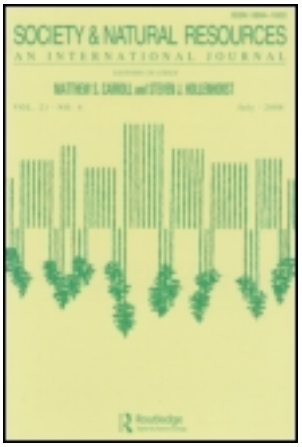


Society & Natural Resources: An International Journal

Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/usnr20

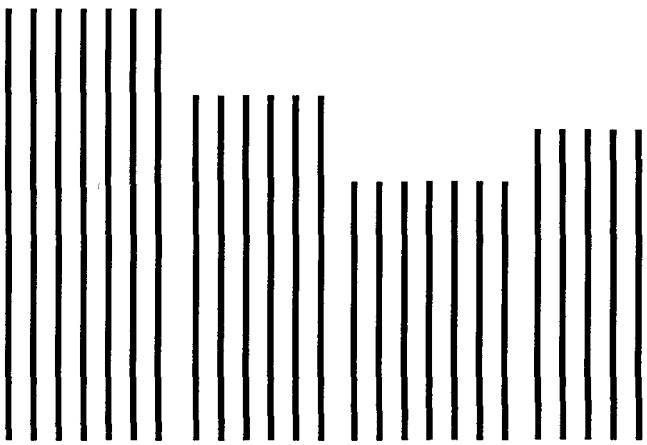
Explaining persistent conflict among resource users: The case of Honduran mariculture

Denise L. Stanley [a]

[a] Department of Economics, Stokley Management Center, University of Tennessee, Knoxville, Tennessee, 37996, USA E-mail:
Published online: 21 Nov 2008.

To cite this article: Denise L. Stanley (1998) Explaining persistent conflict among resource users: The case of Honduran mariculture, Society & Natural Resources: An International Journal, 11:3, 267-278, DOI: 10.1080/08941929809381079

To link to this article: http://dx.doi.org/10.1080/08941929809381079



INSIGHTS & APPLICATIONS

Insights and Applications

An Insights and Applications article should be a tightly written descriptive case study of a human-environmental issue. The case study could follow a natural history approach. It should include a concise, brief description of methods employed, and should attempt to illustrate a specific relationship or set of relationships about human behavior and the environment. Insights and Applications articles could describe a particular problem and draw attention to the implications of the work for the larger field of study of natural resources and social science. In either case, the piece should provide a contextual framework—what is the issue that drives the research question? It doesn't test theory or propose new theory, but instead uses theory as a guide to the analysis. Total length, including tables, figures, references, and notes, should not exceed 15 double-spaced, typed pages.

Explaining Persistent Conflict Among Resource Users: The Case of Honduran Mariculture

DENISE L. STANLEY

Department of Economics
University of Tennessee
Knoxville, Tennessee, USA

Numerous examples of environmental degradation and conflict among resource users have arisen in areas impacted by mariculture. In particular, instances of mangrove deforestation, destruction of the bycatch fishery, and estuary water pollution are growing concerns. This article presents an in-depth case study of Honduran mariculture to explain the persistence of these conflicts among resource users. Different explanations for the persistence of externalities—based on the resource type, information problems, resource tenure, and the role of the state—are integrated in an analysis of three environmental conflicts. The article concludes that the link between tenure and environmental degradation is incomplete, and establishing an indirect relationship between users' actions and environmental quality is an important first task.

Keywords estuary, externalities, larva, mangroves, mariculture, property rights, resource type, wetlands

The expansion of shrimp farming in southern Honduras has created one of today's most contentious natural resource debates in Latin America. On one side, powerful shrimp farming interests organized around the National Association of Aquaculturalists of Honduras (ANDAH) point to the employment and foreign exchange benefits of the industry. An estimated 12,000 jobs have been created in the southern region, and mariculture exports earn nearly $80 million in foreign exchange annually as Honduras' third largest source of export revenue (*El Heraldo* 1994).

On the other side, artisanal fishermen and environmentalists grouped in the Committee for the Defense of the Flora and Fauna of the Gulf of Fonseca (CODDEFFAGOLF) highlight the social and ecological damage of the shrimp industry. The fishermen primarily capture finfish, shellfish, and grown shrimp for local markets, and members of their families also gather crabs, mollusks, animals, wood, honey, and other items from the wetlands. Groups representing the fishermen argue that the shrimp farmers have restricted access to communal gathering areas and deforested mangroves, thus reducing the habitat for fish stocks. It also has been suggested that larva gatherers, who supply the shrimp ponds, discard a large amount of bycatch of other fish species. In addition, shrimp farms may be carelessly discharging pond waste, polluting the estuaries, and damaging fish populations.

Received 5 June 1995; accepted 14 November 1996.

The author acknowledges the support of financial assistance from the John D. and Catherine T. MacArthur Foundation, the Inter-American Foundation, and the Organization of American States. The helpful comments of anonymous reviewers, Conner Bailey, James C. Scott, Gerry Shively, Douglas Southgate, and members of the MacArthur Scholars Dissertator's Workshop and the Taylor-Hibbard Club Seminar Series are appreciated. All opinions, omissions, and errors remain the responsibility of the author.

Address correspondence to Denise L. Stanley, Department of Economics, Stokley Management Center, University of Tennessee, Knoxville, TN 37996, USA. E-mail: dstanle1@utk.edu

Society and Natural Resources, 11:267–278, 1998

0894-1920/98 $12.00 + .00

In summary, severe "externality" problems are occurring between mariculturalists and those who collect aquatic organisms from the wild.[1] Community discontent in Honduras has risen, and protest marches and quiet sabotage of shrimp farming activities (i.e., poaching) are common. These problems have accompanied shrimp farming expansion throughout the world (Bailey 1988).

This article applies externality theory to analyze why the conflicts among users of wetland resources in southern Honduras have been so strident. The research draws on observations from a 15-month period of fieldwork involving interviews with shrimp farm managers, fishermen, seed gatherers, environmental activists, and government staff, as well as a review of secondary data sources. The article is organized as follows. The section, Natural Resources and Externality Theory, reviews the frequently cited causes of resource "externalities" in the social science literature. The section, A Case Study of Environmental Degradation in Honduran Mariculture, contains a study of problems among the stakeholders of the land, larva, and water resources in the mariculture zone of Honduras. The section, Conclusion: Attacking the Roots of Conflict, draws together common trends in the externalities to provide insights into the most critical areas of applied social science research and policy to enhance wetland management.

Natural Resources and Externality Theory

Several components of externality theory suggest why conflicts such as those among resource users in Honduras are occurring.

Characteristics of the Resource

Intrinsic aspects of each natural resource affect its susceptibility to externalities. First, use of joint resources reduces (subtracts) their availability to others. Second, the ease of excluding outsiders from resource use and regulating use patterns varies across different technological and spatial regimes. Most "fugitive" ocean and estuary resources move across sites, and their capture is hard to monitor. These two intrinsic factors of a resource—subtractability and excludability—combine to create four types of natural resource "goods": private, toll, collective, and common pool goods (Salazar and Leonard 1994). Resources that are intrinsically common pool—having the properties of subtractability and nonexcludability—are considered the most "externality-prone" as one person's use reduces another's, while it is nearly impossible to exclude users or extract a price for use. Private goods are easy to exclude and should provide manageable solutions to externalities.

Information and Resource Valuation

Insufficient and inequitably distributed information prevents agreement among resource users. Scientists, businessmen, bureaucrats, and villagers possess different concepts and sources of data, with little sharing of information between them. Efforts to resolve the parties' differences are hampered as long as the damage done by the users' actions cannot be clearly assessed. In addition, users who are well informed about the market value of a developed resource, yet unaware of how a resource contributes to an ecosystem, may be motivated to quickly convert the resource. Those users who understand a resource's full (financial, cultural, and ecological) worth in its present state are more likely to preserve it in situ (Dixon and Sherman 1990).

Property Rights Access and Use Rules Related to Externalities

Unsuitable property rights have emerged as the raison par excellence for externalities and social conflict.[2] Important components of the property rights bundle include not only the type of tenure regime (state, private, common property, or nonproperty) and the license for economic gain, but also the duties and charges expected of users, the extent by which users can access and transfer the resource, and acceptable management methods. Several components of this rights "bundle" are particularly important. First, some have claimed that, since private property tenures are well defined, they should be sustainably managed and less "externality-prone" (Hardin 1968). Other literatures have shown the social and ecological superiority of common property management which embodies a clear set of rules over resource access and use (Bromley 1989). Many natural resources (such as forests and wetlands) are held as public property but, when the state cannot manage the resources, they revert to open access in which there is no well-defined group of users. Second, selective enforcement of property environmental regulations creates confusing expectations about the penalties for harmful resource use. Finally, the allocation and enforcement method of the property rights also can affect user behavior. A person who acquires land rights through patronage receives unclear signals about the resource management needs. If resource use is not granted dependent on management ability, careful stewardship may appear unnecessary.

A Case Study of Environmental Degradation in Honduran Mariculture

A case study of the southern Honduran mariculture industry offers an excellent opportunity to examine resource use conflicts and how these theoretical concepts come into play. Southern Honduras is a 6,840 km region covering the Gulf of Fonseca and a lowland plain of mangrove swamps, small towns, and pasture area. The provinces of Valle and Choluteca are the most densely settled regions of the country with 5% of the territory and 11% of the population (CRIES 1984). The region is home to at least 2,875 full-time fishermen and several thousand gatherers (Morales and Nieto 1990). Many of these people lack land for agricultural activities. Migration remittances and wage work are the only options to gathering. For instance, in a coastal village where no shrimp farming has occurred (Valle Nuevo), households sampled in 1993 earned on average 30% of their $258 per capita yearly income from fishing, 1.7% from agriculture, 12.4% from wage labor, 13.9% from gathering shellfish, and 42% from remittances (Stanley 1996).

The change in property rights to public wetland resources by concessions has been one of the most important factors conditioning the shrimp industry's growth and interaction with the coastal villages of southern Honduras. Gatherers of fish and mangrove products have had claims to extract resources from the state-owned land, yet recently the state has chosen to ignore these claims as the short-run rents from the wetlands are higher by converting the area to export cropping. Under Decree 968 of 1980 and Agreement 229 of 1991, the Ministry of Tourism (SECTUR) and the General Directorate of Fishing (DIGPESCA) were mandated to transfer coastal land use rights to exporters at the rental rate of about $5 per ha per yr. The concession areas were leased out on a first-come basis for 20 years with possible renewal. Originally, the concession acquisition process involved 47 steps across five agencies, taking an estimated 14 months and costing 7,000 lempiras ($2,500 in 1990) (Guevarra 1991). Given the administrative difficulties in acquiring concessions, it is not surprising that those with political connections received concessions.[3]

As a result, over 31,000 ha of wetlands have been conceded to private users, and 80 farms operated 6,400 ha in 1993 (Stanley 1994). The fencing off of some Honduran "winter lagoon"[4] areas has been harmful to artisanal fishermen and gatherers. Under the new tenure regime, fishermen and gatherers must travel to more distant zones to work, thus raising their costs of operation; women and children involved in gathering have been especially hurt as their options simply have been closed off.

In addition to the enclosure process, the mariculture industry has affected the local economy by increasing demand for three scarce factors of production—cleared land, shrimp larva, and estuary water. As seen in Figure 1, a shrimp farm enterprise creates interaction with the natural environment and other resource users. Shrimp farms may be constructed in mangrove or salt flats areas[5] with unclear boundary lines. Vegetation must be cleared to build access roads, pumping canals, and even grow-out ponds. Then, mariculture associated larva gatherers who supply shrimp seed use the same estuaries as artisanal fishermen. These gatherers may capture and waste a large amount of bycatch of other fish species. Finally, at the end of the cycle, shrimp farms dump wastewater into the common estuary that others pump in to start again.

It is also worth noting in Figure 1 that agriculturalists, processing industries, and upstream city dwellers interact with the health of the wetland ecosystem. In the Honduran case, wastes from nearby melon farms and city sewage have reduced the levels of dissolvable oxygen in the water (COHECO 1994). And half of the region's mangrove degradation is attributable to salt, tanning, fuelwood, and other industries in the gulf (Vergne, Hardin, and Dewalt 1993).

Deforestation Associated with Mangrove Clearing

Clearing of mangroves and other vegetation for pond construction has produced the liveliest debate over mariculture expansion. As the salt and tanning industries have nearly come to a standstill in recent years, the mariculture industry probably remains the largest threat to the mangroves. Initial estimates now suggest that 2,100 ha of mangroves have been destroyed in southern Honduras by shrimp farms (Vergne, Hardin, and Dewalt 1993), while other estimates place the figure at 4,300 ha (Ramirez 1994). These numbers have been hotly contested by shrimp farm industry spokesmen, who argue that "smart" farmers would never enter a mangrove swamp zone since the overly high salinity levels and soil structure there imply lower yields (Torres Díaz 1991). Mangrove destruction causes external diseconomies by reducing the supply of fish species and forest products to gatherers and fishermen. Numerous studies have demonstrated a direct relationship between mangrove forest cover and fisheries stocks and crustacean species, as the abundance of larvae is linked to estuarine salinity which depends on the mangrove cover and wetland development level (Swallow 1994).

Several factors from externality theory can explain why some mariculture operators have deforested mangroves. Characteristics of this forest resource should not be an important factor in their degradation. The spatial wetland area is subtractable when used, and its exclusion is not costly. This type of private good should be less externality-prone. But, wetland forests also have common pool aspects. Excluding users from the off-site environmental benefits of the mangroves is difficult, and the subtractability of these attributes by direct and indirect users remains unclear. The dual nature of the mangroves' attributes makes their management difficult.

Property rights problems offer another compelling explanation. At first glance, it appears that Honduran wetlands are characterized by well-defined property rights. Although

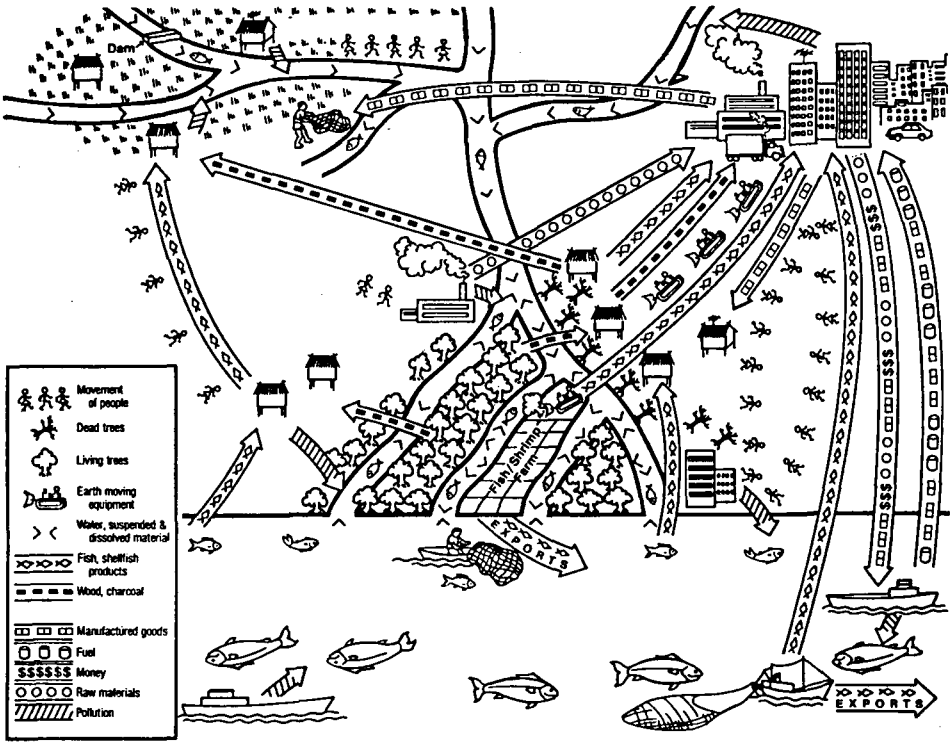


Figure 1. Interaction of different estuary users with land, larva, and water resources in the coastal ecosystem (reproduced from Kunstadter, Bird, and Sabhasri 1986).

the state has legally transferred only coastal zone use rights to investors, nearly all shrimp farms have fences, "no trespassing" signs, and watchmen on the perimeters. Yet, while access rules may be clear, other aspects of the property rights bundle remain problematic.

Duties associated with the property rights bundle have become almost nonexistent as the state's policing of wetland use and enforcement of penalties have been sporadic. Under Decree 85 of the current forest code in Honduras, mangrove woodcutting is illegal and subject to a sanction of approximately $400 per ha. By April 1989, over 900,000 lempiras ($450,000) in fines were registered for mangrove deforestation at the (Honduran Corporation for Forest Development (COHDEFOR) office in Choluteca, yet few have been collected (COHDEFOR 1989).

The allocation of leaseholds by administrative rationing and the low rental rate of leaseholds are other stimulants to poor land use by shrimp farmers. The fact that the land is being given as a "concession" implies that it is plentiful and nearly worthless. The current leasehold price of $5/ha/yr is far below the rent earned by mariculture operators, the value of alternative uses of the land, and the reported black market values for leasehold swapping among concessionaires (Stanley 1994). The traditional uses of wetlands have been found to generate high economic value.[6] Paying a rental fee below the "true" value of the resource may cause profit-maximizing investors to think that the land indeed is worthless and undertake a rapid rate of conversion area into ponds (Barbier 1994).

A third related explanation for the externality problem may be found in the common discourse about mangroves. Wetlands, salt flats, and mangroves are commonly described

as "marginal, unproductive areas" in much of the export promotion policy literature (Kunstadter, Bird, and Sabhasri 1986; Torres Díaz 1991). This discourse overlooks the values of mangroves to gatherers and the functions of wetlands in the overall coastal ecosystem.[7] Divergent perceptions of value are apparent in recent debates. Fishermen affiliated with CODDEFFAGOLF have argued that a nearly extinct species of crab extracted for subsistence (ponche) is threatened by shrimp farming as mangroves are cut (*Tiempo* 1992). Yet, industry technicians have replied that this animal's economic value is negligible and that the tidal flush zone is not an "ecological niche" for bivalves or crustaceans (Torres Díaz 1991). These divergent perceptions of whether environmental degradation is even occurring have prevented serious monitoring and protection of the mangrove resources.

Degradation Associated with Larva Gathering

Shrimp farm managers acquire larva to stock the ponds from natural seed gatherers or from hatcheries selling laboratory produced seed. Some 1,500 larva gatherers work throughout the Gulf of Fonseca using a variety of techniques and contractual arrangements (Stanley 1996). Larva gathering involves pushing a dense 1/16 in hoop net along the estuary edge during low tide; small shrimp larvae are collected in the net and passed by hand into collection buckets. Farm managers can reduce their operating costs by over 50% if they buy natural seed with a high amount of the preferred *Penaeus Vannamei* species. Wild seed also demonstrates higher survival rates than the imported laboratory seed.

However, the gathering work is a second side effect of the shrimp industry which has fomented social conflict among two groups of poor coastal dwellers: the larva gatherers and the artisanal fishermen. Artisanal fishermen perceive that their catches have fallen since the arrival of the larva collectors who destroy the bycatch (Vergne, Hardin, and Dewalt 1993). For every shrimp larva caught, five fry of other species are caught in the net and destroyed, according to Foer (1992). Other researchers have found that for every shrimp larva caught, three other organisms are captured which are not used by the shrimp industry (COHECO 1994). Mariculture industry proponents disagree over whether the natural mortality rate of the bycatch fish is greater than the effect of human predation and whether this bycatch represents economically valuable species (Scura 1988). However, a recent consultancy doing estuary water sampling found that 24% of the catch was wasted and half of the bycatch included commercially harvested species (COHECO 1994).

The persistence of natural larva gathering with uncounted environmental costs is due to a variety of reasons. First, shrimp larva gathering is an unusual activity in which human effort causes more harm to the fry bycatch than to the shrimp themselves. The biologically maximum sustainable yield for most shrimp species occurs beyond the economically feasible levels of extraction.[8] Habitat-related factors affect the sustainability of the stock more than human effort, so overfishing is less likely (Smith and Panayatou 1984).[9]

In other words, shrimp larvae are a collective good. Unlike livestock, larva cannot be branded or easily privatized.[10] Larvae have low subtractability, and the costs of excluding others from their use are high. The problem arises with the gathering equipment that harms the fish bycatch. These bycatch species are common pool goods and highly subtractable. The larva gatherers hurt fishermen of other species more than they hurt themselves, and dichotomous intrinsic characteristics of the resource create external diseconomies.

Second, the problem of insufficiently shared information again has provoked debates among the fishermen and the shrimp industry. The dispersed, mobile nature of the fishery resource has made it difficult to pinpoint which actors—fishermen, gatherers, or Mother Nature—are most at fault for declining fish stocks. The shrimp farmers argue that fish catches are falling due to changing water temperatures and increases in the number of fishermen, illegal explosives, and motorized boats in the Gulf of Fonseca (*La Prensa* 1991a). Artisanal fishermen continue to blame the arrival of the larva gatherers with the hoop nets (*La Prensa* 1991b). Unified efforts at environmental management have been blocked since the relationship between each user's action and fish stock levels is undetermined.

Finally, the open access property rights regime governing larva use is problematic. The estuaries are national patrimony, yet monitoring user entry and actions along all waterway points is difficult. In effect, a state property regime has become "nonproperty." Although the larva is a crucial factor in mariculture production, the perception of its abundance has not yet changed, and its use remains unregulated. Given its limited staff, the Honduran government has not been able to strongly enforce fishing gear rules or limit the number of larva gatherers (or, in general, fishermen of any other species) (DIGPESCA 1993). And, no attempt has been made to introduce the type of selective gear used in Guatemalan and Ecuadoran mariculture which virtually eliminates the bycatch problem (Barrillas 1993). Instead, more emphasis has been placed on promoting substitutes (i.e., hatchery-raised larvae) for natural seed. While this trend could reduce the bycatch externality problem, it could create new dilemmas if the dislocated larva gatherers remain unemployed.

Water Pollution as an Emerging Externality to Mariculture and Fisheries

Growing levels of point source surface water pollution represent an immediate threat to both the shrimp industry and the surrounding artisanal fisheries. Fertilizer- and pesticide-related effluents from shrimp pond drainage canals are causing eutrophication and reducing water quality along the San Bernardo, Pedregal, and Jagua estuaries of southern Honduras. The high levels of phosphorous contaminants and organic matter content in the estuary water led a consultancy report to conclude that all new shrimp farms face "high economic risk" (COHECO 1994).

Under the common flushing patterns used, over 8 million gal of effluents (per 100 ha of ponds) are pumped into the estuaries daily (Vergne, Hardin, and Dewalt 1993). Waste material from mariculture is largely related to the amount of food fed, type of diet, and farming practices (Gowen and McClusky 1988). Honduran managers often use high amounts of agricultural-related fertilizers, pesticides, and nitrogen- and phosphorus-based feeds during the shrimp grow-out period, and too high stocking rates also increase excrement levels (COHECO 1994). Estuaries fouled with pond excrement affect the water sources of neighboring farms and lower the survival of other fish as well as the livelihoods of artisanal fishermen.

At least three factors have contributed to the growing water quality problem. Estuary water is a classic collective resource, the type most prone to externalities. It is difficult to exclude users along the winding, isolated waterways, and the quantity of water seems nearly nonsubtractable. However, one user's actions reduce the water quality available to the next farm, creating incompatible uses and subtractability of an aspect of the natural resource. Location-specific levels of degradation are especially difficult to pinpoint.[11]

In addition, the property rights regime which demands minimal duties from resource users has affected the shrimp farmers' behavior. Shrimp farmers have relied on a

mix of appropriative and riparian rights for estuary water use.[12] The 1927 Water Law states that most waterways are public resources. Free and uncontrolled use is available for drinking and cattle operations. Water user fees (at the rate of 1 0.001/m^3) should be charged to those receiving registered concessions for other water uses; however, only 2% of agricultural uses of water are registered (Johnston et al. 1992). And, while the Fisheries Law of 1989 prohibits noxious waste discharges into watercourses that cause damage to resident fauna, few attempts have been made to collect fees set in the law (Johnston et al. 1992). Thus, an established custom has emerged in which each user takes estuary water for free, caring only about his or her own profits with no sense of reciprocity for other users. The Environmental Ministry (SEDA) is hoping to change this practice through laws that are being written which would set permitted effluent concentration levels in the waterways.

Finally, there simply is insufficient data to guide development of new water policy. Fish and shrimp survival rates, the interrelationship with natural phenomena (stream flows, water turbulence, and temperature), and the level of damage caused by different estuary users are still unclarified. On the basis of microscopic water analysis, shrimp farmers argue that their discharge levels are minimal, and that the fertilizers and pesticides used (such as rotenone) are organic. Yet, the fishermen blame the shrimp farmers for damaging water quality, and point to the number of dead fish seen floating in the estuary adjacent to the farm as an indicator of the water pollution done by mariculturalists.

Here, the parties contesting the water resources are relying on different knowledge bases for their claims. Divergent discourses about the causes of pollution have prevented cooperation among the users who together suffer from declining water quality. In other words, there are different social constructions of environmental degradation, little closure over whether degradation even is occurring, and few means to reach a mutually acceptable solution (Blaikie 1995).

Conclusion: Attacking the Roots of Conflict

Farm-raised shrimp is one of the more successful new crops in many developing countries, producing large, and growing, export earnings as well as employment growth. Yet, questions have arisen about the long-term environmental and developmental impact of the mariculture industry. This article examines the most salient conflicts arising in the coastal communities of southern Honduras and draws on externality theory to highlight the roots of the problems.

Resource use agreements among shrimp farmers and fishermen have been hampered by dualistic aspects of the resources. The wetlands are private goods, and the larva and water are collective goods, in certain aspects. Yet, these resources also have common pool characteristics, as the quality of the resources is subtractable in a sense that is hard to visualize. The shrimp farmers cannot see the effects of a cut mangrove, a dead fish larva, or a contaminated area of water.

This phenomenon is linked to two outstanding problems which exist with respect to information flows in the mariculture zone. First, each immediate stakeholder—the shrimp farmer, the fisherman, and the state—values each resource differently, so no one value may be mutually acceptable. In general, the ecological benefits of the resource have been undervalued, while the financial benefits of conversion have been overvalued. Second, it has been impossible to separate the marginal impact of each user's actions in the total environmental degradation. Different perceptions exist about the level of, and responsibility for, mangrove deforestation, the destruction of the larva bycatch, and estuary water pollu-

tion. Shifting of the blame will continue as long as benchmark indicators linking actions and environmental quality outcomes are not available.

Finally, the incomplete delineation and controversial distribution of the property rights have stimulated poor user behavior. The larva and estuary water remain as open access resources. Formal environmental rules around mangrove cutting, fishing gear, and water pollution have not been effectively enforced. And apparently wetland property rights endowments in Honduras have been linked to the alignment of political power in the country.

These economic features of the contested resources suggest that no immediate solution is likely. Mariculturalists have rejected many legal environmental controls, and the affected low-income fishermen have found denouncements in the sympathetic national and international press to be one of their only means of recourse. The state has yet to assume an aggressive role in regulating either the shrimp farmers or the fishermen.

However, the analysis suggests several research and policy tools for more sustainable coastal zone management.

1. Trends in the functional relationship between each user's actions, deforestation, noxious output, and the fisheries' declines could be established. Time series data and satellite imagery should be able to pinpoint disturbances and causes of mangrove deforestation. Yet environmental quality indicators linking a user's action to fisheries destruction and water quality remain illusive. As an alternative, input-output analysis of an estuary's nutrient concentrations upstream and downstream from mariculture operations would provide some indication of how each industry contributes to eutrophication (Carpenter and Joeres 1996).
2. Policies could be considered that would force users to consider the results of their actions. This could include a land tax on the damage done to interdependent habitat through mangrove disturbance and a tax on natural larva gatherers or purchasing shrimp farmers to account for environmental damage to the bycatch stock (Parks and Bonifaz 1994).
3. A system of checks and balances could be outlined among the contesting parties. For instance, community-level groups who reside alongside mangrove areas and estuaries could have a role in monitoring resource access and use by regular patrols and rotating watchgroups. Members of CODDEFFAGOLF have been very active in drawing attention to infringements of the winter lagoon reserves established under Executive Accord No. 1118 of 1992. The mariculturalists also are positioning to play a role in sustainable management of the coastal resources. The shrimp farmers' association, ANDAH, has drawn up a Mariculture Business Ethics Code and has begun a program of environmental education for its members and means for group monitoring (ANDAH 1994). And different branches of the state bureaucracy are becoming involved in coastal zone management; in 1995, SEDA began requiring environmental impact assessments for new shrimp farm operations. These trends suggest that previous calls for multiple use management plans of coastal resources may be possible if a role is outlined for each stakeholder in the conflict.

Notes

1. Externalities represent a persistent interdependence among producers in which one user's actions create uncompensated cost implications for another (Bromley 1989).

2. Property rights are sets of ordered relationships among people that define their opportunities, exposure to the acts of others, privileges, and responsibilities (Bromley 1989).

3. Some of the reported stockholders in Honduran shrimp farms include the ex-president of the country, the ex-president of the Central Bank, the brother-in-law of the current president, three military colonels, and the director of the military pension board.

4. Winter lagoons are seasonal, rainwater-fed pools in mudflats that become home to fish and crustacean larva.

5. A salt flat is dry land that builds up following natural or manmade disturbances to the mangrove ecosystem.

6. The value of direct products extracted from mangroves (firewood, construction materials, fish products) has been estimated in the range of $60 to $2,400 per ha per yr (Dixon 1990). Recent calculations of the value of Nicaraguan mangroves are $68–$120/ha/yr (Windoxhel 1994). The ecological functions of the whole mangrove ecosystem (both the trees and the "useless" salt flats) also include groundwater recharge, flood control, shoreline stabilization, and sediment retention; no study has successfully placed a monetary figure on these values.

7. Debates between fishermen and mariculturalists highlight their divergent perceptions of resource value. For instance, gatherers argue that a nearly extinct species of crab extracted for subsistence (ponche) is threatened by shrimp farming as mangroves are cut. Yet, technicians reply that this animal's economic value is negligible and that the tidal flush zone is not an "ecological niche" for bivalves or crustacea (Torres Díaz 1991).

8. Shrimp do not follow a traditional logistic growth curve associated with most fisheries stocks. The logistic growth model implies that the economically feasible extraction point occurs at a higher harvesting level than the maximum sustainable yield, leading to overharvesting and stock depletion (Hartwick and Olewiler 1986).

9. *Penaeus* sp. is a species of selection model "r" (like rabbits), which reproduce at extremely high rates to ensure survival in conditions of extreme climatic stress.

10. In some Asian countries as the value of natural larvae rises, territorial use rights for fishing (TURFs) for larva gathering have been put in place to encourage sustainable management (Smith and Panayatou 1984).

11. Farms are located along different positions of an estuary covering the distance between dry land and the open sea. A farm's location could affect its susceptibility to polluted water intake; however, regular tidal flushing patterns ensure an unpredictable water quality pattern across time and geographic location (Vergne, Hardin, and Dewalt 1993).

12. Riparian water rights assign water ownership or "reasonable use" rights to the party whose property borders the water. Appropriative rights are given on a first-come basis to a water user, regardless of the location of his or her productive activity (Hartwick and Olewiler 1986). These arrangements may contain provisions about both the quantity and quality of water involved.

References

National Association of Aquaculturalists of Honduras (ANDAH). 1994. *La Industria Camaricultura Buscando Asegurar la Viabilidad a Largo Plazo.* Forum proceedings, Choluteca, Honduras.

Bailey, C. 1988. The social consequences of tropical shrimp mariculture development. *Ocean and Shoreline Management* 11:31–44.

Barbier, E. 1994. Valuing environmental functions: Tropical wetlands. *Land Economics* 70:155–173.

Barrillas, M. 1993. Interview, shrimp program coordinator, Guatemalan Non-Traditional Exporters Association, Guatemala City, Guatemala, 13 June.

Blaikie, P. 1995. Numbers and narratives, science and discourses: Opportunities and change in researching the environment. Lecture, MacArthur Scholars Program, University of Wisconsin-Madison, 9 March.

Bromley, D. 1989. *Economic interests and institutions.* New York: Basil Blackwell.

Carpenter, S., and E. Joeres. 1996. Personal communication, professor of limnology and professor of environmental engineering, University of Wisconsin-Madison, 15 July.

Honduran Corporation for Forest Development (COHDEFOR). 1989. Cortes Illegales al Bosque de Manglar en el Golfo de Fonseca para Instalación de Proyectos Acuicolas and Denuncia Forestal No. R.F.F.M. 34/89. Mimeos, Choluteca, Honduras.

Honduran Consulting in Eco-Development (COHECO). 1994. *Evaluación de impacto ambiental: Camaroneras de la zona sur.* Tegucigalpa, Honduras: Consultoria Hondureña en Eco-Desarrollo.

Comprehensive Resource Inventory Assessment (CRIES)/Michigan State University. 1984. *Resource assessment of the Department of Choluteca.* Tegucigalpa, Honduras: Ministry of Natural and Renewable Resources.

Dirección General de Pesca (DIGPESCA). 1993. Informe de Taller de Ordenación de las Pesqueras de Crustaceos de Honduras. Dirección General de Pesca/Food and Agriculture Organization of the United Nations, Tegucigalpa, Honduras, February.

Dixon, J. 1990. The valuation of mangroves. *Tropical Coastal Area Management Newsletter* 4:1–6.

Dixon, J., and P. Sherman. 1990. *The economics of protected areas: A new look at benefits and costs.* Washington, D.C.: Island Press.

El Heraldo (Tegucigalpa, Honduras). 1994. La industria camaronera revolucioná la económia Hondureña. 28 June, p. 7.

Foer, G. 1992. Profile of the coastal resources of Honduras. In *Central America's coasts: Profiles and an agenda for action,* eds. G. Foer and S. Olsen, 165–197. Narragansett, R.I.: Coastal Resources Center, University of Rhode Island.

Gowen, R., and D. McClusky. 1988. How farms affect their surroundings. *Fish Farmer,* October, 33–34.

Guevarra, R. 1991. Ponencia sobre la acuicultura en Honduras, con enfásis en el cultivo de Camarón. Paper presented at the First Symposium of Farmed Shrimp in Central America, Tegucigalpa, Honduras, 24–26 April.

Hardin, G. 1968. The tragedy of the commons. *Science* 162:1243–1238.

Hartwick, J., and N. Olewiler. 1986. *The economics of natural resource use.* New York: Harper & Row.

Johnston, G., J. F. Rodas, M. Garcia, E. Bondy, C. Castaneda, and W. Aguilar. 1992. *Natural resource policy inventory of Honduras.* Report for U.S. Agency for International Development, Honduras. Tegucigalpa, Honduras: Abt Associates, Inc.

Kunstadter, P., E. C. Bird, and S. Sabhasri. 1986. *Man in the mangroves: The socio-economic situation of human settlements in mangrove forests.* Tokyo: United Nations University.

La Prensa (San Pedro Sula, Honduras). 1991a. Con redes ilegales acaban con el camarón. 14 February, p. 4.

La Prensa (San Pedro Sula, Honduras). 1991b. Pescadores artesanales en via de extinción. 19 February, p. 10.

Morales, L., and E. Nieto. 1990. Informe preliminar del censo de pescadores artesanales en la costa pacifica de Honduras (Golfo de Fonseca). Tegucigalpa, Honduras: Ministry of Natural Resources.

Parks, P., and M. Bonifaz. 1994. Nonsustainable use of renewable resources: Mangrove deforestation and mariculture in Ecuador. *Marine Resource Economics* 9:1–18.

Ramirez, X. A. 1994. Coddeffagolf: Los defensores de los manglares del Golfo de Fonseca, Honduras. *Revista Forestal Centroamericana* 9:27–32.

Salazar, D., and A. Leonard. 1994. Conservation and the nature of goods. *Society & Natural Resources* 7:331–348.

Scura, E. 1988. *Export development at the enterprise level of shrimp and shrimp products from Central American countries. Report on a mission.* United Nations Commission on Trade and Development/GATT Report ITC/DTC/89/957. Geneva: International Trade Center, UNCTAD/General Agreement on Tariffs and Trade.

Smith, I. and Panayatou, T. 1984. *Territorial use rights and economic efficiency: The case of the Philippine fishing concessions.* FAO Fisheries Technical Paper No. 245. Rome: Food and Agriculture Organization of the United Nations.

Stanley, D. 1994. *Politicas estatales e impactos economicos y ecologicos de las nuevas exportaciones: El caso de Camarón NTX en Honduras.* POSCAE-UNAH Working Paper No. 7. Tegucigalpa, Honduras: Central American Postgraduate Economics and Development Program.

Stanley, D. 1996. Labor market outcomes in a natural resource boom: The case of mariculture exports in Honduras. Ph.D. dissertation, Department of Agricultural Economics, University of Wisconsin-Madison.

Swallow, S. 1994. Renewable and nonrenewable resource theory applied to coastal aquaculture, forest, wetland, and fishery linkages. *Marine Resource Economics* 9:291–310.

Tiempo (San Pedro Sula, Honduras). 1992. Sigue la destrucción de manglares en el Golfo de Fonseca. 20 July, p. 8.

Torres Díaz, A. 1991. *Manual practico de cultivo de Camarón en Honduras.* San Pedro Sula, Honduras: Federation of Non-Traditional Export Producers of Honduras.

Vergne, P., M. Hardin, and B. Dewalt. 1993. *Environmental study of the Gulf of Fonseca.* Gainesville, Fla.: Tropical Research and Development, Inc.

Windoxhel, N. 1994. Valoración económica de los manglares: Demonstrando la rentabilidad de su aprovechamiento sostenible. *Revista Forestal Centroamericana* 9:18–26.