. For San Felipe, on the other hand, the patrones had a mean ratio of 1.38 of income to expenses which means that they more than cover their costs while trabajadores had a 0.94 ratio of income to expenses. These parameters are important to understand not only household's economic dynamics, but also to appreciate how precarious is the living that

households in each community manage to make.

Households have evolved several strategies to cope with this tremendous drop in income, earning in a year what they used to make in a month. Basically, these involve strategies to increase earnings, decrease consumption, or dip into savings and assets. To raise their incomes, households employ a range of tactics-- migrating elsewhere in search of work, sending additional workers into the work force, starting small businesses, renting properties, during the *veda* (the closed season for shrimping) switching to other kinds of fishing, or other kinds jobs, and abandoning fishing altogether for other kinds of employment.

Migration takes two forms-- permanent out-migration, and cyclical migration. Fishermen have long engaged in some cyclical migration, particularly during their summer off-season. With the downturn in shrimping in the upper Gulf, permanent out-migration is becoming much more prevalent. One fisherman estimated that in Puerto Peñasco there must be 500 empty houses in town. Of those migrating, perhaps half come to the United States, where they do anything from yard work in Phoenix to working as a captain on a shrimp boat in Alaska. The other half is split evenly between those that have gone to other ports to find work and continue fishing, and those scattered in towns and cities in the interior.

For those fishermen who stay, most try to continue earning a living during the off-season either by refitting and going after other kinds of fish, or by switching to other kinds of fishing. In El Golfo de Santa Clara, for example, since shrimp catches have declined, panga fishermen stop fishing for shrimp in March, change nets, and go out for chano, which though it fetches a low price, is abundant. Some trawlers also go after scale-fish during the veda, but this is a risky proposition given the high costs of diesel and the low price of fish. In Puerto Peñasco and San Felipe we find that some trawler fishermen work on other kinds of boats during the veda. A man might work as a captain on a trawler during the shrimping season, and then work as a crewman on a panga fishing for scale fish during the summer. In San Felipe-- where there is a sports fishing industry, both panga and trawler fishermen may switch to tourism from May to August. Pangas take tourists out for half-day and day trips. While they are supposed to be licensed, many are not. There are also large tourist boats (which carry six to nine pangas) and take from eight to twelve tourists out for a week. During the summer, both panga and trawler fishermen work on these.

Because of the economic problems that have plagued coops, the number of trawlers operating in the upper Gulf has declined significantly. Since trawlers normally carry a crew of seven, the reduction in the fleet has narrowed the options of fishermen considerably. If we look at what has happened to the members of two trawler coops in Puerto Peñasco, we may begin to appreciate just how narrow this range is. These two coops together had 147 members. In the spring of 1993, only 28 percent were still active as fishermen locally; 23 percent

of the members had left the community. Only 24 percent of the members have been able to find other work locally. Of the remaining members, 4 percent were on sick leave, 10 percent had retired, and 11 percent were without work of any kind. Local businesses, excepting tourism, depend on the monies generated by the fishing industry. As a result, most businesses have also been hard hit, and have not been able to absorb the many displaced fishermen. Of the thirty six coop members in Puerto Peñasco who were able to find work locally, fifteen were involved in commerce, four found government jobs, five were working in construction, one was prospecting for gold, two were doing maintenance or repair work, three were drivers, five were employed in communications, one was a musician, and one had become a policeman.

Switching jobs or types of fishing, however, are merely ways for fisherman to keep occupied. Given the recent history of poor catches, such switches alone probably cannot make up for the income lost. One alternative is for households to send more workers into the labor force. Boys commonly begin fishing with their fathers from an early age, and when they leave school-- even if they decide not to become fishermen-- are expected to contribute to the household economically. But even households with extra male workers are having hard times. As a trawler captain from San Felipe, and head of a family of four, explained, "five years ago, people could afford to buy pangas, houses, everything, now even though I have two sons working in construction who contribute half of what they earn to the household, I can't afford anything." As a result, increasingly households are sending members into the work force who had not worked before. Wives and daughters of fishermen are cleaning houses, washing clothes, making and selling tamales and tortillas. If they are lucky they may find work in a local business, store, restaurant, or hotel. Increasingly over the last five years, as one school teacher noted, kids in the fifth or six grade are being pulled out of school either to help their fathers fish, or to take care of smaller children so that their mothers can go to work. As one mother in El Golfo de Santa Clara explained, "my son was studying computing in San Luis Río Colorado, but he had to return because we had no money to send him, and now he is a clam fisherman." It is not just boys who are being pulled out of school. In El Golfo de Santa Clara, one panga fisherman, unable to pay crewmen to work with him, pulled his three daughters (ten, fourteen, and sixteen years of age) out of school and taught them to fish.

Because there are so few sources of employment, another common method households use to increase their income is to try their hand at trade. A few have succeeded in formal businesses. More frequently, however, households open food stands, candy stands, and small stores that either occupy part of their house, or sit on their property. Such shops do not require any rent, and allow household members to continue to meet their domestic responsibilities while earning a few pesos. One typical example of this is a grocery store owned by a panga fisher-

man's family in El Golfo de Santa Clara. The store, which is run by his wife, is seen as a necessity because fishing does not cover household expenses. However, the store was in direct competition with larger, better stocked, and probably more efficient stores almost adjoining his own. When asked how he can sell candy or cigarettes at prices cheaper than his competitors, he replied simply that he cannot. They are able to survive, first, because his fishing helps subsidize the business at times. At other times, the business provides capital needed for fishing. Second, the land on which his store si ts is owned by his father, and he pays no rent. Third, he built this rather dilapidated store from an existing structure and therefore provided his own labor. Fourth, the electricity is paid by his father. Finally, his wife provides labor to the store when he is out fishing or otherwise engaged.

The other common option households use to increase their income is petty trading in the informal sector. Again, the advantage of petty commerce is that the only investments are for the goods sold, and the frequency and intensity with which one pursues petty trading can be easily adjusted to domestic responsibilities and schedules. For example, the wives of several fishermen we interviewed in San Felipe were buying clothes, shoes, and perfume in Mexicali and the United States to sell in San Felipe. Many fishermen were selling shrimp and fish out of their homes, and others were buying sea foods and trucking them to border cities to sell. Some of this involves black market transactions. Although crews on coop trawlers are supposed to deliver their catch to the coop, they usually sell 30-40 kilos of shrimp to buyers on the open sea before they ever reach the port, and so make extra money that no one reports.

These strategies, of course, are not mutually exclusive. Households often cobble together a living by combining tactics, and by participating in several sectors of the economy. To examine how households derive their income from various sectors, we will use the categories employed in the Mexican census. In 1990, in Puerto Peñasco, census figures show that 23 percent of the workers were employed in the primary sector, 19 percent in the secondary, and 58 percent in the tertiary sector. In San Felipe, the 1990 census shows that 25 percent of the workers were in the primary sector, 17 percent in the secondary, and 58 percent in the tertiary. In El Golfo de Santa Clara, according to the census in 1990, 76 percent of those employed worked in the primary sector, 3 percent in the secondary sector, and 21 percent in the tertiary sector. In 1993, we found that in El Golfo de Santa Clara, 62 members of the 32 households in our random sample were actively employed. Of these, 58 percent worked in the primary sector, 3 percent in the secondary sector, and 39 percent in the tertiary sector. When we compare the data from El Golfo de Santa Clara to the 1990 census figures, we see that as economic conditions have worsened, households have shifted increasingly from fishing to tertiary activities. In Puerto Peñasco and San Felipe, because our samples were of fishermen only, they cannot be compared to census

data to identify shifts in the sectors, but they can be used to address how households divide their work force among sectors. In El Golfo de Santa Clara, for example, if we exclude non-fishermen, we see that of the 23 households of fisherman, 61 percent depended solely on fishing for their livelihood; 4 percent had income from primary and secondary sectors; and 35 percent had income from primary and tertiary sectors. In Puerto Peñasco, of the 20 households sampled, 50 percent depended on fishing exclusively for their livelihood, and the remaining 50 percent had income from both primary and tertiary sectors. In San Felipe, we find that of the 23 households of fishermen in our sample, 65 percent earned their living from fishing alone, 13 percent had incomes from primary and secondary sector, 18 percent had incomes from primary and tertiary sectors, and 4 percent had income from all three sectors. These data show that in all three communities, though fishermen's households have members working in other sectors, they still depend on fishing extensively.

The tactics households use to increase their earnings, however, are not enough to cope with the large losses of income they have suffered. They have had to decrease consumption and tap their savings and assets as well. One effective means of decreasing consumption is to avoid paying rent. Fortunately, during good times, most fishermen invested in building their own homes. In El Golfo de Santa Clara, 88 percent of the people we interviewed owned their property outright, and paid no mortgage. Another 3 percent lived rent-free in dwellings provided by relatives. Only 9 percent of those sampled paid rent. In Puerto Peñasco and San Felipe, we encounter similar patterns. In Puerto Peñasco, 95 percent of the fishermen sampled owned their own homes and 5 percent lived in borrowed homes. In San Felipe, 87 percent owned their own home, 9 percent lived in borrowed residencies, and 4 percent were renters. Despite the high percentage of home ownership, because of their reduced incomes little money is being spent on home maintenance or repair. Fishermen are also delaying replacement of goods such as cars. The cars they own are on average fifteen years old.

Because fishermen's income is highly seasonal, savings play an important role in household management. Fishermen's income usually is highest at the start of the shrimp season in the months of September and October. The shrimp season typically runs from September 15th to May 5th, and trawler fishermen are often without employment during the summer. Even during the shrimp season there are lean months-- 41 percent of those interviewed reported December or January as the month in which they had the least income. Some notion of the seasonal variation in income can be gathered from figures on the maximum and minimum monthly incomes reported by those interviewed. In El Golfo de Santa Clara the median for maximum monthly income was 1.5 million pesos; the minimum was 160,000 pesos; in Puerto Peñasco the maximum was 1.7 million, the minimum was 125,000; in San Felipe the maximum was 2.6 million, and the minimum was 128,000 pesos. To manage these large swings in monthly income,

when fishing is good fishermen try to pay off bills and save money. Since they generally can anticipate the lean times, and know how much they will need to meet their expenses, they calculate how much they can spend per week, and set money aside for these times. As many readily admit, saving money is difficult, and they would have a much harder time making ends meet if it were not for their ability to freeze and store shrimp and fish. Nearly everyone owns either a refrigerator or freezer. Trawler fishermen, for example, take home a "family basket" each trip that typically includes from 5 to 10 kilos of shrimp, and 50 to 100 kilos of fish. Most fishermen freeze 50-100 kilos of shrimp per year. These frozen savings not only reduce food costs, but most of the shrimp, which can fetch 60,000 pesos per kilo, is sold to tourists, neighbors, and local buyers. Fishermen, however, never buy fish for their own consumption. They not only usually eat fish everyday, but give fish away to other family members and friends. The reciprocities created this way mean that if a fisherman has poor luck, others will give him fish. When cash runs low, fish are frequently bartered for produce-- vegetables, fruit, eggs-- or clothing. In El Golfo de Santa Clara 59 percent of those interview reported engaging in such transactions; in Puerto Peñasco 55 percent did so; however, in San Felipe, probably because it is a richer community, only 30 percent reported bartering fish for goods.

Despite their efforts to cut consumption, delay purchases, and save because their incomes have fallen so sharply, fishermen are easily driven into debt. Usually if fishermen need to borrow money, their friends or patrons will lend them small amounts to buy food and pay bills until fishing picks up. However, this often is not enough. As a panga fisherman from San Felipe observed, "five years ago, before catches began to fall, I belonged to a panga coop and owned three pangas. I have had to sell them all." Now he is making his living working for other panga owners. This panga fisherman's experience is quite common. When householders were asked if they had had to sell anything to pay debts in the past twelve months, 31 percent of those in El Golfo de Santa Clara responded affirmatively. In Puerto Peñasco and San Felipe the figures were 30 percent and 35 percent respectively.

Conclusions

There can be little question that along a continuum, San Felipe's fishing households are economically in a much better state than any of the rest. The lower unemployment rate, the lack of permanently or semipermanently unemployed statuses, and the seeming lack of reliance on either spouses or other members for income may be due to the availability of other resources of employment directly associated with marine production such as recreational fishing, and aquaculture. Puerto Peñasco fishing households, on the other hand, depend heavily on employment of both spouses for its positive income to expenses ratio and therefore indicates employment possibilities for women. For Santa Clara,

neither the addition of a spouse nor the employment of other productive members in the household was enough to compensate sufficiently for lost income and "normalize" the income to expense ratio.

On the other hand, there are other economic behavioral characteristics within Santa Clara that seem to mitigate the onerous income to expense ratio due to the well established existence of an informal economy. The use of exchange and barter is well developed within the community so that households exchange labor for materials, clams for vegetables, labor for other labor, tortillas for fish, and a variety of debt dispensations that allow households to survive. This exchange system based on the value of "*confianza*" (mutual trust) is a key element in mitigating some household expenses by removing households partially from a cash-short or even cashless economy and placing them within a reciprocity network of exchange.

Moreover, an important element of subsidy provided by concurrent small businesses to fishermen should not be ignored. Interviews with fishermen/entrepreneurs clearly show that small confectioneries, candy stores, snow cone stalls, second-hand tools and utensils "*tianguis*" and other assorted very small scale businesses serve as part of the subsidy necessary to survive poor fishing catches, indebtedness, and the fluctuating economic returns of fishing. As well, however, depending on the season, fishing provides the fishermen/entrepreneurs with some subsidy to maintain their various enterprises described above.

Within such contexts lay another means of survival for small businesses in which there are relatives who also fish. For the most part, many restaurants, fish and shrimp stalls, and other businesses dependent on marine life are provided fish, shrimp, and other marine resources at greatly reduced prices or are given the products for nothing in exchange for monies earned by the businesses for their individuals expenses.

Last but not least, the informal economy has a well established illegal economy of shrimp and other species that are either taken from protected environments or fished during vedas. This part of the economy is admitted to by many fishermen and perhaps may be responsible for up to 40 percent of the unreported income of many fishing households in Santa Clara, Puerto Peñasco and San Felipe.

Chapter 4

The Political Organization of Fishing

Marcela Vásquez León

The offshore sector

The offshore sector in the upper Gulf of California is characterized by being a single-species fishery. Shrimping is the most important activity of this sector, although some less important activities have developed in recent years, such as shark and chano fishing. *Escama* fishing occurs at a small scale during the summer months; however, there are a few boats that specialize in escama throughout the year.

Offshore shrimp fishermen traditionally have been organized in cooperatives that until 1991, provided them exclusive rights to exploit the shrimp fishery. The cooperatives were originally designed to give shrimp fishermen political representation, facilitate credit, organize marketing, and provide a few personal benefits. Local cooperatives, in turn, are organized regionally into a *Confederación Nacional de Cooperativas* that is supposed to provide them political representation at a national level. This organizational system, however, has been undergoing a rapid process of disintegration since 1990, mainly due to changes in the current Mexican government's political agenda. Internal problems, which will be explained later, have sped up the process of disintegration.

Individual cooperatives are ruled by federal legislation specifying that members must elect four officials to represent them every two years. These are the *Presidente de Administración* (having the highest power and in charge of all administrative matters), *Presidente de Vigilancia* (in charge of matters related to boats and equipment, and enforcement of internal rules), *Tesorero* (in charge of financial matters) and *Secretario*. In addition, a delegate to the federation is also elected. Cooperatives have been able to provide benefits to their members that include providing some jobs during the closed season by using a few trawlers for fishing, lending money to members who have not been able to save enough for the closed season, credit in times of necessity such as accident or death of a family member, some financial support to the family of a deceased cooperative member, and social security benefits. In the past, cooperatives provided a certain degree of security to fishermen. However, as stated above, the complete disinte-

gration of the cooperative system at a national level is now imminent. Although some fishermen feel the end of cooperatives is a threat to their livelihood, others feel it may be necessary if the shrimp industry is to recuperate financially.

Our interest here, however, is to describe how this process of disintegration is being played out at the local level; how it affects fishermen and their families; and, what are the implications for future employment in the industry. The economic crisis experienced by offshore coops in the upper Gulf today must be understood from a historical perspective: before describing the current situation of offshore coops in the upper Gulf, it is important to look at historical development of the industry, to examine the various groups involved. Doing so will give us a clearer picture not only of where responsibilities lie, but also how sacrifices the bioreserve may impose should be shared. As the following analysis shows we already have a human population in crisis. Further pressures, such as the proposed immediate closure to commercial trawling in the bioreserve area, could very well lead to the collapse of commercial fishing, the most important economic sector in the communities of the upper Gulf. Thus when planning for the best strategy for managing the bioreserve area, it must be clearly understood that resident fishermen have already invested a significant portion of their productive lives in trying to develop and sustain an industry that provided significant benefits to the Mexican economy.

Background on the economic crisis of offshore coops in the upper Gulf

Government involvement has been a constant factor in the development of the shrimp industry throughout its history. The government organized labor into cooperatives and gave them exclusive rights of direct exploitation of shrimp. It organized the export marketing system through the parastatal company, Ocean Garden. It provided the private sector with a variety of subsidies designed to stimulate the rapid growth of the industry during the 1960s. Until 1982 the private sector had control over the means of production such as boats and freezing plants. The government, through the Secretaria de Pesca, also has been the absolute manager of the fishery from the beginning.

Because shrimp provided Mexico with significant amounts of foreign exchange, government policies encouraged the seemingly unrestricted rapid growth of the industry. By the early 1980s, problems with these policies began to surface that account for many of the troubles experienced today -- such as cooperative debt and subsequent boat embargoes by private banks, overexploitation of shrimp, overcapitalization of the fleet, and the sharp decline in profits.

Cooperative debt, a crucial problems facing producers, started in 1982 with the forced transference of the fleet from the private to the social sector. Government policy forced cooperatives to buy boats and equipment from the private

sector at very high prices no matter their age or working condition (Miller 1990). This was done through the provision of public credit to coops. BanPesca, a public bank specially designed to develop productive enterprises, gave cooperatives loans at interest rates that were lower than commercial loans available through private banks. It also had a policy of seemingly almost limitless credit. According to a cooperative official of the time when BanPesca was operating, "BanPesca never wanted us to get out of debt, the greater the amount of money that it gave us, the more we asked for. Every season we started with new boards, new cable, if a net broke we would throw it away and buy a new one. Eight years ago we could have paid all of our debt, and we decided to do so but they sent a *licenciada* and she convinced us not to pay everything back; instead we ended up acquiring new boats that we did not need" (personal communication). Another fisherman clearly summarized the point in a few words, "*el pescador despilfarró y BanPesca se encargó de que pudiera hacerlo* (the fisherman overspent and BanPesca made sure that he could do it)."

Seeing the blatant corruption at a higher level, fishermen reacted by selling the product outside the cooperative. Although *guaterismo* -- the illegal selling of shrimp through the black market -- has been a common practice throughout the shrimp industry's history, it intensified after the transference of the fleet to the social sector. As cooperatives became less and less responsive to fishermen, the volume of shrimp sold in the black market apparently increased. The volume increased even further during the 1992-93 season when fishermen began to feel uncertain about the future of their cooperatives. As the inability of cooperatives to compete with the black market has risen, so has their financial troubles. However difficult it may be to estimate this volume, there is no doubt that part of the sharp decline in officially reported productivity is a reflection of product sold in the black market.

Corruption at every level could be sustained while production was good, but when the bad seasons came, the system began to collapse. The problems were compounded when, after 1982, the price of diesel skyrocketed. Indirect subsidies provided by the government during previous decades were cut. Since then, costs of production in general have been constantly on the rise, and inflation has caused the price of food and other basic needs to increase. Shrimp prices, on the other hand, have either remained unchanged or declined because of competition from cultivated shrimp.

Offshore shrimp fishermen

To understand how the process of disintegration of the cooperative system affects offshore shrimp fishermen, it is important to differentiate them briefly into several categories. Differences in status, economic position and skill greatly influence their responses and possibilities to adapt to change.

Offshore fishermen cannot be taken as a homogeneous group; there are marked differences in terms of economic position, social status, skills, and experience that will have a different effect on the different groups of offshore fishermen. Offshore shrimp fishing is characterized by a variety of specialized jobs on board the trawler, each of which is delegated to the most qualified person. Specialization of jobs not only leads to differentiation in skills but also to differentiation in the economic and social position that fishermen may have on a boat, leading, ultimately, to a highly hierarchical arrangement.

In a seven man crew, the lowest ranked is the *pavo* (the turkey) who is the boat's 'gofer,' generally the youngest and least skilled of the crewmen. Immediately above the pavo are the two sailors who are required to have a certain degree of knowledge of repairs of nets and the operation of the trawler. Like the pavo, they have the least to loose by moving to another form of employment, since they are the ones who have invested the least amount of time and effort in developing the necessary skills to become good fishermen. The economic rewards they receive do not render their jobs irreplaceable either.

Higher in social rank are the cook and the *ayudante de motorista*. While both have not necessarily spent more time and energy in trying to develop their capacity to improve their fishing ability, they have a particular skill marketable outside the fishing environment. The cook may be able to find a job in the restaurant business, the ayudante de motorista, being the motor man's apprentice, may find a job as a mechanic or assistant mechanic on land. In addition, he must have a certain degree of knowledge of refrigeration since one of his duties is to deal with any problems in the cold room.

At the upper end of the hierarchy are the motorman and the captain. The motorman must have considerable knowledge of the working of all mechanical parts of a boat. He decides what action needs to be taken regarding engine or compressor problems. Besides this, he takes shifts with the captain at the helm, and is usually in charge of the boat during the night. He also has already acquired some knowledge of specific landmarks and fishing grounds, bottom features, and changes in depth. The captain has the greatest fishing knowledge. He decides the direction in which the boat should be steered, when and where the nets should be set and retrieved. He is in charge of production and of coordinating the crew to ensure that the fishing trip does not end in quarrels and disputes between crew members. He is the better paid and the ultimate boss. Motorman and captain have the most to loose by moving to an occupation on land. First, their skills are so specialized and their knowledge so specific to the marine environment that there are no parallel occupations on land. Second, their salaries and social status are also highly unlikely to be matched outside fishing.

Current problems

The last season for which BanPesca provided credit was 1988-1989. After that private banks such as Bancomer and Banamex began to finance the cooperatives. Credit by private banks was given according to the cooperatives' ability to pay. This led to a gradual decline in the credit provided. For instance, while 30 million dollars were given during the first season to one cooperative, this amount declined to 20 million by the next season. As cooperatives were unable to meet their financial obligations, after the 1991-1992 shrimp season private banks refused to continue extending credit to the cooperatives. Presently, according to a bank official, the value of the debt is equivalent to the value of the whole fleet. Cooperatives received initial credit for the 1992-1993 season through an accord reached between the parastatal Ocean Garden, private banks, and the state government. However, credit was suddenly stopped in December of 1992. Banks and government officials argued that the beginning of the 1992-1993 season had been agreed to as a trial period, the last opportunity given to the cooperatives. Cooperative officials and members took the sudden credit cutoff in the middle of the shrimp season as an intentional manoeuver to destroy any possibility of financial recuperation open to the cooperatives. Members had assumed that a final evaluation of each cooperative would come at the end of the shrimp season. Thus, cooperative members were taken by surprise when private banks started to embargo shrimp trawlers, and Pesca officials refused to give fishing permits to cooperatives. After January 1993, some coops that had been operating with ten boats were left with only one. The consequences for short-term employment were particularly hard felt since no plans to account for such a situation had been made. Suddenly, fishermen were left to fend for themselves, and few had any possibility for employment. This situation is all the more critical because offshore fishermen derive their annual income from seven months of intensive fishing. By the end of the season most have saved enough to sustain them and their families through the closed season, a few look for employment on land, and others go out in cooperative boats to fish *lenguado* (flounder or sole). In 1993, summer fishing was not possible, and most have not been able to save for the summer, compounding the crisis. They feel betrayed by the system. Among the trawler fishermen in the three communities, the hardest hit were those in Puerto Peñasco, as they had no time for adjustment.

For fishermen, the decision to stop the fleet in the middle of the season was completely unreasonable. As a captain of a boat argued, "if we cannot pay the credit by the middle of the season, there is still hope to pay at least part of the debt by the end of the season, but if the bank takes our only source of income, then we won't pay for sure, and we both end up loosing, banks and coops." The cooperative sector argues that private banks never gave loans on time, making it very difficult for complete repairs before the beginning of the season, thus increasing the risk of equipment break downs in the middle of the season. It also

argues that the credit given was insufficient to maintain the full fleet fishing through the season, and that it was only given at the beginning of the season, which made it impossible to continue going out for long voyages. Thus, some boats only went out three or four times during the season, most went on very short trips from five to ten days at most, and much of the season time was not exploited due to the shortage of capital for fuel. Some boats had to wait fifteen days at port for some fuel. This also limited fishing activities to the upper Gulf.

Banks, on the other hand, see themselves as financial institutions, business enterprises that have a purely economic interest in mind. As one bank official stated: "we are a business not a charity organization." Unwilling to take any risks, they now refuse to issue credit to cooperatives; only private individuals with appropriate collateral will receive any loans. Finally, the government has instituted a plan of privatization of the shrimp industry, opening shrimp fishing to private individuals who have obtained the necessary permits from Pesca and have the necessary financial backing.

Present state of the fleet and coops

In 1987, Puerto Peñasco had a fleet of 220 shrimp boats. This number declined to 192 boats in 1990. By 1993 the number has declined to half or less. Several reasons account for this decline: some boats have sunk, others have become obsolete as resources to maintain them shrunk, some have been sold to other ports such as Guaymas, Matzatlán and La Paz, and some are still in the shipyard, waiting to be repaired. In the summer of 1993, there are about 100 boats that are in reasonable condition; that is, they can be repaired and maintained at reasonable cost.

There were eighteen offshore shrimp cooperatives in 1990; now only six remain active.[1] In San Felipe in 1988 there were forty trawlers and seven offshore cooperatives. Now only three cooperatives remain. Of the total of twenty-three boats operating, eight are owned by three "armadores" (private sector owners). In Santa Clara, out of a fleet of sixteen boats, only nine went out during the 1992-93 shrimping season. By the beginning of March 1993, only six boats were in operation.

Cooperative response to the present situation: short term adjustment

One outcome of the drastic economic crisis cooperatives faced during the 1992-93 shrimp season is that mechanisms for equitable participation in the fishery have begun to take shape. These mechanisms have arisen from local initiatives within cooperatives (and so must be considered before carrying out any process of effort reduction). As stated above, fishermen were unprepared to deal with sudden unemployment after the confiscation of cooperative boats by banks

in December, 1992. Cooperative officials were immediately faced with the dilemma of whom should be allowed to continue fishing, since the number of unemployed fishermen by far exceeded the number of fishermen needed to crew the few boats left. For example, after January, the Puerto Peñasco Coop was able to use only one of its ten boats, reducing employment opportunities from seventy jobs to just seven.

Officials in several coops decided that the best way to deal with the situation was to rotate people. Every ten days a different crew and captain went out fishing. Since several fishermen were able to find employment elsewhere, some part time, some full time, and others migrated outside the region, priority was given to those unable to find a job; and, of those, priority was given to those who showed up the most often to ask about a boat. The number of children and a member's economic situation were also taken into consideration. This was eased by the fact that fishermen have worked together for many years and know each other's families. Officials and secretaries met to decide who would be allowed to go on a trip. Each available member was allowed to go out at least once. Also the crew was augmented from seven to eleven fishermen. The reduction of individual shares was seen as necessary if some benefits were to be provided to more people. Good captains were able to find jobs in Guaymas, as captains of privately owned boats. Boat owners preferred to hire captains from the upper Gulf because they will work for less pay than Guaymas' captains.

Another response to the economic crisis has been an attempt by some fishermen to form partnerships to buy boats, putting their property (usually their houses) up as collateral. Although many are afraid to loose what little they have left, they would rather secure boats. Many are afraid that the wealthy, who are more able to provide guarantees for the bank, will buy boats and take them to other ports. Others argue that to work for a non-fisherman owner is to become a

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1. There is one offshore shark fishing cooperative in Puerto Peñasco. It started six years ago. Unlike shrimp cooperatives, it has been quite successful, and has not suffered the financial troubles the others have experienced. There are two important differences in this cooperative's organization. First, individual skippers own their boats and equipment. They are responsible for the administration of their boats, for obtaining credit and paying back loans. The cooperative exists to obtain permits, provide accounting and secretarial services, and to contribute either financially, or with labor or equipment in cases of emergency.

Another major difference is its attempt to diversify as a risk management strategy. Besides shark, shrimp is also an important species, and some also will catch *baqueta* (baqueta) during certain months of the year. They fish for shark south of the recently declared bioreserve, that is south of San Felipe and Puerto Peñasco. From Yavaros the shark starts going north. In March and April, fishermen go to Guaymas to wait for the school of shark and will follow them north. In June and August, shark are running by the Isla del Angel de la Guarda. From September until December offshore shark fishermen switch to shrimp, and during the months of January and February they repair equipment and get ready for the shark season.

proletarian, to risk being paid a miserable salary. Fishermen recently employed by private owners claim that there has been a polarization of salaries, with captains and motorman receiving a substantial percentage of production, and the rest of the crew receiving subsistence level salaries. As in the cooperatives, salaries continue to be about 20 percent of the value of the product caught.

One reaction to the lack of credit has been to try to obtain loans from private sources, such as wealthy residents, as is true in Santa Clara, or middlemen. To repay these loans, coop members deliver the product to the coop that in turn hands it over to the financial backer. After December, 1992, another strategy was to rent boats embargoed by the bank at 10 million pesos per month, in an attempt to increase production through the rest of the season. Bank officials say that this is not a rent, but an anticipated payment for credit.

The non-resident users of the upper Gulf

Not all of the trawlers exploiting the upper Gulf put out from local ports. With available data provided by Pesca officials (*Delegación Federal de Pesca en el Estado de Sonora, Departamento de Flota e Industria)*, we will attempt to estimate the degree to which "outsiders" to the area exploit the marine resources in the upper Gulf, more specifically, shrimp trawlers primarily from Guaymas. Although these trawlers are not the only "outsiders" exploiting resources in the upper Gulf, we believe the Guaymas fleet has traditionally benefited the most; and so stands to loose the most if excluded from the area. The Guaymas fleet has also had the greatest impact on the upper Gulf ecosystem of any of the external users.

Unfortunately quantitative data on this point are rather scarce. We do, however, have data for a few years that, when complemented by oral accounts of knowledgeable informants, provide a rough estimate of the effort by shrimp trawlers from Guaymas in the upper Gulf, and how this effort has changed in the last few years. The following data refers to boats from Guaymas fishing in the upper Gulf area:

Table 4.1
The Guaymas fleet fishing in the upper Gulf

Year	Month	No. of boats	% of fleet	Fishing area
1986	Oct.	32	12.60	San Felipe area of Bajos
	Nov.	44	47.05	40% San Felipe; 6.14% Santa Clara; 0.91% Puerto Peñasco
	Dec.	32	47.75	40% San Felipe; 7.75% Puerto Peñasco
1989	Oct.	80	23.00	Total of 350 boats
	Nov.	20	5.70	
	Dec.	29	8.29	
	Jan.	30	8.57	
	Feb.	46	13.14	
	Mar.	55	15.70	
	Apr.	59	16.86	
1990	Oct.	16	4.78	Total of 335 boats
	Nov.	16	4.78	
	Dec.	23	6.87	
	Jan.	31	9.25	
	Feb.	22	6.57	
	Mar.	28	8.36	
	Apr.	18	5.37	
1991	Oct.	15	6.00	Total of 268 boats
	Nov.	10	3.73	
	Dec.	23	8.58	
	Jan.	23	8.58	
	Feb.	19	7.09	
	Mar.	0	0	
	Apr.	0	0	

(Data collected for 1986 are based on a sample of boats taken from arrivals to freezing planta. Data collected for 1989-90 to 1991-92 seasons come from the *aviso de arribo* each boat provides through the cooperatives to the Pesca delegation in Guaymas. The private sector is also included in the 1991-92 season).

Informant's accounts concur. According to Pesca officials and fishermen in the area, the Peñasco fleet habitually stayed in the north, and Guaymas boats customarily went to the upper Gulf during their first trip in October or one trip in November and during trips from the months of January to March. Quality and size of blue shrimp in the area have made the trip from Guaymas particularly profitable. In spite of increased costs of production that a longer trip implies, the

market value of blue shrimp in the upper Gulf has had no parallel in the rest of the Gulf. Favorite spots for the Guaymas fleet have been from Punta Cerro to San Felipe by the Bajo Macho, and from El Piedrón (Isla Conzaga) to the south. These areas are good for blue shrimp during October because the waters tend to be warmer. During the months of January and February, besides the areas mentioned above, El Tornillal, Las Salinas and Punta Estrella have been important areas for shrimping. The region near Puerto Peñasco has not been as important for the outside fleet, principally because blue shrimp are not as abundant there as elsewhere.

As these data show, the external fleet's effort fluctuates according to shrimp availability. During good seasons, such as 1985-1986, boats from areas south of Guaymas, such as Mazatlán, Topolobampo, and Yavaros where seen in the upper Gulf. From 1985 to 1987-88 seasons fishermen reported at least 200 boats per season from Guaymas fishing in the upper Gulf.

Since the 1987-88 season, this pattern has changed dramatically mainly as a result declining shrimp catches. Simply put, it has become unprofitable for the Guaymas fleet to go to the upper Gulf. The scarcity of shrimp also has forced part of the upper Gulf fleet to try their luck south of Desemboque, in the Guaymas area. A few have gone as far down the coast as Matzatlan. Captains from Puerto Peñasco have been forced to learn about new fishing grounds. However, this strategy has not proven to be very profitable. In the words of a captain, "you end up investing more than what you gain."

This shift in the traditional fishing areas has important implications in terms of territoriality. Right now, a decline in shrimp stocks has resulted in less effort. However, once stocks begin to recuperate, it is very probable that outside effort in the upper Gulf will increase accordingly. Although measures that would exclude outsiders may have a beneficial impact on the ecosystem, it might have a negative impact for the upper Gulf fleet. As we discovered during our field work, the notion of territoriality is not widespread. Fishermen feel that if they deny the Guaymas fleet access to the upper Gulf, when the need to go south arises, as it already has, the upper Gulf fleet will not be welcomed in the south. In the words of a captain from Puerto Peñasco:

> When we go to Guaymas, to Sta. Rosalía, Mazatlán, nobody says anything, and we are the same way, if people come here we won't say anything, we must all follow the shrimp wherever it goes. If we limit entrance to the upper Gulf, they will limit us when we go south, and we would not like that. While traditionally boats from Guaymas came here from November to June, and we stayed here, now shrimp is scarce in the north and for the past three years boats from Puerto Peñasco have gone all the way down to Mazatlán.If there were strong feelings of territoriality we would have been screwed, but on the contrary, we are well received wherever we go.

Thus potential conflicts have to be considered when devising a plan for a sustainable use of resources by resident fishermen that may very likely exclude outsiders, at least for a time.

Inshore small scale fishermen

The inshore fishermen, like offshore fishermen, are hardly a homogeneous group. Fishermen in this sector can be roughly categorized as owners of equipment (*patrones*), cooperative members, fishermen-apprentices, and fishermen-workers. Each group has a different political, economic and social status within the community. Fishermen in the four groups are interrelated, may shift from one category to another, and may belong to two categories simultaneously. Whatever the category, there are two basic positions in a panga, the captain and the *marinero* (sailor); sometimes a *pavo* is included. The captain makes all decisions and chooses his marinero. The marinero must obey the captain and try to learn as much as possible from him. Pavos are usually high school or junior high students who go out with a relative occasionally.

Owners of equipment (patrones)

Fishermen in this category may own one or several pangas. patrones may be highly skilled, experienced fishermen who not only own equipment but are also captains. For the sake of simplicity the word patrón will be used only to refer to a panga owner (although captains are also called patrones). patrones may or may not belong to a cooperative. If they do not belong to a cooperative, they are called *pescadores libres* (free fishermen). The fact that they are panga owners generally means that they have been economically successful fishermen who have the capacity and flexibility to adjust to the change in species present near coastal areas throughout the year. This requires the knowledge of how to use a large variety of nets and lines, and the ability to recognize and follow a large variety of species. patrones usually earn 2/3 of the catch in the panga in which they are captains. In pangas that they do not operate themselves, they will earn 1/3 of the catch. patrones may also be middlemen, also called *permisionarios,* who buy product from their pangas to be sold in the market. A patrón may own from one to fifteen pangas.

Cooperative members

There are generally two types of cooperatives, shrimp coops and escama coops. At this point, it seems that inshore sector cooperatives in the upper Gulf, though officially recognized, do not really provide the essential services that members require. In the past, however, cooperatives did provide many advantages to members, such as social security, permission to work without hassle from Pesca officials, and shrimping equipment. Fully recognized cooperative

members tend to be captains, bringing with them their own sailors, usually fishermen-apprentices, who will eventually become full members and captains.

Fishermen-apprentices

Fishermen-apprentices do not own a panga. They are *marineros* who must do everything the patrón orders them to do. The main difference between these fishermen and fishermen-workers is that they usually work with a close relative, a father, uncle, godfather, or older brother. They are learning skills, and if they turn out to be good fishermen they will eventually become patrones. They are paid a customary share of the catch, generally 1/3 if he does not contribute to repairs and maintenance of equipment, or 1/2 if he helps and contributes to maintenance costs. Fishermen apprentices may or may not belong to a cooperative.

Fishermen-workers

Fishermen-workers are the proletariat of the sea. Since they do not own any equipment, they are forced to accept work in someone else's panga. They also tend not to come from fisher families, or have migrated at a very young age and have not had access to family support. Fishermen-workers occupy the lowest status among fishermen. Economically, this is because they have very little power of negotiation over how much a patrón will pay for their product. And socially, it is considered that a fisherman who cannot decide when and what to fish, that is, who cannot be his own boss, lacks the very characteristics which make fishermen feel proud to be fishermen. These fishermen have a very low probability of upward mobility. They also do not have access to cooperative membership, so do not have any labor guarantees, social security benefits, or any kind of political representation.

These fishermen are usually hired by *permisionarios*; that is, owners of several sets of equipment who are middlemen, not fishermen, and hire fishermen-workers to operate their pangas to obtain product to sell in the market.

The inshore sector in the three communities under study varies significantly. However, in all three communities panga fishermen have lost a large part of their income because of the decline in shrimp availability. The breakdown of inshore cooperatives has also greatly affected the three fishing communities. Because of the lack of importance historically given to the inshore sector, this process of disintegration is much more difficult to trace.Fishermen feel more vulnerable to Pesca inspectors who, on a whim, may demand a share of their catch. Previously these demands tended to occur through the coop. The vulernablity of individual fishermen to Pesca inspector's demands has increased because they no longer have direct access to shrimping permits. Since accidents often occur, the lack of insurance and credit in times of emergency is particularly worrisome to

inshore fishermen. Marketing opportunities, especially for fish, have also shrunk, as fishermen must deal directly and individually with buyers.

Finally, it is important to look at the inshore sector within the larger scheme of the fishing political economy particularly, as it relates to the offshore sector and the shrimp fishery. From its beginnings, the offshore sector, being the focus of modernization efforts, has had much more control over financial and technological resources as well as political influence over management decisions. The inshore sector has instead tended to be marginalized at every level. This difference in terms of power and influence has been traditionally attributed to the belief that the offshore sector substantially contributes to the overall national economy through the export of shrimp. However, it has also been commonly believed that the inshore sector has been allowed to subsist for social reasons, rather than for its contribution to the overall economy.

While the last two statements might have been true in the past, the current situation requires a reevaluation of these common beliefs. This reevaluation has been done elsewhere (Vásquez León and McGuire 1993). It indicates that currently, the inshore sector in the state of Sonora produces 40-50 percent of high quality blue shrimp for the export market at much lower costs than the offshore sector.[1] It also indicates that technological improvements developed by the offshore fleet--specifically designed to enhance its efficiency--are leading not to an increase in production but to overcapacity and, perhaps, to resource depletion.

One crucial factor which accounts for the increased efficiency of the inshore sector, as well as its capacity to bring foreign exchange into the country, was the introduction of the *chinchorro de línea*. This net attracted an unprecedent number of people to the shrimp fishery. Fishermen as well as non-fishermen (also called *oportunistas*: doctors, teachers, government employees, lawyers, etc.) took advantage of the great profits brought in during a one-to-two month inshore shrimp season. However, the explosion in the number of shrimpers served as the justification to ban the net in 1991. For inshore shrimp fisherment this decision came as a hard blow. They argue that there was no need to ban the net; instead, it would have been better for SEPESCA not to issue any permits to non-fishermen.

Underlying the recent ban of the *chinchorro de línea*, two issues become evident. First, the banning of a net that considerably increased the efficiency of

1. As blue shrimp reaches maturity and an optimum market size, it migrates offshore from estuaries and bays. However, inshore fishermen intercept a large percentage of this shrimp before it is out of their reach. Much of what inshore fishermen are unable to catch will be caught by offshore shirmpers. By limiting the capacity of inshore fishermen to capture the resource there is an actual redistribution of benefits from the inshore to the offshore sector.

the inshore sector demonstrates that, inspite of its economic contribution, this sector continues to be marginalized. Second, despite its relatively lower economnic efficiency, the offshore sector continues to have the upper hand in terms of influencing regulations. The banning of the net gives obvious advantages to the offshore sector since both sectors compete for the same resource.

Management issues

From an organizational point of view, fisheries management in Mexico is characterized by a highly centralized and rigid structure controlled from the top. Since the late 1930s, the Mexican Government has played a central role in the management of commercially important species. The Fisheries Ministry and the Instituto Nacional de la Pesca (INP), from its central offices in Mexico City, control all matters concerning research, law, and regulatory enforcement. This is done through regional delegations that implement and enforce national regulations at a local level, and Regional Fisheries Research Centers (CRIPs) located in coastal states. CRIPs are in charge of monitoring particular species and advising central offices as to the need for closures.

Fisheries management has essentially been based on single species methods. For instance, for shrimp, which has been the most closely monitored fishery in the upper Gulf, it has been assumed that shrimp production is an equilibrium function of the stock itself. However, methods for calculating allowable yield do not take fundamental external factors, such as ecological considerations and the effects of other species in the biotic community, into account. Although this has been the traditional way marine stocks all over the world have been managed, there is an increasing awareness of many instances of failure (McGuire 1991). As will be discussed later, the declaration of a bioreserve in the upper Gulf of California provides an exceptional opportunity for Mexican administrators and researchers to attempt innovative management strategies and incorporate key external factors into a multi-species management approach.

Current single species management efforts in the upper Gulf concentrate on three selected species: totoaba, turtle and shrimp. Totoaba fishing has been permanently banned since 1975. The market value of this species attracted many fishermen to the area. Indeed, all three communities began as fishing camps for totoaba fishermen. The species is still economically attractive, making enforcement of the ban difficult. Although fishermen in both Santa Clara and San Felipe have reported being fined and having equipment confiscated for fishing totoaba, it is also common knowledge that totoaba is still fished with the tacit cooperation of officials. In an attempt to improve enforcement efforts, in 1992 the Fisheries Ministry banned the use of nylon monofilament gill nets with a mesh size greater than ten inches. It is claimed that these nets are used for totoaba and accidentally also catch vaquita (Villa 1993). However, our own field observations, and data provided by key informants, indicate that nylon monofilament thread is not

strong enough to be used for totoaba. Instead a silk thread must be used. If the latter is the case, it is unlikely that the 1992 ban will be successful in the conservation of the totoaba. In Santa Clara, fishermen related that Pesca had offered to pay them 200,000 pesos per week if they agreed not to fish totoaba. Sixty people signed up. But when the checks finally came, only twenty people received them, all rich boat owners, and they received only 100,000 pesos, and the payment was made once.

The fishing of sea turtles was also banned in the 1970s. Field observation and accounts from informants suggest that fishermen are very aware of the ban. There is concern over "getting caught" when a turtle is accidentally caught by a shrimp trawler, and most of the time it is returned to sea. However, as for totoaba, enforcement is not complete. When offenders are caught, bribing of officials seems not to be uncommon.

Additional conservation measures in the upper Gulf include the establishment of an exclusion zone across the mouth of the Colorado River in 1955. In 1974, the area was decreed as reserve zone, its southern boundary being an imaginary line between Punta Machorro, in Sonora and La Zacatoza in Baja California. This reserve area has been generally considered as beneficial by local fishermen who appreciate its ecological importance. However, since it includes Santa Clara itself, fishermen heading into port claim to have been accused of fishing in the reserve area and have had their equipment confiscated. Again, as in the cases above, enforcement has not been totally effective or carried out in the best possible way. Pirating of shrimp from the bioreserve remains an ongoing activity.

General government policies have been an integral part of management efforts of the shrimp fishery. This has had important repercussions that underlay the present crisis faced by the shrimp industry. For instance, modernization efforts and policies of the 1960s and 1970s -- such as indirect subsidization of imported boats and engines through an overvalued peso, and oil and diesel subsidies -- prompted a dramatic expansion in fleet size. These efforts seem to have been even more pronounced in the upper Gulf. As data (Evaluación de la Flota Camaronera por Puerto, Agosto 1991) provided by the Pesca Delegation in Guaymas suggests, the Puerto Peñasco fleet, although smaller in size, has been better equipped than the Yavaros and Guaymas fleet. This point is important. It suggests that fishery managers, as agents of government policy, have direct responsibility for the present ecological problems of the upper Gulf. While in the past, government chose to stress policies designed to increase productivity, now, after a recognition of overcapitalization, probable overexploitation of stocks, and concern for the effect of shrimp trawling on the totoaba population, it chooses to take the opposite direction, a complete halt to shrimping activities by the offshore sector in the upper Gulf. At the local level, there is a general feeling that the sacrifices resulting from this changing policy must be endured by only one

party involved, the offshore fleet. This point will be discussed further as an attempt to show the advantages of integrating management and fishing efforts to better balance ecological and economic concerns.

Recent management efforts of the shrimp fishery reflect a series of contradictions at the local level. These contradictions, we believe, arise precisely from looking at ecological and economic concerns as separate issues, and from a lack of local level intervention in the decision making process. For instance, the closing and opening of the shrimp season is determined by the INP after reviewing regional proposals sent by scientists from the different CRIPs. Researchers in turn base their decisions on studies of gonadal maturation. The dates when studies are carried out and how quickly a decision is reached are crucial factors in the conservation of the resource. However, because decisions over when the season should open and close become entangled in the bureaucracy, over the long term they often hurt the fishery they are intended protect. According to our own field observations during the 1992-93 season, by the time researchers started sampling shrimp to establish the date for closure, approximately 25 percent of females caught were gravid. By the time the actual decision to close the season was announced, the number of gravid females had doubled. The most frequent complaint made by offshore skippers is that the season has always closed too late. In 1992, fishermen in Puerto Peñasco refused to go out after April. However, there was little support from officials, so while they were on strike, fishermen from Guaymas were shrimping in the area, rendering their conservation efforts useless.

Another contradiction stems from recent regulations regarding the offshore sector. Despite concerns with overexploitation (Rodríguez de la Cruz 1987) and stock depletion, in May, 1991, it was announced in the *Diario Oficial* that the capacity of shrimp trawlers will not be in any way reduced or modified. On the contrary, their territory of exploitation was increased from a depth of ten to five fathoms. Although this measure may sound good to shrimpers presently, the long term effects on a fishery already in a critical condition may be devastating.

Although we have already raised the issue of enforcement, there are several other problems which require cooperation between local level users and regional as well as national administrators. The Fisheries Ministry and regional delegations do not seem to have enough financial resources to sustain the high level of enforcement required in any marine fishery, nor do they provide enough incentives to officials in charge to avoid instances of corruption. Three or four inspectors at the most are assigned to each Pesca office. However, they require the cooperation of the local navy, military, *capitanía de puerto* and the federal police, none of whom are specifically trained to do the job. Lack of training and a salary insufficient to support a family may induce inspectors to accept or demand bribes.

Finally, the issue of foreign boats fishing in Mexican waters, particularly in the upper Gulf, has caused much resentment among local users who feel that managers are ready to limit locals' activities for the sake of conservation but allow foreign vessels to fish for commercial purposes. Reports by local fishermen indicate that Japanese and Koreans have high technology equipment and literally sweep the seas using vacuums and high powered lights to attract fish and squid. For fishermen in the upper Gulf, the policy that allowed foreign boats into Mexican waters is an indication that the gulf is an open access resource available to all, Mexican nationals and foreign fleets. They feel that their rights have not been respected by managers.

Marketing channels

The marketing systems for marine products in the upper Gulf between inshore and offshore sector operations vary according to species. Shrimp, assorted fish, first class fish for exports usually caught at large depths, shark, and chano make up the bulk of the commercialized sea foods. Less important from an economic viewpoint are oysters and clams. The offshore sector's marketing system is generally much more organized, with a few large specialized firms, while the marketing system of the inshore sector varies a great deal. Despite this variation there are commonalities. For instance, fishermen are not involved in the marketing process. They are usually unaware of how often their catch will change hands before getting to the consumer. They have access to little market information. They only know that prices can change very fast over one month, and are aware of their inability to control prices from the supply side. They do not always target species that have the highest market value, targeting instead a species that is abundant and for which there is a buyer, thus compensating the lower price with a larger volume. However, abundant species with high market value and an assured buyer are preferred. This is the case with shrimp and shark to a lesser extent. Economic profits are not the only goal when selling product. Instead of selling to the highest bidder, it is important to develop ties to assure that the product will be bought. However, marketing agents are distrusted and commonly considered thieves with no compassion for the risks and troubles a fisherman faces.

In terms of commercial species, market value largely depends on quality. The product's quality depends on keeping it at the right temperature, either frozen like shrimp, or iced like most fish, and selling it fresh. The longer the product is kept in storage, the lower is its market value. Fishermen are thus highly dependant on having immediate buyers because it is impossible for them to store significant quantities of product for times when prices peak. Often their inability to store product results in its loss. Moreover, markets for fish tend to be fairly specialized. Shrimp channels do not handle other marine products and vise versa.

The export shrimp market has traditionally been highly organized through

the parastatal company, Ocean Garden. This company started operating in the upper Gulf about 25 years ago and buys a large percentage of blue shrimp from cooperatives that are sold in the U.S., and of brown shrimp that are exported chiefly to Japan. The idea of creating one government controlled export company, and giving it almost monopsony power, is based on the assumption that such a company is better able to centralize marketing information, so is able to obtain the best price for the product on the international market. It is also able to provide an assurance of product quality to consumers. Through Ocean Garden, Mexican producers are also able to sell their product as a consolidated group. Since the market for shrimp is very competitive, this at least ensures that Mexican producers will not compete with one another. Fragmentation from the supply side would mean greater vulnerability to producers and marketing agents. In spite of its claimed economic efficiency and high prices offered to producers, the company is undergoing privatization. In the past, it has provided credit to producers. However, during the 1992-93 season it restricted loans. Now there are private companies such as *Pesquera Siete Mares* in San Felipe, or a small private buyer in Santa Clara, that are competing with Ocean Garden and willing to lend money to cooperatives to increase their share of the market.

Parallel to the official market is the black market that offers a higher price than the cooperatives offer. The black market has emerge because of a governmental mandate that required all shrimp for export to be delivered to cooperatives and marketed by Ocean Garden. *Guaterismo*, or black market activity, has traditionally occurred. However, it seems to have intensified in the 1990s, perhaps as a way of protesting against government policy, and because of the uncertain future of the fishery. Black market shrimp is sold to *guateros* who may export it or sell it in the domestic market.

The market for fish is very different from that for shrimp. While it is guaranteed that there will be buyers for shrimp, fish is much more risky for most of the year. However, during and before *cuaresma* it sells well, especially in places like Mexico City. At such times, prices tend to reflect market forces. Buyers come from different areas --Mexicali, Ensenada, and Tijuana-- looking for fish.

During the rest of the year there are few buyers, and prices do not reflect changes in supply and demand. Very large volume is what counts. The most important thing for fishermen is to be able to sell product immediately, at any price, before it spoils. Most of the by-catch from shrimp trawlers can be considered in this category.

Unlike the shrimp market, the marketing system for fish is characterized by many small businesses and relations between buyers and sellers that are based more on being able to assure a long-term commitment rather than on being able to offer the highest price. For instance, during the offshore season, shrimp cooperatives may contract with a specific fish buyer who has provided them with

credit. Through this contract, however, the buyer is able to negotiate a lower price. There is also the case of fishermen-workers producing for patrones. The latter tend to be *permisionarios*; that is, they are middlemen who must have a license for commercializing marine products, and hire their own producers. There are also many middlemen without licenses who work in the informal economy.

First class fish, usually caught with line, can be more profitable. However, it is a much more risky choice since the catch is usually very low. The fish caught is much higher quality and can be exported to the U.S.

Even though there are many abundant species in the Upper Gulf, such as *sierra, mojarra*, and squid, low market value in relation to costs of production makes them unprofitable to fish. Only those species with developed markets can be exploited commercially; this, however, increases the likelihood of overexploitation and stock depletion.

A case of a fishery for which a market has rapidly developed is that of *chano*. Chano has been very abundant and, prior to 1992, it was not commercially exploited. although this species does not have a high market price (800 pesos/kg), assurance of a buyer and its abundance has made it attractive enough to become the focus of fishing efforts in the last two years. The marked has developed as a result of demand by Koreans who use chano to make surimi--a fish paste-- from which artificial shrimp is made. During the first year, only one buyer from Mazatlán arrived in El Golfo de Santa Clara, causing a shortage in demand and an excess in supply. Some 60 tons were produced and much of the product was lost, since there were no mechanisms to store or sell product other than the one buyer. In Puerto Peñasco, however, there is already a company which has established several freezing operations. But inspite of a developed and promising market, this year the production of chano in this community plummeted. Chano was expected to arrive during the months of April or May, but by the end of July the chano had not arrived yet. Fishermen speculated that it had been overexploited already.

Summary

The organization, management, and marketing of fish and fishermen in the upper Gulf are complex, and in a state of flux. Market imperfections lead to the production of volume over quality. Management decisions are often made in Mexico City, not responding to the regional ecosystem, nor to local economies. Organizational lines have been blurred by recent political and monetary changes. Through all of this, experienced fishermen continue to practice their trade. In the next two chapters, we look more closely at this trade: first, through an "ethnography" of fishing, an examination of the cultural knowledge possessed by fishermen in the upper Gulf; then through a spatial and temporal analysis of fishing

patterns in the region. From these three chapters -- all underscoring the organizational, managerial, and ecological crisis in the upper Gulf -- we extract some recommendations, in Chapter 9, for a more responsible fishery.

Chapter 5

The Ethnography of Fishing

Hernan Aubert and Marcela Vásquez León

Introduction

Fishing demands skill, practice, commitment, and, frequently, luck. In this chapter, we endeavor to record some of the vast funds of knowledge developed over time by the practicing fishermen of the upper Gulf, knowledge of how fish and shrimp behave, how the tides, currents, and bottom effect the success or failure of their efforts, and knowledge of how the larger "political economy" of the region impedes or enhances their chances for success. Our approach, and our methodology, is ethnographic: it is based on participant-observation, on board and on shore. And the information is drawn from a group of highly experienced fishermen. In Puerto Peñasco and San Felipe, 50 percent of the panga and trawler fishermen interviewed had more than 20 years of experience on the water, while at El Golfo de Santa Clara, panga fishermen had worked an average of 11 years and their offshore counterparts an average of 19 years.

The offshore shrimp trawler sector

The following description is based on observations made while on board the Magdalena XXI, a shrimp trawler privately owned by Zavala, during its fourth fishing trip in the upper Gulf region (that lasted twelve days). The senior author spent eighteen days on board the María, another privately owned shrimp boat during its fishing trip (in the region between north of tiburón and south of Puerto Lobos). Alfredo is the captain of the Magdalena XXI and Pancho is the captain of the María.[1]

Preparing for the trip

The Magdalena XXI returned from its third trip on March 14th, 1993 after 70 days away at sea. The crew worked 50 days out of the total 70 days and

1. The names of people and boats used in this report are pseudonyms to protect the privacy of those involved.

caught 2.3 tons of mixed (brown and blue) shrimp at the expense of 95,000 lts. of diesel (25,000 gallons), three severely damaged chinchorros, and a broken winch reel. According to Alfredo, the captain of the boat, "Zavala did not fire me because all other boats were reporting similar catches and, furthermore, the shrimp fishery is in such a bad shape that nowadays 2.3 tons in 50 days is a good catch". After spending some time with the crew during the fourth trip, we are almost sure that they sold some shrimp through the black market -- during the fourth trip we sold 365 kg through the black market, and only reported 800 kg of shrimp when temporarily returning to Peñasco for refueling.

Upon arriving in Puerto Peñasco after the end of the third trip, the crew spent five days at port unloading the shrimp, fixing the nets, replacing damaged equipment (one of the winch reels was severely damaged and had to be replaced), visiting the cantinas, and refueling. Only 20,000 lts. of diesel were obtained, enough to work 10-12 days, since the boat owner was uncertain about the official closing date for the season and did not want to risk overfilling the boat with diesel.

Alfredo was in complete control of the boat, meaning that he decided when to leave port again. As we observed, this was not the case with other captains working for Zavala. Zavala has a worker in charge of all the boats arriving to Peñasco, who supervises the loading and unloading of the boat, decides how much fuel the boat will get, and when the boat will leave port again.

Magdalena XXI as a trawler

The Magdalena XXI could be classified, due to its trawling capacity and power, as one of the bigger boats used in the area.[1] This boat was built by Astilleros Monarca (Guaymas) and is equipped with a diesel Caterpillar 3412 (one of the biggest boat engines used by trawlers in the Gulf), a winch with 2-2.5 tons leverage capacity/reel, chinchorros of 110 feet mouth opening and 12-13 foot boards. The boat was designed to provide the largest possible working area in the deck, thus living space is very limited. At the back of the cabin there is a small kitchen and dining area (where the crew must take turns to eat). The kitchen has two side doors leading to the deck. The galley and the *puente de mando* (bridge) are connected by a narrow corridor, at one side of this corridor is the captain's cabin (single bed and larger space), and at the other side the two cabins for the crew, one with four beds and literally no space to move around, and the second, with two beds and a space to crawl in and out the bed. The puente de mando is just big enough for its purpose. It contains three different radio systems, a *video sonda* and a compass. This is basic equipment and it is what most fishermen use; they never carry a bathymetric chart or anything of that sort on board. Ultimately they rely on their experience and land features to determine the locations of the fishing grounds and the depth at which to fish.

The only toilet is located outside and is rarely used. Due to its reduced size and the long history of boats without a toilet, crew members prefer to use the stern (*popa*). The toilet is more often used as a shower room than for its intended purpose. To take a shower, water must be warmed on the kitchen stove, collected into a bucket, and placed on top of a piece of plywood that covers the toilet bowl. A small jar (a tomato can or something of the sort) is then used to take the water from the bucket and to poor it over yourself. Each crew member has his personal can used for this purpose.

Crew composition, duties, and salaries

The crew is usually composed of seven men with different responsibilities and social status while on board. The lowest ranked of the seven is *el pavo* (the turkey) who is the boat's 'gofer'. He must be available at all times for every duty and situation that may arise: helping the sailors to repair the nets, taking charge of the steering (a *guardia* or watch of 2-3 hours/day), cleaning the nets, separating the shrimp from the total catch, cleaning and beheading shrimp, storing the shrimp in the cold room, walking on the polls (*tangones*) to check the nets, the boards and the foll (cable), and '*changear*' which means that for a period of 3-4 hours/day he must be 'on duty' to retrieve the chango every 30 minutes to an

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1. Not all the boats in the fleet are the size of the Magdalena XXI. Some of the smaller shrimp trawlers that range from 56 to 70 feet in length and use smaller and older engines, 342 Caterpillar (360 h.p.) and are also used for shark fishing. These boats are used for a few months during the shrimp season, and then are modified so that shark nets can be used.

For shark a drift net locally known as *chinchorro de amallar* is used. It is left buoyed at a depth of 300-500 brazas. It measures between 12 and 16 meters in width (*de caída*) and from 1,000 to 1,260 meters in length. Mesh size may vary from twelve up to twenty inches, however, the 12" is more efficient, and is the one used by most shark fishing boats in Puerto Peñasco. A silk thread #36 is used. Boats used for shark fishing do not have refrigeration, so ice has to be bought at 24,000 pesos per bar. Eight tons of ice are needed for a seven day trip, a total of 56 bars (7 bars = 1 metric ton) or 1,344,000 pesos. A steel reel is used for the net, it costs 30 million pesos.

The important species caught by offshore fishermen are the *tiburón bironche* (*Rhizoprionodon longurio*); the *tiburón grillo* or *azul* (*Alopias valpinus*); they have very soft meat, too soft. They get 2,500-3,000 pesos per kg for these sharks, but the price can go as low as 1,000 per kg if they are a few days old. It takes many days to dry shark meat. If they have no ice, the heat softens the meat. The *tiburón bonito* or *mako* (*Isurus oxyrinchus*), they catch perhaps one per trip. Near Ensenada more sharks are found-- *tiburón coludo* (*Alopias pelagicus*) and *tiburón grillo* (*Alopias superciliosus*); and the *tiburón limon* or *amarillo* (*Negaprion brevirostris*), which is rare. For these, they can get about 1,200 pesos per kg. All of the targeted species run in schools, and must be chased.

hour. He is the busiest person with the lowest salary on the boat. He only receives a share of what the captain sells on the black market-- shrimp and/or by-catch.

Immediately above the pavo are the two sailors. Sailors' main duties are to *changear*, retrieve, set, clean and fix the main nets. Since there are two nets, each sailor takes care of one and considers it to be his own. They develop a special feeling of love and attachment to their nets and often compete to see whose net works better. They joke a lot about each others' nets. Other duties include guardias at the helm, and cleaning and processing the catch. A sailor's salary is determined before leaving port and is usually agreed to on a per ton basis. Salary/ton varies widely from armador to armador. On the Magdalena XXI the sailors were paid 600,000 old pesos per ton (plus a share of the by-catch and illegal shrimp sales).

Higher in social rank is the cook. The cook's duty is to make sure the food is ready on time. He makes the shopping list for the entire trip, and helps the sailors when retrieving the nets. (He had better be a good cook, whose cooking meets with the crew's approval, otherwise problems begin to surface.) The cook has a spot on the deck at one side of the winch that is his and no one else's. This makes him responsible for winding the cable into one of the reels every time the nets are retrieved and set. Besides this task he must help in the separating of shrimp from by-catch and beheading of shrimp, like everyone else. Cook's salary is $1,180,000/ton. The four positions described so far share the small room with four beds.

Next position up the ladder is the *ayudante de motorista* (motorman assistant). Even though his duties while on the deck are identical to those of the cook, and both receive the same salary, the ayudante has a higher status since he is the one that, together with the motorman, looks after the boat's mechanical parts. The ayudante is the motorista's gofer and has to be ready at all times to deal with any engine problems, or problems related to refrigeration in the cold room. Important here is the fact that even though a sailor and the pavo are in charge of processing the shrimp in the cold room, the ayudante and motorman are entirely responsible for whatever happens to that shrimp. In other words, they must ensure that the cold room is kept at the right temperature by constantly checking the temperature of the cold room and the shrimp.

Directly above the ayudante is his boss, the *motorista*, whose duty is a little less demanding than those of the ayudante. He is the one who determines what action needs to be taken regarding engine or compressor problems, and the ayudante simply carries them out. Apart from that, the motorista takes shifts with the captain at the helm, and is usually in charge of the boat during the night. Some captains are relaxed about time shifts but usually, if there are no problems, the captain will trawl between 7:00 a.m.-1:00 p.m., and between 7:00 p.m.-1:00 a.m.; the rest of the time the motorista will be the one in charge of the boat.

These shifts will only take place during fishing operations. When moving from fishing ground to fishing ground (running), however, the sailors, pavo, and occasionally the cook have an established round of shifts at the helm. The motorista does not usually make decisions as to what direction the boat should be steered, the captain makes those decisions and simply gives the instructions as to where and how deep the motorman will be fishing. The captain may also point to specific landmarks for the motorista to get familiarized with the fishing ground. Landmarks include big objects in the bottom (sunken boats and rocks), bottom features such as sudden changes in depth, and hills and other land features. The motorista's salary is $2,600,000 per ton.

Finally, the better paid and the ultimate boss is the patrón. (Most "*patrones*" are offended if you call them Captain). One should not be using the word captain here but, in the boat everybody makes fun of the patrón by calling him captain, comandante or general. This is a common joke (of course always behind his back). Captain's responsibilities are to take care of the boat and produce a lot of shrimp for the armador. He is also in charge of coordinating the crew so as to ensure that the fishing trip does not end in quarrels and disputes between crew members. This is hard to achieve since everybody, including the captain himself, gossips about those that are not present at the time, and it is common to hear a lot of talk behind somebody else's back. Captain's salary was negotiated at $4,000,000/ton.

Types of nets and modifications

There are different types of trawling nets (*balón, semi-balón, fantasma, buzo,* etc.) that vary in their construction, usually in the size and shape of the *cuchillas* (blades), the height of the *ala* (wing), and, the relative displacement (backwards or forward) of the *tapadera* (upper part) to the *arrastre* (lower part). Shrimp boats use two trawling nets and what is locally known as a *chango*. The chango is a miniature drag net used to sample the catch. It is set after the trawling nets and retrieved every 30 minuets and used to decide how long to trawl. The mesh size for a trawling net is 2 1/4" in the main body and 1 1/2" in what is called the *bolsa* or bag at the end of the net. Most commonly the net is made of a cotton thread covered with wax. The fabric for the net comes in *fardos* which have 2,000 *mallas* (approximately 375 feet). A net of 110 feet across the mouth requires one *fardo* while an eighty foot net requires half a fardo. A captain may carry different types of nets on board, to be used with the different species of shrimp found in the Gulf and at different depths. For instance, *fantasmas* and *mixtos* are commonly used for blue and white shrimp (*P. stylirostris* and *P. vannamei*) that are caught in relatively shallow waters (5-18 fathoms) and are more active than brown shrimp. *Balón, semi-balón* and *buzo*, on the other hand, are designed to work more efficiently with brown shrimp (*P. californiensis)* at depths up to 35-40 fathoms. Captains, however, may decide simply to carry mixtos that

are a hybrid between a fantasma and a balón. Further modifications of a standard net can be achieved by playing with the number of floats and the amount of weight added to the net. To decide the best float and weight combination, the captain needs to be aware of the type of bottom sediment, the amount of mud retained in the nets, the type and abundance of by-catch, the strength of the currents, type of shrimp and its behavior, and trawling depth. Usually nets are prepared with an average weight, which is generally a single chain along all the length of the arrastre and a double chain under the cuchillas. This practice makes the nets suitable for a variety of bottom types. The final tuning of the net is then achieved by adding or removing floats because they are easier to install and remove than are weights.

The *espantadera* (tickler chain), which is a long chain that holds the base of the two boards at a specific distance (usually the same size as the chinchorro's maximum aperture), works in front of the chinchorros lifting whatever it encounters into the nets. Since it is a free piece of heavy duty chain, when the espantadera touches something in the bottom (old tires or rocks), it produces a swinging motion that lifts the objects from the bottom and throws them into the net. For the espantaderas to work optimally, they must be fully extended. If the boards cannot open completely, the espantaderas will not have the necessary strength to produce the swinging motion and will get entangled in the rock or whatever they are supposed to lift, causing more harm than good. The espantaderas are checked less frequently than the chinchorros; usually they are checked when the boards are brought on the deck.

Besides differences in design, a net also can vary in its size or mouth aperture. The maximum size net a trawler can handle is determined by two factors: engine power and size of the boards. For 12 foot boards, many captains use nets that range from 110 to 115 feet (which are prohibited). These are mainly used for blue shrimp. Smaller boards tend to carry smaller nets.

The catching efficiency of the different sized nets (85', 90', 100', 110' or 115') depends upon the depth at which the nets are used. The reason is that, with increasing depth, the increased drag (caused by the boards and the nets), reduces the speed at which the chinchorros can work. Thus, a big net in deep waters cannot open its mouth to its full extent. This not only reduces the catch, but also causes a series of other problems with the espantadera and the arrastre. On the other hand, a smaller net will contribute less to the total drag and can open its mouth to the full extent, increasing the chances of catching shrimp (or other targeted species). The common belief that the bigger the net the more shrimp it catches is not always true. For instance, when trawling at depths shallower than twenty fathoms, a small 85' net can achieve the same, or even better results, than a 110'. Moreover, the smaller net produces less drag on the boat that in turn reduces fuel consumption.

It is important for a captain, therefore, to understand how the nets work and what factors influence their performance. For a captain who is less skilled, or unlucky, repair costs can be high. Repair costs for a net can range between 100,000 to 300,000 pesos for a 100 feet net, depending on the skill of the net mender. More highly skilled menders charge more. Minor repairs are done by the sailors as part of their duties.

Handling the chinchorros

The chinchorros must be completely untangled before they are set. While on deck, the chinchorros are opened to separate the floats from the chain, to inspect the net for damage, and to clean obstructions. This task is carried out at least once a day, usually early in the morning, and it could take between 20 minutes to one hour depending on how dirty the net is. For instance, if you get a school of *pez chiles*, round and pointed 10-25 cm. long fish, every mesh in the net will be clogged by one chile stuck by the throat, the process of cleaning will be rather long.

When trawling 24 hours, the nets are brought on board whenever cleaning becomes necessary. We had to clean the nets often because of the incredible abundance of squid eggs that can clog a net completely. Sometimes, because of the presence of large concentrations of squid eggs, it was imperative to clean the nets each time they were retrieved.

The reason why nets are brought on the deck, cleaned and hanged in the morning, is because they have to be dry before the sailors can mend them. There is always mending to do. The time fishermen spend fixing a net can vary from an hour, to all afternoon, to three or four days, depending upon the size and the location of the damage. The most difficult part to mend, due to the way in which the mesh is cut and sewed, is the *cuchilla.*

Trawling

Shrimp trawlers in the Gulf of California drag three nets: two *chinchorros de arrastre* (one on each side of the boat), and a *chango* which is a small version of the chinchorro used to sample the quality and amount of catch. The chango is basically used to decide how long the trawling period will be, and when to move back to a previous spot. This small net is set immediately after the chinchorros and is retrieved every 1/2 hour to see what is being caught by the nets --this varies a lot depending on the captain; some are very accurate about retrieving time for the chango, others are more relax and tend to forget about them. The catch in the chango will tell the captain whether to carry on fishing in the same direction or make a 180 degree turn to go back to where the boat was before. For example, if the chango catches six shrimp the first 1/2 hour, twelve shrimps in the next 1/2

hour and three in the last 1/2 hour, the captain will start an 180 degree turn to go back where he caught the twelve specimens.

Retrieving operation

Bringing the nets on board requires coordination and cooperation. Ten minutes before retrieving the nets the captain, or the motorman, gives the instruction to the crew to get ready. Usually the crew uses the time between trawls to catch up on their sleep, so the ten minute call gives them the opportunity to get dressed in their yellow rain coats, and drink a cup of coffee (which is always ready). The crew then goes on the deck and everyone takes his position. The cook and ayudante stand by the winch, with a sailor on each side of the boat, and the pavo in the center of the deck, ready for any eventuality that might occur, while waiting for the captain's signal to start recovering the chinchorros. Meanwhile, the person on chango duty fetches the chango, ties it, and puts it away so that it will not interfere with the operation. When everybody is ready and the chango is out of the way, the captain gives the signal-- a sudden reduction of the RPMs (from 1400 to about 750-900). The term used for this drop in RPMs is *recortar* (to cut the engine). Cutting the engine is very important, because if the winch is connected at high RPMs the coupler between the winch and the main engine (*toma de fuerza*) can be seriously damaged. To replace this part is expensive, and requires a fair amount of labor. Once the winch is connected, the *cuñas* or reel retainers are removed and a foot brake is used to keep the reels in the position. The winding begins when the foot break is released and a clutch, that independently connects each reel to the coupler, is activated. The cable must be wound up very tightly. If they don't do this, the boards will not come out of the water at the same time, increasing the risk of breaking the boards or bending a *tangón* (the poles or outriggers that extend horizontally outward at each side of the boat, designed to keep the nets separated from the boat). To wind the cable tightly, a piece of galvanized tube is attached to the floor and used as a leverage to push and pull the cable as it winds. This extra pressure increases the tension of the cable and directs its position in the reel. When the boards reach the tip of the *tangones*, the cook and ayudante put the *cuñas* on the reels and disconnect the winch. At this point, the boat produces a sudden movement (it feels as if the boat becomes heavy and rocks a little, first on one side and then on the other) which is the signal that the captain is waiting to increase the RPMs to 1700-1800.

Running with the nets in the water will force all the catch to the end of the net (*bolsa or embudo*) and will get rid of mud and other things that may be washed away. It also forces the nets and the *chimbomba* to come to the surface. The *chimbomba* is a piece of nylon rope that is attached to the two *falsos* (rope which loosely joins the board and the mouth of the bag) and allows the crew to retrieve both nets at the same time. When boats do not use a chimbomba the captain has to make a complete left turn for the sailor at the right side to catch the

falso at his side of the boat, and then a sharp right turn for the sailor in the left to get the falso at his side of the boat. This considerably increases both retrieving time and risk of accidents. So, there is one falso per net, made of much thicker nylon rope, connecting the mouth of the bolsa to the boards; when pulling the falso the bag closes so whatever is in the bag remains there.

While running, the captain positions the boat so that the current and waves come from the front. Meanwhile, the pavo seizes the chimbomba and waits for the captain's next signal. Once the boat is positioned, the captain will reduce the RPMs once more, allowing the pavo and the sailors to pull the chimbomba and grab the falso, and allowing the cook to connect the winch once again. Each falso is wrapped around a pulley in the winch and recovered; this brings the bag to the side of the boat. The end of the falso (which is the mouth of the bag still in the water) is secured with a hook that moves up and down the mast (*pluma*). Once secured, the falso is released from the winch and the *sencillo* is attached to the mouth of the bag. The *sencillo* is a single piece (thus its name) of thick silk rope that is passed through a pulley located at the top of the mast right above the centre of the deck. One end of the sencillo has a big iron hook used to anchor itself around the mouth of the bag, right above the falso. The other end is wrapped around the winch to retrieve the bag onto the deck. As the sencillo is pulled up by the winch, the hook that holds the falso moves up the mast; as a result, the bag is pulled out of the water and onto the deck. Once retrieved, the bags are maintained at a certain distance from the deck so as to allow the sailors to fetch the rope that closes the far end of the bag, untie it to release the catch, shake the nets to dislodge major obstructions, close the bags, and throw them over board. This is where good coordination is necessary. The sailor will balance on the end of the hanging net to gain the necessary inertia that will allow him to throw it back into the sea. The people manning the winch must know exactly when the sailors will throw the net in order to let the sencillo go at the same time. Once the bag is in the water, the winch is turned off, the sencillo removed from the bag, the falso released from the hook, and the chimbomba attached to the falso. The chinchorros will be fully extended as the captain positions the boat in the fishing ground. A slight mistake can be time consuming. In the best scenario, the whole operation might have to be repeated, but, if things go really wrong though, the nets can be caught by the propeller, a major headache.

Setting the nets

Once the sailors throw the bag overboard and the hooks that hold the falsos are released, the nets are completely in the water, held to the boards by the *relingas* (the float and weight lines). The captain will run to the fishing ground or position the boat where he wants the nets to be set. The signal for the people on the winch to set the nets is a sudden *recortón* (reduction in RPMs). When the captain reduces the revs, the cook and ayudante connect the winch once more to

remove the cuñas that hold the winch reels, hold the reel in position with the break, and disconnect the winch. Removing the cuñas produces a shaking movement identical to the one described for the retrieving procedure that serves as a signal to the captain to increase the revs (to 1700-1800 RPMs). Increasing the speed of the boat when setting the nets ensures that the boards will open completely and that the chinchorro will be perfectly stretched. At high revs, the men at the winch will release the breaks and let the boards go. When the boards touch the water the cook and ayudante begin to count the marks (usually pieces of rope rapped around the cable) that are placed at 10-20 fathoms intervals along the cable. The captain will tell them how many marks they need to release and where to position the mark in the boat. There are three commonly used positions: a) at the winch (meaning that the mark has to be stopped immediately after it leaves the reel), b) at the tip of the *tangón*, or, c) at the water. The position and number of marks used are directly dependent on the depth at which fishing occurs and it is the captain's duty to know the relationship between depth and number of marks. If they screw up the marks, releasing too little cable or too much, the nets will not work optimally. This, in turn, causes other problems, such as boards getting stuck in the mud, loosing nets, spinning boards and tangled chinchorros.

Counting the marks, and hence setting the gear, is carried out at full speed. When the mark that needs to be positioned is about to get out of the winch reel, the ayudante sends the captain a signal (a strong noise like hammering on the deck or a sharp whistle) with the message "the mark is approaching, reduce the speed". So the captain reduces the speed again (to allow the boards to touch the bottom) until a second signal (meaning reset the power at trawling speed of 1400 RPMs), is sent when the mark is in the right position. Once at the appropriate speed, the cuñas are set again and the crew can forget about the nets for the duration of the trawling period. The only member of the crew during the trawl who keep an eye on the gear is the one who is on-duty retrieving the chango.

Handling the catch

While the people in charge of the winch are setting the nets, the rest of the crew on deck is separating by-catch from shrimp. This can be an enjoyable experience or a real pain in the neck. It is the time when sailors joke about each other's net and play with the by-catch, teasing and playing tricks on the unexperienced crew members (in this case the biologist). The by-catch is separated with the aid of a *rorro*, which consists of a thick piece of wood attached at a right angle to a wooden handle. The crew works the catch from the sides to the center of the deck, leaving behind the unwanted by-catch and separating the valuable fish (for personal consumption or to be sold to the pangueros) at either end of the deck to be processed after the shrimp.

The shrimp are collected into several straw baskets that are placed in the

middle of the deck, on top of the total catch. Once all the shrimp are collected, the doors at the side of the boat are opened, and the unwanted by-catch is shoveled overboard. This is dinner time for an enormous amount of birds, sea lions and big predatory fish like *barrilete* (a type of tuna with red meat).

All the baskets of shrimp are then washed with sea water (a relatively high pressure hose is connected to a pump that is constantly delivering sea water onto the deck and used for cleaning the deck and the shrimp) and then emptied in the center of the deck. The crew will sit around the pile of shrimp and will begin to dehead the shrimp and separate the big ones from the damaged or small ones. This close gathering of the crew around the pile of shrimp is used to joke about something or to complain and exchange opinions about a captain's decision or the way someone, usually not present, did this or that. It is usually through this conversation that the crew make decisions and take subtle actions against or in defense of a crew member.

The shrimp tails are collected into the baskets, washed, placed in a bag (made out of chinchorro netting), weighed, and sent to the cold room for further processing. The cold room is equipped with a small wooden box that contains the *salmuera* which is kept close to freezing temperature with the aid of a copper coil connected to the cold room's compressor. The *salmuera* is a solution of sea water, salt and honey. The hypersaline concentration removes some water from the shrimp tail and at the same time, the honey coats the shrimp, glazing it. This chemical treatment and low temperature in which the salmuera is kept ensures a rapid freezing process that prevents shrimp from sticking to each other. The time that the shrimp is kept in the salmuera varies depending on the amount of shrimp handled at the time. Small quantities of shrimp may be kept in the salmuera for 12-18 hours, but if a large amount of shrimp has to be glazed, the time each batch will be kept in salmuera could be as little as two or three hours. Another caveat to this glazing operation is that if the shrimp is glazed for too long, they become dehydrated and weigh less, reducing their market value. Once glazed, the shrimp are moved into the cold room (kept at -15 degrees centigrade) spread on the floor, and left there for a day or two. After this time the shrimp become frozen hard and are ready to be stored in sacks.

Gloves must be used at all times since the catch tends to concentrate acids and poisons that are released by the fish as a response to the stress of being handled. Besides this, shrimp produce several enzymes in the hepatopancreas that are used as a defense mechanism.They inject the enzymes by piercing your hand with their tail and rostrum in a rapid and strong bending movement This often happens when you separate the shrimp from the by-catch, and becomes worse when you dehead the shrimp since the hepatopancreas is more likely to be ruptured, thus liberating more of the enzymes that literally burn your hands. The enzymes produced by the shrimp's hepatopancreas cause a rather unpleasant burning and inflammatory response in the hands that can last for a long time (up

to 48 hours when pierced by a shrimp rostrum).

Any big (trophy size) fish, caguama, or totoaba that is caught, is given to one of the crew members. The order in which the special prey is allocated is usually agreed upon before leaving port. The allocation of big fish often becomes another game (and a way of making fun of each other) in which the winner is known but the prize is the real surprise. For example, one of the sailors, when he received his prize (a nice, big caguama), started to make fun of another sailor who received a big flounder.

The rest of the by-catch is processed after the shrimp. The amount of by-catch that is kept depends on how much is already in the cold room. It also depends on how much is brought on board at one time. The problem with by-catch is that it increases the temperature of the cold room, which must be kept constant, as close to -15 degrees as possible at all times. So, if you load the cold room with 300 kg of chano or manta you risk damaging the shrimp. If the temperature is increased by adding by-catch, the ayudante must turn the compressor on for at least 24 hours; this operation means extra fuel consumption on cheap fish.

Most of the by-catch is sold to individuals that run fish supply businesses. These people come out in pangas as the trawlers approach port. It is very important that the buyers go to the boat before it enters the port; if the buyer waits on the docks to bargain over the fish, the captain will turn around and find several other buyers willing to pay a better price. When a legitimate buyer comes to the trawler, if the captain wants to sell shrimp he will ask the panguero about the current price and who is buying. Captains usually have a very good idea of current prices, and which panguero offers the best deal in town. The captain that sells shrimp on the illegal market must know how many people working for his patrón are selling shrimp, how much chatarra (shrimp for domestic market) they reported to his patrón, and what proportion they sold; all this information is given to the captain by the buyer. If he enters port with the cold room full of export size shrimp and no chatarra, his patrón will be very suspicious, especially if other captains are bringing large quantities of chatarra shrimp. Since the patrón pays them only $10,000/ kg for chatarra, and the panguero offers $30,000, the captain wants to sell as much as he can on the black market to maximize his (and all other crew members') profit. But the limit as to how much he can sell is set by the other captains in the patrón's fleet-- that is, if the captain wants to keep working for this patrón. Not all captains sell shrimp to guateros, for instance, Pancho from the boat "María" never sold any shrimp.

Most of the edible fish, crabs and snails are kept for personal consumption. Each crew member will have a sack in the cold room where they store their trophies (caguamas and totoabas) and all other fish that they want to take home. Quarrels over who keeps what seldom occur. The custom among the crew is

"whoever fillets the fish owns it and may do whatever he likes with it." This includes exchanging one fish for another or a piece of totoaba for some cochito fillet. So, anyone who is willing to take the time to fillet a fish may take what he wants from the by-catch. Most of what is taken by individual crew members will be consumed during "*el piojo*" (the period between seasons) or given as presents to friends and family.

Totoabas, machorros, and cahuamas must be hidden away in special compartments in the cold room, designed for the intended purpose. Even though this is incidental catch, and it is usually dead already when it is brought on board, fishermen know the risks involved in being caught with a caguama or totoaba on board. Crew members not only know that vigilancia officials are usually after a *mordida* (bribe) or some shrimp to take home, but also that they will not bother to check the cold room very thoroughly.

Fishing areas: a captain's decision

A good captain is one who knows well many fishing grounds in different regions. This knowledge entails not only the location, but also the depth at which trawling must be carried out, depth and locations of *pegazones* (sunken boats, rocks, shell beds, or anything where the net can get stuck), the types of bottom sediment and currents. These last three things are perhaps the most important of all since setting the nets on loose muddy bottoms or where there are numerous pegazones could mean loosing gear.

To figure the exact location of a fishing ground, captains use two things:(a) the sonda (or sonar) to find the right depth, and (b) the relative position of land features, such as a stretch of beach, a hill or an island, to identify the location of the pegazones. This requires a lot of previous experience and a good memory. The difference in experience and knowledge between the motorista and the captain is quite remarkable. Since a motorista is very close to becoming a captain one might expect that he would know some fishing grounds. However, every time the motorista takes charge of the boat, it is the captain who tells him where to go, when to turn, and what to avoid. It is by no means easy to learn the location of fishing grounds, especially at night when all the land marks used during the day are unrecognizable (and is the time when the motorista takes over the helm). So it is not easy for a motorista to become a captain unless he is very sharp and has a good memory.

Besides knowing the fishing grounds, a captain must know the behavior of the species he is trying to catch. Shrimp that are caught mostly at night, such as the brown shrimp, are influenced by the tidal currents and the moon in a different way than shrimp which are fished during the day, or during day and night such as the blues and the whites. For instance, when fishing in the region between the north end of Tiburón Island and Puerto Lobos, the "good tides" are the dead

ones, as opposed to the good live tides in Guaymas for the whites and blues. The reason for this is that live tides produce a series of very strong currents in the tiburón Island area that affect the behavior of brown shrimp, the principal fishery in the region. It forces them to hide deep in the muddy bottom. Blue shrimp come in sporadic random movements at the end of the season to release eggs in the regions of El Desemboque de los Seris and El Desemboque de Caborca. On the other hand, blue shrimp react to live tides in exactly the opposite way, becoming more active and willing to stay out in the strong currents.

The captain also extracts interesting information from the catch and by-catch brought by the chango. Pancho or Alfredo do not merely count shrimp in the chango, they also look at the accompanying fauna to determine both how long to continue trawling and the direction to take the boat. If, for example, there is a lot of by-catch in the chango, or if some species, known to swim in large schools (such as sardines) are present, the captain will then reduce trawling time to be able to bring the nets on board safely. For instance, when we caught a big manta with the chango, the captain reduced the trawling time from 3 to 1 1/2 hours because the chances of catching such a big animal with a chango are very close to zero, so he concluded that there must be tons of manta in the chinchorros. He was right, but it was already too late. One of the chinchorros broke completely and all the catch was lost; the other net could only be brought on board after the bag was cut and some by-catch dumped. The outcome was that the crew not only invested a lot of time retrieving and fixing the nets (more than 3 hours), but also, the catch, that had been kept on the deck all this time, was crushed by *jaivas* and stepped on by the working crew, so it lost almost all its value.

A knowledgeable captain will also observe the shrimp themselves for valuable information (size, coloration, how active the shrimp are, etc.). One time, Pancho, the captain on the first trip, showed us the differences in coloration between two specimens of brown shrimp. He described the differences in terms of day/night shrimp. We were really amazed. It seems that brown shrimp have two different forms, one dark brown with red legs and pleopods, that are the dominant catch during the night, and one lighter with white-yellow legs, that are dominant at dawn and dusk. Then, he explained the importance of setting the nets in the right spot during the first trawling period (at dusk, since at the time we were fishing only brown shrimp and we worked from 6:00 p.m. to 7:00-8:00 a.m. only). He explained that the first setting will determine the place where he will cast the last one; if he catches a lot of shrimp in the first setting, the catch will be mainly composed of day brown shrimp. That means that the territory is dominated by day shrimp and hence, looking for night shrimp there will not be wise. Pancho will then record the place of his first trawling period (if it was successful) and the rest of the night he will be wondering about other fishing grounds, trying different places, listening to the radio for reports on catches and so on in order to hit the spot where the night shrimp are. Then, early in the morning, he will return

to the first fishing ground to get the day shrimp that the could not catch in the first setting; this ensures him that at least two out of the total of five casts that can be carried out per night will produce good catches.

Sharing Information

We have mentioned, in passing, the communication that exists between boats. The degree to which captains share information on their catches and location varies a lot between captains. It seems to be profoundly rooted in friendship or family ties. Alfredo, for example was a rather quiet captain who did not like to talk on the radio much. Indeed, he kept the radio off most of the time. He would listen and share some gossip with other captains --during the fourth trip he was constantly gripping about the motorista who did not show up on the dock and was seen in Guaymas when he was supposed to be in Ciudad Obregon taking care of his ill mother-- but, he disliked the idea of telling the truth about the relative success of his fishing. Another thing that infuriated Alfredo was that as soon as the motorista took charge of the boat, he was on the radio constantly talking to everybody about his location and how good the fishing ground was. The following morning, Alfredo would wake up to find that the fishing ground that he had all to himself the night before was suddenly full of boats (attracted by the motorista who was sleeping quietly in his bed).

On the other hand, Alfredo was a different man when communicating with one of his buddies or a compadre. Alfredo would be honest about the catch and assumed that his friend was also telling the truth, since he would make a decision to whether to stay or leave based on his reports. Captains always amazed us with both their talents in recognizing other captains' voices on the radio and their ability to recognize boats at night. These special talents are used when a boat is not catching anything; by turning the radio on, listening to a conversation about catches, and recognizing the boats, the unlucky captain can move to the region where those boats are fishing and share the resources with them. Therefore, talking and listening is a very dangerous operation that requires caution if the captain does not want to attract the attention of the unlucky captains. Some captains like to tell lies (or a half truths) about excellent catches in other regions. By doing this they hope to get rid of competition in a particular fishing ground. Because of this fact of life, some of them (like Pancho) will only talk and listen to another captain whom they know well, and whom they respect for his knowledge of an area and his fishing ability, or, like Alfredo will use the radio very seldom.

On several occasions, Pancho and another boat (captained by his old buddy "El Pavo Carlos") teamed up in a specified zone, and exchanged information about each other's success through a complicated system of code words previously agreed upon. Using this communication system, they call 20 kg a "*chanfle*", 40 kg a "*cremallera*", 50 kg a "*piececita*", and 60 kg a "*frío*." They

also use combinations of this words when catching additional quantities. For example, 80 kg would be called a *frío* and a *chanfle* and so on. Under these circumstances, one of the boats will be fishing on one side of a "*bajo*" at 20 fathoms, and the other will be trawling on the other side at 25 fathoms. During the whole night, both captains would call each other every time they retrieved the changos and the chinchorros, and the one who was catching less would move closer to the one that was doing better.

A knowledgeable captain will never make a decision based on reports from chango catches; he will only make a move when he hears a report based on chinchorro catches. The reason for this is that, depending on the size of the chango's boards, the length of the chain that is used to adjust these boards, and the way the boards are adjusted, the chango's yield may be completely different, even in the same fishing ground and depth. Pancho knew that due to the way in which Carlos has calibrated his chango boards, the reported number of shrimp per "*changazo*" was going to be higher for Carlos than for him. In fact, Carlos' chango reports were consistently higher that Pancho's. He told us that it was almost impossible to find two changos that will work and produce identical results: "they are all different and you have to know who has changos 'marcadores' like the one Carlos is using (that catch a lot), and who has changos less marcadores like our own!"

The inshore panga sector

In contrast to the offshore sector, the inshore sector is characterized by multi-species fishing. The kind of equipment used varies according to the species being targeted. Knowing how to use a large variety of nets and lines give fishermen flexibility in adjusting to changes in the species present along the coast through the year. Because the area that small-scale fishermen exploit is more limited than to offshore shrimpers, who are able to exploit the entire Gulf of California, their economic success of fishing largely depends on their skill in rapidly changing gear to exploit species variations.

Specialization occurs in cases where fishermen develop a specific liking for types of fish or certain types of gear. However, experienced fishermen who specialize usually already have the skills needed to change strategies during critical times. Thus, there are fishermen who prefer working at night, using gill nets. There are *cazoneros* who also work at night using drift nets. Those who work during the night have extensive knowledge of the runs of each species. They are able to recognize the luminescence left by the different schools of fish. *Piola* fishermen are also very specialized, and need very particular skills to be good.

Some fishermen, however, specialize simply because they lack the skills needed to use a strategy of flexibility. These tend to be fishermen who do not come from fishing families and have learned how to fish only an economically valuable species such as shrimp. When the species they know how to fish are

scarce, these fishermen are particularly vulernable.

Basic equipment

Small-scale fishermen use small boats called *pangas*. There are two main types. The *panga boogie* can be either 20-23 feet in length, is very light and has a capacity of one metric ton. The price for this panga ranges between 6 and 7 million old pesos. The other type of panga is the *boa*, which is 25 feet in length and much heavier than the boogie. Both types of pangas are made out of fiberglass.

Pangas are operated with outboard engines, mainly 40, 48 and 75 horse power. Yamaha is the preferred brand because it is well made, lasts long and is easy to repair. A 48 h.p engine costs between 9 million and 12 million old pesos; a 75 h.p. Yamaha costs 22 million old pesos. However, discounts are available to coop members. New equipment will last for a minimum of two years without extra investment for repairs; longer use depends on how it is treated.

Shrimp nets

Chinchorro de línea: The *chinchorro de línea* is the most popular net for shrimping due to its efficiency. It catches high quality blue shrimp -- shrimp of marketable size -- and little by-catch. It is an easy net to use: one need not be a skilled fisherman. Ironically, this is the reason that the net has been highly criticized by Pesca officials as well as "*armadores*" or private owners of shrimp trawlers. Like any other chinchorro, the chinchorro de línea works as a gill net, hanging like a curtain perpendicular to the incoming current. To maintain the chinchorro in one place and fully stretched, a line of lead weights is attached to the bottom of the net, and a line of buoys is attached to the top. Buoys and lead weights are held together by a *cabo* (plastic rope) and together form the *relinga*. Buoys are set every half meter. A nylon monofilament thread, number .25-.35, is used, with a mesh size of 2 1/2" to 2 3/4." Chinchorros can range from 100 to 270 meters in length, although larger chinchorros are much heavier to lift, especially at maximum depths of ten fathoms. They tend to work best at a depth of six to seven fathoms, but they can be used between ten and twelve fathoms. Two chinchorros per panga are used, set for about a half-hour.

A chinchorro lasts for one season, and has to be mended constantly. It can catch between 350 and 600 kgs (depending on the size of the shrimp) during a good tide at the beginning of the season. It is most efficient during the first two months of the season, when shrimp can be found in schools. As shrimp migrate offshore and disperse, the chinchorro looses its efficiency. A daily expenditure of 150,000 pesos in gas and oil is required for chinchorro fishing, and a set of large chinchorros can cost between one and a half and two million pesos.

Chango: The *chango* is a miniature trawling net that works very much like those used by shrimp trawlers. It has two boards that maintain it open, lead weights and buoys, and the tickler chain or *espantadera* at the bottom. Mesh size is 2 1/4". It can be modified to catch blue or brown shrimp. For blue shrimp the *cielo* (sky or upper lid) of the chango is made out of monofilament nylon, whereas for brown shrimp it is made out of silk. It can be used at a maximum depth of fifteen to twenty fathoms. The chango is best used at the middle and end of the season: unlike the chinchorro it does not require that shrimp run in large schools since it is designed to search for shrimp. A good changuero is recognized by his ability to make the net and by his knowledge of fishing spots and terrain. Although for a good *changuero* a certain amount of catch is almost guaranteed, many fishermen dislike it because it catches small shrimp and a lot of by-catch, and it also puts a great strain on the engine.

With a 75 h.p. engine, an average of 150,000 pesos in gas are spent per trip. With a 48 h.p. engine an average of 60-70,000 pesos is spent per trip. It can catch up to 80 kgs per hour. A chango that is chained, painted, with buoys, lead and bag can cost between 800,000 to one million pesos. It can last 2-3 seasons, repairing it constantly, or it can last a week if it gets entangled in rocks or a sunken ship. How long it will last depends on the type of area in which it is used: rocky or muddy bottoms make a big difference.

Suripera, jorongo or churupera: The *suripera, jorongo or churupera* is a net tied to two poles that extend outward at each side of the panga. In order for the shrimp to enter through the mouth opening, the net must be moving constantly in opposite direction of the shrimp. In appropriate areas, this movement is achieved with the aid of a sail. However, in the upper Gulf, wind and current patterns render the net useless. The engine must be used at all times, making fishing with this net rather costly. Ironically, of the three shrimp nets described, this is the only legal one, along with the traditional cast net. It lasts two or three seasons and is best used when shrimp have dispersed. Because of its unpopularity, it may sell for a very cheap price, 300,000 pesos. Because of the currents and winds in the upper Gulf, suriperas are not used in area. However, they continue to be used to the south, by Bahía de Lobos, south of Guaymas.

Fish nets *(chinchorros escameros)*

There are many types of specialized chinchorros escameros that vary according to the fish being targeted. Mesh size as well as the material and thickness of the thread used in the net determine what is caught and what escapes. There are three main types of chinchorros, *chinchorro de cerco* which is a drift net that floats and is set encircling the panga, *chinchorro de enmalle*, a drift net set in a línear fashion, and the *chinchorro de línea* which is also set in a línear fashion, but is kept in one place through the use of lead weights (like the chin-

chorro de línea for shrimp described above).

Sierrero: A *chinchorro de cerco* o *sierrero* is used to catch sierra (*Scomberomorus sierra*). It also can be used to catch *corvina*, *lisa* and small manta. It has a mesh size of 3-3.5" and uses monofilament nylon thread number .55. It can be 216-324 meters in length and six brazas in depth. It is used during the night, when the sierra 's luminescence makes it easier for fishermen to recognize schools. If large schools are hit, very large volumes of sierra (up to 1 to 1.5 metric tons) can be caught. However, since sierra has a low market price, unless large quantities are caught it is not profitable. The chinchorro sierrero can cost up to 2,700,000 pesos. It is also used for chano.

Corvina: The chinchorro to catch *corvina* (*Cynoscion xanthulus*) differs from the sierrero in that it uses thread .40, slightly thinner. This chinchorro is also used to catch lisa.

Chinchorro chanero: *Chinchorro chanero* is used to catch *chano* (*Menticirrhus nasus*). It uses a nylon thread .50-.55, and four" mesh. The net can measure 630 meters and costs and average of 3 million pesos. Each panga carries two chano nets, and can hold up to one ton of chano. However, chano is very labor intensive. The chano become entangled in the nets, and perhaps 60 percent must be removed one by one, once ashore. Chano have a razor sharp spine that chews up and destroys nets, so nets only last for one season. Some question its actual profitability, since the costs of production are high, and since it is not known how the stock will react to the massive exploitation of the last two years. Also the price for chano is quite low, 850 pesos per kilo. Since fishermen need a high volume of chano to make a profit, this may lead to over exploitation.

Tiburonero: The shark nets used by pangas are called *chichorros de enmalle.* These net are left to drift during the night, and picked up the next morning. The net is woven from a monofilament nylon thread number .70, and has 6" mesh. Generally, it is 7.5 meters in width, and may be 320 brazas in length. It is mainly used to catch big shark, *bironche* (*Rhizoprionodon longurio*). For smaller shark like the *tiburón tripa* or *cazón* (*Carcharhinus limbatus*), *cazón* (sicklefin smoothhound) (*Mustelus californicus* and *Mustelus henlei*), a net with 4" mesh is used. These nets generally have 26 meters in width and 720 meters in length. Fishing for smaller sharks is done at 6-7 fathoms.

Chinchorro jurelero: The *chinchorro jurelero* is used to catch *jurel* (*Seriola lalandi*), This net has 6" mesh, and can cost 5 million pesos. It is also used to catch corvina.

Malla 7: The *chinchorro malla 7* has a 7" mesh, and is used to catch a variety of fish, corvina, large sierra, and shark.

Chinchorro totoabero: The chinchorro totoabero is used to catch totoaba.

Traditionally, a number 54 cotton thread was used, but now number 32 silk thread is preferred with a 12" mesh. Monofilament nylon thread is not used because it is too weak. This net can also be used for shark. Silk nets with an even larger 14" mesh are used to catch manta raya.

Line fishing

Cimbra: The *cimbra* is a rack with lines, each with a hook. A cimbra can have between 300 and 1,000 *anzuelos* (hooks). A number 6 hook and a number 150 monofilament nylon line are used. Each panga carries two cimbras. In the upper Gulf, the hooks are baited with squid. With good luck with the cimbra one can catch 30-40 kgs in one pull. Hooks are placed every two *brazas* (12 feet). Besides hooks one needs *destorcedores* (untwisters), *cabo* (plastic rope) for the *boyarines* (floats) and the *piola* (line). A 400-hook cimbra can cost 900,000 pesos. Shark, *baqueta* (*Epinephelus acanthistius*), manta (*Gymnura marmorata*) and *guitarra* (*Rhinobatus productus*) are caught with cimbra.

Piola: The *piola* may be 200 brazas (360 meters) in length. Commonly lines are made out of nylon number 200, and use big, number 12 and 14, Japanese hooks. The thickness of the nylon line and the size of the hook used depends on the fish one wants to catch. For a jurel of 9-12 kgs, a number 90 line is needed. Cabrilla (sea bass) is caught with big hooks. Not everyone is a good piola fisherman. Piola fishermen are the real specialists. They need great energy, and to endure they must know how to balance and position their bodies. Piola can be used in rocky areas where cimbra and nets cannot be used. It is used to catch first class fish: extranjero (*Paralabrax auroguttatus*), jurel, baqueta, huachinango (*Lutjanus peru*), corvina, and totoaba are caught with line in San Felipe. Piola fishermen can fish at great depths, 150-190 brazas.

The inshore strategies of the three communities

Puerto Peñasco

Puerto Peñasco's inshore fishermen are the most disadvantaged of the three communities. They have to travel the longest distance to reach fishing grounds for shrimp. Indeed, with the decline in shrimp, it has become unprofitable for them to travel to their favorite areas, such as El Tornillal near Santa Clara. Also, for all practical purposes, there are no inshore cooperatives in Puerto Peñasco. There is one cooperative registered in Mexico City with twenty-five pangas and thirty members; however, its membership does not encompass the majority of the Puerto Peñasco fishermen. The cooperative is controlled by one family: mother, father, sons, daughters, grandsons and granddaughters are all registered members. Even though the coop is the only one that can issue shrimping permits, its members are not benefiting much from holding such privilege. The last time they

went shimping was two years ago, and their pangas caught a total of 8 kgs of shrimp.

Of about eighty pangas that fish commercially, ten to fifteen belong to individual patrones who are captains of their own pangas and the rest belong to nine patrones, who own from three to fifteen pangas each. One of those patrones is a North American. These patrones hire most of Puerto Peñasco's small-scale fishermen. Besides owning pangas, they also own nets, pay for gas, oil and repairs, and set the price of fish they will give to the fisherman-worker. All of these patrones are intermediaries and sell fish outside the Peñasco area. Fishermen-workers deeply resent their patrones. Their relationship is unstable and conflictual. Fishermen will change patróns if there is too much conflict between them, but may eventually return to the same patrón. The biggest complaint from fishermen is that they have not only lost ownership of boats and equipment, but they have also lost control over their own labor. patrones decide where, when, and what species their fishermen will catch. They do not provide any guarantees such as insurance, credit, or even a secure job. They often send their pangas to fishing camps such as Puertecitos, in Baja California, for ten or twenty days; if workers are unable to go due to illness or family emergency, they will simply be replaced, without guarantee that they will regain their place in the panga. patrones do not feel forced to pay their workers on time, and workers have very little power of negotiation when it comes to the price that they will be paid for their catch. If a panguero decides to sell the fish to someone else, he will be fired. All patrones will know about it, and no one will hire the panguero for a long time. Workers who have been able to buy their own equipment have been sabotaged by patrones. In the words of one worker, "first, pieces of the engine started disappearing, then the whole engine was stolen. Sooner of later we end up working with patrones again to repair the equipment that we never finished paying for in the first place." The main problem is that there are too many panga fishermen who are in desperate economic plight, and permisionarios are able to take advantage of that. Fishermen-workers seem caught in a cycle of poverty. They are barely getting their daily subsistence, they do not have alternatives, and they simply cannot get out, since most have dependents. Most will take advantage of any opportunity to work on land when they are not able to go out fishing, doing things like throwing up a roof or unloading shrimp trawlers.

The other type of fishermen working in Puerto Peñasco are the divers, organized into solidarity groups. There are conflicts between line fishermen and divers. Fishermen claim that divers scare away the fish, and that they tear them out of the rocky areas, sometimes killing them and leaving them to rot. When this occurs, other fish will not use that same *tepetate* (rock shelter) again. Piola fishermen believe that *tepetates* are refuge areas for fish, where lines or nets cannot reach them. Divers can now reach every area, and fish are loosing their protection. However, there are very few line fishermen, since this type of fishing

requires great skill to be economically profitable. Only older fishermen who have significant knowledge of the area and who know where the most important fishing spots are, become line fishermen.

Many panga fishermen have stopped fishing commercially. They now devote themselves either to sports fishing, or to buying product from offshore shrimp trawlers and selling it to intermediaries on land. These ex-fishermen also use their pangas to transport people and goods to and from shrimp trawlers that are anchored near the port.

Fishing cycle in Puerto Peñasco

January-March: These are good months for *baqueta* and *tiburón tripa.* Production is highly variable. One day only two baquetas may be caught, the next day 280 kgs may be landed. An average catch for baqueta would be about 60-70 kgs per day. For baqueta fishing 120 lts. of gas are used daily. Fishing areas for baqueta include south toward Desemboque and toward El Piedrón, thirty to forty miles from Puerto Peñasco. During March, some patrones send their pangas to Puertecitos in la Baja for baqueta, shark and manta. baqueta is also found by the Canal de Ballenas, in front of Bahía de los Angeles. Manta has a low market price. Buyers pay fishermen 500 pesos per kilo. For small shark, fishermen receive 1,000 per kg. For baqueta, they get from 2,600 to 3,000 peso per kg. Big shark, bironche, is fished near the shore, throughout the Sonoran coast, all the way up to Santa Clara. Fishermen receive 1,200 pesos per kg of corvina, broncacho and sierra are also caught during this time, but at very low volumes. By-catch from shrimp trawlers is used as bait. Fishermen get up at 4 a.m. and approach boats at 6 a.m. when the first net retrieval of the day occurs. Divers also go for baqueta: they are sent to Pta. Angel de la Guarda. About fifteen pangas were sent during the 1992-93 season.

March-May: By the end of March, the sierra season begins, and lasts through May. However, production is not continuous, it depends on the moon; there are good days for sierra and lisa. They might get 300-400 kgs of sierra per night.There are years whenfishermen expect the sierra to come, and it never arrives. Price varies according to volume from 1,000 to 3,000 pesos per kilogram. Lisa is found all year around, always near shore.

Chano has recently become an important species. It is expected during April, and the season may last for two months. Chano first appears around Santa Clara. But for Puerto Peñasco fishermen, it is not worthwhile to go up to Santa Clara, so they wait for it to come to Puerto Peñasco. When chano arrives most pangas are sent to nearby Bahía Adair and go out to fish for it in 7-8 fathoms. About 15 lts. of gas are used daily. Catch for the season can go as high as 30 metric tons. However, in 1993, although tons of chano were caught in Santa Clara, they never reached Puerto Peñasco. The last time that fishermen were questioned

about chano in June, chano still had not arrived.

June-August: This period of the year brings very trying times. Winds from the south come, *los sures*, especially in August. "You are lucky if you can go out twice a week during this time." During July and August, patrones do not let their pangas go out. It is not advantageous for them because fish rot due to the heat. Most fishermen look for something else to do during these months. They either gather clams, work on shark boats, work as plumbers, masons, or do whatever turns up. Often they cannot find any work.

October-November: The shrimp season for Puerto Peñasco inshore fishermen starts in October, at the same time as the offshore season, instead of September as in San Felipe and Santa Clara.[1] Because the Bahía Adair is considered a breeding ground for shrimp, it is not exploited. If pangueros go out during September, their equipment and product will be confiscated. In the past, Puerto Peñasco looked forward to the shrimp season as the time in which they would make the most money. However, since the 1991-92 season, fishermen have stopped shrimping. On the one hand, they were receiving a price of 7,000 pesos per kilo for blue shrimp (while buyers in Santa Clara were paying 15,000 pesos per kg); on the other hand, there were very few shrimp. Moreover, Pesca inspectors demanded a part of the product. Only eight pangas went shrimping in 1992-93, using the chango. Instead, this season, fishermen are exploiting *corvina*, for which they get 1,000-1,500 peso per kg. Some pangas were catching a metric ton or more.

December: During December some white corvina is caught. It is caught during the night. Buyers pay 1,500 pesos per kg for corvina.

San Felipe

San Felipe inshore fishermen have had some of the same problems as Peñasco fishermen. While there were fourteen inshore shrimp cooperatives in the past, only two remain active. The number of pangas organized in shrimp cooperatives declined from 500 to less than 60. The number of fishermen-workers also increased as many panga owners lost legal title to their pangas when they were required to join a cooperative in order to shrimp. As cooperatives went bankrupt, the original owners were unable to regain title to their pangas. However, it is esti-

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1. There are two classifications for inshore shrimp cooperatives, bay cooperatives and *ribera* cooperatives. The main difference between them is that bay cooperatives are only allowed to shrimp inside bays and estuaries, their season has traditionally began one month before the offshore season so that they have time to capture optimal sized shrimp before it migrates offshore and out of their reach. In places where bays are too small to sustain the local inshore population, or where there are no bays, fishermen are organized in *ribera* cooperatives. This means that they can fish offshore, at a maximum depth of 5 or 10 fathoms (the law is unclear about this).

mated that 50 percent of the fishermen are patrones and 50 percent are fishermen-workers.

While fishermen workers experience the same problems as in Puerto Peñasco, they have more opportunities for employment, thus more power of negotiation with patrones. Most fishermen fish commercially from September to March, but during the summer many have the option of shifting to employment in the tourist industry. Also, important fishing camps, such as Santa Teresa and Puertecitos, are closer to San Felipe. Thus, patrones have lower production costs and offer their workers a better price for the product.

While income derived from shrimping has declined sharply, fishermen continue to go out. However, because shrimp is scarce in the upper Gulf, they are now moving away from fishing in the nuclear zone of the bioreserve and concentrating more of their effort in areas south of San Felipe.

Fishing cycle in San Felipe

February-April: Baqueta is among the most important species in February and March. Fishing activities are very similar to those of Puerto Peñasco's fishermen, but costs of production tend to be lower because the important fishing grounds are closer to San Felipe. *Baya, extranjero*, white bass and *cabrilla* are

also important species at this time of year. From Febuary to April, weather conditions are ideal, and waters are very calm. As in Puerto Peñasco, March and April are also good months for sierra . It is caught near El Piedrón, eighteen miles south of San Felipe. There is also some corvina. However, shrimping has traditionally been more profitable during these months.

April-June: From the end of April to June, shark (*cazón*), *corvina, chano* and *lisa* are the prinicipal species exploited. Favorite spots during these months occur in the nuclear zone, north of San Felipe.

June-August: From June to August the most important species is *corvina* for export caught with line. *Lenguado* and sierra are also exploited. During this time of the year, strong south winds make it difficult for fishermen to go out every day.

August-September: Unlike the Puerto Peñasco inshore sector, in San Felipe the shrimping from pangas begins one month before the offshore season opens, usually September. However, some eight to ten pangas will go up to the Río Colorado to shrimp before the season opens. In September, besides shrimp, the other species caught are *corvina, sierra* , and shark.

October-November: During this period of the year shrimp continues to be an important species. However, in the 1992-93 season, fishermen reported very

low catches of 5 kgs per day. *Baqueta* and *corvina* are also caught.

December-January: During these cold months, *sierra* fishing is very poor. These are the worst months because of weather conditions. Strong north winds limit fishermen from going out.

El Golfo de Santa Clara

In contrast to the other two communities, in El Golfo de Santa Clara the inshore sector is the most important sector of the economy. Since 1980 this sector has continued to grow. Currently, there are about 200 pangas in the area. Most Santa Clara fishermen are either patrones or fishermen-apprentices; there are also a few middlemen who own two to five pangas. As in the other two communities, these are resented by fishermen. However, fishermen-workers have a much greater power of negotiation with patrones. If they feel unfairly treated, they may simply hold back some product and sell it to someone else.

There are two inshore cooperatives that worked quite well until 1990. Members always received credit for gas at the beginning of the season, social security, and other benefits. Now these cooperatives are undergoing financial stress due to the scarcity of shrimp; however they are still viable organizations for inshore fishermen. Besides the cooperatives there are also two informal fishermen associations, *uniones de pescadores*, which do not have federal or state recognition.

Unlike the other two communities, Santa Clara's fishermen do have a sense of territoriality. Although feelings of territoriality are not acted upon, they feel that communities such as San Felipe and Puerto Peñasco are at an advantage because they have large fleets and a greater capacity for mobility. Santa Clara's fishermen, on the other hand, have limited capacity and can only fish in a small area. Also, most fishermen in El Golfo de Santa Clara do not have the capacity to travel long distances, especially given the scarcity of product.

In terms of access to productive fishing areas, Santa Clara's inshore fishermen have had an advantage when compared to Puerto Peñasco's inshore sector. El Tornillal, a favorite shrimping area for both inshore and offshore fishermen, is a half hour south of Santa Clara. However, the productivity of this area has declined sharply. While in past seasons, more people lived in El Tornillal than in Santa Clara, and at least 120 fishermen camped in the area, now effort has declined, especially from outside fishermen. In the past, as many as 400 pangas would come to El Tornillal from Puerto Peñasco to shrimp. El Burro and El Borrascoso are other important fishing camps close to Santa Clara.

Fishing cycle in El Golfo de Santa Clara

Feburary - June: Feburary to March are good months for large lisa in Santa Clara. The chano season begins in mid-March and runs through April. Exploitation of chano is a recent phenomena. Since 1992 the production of chano for Korean buyers has become a booming activity. Chano buyers have provided credit through the cooperatives, enabling fishermen to outfit their pangas with chano nets. In 1993, all but 15-20 pangas got the specialized equipment. Totoaba fishing used to be an economically important species in March. Despite the ban on totoaba, which may fetch 15,000 pesos per kg, and weight 40 or 50 kg, it remains an economically attractive species. A few fishermen continue to go after totoaba; however, if they are caught, fines, confiscation of boats, and jail sentences may outweigh the economic benefits derived. In May and June sierra, shark, and rays are caught. Gathering of oysters also occurs at this time of year.

July and August: These are very slow months. Many inshore fishermen go for clams. Eight or nine fishermen will go in a panga and the patrón receives 30 dozen clams per fisherman. A favorite spot is near the large island at the mouth of the Colorado River. It is common practice to exploit a clam bed only once every three to four months to allow young clams to reach maturity. Lisa is also caught at the beginning of July.

September - November: The shrimping season for pangas begins in mid-September and runs into March. Sardines, which are running in September and October are also exploited. Lisa also remains an important species. Oyster gathering begins in November and continues through June.

December-January: During the cold months, weather permitting, shrimping continues, as does lisa fishing and oyster gathering.

Summary

It is important to point out that panga fishermen, as well as their offshore counterparts, are highly dependent on weather conditions, currents and tides. Environmental factors can limit fishing greatly, and may deceive a non-fisherman as to the profitability of small scale fishing. Although the only way to determine profitability accurately is to record detailed data on daily catches and count the actual days of work during each month of the year, from personal observations, we can conclude that it is not uncommon for an inshore fisherman to work actually only 180-200 full days during a year, due to environmental conditions, days missed because of illness, damage to equipment, or simply because it is not profitable for a patrón to send his pangas out. Very high tides detain fishermen: currents can run up to sixteen knots, making it impossible to work. Because tides

can go four *brazas* (7.2 meters) high and low in one day, fishermen must return before the tide is too low. There are particularly difficult months when the south winds come, and there are good months in which the waters are calm, but the schedule is very erratic. Although we have attempted to describe what most fishermen do throughout the year, there are years in which the expected school of fish does not appear or runs a month later than anticipated, and fishermen are forced to change their strategies.

Chapter 6

The Spatial Organization of Offshore Shrimping

M. Nieves Zedeño and Hernan Aubert

Fishing activities are carried out by two sectors, the offshore and the inshore. Of the two, the offshore sector is believed to be more damaging to the ecology of the upper Gulf. The complete exclusion of trawling activities from the newly created biosphere reserve in the upper Gulf of California clearly reflects this belief. It is important to point out, however, that trawlers do not operate in the entire area of the upper Gulf, but only in specific fishing locales determined by specific landmarks.

This chapter examines the spatial and temporal exploitation patterns, in an effort to identify the locality of and fishing activity on the different fishing grounds. By doing so it is possible to identify which fishing grounds are threatened by trawling, and which ones can be open to exploitation with minimal risks.

The ecological context

The upper Gulf of California is a rich environment where spawning and nursery grounds for many commercial species of fish and crustaceans are found. The quality of these spawning and nursing habitats used to be maintained by the Colorado River's flow, bringing fresh water, large amounts of nutrients, and organic matter into the system. Also, nutrients produced and discharged locally from estuaries and coastal lagoons complemented and buffered the inputs from the Colorado River, maintaining and expanding available habitats.

Among the most significant oceanographic patterns in the area is the very large tidal fluctuations. Water movements are considerably magnified due to the nature of the physical processes that drive the tides. Tidal effects are mainly produced by a "standing wave" with its node located at the center of the gulf, off Guaymas. This type of tide becomes more prominent as the observer moves further away from the node (Duxbury and Duxbury 1989); that is why the difference in tidal peak periods of flood and low tides is extreme in El Golfo de Santa Clara and less conspicuous in Guaymas. The exposure of an extensive area of the continental shelf in the upper Gulf during extreme low tides is not entirely produced by the standing wave effect, but further facilitated by the local bathymetry of the region. The shallow and extensive continental margins amplify the effect

of the standing wave, exposing more of the shallow continental shelf. High water fluctuations and the constant supply of fresh water, promote movement and cleaning of the sediments, resuspending the fine particulate organic and inorganic matter, and other exogenic nutrients that reside in the mud. The same processes provide large supplies of oxygen to the biological component of the continental shelf.

Current patterns are another interesting aspect of the upper Gulf of California. Dispersion of living and non-living resources toward the south is restricted by wind-generated currents that, in the upper Gulf, are localized and predominantly circular (eddies). Evidence pointing to the isolation of the upper Gulf from the southern regions (south of the mid-reef islands) and the formation of an eddy system in the north has been gathered from satellite imagery (Hammann et al. 1988) and plankton sampling (Hammann et al. 1988; Jimenez-Perez and Lara-Lara 1988). These observations, if correct, identify the eddy currents in the upper Gulf of California as an isolating mechanism for allopatric speciation events to occur. Eddies in the upper Gulf are beneficial in promoting local adaptations, concentrating nutrients, and delaying their transport to the south. However, they also can have a very profound negative impact on the benthic and pelagic fauna in the case when toxic compounds find their way into them.

In the past, strong currents of the Colorado River not only reduced the seawater salinity, but also disrupted, at least partially, the eddy system, pushing accumulated organic matter and toxic compounds to the south. The Colorado River's waters further reduced the concentration of toxic compounds and were responsible for shifting and rearranging the sand bars and their muddy valleys. All these processes (disrupting the eddies, flushing of the system, and sand bar movement) that helped in maintaining a high biological diversity and provided the right set of conditions for the spawning, growth, and exploitation of many commercial species of fish, were substantially reduced by the impoundment of the river. The consequences brought by the impoundment of the Colorado River on the ecosystem are, up to this point, and due to the lack of research efforts in this area, largely unknown.

Shrimp trawling: spatial and temporal patterns

The sources of information on the 1992-93 shrimp trawling activities in the upper Gulf of California are based on ethnographic data collected during fishing trips on board two privately owned boats from Guaymas, and bitácora log book entries of a boat from San Felipe. Data on locality, depth, and catch were used to assess intensity of use of localities both outside and inside the biosphere reserve, to ascertain the exploitation of shallow waters and its potential for commercial fishing as compared to deeper waters, and to estimate the efficiency of fishing in localities within the biosphere reserve and in other localities to the south.

The data from ethnographic sources and from bitácora entries represent one fishing trip at the beginning of the season (October-December 1992), and six fishing trips at the end of the season (February-April 1993). Because these data are not completely equivalent in their detail and amount of information, only one trip (March 1993, on the Magdalena XXI) for which data on locality, time, sediment, depth, shrimp catch, by-catch, and variability of species per catch is fully recorded, was used as a control sample for statistical calculations of trawling efficiency within the biosphere reserve, both in the nuclear zone and in the buffer zone. The remaining trips were helpful for assessing the intensity of fishing on localities along the Sonora and Baja California coasts at different times during the fishing season, and for comparing the amount of shrimp catch across localities.

Fishing localities

Fishing localities were defined according to names commonly used by fishermen. Grid localities recorded in the bitacora were converted into geographic place names to facilitate their ready recognition (see Maps 3 and 4). Fishing localities were then classified according to their situation into nuclear zone, buffer zone, and outside localities along the Sonora and Baja California coasts. Data on each locality was then compared, both quantitatively and qualitatively. Localities used in this study are:

Zone	Localities
1) Nuclear Zone:	Santa Clara/La Horqueta
	El Moreno
	El Chinero
2) Buffer Zone:	El Tornillal/La Salina
	San Felipe/Punta Estrella
	Rocas Gonzaga (El Piedrón)
3) Baja California:	Punta Diggs
	Puertecitos
	Bahía San Luis Gonzaga
4) Sonora:	Puerto Peñasco
	I. San Jorge
	Cabo Lobos

Unfortunately, data necessary for assessing trawling efficiency were available only for the localities within the biosphere reserve, which precludes detailed comparison with localities to the south.

Temporal patterns

According to information gathered in the field, shrimp trawlers generally make their first trip to the south, sometimes as far as the coast of Nayarit. On subsequent trips they tend to move northwards, from Cabo Tepoca to Kino Bay and Puerto Peñasco on the Sonora coast, and from Bahía San Luis Gonzaga to Punta Estrella on the Baja California coast. Fishing on localities about four miles from Rocas Gonzaga (El Piedrón) occurs throughout the shrimp season. Records show that trawlers often enter the northernmost area of the gulf to the river mouth. Trawling along and across the sandbars (*bajos*) and channels between sandbars that run parallel to the coast on the northern portion of the gulf also takes place during most of the season.

Data available on shrimp catch per 24 hour period shows that southern localities were quite productive in blue, brown, and white shrimp during the first months of the season (September-October, 1992), declining as the winter approached. For example, on the first trip of this season, along the Sonora coast from Agiabampo and Las Cabras to Mazatlán, boats caught an average of 230 to 280 kg of blue and white shrimp on a 24 hour period. Shrimp production diminished rapidly as the season progressed. Records from a second trip to the north during the months of October to December, reveal that up to 224 kg/day of shrimp, half of which were blue shrimp, were caught on localities near Rocas Gonzaga. On the second trip of another boat, 142 kg/day and 167 kg/day of brown shrimp were caught in front of Puerto Peñasco and Puerto Lobos, respectively. Other northern localities such as Isla San Jorge, La Salina, and San Felipe yielded an average of 78 kg of shrimp per day. These data suggest that, for the season in question, there was a 50 percent or higher decrease in fishing productivity after the first trip, once the boats moved northward. This trend is reflected in net weight of shrimp per day, and particularly in the decrease of blue shrimp, as noted in the record for the Rocas Gonzaga locality. During the late part of the season (January-April 1993) efforts seem to have concentrated on, from north to south, El Moreno, Punta Estrella, Rocas Gonzaga, La Salina, and Peñasco; this is true for the three boats from different ports. An average of 60 kg/day of shrimp, including blue and brown shrimp, was caught in these localities, which are the richest and most intensively exploited in the upper Gulf. Other localities such as Isla San Jorge yielded a slightly lower average of 48 kg/day of brown shrimp. Bitácora records for the boat from San Felipe provided data on shrimp catch along the Baja California coast, south of the port. An average of 31 kg/day of brown shrimp were caught from Punta Diggs to Puertecitos and to Bahía San Luis Gonzaga during late March-early April, shortly before the end of the season (this average may be underestimated, however, because records of shrimp catches from the bitácora do not include broken shrimp or chatarra).

To summarize, temporal patterns of locality of shrimp exploitation gath-

ered from this sample suggests that, although southern fishing localities seem to have been the most productive during the first half of the season, overall fishermen preferred to concentrate their efforts in localities to the north of an imaginary line that connects San Felipe, Rocas Gonzaga, and Puerto Peñasco, and along the upper Gulf coast of Sonora and Baja California, even though these localities appear relatively less productive than the southern ones. Factors such as distance from port, boat logistics, financing, familiarity with fishing grounds, and presence of blue shrimp vs. brown shrimp, when measured against relative productivity, may have weighed on the decision to concentrate efforts on the northern localities. During the second half of the fishing season, on the other hand, northern localities such as El Moreno, Punta Estrella, La Salina, Rocas Gonzaga, and Peñasco appear to have produced twice the shrimp than the southern ones (San Luis Gonzaga, Puertecitos, or Punta Diggs), even as the amount of shrimp decreased sharply in the north during the spring months. These data should be taken cautiously, however, because shrimp catches from boats fishing on the northern localities may be recorded differently than those on the southern ones (i.e., whether they included broken shrimp and chatarra or not).

Productivity and depth

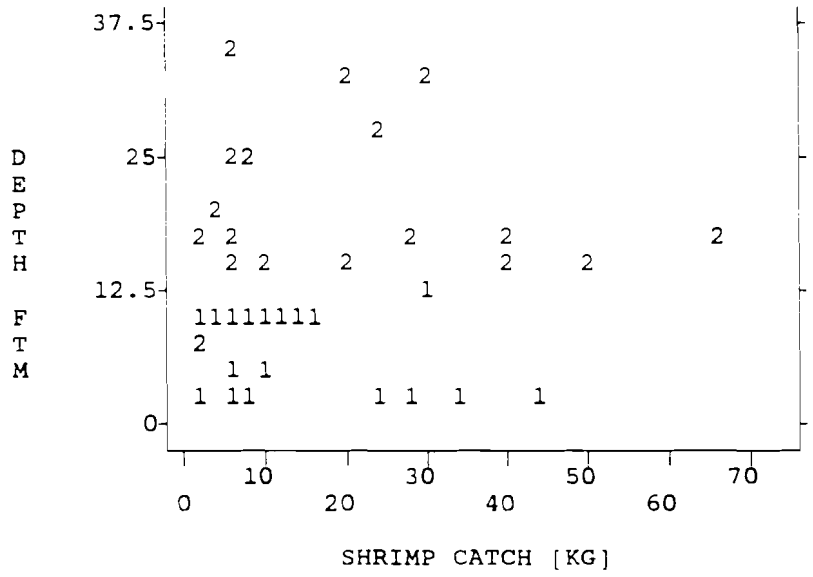
Information on depth of shrimp catches used in this discussion was restricted to the control sample of the boat for which reliable measurements are available; number of trawling events per locality further limited the data set to El Moreno, Punta Estrella, La Salina, and Rocas Gonzaga. Comparison between depth, shrimp catch by species, and locality, demonstrates that, although depth does not affect the total amount of shrimp caught in a particular locality, it does correlate strongly with the species available at a particular depth. All catches of blue shrimp occurred between 1-12 fathoms; brown shrimp was caught most often in waters no deeper than 40 fathoms (see Figure 6.1).

Most catches of blue shrimp occurred in El Moreno and Punta Estrella, whereas those of brown shrimp occurred in front of La Salina; both species were found around Rocas Gonzaga. The bajos and channels along the Sonoran coast, with depths up to 37 fathoms, were also rich in blue and brown shrimp, particularly during the winter months. The relative "abundance" of the high priced blue shrimp in the shallow waters of northern localities, particularly along the Baja California coast and near Rocas Gonzaga, may offer yet another explanation for the trawling intensity on these localities, not only during the spring months but throughout the season.

Trawling efficiency

Although the data presented above give us a very general idea of local exploitation and use of shrimp resources in the sampled areas of the upper Gulf,

Figure 6.1
DEPTH WITH SHRIMP CATCH BY SPECIES



1 = Blue Shrimp

2 = Brown Shrimp

the efficiency of trawling in a given area must be measured in relation to both shrimp catch and by-catch. In this sense, we must assume that trawlers are targeting shrimp and that by-catch only means extra work on deck. With this approach in mind, if two shrimp trawlers catch 30 kg/hour of shrimp but one of them does it at the expense of 1,000 kg of by-catch whereas the second catches only 200 kg of unwanted by-catch, then we consider the latter more efficient than the former. Trawling efficiency (TEFIC) is determined by the ratio between shrimp catch/hour (CPUE or Catch Per Unit Effort) and total catch/hour (total catch or CPUET). Trawling efficiency is represented as a percentage calculated by:

(shrimp catch per hour/by-catch per hour)x100

The derived measure of efficiency is a function of both CPUE and CPUET. This means that a trawler can be more efficient if either CPUE is high or if CPUET is low; therefore, to determine why a trawler is more or less efficient when trawling in a particular region, the variables CPUE and CPUET must the analyzed separately. This calculation was applied to the control sample only. Two types of comparisons were made: all data for the nuclear zone vs. all data for the buffer zone, and data for each fishing locality having an adequate sample size ($n>5$) for non-parametric analysis. To compare localities in terms of shrimp catch, by-catch, and trawling efficiency, the Kruskal Wallis (K-W) test was used, because the variables of interest were not normally distributed.

The analyses were carried out with the following questions in mind: are these two regions (nuclear and buffer) different in terms of trawling efficiency? If so, do these differences reflect changes in CPUET, amount by-catch, or CPUE, amount of shrimp? Can we justify the creation of a nuclear zone as a protective measure for spawning grounds? Can we allow trawling in the buffer zone with minimal risk to the local fisheries? The following are the obtained results of K-W analyses.

Table 6.1

Kruskal-Wallis 1-way ANOVA, TEFIC by ZONE where 1= Nuclear and 2= Buffer

Mean Rank	Cases	
23.76	21	ZONE = 1
37.41	44	ZONE = 2
	--	
	65	Total

Corrected for Ties

CASES	Chi-Square	Significance	Chi-Square	Significance
65	7.4057	.0065	7.4088	.0065

It is apparent from this analysis that there is a highly significant difference between the nuclear and the buffer zone in terms of trawling efficiency (TEFIC). In order to identify the nature of this difference, the two variables involved in the calculation of TEFIC were analyzed separately.

Table 6.2

Kruskal-Wallis 1-way ANOVA, CPUE by ZONE

Mean Rank	Cases	
30.57	21	ZONE = 1
34.16	44	ZONE = 2
	--	
	65	Total

Corrected for Ties

CASES	Chi-Square	Significance	Chi-Square	Significance
65	.5118	.4744	.5124	.4741

CPUET by ZONE

Mean Rank	Cases		
43.50	21	ZONE =	1
27.99	44	ZONE =	2
	--		
	65	Total	

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
65	9.5671	.0020	9.6396	.0019

These results show that the two zones do not differ significantly in the amount of shrimp caught per unit of effort (CPUE), but highly significant differences are observed in the proportion of by-catch/hour. This evidence suggests that the nuclear zone has a higher abundance of by-catch than the buffer zone. If a trawler does not draw profits from the by-catch, it is more efficient to fish outside the proposed nuclear zone, since the same amount of shrimp can be caught with less by-catch, thus with less effort. The occurrence of higher concentration of several species of fish (both adult and juvenile forms) in the nuclear zone suggests that these species use the nuclear zone for reproduction or nursing the young. In this sense, the creation of a nuclear zone that excludes human activity can be completely justified. On the other hand, the buffer zone, having a higher shrimp catch/by-catch ratio, should not be considered critical habitat for the survival and maintenance of commercial fish species. Since the amount of by-catch is very low, some trawling activity can be allowed without drastic consequences to the local stocks.

Resource use and availability in specific localities within the biosphere reserve

To evaluate local or regional differences in terms of the variables discussed above within the newly created reserve, the original data set was partitioned by locality and a similar analysis was conducted. In this section we concentrate our attention on identifying localities within the buffer zone where shrimp trawling can be allowed with least disruption to the benthic communities and the lowest ratio of by-catch to shrimp catch.

Four localities were thus analyzed: El Moreno, within the nuclear zone, and Punta Estrella/San Felipe, Rocas Gonzaga, and La Salina/Tornillal, within

the buffer zone. First, all four localities were compared along the two variables of interest: shrimp catch/hour (CPUE) and by-catch/hour (CPUET):

Table 6.3

Kruskal-Wallis 1-way ANOVA, SHRIMP CATCH PER UNIT EFFORT (CPUE) by LOCALITY

Mean Rank	Cases	
28.96	13	Rocas Gonzaga
28.66	19	El Moreno
22.38	8	La Salina
31.00	16	Punta Estrella
	--	
	56	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
56	1.5164	.6785	1.5189	.6779

BY-CATCH PER UNIT EFFORT (CPUET) By LOCALITY

Mean Rank	Cases	
31.77	13	Rocas Gonzaga
38.42	19	El Moreno
10.63	8	La Salina
23.00	16	Punta Estrella
	--	
	56	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
56	18.9819	.0003	18.9825	.0003

The data above suggest the most important difference between these localities, when compared as a whole, is not in the shrimp catch per hour, but in the by-catch per hour caught during trawling. When examining the ranks of each fishing locality, one can find that La Salina, located on the upper Sonoran coast,

ranks the lowest in amount of by-catch and CPUET, and only a slightly lower rank in CPUE.

When fishing localities are compared pairwise across both variables, we find that there are no significant differences between El Moreno and Rocas Gonzaga, nor between Rocas Gonzaga and Punta Estrella. Likewise, there are no significant differences in CPUE among the four localities. Differences exist, again, between La Salina and the other three localities in terms of CPUET:

Table 6.4

Crosswise Comparison of Trawling Effeciency by Locality

	El Moreno	Pta. Estrella	Rocas Gonzaga
La Salina	0.0004	0.0120	0.0113

Further significant differences identified are: in trawling efficiency ($p=0.0156$) and CPUET ($p=0.0004$) between El Moreno and Punta Estrella, which are the richest localities in blue shrimp and the most intensely trawled. Trawling efficiency differences between La Salina and El Moreno are not significant.

To summarize, comparison among the fishing localities within the biosphere reserve that were most intensely trawled during last season (that is, insofar the data from the control sample represents a general trend; although bitácora entries were not appropriate for statistical manipulation, they do show that Punta Estrella, Rocas Gonzaga, and El Moreno were highly targeted localities) tend to point to the upper Sonora coast, along La Salina and El Tornillal, as the most efficient fishing locality, producing the least amount of by-catch, followed by Punta Estrella. However, the control sample reveals that only 25.8 hours of actual fishing were spent at La Salina, whereas 31 hours were spent at Rocas Gonzaga, 42.5 hours at El Moreno, and 51.5 hours at Punta Estrella. One major difference between these localities, which may affect intensity of fishing and net return, is the scarcity of blue shrimp in La Salina when compared with Punta Estrella or El Moreno. El Moreno and Rocas Gonzaga, on the other hand, seem to be the least efficient localities because they produce large amounts of by-catch, but the same shrimp catch than the other localities; nonetheless, they are preferred because of the presence of blue shrimp. Introducing depth and sediment as additional variables further illustrate the problem of poor trawling efficiency in intensely exploited localities.

As mentioned above, all recorded catches of blue shrimp occurred between 1 and 12 fathoms, whereas most catches of brown shrimp occurred in deeper waters. Taking all recorded cases for the four fishing localities in the control sample, trawling efficiency, CPUE, and CPUET, were compared for depths

below and above 12 fathoms. Results of the Kruskal Wallis test show that trawling efficiency is much higher in waters deeper than 12 fathoms than in shallow waters, mainly because of the amount of by-catch caught in shallow waters. The amount of shrimp catches, however, does not differ significantly for either depth interval.

Table 6.5

TRAWLING EFFICIENCY BY DEPTH (SHALLOW= DEPTH<=12 FTM; DEEP= DEPTH>12 FTM).

Mean Rank	Cases	
24.97	43	Shallow
40.19	13	Deep
	--	
	56	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
56	8.7013	.0032	8.7060	.0032

CPUE BY DEPTH

Mean Rank	Cases	
28.09	43	Shallow
29.85	13	Deep
	--	
	56	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
56	.1153	.7341	.1155	.7339

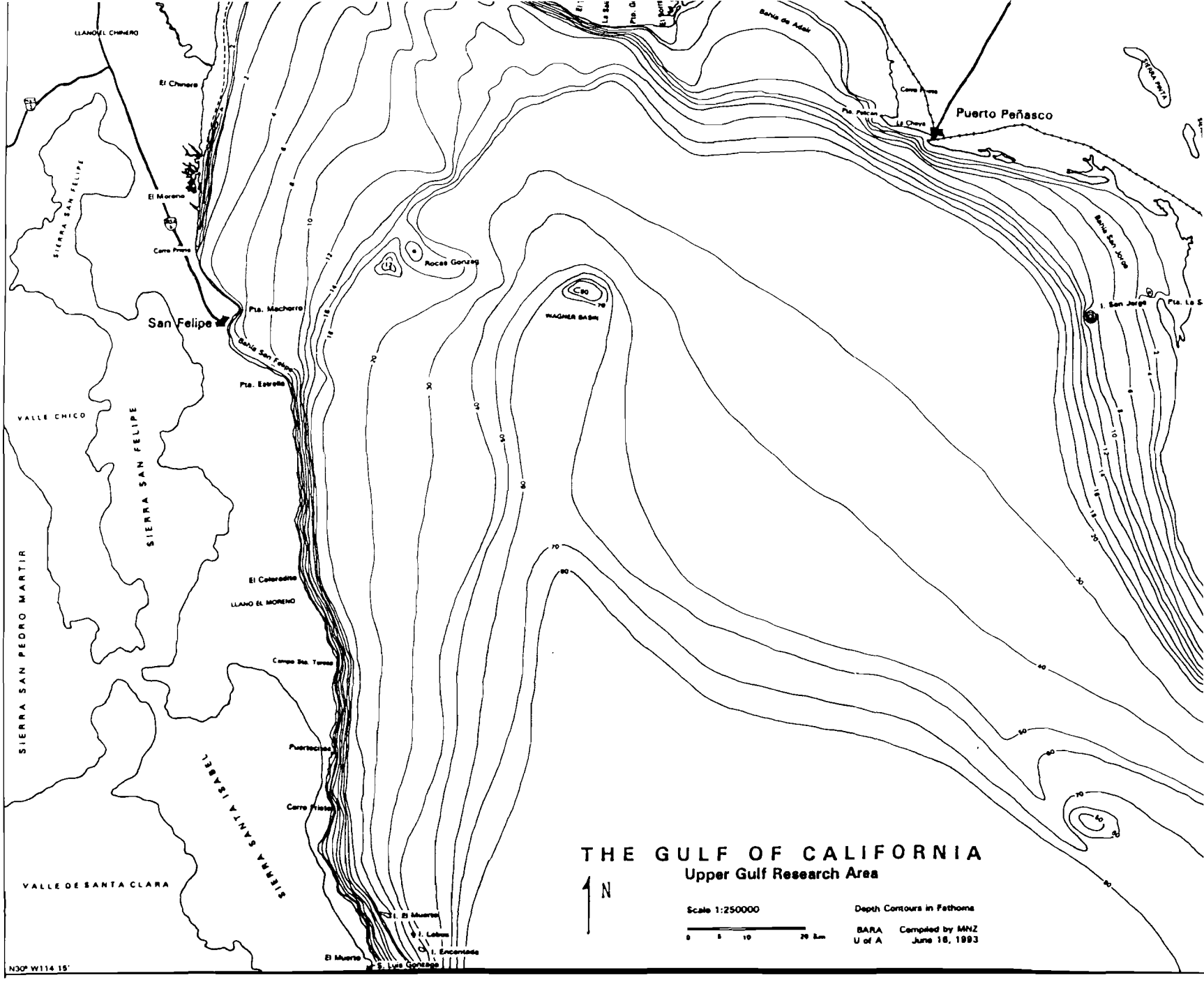
CPUET BY DEPTH

Mean Rank	Cases	
33.44	43	Shallow
12.15	13	Deep
	--	
	56	Total

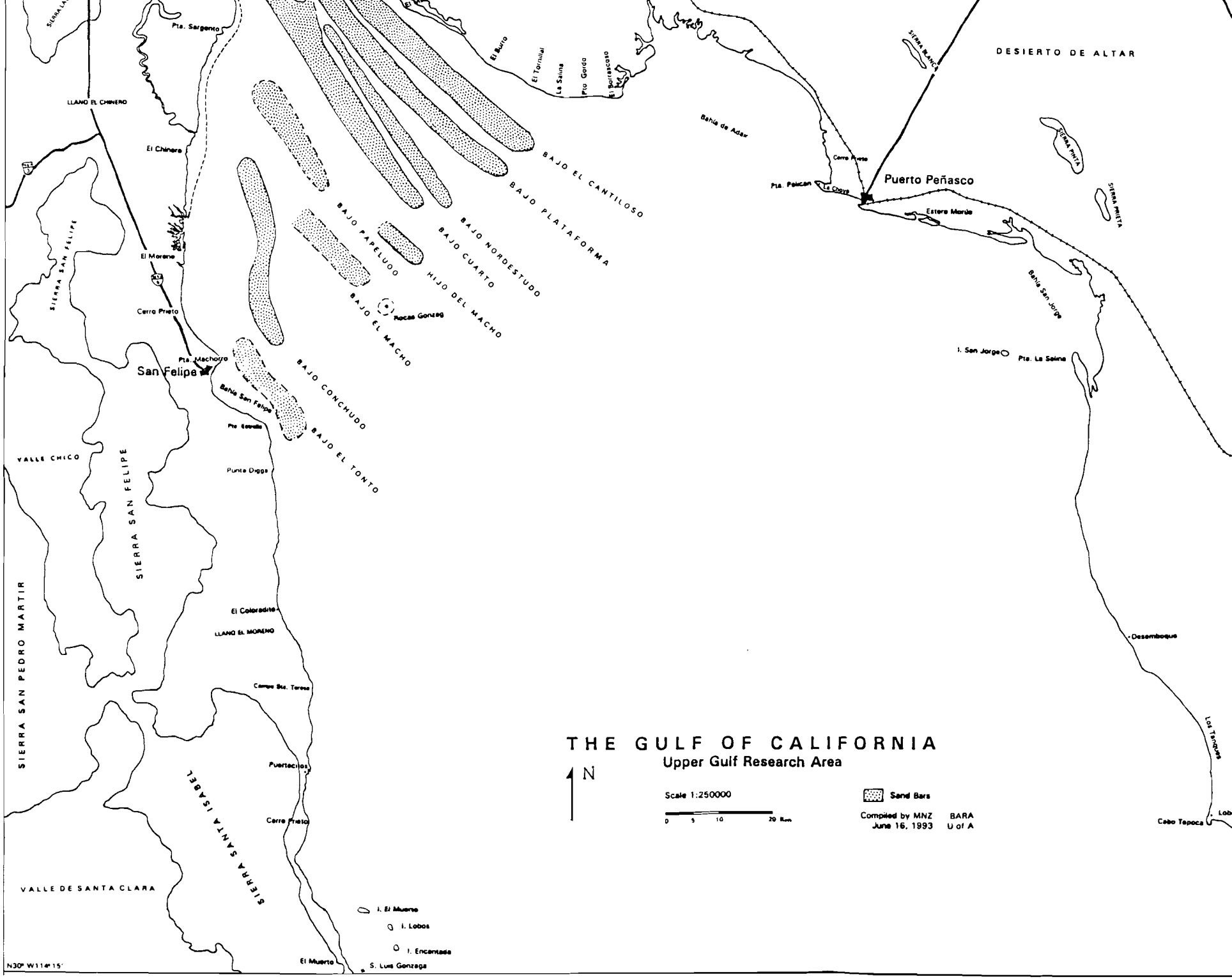
			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
56	17.0064	.0000	17.0070	.0000

Most cases of fishing in shallow waters were recorded for El Moreno (n=18), Punta Estrella (n=16), and Rocas Gonzaga (n=8); only one instance of shallow water fishing was recorded for La Salina. Differences in trawling efficiency between the first three localities are also significant: Punta Estrella provides the most efficient fishing ground in shallow waters, whereas Rocas Gonzaga is the least efficient shallow water locality. Not enough cases by locality were recorded for fishing in deeper waters to make pairwise comparisons.

The data suggest that, despite the presence of blue shrimp in shallow waters in the upper Gulf, particularly in El Moreno, time and effort put into fishing in those areas do not yield productive returns in terms of shrimp catches. Furthermore, fishing in shallow waters tends to produce large amounts of by-catch with the consequent impact on the marine environment. Large amounts of by-catch, in turn, come from localities with muddy and loamy (sand/mud) sediments, where variability in noncommercial species is high; such areas are, for example, Punta Estrella, Rocas Gonzaga, and El Moreno. Sediment records for the control sample (including localities with less than five cases) suggest that trawling efficiency is significantly higher in localities with sandy sediments, as found along the upper Sonora coast and the bajos parallel to it, than in those with finer-grain sediments; shrimp catches, however, are only slightly higher on localities with sandy sediments.



Map 3. Bathymetry of the Upper Gulf of California



Map 4. Fishing Localities in the Upper Gulf of California

Table 6.5

TRAWLING EFFICIENCY BY SEDIMENT

Mean Rank	Cases	
45.15	13	SEDIMENT = SAND
30.91	33	SEDIMENT = MUD/SAND
26.28	18	SEDIMENT = MUD
	--	
	64	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
64	8.2557	.0161	8.2591	.0161

CPUE BY SEDIMENT

Mean Rank	Cases	
36.88	13	SEDIMENT = SAND
33.62	33	SEDIMENT = SAND/MUD
27.28	18	SEDIMENT = MUD
	--	
	64	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
64	2.2566	.3236	2.2592	.3232

CPUET BY SEDIMENT

Mean Rank	Cases	
15.92	13	SEDIMENT = SAND
37.23	33	SEDIMENT = SAND/MUD
35.81	18	SEDIMENT = MUD
	--	
	64	Total

			Corrected for Ties	
CASES	Chi-Square	Significance	Chi-Square	Significance
64	12.9994	.0015	12.9997	.0015

Besides the problems of low efficiency and low shrimp yield, fishing localities in shallow, muddy or loamy waters tend to have high numbers of juvenile species--commercial or not-- such as chano, manta, flounder, corvina, broncacho, and totoaba. Punta Estrella, Rocas Gonzaga, and El Moreno have extremely high variability of juvenile and noncommercial species in the by-catch.

To summarize, no justification was found, in terms of shrimp catch and efficiency (effort/return), for fishing in waters shallower than 12 fathoms, or along the upper Baja California coast. Although the issue of the commercial value of shrimp species remains, shrimp catches for last season do not seem to justify intensive exploitation of "rich" localities such as El Moreno within the nuclear zone or even those within the buffer zone. One exception is the strip along the upper Sonora coast, from Santa Clara to the north edge of Bahía Adair, and over the easternmost bajos and channels of the upper gulf, where equally abundant shrimp (brown throughout the season, blue and brown on the bajos during winter time) can be found, but where sandy sediments, deeper waters, and related lower abundance of noncommercial species favors efficiency of shrimp trawlers that, with the appropriate equipment modifications, should represent minimal risk to the marine environment in that area. Exploitation of localities immediately to the south of the buffer zone should be encouraged, at least during the first two to three fishing trips of the season.

Chapter 7

Local Preferences for Development

James B. Greenberg

Everyone agrees that the fishery in the upper Gulf is in crisis. Why it is in trouble, however, is another matter. The fishermen we interviewed used and combined two lines of argument. The most common refrain we heard attributed the problems in the fishery to environmental problems. Fishermen who use this line of argument point toward factors such as the damming of the Colorado River, and the lack of fresh water discharge into the gulf, flows that they say are important to the reproduction of blue shrimp and totoaba. This line of argument also includes red tides, el Niño, and shrimp viruses.

The other argument attributed the cause to overfishing. For those fishermen who grant that overfishing may be involved, the problem is that there are simply too many boats and pangas in these waters; that their fishing operations are wasteful and use gear that is not efficient; that the shrimping season begins too early and ends to late; and that government officials fail to enforce regulations, do so arbitrarily, are corrupt, and consequently fishermen do not respect such regulations. Despite these very different interpretations of the causes of the problem, fishermen and other community residents we interviewed felt that the solution to the problem lay in diversifying the local economy, and in better management of the fishery. People proposed four types of developments that they felt could work locally and might be acceptable: tourism, aquaculture, maquiladoras, and agricultural development of the ejidos.

Tourism

For the residents of Puerto Peñasco, El Golfo de Santa Clara, and San Felipe, tourism is tantalizing, in part, because few other alternatives are viable. There is little fresh water available, so the potential of agriculture and cattle ranching is limited. The lack of infrastructure and services also make industrial development problematic. Tourism, of course, already plays a significant role in San Felipe, less so in Puerto Peñasco, and a minuscule one in El Golfo de Santa Clara. According to townspeople in the three communities, if tourism is to grow, then investments in infrastructure would be required, particularly roads. They also suggested that a ferry from San Felipe to Puerto Peñasco and Guaymas

would help increase tourist traffic. In El Golfo de Santa Clara residents would like to see a marina built to attract tourists.

Many fishermen consider sports fishing an attractive alternative to commercial fishing. In Puerto Peñasco, for example, fifteen ex-members of the coop Pescadores Mexicanos, with money from the governmental program *Solidaridad*, have formed a group that is exploring sports fishing. Another coop in Puerto Peñasco, El Faro, that has eighteen members, is in the process of legalizing four yachts. The coop also has three pangas used for sports fishing. The initiatives to develop sport fishing, however, are not confined to those of local fishermen. For example, a group of investors who developed sports fishing in Puerto Aransas, Texas after the collapse of the shrimp industry there, are doing a feasibility study in Puerto Peñasco.

Despite support for tourism, residents complain it is not a solid source of work: the only businesses that really benefit from tourism are hotels, restaurants, and beer distributors. Sentiments of this kind were expressed vehemently: "ten million tourists could come here, and we wouldn't see a nickel." Another refrain head in their complaints is that the tourists who do come spend little money: "the students that come will rent a hotel room, and pile ten to fifteen kids in it. They often bring their own food, so about all they buy is beer." Because groceries are more expensive in these communities than on the border, "even the retired people who live here part of the year go to the U.S. every couple of weeks to buy everything they need."

Aquaculture

Several people we interviewed felt that aquaculture may be part of the solution to the economic problems in the upper Gulf. There are presently two kinds of aquacultural development projects-- large-scale shrimp farms and small-scale oyster and clam operations. Currently, a shrimp farm in operation in El Golfo de Santa Clara employs sixty to one hundred people. Another farm is being developed in San Felipe. Residents of Santa Clara claim that a lot of suitable land is still available, and shrimp farming could be expanded. Oyster cultivation on a small scale is being done by coops in estuaries near Puerto Peñasco. Residents also suggest that fish, crab, sea cucumber, octopus, and *cayo de hacha* also could be grown in these estuaries. To the north of El Golfo de Santa Clara, residents point to freshwater cienegas where they say *talapia* and *mojarra* could be raised.

Maquiladoras

A few people proposed that maquiladora industries may be a partial solution to region's economic problems. Currently, a Korean firm is in the process of building a plant in San Felipe that will manufacture tennis shoes. Most fishermen, however, said that they would not want to work in a maquiladora because

of the poor wages they pay. One of them put it more bluntly, "I'd rather steal for a living than take a job that paid so little."

Agriculture

As all three communities possess ejido lands, a few people discussed agriculture as an option. However, since no water is available for irrigation, the ejidos have not been very productive. In El Golfo de Santa Clara one person suggested that watering troughs could be built to the north of town, and sheep and cattle grazed on the sparse vegetation. It was also suggested that the ejido could produce chickens or pigs by feeding both on what is currently wasted bycatch. Quite apart from the technical feasibility of these projects, the ejidos are embroiled in various kinds of conflicts. Like the shrimp coops, they are entangled in credit problems, and plagued by poor administration and corruption, consequently there are deep disagreements over how to use the lands. Since all of the ejidos have beaches, the options are to develop coastal areas for tourism or aquaculture. We will not specifically evaluate agriculture here as an occupational alternative, on the presumption that little additional expansion of this sector is feasible, due to the limitations of water supply.

Fisheries management

Of the forty-five people we interviewed who expressed preferences for the kinds of development they would like to see in the region, 24 percent mentioned tourism, 16 percent alluded to aquaculture in their list of preferences, 4 percent referred to maquiladoras, and 4 percent spoke about agriculture. Seventy-six percent, however, felt that the solution to the region's economic problems lay in better management of the fishery. While the criticisms and suggestions people expressed in this regard were often detailed, well reasoned, and concrete, many options are being hotly debated in these communities.

The opinions, for example, concerning closure of the upper Gulf to commercial fishing varied widely. Some felt that no closure was warranted or needed. Among the accusations hurled was that "ecology is just the latest tool used by developed countries to limit the development of the third world." Some trawler fishermen called for a complete closure, arguing that "we don't need to fish the waters north of a line from San Felipe to Puerto Peñasco. The shrimp breed there, and swim out to deeper waters anyway. If we wait till they grow, we'll get higher yields and better prices." Still others argued that only a much smaller area, the nuclear zone, need be closed. These shallow waters are not only the breeding grounds for shrimp, but the areas where totoaba spawn, and vaquita are most commonly found. Closing these areas to fishing would protect both endangered species, and ensure shrimp's recovery. Other voices call for only a temporary closure of two years to give the fishery a change to recover.

Many argued that rather than close the upper gulf, the shrimp season should be shortened, that certain kinds of gear should be prohibited, and that there should be limits on the number of boats operating in the upper Gulf. Of

these options, shortening the shrimping season enjoyed the widest support. Fishermen noted that the season both begins too early and ends too late. Because shrimp season begins in September, the totoaba machorritos have not reached maturity, and tons of totoaba fry are taken with the trawling nets. They reason if the season started later, not only would more totoaba survive, but shrimp would be larger when caught. If it ended earlier, they would not catch as many gravid female shrimp, reducing the breeding stock. Similarly, fishermen argue that some gear is very damaging to the ecosystem. Charges were made that the chincorro de arrastre used by the trawlers is very destructive; that because of its small mesh, it is not very selective, and tons of by-catch are wasted, including totoaba juveniles. Trawler fishermen also point the finger at the chincorro de línea used by the panga fishermen, arguing that these are not selective, that they kill thousands of fish. This charge is vehemently denied by panga fishermen. Similarly, some call for bans on shark nets-- in which vaquita are occasionally caught-- not because of the vaquita, but because they claim these nets kill shrimp larvae and tiny shrimp. More radical voices call for limits on the number of boats working the waters of the upper Gulf. Here again there is a clash of opinions. Trawler fishermen feel that there are too many pangas. Panga fishermen say there are too many trawlers.

Fishermen disagree on many technical matters such as when seasons should begin, how many boats should be licensed, or what kinds of gear should be permitted or not. They universally complained, however, about enforcement. Policing is lax. The agencies charged with these responsibilities are understaffed. The officials involved, fishermen complain, are corrupt or arbitrary in their enforcement of regulations. The problem, however, is not just with enforcement. The financial rewards of poaching shrimp out of season, or taking species like totoaba or sea turtles that are protected lead many to yield to temptations, especially as economic conditions worsen. Fishermen understand that they are to blame for many problems-- and that the solution lies in respecting such regulations.

Although the communities hopes that a fisheries' management solution to their economic plight may be found, they express support to a lesser degree for tourism, aquaculture, maquiladoras, and agriculture in that order. However, disagreements exit concerning all these options. In the following two chapters, we shall evaluate the potential contribution that each of these -- with the exception of agriculture -- holds for the communities of the upper Gulf.

Chapter 8

Occupational Alternatives for the Fishers: An Assessment

James B. Greenberg, Hernan Aubert, and Thomas R. McGuire

Several occupational alternatives have been proposed for fishermen affected by the creation of the biosphere reserve in the upper Gulf of California. This chapter seeks to evaluate the feasibility and impacts of aquaculture, tourism (including ecotourism and sport fishing), and industrial development. Our criteria for assessment are simple: (1) do these alternatives conform to the notion of "ecodevelopment," as discussed in Chapter 1; and (2) do they offer opportunities for those most affected by the creation of the biosphere reserve?

Maquiladora industries and mitigation of economic effects on fishermen's households

Logic of evaluation

This section of the report attempts to evaluate what role the maquiladora industry may play, if any, in replacing lost jobs and lost household income as restrictions on fishing in the upper gulf are implemented. In making this assessment, we shall look at the various kinds of maquiladoras in terms of composition of their labor force and levels of wages they offer. Here our concern is to identify those segments of the maquiladora industry where the wages paid might be attractive to fishermen or members of their families. To determine this, we will estimate the current household income of fisherman of varying kinds by examining data on household income gathered as part of this study, and analyzing what proportion of household expenses are met from fishing or related activities. Finally, if industries are discovered that could replace the lost jobs and income of fishermen, we will examine what risks such industries may pose to the environment or to the health of workers. As part of this assessment, we shall examine government policy and its implementation, and address whether these provide adequate protection, particularly to the fragile environment of the bioreserve.

The maquiladora program

In 1965, the United States and Mexico signed an agreement that created the Border Industrialization Program. Under the terms of this agreement, U.S. based manufacturers were allowed to export components to their twin plants in Mexico, assemble them, and bring the finished product back into the United States, paying only import duties on the value added by inexpensive Mexican labor. By 1966, there were some twelve plants or *maquiladoras* operating in Mexico, employing 3,000 people. Currently, there are 2,186 such maquiladoras in Mexico with a work force of 501,459 employees. Although originally the maquiladora program was confined to the 25 km border zone in Mexico, in recent years maquiladoras have been encouraged to locate in interior cities. Nonetheless, approximately 80 percent of the maquiladoras are still located on the border; and, in the western states, this concentration is even more pronounced. In Sonora and Baja California (where nearly 45 percent of the maquiladoras in Mexico are located) 97 percent of the factories are in border cities (Lowery 1992:58). The continuing preference for the border itself probably is due to two factors: (1) lower transportation costs and (2) not having to pass through a second set of time-consuming customs check points to import goods into the interior of the country. In this context it should be noted that although San Felipe, El Golfo de Santa Clara, and Puerto Peñasco are on average some 70 miles from the border, they are technically within the border zone. Once over the border no further check points must be passed to reach them. This alone could make them attractive to maquiladoras. The advantage of locating in the country's interior lies in less competition between maquiladoras for workers and wages that are from 16 to 20 percent lower than prevailing rates on the border (INEGI 1990).

The kinds of industries that have been attracted to Mexico's border are those that tend to be labor-intensive and compete in very competitive markets. As may be seen in Table 8.1 below, electronic, automotive, garment, and furniture manufacturers comprise more than 65 percent of the plants located within the border zone, and employ 75 percent of its work force.

Table 8.1

Distribution of Maquiladoras By Type in the Border Zone, 1989

	No. Maquilas	% Maquilas	Work force	% Work force	Ave.Plant Size
Municipios fronterizos	1327	100.00	339,918	100.00	256
Packing and canning	25	1.88	4,361	1.28	174
Garments	152	11.45	20,672	6.08	136
Leather goods	42	3.17	7,298	2.15	174
Furniture & accessories	219	16.50	21,384	6.29	98
Chemical products	45	3.39	2,282	0.67	51
Automotive	113	8.59	75,765	22.29	670
Tools and equipment	35	2.64	5,696	1.68	163
Electronic equipment	93	7.01	53,463	15.73	575
Electronic components	308	23.21	87,079	25.62	283
Sporting goods & toys	29	2.19	12,154	3.58	419
Other manufactures	208	15.67	34,495	10.15	166
Services	58	4.37	15,269	4.49	263

(Calculated from INEGI 1990: Estadística de la Industria Maquiladora de Exportación 1979-1989)

What makes maquiladoras attractive as an employment alternative is that a single plant can provide many jobs. While the size of work force varies depending on the type of operation , the average maquiladora in the border zone employs 256 people. In the small communities of the upper Gulf, a few maquiladoras could have a significant impact on employment. But the question is not merely one of numbers of jobs, but also of what kind and for whom. As may be seen in Table 8.2, by far the largest percentage of the jobs created are assembly line jobs for workers. On average, 81 percent of the jobs created are those for manual workers. Plants also employ some technicians of one sort or another. These, on average, comprise 12 percent of the work force. Administrative personal make up the remaining 7 percent of salaried employees.

Where the profile of work categories is fairly consistent across the industry,

the gender composition has changed considerably of the past decade. In 1981, for example, women comprised 77 percent of the maquiladora work force nationally (INEGI 1990: 29). Employers' preference for women, while often expressed in terms of efficiency, appear to have been motivated by their perception that women were less likely to unionize (Anderson 1989:87-96; Carrillo and Hernandez 1985). By 1989, however, this percentage had dropped to 61 percent nationally, and 58 percent along the border (INEGI 1990: 29). While this drop has been explained in terms of increasing competition for workers (Brannon and Lucker 1989:39-70), it also appears due to the expansion of industries in which male workers predominate, particularly in furniture, chemicals, tools and equipment. It is also due to the rough parity in gender employment achieved in leather goods plants, automotive industries, and among other manufacturers. Nonetheless, in packing and canning, in the garment industries, in electronics, sporting goods and toys, and in service maquilas, which account for half the maquiladoras in the border region, 68 percent of the work force are women. (See Table 8.2).

Table 8.2

Composition of Work Force of Maquiladoras in the Border Zone, 1989

	% Workers	%Technicians	%Salaried	%Men	%Women
Municipios fronterizos	81.19	12.18	6.63	41.87	58.13
Packing and canning	87.55	6.86	5.60	31.64	68.36
Garments	83.78	11.71	4.51	30.76	69.24
Leather goods	84.63	9.85	5.52	45.63	54.37
Furniture & accessories	83.14	9.42	7.44	72.50	27.50
Chemical products	87.16	7.14	5.70	59.78	40.22
Automotive	80.89	12.14	6.97	52.01	47.99
Tools and equipment	82.62	10.81	6.57	67.42	32.58
Electronic equipment	78.50	14.25	7.25	31.93	68.07
Electronic components	78.94	14.23	6.83	34.29	65.71
Sporting goods & toys	81.25	11.80	6.95	31.67	68.33
Other manufactures	83.00	10.83	6.17	43.43	56.57
Services	89.63	5.26	5.11	32.73	67.27

(Calculated from INEGI 1990: Estadística de la Industria Maquiladora de Exportación 1979-1989)

Figures for wages paid by maquiladoras vary widely. For example, according to the Diario Oficial as of January 1st, 1993 the official minimum daily wage for general and farm workers in Zone A (which is the border) is $N14.27 or about $N368.17 monthly. However, wages paid by the maquiladoras tend generally to be higher than this minimum wages. The minimum wage for a factory seamstress in Zone A is $N475.24 monthly; for a tool and die maker $N485.30;

for an upholsterer $N510.07; or for a lathe operator $N522.71 (Twin Plant News, March 1993:21). Because each industry has its own profile of labor needs, the average wages paid by different types of maquiladoras vary widely as well. As may be seen in Table 8.3, while the monthly wage paid maquiladora workers averages $N514.12 along the border, the range extends from a low of $N402.46 paid to workers in the packing and canning industries to a high of $691.33 paid workers by tool and equipment manufacturers. Just how attractive maquiladora jobs might be to displaced workers, not only depends upon whom would be employed, but upon the prevailing wage rates paid in that particular type of plant.

Table 8.3

Monthly Wages in Border Zone Maquiladora by Category of Employee in 1993
Nuevos Pesos

	Workers	Technicians	Salaried Employees
Municipios fronterizos	514.12	1,366.08	1,915.59
Packing and canning	402.46	812.23	1,010.90
Garments	459.82	1,092.17	1,685.91
Leather goods	417.66	1,210.85	1,704.80
Furniture & accessories	515.06	1,365.00	1,659.33
Chemical products	524.32	1,428.97	1,554.33
Automotive	527.52	1,410.15	2,479.80
Tools and equipment	691.33	1,622.11	1,651.34
Electronic equipment	496.04	1,365.85	1,845.86
Electronic components	540.34	1,448.45	1,847.90
Sporting goods & toys	544.62	1,318.00	979.40
Other manufactures	484.19	1,260.06	1,941.85
Services	497.37	1,136.44	1,278.20

1993 monthly wages calculated by dividing 1989 wage by 1989 exchange rate, multiply by 1993 exchange rate, and dividing by 1000.

(Calculated from INEGI 1990: Estadística de la Industria Maquiladora de Exportación 1979-1989)

For instance, a shoe factory is being built in San Felipe. If it follows the industry pattern, when it opens it will employ 174 people, of which seventy-nine would be men. The question is how does $N417.66 paid to workers in shoe factories compare with the level of wages that fishermen in San Felipe are accustomed to; and if fishermen are unwilling to accept such wages, who would find them attractive. The answers to these questions lie in the examination of household economies in these communities.

Household economy among fishermen in the upper Gulf

Before embarking on a description of the household economy of fishermen in the upper Gulf, some discussion is required of: (1) types of boats; (2) shares and pay accorded to patrones, captains, and crewmen on these boats; (3) variability and measures of income; and (4) other sources of household income.

There are two basic types of fishermen found in the region, those who work on pangas, and those who work on shrimp trawlers, tourist ships, and factory ships. Pay on these boats is typically based on a system of shares of catch after expenses are met. Among panga fishermen, if the owner goes out with a sailor, often the catch and expenses are split 50/50. If the panga owner rents out his boat, he receives a 1/3 share, and the remaining 2/3 share is split between the captain and his crewman. On shrimp boats, because the captain and mechanic each get 1.5 shares, for a normal crew of seven there would be eight shares. For example, on the last voyage made by the Felipe Angeles that put into port on May 5, 1993 after a ten day trip, once the boat's expenses were deducted, each share was worth $N380 pesos. This works out to $N57 pesos per day for the captain and mechanic, and $N38 per day for each crew member. In addition, each fisherman takes home a certain amount of fish, the so-called *canasta familiar* or family basket that typically includes, besides fish, from five to ten kilos of small shrimp, much of which is sold or given to friends, neighbors, or tourists. Pay on the six tourist ships that put out from San Felipe for a week's sport fishing cruise is the one exception to the share system. On one of them, the captain and crew are paid straight salaries. A captain typically earns $N500 per voyage, crewmen $N300. However, they also earn tips-- that may add as much as $N300 to their week's wages.

No matter what the type of craft, the income of fishermen is both seasonal and highly variable. For example, although the shrimp season runs from Sept. 15th to May 5th, the first trip is likely to be the best. This is not only because there is a new crop of shrimp to be harvested but also because trawlers are able to obtain enough credit to fill their tanks and go out for a four to six weeks. As they must finance each trip with the proceeds from the last one, as the season progresses, trips tend to become shorter and shorter. Boats can even lose money. When this happens, the amount is divided into eight shares, and it will be deducted by the cooperative from their earnings on the next voyage. Because incomes are so variable, daily wages or even monthly earnings are not very good measures of income, unless averaged over time. For instance, each share on the trawler La Bahia for the seven months of the shrimp season came to $N7,367.55, or a little over a $N1000 a month for the simple crewman, and about $N1,500 for the captain and mechanic. This figure does not include their share of scale fish caught.

In our survey, we approached the problem of income in two ways. One was to ask about the previous month's income. Because monthly income tends to decline as the shrimp season progresses, these spring figures appear to be a little lower than season average, but as income can drop to nothing at the end of the season, they give us a conservative estimate of monthly income. As people tend to play down their income, a more stable estimate of income was made by asking questions about fixed monthly expenses-- costs of food, electricity, propane, gasoline, and rent. Thus, in estimating income we shall use the following measures: (1) household size; (2) number of workers per household; (3) percent fisherman of workers in the household; (4) monthly income of household; (5) monthly income per worker in the household; (6) monthly income per fisherman in household; (7) monthly household expenses; and (8) monthly expenses per worker in household. It should be observed that these figures do not present income of fishermen per se, but of their households that often contain members who work in other sectors. It also should be noted that the following table presents the mean averages for these variables and that, because variables are calculated directly from cases, figures such as the monthly income per worker cannot be validly derived by dividing the mean for monthly income by the mean number of workers in the household.

When the data in Table 8.4 are examined, we may first observe that the households of panga owners on average are larger and contain more workers than do those of other kinds of fishermen. Not only are these households larger, but because fishing is a household enterprise, panga fishermen make up a greater percentage of the workers in the household than they do among other kinds of fishermen. Panga owner's monthly income and expenses show a close correspondence. However, because these households have more workers on average, though the household income of panga owner's is second only to that of captains and mechanics on large boats, the per-worker monthly figures are lower than one might expect.

Table 8.4

Household Economy of Fishermen in the Upper Gulf of California

	Panga owners	Panga crewmen	Large boat captains and mechanic	Large boat crewmen
Valid Observations N=	8	12	23	14
Household size	6.5	4.8	4.9	5.2
Mean no. of workers	2.8	1.5	1.8	2.1

	Panga owners	Panga crewmen	Large boat captains and mechanic	Large boat crewmen
% fishermen of workers in the household	81.00	74.00	63.00	62.00
Total household income monthly	1,208.00	1,037.50	1,817.82	871.43
Monthly income per worker	550.96	873.61	1,096.14	517.26
Monthly household expenses	1,280.06	1,159.46	1,529.34	1,255.96
Monthly expenses per worker	516.94	883.54	1,088.14	764.78

(Source: BARA survey, 1993)

Although the households of panga crewmen are smaller and have about half the number of workers than do panga owners, again fishermen form a high percentage of the work force in these households. Estimates of mean monthly income and expenditures for these households are generally consistent. These figures also suggest that panga crewmen fair better than do crewmen on larger boats. Surprisingly, crewmen on large boats come out at the bottom by these measures of income. This may be due to an underestimation of their income. In this regard, we should note that their monthly expenses seem far to exceed their reported monthly income. It also is probably an effect of calculating their income late in the shrimping season when trips are shorter and catch is correspondingly less. In this regard, panga fishermen are much less constrained by credit or fuel costs, and their fishing effort does not vary as much seasonally.

By almost every measure, boat captains and mechanics on large boats form an elite class among fishermen. For instance, although the size and number of workers in their households is much like that of crewmen both on pangas and large boats, their household monthly income is from 34 to 52 percent greater than for other fishermen.

Comparisons of fishermen's income to wages paid in maquiladoras

There are two ways in which we may compare wages paid in maquiladoras to the incomes of fishermen in the upper Gulf. One is simply to divide per-worker income of fishermen households by the prevailing maquiladora wage, yielding the number of maquiladora job equivalents needed to match worker's earnings. The other calculates the number of maquiladora job equivalents that would be required to match the household income of fishermen.

Table 8.5

Maquiladora Job Equivalents Compared to Per-worker Monthly Income in Fishermen's households in the Upper Gulf of California, 1993.

	Panga owners	Panga crewmen	Large boat captains and mechanic	Large boat crewmen
Per worker income monthly	550.96	873.61	1096.14	517.26
Workers per household	2.8	1.5	1.8	2.1
Average maquila jobs	1.07	1.70	2.13	1.01
High end	0.80	1.26	1.59	0.75
Low end	1.37	2.17	2.72	1.28

(Ave. Maquiladoras = $N 514.12; High end maquiladoras = 691.33; Low end maquiladoras = 402.46)

Three rates are used to make these calculations: (1) the average worker's pay in maquiladoras on the border; (2) worker's pay at the high end of maquiladoras; and (3) worker's pay at the low end of the industry (see Table 7.3). As may be seen in Tables 8.5 and 8.6, the data suggest that maquiladora jobs could match earning of panga owners and the crewmen on large boats, but maquiladora wages would constitute a hardship for panga crewmen and larger boat captains and mechanics. For these latter groups to maintain their present standard of living, they would need to supply more workers to maquiladoras than these households on average have available. However, the conclusion that maquiladora wages could meet the needs of panga owners or crewmen on large boats may be deceptive. For example, because the monthly earnings of crewmen were recorded in the spring when trawler trips are shorter and catch is correspondingly less, they are probably below the seasonal average. These figures do not include any calculation of the value of the shrimp and fish in the "family basket" that crewmen take home to their families to consume or sell. Moreover, these income figures also reflect a bad year-- historically crewmen did much better in the past. These figures are also deceptive in that because they average the income of men, women, and children in the household, they tend to understate the earnings of fishermen who usually are the household's principal bread winners. If the proportionate earnings of various workers were examined, they would likely show that although factory work would be economically unattractive for fishermen, it would be attractive to the wives of fishermen and to other secondary workers in the households such as teenagers and unmarried adults.

Table 8.6

Maquiladora Job Equivalents Compared to Monthly Household Income among Fishermen in the Upper Gulf of California, 1993.

	Panga owners	Panga crewmen	Large boat captains and mechanic	Large boat crewmen
Per worker income monthly	1,208.00	1,037.50	1,817.82	871.43
Workers per household	2.8	1.5	1.8	2.1
Average maquila jobs	2.35	2.02	3.54	1.69
High end	1.75	1.50	2.63	1.25
Low end	3.00	2.58	4.51	2.17

(Ave. Maquiladoras = $N 514.12; High end maquiladoras = 691.33; Low end maquiladoras = 402.46)

Even if a case could be made that maquiladoras could provide earnings that would match those obtained by some fishermen, their willingness to do factory work is quite another matter. For those who make their living from the sea, fishing is more than a job; it is a way of life that offers more than economic rewards. As one fisherman put, most fishermen would sooner sign their mother's death warrant than give up fishing. Even though all recognize that the fishing industry is in a state of crisis, of the 57 fishermen with whom we did formal interviews, only two people proposed maquiladoras as a possible alternative for the communities of the upper Gulf. No one, however, had ever worked in a maquiladora, nor did anyone express a desire to do so.

Ecological issues

The environmental record of maquiladoras has not been exemplary. Because until recently Mexico's environmental and public health laws were weak and rarely enforced, U.S. corporations were attracted to the border "as much for the freedom to pollute as for the low labor costs" (Sklair 1989:95). As a result, the charge has often been made that maquiladoras have been lax in their enforcement of health and safety standards-- such as in the use of chemical solvents and other toxic materials-- and have not only harmed workers, but have harmed the environment (Alvarez and Mungaray 1986:168-185). The issues surrounding maquiladora use of chemical and hazardous materials are manifold: (1) safety standards to prevent worker exposure; (2) site contamination as may occur if chemical or toxic substances are not properly recovered or stored; (3) spills of

toxic chemicals that may occur during their transportation; and (4) dumping of industrial wastes into sewage systems. In Mexicali, for example, the dumping by maquiladoras of industrial wastes into the New River that eventually flows into the Salton Sea in California has caused it to be labeled by the U.S. Geological Survey, the State of California, and the Imperial County Health Department as the "dirtiest river in America," (Wilhelm 1987). Research on both sides of the border has documented the almost uncontrolled environmental degradation due largely to unplanned industrial growth (Sklair 1989:95).

As negotiations over the North American Free Trade Agreement have progressed, Mexico has realized that congressional ratification of NAFTA in the U.S. may rest on environmental concerns, and has become increasingly sensitive to ecological issues. Mexico has renewed its efforts to regulate pollution by maquiladora industry, particularly on the border. From a legal standpoint, these efforts build upon the 1983 Environmental Cooperation Agreement. Under the terms of this agreement United States and Mexico established a 100 km zone on each side of the border within which the two governments agreed to cooperate in the protection, conservation, and improvement of the environment. On the U.S. side, the Environmental Protection Agency (EPA) was designated the agency to execute this agreement; on the Mexican side, the Secretariat of Ecology and Urban Development (SEDUE) was to play this role. Since 1983, five annexes have been added to this agreement. Annexes II, and III specifically deal with problems associated with the maquiladora industry. Annex II addresses the discharge of hazardous waste in this zone. Annex III deals with the shipment of toxic materials. It provides that, as required by Mexican law, hazardous wastes generated by the maquiladoras will be returned to the U.S. (Pettis 1992: 49-50).

As part of Mexico's efforts to improve its environmental record, SEDUE was recently reorganized under the Secretariat of Social Development (SEDESOL). Out of SEDUE's reorganization two agencies emerged: the National Institute for Ecology, SEDESOL's research arm, responsible for issuing standards and setting environmental policy; and the *Procuraduría del Medio Ambiente*, an enforcement agency that acts as an attorney general's office for the environment. As part of SEDESOL's new "get-tough" policy, not only have guidelines been established for handling hazardous materials, but warnings have been issued to maquiladoras found not to be in compliance (Lowery 1992:48-50). To pass SEDESOL's audit, companies must have a licence to function, file chemical material safety data sheets, do risk assessment studies, develop prevention plans, keep hazardous waste shipping manifests, and keep monthly hazardous waste logs. If waste waters are discharged they must do analyses to find out if they contain hazardous materials before they can obtain a wastewater discharge permit. As well, they must maintain logs for their air pollution control and wastewater treatment unit. Because an unfavorable SEDESOL audit could lead to the shutdown of a facility, loss of revenue, and bad publicity, complying

with environmental regulations has become an important aspect of plant management. Nonetheless, critics of these efforts continue to argue that Mexico's enforcement policies rely far too much on voluntary compliance by maquiladoras (Stuckey et al. 1993:34-38).

The real question, however, is not merely one of enforcement or standards, but of the potential risks maquiladoras may pose to an ecologically fragile biosphere reserve that includes several endangered species. Here even ordinary risk assessment criteria might not be adequate. For example, let us presume that a risk assessment analysis would predict that there is a 1 in 100,000 chance of a toxic spill entering the Gulf's waters. The potential costs to the ecosystem-- let alone the costs to the fishing industry-- would argue that even such low risks are too high. While enforcement, site choice, and permits may help reduce the environmental risks posed by such industries, such measures cannot reduce these risks to zero. This does not mean that all maquiladoras pose such risks equally. Certainly garment and shoe factories or other manufacturing operations that do not use toxic materials, heavy metals, or produce hazardous wastes as part of the manufacturing process pose much less of a threat to the environment than do electronics, chemical products, or automotive plants. While our recommendation is that licenses not be issued to maquiladoras that use hazardous materials or produce toxic wastes as part of their operations in the bioreserve and adjacent communities, other kinds of industries that do not pose such risks or pollute the environment may fit within the framework of ecologically sensitive forms of development.

Summary

While no one solution exists to the economic problems in the upper Gulf, maquiladoras seem destined to play a role in future development. Indeed, as the tennis shoe factory being built in San Felipe by a Korean company attests, maquiladoras are already part of the development landscape. Even a few maquiladoras could create many jobs.

If roads and infrastructure were improved, companies would find these communities much more attractive. They are within the border zone, close to the border, have untapped labor markets, plus these towns offer the many amenities of coastal communities. Nevertheless, because of ecological fragility of the bioreserve, we would recommend that only non-polluting industries such as garment manufacture be allowed to operate in this region.Whether maquiladoras can replace the jobs being lost in the fishing industry, however, is another matter. Garment factories, packing and canning plants, sporting goods and toy manufacturers tend to employ more women than men. Most fishermen probably would not only find the wages offered in these industries unattractive, but be unwilling no matter how poor to quit fishing to work in them. The secondary workers in

their households, however, would be more likely to find such employment attractive. Besides the direct ecological problems maquiladora plants may pose, there are other down sides to such development. Because maquiladoras tend to have a very rapid employee turn-over, they go through the local labor supplies quickly, and soon are forced to recruit laborers from surrounding areas. This pattern, which may be seen in communities all along the border, has resulted in rapid growth. Increasing populations put more strains on local infrastructure than communities are usually prepared to handle. The ecological problems associated with such rapid growth are legion. Sewage and garbage, for instance, may threaten fragile zones. These indirect consequences of industrial development can have as much or even more of an impact on fragile ecosystems as any toxic wastes and hazardous materials produced by industries themselves, no matter how clean they may be, and need to be considered as well in planning for the region's future.

Aquaculture: environmental, economic, and social concerns

Introduction

Shrimp and oyster aquaculture have been suggested as the most appropriate alternatives for the affected communities since they have the potential to provide employment opportunities to the fishermen and to ameliorate the cutback in local shrimp production caused by the reduction in fishing effort.

However, aquaculture can modify the environment and jeopardize the well-being of the flora and fauna that live within it. The regional alterations caused by the creation of aquaculture farms not only pose a threat to the environment, but it also may have unpredictable consequences for both the communities and the local fisheries (Lee and Wickins 1992). It is thus of extreme importance to concentrate efforts, at the planning stage of the development, in identifying the environmental and social changes produced by different types of aquaculture, anticipating the need of appropriate solutions to these problems, and creating enforcement mechanisms to avoid further damage to the ecosystem by an aquaculture industry. According to Braaten and Hektoen (1991:464),

> Environmental concerns have become a major issue in western Europe over the past few years, both in terms of the impact of the environment on aquaculture and the impact of aquaculture on the environment. Problems associated with effluent discharge, use of antibiotics, habitat damage in aquaculture and adverse effect of red tides have led to serious problems for the fin fish, crustacean, mollusc and seaweed farmer as well as to the local fisheries. The aquaculture industry has been partly blamed for these problems and it has become increasingly clear that environmental aspects of aquaculture development have been neglected and need to be addressed as a matter of urgency.

This situation is not restricted to developed countries, where the use of technology has led to the hyper-intensification of most aquaculture operations. A similar concern for the environment was expressed by Southeast Asian countries, where the level of investment (extensive and semi-intensive systems) is much lower than in the European countries. The existing evidence seems to indicate that even though the level of technology used determines the degree of damage to the environment, pollution and habitat deterioration from effluent discharge, introduction of exotic species, and disease, are the most common threats of aquaculture (Beveridge 1984; Braaten et. al. 1988).

Types of shrimp systems

Among less polluting types of aquaculture operations are those with low levels of technological support, the so-called extensive systems. Extensive aquaculture relies on the tides for food, water exchange, and dilution and flushing of toxic metabolic by-products (such as unionized ammonia). The low stocking densities characteristic of this type of systems (usually 1-5 juvenile shrimp/ m^2) mean there are very low returns and create few employment opportunities for local populations. Growout ponds for extensive culture methods are usually located in estuaries or mangrove swamps. Typically, the considerable damage and disturbance of coastal areas created during the process of building and maintaining the ponds promotes the loss of mangrove habitats with the consequent reduction in mangrove-associated species as well as traditional resources gathered by local populations, such as wood, medicinal plants, fish, and clams (Bardach et al. 1972; Lee and Wickins 1992).

It is also important to point out the fact that many estuaries and almost all mangrove swamps are characterized by the presence of extremely acid sulphate soils, commonly found in places with poor periodic aeration. The most harmful effect caused by the oxidation of this type of sediment is the excessive amount of sulfuric acid produced which, if not neutralized by exchangeable bases, creates strong acid conditions with devastating consequences for the species under culture (Pillay 1992). Therefore, from the points of view of suitability for sitting aquaculture farms, expected benefits to local communities, and possible ecological risks, mangrove swamps and most estuaries would rank very low in order of preference.

Utilizing closed coastal lagoons for extensive aquaculture operations would not be wise since water circulation and exchange do not occur naturally. The level of difficulty and the cost involved in channeling a connection from the lagoon to a nearby estuary or ocean, will depend on their relative physical location; nevertheless they are relatively high. Although water can be brought into a lagoon in principle, in practice water quality and regime may not be adequate for maintaining a level of production that would justify investment costs.

To minimize conversion of swamps, coastal lagoons and estuaries for expansion of pond farming, the introduction of "intensive" systems has been recommended (Kapetsky 1987). Intensive farming actually comprises two sub-categories, semi-intensive and intensive systems, which differ in the level of technological input and stocking density. A semi-intensive shrimp farm uses water recirculation for flushing the wastes that accumulate in the ponds and for maintaining oxygen levels; stocking densities are usually between 20 and 100 Pls/m^2 and their growout relies in part on supplementary feed. On the other hand, intensive systems flush the ponds in the same way as semi-intensive but do not rely entirely on water exchange for supplying oxygen to the ponds; the use of aerators and supplementary feed allows the aquaculturist to set higher stocking densities (between 100-200 Pls/m^2).

The required investment in technology and personnel necessary in intensive aquaculture systems is significant. A well-planned farm must incorporate a laboratory for diagnosis of disease and water quality parameters, employ pond managers and biologists, and have infrastructure such as storage capacity for food supplies and chemicals, and ponds with riser and drain spillways. All of the above are essential in intensive methods since the higher levels of production are attained through high water exchange rates (50-100%), the use of pelleted feed, and the constant monitoring of water quality in the ponds.

Larvae acquisition: The shrimp aquaculture industry is usually constrained by the quality and availability of Pls (D. Lightner, per. comm.). This situation results in an increased dependency on wild Pls for stocking ponds. In Mexico, this dependency is more than obvious. According to the 1991 SEPESCA aquaculture census, there are 16 hatcheries, distributed in five states (B.C.S., Jalisco, Sinaloa, Sonora, and Tamaulipas), with a joint production of 515.5 million Pls per year. The total number of hatchery produced Pls can only supply the demand of ten small farms (with a stocking density of 100 Pls/m^2, an average size of 50 ha of ponds per farm, and only one growout season). However, the state of Sonora alone has eight registered farms, which account for 80 percent of the demand for hatchery produced larvae (SEPESCA 1991). The lack of hatchery facilities and the use of wild Pls in shrimp aquaculture has not only caused conflicts between fishermen and farmers, but this practice has the effect of reducing the recruitment of juveniles to local wild shrimp stocks. Reduction in recruitment becomes critical when the shrimp stocks are under heavy exploitation by the existing Pacific shrimp fleet.

A side effect of introducing shrimp from other regions is the increasing risks of spreading exotic varieties and disease from region to region; as a result, what could have been a localized problem becomes a wide-spread epidemic. Cases of introduction of viruses (such as IHHN, BP and MBV) through Pl imports and their subsequent spread into wild shrimp stocks, have been well doc-

umented in northwestern Mexico and other regions of the globe (Lightner et al. 1992a; 1992b). It is a common practice to import wild Pls or broodstock from remote Mexican areas (such as Oaxaca and Chiapas) and from other countries (Ecuador and the United States) into Sonoran farms without the proper sanitary control. These type of operations are regulated by PESCA through the issuing of collecting permits. Unfortunately, the number of individuals and firms that profit from the harvesting of Pls with very little investment are constantly increasing; enforcement mechanisms to regulate this activity are literally out of the hands of local PESCA officials. The only feasible solution for regulating both the introduction of larvae from other regions and the spread of disease to wild stocks, is to guarantee the creation of laboratory facilities in the region where aquaculture will be promoted.

Oyster culture systems and related problems

Oysters are usually cultivated using rafts or floating trays anchored to the substrate. Most culture techniques have been developed in Asia and are, nowadays, practiced in most parts of the world in protected bay, estuarine, and mangrove swamp areas (Bardach et al. 1972). Growth and survival of cultured oysters is largely determined by the quality of the beds, which "should be on hard bottom in 1-12 m of water where tidal currents are strong, and relatively free of pollutants, particulate metallic salts, pesticides and detergents" (Bardach et al. 1972). Oysters are filter feeders; they use their gills for oxygen uptake and for trapping small particles (unicellular algae and small zooplankton) that form their food resource. Being low in the food chain and due to the low selectivity of their filtering capacity, oysters are most of the time the first agents in promoting bio-accumulation and bio-magnification events. Bio-accumulation in oysters could become a major problem when the stored products in oyster tissues are toxins produced by algal blooms (Angell 1986; Doyle 1988; Shumway 1989). Toxic algal blooms, such as those caused by flagellated algae, occur world-wide; most times, these are produced in the open ocean and drift toward the estuaries and bays, hence these events are unpredictable and out of the farmer's control. Toxic algal blooms and the accumulation of toxins in bivalves is a matter of public health concern, especially in areas where shellfish is eaten raw or partially cooked.

Bivalves (oysters, mussels and clams) are also important vectors of various forms of shellfish poisoning, such as: Paralytic Shellfish Poison (PSP), Diarrhetic Shellfish Poison (DSP), Neurotic Shellfish Poisoning (NSP) and Amnesic Shellfish Poison (ASP). Both PSP and DSP blooms have been found to occur world-wide (Braaten and Hektoen 1992; Shumway 1990); the reported toxin retention time for *Crassostrea gigas* and *C. virginica* are one to nine and two to six weeks respectively. In France, the severity and frequency of red tides and toxic algal blooms caused the government to enforce quarantine procedures for

the depuration of oysters and other bivalves before reaching the market. Spain also had to follow quarantine laws when their mussels were reported to have very high levels of bacteria and other microorganisms.

Implementation of quarantine procedures not only causes a considerable delay in the marketing process but also creates additional costs, generated by moving oysters from one bed to another or into depuration ponds. Bivalves must be placed in ponds or tanks containing filtered, and sometimes U.V. or ozone radiated water, for a period determined by the severity of toxin accumulation. Throughout the quarantine, the aquaculturist must feed the oysters with pure cultures of microalgae (which are reared under strict laboratory conditions). The infrastructure needed for the production of microalgae and the intense labor involved in the operation create extra costs for the farmer.

Mollusk culture itself can affect the environment by removing phytoplankton. Depending on the stocking density of living mollusks, this process may cause a high accumulation of organic sediment on the bottom. The production of biodeposits by filter-feeding bivalves augments the rate of sedimentation (Pillay 1992). Pillay points out the fact that "biodeposits increase the quantity of mud, and since organic mud is resistant to erosion, sedimentation rates are enhanced, resulting in the elevation of seabed to the extent of 30-50 cm. per year" (1992:8). Biodeposits utilize considerable quantities of oxygen in oxidizing the organic matter contained in them, and eventually create a reducing environment and the production of hydrogen sulphide (H_2S); this in turn reduces the diversity of benthic fauna (Mattson and Linden 1983).

An equally important problem is the restriction of water flow in and out the estuaries and bays produced by cage culture operations. In the rack culture of oysters, where bags of oysters are placed on racks arranged in lines hundreds of meters long, parallel to the tidal currents. As Pilley notes:

> Constant deposition of large amounts of biological wastes can create azoic zones devoid of macrobenthic organisms beneath cage farms. An impoverished microfauna, dominated by opportunistic species characteristic of enriched sediments, may develop in the vicinity of the farm. A transition zone can be recognized beyond this, and further beyond a zone of normal conditions (1992: 14).

Economics

The Mexican government has proposed an ambitious plan to foster aquacultural development throughout the country. Under the *Programa de Desarrollo Integral de la Acuacultura 1990-1994*, projected investments in aquaculture through the mid-1990s amount to $N950,500,000, some $300 million U.S. (SEPESCA:31). If these goals are met -- by private financing and government

assistance -- the total value of output by 1995 would reach $N1,545,950,000, $500 million U.S. (Ibid.:31).

Are shrimp and oyster cultivation, in fact, profitable? Drawing upon surveys of shrimp farms in Mexico, Margaret Miller answers in the affirmative, particularly if land acquisition costs are not involved, as is true of farms established by ejidos. Her calculations (see Table 8.7) of internal rates of return on invested capital, a measure of profitability, as she notes, are:

> impressive and indicate that, even when firms are required to pay full value for land and larvae, there are positive private financial incentives to undertake investments in aquaculture. However, for a commercial firm they are modest if the firm must compete for the limited amount of suitable land that is available from private sources. Much more impressive are the returns to aquaculture when the IRR's are computed at social prices that represent costs and returns to the economy as a whole. This case approximates the ejido estimates in that the land being used for shrimp farming has no opportunity cost as a result of foregone agricultural output (Miller 1990:94-95).

Table 8.7

Internal Rates of Return on Aquaculture Investment (Annual percent return on investment)

	50 hectares	100 hectares	200 hectares
Extensive commercial	.21	.31	.37
Commercial ejido	.41	.61	.74
Semi-intensive commercial	.45	.59	.67
Ejido	.73	.94	1.06

Source: Miller (1990)

Recent changes in Mexico's agrarian laws facilitate private investment in ejido lands, reducing the cost of land to financiers. And, short of extensive government financial support and technical assistance to ejido-based aquaculture, it is likely that the private sector will underwrite, and profit from, shrimp farming. Miller estimates that semi-intensive shrimp farms of 50, 100, and 200 hectares, respectively, require the following levels of initial investment: US $258,660; $459,764; and $869,903 (1990:106; see Appendix C of this report for her investment and operating cost calculations). Annual returns from such operations range from $69,992 to $334,729, if larvae is collected from the wild, and from $44,922 to $234,729 if ponds are stocked from cultured larvae.

Although labor requirements on shrimp farms are not large, they could, nonetheless, provide an important source of local employment. Miller estimates, for a 200-hectare farm, an unskilled labor force of 33 persons yearly, paid at minimum wage rates. An additional 10 persons yearly in skilled labor -- pond managers, technicians, accountants -- also would be required, but they are more likely recruited outside the local populations. These figures -- .215 workers per hectare -- conform closely to estimates in the government's *Acuerdo Nacional para la Modernización en la Acuacultura* (SEPESCA:31).

Oyster culture also appears to offer potential profits. Mexico's national aquaculture plan calls for the development of 10,000 ha by 1995, generating 18,000 jobs, with a projected annual profit of $N26,231,000 ($8.5 million US). However, this calculates out to only $470/year per employee, at best a supplemental income. Field data give a better picture, however. A cooperative of women has been cultivating oysters successfully near Puerto Peñasco for 15 years, is not in debt, and cannot produce enough oysters to fulfill the demands of its clients, buyers from throughout Sonora. Fifteen women work the oyster trays and bags year-round, earning between $50 to $60 US per week.

Strictly in terms of economics, then, both shrimp and oyster cultivation are viable businesses in the region. Neither should be considered a panacea for the economic crisis in the upper Gulf, but they hold some potential for diversification. It should be underscored, however, that, to date, a significant amount of the investment in aquaculture in the upper Gulf has been from foreign sources. The United States, for example, has tough regulatory procedures for obtaining permits for aquaculture farms. This, plus the high cost of land, makes aquaculture operations in the U.S unprofitable, promoting U.S. investment in coastal properties in Mexico and other foreign countries. The upper Gulf, being so close to the U.S. border, may continue to attract foreign capital for aquaculture facilities and reduce potential benefits to local populations.

Summary

Aquaculture development in the upper Gulf region must be carefully planned to avoid the possibility of furthering the ecological and social damage of an already threatened region.

The actual participation of local communities in the decision making process and the development of farms may be negligible, as extensive technical knowledge and trained personnel are required to run these types of operations. As a result, fishermen may not only loose their highly valued independence, characteristic of fishing activities (i.e., to decide when and where to go, and what species to go after), but their only alternative may be to become maintenance workers in an aquaculture farm. This might be an unacceptable alternative for many fishermen. Other local conflicts, such as those regarding land tenure and

migration of workers from other regions seeking employment in the farm also could occur, and hence, must be considered during the planning stage of all aquaculture facilities. The allocation of land for aquaculture also must be considered since it could create the undesired effect of disrupting a community, especially when available land for aquaculture is leased or sold to private foreign and domestic investors.

Apart from problems associated with social disruption and lack of local participation, both intensive shrimp farms and oyster culture have been shown to have the potential to alter and even degrade the local environment. Further loading of the ecosystem with the chemicals and waste products present in a shrimp farm's effluent discharge could have a devastating effect for the region since the predominant ocean circulation will tend to concentrate rather than disperse the discharge. If these aquaculture wastes are kept in circulation by the eddy systems in the upper Gulf region, it is expected that toxic algal blooms will not only be wide-spread but also will occur more frequently. The occurrence of toxic algal blooms could jeopardize both the local fisheries and aquaculture crops by either causing direct mortality of shrimp and oysters, or through the build-up of consumer resistance, which can drive the products generated in this region out of the market.

Tourism

The final occupational alternative to be addressed briefly is tourism, already a significant component in the economies of San Felipe and Puerto Peñasco, and one that is anticipated to play an increasingly important role in the future (Hardie 1993; Aldrete 1992a, 1992b). We will not attempt to project rates of growth for this sector, nor calculate any "multipliers," i.e., jobs to be created by increased tourist activities. Our focus, rather, is on the potential for displaced fishers to find satisfactory employment in tourist-related enterprises, based on present patterns of development in the upper Gulf. As in the other two occupational alternatives evaluated here, we also will look at the environmental and social issues likely to be raised by an expansion of this sector.

For the purposes of this analysis, we can distinguish three categories of tourism: (1) traditional tourism, which includes hotels and resorts, R.V. parks and beach camping, and semi-permanent residency; (2) nature tourism or ecotourism; and (3) sport fishing. The guidelines for the biosphere reserve encourage all these activities, in controlled fashion.

Traditional tourism

Puerto Peñasco receives 250,000 visitors annually, 70 percent from the United States (Plan Municipal nd.:125). San Felipe receives over 500,000, 95

percent from the United States (Kulander 1992:84). While we do not deny the importance of this sector to the economic future of these communities, field observations prevent us from enthusiastically endorsing this option.

It was a common observation among those interviewed in these communities that a substantial portion of foreign tourists are self-sufficient, equipping themselves in the U.S. for brief visits. This, of course, is due to the proximity to the international border: 95 percent of the tourists visiting San Felipe, for example, arrived in their own cars, R.V.s, vans, or campers (Rodríguez 1991:22). While we made no attempt to calculate average daily expenditures, we are very skeptical of the one published estimate we obtained, of $160 per person per day (Rojas Caldelas et al. 1991) for San Felipe. Besides short-term visitors, there are semi-permanent residents, but many of these are retired people on fixed incomes and thus unlikely to contribute substantially to the local economy.

The supply of tourists, and their spending capacity, is also heavily dependent on external economic factors. There was a reported rise in tourism during the Persian Gulf war, as the fear of air travel apparently induced vacationers to drive to tourist destinations, But over the last several years of economic recession in the United States, tourism has declined. Owners of tourist related enterprises report a 50 percent drop in business; many are unable to repay loans at high interest rates; some are closing. With this decline in visitations, too, the proprietors of enterprises catering to tourists are reportedly finding the "pie," the tourist dollar, cut into smaller and smaller pieces. Thus, as one local informant reported to us in San Felipe: "When the United States gets a cold, we get pneumonia."

Thus, until the "supply" of tourists increases, efforts to expand the number of enterprises catering to tourists will be likely to further divide the pie. A common observation, concerning this "supply," was that Mexico is no longer the "bargain" that it once was: prices for food, lodging, and gas are now equivalent to or higher than those in the U.S. This fact will have to be taken into account in projections about the growth of the tourist sector and concomitant employment opportunities.

There are two other aspects about tourism development in the upper Gulf, based on our observations or as reported to us by local informants, which we find troublesome. We simply note these as potentially deleterious factors in the expansion of this sector. One is the acquisition of ejido lands for resort development. Much of the coastal zone in the upper Gulf is under ejido control, though now such land can be leased and sold to private owners. Substantial oversight will have to be exercised to assure that such transfers are in the best interests of ejiditarios. Second, there is the question of the compatibility of tourist recreational activities with the goals of the biosphere reserve. A significant and increasingly popular activity is "off-roading." For example, the major deficiency in San Felipe's tourist infrastructure, identified through a survey of visitors, was

the lack of secure storage areas for all-terrain vehicles (Rodríguez 1991:25-26). The destructive effects on uncontrolled off-road travel include damage to plants and root systems, leading to the destabilization of sand dunes, trampling of eggs laid in esteros, alteration of natural drainage patterns, and the destruction of plant foods for animals (CEDO:1988:7). And from a social perspective, the expansion of such activities may prove to detract significantly from the appeal the biosphere reserve will have for nature tourism.

Ecotourism

Nature tourism or ecotourism -- visitations motivated primarily by a region's physical or ecological features -- is praised as a potential contributor to "sustainable development." As Whelan observes,

> It promises employment and income to local communities and needed foreign exchange to national governments, while allowing the continued existence of the natural resource base. In fact, it cannot survive unless the resource on which it is based is protected. It can empower local communities, giving them a sense of pride in their natural resources and control over their communities' development. It can educate travelers about the importance of the ecosystems they visit and actively involve them in conservation efforts. In sum, it has the potential to maximize economic benefits and minimize environmental costs (1991:4).

The upper Gulf, the delta, the Pinacates, and Organ Pipe National Monument in Arizona form an obvious destination package for potential ecotourists. Although we have no way of assessing the potential magnitude of ecotourist activity, we would encourage every effort to develop it, provided these efforts are planned so as to avoid the pitfalls of ecotourism elsewhere. Primarily, these result from external organization and control of the activity: foreign-operated tours typically bring in their own supplies and hire few local guides or assistants; user fees collected by state or national agencies frequently do not return to the local communities; and locals, if not involved in the activity or not otherwise gainfully employed, are likely to harbor substantial resentment against those who come to enjoy land and resources once utilized by the local communities (see Whelan 1991; West and Brechin 1991; and Smith and Eadington 1992 for case studies and planning guidelines).

There is some doubt, however, that local fishermen will be major beneficiaries of ecotourist activity. Several sport-fishing panga owners now offer sightseeing services, but generally find this business unprofitable. The simple reason is that, in contrast to fixed-location bottom fishing, "*paseos*" of sightseers require much more gasoline, and the current willingness-to-pay (about $40/person/day) requires a dangerously large party (8-10 people) for the operator to make a small profit. In addition, as one part-time R.V. park manager told us, there is no guar-

antee of seeing marine life. He had no repeat customers on the sightseeing trips he organized, and suspected that the dissatisfied ecotourists turned other potential sightseers away.

Sports fishing

Local participation in sport fishing, another activity to be promoted in the biosphere reserve, is already problematic. Several legitimate complaints have been raised by operators of sport-fishing pangas and yachts, and tensions are likely to increase markedly as fish, once exploited commercially, are reserved for foreign anglers. Here we simply summarize the nature of these complaints.

The primary irritant is the loss of clients to American yacht owners, operating through local RV parks. In Puerto Peñasco, Mexican panga operators charge that about 20 such "*piratas*," working without licenses, make two or three trips a week with American customers. Yachts, with bathrooms, the latest navigational and fish-finding equipment, and, of course, English-speaking skippers, find a ready clientele. Against this competition, Mexican operators find themselves at a disadvantage, and indeed are not allowed to solicit clients at several of the R.V. parks.

Besides fostering intercultural tensions (and local disrespect for the authorities who do not enforce regulations on the American sportsmen), this pattern represents foregone community income: American boat owners hire few locals and repair and maintain their boats in the United States. When challenged, the American skippers respond that they are simply taking out a few friends, a claim difficult to disprove.

A more highly organized sport fishing sector has developed in San Felipe, with seven large boats, 80-footers, taking 20 to 30 passengers on week-long trips, fishing the deep waters around the islands to the south. With a crew of 10 to 12, fishing from April to October, charging $600-700 US per passenger, this represents a significant economic activity. Captain, motorista, and cook make 500 NP ($160 US) per week, guides less, but receive substantial tips, and a boat owner, on a fully-booked trip, can earn $4,000 US. One boat is now being prepared for such activity in a Puerto Peñasco shipyard.

While this type of sport-fishing activity appears a viable venture, there are indications that it may be leading to overfishing (as well as capturing totoaba; see Martínez and Corona 1992). Any additional expansion of this sector would have to be carefully monitored and regulated.

Conclusions

We have attempted in this chapter to provide an overview of possibilities

and problems with the three primary occupational alternatives proposed for displaced fishermen in the upper Gulf. Our primary conclusions may be summarized as follows. The maquiladora and aquaculture industries pose some significant environmental threats, if not carefully regulated, while employment opportunities in maquiladoras may not be very attractive to fishermen. As far as tourism is concerned, limited local long-term employment is quite possible. But we observed that there are significant barriers to entry into some of the acceptable occupational niches within the tourism sector, such as sport fishing. We acknowledge, however, that tourism, if carefully developed, may prove to be an economic asset to the communities.

While we do not want to denigrate the need for economic diversification, we do see a revitalized fishery as critical to the future of the upper Gulf. The following chapter proposes some measures to return to a reasonable level of exploitation of the marine resources in the region.

Chapter 9

Suggestions for a Sustainable Fishery

Marcela Vásquez León, Thomas R. McGuire, and Hernan Aubert

In this chapter we recommend some measures that we believe should be included in the planning and implementation of programs for the better management of the upper Gulf. Our recommendations focus on the modification of fishing strategies and gear used by fishermen who directly depend on the area for their economic sustenance, on changes in the actual fisheries management regime, marketing adjustments that may lead to a more sustainable commercial exploitation of resources, on the possibility of revising the regime of the Colorado River, and on "co-management," the effective involvement of local resources user in the decision making process. As a crucial component of this process of better management we call here upon the scientific community to monitor the effects of the proposed modifications.

Offshore trawler effort reduction

It is well known that the shrimp fleet of the Mexican Pacific has been overcapitalized for years (see Chávez and Lluch 1971, Rodríguez de la Cruz 1987). There are too many boats that are too big and costly to operate in the pursuit of a resource that is becoming increasingly scarce. The problem of overcapitalization of the fleet is a historical one, for which many parties bear responsibility, including users both from the social and the private sectors, politicians in charge of planning and execution of national fishery programs (see Miller 1990), and administrators and scientists in charge of monitoring the fishery (see McGuire 1991).

By now, the need for a reduction of fishing effort has become obvious to those interested in the future of the shrimp industry, and to those concerned with the conservation of the upper Gulf. However, we believe that a total and permanent closure of the area to shrimp trawlers is a simplistic measure that runs the risk of unnecessarily endangering the livelihood of fishermen and further debilitating related industries, and will simply displace the trawling effort to other grounds, to the south of the proposed biosphere reserve boundary. In addition, efforts to enforce a total closure of the upper Gulf to shrimp trawlers are likely to be extremely costly or unsuccessful. This is particularly true in light of evidence

from other shrimp fisheries that suggests that overexploited populations have the capacity to recuperate after a few consecutive years of greatly reduced effort (Penn, Hall, and Caputi 1989). Shrimpers historically active in the upper Gulf are unlikely to abide by regulations that deny them access to a revitalized stock.

Given these considerations, we have calculated what we consider a reasonable and responsible level of continued fishing effort in the upper Gulf. The estimation of fleet size is predicated upon de assumption that, as stipulated in the biosphere reserve declaration, shrimp trawling will be prohibited in the buffer zone (as well as in the nuclear zone). We believe that such a restriction may be valid as a short-term measure to foster the recovery of the upper Gulf. However, we do not believe such a prohibiton need be permanent, if fleet size is reduced throughout the Gulf , and gear, areal, and seasonal restrictions are implemented and enforced.

Calculation of a long-term supportable fleet size for the Gulf of California

Historical records representing the last 39 years of exploitation of shrimp stocks in the Gulf of California were obtained for the Guaymas fleet. This data set is composed of two variables, the number of boats and reported total catch. Similar information was gathered for San Felipe and Puerto Peñasco. Data available for these two towns, however, are used for comparison since it only represents landings for the 1987, 1988, and 1989 seasons for the former and 1988 and 1989 for the latter. These landing records are processed separately and considered in the calculation of the optimum fleet size for the entire Gulf of California.

Landing records for the early years of shrimp exploitation (from 1953 to 1969) are characterized by larger catches (on the order of 6,000 to 7,000 tons/season) and fewer boats (between 133 to 200) than in recent years. The average catch per boat for this period was calculated to be 27.86 tons. This average contrasts sharply with the average catch/boat of 9.67 tons calculated for the period 1980-1992. The observed decline in shrimp production per boat appears to be a direct function of both the number of boats competing for the resource and the reduction in shrimp stock size. When comparing the average total production for the last ten years against the average for the period 1953-1979, a highly significant reduction in landings is observed [Mann-Whitney N=12 & 27, Z=2.677, Prob. Z>2.68= 0.0074]; this difference represents a reduction of 20 percent in shrimp production. The opposite trend is observed in the average number of boats that operated from Guaymas. Fleet size grew from an average of 263 boats (for 1953-79) to 357 boats during the 1980s and the beginning of the 1990s, which represents a 26 percent increase.

It is important to point out that the calculated reduction in landings does not have a precise relation to stock assessment because of the black market channels for shrimp, and the proportion of the "real" total production they represent,

are not considered in the data set. Black market shrimp volume could have increased during the 1980s, especially in the situation where cooperative leaders began to loose control over their members and internal corruption led to a loss in confidence in coop affairs. Since we cannot quantify black market activity, and since differences exist between the entire time-series and the reduced series (the 1980s), we will use the average catch of the 1980s (lower and more conservative) in the calculation of the maximum fleet size (MFS) for the Gulf of California. The catch and fleet size records, corresponding to the five data points for the Puerto Peñasco and San Felipe fleet, are analyzed separately and used for the calculation of MFS; this is justified since the average catch/boat and total catch for the five years are not significantly different from the average of the recent data set for Guaymas [Catch/boat Mann-Whitney N=3 & 12, Z =1.299, Prob. Z>1.299= 0.193. Total Catch M-W Z=.577 Prob. Z>.577= 0.56].

The estimate of the MFS is based on a measure of economic efficiency.[1] In a cost/benefit analysis presented elsewhere (Vásquez León and McGuire 1993), a break-even point (where total costs = total benefits) of 12.295 tons/boat per season was calculated. The "Long Term Average Yield" (LTAY) for the Pacific coast (that is, the average catch for the 1980s), is divided by this break-even point to give us an estimate of the "On Average MFS." The calculated LTAY for Guaymas records in the last decade is 3,886.583 tons which, divided by the 12.295 ton break-even point, gives us an absolute maximum of approximately 316 boats for the entire Gulf. The intrinsic problem of taking Guaymas landings as the only ones that occurred during these seasons for the calculation of the MFS is solved by calculating the average relative contribution to the total landings that Peñasco and San Felipe represent for the years for which records exist. In our case, the average landings for these ports during 1987, 1988 and 1989 was calculated to be 1429.5 tons, representing 26 percent of the total average production of Guaymas. Increasing the calculated MFS by 26 percent gives us a total of 398 boats for the entire Gulf of California. [2]

The 398 maximum allowable fleet size, however, must be further reduced according to the percentage of fishing ground lost inside the newly created reserve. The reasoning behind this further decrease in fleet size is that we must assume that a reduction in total landings, proportional to the area lost, will occur. To calculate the percentage of area lost, our cartographer measured and esti-

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1. Unfortunately, we do not have shrimp population parameters which, if included in the equation, would give us a better estimate of the fleet size from a biological and economic perspective rather than pure economics alone.

2. In calculating the maximum fleet size for the Gulf, we have not taken the Santa Clara fleet into account, since it has very little impact on total fishing effort. We suggest that the size of the community's trawler fleet be determined by economic conditions, i.e. by the number of boats which can be economically repaired and obtain "break-even" levels of production.

mated the area between the 40 fathom contour (the effective limit to trawling) and the 5 fathom contour line (the current legal limit on shallow-water trawling) from a bathymetric chart for the entire Gulf of California (from Mazatlán to Isla Montague to La Paz) and for the buffer zone of the proposed bioreserve. These areas were calculated to be 37,553 km^2 and 3471 km^2 respectively. The new reserve represents a 9.24 percent areal loss to fishing. Thus, the areal-compensated MFS is 90.76 percent of the original MFS, totaling 361 boats for the whole Gulf of California. Based on the fleet size for each port, a pro rata reduction, allocating reductions proportional to the fleet size, can be calculated. For this calculation, fleet size records for the season 1988-1989 were used, since we consider that the last three seasons to have been very anomalous. The recommended Maximum Fleet Size for the three ports, the number of boats registered for the 88-89 season, and the relative contribution to the MFS for each port are presented in Table 9.1.[1]

Table 9.1

Reported 1988-1989 fleet size for all three ports, the proportion each port represents of the pacific Fleet size, and the pro rata allocation reduction to attain the recommended MFS

	No. boats '88-89	% Pacific Fleet	Recommended MFS
Guaymas	372	62.2	226
San Felipe	40	6.7	24
P uerto Peñasco	186	31.1	112
Total	598		362

Excess # Boats= 236

% Reduction in Fleet Size (from 1988 to present)= Approx. 40%

MFS used in calculation= 362

These figures are in reasonable accord with calculations made by other researchers. For example, in 1991, Alonso Alemán from the Mexican ministry of fisheries proposed the reduction of fleet effort in the Puerto Peñasco area based on the application of a bioeconomic model. She concludes that the point of biological equilibrium can be found between 81 standardized vessels when recruit-

1. An additional 1,244 km^2 of potential trawling grounds would be lost if, as we suggest below, trawling be prohited in areas shallower than 10 fathoms. Thus following the methods use in the above calucations, a further fleet reduction of 3.3% would be called for. Moreover, if "profits" are desired, above the economic "break-even" point, then fleet size should be further reduced. For example, if a 10% profit margin is socially desirable, then a farther 10% pro rata reduction would be necessary.

ment is low, and 151 vessels when recruitment is high. The point of economic equilibrium can be found between 62 and 137 standardized vessels during low and high levels of recruitment respectively (Alonso Aleman 1991). [1]

Economic circumstances in the upper Gulf present an ideal moment to carry out a plan of effort reduction. Fishing effort by resident trawlers and outside users was significantly reduced during the last shrimp season due to financial problems faced by cooperatives and the increasing unprofitability of the industry. Thus, maintaining a reduced effort at this time would not be a difficult undertaking as a large part of the fleet is either obsolete or beyond repair. Only boats in working condition should be repaired in preparation for the next shrimp season. A second and third season of reduced and directly monitored effort would give us a better idea of the role of shrimp trawling in the ecological crisis of the upper Gulf.

Equipment modifications

Shrimp boats

Although size, equipment and storage capacity have given offshore shrimpers significant mobility, the possibility of making longer trips, and capability of catching shrimp in remote areas, several questions about the way they operate have arisen. Our own data collected in the upper Gulf region suggest that, in some areas, shrimp make up only 10 percent of the total catch, the rest being by-catch of a variety of benthic species (see Chapter 6). Unfortunately, fishermen are forced to throw most of the by-catch back into the sea, since the costs of keeping it refrigerated, at the risk of loosing the shrimp, do not justify retaining it on board given its low market price.

However, trawlers can be made more efficient if the ratio of by-catch to shrimp is reduced. Several countries, attempting to deal with this problem, have experimented with a variety of fish excluders which, installed in trawls, are designed to reduce the proportion of by-catch in relation to shrimp. For example, fin fish excluders developed in Norway are used in the shrimp fisheries of New England in the United States and in Canada. Turtle excluders or TEDs, also known as "Trawling Efficiency Devices" (Watson et al. 1986), have also been developed as a response to the decline of sea turtle populations. Since 1987, their use has become mandatory for the shrimp fleet operating in the southeastern

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1. A more precise bioeconomic equilibrium level must consider the unpredictability of resource availability, leaving room for vessels to exit and enter the fishery accordingly. Thus, the point of equilibrium is not a static, but a dynamic concept which demands constant monitoring (see McGuire and Langworthy 1991). Likewise, effort reduction must consider a greater flexibility in terms of equipment used by the fleet, so that during bad seasons fishermen may either switch to another fishery or stop operations without incurring unbearable costs.

United States and in 1993 the Fisheries Ministry in Mexico legislated their use for the shrimp fleet operating in the Gulf of Mexico (Krapf 1993).

The actual success of these devices in increasing trawling efficiency without causing substantial economic losses is not clear. Some studies show a substantial decrease in by-catch with a minimum reduction in shrimp catch. For example, the United States National Marine Fisheries Service reports a by-catch exclusion of 95 percent, and a 95 percent shrimp retention (Crowley, 1993). However, one study indicates that shrimpers' assessments of these devices contradict assertions made by federal management agencies. In the shrimp fishery in the Gulf of Mexico fishermen, already experiencing economic losses because of low product prices, have strongly resisted the use of excluders, arguing that these devices reduce their shrimp catch so much that they will force them out of business (Dyer and Moberg 1992; also see Clark et al. 1991; Andrew and Pepperell 1992).

Considering the current economic crisis most fishermen in the upper Gulf of California are facing, the use of excluders may cause a similar negative reaction. Nevertheless, we believe that serious experimentation in the use of excluders and an analysis of their economic viability for users will be perceived as a worthwhile undertaking if the alternative is total closure.

Another issue is the disturbance to the sea floor caused by trawling. Local fishermen suggest that the way to deal with this problem is by decreasing the size of the net's mouth. Currently, nets are up to 110 feet wide. Reducing their aperture would lessen the nets' impact on the ecosystem, and would allow trawlers to catch shrimp without necessarily reducing shrimp catch. The benefits mentioned about this gear modification were the following: it would decrease the amount of by-catch, reduce the surface area dragged, and increase in efficiency at greater depths since the smaller the opening, the less resistant the net is to the water. The size recommended was between 85-90 feet.

The dumping of expended oil by trawlers into the sea has the potential of creating other ecological problems. Fishermen suggested that it should be mandatory that boats return with the same quantity of oil with which they departed, and have this recorded upon the boat's arrival to port.

Constant monitoring of the effectiveness of the modifications proposed over a trial period of, say, three years, would very likely lead to further modifications of equipment and other changes that would be more specific both to the type of trawlers used in upper Gulf and to the environmental conditions of the area.

Shark fishing

Offshore shark fishing, with converted shrimp trawlers, is affording some fishermen a means to diversify their production during the current decline in shrimp populations. Nets with a mesh size of 12" are currently being used by shark fishermen south of the biosphere reserve area. In the past, offshore shark fishermen only used cimbras. However, this technology was transferred entirely to the small scale sector because of numerous offshore accidents. Given their momentum when running, boats cannot be brought to a stop immediately. If a line or a hook becomes entangled, it can cause grave injuries such as cutting a fisherman's finger or hand off. Shark fishermen claim that the only way to avoid accidents caused by cimbras is to equip the boat with "cobradores de línea." This is a type of winch whose handle mechanically stops the cimbra lines and allows the reel in which the lines may become entangled to be more easily maneuvered. Pangas do not require the use of cobradores de línea since, when a line or a hook gets entangled on a fisherman's hand or finger, the panga can be quickly stopped.

In spite of the potential advantages of the cobrador de línea, offshore fishermen have been unable to purchase them because of their high costs. To adapt a cobrador de línea, a hydraulic engine is needed for the winch, at an approximate cost of US$3,200; a hydraulic pump is also needed (US$600), as is an aluminum *cobrador hidráulico* (US$1,500-1,700). Finally, a steel reel for the lines is also needed, at a cost of at least US$8,000. Fishermen interviewed stated that they would be willing to exchange their nets for cimbras if provided the necessary financial support. This not only would allow them to fish throughout the Gulf, including the buffer zone in the bioreserve, but also with a less detrimental effect to the ecosystem since cimbras are more selective than nets.

Inshore sector modifications

As already described, within the inshore sector there are a great variety of gill nets used to target different species. The use of such diverse equipment not only lessens the tendency to overexploit any one resource, but increases the chances for sustainable exploitation of a variety of species. In general, gill nets, cimbras and lines are highly selective and what little by-catch is obtained is either sold in the market or used for home consumption. Selectivity is further enhanced by the knowledge that fishermen have of the behavior and habitat preference of target species. Such knowledge is a requisite for successful fishing.

One proposal we want to discuss in this section is the prohibition of nets with a mesh size higher than 4" (Villa 1993), which, it is believed, capture vaquitas and totoabas. We have no direct evidence that nets with mesh sizes below 10"

capture these endangered species. Nets with 7" mesh are used for bigger fish such as corvina or large sierra , which have a high market value. By confining legal nets to the 4" limit what is likely to happen is that fishing pressure on smaller species will tend to increase. Again, having the necessary equipment to shift to different species as a target species becomes scarce or as market values decline is an important strategy for small scale fishermen. Limiting what kinds of nets fishermen may use not only restricts their flexibility, but would increase pressures on selected species.

On the other hand, we feel that it is important to reinforce the law put in place by the Fisheries Ministry that bans the use of nets with a mesh size larger than 10" for the protection of the totoaba. However, the following factors should be considered if there is a future revision of this law. Retired totoaba fishermen argue that nylon monofilament shark nets, whatever the mesh size, cannot catch totoaba since the totoaba will easily break the net. Instead, shark nets made out of silk or cotton, being stronger materials, do capture totoaba. Mesh size should be regulated for silk nets since 12" to 16" have been reported as used indiscriminately for shark and totoaba fishing. The large variety of shark nets (both in terms of thread material and mesh size) must be considered separately since their particular characteristics have vastly different implications for the catch of totoaba and the incidental catch of vaquita.[1]

Finally, we want to discuss a device that may prove useful in limiting the capture of marine mammals. Net 'pingers' are devices developed in response to the incidental capture of the harbor porpoise in the New England gill net ground fishery. They are acoustic transmitters or alarms, designed to warn the animals away from the nets. These devices are enclosed in a steel trawl float and clipped to the net's float line. In the U.S. they cost between $5 and $10 dollars (Crowley 1993b). Since researchers have found similarities in the behavior and life cycle between harbor porpoises and the vaquita (Anita Hohn, personnel communication), pingers could be employed and possibly reduce the incidental capture of

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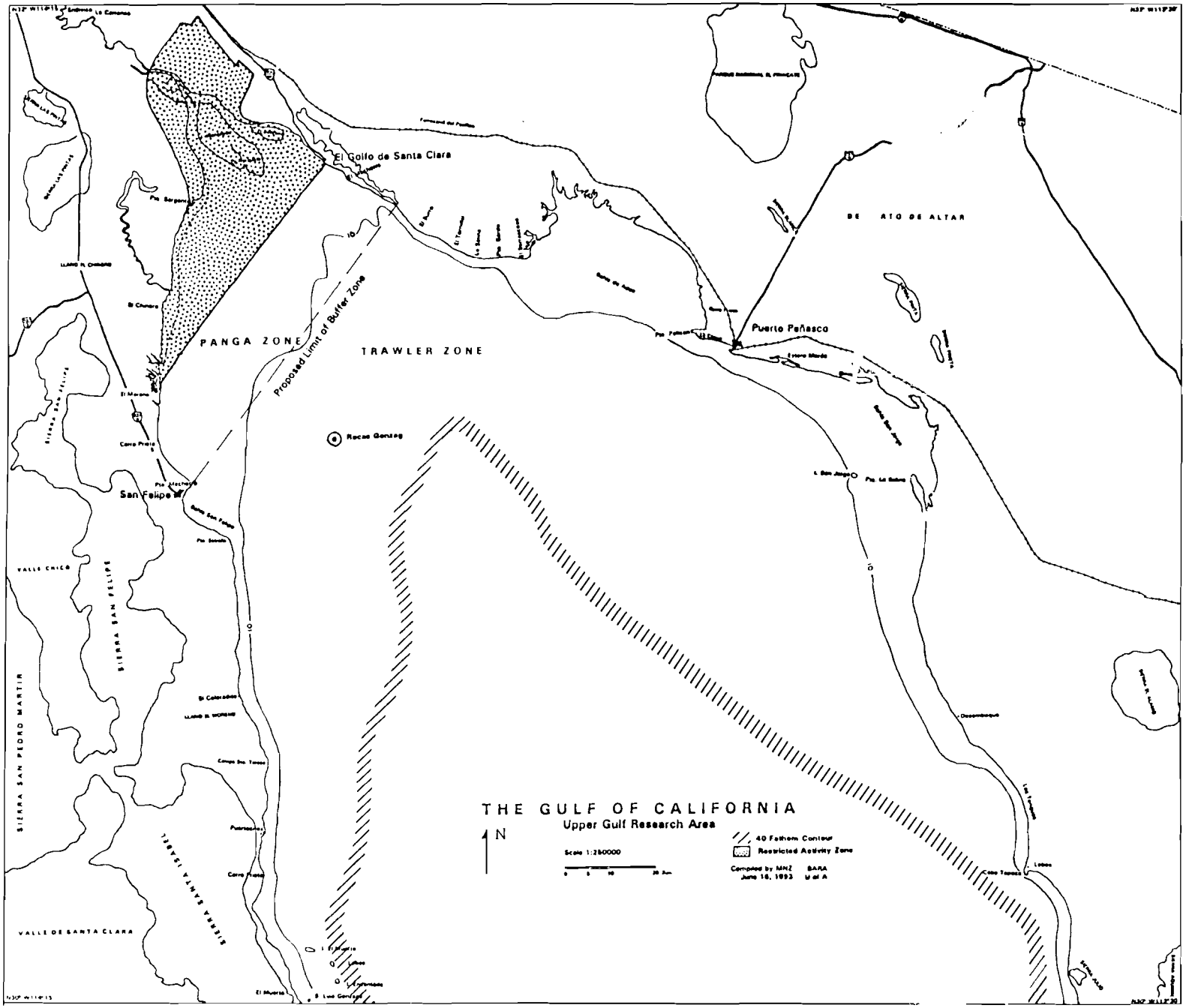
1. We should also note that the chinchorro de línea that has been banned in the Guaymas-Emplalme area for the supposed ecological damage it does. This net is used by small scale fishermen to catch shrimp. However, no scientific studies have been done to justify this prohibition. Rather, the variety of assumptions about this net are contradicted both by the accounts of actual users and our own observations. This net is highly selective and economically efficient that primarily captures shrimp of optimum market size. One of the arguments fishery managers make against this net is that it attracts too many users to the fishery.However, this is not a problem intrinsic to the net, but one of the enforcement of entry requirements in the fishery. Extension of the ban on this net (a ban which is not heavily enforced in Guaymas-Empalme) to the upper Gulf would have extremely harsh economic consequences.



Map 5. Proposed Zonation of the Upper Gulf of California

vaquita. An effort to test the use of this device would be a positive step. If it is successful, the vaquita may be protected at a minimum cost to fishermen.

Changes in the fisheries management regime

Gear modifications and changes in fishing strategies are by no means sufficient to ensure sustainable economic development of the upper Gulf. Equally important are changes related to the management of fishing areas, reserves, and commercial species as part of the ecosystem. Successful management will not only require the acceptance of regulations by the local communities, and the growth of respect for fisheries managers and officials, but depends equally upon local feelings that these resources belong to them, and that they have a greater voice and stake in how they will be used in the future.

Regulations related to fishing areas

While it appears that scientists and local fishermen agree that all fishing should be banned in the nuclear zone of the bioreserve, including sports fishing, there appears to be no clear plan yet on how the buffer zone should be managed. In this section we address the issue of whom should have access to the buffer zone within the bioreserve, why, and under what limitations.

A strict enforcement of the nuclear zone will undoubtedly create immediate economic losses for both offshore and small scale fishermen. The losses created for the offshore shrimp sector, however, will not be considered here since their use of the area has been illegitimate (the nuclear zone is less than five fathoms, waters from which trawlers are technically prohibited). Strict enforcement of the nuclear zone, nevertheless, may mean more benefits than losses for shrimp trawlers in long run. The small scale sector will have less of a chance to catch shrimp after it reaches maturity and begins to migrate into deeper waters. For the trawlers, this translates into reduced competition from the inshore sector and, thus, a greater share of the shrimp that migrate out from the nuclear zone. In contrast, the small scale sector probably will not see any benefits from enforcement of the nuclear zone. They will be forced to move to less productive areas, lowering their gains and raising their costs of production. For many, shrimping may turn unprofitable.

So as to avoid such an unequal distribution of benefits, we propose that a transitional zone be created, drawing a line parallel to the imaginary line demarcating the nuclear zone, a line going from San Felipe to the Sonoran coastline (see Map 5). The intent of this transitional zone is to both create an area where small scale fishermen may fish without direct competition from shrimp trawlers, and to protect this transitional zone with depths under 10 fathoms from trawling. In this way, both sectors will be able to share benefits from strict enforcement of

the nuclear zone in a more equitable manner.

Following the same argument, we recommend that exclusive concession of areas outside the nuclear zone shallower than 10 fathoms be given to the small scale users who are residents of the upper Gulf. We believe that this measure would lead to a more equitable share of long-term benefits, limit to a greater extent pressure on the ecosystem caused by trawlers and non-resident small scale users, and develop a sense of territoriality among small scale users. For instance, this is precisely what happened when an exclusive concession was given to the Yaqui tribe over the use of the Lobos Bay in southern Sonora (see McGuire 1983). A sense of control and territoriality developed, backed by federal authorities, that promoted cooperation between users and managers and led to more successful enforcement efforts.

In the case of the offshore shrimp sector, limiting the exclusive use of the buffer zone to resident fishermen would certainly be more difficult, so much so that it might not be a viable suggestion. We want to point out, then, the potential difficulties that must be taken into account when considering exclusion of outside fleets (such as the Guaymas and Yavaros fleets) from the buffer zone.

Anecdotal accounts reveal a marked difference between upper Gulf fishermen and fishermen from the south with regard to their mobility within the Gulf of California. Traditionally fishermen in the upper Gulf have tended to be less mobile. Their trips are shorter. They prefer to stay close to port. The are several reasons for this: resource abundance motivated fishermen to remain in the area through the season; more recently, the lack of diesel prevented them from moving long distances. On the other hand, resource scarcity during certain months of the season forced Guaymas fishermen to travel north into the upper Gulf in search of shrimp (see Chapter 6). However, when shrimp became scarce in the upper Gulf, we saw a reversal in the situation. More and more trawlers from the upper Gulf wanted to go as far down as Mazatlán. Following this argument, resident offshore fishermen claim that if entrance into the upper Gulf is denied to outside fleets, they in turn will experience difficulties when they try to move out of their own region. Any restrictions would affect them as much as they would affect outsiders; therefore, careful consideration has to be given to this issue.

Seasonal closures

Decisions, enforcement and research on seasonal closures in the upper Gulf have concentrated on one species, shrimp, but this has been done without local input. What we recommend here, then, is local input into the decision over when the season should open and close. That is, decisions should be decentralized and carried out according to local conditions, based on studies of gonadic maturation done in the area. This may mean that the shrimp season in the upper Gulf may close at a different time than in the rest of the Gulf and the Pacific. However, as

we have already mentioned in Chapter 5, a timely closure has crucial implications for the conservation of the resource.

In addition, the season for small scale fishermen should continue to open one month before the offshore season begins. Although this has been the traditional practice, we observed that during the 1992-93 season, the small scale sector had only a two-week advantage over the offshore sector.[1] Maintenance of this sequential opening practice helps small scale fishermen by reducing competition with the offshore sector, which can move to much greater distances and outside the bioreserve area in the search for shrimp.

Marketing adjustments

Market incentives also must be considered in the plan for a sustainable development of the reserve, since to a large extent such incentives determine how diversified fishing in the region is. A recent example of how fishermen respond to market incentives may be seen in the opening of the market for chano by Korean buyers in the area in 1992. Previously an unexploited but abundant stock, it suddenly became a viable alternative for fishermen. It also opened up employment opportunities on shore through the creation of freezing and processing facilities. However, the massive exploitation of this species in the past two years has not been monitored by biologists, and it is unknown how much fishing pressure it can withstand.

In the case of the by-catch coming from shrimp trawlers, fishermen report making a better use of it as shrimp became scarce. However, shrimp continues to be the most valuable species economically. This limits the incentives to find markets for other less valuable species. As already mentioned, this may lead to a possible overexploitation of a particular resource.

It is important to emphasize the implications that a reduction in effort from shrimp trawlers and a possible use of by-catch excluders may have on the market for fish. A reduction in by-catch would lead to a less wasteful use of the resources: fishermen could select and maintain better quality fish to be brought into the market, thus obtaining a higher price for the product. A reduction in by-catch brought by shrimp trawlers into the market also would reduce competition between offshore shrimp sector and fishermen, inshore and offshore, who specialize in the catching fin fish.

There are several small scale family industries in the area that are developing, such as the processing of dried ray or shark. With the proper economic

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1. Researchers for the Centro Regional de Investigación Pesquera in Guaymas are recommending a simultaneous opening of the 1993-1994 shrimp season for inshore and offshore sectors, on September 15 (see Rodríquez 1993).

incentives, these industries could expand and new ones could be started. However, part of the incentive to open new markets lies in the existence of a reliable infrastructure for transportation, freezing and processing. This, to a large extent, determines when and how the product can be sold. Without proper freezing and processing facilities, fishermen must sell the product immediately upon landing, at whatever price they can get. Without proper transportation and communication facilities, so few buyers will come to the area that little competition will exist on the demand side. With few buyers, fishermen have little power to negotiate better prices. And, without reasonable prices for a variety of species, fishermen have no other alternative but to concentrate their efforts on selected resources.

Management of the Colorado River

There is some scientific disagreement over the potential benefits accruing to the marine ecosystem from freshwater river flows. However, there is virtual unanimity among fishers in the upper Gulf that the floods of January, 1993, were responsible for luring substantial stocks of recently scarce species to the region (especially shark and corvina golfina), and may enhance blue shrimp stocks the next season to the point where the fleet may recover from its economic crisis. Indeed, the current crisis in the upper Gulf is attributed to the "closing" of the river in 1987-1988. In reality, the river through the delta began to dry when Hoover Dam filled in 1941, and virtually ceased flow with the filling of Glen Canyon Dam in the early 1980s. The "golden years" in the memory of contemporary fishermen in the upper Gulf appear to refer to the flood of 1983, when massive snowmelts caused the river to flow at a rate some 210 percent above normal and threatened to breach both Hoover and Glen Canyon dams (Stevens 1988; Carothers and Brown 1991). It took several years of water releases from the dam to return the river to its "normal" flow -- a flow that provides Mexico with only 1,500,000 acre feet of agricultural water, little of which enters the gulf.

While it is not our mandate to resolve the scientific debate over the effect of freshwater flows on the biota of the gulf, nor to rewrite international law, we nonetheless will make some cursory observations on how the issue of freshwater flow enhancement might be approached.

Evidence for benefits

Few direct efforts to correlate river discharge and productivity in the upper Gulf have been made. The most notable, Flanagan and Hendrickson's 1976 study of the totoaba fishery, could not unambiguously attribute the decline in totoaba stocks to decreased river flow (Flanagan and Hendrickson 1976). And Villa assesses the hypothesis that a drastic change has occurred in the ecosystem due to the lack of fresh water as follows:

> ...there is no information to substantiate this hypothesis. In fact, evidence suggests that the Río Colorado delta behaves as a very fertile coastal lagoon, supporting abundant populations of crustaceans and mollusks...and that substantial numbers of bottlenose dolphins utilize the delta.... There is no evidence to suggest that this apparent richness is different from naturally occurring conditions of the past (1993:9).

Studies elsewhere, however, find strong correlations between rainfall and shrimp stock sizes. Gunter and Edwards (1969) found a significant correlation (at the 0.1 percent level) between stocks of white shrimp (*Penaeus fluviatilis*, now *P. setiferus*) and rainfall for the two previous years over a period of 38 years. The correlations did not hold for brown shrimp, nor were they found in the adjacent Louisiana shrimp fishery, primarily due, apparently, to the much higher and consistent flows of the Mississippi River.

Zein-Eldin and Renaud, in a subsequent review of the literature on inshore environmental effects on shrimp along the Gulf of Mexico coast, observe that the interaction of water temperature and salinity may have more profound effects than either factor alone. They suggest, as an outline of a water management regime, that

> it would appear that water flow could be restricted during the early spring months, when cold fronts are still likely, to minimize the negative effects of the combination of cold and low salinity on young brown shrimp. Conversely, water inflow would be most necessary during the late spring and summer in the presence of young white shrimp needing salinities below 20 0/00 and perhaps less, during the warmer months (August-September) of the year. As temperatures decrease in the fall, control of water flow might again be important, since it appears that in postlarvae of both species, survival is better at higher salinities than at 5 0/00 or less as temperatures decrease to 18°C or less. Penaeids may require variable water flow into nursery areas depending on season, and perhaps on particular year, e.g., early or late entrances of postlarvae into a given system (1986:11).

In a similar vein, analyses mandated by the California State Water Resources Control Board have been undertaken to determine the fresh water flow requirements to revitalize the estuaries of San Francisco Bay. Williams summarizes the results of extensive research:

> in order to maintain phytoplankton abundance, brackish marshes and fish migration, independent but mutually supportive [i.e., similar seasonal requirements] standards can be established which would govern reservoir operations and diversions upstream...meeting these standards to protect the estuary...would require reductions in upstream diversions by about 40 per cent (1989:297).

While we are not claiming that these works apply directly to the Gulf of California, we are simply suggesting that, elsewhere, estuary management is being given serious attention.

Potential sources of freshwater

While it is a truism to say that the Colorado River is over appropriated, there are nonetheless signs that the appropriators are entering an era of creative water management. In Arizona, for example, an active water market has developed, through which water rights are being transferred from agricultural users to municipalities. And there is currently a financial crisis in the Central Arizona Project, the massive aqueduct that delivers the state's share of the Colorado River to cities, farms, and Indian reservations in central Arizona. Farmers quite simply, cannot afford the cost of CAP water -- currently some $50 US/acre-foot (Wilson 1992). Indian tribes, being awarded substantial quantities of water to fulfill historic Winters rights to water sufficient to irrigate all "practicably irrigable acres" of their reservations (see McGuire, Lord, and Wallace 1993), are now finding it unfeasible to construct new farms in the face of a depressed agricultural economy. In short, water has become a tradable commodity in the southwestern United States.

There is some sentiment within Arizona's official circles that CAP water could be leased out-of-state, although the position is understandably one of extreme caution (Volante 1993). And it is inconceivable that enough "surplus" water would ever become available to restore the river to its virgin flows into the Gulf. Nonetheless, it is an opportune time to explore possibilities of acquiring water for environmental enhancement. We strongly recommend serious study of these possibilities, studies which should attempt to project the quantity, quality, and timing of flows necessary to rehabilitate along the delta's lower channel. Such studies also should attempt to project expected economic benefits accruing to users of the Gulf and determine whether such benefits outweigh the costs of acquiring water.

The need for co-management

We conclude with a final recommendation, implicit in much of the foregoing discussion. We suggest that a system of "co-management" be established for the fisheries of the upper Gulf. Such a regime implies, simply, that fishermen take an active role in the design, implementation, and enforcement of fisheries regulations. It is a middle course between government regulation and local autonomy, a "meeting point between overall government concerns for efficient resource utilization and protection, and local concerns for equal opportunities, self-determination and self-control" (Jentoff 1989:44). The motivation behind such an arrangement is that it is likely to enhance the legitimacy of regulations

and thus promote compliance.

Svein Jentoff elaborates the rationale for such an approach:

> ...the legitimacy of a regulatory scheme is related to at least four general hypotheses: (1) Content of the regulation: the more that the regulations coincide with the way fishermen themselves define their problems, the greater will be their legitimacy. (2) Distributional effects: the more equitably are restrictions imposed, the more legitimate will the regulations be regarded. (3) Making of the regulations: the more fishermen are involved in the decision-making process, the more legitimate the regulatory process will be perceived. (4) Implementation of the regulations: the more directly involved fishermen are in installing and enforcing the regulations, the more the regulations will be accepted as legitimate (1989:139).

Several of the specific management recommendations presented in this chapter were drawn with the first two points in mind. Here we briefly address the latter two.

Local Involvement

None of the fishermen we interviewed during our fieldwork in the three communities of the upper Gulf had any knowledge of the regulations contained in the declaration of the biosphere reserve. At the same time, most of them readily acknowledge that fishing cannot continue as it has been practiced in the past. Thus, in our opinion, there is a propitious climate for true local input into the design of a restructured and safe fishery.

Two critical issues should be put on the table before the fishermen: the content of the regulations and the process of implementation. While we have suggested some management alternative to those contained in the biosphere decree, these sets of propositions, and any others, should be open for discussion and debate with local resource users. And local knowledge of the behavior of the resources should be carefully heeded. For example, the implication of the trawler fleet in the killing of vaquita, where no patrón or sailor we interviewed had ever encountered one, is not likely to lend legitimacy to a trawl-fleet ban.

Second, whatever regulations are adopted, they should be implemented only when there is sufficient enforcement capability in place to assure that the regulations are not arbitrarily or selectively imposed. And they should be carefully monitored and assessed after several years of implementation. The assessment process, which will entail accurately-reported catch records, will be facilitated if such regulations are perceived as non-arbitrary, equitable, legitimate, and necessary for the rehabilitation of the upper Gulf.

Enforcement

Regulations are violated out of economic necessity as well as a perceived lack of legitimacy. Local participation, as the co-management model suggests, may enhance the perception of legitimacy, yet economic needs may still compel violations. This is a likely scenario over the next several years for the biosphere nuclear zone. Fishermen do recognize the area as a critical habitat, but until marine resources rebound throughout the upper Gulf, pressures to exploit the zone will continue. Under such circumstances, as experience with other co-management schemes has shown, fishermen are not inclined to police themselves (see Jentoff 1989). Appropriate levels of government enforcement and fine schedules (see Milliman 1986; Sutinen and Henessey 1986) will have to be determined to keep the integrity of the nuclear zone intact.

It should be noted that the success of enforcement of an areal closure is largely a function of size. Tisdell and Broadus make this point for marine reserves:

> ...there is little point in having a large marine reserve if resources for, say, enforcement are thereby spread too thin. In some cases it is better to have a smaller reserve that can be managed effectively... (1989:45).

We anticipate that enforcement of the nuclear zone is feasible, particularly if economic conditions improve in the upper Gulf. And we also firmly believe, given the genuine local concern over the marine environment, that fishermen will abide by regulations they perceive as legitimate and equitable.

Conclusions

In this chapter, we have offered a number of suggestions aimed at introducing a measure of responsibility into the fisheries of the upper Gulf of California. That we undertook such a task, in the wake of the decree establishing the biosphere reserve, requires some explanation. The motivation for that undertaking stems, in brief, directly from the research results reported throughout this study.

The communities of the upper Gulf -- San Felipe, El Golfo de Santa Clara, and Puerto Peñasco -- were established as fishing camps, and fishing remains integral to their social and cultural survival. The current resource and economic crisis baldly attests to this. Households are struggling to survive; shipyards are closed; packing plants are operating well below capacity; restaurants and other commercial establishments are suffering. The most direct way to revive the economies of the upper Gulf is to revitalize the upper Gulf itself, and to manage the fishery in a sustainable fashion.

This is not to deny the pressing need for economic diversification in the

region. Any economic system focused on a single natural resource base is vulnerable and fragile. Yet our field research suggested to us quite clearly that the occupational alternatives proposed for the upper Gulf may not be adequate to compensate for the loss of the primary economic pursuit in the region, may not be environmentally benign, may not be attractive and available to displaced fishermen, and may, in fact, erode the cultural integrity of the region. Moreover, there is a rather apparent pattern of "over-selling" of these alternatives, a pattern common to the process of establishing bioreserves and parks throughout the world. As West and Brechin note,

> ...the local "hard sell" of tourism as a blanket solution to local people to compensate them for the loss of residence and traditional economic uses of reserves will only be counterproductive in the end, as local people become embittered and distrustful in the face of empty promises (1991:394).

This need not occur. West and Brechin's primary prescription for avoiding this result is genuine local participation in decision making, through which land and resource managers communicate with, not to, local communities. As they warn,

> We seem to be more concerned sometimes that participation rituals function to educate the local people and facilitate implementation of our plans, rather than to serve as a vehicle for true participation and power sharing in determining the basic policies of protected areas that will affect their lives (1991:395).

This admonition compels us to underscore one final point. The fishermen of the upper Gulf acknowledge the urgent need for change, they acknowledge the inherent rights of future generations to a sustainable ecosystem, and they have a number of valuable ideas on how to accomplish this. In short, they need to be heard.

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Appendix B: Listing of Field Informants/Consultants

Fishermen

1. San Felipe, Shrimp trawler captain
2. San Felipe, Shrimp trawler captain
3. San Felipe, Shrimp trawler captain
4. San Felipe, Shrimp trawler captain
5. San Felipe, Shrimp trawler captain
6. San Felipe, Shrimp trawler captain
7. San Felipe, Shrimp trawler captain
8. San Felipe, Shrimp trawler captain
9. San Felipe, Shrimp trawler captain
10. San Felipe, Shrimp trawler captain
11. San Felipe, Shrimp trawler captain, retired
12. San Felipe, Shrimp trawler captain & sport fishing cruise captain
13. San Felipe, Shrimp trawler captain and sometimes mechanic with coop
14. San Felipe, Shrimp trawler fisherman and captain of tourist boat
15. San Felipe, Shrimp trawler mechanic
16. San Felipe, Shrimp trawler mechanic
17. San Felipe, Crewman on shrimp trawler
18. San Felipe, Crewman on shrimp trawler
19. San Felipe, Cook on shrimp trawler
20. San Felipe, Armador de pangas
21. San Felipe, Panga owner and fisherman also shrimp trawler crewman
22. San Felipe, Panga owner and fisherman
23. San Felipe, Panga owner, son panga fisherman
24. San Felipe, Panga owner and fisherman, and owner of tourist camp
25. San Felipe, Panga fisherman and owner
26. San Felipe, Panga fisherman and owner
27. San Felipe, Panga fisherman (crew)
28. San Felipe, Panga fisherman (crew)
29. San Felipe, Panga fisherman (crew)
30. San Felipe, Panga fisherman (crew)

31. San Felipe, Panga fisherman (crew)
32. San Felipe, Panga fisherman (crew) and guide on sports fishing cuise ships
33. San Felipe, Panga owner and guide; panga fisherman and owner, and teacher
34. San Felipe, Panga owner and tourist guide
35. San Felipe, Panga owner and fisherman, and tourist guide
36. San Felipe, Tourist panga owner and guide
37. San Felipe, Panga ower and fisherman, guide on tourist ship
38. Santa Clara, Shrimp trawler captain
39. Santa Clara, Shrimp trawler captain
40. Santa Clara, Shrimp trawler captain
41. Santa Clara, Shrimp trawler captain
42. Santa Clara, Shrimp trawler captain
43. Santa Clara, Shrimp trawler captain, retired
44. Santa Clara, Shrimp trawler captain, retired
45. Santa Clara, Shrimp trawler captain, retired
46. Santa Clara, Shrimp trawler captain, retired
47. Santa Clara, Shrimp trawler mechanic
48. Santa Clara, Shrimp trawler cook
49. Santa Clara, Shrimp trawler cook
50. Santa Clara, Crewman on shrimp trawler (former captain-- ship sold)
51. Santa Clara, Crewman on shrimp trawler
52. Santa Clara, Crewman on shrimp trawler
53. Santa Clara, Crewman on shrimp trawler
54. Santa Clara, Crewman on shrimp trawler
55. Santa Clara, Crewman on shrimp trawler
56. Santa Clara, Crewman on shrimp trawler
57. Santa Clara, Panga owner and fisherman
58. Santa Clara, Panga owner and fisherman
59. Santa Clara, Panga owner and fisherman
60. Santa Clara, Panga owner and fisherman
61. Santa Clara, Panga ower and fisherman
62. Santa Clara, Panga owner and fisherman
63. Santa Clara, Panga owner and fisherman
64. Santa Clara, Panga owner and fisherman
65. Santa Clara, Panga owner and fisherman
66. Santa Clara, Panga owner and fisherman
67. Santa Clara, Panga owner and fisherman
68. Santa Clara, Panga owner and fisherman

69. Santa Clara, Panga owner and fisherman
70. Santa Clara, Panga owner, no longer fishes
71. Santa Clara, Panga fisherman (crew)
72. Santa Clara, Panga fisherman (crew)
73. Santa Clara, Panga fisherman (crew)
74. Santa Clara, Panga fisherman (crew)
75. Santa Clara, Panga fisherman (crew)
76. Santa Clara, Panga fisherman (crew)
77. Santa Clara, Panga fisherman (crew)
78. Santa Clara, Panga fisherwoman (crew)
79. Santa Clara, Panga, clam fisherwoman
80. Santa Clara, Panga, clam fisherwoman
81. Santa Clara, Boat watchman
82. Puerto Peñasco, Trawler owner (private sector)
83. Puerto Peñasco, Capitain of a Korean chano boat
84. Puerto Peñasco, Crewman on a Korean chano boat
85. Puerto Peñasco, Shrimp trawler captain (private sector)
86. Puerto Peñasco, Shrimp trawler captain (private sector)
87. Puerto Peñasco, Shrimp trawler captain (private sector)
88. Puerto Peñasco, Shrimp trawler captian (cooperative)
89. Puerto Peñasco, Shrimp trawler captian (cooperative)
90. Puerto Peñasco, Shrimp trawler captian (cooperative)
91. Puerto Peñasco, Shrimp trawler captian (cooperative)
92. Puerto Peñasco, Shrimp trawler captian (cooperative)
93. Puerto Peñasco, Shrimp trawler captian (cooperative)
94. Puerto Peñasco, Shrimp trawler captian (cooperative)
95. Puerto Peñasco, Shrimp trawler captian (private)
96. Puerto Peñasco, Shrimp trawler captian and owner
97. Puerto Peñasco, Shrimp trawler machinist (cooperative)
98. Puerto Peñasco, Shrimp trawler machinist (cooperative)
99. Puerto Peñasco, Shrimp trawler crewman (cooperative)
100. Puerto Peñasco, Shrimp trawler crewman (cooperative)
101. Puerto Peñasco, Shrimp trawler cook (cooperative)
102. Puerto Peñasco, Sports fishing guide, former shrimp trawler fisherman
103. Puerto Peñasco, Panga owner and fisherman
104. Puerto Peñasco, Panga owner and fisherman
105. Puerto Peñasco, Panga fisherman (crew)
106. Puerto Peñasco, Panga fisherman (crew)

107. Puerto Peñasco, Panga fisherman (crew)
108. Guaymas, Shrimp trawler captain (private sector)
109. Guaymas, Shrimp trawler machinist (private sector)
110. Guaymas, Shrimp trawler machinist (private sector)
111. Guaymas, Shrimp trawler cook (private sector)
112. Guaymas, Shrimp trawler cook (private sector)
113. Guaymas, Shrimp trawler crewman (private sector)
114. Guaymas, Shrimp trawler crewman (private sector)
115. Guaymas, Shrimp trawler crewman (private sector)
116. Guaymas, Shrimp trawler crewman (private sector)
117. Guaymas, Shrimp trawler crewman (private sector)
118. Guaymas, Shrimp trawler crewman (private sector)

Aquaculture

1. Santa Clara, Technician at shrimp farm
2. Santa Clara, Shrimp farm employee
3. Santa Clara, Shrimp farm employee
4. Santa Clara, Shrimp farm employee
5. Santa Clara, Shrimp farm employee
6. Puerto Peñasco, Oyster coopertive member
7. Puerto Peñasco, Oyster coopertive member
8. Puerto Peñasco, Oyster coopertive member
9. Puerto Peñasco, Oyster coopertive member
10. Puerto Peñasco, Oyster farm owner (private)
11. Puerto Peñasco, Shrimp farm manager
12. Puerto Peñasco, Shrimp farm manager
13. Puerto Peñasco, Clam cooperative manager
14. Puerto Peñasco, Clam cooperative member
15. Puerto Peñasco, Clam cooperative member
16. Puerto Peñasco, Clam cooperative member
17. Puerto Peñasco, Clam cooperative member
18. Puerto Peñasco, Clam cooperative member

Cooperatives

1. San Felipe, President of a trawler cooperative
2. San Felipe, President of a trawler cooperative
3. San Felipe, Trawler cooperative official

4. San Felipe, Presidente of a panga cooperative
5. San Felipe, Official of the Comision Federativa de Cooperativas
6. Santa Clara, President of a trawler cooperative
7. Santa Clara, Founder of a panga cooperative, retired panga fisherman
8. Puerto Peñasco, President of a trawler coopertive
9. Puerto Peñasco, President of local Comision Federativa de Cooperativas
10. Puerto Peñasco, Treasurer of local Comision Federativa de Cooperativas
11. Puerto Peñasco, Official of the Comision Federativa de Cooperativas as well as an Official of a panga coopertive
12. Puerto Peñasco, Official of the local Comision Federativa de Cooperativas
13. Puerto Peñasco, Official of the local Comision Federativa de Cooperativas
14. Puerto Peñasco, President of a panga cooperative
15. Puerto Peñasco, President of a shark fishing cooperative
16. Puerto Peñasco, Secretary of a shark fishing cooperative
17. Puerto Peñasco, Member of a cooperative working with the Koreans.
18. Puerto Peñasco, President of a panga cooperative
19. Puerto Peñasco, President of a sports fishing cooperative
20. Puerto Peñasco, President of a shrimp trawler cooperative, machinist of shrimp trawler
21. Puerto Peñasco, Secretary of a shrimp trawler cooperative, captain of shrimp trawler

Businesses Dependant on Commercial Fishing

1. San Felipe, Welding shop
2. San Felipe, Welding shop
3. San Felipe , Armador of shrimp trawlers & tourist ships, with hardware, marine supplies, building material business
4. San Felipe, Sea food processing plant (private)
5. Santa Clara, Marine supply salesmen (from Ensenada)
6. Santa Clara, Fish buyer and wholesaler
7. Santa Clara, Woman clam seller traveling to nearby communities
8. Puerto Peñasco, Fish buyer and wholesaler (large)
9. Puerto Peñasco, Fish buyer and wholesaler
10. Puerto Peñasco, Fish buyer and wholesaler
11. Puerto Peñasco, Manager of a Korean company specializing in Chano
12. Puerto Peñasco, Ocean Garden Representative (state owned company exporting sea food)
13. Puerto Peñasco, Sea food processing plant (private)
14. Puerto Peñasco, Sea food processing plant (private)
15. Puerto Peñasco, Aramador shark fishing boats
16. Puerto Peñasco, Chinchorro maker

17. Puerto Peñasco, Ship yard
18. Puerto Peñasco, Refrigeration plant

Businesses Oriented Toward Tourism

1. San Felipe, Sports fishing cruises
2. San Felipe , Sports fishing panga charter business
3. San Felipe, Sport fishing cruises
4. San Felipe, Fish retail store
5. San Felipe, Fish retail store
6. Sant Felipe, Pizza restaurant
7. San Felipe, Restaurant
8. San Felipe, Trailer park
9. San Felipe, Trailer park
10. Santa Clara, Hotel
11. Santa Clara, Cantina
12. Santa Clara, Restaurant y Miscelanea
13. Santa Clara, Trailer park
14. Santa Clara, Restaurant.
15. Santa Clara, Restaurant-bar
16. Santa Clara, Sea food retailer
17. Santa Clara , Restaurant
18. Santa Clara , Restaurant
19. Santa Clara, Restaurant
20. Santa Clara, Craftsman making and selling currios
21. Puerto Peñasco, Beach Club
22. Puerto Peñasco, Sports fishing panga charter business
23. Puerto Peñasco, Sports fishing panga charter business
24. Puerto Peñasco, Sports fishing operation run by North American
25. Puerto Peñasco, North American manger of real estate company that owns Sandy Beach and Cholla Bay
26. Puerto Peñasco, Currio shop owner and craftman
27. Puerto Peñasco, Currio shop
28. Guaymas, Operator of a big sports fishing boat out of La Paz

Other Businesses

1. San Felipe, Bank director.
2. San Felipe, Clothing store

3. San Felipe, Pharmacy
4. San Felipe, Bakery
5. San Felipe, Grocery store
6. San Felipe, Fruit stand
7. Santa Clara, Grocery store
8. Santa Clara, General store
9. Santa Clara, Auto Parts Store
10. Santa Clara, Supermarket
11. Santa Clara, Supermarket
12. Santa Clara, Grocery store
13. Santa Clara, Grocery store
14. Santa Clara, Ices
15. Santa Clara, General store
16. Santa Clara, Candy stand
17. Santa Clara, Candy stand
18. Santa Clara, Candy stand
19. Santa Clara, Soda stand
20. Santa Clara, Pharmacy
21. Puerto Peñasco, Bank official

People Working in Other Jobs

1. Santa Clara, Truck driver
2. Santa Clara, Car mechanic
3. Santa Clara, Restaurant cook
4. Santa Clara, Carpenter
5. Santa Clara, Hotel maid
6. Puerto Peñasco, Hotel maid
7. Puerto Peñasco, waitress
8. Puerto Peñasco, truck driver working for sea food company

Government Officials

1. San Felipe, Pesca offfical
2. San Felipe, Land registration and building permits official
3. San Felipe, Registars office official
4. San Felipe, Urban planner
5. San Felipe, Tourist bureau official
6. Santa Clara, Pesca official

7. Santa Clara, Pesca official
8. Santa Clara, Capitania del Puerto official
9. Santa Clara, Capitania del Puerto official
10. Santa Clara, Delegacin del Golfo de Santa Clara official
11. Santa Clara, Delegacin del Golfo de Santa Clara official
12. Puerto Peñasco, State tourism office official
13. Puerto Peñasco, Pescal official
14. Puerto Peñasco, State senator

Research Professionals Working in Mexico

1. Santa Clara, Instituto Nacional de la Pesca, Centro Regional de Investigaciones Pesqueras, CRIP (Ensenada) oceanographer
2. Santa Clara, CRIP (Guaymas) biologist
3. Puerto Peñasco, Researcher with CEDO
4. Puerto Peñasco, Researcher with COBACH
5. Guaymas, Instituto Nacional de la Pesca, Regional CRIP head
6. Guaymas, CRIP researcher
7. Guaymas, CRIP researcher
8. Guaymas, CRIP researcher
9. Guaymas, CRIP researcher
10. Guaymas, CRIP researcher
11. Guaymas, CRIP researcher
12. Guaymas, UNAM biologist
13. Guaymas, UNAM biologist studying sports fishing operations in San Felipe
14. University of Arizona, Enviromental Research Lab researcher, studying the Cienga de Santa Clara
15. University of Arizona, shrimp virus expert

Other Interviews

1. San Felipe, Teacher, Escuela Tecnica Pesquera
2. San Felipe, Teacher, Escuela Tecnica Pesquera
3. San Felipe, Teacher, Escuela Tecnica Pesquera
4. San Felipe, Tecnico pesquero at the Escuela Tecnica Pesquera
5. San Felipe, Long-time america resident
6. Santa Clara, Teacher, Elementary School
7. Santa Clara, Teacher
8. Santa Clara, Kindergarden teacher

9. Santa Clara, Elementary school principal.
10. Santa Clara, Secondary school principal
11. Santa Clara, Woman resident of 20 years.
12. Santa Clara, Wife of shrimp boat cook, native of the community
13. Santa Clara, Catholic priest
14. Puerto Peñasco, Founding member of Puerto Peñasco
15. Puerto Peñasco, Founding member of Puerto Peñasco
16. Puerto Peñasco, Long time American resident
17. Puerto Peñasco, Long time American resident
18. Puerto Peñasco, Fisherman and local historian
19. Puerto Peñasco, Film crew from Mexico Desconocido doing a story on vaquita

APPENDIX C: BUDGETS FOR SHRIMP CULTIVATION FACILITIES

Table 1
Investment Expenses: Extensive Shrimp Cultivation Facilities
(U.S. dollars)

Investment costs	50 hectares	100 hectares	200 hectares
Constructing border	21,806	39,333	55,627
Clearing land	5,556	11,111	22,222
Building canal	4,167	8,333	16,667
Flood gates	2,014	4,028	8,056
Pump and motor	13,333	26,666	53,333
Transport	3,333	3,333	6,666
Fiberglass tank	889	889	1,778
Boats	1,667	1,667	3,333
Structures	5,556	11,111	22,222
Miscellaneous	5,110	7,992	13,838
Subtotal	69,431	114,463	203,742
Land Investment	27,778	55,556	111,111
Without land	69,431	114,463	203,742
With land	97,209	170,019	314,853

Source: Miller (1990)

Table 2
Operating Costs: Extensive Shrimp Cultivation Facilities
(U.S. dollars)

Operating costs	50 hectares	100 hectares	200 hectares
Inputs			
Fertilizer	212	317	633
Diesel	4,000	8,000	16,000
Gas	867	1,134	1,733
Pump maintenance	556	1,111	2,222
Truck maintenance	556	556	1,111
Nets	222	444	889
Ice	212	424	848
Border maintenance	4,171	5,900	8,344
Subtotal	10,796	18,486	31,780
Labor			
Guard duty	2,500	3,333	6,667
Larvae collection	278	556	1,042
General maintenance	2,500	3,333	6,667
Technicians	6,667	13,333	26,667
Shift manager	1,067	2,133	4,267
Business director	3,333	6,667	13,333
Subtotal	16,345	29,355	58,643
Larvae cost			
Processing	3,750	7,500	15,000
Packing ($.33/kg.)	2,228	4,455	8,910
Distributor (7.5%)	3,898	7,796	15,593
Export duty (1%)	520	1,040	2,079
Taxes (2.3%)	1,195	2,391	4,782
Subtotal	7,841	15,682	31,363
Total costs			
Without larvae	34,982	63,523	121,786
With larvae	38,132	71,023	136,786
Shrimp yield (kg./ha)	135	135	135
Shrimp price ($/kg.)	7.70	7.70	7.70
Total net revenue excluding larvae	16,993	40,427	86,114
Including larvae	13,243	32,927	71,114

Source: Miller (1990)

Table 3
Expenses: Semi-intensive Shrimp Cultivation Facilities
(U.S. dollars)

Investment costs	50 hectares	100 hectares	200 hectares
Constructing border	47,475	88,550	152,958
Clearing land	16,667	33,333	66,667
Building canal	40,000	53,333	113,333
Flood gates	10,000	16,667	44,444
Pump and motor	13,333	26,666	53,333
Transport	3,333	6,667	16,667
Fiberglass tank	1,778	3,556	7,112
Boats	2,667	3,333	6,667
Structures	50,000	83,333	122,222
Pond	14,518	27,708	53,167
Miscellaneous	3,333	5,556	11,111
Subtotal	230,882	404,208	758,792
Land Investment	27,778	55,556	111,111
Without land	230,882	404,208	758,792
With land	258,660	459,764	869,903

Source: Miller (1990)

Table 4
Operating Costs: Semi-intensive Shrimp Cultivation Facilities
(U.S. dollars)

Operating costs	50 hectares	100 hectares	200 hectares
Inputs			
Fertilizer	212	317	633
Diesel	4,044	8,089	16,178
Gas	867	1,734	2,778
Pump maintenance	2,222	4,444	8,889
Truck maintenance	556	1,111	2,778
Nets	222	444	889
Ice	667	1,333	2,667
Food	8,367	16,734	33,469
Border maintenance	7,121	13,275	22,944
Subtotal	24,278	47,481	91,225
Labor			
Guard duty	2,500	3,333	6,667
Larvae collection	500	1000	2000

Operating costs	50 hectares	100 hectares	200 hectares
General maintenance	2,500	3,333	6,667
Technicians	6,667	13,333	26,667
Shift manager	1,067	2,133	4,267
Water control	9,167	14,167	21,667
Nursery	7,500	8,333	15,850
Business director	3,333	6,667	13,333
Subtotal	36,568	55,632	97,118
Larvae cost			
Processing	25,000	50,000	100,000
Packing ($.33/kg.)	6,600	13,200	26,400
Distributor (7.5%)	11,500	23,100	46,200
Export duty (1%)	1,540	3,080	6,160
Taxes (2.3%)	3,542	7,084	14,168
Subtotal	23,232	46,464	92,928
Total costs			
Without larvae	84,078	149,577	281,271
With larvae	109,078	199,577	381,271
Shrimp yield (kg./ha)	400	400	400
Shrimp price ($/kg.)	7.70	7.70	7.70
Total net revenue excluding larvae	69,992	158,423	334,729
Including larvae	44,922	108,423	234,729

Source: Miller (1990)