Mangrove destruction and shrimp aquaculture in Ecuador: A focus on property right enforcement

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Abstract

Mangrove land along the coast of Ecuador traditionally followed various forms of common property regimes. Often it was controlled and used on an environmentally sustainable and economically efficient manner by the native communities. This property regime did not require government regulation or monitoring assistance. However, when the land became more valuable, the Ecuadorian government, along with the encouragement of international financial institutions, allowed the land rights to transfer to wealthy individuals and companies. Often, the land transfer did not respect the legislation designed to protect the mangrove land. Over a relatively short period of time, the common property system broke down. The newly formed 'private property' regime inefficiently required property right enforcement in conjunction with the implementation of proper government regulations. Data collected from 215 household surveys and 25 community surveys (created and conducted by the researcher), will be used in the analysis of the property right structure of coastal Ecuador. Finally, policy alternatives are proposed and compared to Elinor Ostrom's design principles to help predict its effectiveness.

Shrimp farm in Daule, Esmeraldas, Ecuador

Conchera's house in Bolivar, Esmeraldas, Ecuador

mi manglar, mi sangre, mi fuego, mi vida, mi todo ~ my mangrove, my blood, my fire, my life, my everything

Dedication

I would like to dedicate this paper to the coastal people of Ecuador. They have lived in harmony with their surrounding environments for generations and have recently had to endure many hardships due to the encroachment of shrimp farming. The first time I visited Ecuador, I was lucky to meet many people who loved their mangroves and showed me their ever increasing interdependent relationships, based on survival. Throughout this research I visited many communities and spoke with many local people and was welcomed with open arms every time. This project would never have been possible without the help from the coastal Ecuadorians, they are truly amazing.

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***Eutrophication*:** the process (natural or artificial) of a body of water becoming enriched with nutrients and minerals, resulting in excess growth of algae and lower oxygen content.

FUNDECOL: *Fundación de Defensa Ecológica;* Foundation for Ecological Defense. Headquarters are located in Muisne, Esmeraldas, Ecuador. Its mission is to protect the local ecology (including mangrove ecosystems) by educating and working with the local population of communities in the Muisne Canton.

High land (shrimp farm): corresponds to ponds that were built on land higher than the high tide line and thus, are not incorporated in the Decree 1391. Often, the shrimp farm is improperly included in the *high land* category – where at least part of the farm is below the high tide line (see section *2.1.1*).

Illegal (shrimp farm): shrimp farms built below the high tide line after 1999 (see section *2.1.1*).

Irregular (shrimp farm): refers to shrimp farms that will be stripped of its occupancy, as it is not regularized in accordance to Decree 1391. According to Decree 1391, these shrimp farms are able to legalize themselves if they were built before 1999; the deadline was March 31, 2010 (see section *2.1.1*).

Mangrove degradation: *mangrove destruction* plus mangrove loss resulting from externalities from shrimp farm activities.

***Mangrove dependency (for community)*:** From survey respondents, the estimated percent of the population that is dependent on the mangroves in one form or another (consumption, housing, income, etc.). Note that mangrove dependency for households is defined depending on the section of the paper.

Mangrove destruction: the loss of mangrove land from shrimp farming, urbanization or tourism.

***Muisneño*:** a name referring to a person from Muisne, Esmeraldas, Ecuador.

***Total Economic Value*:** the total sum of all use and non-use values of a good or service.

Tragedy of enclosures: when there is a "conversion of (a) multiple-user, open access resource into a single-user, single-owner one" (EJF, 2003b).

***Transitory income*:** based on the *permanent income hypothesis*, it refers to the portion of income that is unexpected or irregular, short-term changes in income.

***Transparency Organization*:** (check old version, I think it was included in there...)

White Spot Syndrome Virus: *La Mancha Blanca;* a viral infection of penaeid shrimp (the main type of shrimp cultivated in the coast of Ecuador). The virus is highly contagious and kills the shrimp quickly. It is named after the white spots that appear on the brains of the infected shrimp.

mechanisms that might otherwise protect the [mangrove] forests and/or interests of local users ... In short, conflict is more likely to emerge in the absence of shared understandings about rules of access, clear government regulations, and effective means of enforcement and dispute resolution".

In 1966, Ecuadorian companies and individuals began shrimp farming by creating artificial ponds in the Guayaquil Gulf. This period was followed by a large increase in production and consumption throughout the 1980s, which led to the destruction of approximately 50 per cent of mangrove forests along the Ecuadorian coastline. Many inhabitants of coastal Ecuador have historically relied directly on the mangroves for their income by gathering fish, molluscs and crustaceans. According to Jesus Gomez Perez, from Spanish NGO Azacan-Serso Castilla y Leon, the loss of potential earnings from the natural mangrove ecosystem, not including environmental externalities, is estimated to be at least ten times larger than the income generated by shrimp farming (EJF, 2003d). However, the Ecuadorian government neglected to properly monitor and enforce the laws enacted to conserve the mangrove forests. Thus, the current market value of shrimp was considered greater than the continuous value of the mangrove forests.

"Mangroves are the rainforests by the sea. Large stretches of the subtropical and tropical coastline are dominated by mangroves, once estimated to cover an area of over 36 million hectares (worldwide). Now, less than 15 million [hectares] remain—less than half the original area" (Corets, 2008). Mangrove destruction causes problems with regards to protection from *El Niño*, tidal waves, cyclones, and landslides. It also increases sedimentation, salinity and acidity of the water and neighbouring farmlands. These destruction-related externalities, in conjunction with shrimp farming contamination from pesticides, antibiotics and other waste by-products, have led to the premature death of many marine species as well as extreme pollution of rivers, estuaries and canals, which many local residents rely on for survival. This has occurred despite the fact that the mangroves were designated as common land, and governed by local natives trying to continue abiding by traditional communal property regimes.

The designation of mangroves as humankind's common heritage at the Rio Earth Summit in 1992 influenced the reversal of attitudes and policies by governments and research institutions (Cormier-Salem, 2006). The Summit led to the implementation of integrated coastal management schemes by governments and development agencies (World Rainforest Movement, 2006). The estimated *Total Economic Value*[5] of mangrove ecosystems exceeds the value of shrimp aquaculture by approximately 70 percent, or $60,400 versus $16,700 per hectare of shrimp farms (Barbier, 2000).

Potential penalties for destroying mangroves include fines, reforestation requirements, and imprisonment, but these laws are rarely enforced. For example, Ecuadorian law technically requires the reforestation of 50 per cent of its mangroves. Decree 1391[6], a regulation created in October 2008, attempts to regularize the industrial shrimp aquaculture industry by requiring companies to conduct reforestation projects and pay fines (Yépez, 2008). However, this is an unacceptable solution to the problem as it requires the companies to reforest much less than the 50 percent target outlined in Decree 1391. Also, the fines are minimal in comparison to previous legislation and the illegality of mangrove clearing is contradicted by categorizing previous mangrove land as 'national assets for public use'. Investigation of effective policy alternatives need to be explored and implemented in order for the mangroves of coastal Ecuador to be conserved.

The main methodology for the paper is: (1) to evaluate the socio-economic relationships of mangrove dependent communities, and; (2) to evaluate different community scenarios and compare the respective rates of mangrove destruction, property right enforcement and community involvement. In order to answer the above questions, a conceptual approach is first made and then the resulting theoretical background is tested with the help of both primary and secondary sources. The primary data that I have collected first-hand has been compiled from the two different questionnaires that I prepared: one aimed at the household level; the

[5] See *Glossary of terms* for definition.
[6] See section *2.1.1* for more details on Decree 1391.

The remainder of the paper is organized in the following manner. Section *2* first explains the history of *mangrove destruction* and shrimp farming in Ecuador in order for the reader to understand the current scenarios across communities. A conceptual approach is presented with the use of theoretical literature and real-life examples in section *3*, followed by a thorough discussion on survey creation and justification for influential questions. Next in section *5*, statistical analysis is performed on the household survey data to better understand the population's dependent relationship with the mangroves. In section *6* the data from community surveys and secondary research are thoroughly evaluated in order to discuss important contrasts and similarities with respect to mangrove conservation and property right enforcement.

Later, in section 7, a proposal of policy regulations is made and theoretical rate of success is hypothesized in reference to previously discussed theory and framework proposed by Elinor Ostrom in "*Governing the commons*". An overall conclusion of findings is made in section *8*. The appendices at the end of the paper include survey questions and tables created from primary and secondary data. A *Glossary of terms* section is included at the beginning of the paper to help with the understanding of terminology used throughout the paper.

(*Conocarpus erectus*), Golden leather fern (*Acrostichum aureum*), Tea mangrove (*Pelliciera rhizophorae*, 'Mangle Piñuelo'), and hybrid of Red and White mangroves (*Rhizophora harrisonii*). The most common mangroves in Ecuador are: red, white and hybrid.

The most common crabs are the Blue crab (*Cardisoma crassum,* 'cangrejo azul'), Red mangrove crab (*Ucides occidentalis*, 'guariche') and Blue crab (*Callinectes arcuatus,* 'jaiba'). The most common shell, a type of clam, is the '*concha*'[11]. Collecting clams and crabs is a common profession, called shell fishers, for coastal Ecuadorians. Many women work as shell fishers (*concheras*) and often organize themselves; they are extremely active in the protection of their mangroves. This profession does not require a large initial investment; historically the women were able to provide for their families without having to depend on the more variable male wages.

The inception of shrimp farming circa 1966 in the El Oro province involved conversion of the salt flats (also a part of the coastal ecosystem). The *mangrove destruction* began a few years later; the exact date has not been agreed upon (Southgate, 1992). The Guayaquil area was the commercial capital of Ecuador. The government saw this as an ideal location to export shrimp to supply the increasing international demand. Shrimp aquaculture development later moved along the coast, from south of Guayaquil to northern Esmeraldas. The Ecuadorian government also encouraged the conversion of agricultural land. Many of the farmers, who preferred to keep their land, were later forced off their land by its salinization from nearby shrimp farms, thus rendering the land worthless for agriculture (EJF, 2003b).

[11] See *Glossary of terms* for definition.

government activity consistently recorded lower levels of *mangrove destruction* and *degradation*.

Southgate (1992) revealed in his study of Machala, that the Ecuadorian shrimp farm regulations included a 10 year use permit, granted by the General Merchant Marine Directorate. At that time, Southgate (1992) argued that regulations varied, depending on the type of land: "approvals might be needed from the Ministry of Agriculture and Livestock, the Ecuadorian Institute of Agrarian Reform, and other public agencies". The annual permit fee per hectare was calculated as 11 percent of the minimum monthly wage – the equivalent of an average $10 per hectare annually. The study also reported that some individuals constructed the ponds without permission, and once they had already begun, they claimed the land was higher than the *high-tide lines*[13]. Little, to no, repercussions of this have been reported throughout the research literature.

In 1999, *Naturland*[14], a German non-governmental organization, began an organic shrimp farming certification process for Ecuador. However, it is controversial in nature given that many requirements are less stringent than or contradictory with Ecuadorian law. Monitoring policies of organic certification are also inadequate – typically the shrimp farms are not monitored after receiving the organic certification (Cuoco, 2009 and Collins, personal observation and discussion with shrimp farmers, 2009).

Finally, the Decree 1391 and privatization of mangrove land are thoroughly discussed in Yépez (2008). Specifically, "Decree 1391 not only violates Ecuador's laws and codes, but, above all, the text of the Constitution, approved by majority vote on behalf of the Ecuadorian people on 28 September 2008" (Yépez, 2008). The new Constitution was commended internationally for establishing progressive environmental, water and human rights; however, Decree 1391 directly violates these rights. Although there is additional legislation, this shows that the regulations and property right enforcement remain insufficient in Ecuador.

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[13] See *Glossary of terms* for definition of high land shrimp farms, and section *2.1.2* for further discussion.
[14] See *Glossary of terms* for further details.

The lack of property right enforcement is a reflection of the historic corruption problem in Ecuador. For the purpose of this paper, the Corruption Perceptions Index (CPI), the Global Integrity Report (GIR) and International Property Rights Index (IPRI) are used to demonstrate Ecuador's corruption level based on different definitions. I chose these indices to include corruption data that can be related specifically to property right enforcement in developing countries. The most recent values are summarized in *Table 2-1.*

The CPI is calculated based on surveys conducted by the *Transparency Organization*[16]; the value corresponds to the perceived level of public-sector (government) corruption in each country (CPI, 2009). The GIR index compares more detailed categories of legal framework with actual implementation to compute an implementation gap (see *Appendix E, Notes from Table 2-1 Corruption indices:* for further details). These values illustrate in greater detail, the sub-categories where corruption is more severe, such as law enforcement and business regulation (GIR, 2008). Finally, the *International Property Rights Index* (IPRI) is a relatively new index, created by the *Property Rights Alliance (PRA)*[17] in 2007. "This index incorporates physical and intellectual property rights, based on the strength and effectiveness of the property (right) enforcement" (IPRI, 2007).

Corruption Indices				
Index	**Ecuador**	**Comparison**	**Ranking**	**Notes**
CPI	2.2 / 10	Range 1.1 - 9.4	146 / 180	2009
GIR	60 / 100	See *Appendix E: Notes from Table 2-1 Corruption indices: (a)*	15 /50	2008
IPRI	3.3 / 10	See *Appendix E: Notes from Table 2-1 Corruption indices: (b)*	59 / 70	2007; tied for 8th last place, bottom 25

Table 2-1 Corruption indices

Given the insufficiencies of law and property enforcement in Ecuador, it can be deduced that individuals and firms do not foresee risk in repercussions of destroying and exploiting mangrove

[16] See *Glossary of terms* for details on the organization.
[17] See *Glossary of terms* for details on the organization.

section *2.1.1*). The 21,087 hectares of R*egularized* shrimp farms have conducted legal proceedings to update its status from *Irregular* to *Regularized.* The government has granted permission for the shrimp farm to sustain its occupancy. Overall, 90 per cent of large shrimp farmers have been *Regularized*; however, it is difficult for small shrimp farmers to *Regularize* because of financial constraints (El Universo, 2010).

Another source states that there are 175,748 hectares of shrimp farms – 101,500 hectares of which have been recorded in mangrove areas (57.75 percent). As of September 2009, 44,642 hectares of shrimp farms did not have concessions (equivalent to *Irregular* legal status) (El Universo, 2009). According to Decree 1391, these shrimp farms are able to legalize themselves if they were built before 1999; the deadline was March 31, 2010. It will be interesting to see if the communities actually receive this land and whether or not the central government provides support to monitor and enforce their newly defined property rights.

The *High land* category corresponds to ponds that were built on land at an elevation higher than the high tide line and thus, are not incorporated in the Decree 1391. However, this does not mean that the *High land* shrimp farms do not cause problems. Many agricultural farmers have complained about the increased salinity and pollution from the shrimp farms and its effect on the agricultural land. For this context, it is important to maintain the monitoring and enforcement of externalities from its inputs. Often, the shrimp farm is improperly included in the *High land* category – where at least part of the farm is below the high tide line. Finally, the fact that the *Irregular* and *Regularized* categories make up 41 percent of overall shrimp farms further illustrates the lax property right enforcement throughout Ecuador.

Legal Status	Premises	Hectares	Percentage

The negative effects of misappropriation of aid are enhanced by the lack of common property institutions and property right enforcement and monitoring. The government is directly and indirectly aiding the development of illegal shrimp farms. It is important for the development institutions to ensure that the monetary aid they provide is properly invested by the developing country. Instead of encouraging inefficient ventures such as shrimp aquaculture on mangrove land, they should research the most effective areas in a given country that would benefit and develop most from the aid. "The development of industrial shrimp farming is often promoted by governments that are indebted and under pressure from international financial institutions, as a way of increasing exports and enabling hard currency to enter their country. But the facts always show that this accounting does not work in the same way for local economies" (World Rainforest Movement, 2006). In order to effectively diminish rural poverty, the development agencies need to be more cognisant of how and where their aid is being invested.

1993). Throughout the world, communities in and near the mangrove ecosystems have used it in a sustainable manner for many generations. As mentioned in section *2*, scenarios whereby the common mangrove land rights are transferred to private property occur throughout the world even though the alternative use of the resource, shrimp farming, is inefficient. Normally, a large industry such as aquaculture has a positive impact on regional economies. However, when the products are heavily exported and other means of income are not simultaneously sustained the regional economies can be adversely affected. For example, in the case of coastal Ecuador, mangrove destruction coupled with lack of access causes community members to lose their dependent method of income derivation. The exportation of their food source further deprives the local population of well-deserved wealth[20]. The combination of high poverty levels and lack of alternative employment causes residents to exploit the remaining mangrove land above its threshold levels as they do not have any other option for survival. Theoretically the government's failure to appreciate the economic importance of the mangroves led to its inefficient conversion to shrimp ponds. In other words, the advantages of the communal mangrove land no longer offset the losses to politically powerful groups.

Often, the government encourages aquaculture development in rural areas, stating that it will diminish the need for migration to densely populated areas (Pro Diversitas, 2005). This is not always true. For example, Ecuadorian regional coastal communities are adversely affected by the property transition, while foreigners or wealthy non-coastal Ecuadorians are capturing rent of the resource through non-incorporation of externalities and improper payment for land seizure.

An analysis from Pro Diversitas (2005) shows that lack of economic growth in aquaculture areas is mainly attributable to institutional factors and a dearth of strategic plans to meet harmonious and successful development goals. Damodaran (2006) concludes that nested institutions coupled with a decentralized management of natural resources will help preserve India's coastal ecosystems. Damodaran refers to this as *commons continuum*. He further states that a

[20] See section *6.2 Comparison of Ecuadorian coastal communities* for further details.

even though it does not reflect their long term interests. *Rent seeking* is the act of earning a return from capturing economic rent in an exploitative manner (economically or politically). *Rent capture* refers to the amount of rent obtained in the rent seeking activity. The ease of performing *rent seeking* activity in the shrimp aquaculture industry in Ecuador provided a great incentive for the encroachment on mangrove land. In exchange for an initial payment of $100 per hectare, the shrimp farm owner received, on average, an annual return of more than $3,000 per hectare with shrimp prices at $4,000 per metric ton (Southgate, 1992). The *rent capture* from shrimp farming is comprised of, the insignificant land valuation, the non-implemented payment of proper water treatment and unaccountability of the negative externalities which will be discussed further throughout the paper.

Another economic issue related to the shrimp farm industry in Ecuador is the *tragedy of enclosures*. This occurs when there is a "conversion of (a) multiple-user, open access resource into a single-user, single-owner one" (EJF, 2003b). It is easy to observe, that the absence of proper government regulation and implementation thereof could lead to further economic disparity. Overall the coastal residents who possess the highest poverty levels traditionally depended greater on the mangroves for their livelihood. The conversion of mangrove land to private property therefore affects the poorer residents to a greater degree than those that are better off. Generally, the coastal residents can now only rely on the mangrove land at a subsistence level. Furthermore, the Ecuadorian government does not enforce their laws in regards to percentage of shrimp protein allowed in the feed. The law states that shrimp protein must not exceed 20 percent of the feed. However, concentrations available for purchase range from 22 to 35 percent[21] (Collins, Interview with shrimp farmers, 2009). An open access property regime enables the efficient use of the mangrove land, whereas the shrimp aquaculture industry does not – irrespective of associated environmental externalities it generates a net protein loss.

[21] See *Appendix E: Shrimp farm accounting* for feed schedule details.

will take these theories and findings into account when conducting the analysis of *mangrove degradation* across coastal Ecuador.

The household survey is comprised of seven sections (see *Appendix A* for survey sections[23]). *Part A: Household listing* was created to record important demographic information with the intention to use the data for characteristic analyses of the Muisne population. More specifically, personal level questions include data on *gender*, *age*, and *years of education*, while household level questions include data on *neighbourhood*, *emigration* and *immigration*. *Gender* is defined as male or female. *Age* is defined as the number of years the individual has been living. *Years of education* is quantified as the respective years of highest educational attainment achieved by the individual (this variable is defined further in section *5.2*). *Neighbourhood* is defined as the specific neighbourhood where the household resides. It was important to include this detail in the survey. Neighbourhoods in Muisne share many unique characteristics that might not otherwise be included in other parts of the survey, such as cultural background and ancestry.

The main intention of *Part B: Household consumption* was to collect data on household *mangrove dependency* pertaining to its food and energy consumption patterns. In particular, I wanted to estimate what percent of fish, shrimp, shells and crabs consumed by the household were collected personally or bought from the mangroves and compare it to other household characteristics.

Part C: Remittance was designed with the intent to aid in the accuracy of estimating the annual income of households and to determine whether the household was self-sufficient. Specifically, data on whether individuals provided or received assistance in the form of money and/or food from friends or relatives was included with the intention of adding this to annual household income data. Specifics of the relationship with the individual who provided or received the assistance were also included. In practice, this section was difficult for most households to accurately quantify given that many individuals both provided and received assistance, often in the form of food whose value changed daily.

[23] Note that the survey was conducted in Spanish, but the English version is included in this paper.

4.2 Community survey

In order to investigate the relationship between *mangrove destruction* and the effect of property right enforcement across communities, specific details pertaining to each community were needed. During the creation of the community survey, I hypothesized reasons that could help explain why and how the community mangrove land had been converted to shrimp farming, even though its economic inefficiencies were well documented in the literature. Overall, I combined my previous knowledge from volunteering at the Congal Reserve, Jatun Sacha in Muisne, Ecuador and background information as outlined in section *2* to complete the survey.

The community survey is comprised of ten, often related, sections (see *Appendix B* for survey parts[29]). *Part 1: Respondent details* records details of respondents to aid in organization of interpreting the responses. As discussed in section *3*, often the size and diversification of the area affects the success rates of natural resource protection and efficient use. Therefore, *Part 2: Basic physical and demographic characteristics*, poses questions designed to extract specific community information. Similar to household employment, the questions posed in *Part 6: Energy*, *Part 9: Education institutions* and *Part 10: Observations* are used to predict the development level and other unique characteristics of each community. For example, if the importance of mangrove ecosystems and sustainable development is taught in its educational institutions.

As mentioned in the section *1*, many coastal Ecuadorians were forced to relocate from deforestation of their mangrove habitat and/or increased unemployment. *Part 4: Migration* was designed to obtain data on migration and its relation to employment, in order to evaluate the effect of the property right transfer on the local economy and its main industries. *Part 7: History and development*, *Part 8: Recent events* were created with the intent to use historical events in the comparison. Direct questions were posed in *Part 5: Agriculture* to evaluate land transfer and common land use processes.

[29] Note that the survey was conducted in Spanish, but the English version is included in this paper.

4.3 Conducting surveys

Both surveys were conducted by the author from October – November, 2009 with the help of local residents. Overall, primary data were collected on socio-economic aspects of 215 households residing in *Muisne, Nuevo Muisne* (El Relleno) and *Bunche,* Muisne County, Esmeraldas Province, Ecuador. The respondent sample was chosen in an attempt to accurately represent the average *Muisneño*[30]. Specifically, the number of surveys per *neighbourhood* depended on its expanse and population.

There are 41 communities in Ecuador located in or near mangrove ecosystems (Lemay and Llaguno, 2007). The community survey was conducted in 25 communities and four provinces along the coast of Ecuador. These communities were chosen based on their location and diverse characteristics. The Esmeraldas and neighbouring Manabí provinces are better represented than Guayas and Santa Elena provinces. One reason for this is the fact that I was stationed out of Muisne, Esmeraldas. Another, more important reason, is that the shrimp aquaculture industry showed interest in these areas after they had already established themselves in Guayas (and Santa Elena) and El Oro provinces. This time delay allowed for diversity among communities to affect the degree of *mangrove destruction*.

[30] See Glossary of terms for definition.

estimate for the opportunity cost of foregone wages. This has theoretical significance but increases the estimation error, which is the main reason I use the *mangrove dependency* variable calculated based on hours of work for the analyses.

An alternative dependent variable is the percent of household food consumption from the mangrove (see section *4.1* for explanation). This was calculated by having households estimate its percentage of each seafood category eaten from mangroves, shrimp farms and the ocean. For the overall calculation, the households were asked to state its top three foods consumed, which were given weights of 0.5, 0.3 and 0.1, respectively. The weight for 'all other sea foods' were given 0.02. These weights were included in the calculation in an attempt to accurately estimate the food consumption dependency a household has on mangroves. The weighting incorporates the frequency of consumption in the calculation. If the weights were not included, the dependency would often be over or under estimated, as it would be based on the absolute value of consumption percentage between mangroves, shrimp farms and the ocean. For example, a household that consumes fish sporadically but 100 percent from the mangroves would have its dependency overestimated without the weights. This calculation ensures that the variable has limits between 0 and 1.

In addition to food consumption, the method of cooking is also accounted for in the survey. The frequency of meals that the household depends on *carbón*[33] is used to estimate the household dependency on mangroves for cooking fuel. Thus, this value could be used separately as an independent variable, or added to the household food consumption variable.

Demographics play an important role in describing communities and analyzing influential activities. As explained in section *4*, certain questions were included in the survey to create a dataset on the characteristics of households. Section *4.1* outlines and operationally defines these variables on a preliminary basis. I adjust the definition of particular variables in order to evaluate the data more effectively. These definitions are specified below as required.

[33] See Glossary of terms for definition.

House type is defined based on three different dwelling possibilities: wooden, mixed (cement and wood) or cement. *Location* is defined based on three different location possibilities: current mangrove land, current hard land or current beach land. Given that land type changes naturally and from human interaction, the locations are stated as current type. In particular, current hard land refers to the fact that the land may have previously been mangrove land; however, walls and construction have changed the land type situation.

Depending on the category, or calculation, *Fishing material* can either represent *permanent household income* or a fishing associated household. Depending on the definition the sub-category, *Boat types*, can be used to represent *permanent income* or a fishing associated household. With respect to *permanent income*, the variable *Boat types* is defined based on categories, whether the household does not own any boat or owns a canoe, a boat or a large fishing boat. For the purpose of the analysis of a fishing associated household *Boat types* is defined as a dummy variable that is equal to 1 if the household owns at least one type of boat (canoe, motor boat or large fishing boat) and is equal to 0 otherwise. The sub-category, *Fishing tackle*, represents a fishing connected household[37]. *Fishing tackle* is defined as a dummy variable that is equal to 1 if the household owns at least one type of fishing material (any type of net, fish hook or line) and is equal to 0 otherwise.

Finally, the category *Vehicles* can also be used to represent *permanent income*. Specifically, *Vehicles* is defined as a dummy variable that is equal to 1 if the household owns at least one vehicle (car or motorcycle) and is equal to 0 otherwise.

[37] Note here that shellfish collecting families do not necessarily need fishing material to work in the mangroves.

Given the youthfulness of the Muisne population, it is interesting to describe the child(ren) demographics of the average household. *Table 5-2* summarizes the number of children present across households, based on two different definitions: overall (P*er household*) and per adult (*Per adult(s) in household*).

The total number of children *Per household* ranges from 0 to 7; it is remarkable that 31.63 percent of households have no children, considering the youth of the population. The number of children *Per adult(s) in household* represents the number of dependents per eligible income earner in the household[38]. This additional information could have an effect the dependency rate of a household. Finally, it is obvious from this summarization that most households that have one child or more also have more adults in the household. This information is useful for the overall mangrove dependency analysis; for example, the greater the number of adults in a household, the higher is their probability of the household being dependent on mangroves. Therefore, I expect a positive correlation between the *number of children* in the household with *mangrove dependency, ceteris paribus*.

	Per household			Per adult(s) in household	
Number of children	**under 17**	**under 10**	**under 5**	**under 17**	**under 10**
0	31.63%	41.86%	52.56%	31.63%	41.86%
0.001 - 0.999	N.A.	N.A.	N.A.	27.44%	28.37%
1 – 1.999	20.47%	19.53%	26.98%	30.70%	23.26%
2 – 2.999	18.14%	19.53%	15.81%	6.51%	4.19%
3 – 3.999	13.95%	11.63%	4.19%	1.86%	0.93%
4 – 4.999	7.44%	6.51%	0.47%	0%	1.40%
5 – 5.999	6.51%	0.47%	N.A.	1.40%	N.A.
6 – 6.999	1.40%	0.47%	N.A.	0%	N.A.
7 – 7.999	0.47%	N.A.	N.A.	0.47%	N.A.

Table 5-2 Household survey data - Children in the household

[38] Note that seniors are included in this calculation. Different variations were investigated: number of children per adult worker, per adult and senior worker, per adult and non-senior, however, the values do not change significantly.

The household survey data shows that there is a large disparity between annual *household income* levels throughout the community. The STATA *table* and *tab* commands, I used to calculate the statistics in *Tables 5-4* to *5-7,* attempt to maintain both an equal income range and respondent representation (25 percent) across four categories (Very low, Low, Medium and High). The *Frequency* columns show the exact number of households represented in each category. Given that STATA drops some observations based on the definition criteria the *Percent* columns are included to report the overall percentage of each category. *Tables 5-4* to *5-7* the household income statistics for Muisne based on specific operational *household income* definitions.

I have calculated the statistics based on different operational household income definitions in an attempt to evaluate the complex relationship between *mangrove dependency* and *household income.* These details can also explain the differences in the household demographics, such as age and individuals who are of adults and working in the household. Comparing the statistics between *Table 5-6* and *5-7* can explain the differences based on average wages per individual worker in the specific household. Theoretically, a higher income reflects a household with greater, more stable employment opportunities. Therefore, I expect a negative correlation between *household income* and *mangrove dependency, ceteris paribus.*

Category	Total household income				
	Range	Minimum	Maximum	Frequency	Percent
Very low income	$0 - $1,639.99	$0	$1,608	53	24.65
Low income	$1,640 - $3,275.99	$1,640	$3,268	54	25.12
Medium income	$3,276 - $6,239.99	$3,276	$6,000	54	25.12
High income	$6,240 - $21,120	$6,240	$36,456	54	25.12
Total				*215*	*100*

Table 5-4 Household survey data – Total household income statistics

a higher *mangrove dependency* rate than cement houses, *ceteris paribus*. *Table 5-5* shows the statistics of *house type* in Muisne.

House type	Number of households	Percent of households
Wooden	103	47.91
Mixed	59	27.44
Cement	53	24.65
Total	*215*	*100*

Table 5-8 Household survey data – House type statistics

On average, the land value is highest for beach property, medium for hard land and lowest for mangrove land. Therefore, I expect households residing on mangrove land to have a higher *mangrove dependency* rate than hard land and beach land, and households residing on hard land to have a higher *mangrove dependency* rate than beach land, *ceteris paribus*. *Table 5-6* shows the statistics for location in Muisne.

Location	Number of households	Percent of households
Mangrove land	43	20
Hard land	167	77.67
Beach land	5	2.33
Total	*215*	*100*

Table 5-9 Household survey data – Location statistics

As explained *boat type* can represent a fishing related household or the wealth of a household, depending on the definition of the variable. I expect a positive relationship between owning any *boat* and *mangrove dependency*, *ceteris paribus*.

Vehicle	Number of households	Percent of households
At least one vehicle	34	15.81
No vehicle	181	84.19
Total	*215*	*100*
At least one car	14	6.51
At least one motorcycle	27	12.56

Table 5-12 Household survey data – Vehicle statistics

In an attempt to describe the intricate relationship between household characteristics and *mangrove dependency* I will now discuss its separate relationship with independent variables. Overall 28.64 percent of the households have at least one member who works in the mangroves. This value varies across neighbourhoods irrespective of other characteristics. When looking more carefully, it seems that the poorer neighbourhoods, closer to the mangroves, have a higher dependency on the mangroves. However, some richer neighbourhoods also report high levels of dependency. Per my evaluation of *mangrove dependency* across neighbourhoods I noticed that there is a significant amount of observations on the outer limits, 0 and 1. This is interesting, considering that there are certain neighbourhoods that are more developed than others, which can reflect the wealth of households. This observation proves that additional information, other than income and particular neighbourhood are required to explain this complex relationship. These details suggest that neighbourhoods, themselves, contain specific influential information. Dummy intercept variables based on the *neighbourhood* variable could be used for this to provide for the higher or lower probability of a household's mangrove dependency based on *neighbourhood* characteristics regardless of other household attributes.

relationship between *mangrove dependency* and household. However, as with *Education* more information is required in order to properly explain the relationship.

Mangrove dependency (% hours)	Total household income category				
	Very low	Low	Medium	High	Total
0	24.65	22.54	21.83	30.99	100
1	20	46.67	20	13.33	100
Total	*44.65*	*69.21*	*41.83*	*44.32*	*100*

Table 5-14 Descriptive statistics – Muisne mangrove dependency across total household income categories

Mangrove dependency (% hours)	Total household income per adults in household category				
	Very low	Low	Medium	High	Total
0	28.17	20.42	20.42	30.99	100
1	13.33	46.67	33.33	6.67	100
Total	*41.5*	*67.09*	*53.75*	*37.66*	*100*

Table 5-15 Descriptive statistics – Muisne mangrove dependency across total household income per adults in household categories

I will now use scatter plot analysis to aid in the evaluation of *mangrove dependency* and independent variables. Specifically, *mangrove dependency* calculated as total household working hours affiliated with mangroves per total hours of work is compared separately to *Household income*, *House type*, *House location*, *maximum education* and *number of children*. The reason I have chosen to conduct the analysis with only one *mangrove dependency* definition is twofold: for ease of comparison, and the fact that this definition includes the least amount of estimation error[40].

The *Household income* scatter plots all yield similar, negative correlation results, whether we analyze the relationship based on total income (*Figure 5-1*), total income per total number of household members (*Figure 5-2*) or total income per total number of adults in the household (*Figure 5-3*). With all three definitions the 95 percent confidence interval widens at an

[40] See section *5.1* for further details.

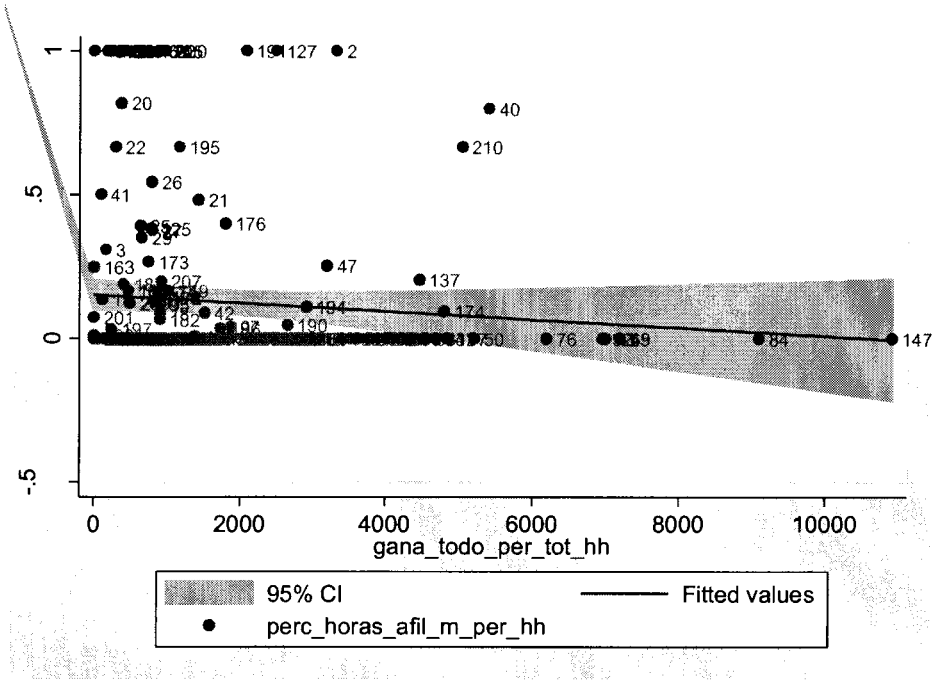


Figure 5-2 Scatter plot – Mangrove dependency and household income per total household

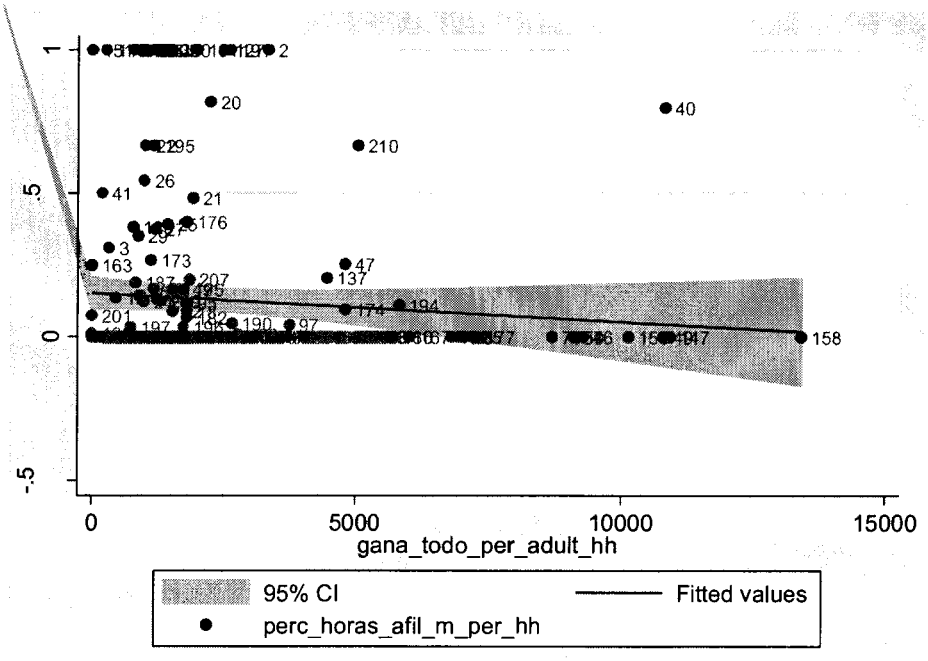


Figure 5-3 Scatter plot – Mangrove dependency and household income per adult

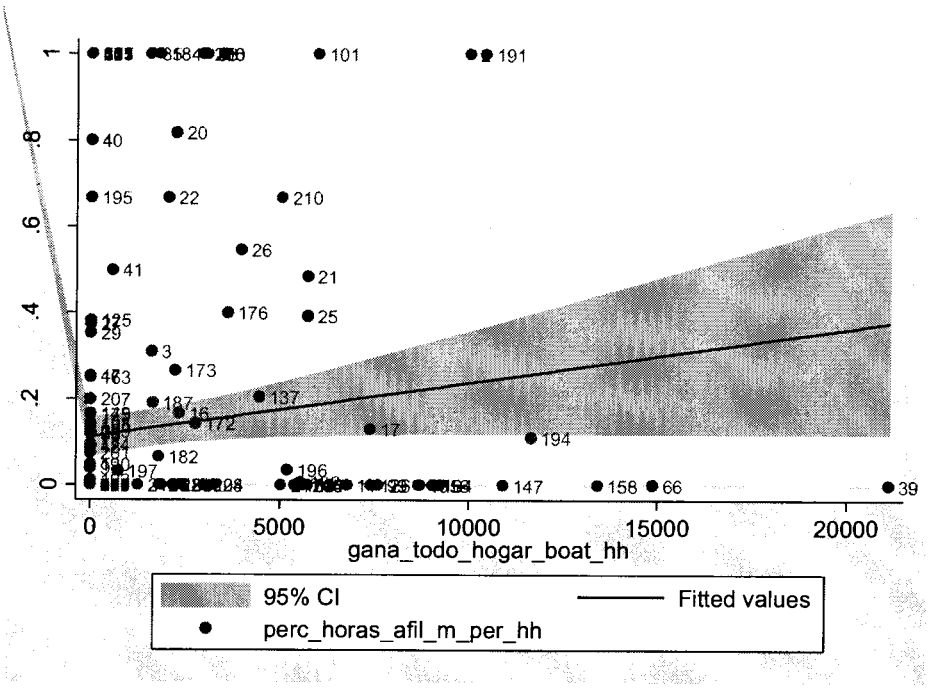


Figure 5-4 Scatter plot – Mangrove dependency and interaction household income and owning a boat[41]

Figure 5-5 and *Figure 5-6* compare *mangrove dependency* with discrete variables, with three possible values. The first independent variable is *House type*, as follows: *wood (1), mixed (2) or cement (3)*. The second variable is *location*, as follows: *mangrove (1), land* (2) or *beach (3)* (see section *5.1* for further details).

As shown in *Figure 5-5*, the relationship between *mangrove dependency* and *house type* is strongest for a range of dependency from 10 to 20 percent. It shows that the *wood (1)* and *mixed (3)* categories are evenly represented and together comprise the majority of the respondents. It is also clear that a greater proportion of *wood (1)* respondents are dependent on the mangroves at higher rates than the households in the *cement (2)* and *mixed (3)* categories.

[41] Here, the dummy variable in the interaction term is 0 if the household does not have a boat and 1 if the family has a boat.

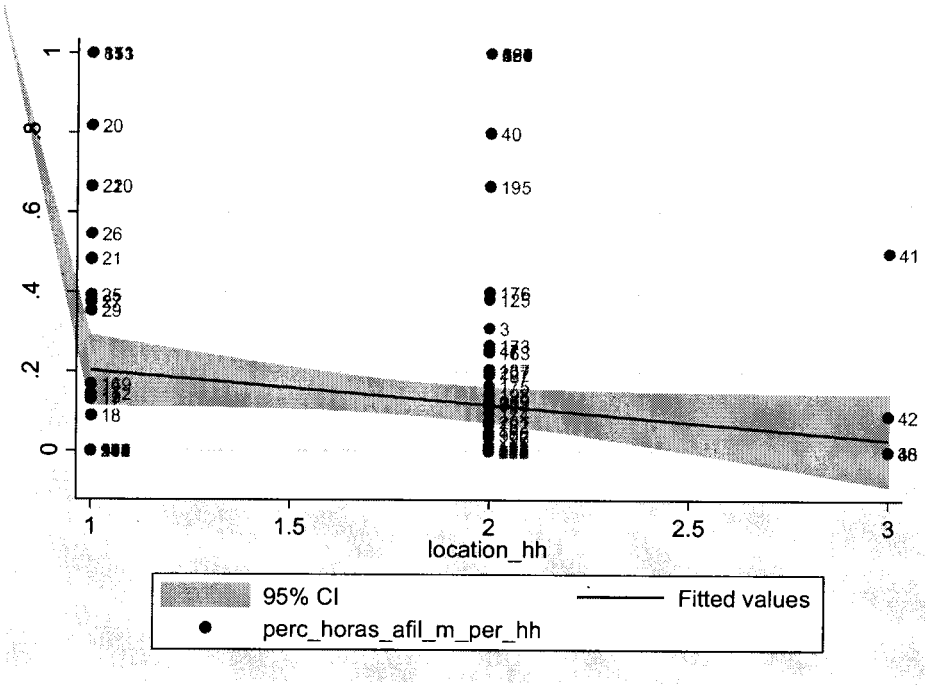


Figure 5-6 Scatter plot – Mangrove dependency and location

As predicted we obtain a negative relationship between the *mangrove dependency* and maximum adult education in the household. The scatter plot in *Figure 4-8* shows that there is also a considerable amount of outliers. Most of the disparity occurs when the dependent variable is equal to one or zero. It is evident that other characteristics influence mangrove dependency independent of education levels. It is interesting to note that there is a similar pattern as seen with the household income comparison. Theoretically this can be attributed to the fact that income and education are highly correlated (as evident throughout our analysis).

- *Fear factor* – whether the individual is afraid of going into the mangroves, due to weather, animals, the frog fish (*pez sapo*), bug bites, etc.
- *Drug addiction* – if the individual has a drug addiction, he/she may not go into the mangroves to work regardless of other family characteristics. (The relevance of drug addiction details and whether the family depends on mangroves could be further investigated by including details of whether the individual works in another sector of the economy).
- *Knowledge of mangrove fishing* – an instrumental variable was created for this, based on whether another individual in the household was working in the mangroves. However, it does not include extended family data, which would be influential as well.
- *Fish preference* – the fish that are caught in mangrove rivers are often juveniles; they taste differently than the adults of the same type. Depending on the individuals' preferences in the given household (and if they have a choice), they may prefer to find alternative work and buy fish from the ocean instead[43].

It can be noted also that some households that are dependent on the mangroves have a relatively high income level. This can partly be attributed to personal preferences. For example, the individual could fish in the mangroves as a form of leisure. In the future, the survey should include a question of whether or not this dependency is leisure based or survival based. Theoretically, a household with low income (for example, the bottom 25th percentile) will be more apt to depend on the mangroves for food consumption and a source of income. However, there are other variables, such as the *Fear factor,* that may need to be included to perform a thorough econometric analysis.

Supplementary questions to consider are whether or not the households' relatives depend on the mangroves and if their ancestors are from the area or not. *Immigration*, that is, whether the family was from Muisne or from another area, was a variable included in the household survey. However, a more detailed variable should be included in the regression in order to effectively predict whether the family will be dependent on the mangroves.

[43] We do have information on household consumption from mangroves, but this does not sufficiently explain an individuals' preference, especially considering ease of purchase and gifts from family and friends.

all consistent with the authors' predictions outlined in section *5.3*. The variable $boat_i$ has the largest effect on mangrove dependency with 16.53 percent. The negative correlation contradicts the prediction I made in section *5.3*. This could be due to the fact that the $boat_i$ information signifies that the household is a fishing affiliated household stronger than its level of permanent income. This base regression was performed to provide details on the econometric relationship between *mangrove dependency* and the household characteristics. I conducted regression analysis on many variants of the base equation; however, the results were inconclusive. Therefore, in the previous section, I used scatter plots to conduct further evaluations of the complex relationship.

Md	Coef.	Std. Err.	T	P>|t|	[95% Conf. Interval]	
Educ	-.0083143	0 .0065797	-1.26	0.217	-.0217921	.0051635
Child	.0187902	0 .0151311	1.24	0.225	-.0122045	0 .049785
Inc	-1.22e-06	3.16e-06	-0.39	0.702	-7.70e-06	5.25e-06
Boat	-0.1652957	0 .0454527	-3.64	0.001	-.2584013	-0.07219
_cons	0.3101284	0 .0873537	3.55	0.001	0.1311925	0 .4890643

Table 5-16 Base equation (1) regression output

The statistical analysis shows that there is a lot of omitted information in the household survey data – a requirement to properly analyze the data econometrically. I have conducted many regression analyses and tests, however, with inconclusive results. Theory of the tests will be discussed in the next section for future research considerations.

As the scatter plot analysis indicated in section *5.2*, there are different scenarios depending on the range of education attainment. This analysis is similar to that of household income. For this reason, a binary interaction term, where the boat dummy variable (see section *5.2* for definition) was multiplied by the education variable, was included in the equation. However, this did not change the regression outcome. The education variable could be further tested based on categories of highest education level attained, as opposed to specific number of years of education.

The statistical analysis showed that there was a relationship between what particular neighbourhood the household resided in, regardless of other household characteristics. A cross-sectional fixed-effects model was tested to account for the unobserved conditions of neighbourhoods. However, this did not sufficiently account for the remaining omitted variables.

Another issue to consider is the individual who does not work at all, and is dependent on the state and family and friends for support. These respondents, although they have little to no income, do not have the desire to enter the mangroves, or work in any other industry. In order to include these data in the regression, a control variable could be created, to determine the chance of mangrove dependency apart from the economic variables already included in the regression. For example, the additional variables that were considered in section *5.2.1*. These control variables will then take into account the average of the dependency and characteristics of the households which are not included in the other independent variables included in the regression.

Finally, when analyzing the regressions, we assumed that the error term had a normal distribution. Perhaps different model specifications would be better suited. This should be tested when the proper information is included.

Note that all survey data tables are included in *Appendix D.* First, we will consider the communities' general information, energy details and recent changes in quality of life. Then, we will compare the communities based on the level of mangrove destruction and community monitoring and shrimp farming. Next, we will discuss the various degrees of property right enforcement and government monitoring and regulations. Finally, we will use the data to consider possible reasons for variations among the surveyed communities. During this comparison, secondary research data will also be used to further support the information obtained from the surveys[46]. *Tables 12-1* to *12-7* provide the detailed information. I decided it was more beneficial to present the data and discuss important relationships with the use of tables opposed to creating a database, because of the large diversity in qualitative data and fluctuations in response rates. Therefore I could not draw any useful conclusions with the database.

For the purpose of this paper, we will investigate the differences in property right enforcement throughout coastal Ecuador and discuss influential factors across communities. Walters et al. (2008) state that "the material poverty of coastal communities and their widespread dependence on mangrove wood products to meet basic subsistence needs means users are often not in a good position to be selective and, instead, will harvest what is most readily available to them". This illustrates the importance to incorporate historical background details on communities before completing the evaluation. Some communities are better organized than others with respect to the control and use of their communal natural resource. We will see that this can directly affect the degree of mangrove conservation.

When comparing secondary data in *Table 14-2* Secondary research data – Poverty indices with primary data in *Tables 11-2 and 11-3* (see *Appendix D*) a positive correlation is obtained between poverty levels and the degree of *mangrove destruction* and construction of shrimp farms across communities. Overall, according to the World Bank, from 1990 to 2001,

[46] Note that given the restriction of the Ethics Board at the University of Ottawa, information obtained from the survey data is strictly confidential; names are only included when the information reflects the secondary research.

filter natural waste and shrimp farm effluents; when they are destroyed, contamination increases. The combination of shrimp farms built on mangrove land and ineffective monitoring of its effluents compounds this effect. Unemployment increased when the mangroves were destroyed and survey participants consistently sourced *mangrove destruction* and lack of fishing as a major culprit. On the other hand, health, drinking water and roads were claimed as the most common reasons for improvements in the quality of life.

Before we begin our analysis of property right enforcement and community involvement per the survey data, information compiled from the Inter-American Development Bank report on protected coastal management areas in Ecuador will be considered (Lemay and Llaguno, 2010). *Table 6-1* presents data on eight regions with *Protected Coastal Management Areas*[48] in Ecuador. Here, the total surface area includes coastal land and coastal and marine waters. Note that the exact hectares of mangroves are hard to determine here, as it depends on the specific ecological makeup of the particular area[49]. The last two reserve areas were unknown to me and were therefore compared to satellite images from Google maps. The satellite images showed there to be minimal mangrove coverage. In addition, the literature found on the reserves did not include any details of mangroves. Therefore, I conclude that mangrove coverage in this area must be minimal. However, the fact that the area is protected is relevant by itself; it illustrates that the communities in those areas are better organized and have strengthened property right enforcement institutions compared to other coastal regions. Thus, based on the *Conceptual approach* developed in section *3*, any mangroves that do exist in the area will have a better chance of protection, *ceteris paribus*.

[48] See Glossary of terms for definition

[49] For example, the coastal waters of Muisne (245) are included in mangrove calculations for the area (3,173). This is because the river is surrounded by mangroves. Other areas, such as Pacoche include open water, and thus do not have as many mangroves there.

a major source of income (with the exception of Cabo, but the area is not as accessible and has a reputation for violence).

The largest area of conserved mangroves is found in La Isla Puná, with 9,190 hectares. The largest original mangrove area is the Muisne-Cojímies ecosystem, with 20,080 hectares. The estimated mangrove land remaining ranges from 4 to 100 percent, with an average of 46.73 percent. The respondents from the Jama survey reported 100 percent of its mangrove land remaining; however, as stated in *Table 12-2* Community survey data – Mangrove details, *Appendix D* – Community survey data this estimate is most likely over estimated. The Jama survey respondents stated that shrimp farms were only located on *high land*[53]; however, personal observation by myself and satellite images from Googlemaps support evidence otherwise (see *Appendix E*). The estimated mangrove land remaining, excluding Jama, ranges from 4 to 77%, with an average of 43.40%. Although Pedro Carbo has an estimated 30% of its mangroves remaining, its inaccessibility because of the shrimp farms, affects the community greatly.

In addition, the lack of property right and government regulation enforcement causes the shrimp aquaculture industry to work inefficiently. "(There is) actually no advantage to people to build shrimp farms in mangrove areas; they only do that because (it is) common land that they can get hold of cheaply" (Barbier and Sathirathai, 2004). In addition to the mangrove destruction, the fact that the government does not properly monitor the farms' effluents results in further degradation of the ecosystem.

It is important to realize that accomplishments of organizations (community, national or international) related to mangrove conservation can vary considerably across coastal Ecuador. In addition, it is also difficult to state outright which groups are better organized or effective. Often, one group's perceived effectiveness can vary across communities as well. This is clearly

[53] See Glossary of terms for definition.

on a daily basis, whereas the shrimp farm job is more stable, with payments on a monthly basis. The average wages range across communities from $5.50 - $20 per day, $120 - $300 a month for shrimp farmers and up to $600 for administrators. Generally, the shrimp farmers and administrators migrate from different provinces and are hired directly by the owner of the farm, who is also usually from a different area. Most of the areas reported employment opportunities for the temporary cultivation position only, and not the permanent shrimp farmer or administrator positions.

The majority of the communities sell a small proportion of shrimp locally, and export the rest (see *Table 12-3* Community survey data – Shrimp farming details, *Appendix D* – Community survey data). The most common export locations are Guayaquil, Quito, Pedernales and Chamanga. Guayaquil then exports most of the shrimp to the United States and Europe. Quito is the non-coastal capital of Ecuador where the shrimp are sold mainly for tourist and wealthy household consumption. Finally, Chamanga and Pedernales are the shrimp trade centres for Esmeraldas and Manabí provinces, respectively. Most of the shrimp initially sent to these places will later be sold to Guayaquil for export. The shrimp farms are not regulated effectively by the government - this will be discussed later in this section.

Per the survey data summarized in *Table 12-5* Community survey data – Government monitoring and reforesting programs and *Table 12-4* Community survey data – Property rights and taxes (see *Appendix D* – Community survey data), property right enforcement and government monitoring vary greatly across communities. In general, the Ministry of the Environment is most active in northern Esmeraldas and southern Manabí. It is interesting then that these areas have a higher rate of preserved mangroves. Overall, eight of the communities had a government agent visit at least once in the past twelve months. The agent was always from the Ministry of the Environment. They visited the Isla Puná (in Guayas province) and Jama once, Daule twice and Muisne four times. The survey respondents all commented on the fact that the effectiveness of these visits is minimal. The respondents believed that the Ministry

Overall, based on community survey data, one of the main reasons a community was pressured by the shrimp industry later than others, in the same general region, is inaccessibility. For example, Daule was quite inaccessible by road (easily accessible by ocean) until 2006, when a road was built. This is the same year that shrimp aquaculture really took over the mangrove land. Another commonality is the type of mangrove system, such as rivers and estuaries, as discussed previously. When these two factors are present simultaneously, the effect is compounded. This case is true for Mompiche, where the residents mainly rely on tourism for their income derivation and generally do not have a lot of threat to their mangroves (see *Appendix D* – Community survey data).

6.1.1 Esmeraldas province

Firstly, one of the main reasons the Cayapas-Mataje Ecological Mangrove Reserve, located in San Lorenzo and Eloy Alfaro cantons is so well preserved, is because "during the 1950s the Majagual mangrove had been depredated by loggers who extracted tannin from mangrove bark to use it in the leather industry" (World Rainforest Movement, 2006). The area became a protected reserve earlier than other areas, on October 26, 1995. It was also designated as a *RAMSAR*[56] sight at this time (Sistemas nacional de areas protegidas del Ecuador, n.d.). Altogether, the reserve is 51,300 hectares; mangrove land makes up 28,367 hectares of this (World Rainforest Movement, 2006).

As mentioned in section *2*, shrimp aquaculture development started later in the northern part of the country than compared to locations in the south. My personal discussions with various community members suggest that once the adverse effects in other regions were evident, the time delay allowed communities to prepare themselves for the arrival of shrimp farm developers. The communities in the San Lorenzo and Eloy Alfaro cantons, in the northern Esmeraldas province, were able to organize themselves effectively (see tables in *Appendix D* – Community survey data). As we have seen in section *3*, communities who organize themselves and group with other communities are more successful at enforcing their common property

[56] See *Glossary of terms* for definition.

Now, we will discuss the Muisne - Cojímies[59] area. In the early 1990s, Greenpeace, with the help of *FUNDECOL*, took action to protect the remaining forests of this area, where "20,800 hectares of mangrove forests have been reduced to 650 hectares after clear cutting by the shrimp aquaculture in the last 10 years" (World Rainforest Movement, 1998). This brought international recognition of what was happening in the area, which led to the activism of *FUNDECOL* throughout the Muisne canton. Most of the reforestation projects are connected to *FUNDECOL* and the particular community. The central government has granted *FUNDECOL* power (through *C-CONDEM*) to monitor the situation and discuss issues with the government (Góngora, 2008). Local knowledge of the mangroves and its importance as an ecosystem has increased over the years because of this; many locals respect their mangroves and usually report any destruction to *FUNDECOL*.

6.1.2 Manabí province

The story is different in the Manabí province compared to Esmeraldas. For example, there is no organization in the northern Manabí province (Cojímies and Pedernales areas) that monitors the destruction or use of the mangroves (see *Appendix D* – Community survey data). As discussed at the beginning of this section, this area has a higher mangrove destruction rate and currently no one is monitoring the situation in the rural areas.

Through my discussions with local residents and personal observation, it is clear that many of the shrimp farmers put poison in the water to kill the fish in the pond. When the water is released into the river this kills the fish in the area. This occurs in other coastal areas as well, but there is a higher rate of un-detection in this area. Shrimp aquaculture developed very quickly in this region and has a higher poverty level than other areas with similar initial characteristics (see *Appendix D* – Community survey data). The people here are comparatively less educated, and perhaps did not have the knowledge of mangrove importance (Romero & Reyes, 2007). Once the local residents realized the negative effects, it was too late, and their mangroves were devastated (Collins, Interview with coastal residents, 2009).

[59] Please note that this only includes the land in the Esmeraldas province.

A mapping project was conducted in Machala, Puerto Bolivar, from the beginning of the shrimp farming until 1982, when *CLIRSEN*[60] and the University of Delaware[61] worked together to write a comprehensive paper of the area's property history (Terchunian et al., 1986). The group used remote sensing to estimate the different land areas, as outlined in *Table 6-2*. Given the fact that there is a great amount of discrepancy in the government records, and the accuracy of remote sensing estimation, the data by *CLIRSEN* is most likely the most accurate type of information currently available.

Land type	Year		
	1966	1977	1982
Mangroves	4692.88	4231.70	3294.08
Shrimp ponds	0	834.23	2330.67
Salt flats	1087.72	478.52	162.56

Table 6-2 Coastal land type comparison Machala, Puerto Bolívar in 1966, 1977, 1982

Now that we have evaluated the various scenarios involving *mangrove degradation*, shrimp farming, property right enforcement and government regulation across coastal Ecuadorian communities, we will now propose policy implementations.

[60] CLIRSEN: Centro de Levantamientos Integrados de Recursos Naturales por Sensores Remotes.
61 Specifically, the Center for Remote Sensing College of Marine Studies, University of Delaware.

In hindsight, we could ask: What would have happened if the government authorized a reasonable amount of sustainable construction and ongoing operation of the shrimp farms from 1966 onwards? Of course, this would also have to include the enforcement and monitoring throughout that time period. As mentioned in section *6.1*, many of the native people from the area had already been living in equilibrium with the surrounding mangrove environment. Often, they had their own laws to respect the reproduction cycles of the crabs and shells. Taking into account Ostrom's (1991) *Operational Rule Management #3*, the continuation of power over the property and its rights and management would have most likely been a continuing economic and environmental success.

Kohn (1994) suggested that as a part of the sustainable policy, the government should have a policy of redistributing the taxes back through the coastal communities. He also states that the tax redistribution could be used for "development, education and reforesting the mangroves, also monitoring the water". Only a few communities in Ecuador redistributed the shrimp farm taxes. In addition, the tax collection percentage is extremely low (see Appendix D, *Table 12-4*). The returned tax income should be used specifically for education and development related to the mangroves, in order for the community to be able to protect its land and continue respecting it themselves.

The government should also implement a retransfer of land program. For example, any future sale of current, 'legal status' shrimp farm land should require the rehabilitation of the shrimp farmland. The land should be fertile with a minimal amount being accessible mangroves. Abandoned land should have non-rehabilitation tax sanctions put on them. Current environmental requirements should include having to plant more mangroves[62] and perform in an environmentally sustainable manner. This would include using only natural methods, nothing in excess; the environment should be used efficiently. In addition, access to the canals should be available for the locals, by land and water. The community would then need to

[62] This law has been passed, but the enforcement and monitoring of it needs to be performed properly as well.

common property rights regime, where each town is responsible for its area should be implemented. The community should then work closely within its Parish in conjunction with regular liaison with neighbouring cantons and nationwide. Finally, government regulations should be enforced consistently throughout the country.

8 Conclusion

The main objective of this paper was based on two related questions. Within a community, what causes a household to be dependent on mangroves? Among communities, what is the relationship between property right enforcement and mangrove destruction rates? Using data from primary and secondary sources, we investigated the proposed hypothesis that mangrove destruction and property right enforcement are negatively related and that the presence of community groups decreases the strength of the relationship, *ceteris paribus*.

A thorough explanation of the household and community surveys was conducted in section *4*. The questions were also justified based on the theoretical literature and various scenarios, discussed in section *3*. Although the household econometric analyses were inconclusive, the data collected from the survey provided interesting information on the interrelated relationship between household characteristics and *mangrove dependency* rates.

The findings from the community comparison were helpful in making a connection between community involvement and property right enforcement. By analyzing the various levels of

9 Appendix A – Household questionnaire

Barrio ☐

1. Does any member of your household have children not living here in this household? YES...1 NO...2 ☐

ORDER OF AGE	2. list every person living in the household (do not include their names; they will be identified by age and sex) YEARS / MALE...1 FEMALE.2	3. How many years of education does [#] have?	4. Have any of your family members migrated? YES (1) (Complete questions 2-3 ;>5) NO (2) (next section)	5. In what province does [#] live? PROVINCE CODES	6. Where does [#] live? Rural Coastal (1) Coastal Town (2) Coastal City (3) Non-coastal Rural area (4) Non-coastal town (5) Non-coastal City (6) Other (7) »»NEXT PERSON
1					
2					
3					
4					
5					
6					
7					

PROVINCE CODES
Azuay 1
Bolívar.....2
Cañar.....3
Carchi.....4
Chimborazo.....5
Cotopaxi.....6
El Oro.....7
Esmeraldas.....8
Galápagos.....9
Guayas.....10
Imbabura.....11
Loja.....12
Los Ríos.....13
Manabí.....14
Morona Santiago.....15
Napo 16
Orellana.....17
Pastaza.....18
Pichincha.....19
Santa Elena.....20
Santo Domingo de los Tsáchilas.....21
Sucumbíos.....22
Tungurahua.....23
Zamora-Chinchipe.....24

Part 1: Household listing

1. During the past 12 months has any member of your household provided money or goods to persons who are not members of your household? For example for relatives living elsewhere, child support or alimony, or to friends or neighbours?

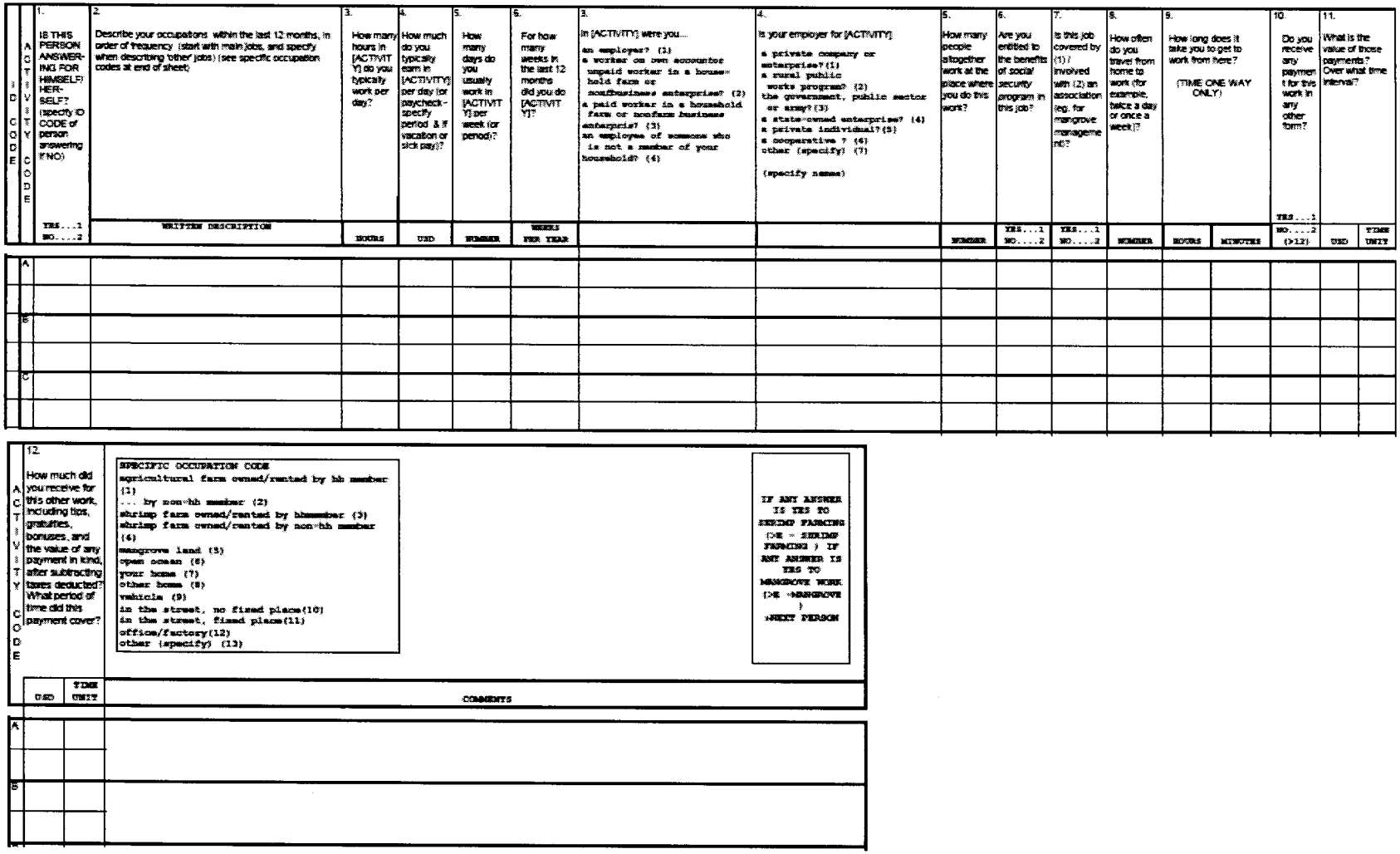
YES..1
NO...2 (»NEXT SECTION)

	2. What are ages and sex of the persons to whom household members have sent assistance during the past 12 months? LIST ALL NAMES BEFORE GOING TO 3-9 AGE, SEX	3. How is this person related to the head of the household? RELATION CODES	4. Is this assistance sent to [RECIPIENT ID] given by a specific member of this household? YES..1 NO...2 (»6)	5. Which household member sends [RECIPIENT ID]? COPY ID CODE OF PERSON FROM ROSTER ID CODE	6. Is [RECIPIENT ID] related to [DONOR ID CODE FROM Q5]? YES..1 NO...2	7. How much money have members of the household sent to [RECIPIENT ID] in the past 12 months? AMOUNT	What is the approximate value in cash of the assistance given in food or other goods? AMOUNT	What is this individual's occupation? OCCUPATION CODES
1								
2								
3								
4								
5								
6								

OCCUPATION CODES
SHRIMP FARMER 1
CONCHERO 2
FISHER 3
CONSTRUCTION WORKER 4
GOVERNMENT EMPLOYEE.....5
TAXI DRIVER (or MOTO) 6
SHOP KEEPER 7
OTHER (SPECIFY) 8

RELATTION CODES
RECIPIENT IS ___ OF DONOR
SPOUSE.....2(»10)
CHILD.....3(»8)
GRANDCHILD.....4(»10)
NIECE OR NEPHEW.....5(»10)
PARENT.....6(»9)
SISTER/BROTHER.....7(»10)
SON/DAUGHTER-IN-LAW..8(»10)
BROTHER/SISTER-IN LAW.....9(»10)
GRAND FATHER/MOTHER.....10(»10)
FATHER/MOTHER-IN-LAW.....11(»10)
OTHER RELATIVE.....12(»10)

Part 3: Remittance



ID CODE	ACTIVITY CODE	1. IS THIS PERSON ANSWERING FOR HIMSELF/HERSELF? (specify ID CODE of person answering if NO) YES...1 NO....2	2. Describe your occupations within the last 12 months, in order of frequency (start with main jobs, and specify when describing 'other' jobs) (see specific occupation codes at end of sheet) WRITTEN DESCRIPTION	3. How many hours in [ACTIVITY] do you typically work per day? HOURS	4. How much do you typically earn in [ACTIVITY] per day (or paycheck - specify period & if vacation or sick pay)? USD	5. How many days do you usually work in [ACTIVITY] per week (or period)? NUMBER	6. For how many weeks in the last 12 months did you do [ACTIVITY]? WEEKS PER YEAR	7. In [ACTIVITY] were you.... an employer? (1) a worker on own account unpaid worker in a household farm or nonfarm business enterprise? (2) a paid worker in a household farm or nonfarm business enterprise? (3) an employee of someone who is not a member of your household? (4)	8. Is your employer for [ACTIVITY] a private company or enterprise?(1) a rural public works program? (2) the government, public sector or army?(3) a state-owned enterprise? (4) a private individual?(5) a cooperative ? (6) other (specify) (7) (specify names)	9. How many people altogether work at the place where you do this work? NUMBER	10. Are you entitled to the benefits of social security program in this job? YES...1 NO....2	11. Is this job covered by (1) / involved with (2) an association (eg. for mangrove management)? YES...1 NO....2	12. How often do you travel from home to work (for example, twice a day or once a week)? NUMBER	13. How long does it take you to get to work from there? (TIME ONE WAY ONLY) HOURS	MINUTES	14. Do you receive any payment for this work in any other form? YES...1 NO....2 (>12)	15. What is the value of those payments? Over what time interval? USD	TIME UNIT
	A																					
	B																					
	C																					

ACTIVITY CODE	16. How much did you receive for this other work, including tips, gratuities, bonuses, and the value of any payment in kind, after subtracting taxes deducted? What period of time did this payment cover? USD	TIME UNIT	SPECIFIC OCCUPATION CODE agricultural farm owned/rented by hh member (1) ... by non-hh member (2) shrimp farm owned/rented by hhmember (3) shrimp farm owned/rented by non-hh member (4) mangrove land (5) open ocean (6) your home (7) other home (8) vehicle (9) in the street, no fixed place(10) in the street, fixed place(11) office/factory(12) other (specify) (13)	IF ANY ANSWER IS YES TO SHRIMP FARMING (>8 = SHRIMP FARMING) IF ANY ANSWER IS YES TO MANGROVE WORK (>8 =MANGROVE) =NEXT PERSON	COMMENTS
A					
B					

Part 5: Employment

For anyone who answered yes to working for on mangrove land

ID CODE	1 How many hours are in a typical day of work?	2 What is the location of the mangrove land? (If work at more than one location, specify separately)	3 How big is the mangrove land? (specify unit)	4 Who is the mangrove land owned by?	5 To your knowledge, is the mangrove land protected for conversion? YES (1) NO (2) DON'T KNOW (8)	6 If yes to Q5, who protects this land? PROTECTION CODES Ecuadorian government (1) local community (2) organization (specify) (3) private owner (specify) (4) other (specify) (6)	7 If yes to Q5, when did the protection begin? DON'T KNOW (8)	8 Is it possible that there is illegal harvesting going on at this mangrove site? (yes 1, no 2; if yes, elaborate in additional comments section)	9 Are there any specific laws regarding access rights? (yes 1, no 2; if yes, elaborate in additional comments section)	10 Were these mangroves replanted (1) or natural (2)?	11 If replanted, who replanted the mangroves? PROTECTION CODES Ecuadorian government (1) local community (2) organization (specify) (3) private owner (specify) (4) other (specify) (6)	12 What types of mangroves are there? MANGROVE CODES Avicennia Bicolor (1) Avicennia Germinans (2) Laguncularia Racemosa (3) Pelliciera Rhizophorae (4) Rhizophora Harrisonii (5) Rhizophora Mangle (6) Rhizophora Racemosa (7)
1												
2												
3												

ID CODE	13 How do you travel to the mangroves? TRAVEL CODES canoe (1) boat (2) rented canoe (3) rented boat (4) Community canoe (5) community boat (6) other (specify) (7)	14 Does anyone help you work in the mangroves? YES (1) NO (2)	15 If yes to Q14, how is this person related to you? (relation codes; household roster code if applicable)	16 What is your most common catch, based on weight? CATCH CODES shrimp (white) (1) shrimp (blue) (2) shrimp (other) (3) shrimp larvae (type) (4) crab (blue) (5) crab (specify) (6) clams(7) mussells (8) snails (9) lobster (10) fish (specify) (11) other (specify) (12)	17 what is the estimated weight per day? (unit codes)	18 what is the most recent price received? (unit codes)	19 what is your second most common catch, based on weight? CATCH CODES shrimp (white) (1) shrimp (blue) (2) shrimp (other) (3) shrimp larvae (type) (4) crab (blue) (5) crab (specify) (6) clams(7) mussells (8) snails (9) lobster (10) fish (specify) (11) other (specify) (12)	20 what is the estimated weight per day? (unit codes)	21 what is the most recent price received? (unit codes)	22 what is your third most common catch, based on weight? CATCH CODES shrimp (white) (1) shrimp (blue) (2) shrimp (other) (3) shrimp larvae (type) (4) crab (blue) (5) crab (specify) (6) clams(7) mussells (8) snails (9) lobster (10) fish (specify) (11) other (specify) (12)	23 what is the estimated weight per day? (unit codes)

ID CODE	24 what is the most recent price received per unit?	25 Do you use the mangroves for anything else other than collecting seafood? YES (1) NO (2) (>28)	26 If yes to Q25, describe activity	27 If yes to Q25, what is the estimated monetary value of this activity per day (specify per activity)	28 Have you had any disease outbreaks relating to shrimp in the past year? YES (1) NO (2) (>30)	29 If yes to Q28, what types of diseases? (specify type of shrimp if applicable) DISEASE CODES White spot (1) Taura syndrome (2) Infectious Hypodermal and Hematopoietic Necrosis (IHHN) (3) Other (specify) (4)	30 If no to Q28, have you ever had a disease outbreak in the time or collecting in the mangroves? YES (1) NO (2) (>34)	31 If yes to Q30, what types of diseases? (specify type of shrimp if applicable) DISEASE CODES White spot (1) Taura syndrome (2) Infectious Hypodermal and Hematopoietic Necrosis (IHHN) (3) Other (specify) (4)	32 If yes to Q28 or Q30, can you estimate the monetary value of the damage caused to you?	33 If yes to Q28 or Q30, how long did were you unable to collect in the mangroves?	34 Additional Comments

Part 7: Employment (Mangroves)

	1 Are there any employers within this community that are involved in the business of [...]?	2 What are they cultivating at [...]?	3 Where do these employers sell their goods? (3 most common)	4 What is the average price they receive for [...]?	5 Do people in this community hire workers for [...]?	6 How much is a worker paid per day for [...]?	7 How much are workers paid per hectare of land/pond for [...]?	8 Provide a description of the jobs for [...]
A. Shrimp Farming								
B. Mangrove Planting/Monitoring								
C. Mangrove Fishing								
D. Livestock Farming								
E. Agriculture Farming								
F. Other (eg. Tagua)								

Part 3: Industry

I would like to ask you some questions about employment opportunities in and around this community.

1. Which activities are the most important sources of employment for individuals in this community?

1ST ☐
2ND ☐
3RD ☐

```
FARMING, ..........1
FORESTRY, HUNTING, ..........2
FISHING - free ocean ..........3
shrimp farming ..........4
mangrove ..........5
MINING..........6
INDUSTRY..........7
ELECTRICITY, WATER, GAS..........8
BUILDING CONSTRUCTION..........9
LARGE TRADE, RETAIL TRADE,
 RESTAURANTS, HOTELS..........10
TRANSPORTATION AND COMMUNICATION....11
OTHER SERVICES (HAIRCUTTING,
 TAILORS, ETC..........12
CRAFTS, SMALL-SCALE TRADE..........13
```

2. Do people in this community leave temporarily during certain times of the year to look for work elsewhere?

```
YES...1
NO....2(»5)
```
☐

3* Where do most of them go?

```
URBAN AREAS (same
province).....1
RURAL AREAS.(same
province).....2
sierra .....3
amazon .....4
overseas .....5
(include province codes)

OVERSEAS.....5
```
☐
☐

4. What type of work do they look for?

☐

```
FARMING, ..........1
FORESTRY, HUNTING, ..........2
FISHING - free ocean ..........3
shrimp farming ..........4
mangrove ..........5
MINING..........6
INDUSTRY..........7
ELECTRICITY, WATER, GAS..........8
BUILDING CONSTRUCTION..........9
LARGE TRADE, RETAIL TRADE,
 RESTAURANTS, HOTELS..........10
TRANSPORTATION AND COMMUNICATION....11
OTHER SERVICES (HAIRCUTTING,
 TAILORS, ETC..........12
CRAFTS, SMALL-SCALE TRADE..........13
```

5. Do people come to this community temporarily during certain times of the year to look for work?

☐

6* Where do they come from?

☐

```
URBAN AREAS (same
province).....1
RURAL AREAS.(same
province).....2
sierra .....3
amazon .....4
OVERSEAS.....5
(include province codes)
```

☐

7. What type of work do they look for?

☐

```
PROFESSIONAL.....1
CLERICAL.....2
SALES.....3
SERVICE.....4
FARM, FORESTRY, FISHING.....5
FACTORY.....6
TRANSPORTATION/VEHICLE OPERATION.7
CONSTRUCTION.....8
OTHER (SPECIFY_____).....9
```

8

Additional Comments

Part. 4: Migration

1. Is electricity available in this community? By available, we mean do any households in this community have electricity?

YES..1
NO...2 (»11)

2* What percentage of households in this community use electricity?

%

	3* Does [...] supply any electricity in this community?		4* Are there times when electricity from [...] is not available?	5* How often does electricity from [...] quit working? DAY.....3 WEEK.....4 FORTNIGHT.....5 MONTH.....6 QUARTER.....7 HALF YEAR.....8 YEAR.....9		6* What is the percentage of community that pays for electricity?
		YES..1 NO...2 (»NEXT LINE)	YES..1 NO...2 (»6)	TIMES	TIME UNIT	
A	State Electricity Company					
B	Local Government Agency					
C	Private Corporation/Cooperative					
D	Individual Generator					
E	Other(SPECIFY_____)					

Part. 6: Energy

	1. Please describe important events that have taken place in this community since [FIVE YEARS AGO] including any events that have occurred this year. We are particularly interested in events that have changed the well - being of people in this community. Examples of events that may have made people better off are new housing projects, a factory that opened, or construction of a new road. Examples of events that might have made people worse off are fires, crop failures, famines, droughts, and other sorts of natural disasters. (specify separately if related to mangroves or shrimp farming) WRITE DOWN THE RESPONSE AND THE CODE . FIRE (1) PROJECT (7) FLOOD (2) EARTHQUAKE (3) DROUGHT (4) MANGROVE DEPLETION (5) MANGROVE REGENERATION (6) DEVELOPMENT EPIDEMIC (8) SHRIMP PONDS (9) SCHOOL (10) ROAD (11) INSECT/CROP BLIGHT (12) OTHER	TYPE	2. In what year did this event occur? YEAR	3. Did this event make people in this community better off or worse off? BETTER (1) WORSE (2) SOME OF BOTH (3)	4. What proportion of the community was affected ? PERCENT
A					
B					
C					

Part. 8: Recent events

1* IS THE AIR IN THIS COMMUNITY POLLUTED?

YES...1
NO....2

2* ARE THERE PILES OF EXPOSED GARBAGE PILE VISIBLE ALONG THE ROADS?

YES...1
NO....2

3* IS ANIMAL MANURE VISIBLE ALONG THE ROADS TO THE COMMUNITY CENTER?

YES...1
NO....2

4* ARE THERE OBSTRUCTED SEWERS, GUTTERS, OR CANALS IN THIS VILLAGE?

YES...1
NO....2

5* ARE THERE STANDING POOLS OF WATER (NOT INCLUDING MARSHES, LAKES) IN THIS VILLAGE?

YES...1
NO....2

6* ARE THERE ANY LARGE LIVESTOCK VISIBLE ROAMING ARGUND THE HOUSES?

YES...1
NO....2

7* ARE THE HOUSE YARDS IN THIS COMMUNITY SWEPT CLEAN?

YES...1
NO....2

8. WHAT MATERIAL IS MOST COMMONLY USED FOR THE OUTSIDE WALLS OF THE HOUSES IN THIS COMMUNITY? TOP 3

CEMENT (1)
BOARDS (2)
BAMBOO (3)
MUD (4)
OTHER (SPECIFY) (5)

9. WHAT MATERIAL IS MOST COMMONLY USED FOR THE FLOORS OF THE HOUSES IN THIS COMMUNITY? TOP 3

STONE (1)
TILES (2)
CEMENT (3)
WOOD (4)
BAMBOO (5)
DIRT/SAND (6)
OTHER (SPECIFY) (7)

10. WHAT MATERIAL IS MOST COMMONLY USED FOR THE ROOFS OF THE HOUSES IN THIS COMMUNITY?

CONCRETE (1)
LUMBER (2)
TIN (3)
ASBESTOS (4)
TILE (5)
LEAVES (6)
THATCH (7)
OTHER (SPECIFY) (8)

PLEASE RECORD OTHER IMPRESSIONS OF THE COMMUNITY THAT ARE RELEVANT TO THE TOPICS COVERED IN THIS QUESTIONNAIRE

11. IS THE GRASS GROWING IN PUBLIC SQUARES GENERALLY WELL CARED FOR?

YES.....1
NO.....2
NO PUBLIC SQUARES..3

12. DO THE HOUSES IN THIS COMMUNITY TYPICALLY USE GLASS WINDOW PANES?

YES...1
NO....2

13. DO THE CHILDREN IN THIS COMMUNITY TYPICALLY WEAR NEAT CLOTHING?

YES...1
NO....2

14. DO THE CHILDREN UNDER 10 IN THIS COMMUNITY TYPICALLY WEAR SHOES?

YES...1
NO....2

15. DO THE ADULTS IN THIS COMMUNITY TYPICALLY WEAR NEAT CLOTHING?

YES...1
NO....2

16. DO THE ADULTS IN THIS COMMUNITY TYPICALLY WEAR SHOES?

YES...1
NO....2

17. WHAT PAVEMENT MATERIAL IS USED MOST FREQUENTLY FOR THE ROADS IN THIS COMMUNITY?

ASPHALT (1)
ROCKS (2)
DIRT (3)
OTHER (SPECIFY) (4)

Question to residents: Who has access to community land? (rank 1-3)

HIGHEST BIDDERS (1)
INHERITED RIGHT (2)
ALL COMMUNITY MEMBERS (3)
ANYONE, INCLUDING OUTSIDERS (4)
OTHER (SPECIFY) (5)

Part. 10: Observations

Table 11-2 Descriptive statistics – Muisne mangrove dependency across education levels (detailed)

Mangrove Dependency (% hours)	Education Levels							
	Zero Education	Kindergarten	Did not complete ES (2)	Completed ES (7)	Did not complete HS (8)	Completed HS (13)	Higher than HS (14)	Total
0	20.42	4.93	28.17	14.08	21.83	7.75	2.82	100
0.007407	100	0	0	0	0	0	0	100
0.011583	0	0	0	100	0	0	0	100
0.032558	0	0	0	0	100	0	0	100
0.034483	100	0	0	0	0	0	0	100
0.040248	100	0	0	0	0	0	0	100
0.047619	0	0	0	100	0	0	0	100
0.066496	0	0	100	0	0	0	0	100
0.074627	100	0	0	0	0	0	0	100
0.088235	0	0	100	0	0	0	0	100
0.089286	0	0	0	0	100	0	0	100
0.09434	100	0	0	0	0	0	0	100
0.111111	0	0	100	0	0	0	0	100
0.11811	0	0	100	0	0	0	0	100
0.121951	0	0	100	0	0	0	0	100
0.125	0	0	0	0	100	0	0	100
0.130435	0	0	100	0	0	0	0	100
0.134832	0	0	0	0	100	0	0	100
0.142857	0	0	0	50	0	50	0	100
0.163934	0	0	0	0	100	0	0	100
0.166667	0	0	0	50	0	0	50	100
0.190476	0	0	0	0	0	100	0	100
0.2	0	0	100	0	0	0	0	100
0.204546	100	0	0	0	0	0	0	100
0.25	0	0	100	0	0	0	0	100
0.253623	0	0	0	0	100	0	0	100
0.267176	100	0	0	0	0	0	0	100
0.310345	0	0	100	0	0	0	0	100
0.352761	100	0	0	0	0	0	0	100
0.375	0	0	0	100	0	0	0	100
0.382979	0	0	0	0	100	0	0	100
0.392857	0	0	0	0	100	0	0	100
0.4	0	0	0	0	0	100	0	100
0.483871	0	0	100	0	0	0	0	100

Mangrove dependency (% hours)	Total household income category				
	Very low	Low	Medium	High	Total
0.2	0	0	100	0	100
0.2045455	0	0	100	0	100
0.25	100	0	0	0	100
0.2536232	0	0	0	100	100
0.2671756	0	100	0	0	100
0.3103448	100	0	0	0	100
0.3527607	0	0	100	0	100
0.375	0	100	0	0	100
0.3829787	0	100	0	0	100
0.3928571	0	0	100	0	100
0.4	0	0	100	0	100
0.483871	0	0	100	0	100
0.5	100	0	0	0	100
0.5454546	0	0	100	0	100
0.6666667	0	66.67	33.33	0	100
0.8	0	0	0	100	100
0.8181818	0	100	0	0	100
1	20	46.67	20	13.33	100
Total	***23.62***	***25.63***	***25.13***	***25.63***	***100***

Table 11-3 Descriptive statistics – Muisne mangrove dependency across household income categories (detailed)

Table 11-4 Descriptive statistics – Muisne mangrove dependency across household income per adults in household income categories (detailed)

Mangrove dependency (% hours)	Total household income per adults in household category				
	Very low	Low	Medium	High	Total
0	28.17	20.42	20.42	30.99	100
0.0074074	0	0	100	0	100
0.011583	100	0	0	0	100
0.0325581	0	100	0	0	100
0.0344828	0	0	100	0	100
0.0402477	0	0	0	100	100
0.047619	0	0	100	0	100
0.0664962	0	0	100	0	100
0.0746269	100	0	0	0	100
0.0882353	0	0	100	0	100
0.0892857	0	0	100	0	100

12 Appendix D – Community survey data

Table 12-1 Community survey data – General information

Community	Province	Community (Canton)	Parroquia	Top three industries			Population	General Details
Borbón	Esmeraldas	Eloy Alfaro	Borbón	Agriculture	Livestock		6,800	
Límones	Esmeraldas	Eloy Alfaro	San Pedro y San Pablo	Agriculture	Livestock	Shrimp Farms	6,000	
La Tola	Esmeraldas	Eloy Alfaro	La Tola	Shrimp Farms	Agriculture	Livestock	1,700	
Rio Verde	Esmeraldas	Rio Verde	Rio Verde	Industria / Mineria / Fabricacion	Livestock	Shrimp Farms	5,000	
Tonchigue	Esmeraldas	Atacames	Tonchigue	Agriculture	Livestock	Shrimp Farms	10,000	Population of Parroquia
Súa	Esmeraldas	Atacames	Sua	Agriculture	Livestock	Shrimp Farms	2,310	
Cabo de San Fransisco	Esmeraldas	Muisne	San Francisco	Business	Agriculture	Livestock	2,554	
Bunche (and River)	Esmeraldas	Muisne	San Francisco	Agriculture	Shrimp Farms	Livestock	800	
Muisne	Esmeraldas	Muisne	Muisne	Agriculture	Shrimp Farms	Business	10,000	
Mompiche	Esmeraldas	Muisne	Muisne	Livestock	Agriculture	Tourism	800	
Mompiche hasta las manchas	Esmeraldas	Muisne	Muisne	Livestock	Agriculture	Shrimp Farms	750	
San Gregorio	Esmeraldas	Muisne	San Gregorio	Shrimp Farms	Agriculture	Livestock	660	Parroquía population 7,000; houses 1,000
Bolívar	Esmeraldas	Muisne	Bolívar	Shrimp Farms	Agriculture	Mangrove (concheros)	800	
Daule	Esmeraldas	Muisne	Daule	Shrimp Farms	Agriculture	Mangrove (concheros)	900	
Pedro Carbo	Esmeraldas	Muisne	Daule	Agriculture	Shrimp Farms	Livestock	700	
San Jose de Chamanga	Esmeraldas	Muisne	Chamanga	Shrimp Farms	Livestock	Agriculture	5,000	
Cojimies	Manabí	Pedernales	Cojimies	Shrimp Farms	Livestock	Agriculture	2,000	

Table 12-2 Community survey data – Mangrove details

Community	Estimated Dependency on Mangroves	Current Mangrove (Ha)	Original Mangrove (Ha)	Mangrove Remaining	Mangroves Reforested (% or Ha)*	Reforestation Details
Borbón	12%	2,565^				
Límones	70%					
La Tola	70%	200			9 Ha	"The company" (El Rosario); APACOVIN de Parroquia, reforested the whole river, 2 ha is in La Tola; The people who live in the estuary have been reforesting
Rio Verde	30%					
Tonchigue	27%	1.5	2	75%	100%	The community in a program with the European Union
Súa	n/a	20				The mangroves that were cut were from urbanization, the shrimp farms are from high land (*tierra firme*)
Cabo de San Fransisco	10%	25	45	56%		An ecological group, *Brisas del Mar* made up of students and the community reforested 2,000-3,000 plants
Bunche (and River)	30%	8	33	24%	37.50%	Jatun Sacha, FUNDECOL
Muisne	80%	*3,175*	*20,080*	16%	*12.60%*	FUNDECOL and communities, also includes natural regeneration, the shrimp farmers left re. White Virus
Mompiche	5%	15	23	65%	5 ha	FUNDECOL and the community
Mompiche hasta las manchas	20%	800	1,045	77%	10 ha	from shrimp farmers, they are reforesting for the law (referring to Decree 1391)
San Gregorio	100%	3,000	6,000	50%	3.33	FUNDECOL is always reforesting
Bolívar	100%					Asociacion virgen de las lajas with FUNDECOL
Daule	40%	5			10 ha	Fundecol y organización de Daule - Asociación en Defensa de Manglar; 8 years, since 2001
Daule (2)	n/a	60	85	71%	2 ha	Fundecol ('apparently')
Pedro Carbo	0%	120	400	30%	0	
San Jose de Chamanga	20%	300	1,600	19%	66.67%	FUNDECOL
Cojimies	n/a (low)					
Pedernales	n/a (low)	3,000	17,000	18%	0	
Jama	n/a (low)	8 km	8 km		0	shrimp farms are only on high land**
San Andres de Canoa	n/a (low)	3	7	43%	100%	the community reforested 6 years ago, because of El Niño
San Andres de Canoa y Biceño	n/a (low)	3	80	4%		

Community	Mangrove meetings in community?	Frequency of meetings	Details	Additional Notes
			Bunche	
Bunche (and River)	Yes	Monthly	FUNDECOL, Jatun Sacha, the community	
Muisne	Yes	weekly	FUNDECOL y mujeres conchera (female shellfishers)	Mangrove area is for total canton of Muisne; pescadores, carboneros, concheras all work with FUNDECOL they are planning to reforest 5000Ha now
Mompiche	Yes	Monthly	FUNDECOL	
Mompiche hasta las manchas	Yes	Monthly	FUNDECOL when there is a problem	
San Gregorio	Yes		FUNDECOL	
Bolívar	Yes	Weekly	Reforesting and talking about the contamination	
Daule	Yes	Monthly	Saturdays, Asociación de defensa de manglar, for reforestation and other projects	APROCAN - org de Agricoles u Artesanales, monthly meetings; women groups - CENDEC, CEPACA; the community is caring for the mangroves; the people protest if mangroves are cut or exploited
Daule (2)		Quarterly	Daule - Asociación devino niños in coordination with FUNDECOL	
Pedro Carbo	Yes		They meet for many topics, mangroves are sometimes	The community depended on mangroves 80%, but now there is no access
San Jose de Chamanga	Yes		Meeting in Muisne (el canton) with FUNDECOL	
Cojimies	Yes		Meeting with ecocosta (from Guayaquil), de costero no solo de manglar, FUNDECOL works here, but very little only the part in Esmeraldas province	This area is extremely deforested; there are many shrimp ponds
Pedernales	No	N/A		Mangrove area is for canton, includes Cojimies
Jama	No	N/A		mangroves are 8km along the river only
San Andres de Canoa	No	N/A	Meetings before because of El Niño they reforested el rio KNOA and rio Muchacho	
Bahía de Caraquez á Salinas	Yes	Weekly	Planet Drum y Fundación Estuario; to protect the Isla Corazon; also the fishers and agriculturists do not cut mangroves; they work with other communities	The protection and conservation of estuario del rio Chone; to protect against urbanization and contamination of natural resources
San Jacinto ' La Boca	Yes	whenever necessary		Asociacion Comunitaria Manglar la Boca San Jacinto, for the ecosystem (10 years), to protect and control the mangroves; money from C-CONDEM with FUNDECOL and Ecua Ecuatorianos; reforesting a 5 ha shrimp farm, dried out the shrimp farm, FUNDECOL is important for reforestation

Table 12-3 Community survey data – Shrimp farming details

Area	Local shrimp farm employees?	Details of employment	Wage*	Organic Shrimp	Different regulations for small and large companies	Regulated by local and/or central government	Details
Borbón	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Límones	Yes	work 22 days/month	$12/day	No	No	No	
La Tola	Yes		$8/day		No	No	
Rio Verde	Yes		$15-20/day; $200-250/month	No	No	Yes	Local and central, but do not function very well
Tonchigue	Yes	Minimal no. locals are employed, not usually as shrimp farmer	$10/day; $400/month	Yes	No	Yes	Central; the marina visits here
Súa	Yes		$12.5/day	Yes	No	1	Regulated by Banco de Fermento (shrimp farmer, agriculture, livestock)
Cabo de San Fransisco	Yes	Only for cultivation; The shrimp farmers are not local		No	No	No	Large companies have regulations to export, but there is no producto grupo here
Bunche (and River)	Yes	Mostly only to cultivate the shrimp, not usually hired for monthly shrimp farm job	$10/day; $200/month	Yes	No	No	
Muisne	Yes		$10/day; $200/month	No	Yes	No	
Mompiche	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Mompiche hasta las manchas	Yes	average 15 people per shrimp farmer, per cultivation; also hire for shrimp farmers, but not very often	$18/day; $200/month	Yes	No	Yes	The marina to examine the use of strong chemicals
San Gregorio	Yes		$9/day	Yes		No	
Bolívar	Yes		$8-10/day; $120/month	n/a		No	

Table 12-3 Community survey data – Shrimp farming details

Area	Top three sale locations of community shrimp production			Additional Notes
Borbón	N/A	N/A	N/A	
Límones	Guayaquil	Quito	Export	
La Tola	Exporta	Guayaquil to export		
Rio Verde	Manta	Local	Esmeraldas	
Tonchigue	Guayaquil	Exporta		
Súa	Manta (para exportar)			
Cabo de San Fransisco	Muisne	Cabo	Otro Lado	
Bunche (and River)	Local	Chamanga	Guayaquil	
Muisne	Local	Guayaquil	Chamanga	
Mompiche	N/A	N/A	N/A	
Mompiche hasta las manchas	Local	Esmeraldas	Guayaquil	
San Gregorio	Chamanga	Guayaquil	Quito	
Bolívar	Guayaquil	Quito		Re: organic certification, the shrimp farmers use chemicals, but do not know if cert.
Daule	Pedernales	Guayaquil	Daule	
Daule (2)	Guayaquil	Quito	Daule	
Pedro Carbo	Manta	Pedernales	Guaya	
San Jose de Chamanga	Pedernales	Guayaquil	Manta	ACEBAR in Muisne always hold meeting with the shrimp farmers
Cojimies	Local	Pedernales	Manta	
Pedernales	Europa	USA		
Jama	Local	Pedernales	Exportar	
San Andres de Canoa	Local	Pedernales	Guayaquil	
Bahía de Caraquez á Salinas	Local	Nacional	Exporter	Previously there were 6 larva laboratories
San Jacinto ' La Boca	Manta			

Table 12-4 Community survey data – Property rights and taxes

Area	Land Access	Who makes decisions based on community land	Details	Clear property rights?	% Shrimp farms considered illegal**	Details
Borbón	Anyone	Township			N/A	
Límones	Anyone	Municipality		No	100%	
La Tola	Anyone	Junta y reserva, Cayapas-Mataje Ecological Mangrove Reserve 51,300Ha				
La Tola (2)	Anyone	Municipality		No	100%	
Rio Verde	Anyone	Municipality		No	80%	Procession is not clear about this, there is no one manager, they came to prepare the mangroves but then they left and others came
Tonchigue	Anyone	Township		Yes	0	All shrimp farms are from high land (*tierra firme)*
Súa	Anyone	Township and Atacames Municipality		Yes	0	All shrimp farms are from high land (*tierra firme)*
Cabo de San Fransisco	n/a	President of Parroquia	Speaks with organizations, police, *junta civil; depends on the project*	Yes	0	All shrimp farms are from high land (*tierra firme)*
Bunche (and River)	Anyone	Township and Muisne Municipality		No	70%	The shrimp farms that are from high land (*tierra firme*) are not illegal
Muisne	Anyone	Municipality		No	90%	Depends on whether they are from the mangroves, most are; the legal farms are from high land (*tierra firme*)
Mompiche	Anyone	Township		Yes	N/A	
Mompiche hasta las manchas	Anyone	Township		No	35%	35% are from mangrove land and do not have a clear property right; the farms from high land (*tierra firme*) have clear rights

Table 12-4 Community survey data – Property rights and taxes

Area	Land tax payments per hectare^		Is this tax redistributed to the community?		Details	% of taxes paid	
	Shrimp Farm	Farm land	Shrimp Farm	Farm Land		Shrimp Farm	Farm Land
Borbón	6.8	4.8	No	No		20	10
Límones	6.8	4.8	No	No		20	10
La Tola	6.8	4.8	No	No		20	10
La Tola (2)	6.8	4.8	No	No		20	10
Rio Verde	3.5	1.5	No	No		n/a	n/a
Tonchigue	2	2	Yes	Yes	Redistributed eg. Schools, roads, etc.	80	n/a
Súa	2	2	Yes	Yes		80	n/a
Cabo de San Fransisco	3.2	0.9	No	No	Only the legal shrimp farms need to pay	10	30
Bunche (and River)	3.2	0.9	No	No		10	30
Muisne	3.2	0.9	No	No		10	30
Mompiche	3.2	0.9	No	No		10	30
Mompiche hasta las manchas	3.2	0.9	No	No		10	30
San Gregorio	3.2	0.9	No	No		10	30
Bolívar	3.2	0.9	No	No		10	30
Daule	3.2	0.9	No	No		10	30
Daule (2)	3.2	0.9	No	No		10	30
Pedro Carbo	3.2	0.9	No	No		10	30
San Jose de Chamanga	3.2	0.9	No	No		10	30
Cojimies	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Pedernales	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Jama	0.2	0.2	Yes	Yes	Redistributed for roads, etc.	n/a	n/a
San Andres de Canoa	3	3	No	No	.05% rural, ~$6,000 per Ha; shrimp farmers pay marina Ecuador per Ha, municipality receives nothing; 0.15% for urban land tax	n/a	n/a

Table 12-5 Community survey data – Government monitoring and reforesting programs

Area	Is there a local agricultura centre or cooperative?		Agriculture inspection visits in the past 12 months		Government agent visits in the last 12 months		
	Yes or No	Details	Agriculture	Mangroves	Times	Agent Type	Details
Borbón	Yes	Many groups	0		0		There are no more shrimp farms
Límones	Yes	They have to have a card if they farm agriculture	2		12	Canton	There is an inspector from Limones for the Canton, available year-round
La Tola				9	12	Environment Ministery	They announce that they come, but do not do anything
La Tola (2)	No		0	0			
Rio Verde	No	Only fisheries department and European Union	0	0			
Tonchigue	Yes	ECUCACAO	2	0	0		Inspector visits for the livestock
Súa	No		12	0	0		
Cabo de San Fransisco	Yes	Cacao Federation (organic in Tonchigue), cooperacion de pesca	1	0	0		
Bunche (and River)	Yes	Some of the farmers are involved					
Muisne	Yes	Some of the farmers are involved	1		4	Environment Ministery	They call the shrimp farmers for a meeting, they do not visit the farms
Mompiche	No		0		0		Only local government
San Gregorio	No	Only with the school, children plant trees	12	0	0		
Bolívar	No		0	0	0		FUNDECOL brings the Ministry of Environment, more

Table 12-5 Community survey data – Government monitoring and reforesting programs

Area	Shrimp farm cooperative in the community?		Government agent visits to investigate mangrove activity in the last 12 months		Government mangrove reforestation program?		Additional organizations
	Yes or No	Details	Times	Agent Type	Yes or No	Details	
Borbón	No	N/A	30	Minister of the Environment	Yes	Ministery of Environmet with community groups, always	Foundations are visiting to inspect the fishing (always)
Límones	No		12		Yes	The community and Ministry of Environment	
La Tola	No		n/a		No		Fishing cooperative '15 de junio'; for sustainability of the ocean; national financial cooperative for 5 years
La Tola (2)	No		0		No	Before there was a group from Japan, not from Ecuador	fishing cooperative, to buy and sell (cannot sell otherwise)
Rio Verde	Yes	Many associations help with processions, viruses, etc.	3	Ministry of Environment	No	Before, the Ministry of Agriculture, now the European Union is reforesting; the people here reforest, they do not cutdown	More than before, helping for whatever, to see crabs and shrimp
Tonchigue	No		0		No	only a group from the European Union	
Súa	No	only 1 owner	0	only Atacames	No		Always visiting for plants and seeds, only tourists are visiting the mangroves
Cabo de San Fransisco	N/A		0		Yes	Yes, but only the government from here, not Esmeraldas or Ecuador	NAZCA - works with artisanal fishers and the marina reserva
Bunche (and River)	Yes	ACEBAE	2		No	only FUNDECOL	types of mangroves, 20% Mangrove rhizophoraceae and Rhizophora Harrisonii
Muisne	Yes	ACEBAE	2		No	only FUNDECOL	types of mangroves, 20% Mangrove rhizophoraceae and Rhizophora Harrisonii
Mompiche	No		3	FUNDECOL and the Marina	No	only FUNDECOL	if mangroves are cutdown FUNDECOL will give a fine (but did not know details)
Mompiche hasta las manchas	No	Can join ACEBAE from Muisne	0		No	2008 they cannot cut and have to reforest	Agriculture & mangroves only FUNDECOL; the national agriculture centre

Area	Shrimp farm cooperative in the community?		Government agent visits to investigate mangrove activity in the last 12 months		Government mangrove reforestation program?		
	Yes or No	Details	Times	Agent Type	Yes or No	Details	Additional organizations
San Jacinto ' La Boca	No		1	Ministry of Environment	Yes	National government, but before, not now	Before, they asked the government to help with there lives and everything with mangroves. Every day there is more contamination. If the government does not help, do not know what will happen
La Isla Puna	No		0		Yes	The community and a foundation, but before, not now	

Table 12-5 Community survey data – Government monitoring and reforesting programs

Area	Households		Electricity providers			Energy cuts occur?			Energy cut info		Details
	With electricity	That pay	State Electricity	Private company	Generator (individual)	State Electricity	Private company	Generator (individual)	Frequency	Average (hours)	
Pedro Carbo	97%	35%	Yes	No	No	Yes	N/A	N/A	Daily	1	
San Jose de Chamanga	90%	30%	Yes	No	No	Yes	N/A	N/A	Daily	1	
Cojimies	85%	10%	Yes	No	Yes	Yes	N/A	No	Daily	1	
Pedernales	98%	96%	Yes	No	Yes	No	N/A	No	N/A	N/A	If they do not pay, they cutthe energy; maybe 4% steal; only cuts when there is a lot of wind for example.
Jama	95%	95%	Yes	No	No	No	N/A	N/A	N/A	N/A	
San Andres de Canoa	100%	100%	Yes	No	No	No	N/A	N/A	N/A	N/A	
San Andres de Canoa y Biceño							N/A	N/A	N/A	N/A	
Bahía de Caraquez to Salinas	90%	60%	Yes	No	No	No	N/A	N/A	N/A	N/A	energy cuts when working on the transformer and sometimes with the wind
San Jacinto ' La Boca	100%	70%	Yes	No	No	No	N/A	N/A	N/A	N/A	only cuts when there is an accident
Palmar	95%	100%	Yes	No	No	No	N/A	N/A	N/A	N/A	If they do not pay they owe the state. Now the poor people pay monthly, because they cannot pay a lot. The state also pays some to help the poor, eg. 40% free; only cuts when there is an accident, doesn't happen often
La Isla Puna	50%	60%	No	Yes	Yes	N/A	Yes	No	Daily	10	the energy cuts from 5-10am and 6-11pm; depends on the community: 4 communities without energy, 5 with energy (campo alegre, bellavista, sube alta, estero de boca, una via)

Table 12-6 Community survey data - Energy cuts, household payment and further details

Area	Quality of life (5 years)	Top 3 reasons (*worse*, better)			Details
San Jose de Chamanga	Worse	*resource contamination*	*less concha*	health care	contamination hurts the fishing
Cojimies	Better	skills improvement	health care	social services	change in opportunity for the population, to improve skills
Pedernales	Worse	*shrimp disease*	*resource contamination*	*Mangroves*	the mangroves have affected the community very severly
Jama	Better	change in agriculture policy	Tourism	social services	
San Andres de Canoa	Better	tourism	better prices		
Bahía de Caraquez á Salinas	No change				
San Jacinto ' La Boca	Worse	*resource contamination*	*shrimp disease*	*Dryness*	Dry season in the summer, not enough water for farming
Palmar	Better	drinking water	Electricity	Schools	electricity, there wasn't much before; building schools
La Isla Puna	Better	health care	Employment	*resource contamination*	employment: tourism, and agriculture planted cacao and mango; the shrimp farms are still polluting

Table 12-7 Community survey data - Quality of life: change in past 5 years

Reference	Source	Mangroves														
		1969	1980	1983	1984	1986	1987	1990	1991	1995	1996	1999	2000	2005	2010
Southgate (1992)		203700			182100		175100								
Bravo (n.d.)	CLIRSEN	203695			182157		175157		162186	146938		149556			
Estudio Multitemporal de Manglares, Camaroneras y Salinas, and CLIRSEN							362802					154087.3		108000	
Gobierno de Ecuador (2008)							365000							108000	

Table 13-1 Secondary research data – Mangrove land cover estimates for Ecuador

Reference	Salt Flats		
	1969	1984	1987
Southgate (1992)	51500	20000	12400

Table 13-2 Secondary research data - Salt flat land cover estimates for Ecuador

Reference	Source	Shrimp Ponds							
		1969	1984	1987	1991	1995	2000	2005	2010
Bravo (n.d.)	INEFAN						207000		
Bravo (n.d.)	Cámara Nacional de Acuacultura						170000		
Southgate (1992)		0	89400	117700					
Gongora (2008)	CLIRSEN	0	89368	117728	145998	178071			
El Universo (2010)	Diario Expreso 3-3-2010 (from Dirnea, Dirreción Nacional de Espacios Acuáticos, Cifras feb 17 2010)								162420
Gobierno de Ecuador (2008)			89368				117632	234000	

Table 13-3 Secondary research data - Shrimp farm land cover estimates for Ecuador

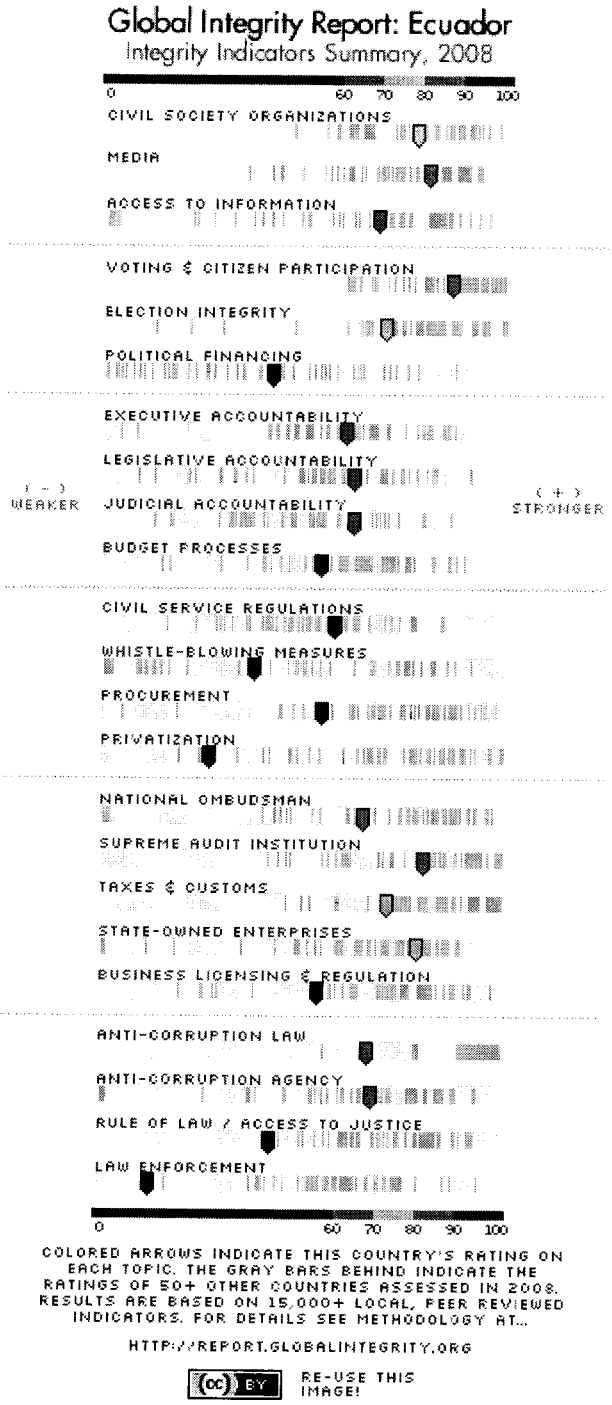


Figure 13-1 Global Integrity Report (Ecuador) 2008

Dia	Item	Detalles	Precio cada Unidad	Unidad	Unidad cada Hectarea	Precio cada Hectarea	Notas
41-49	Balanceado (comida)	28% de camarón	$ 27.00	40 kg	7.5 kg	$ 45.56	30 kg cada 400,000 larva
50-59	Balanceado (comida)	22% de camarón	$ 24.35	40 kg	7.5 kg	$ 45.66	30 kg cada 400,000 larva; camarón tienen ~4 gramos
60	CAL P24		$ 3.75	25 kg	25 kg	$ 3.75	Bajar el agua, tirar (1 saco cada hectarea) para limpiar y disinfectar el agua y suelo, por ejemplo, de cambiar de modar; no se comen esa dia (a veces si no quiere poner CAL P24, ponga carbonato si camarón no esta muy dura, pero la diferencia no tiene significa)
60	ZEOLITA		$ 3.00	30 kg	60 kg	$ 6.00	
61-90	Balanceado (comida)	22% de camarón	$ 24.35	40 kg	10 kg	$ 182.63	40 kg cada 400,000 larva
					Subtotal Cost (never sick)	**$ 552.64**	
	Si estan enferma						
60	Formycine (Antibiotico)	ver las fotos	$ 36.00	4 litros	1 litro	$ 9.00	Solo poner una vez, cuando la camarón estan enferma (a veces enferma 2 veces , dia 80 más o menos)
61	Balanceado (comida)	22% de camarón	$ 24.35	40 kg	10 kg	$ 6.09	40 kg cada 400,000 larva (igual que no enferma, pero tiene que llenar el agua también)
62	Balanceado (comida)	22% de camarón	$ 24.35	40 kg	10 kg	$ 6.09	40 kg cada 400,000 larva (igual que no enferma)
63	Fitovlon		$ 20.00	25 kg	15 kg	$ 12.00	Bajar el agua para tirar el antibiótico; ponerlo para que el agua tiene mas alga, etc.
63	Minercine		$ 25.00	30 kg	5 kg	$ 4.17	
63	Balanceado (comida)	22% de camarón	$ 24.35	40 kg	10 kg	$ 6.09	40 kg cada 400,000 larva (igual que no enferma)
						$ 43.43	

Dia	Item	Detalles	Precio cada Unidad	Unidad	Unidad cada Hectarea	Precio cada Hectarea	Notas
			$ 0.11	10 gramos	$ 1.10	**$ 1,100.00**	si tienen 10 gramos; cultiva 1,000 libras cada hectárea
					Gana cada pesca	$ 426.11	
					Gana cada mes	**$ 142.04**	
			$ 0.11	11 gramos	$ 1.21	**$ 1,210.00**	si tienen 11 gramos; cultiva 1,000 libras cada hectárea
					Gana cada pesca	$ 536.11	
					Gana cada mes	**$ 178.70**	
			$ 0.11	9 gramos	$ 0.99	**$ 1,500.00**	si tienen 9 gramos, entonces se gana $1.00 cada libra; cultiva 1,500 libras cada hectárea
					Gana cada pesca	$ 826.11	
					Gana cada mes	**$ 275.37**	
			$ 0.11	10 gramos	$ 1.10	**$ 1,650.00**	si tienen 10 gramos; cultiva 1,500 libras cada hectárea
					Gana cada pesca	$ 976.11	
					Gana cada mes	**$ 325.37**	
			$ 0.11	11 gramos	$ 1.21	**$ 1,815.00**	si tienen 11 gramos; cultiva 1,500 libras cada hectárea
					Gana cada pesca	$ 1,141.11	
					Gana cada mes	**$ 380.37**	

Table 14-1 Primary research data – Shrimp aquaculture accounting for a typical shrimp pond in Muisne area

Area	Province	Satellite Shrimp Farming (Observations from Google maps)
San Lorenzo	Esmeraldas	A very high amount of shrimp farms
San Fransisco	Esmeraldas	A low amount of shrimp farms
La Tola	Esmeraldas	A low amount of shrimp farms; 50-50 between abandoned and in-use shrimp farms; on La Isla Tola, a very small amount of shrimp farms; La Palma and island near Progresso have more shrimp farms than La Isla Tola
Montalvo (near the shore)	Esmeraldas	A very low amount of shrimp farms (near the shore)
Rio Verde	Esmeraldas	A medium amount of shrimp farms
Rocafuerte	Esmeraldas	A medium amount of shrimp farms
Cabo de San Fransisco	Esmeraldas	An extremely low amount of shrimp farms
Bunche (and River)	Esmeraldas	A very high amount of shrimp farms
Muisne	Esmeraldas	A very high amount of shrimp farms
Las Manchas	Esmeraldas	A very high amount of shrimp farms
Tortuga (and around)	Esmeraldas	A very high amount of shrimp farms
Bolívar	Esmeraldas	A very high amount of shrimp farms
Daule	Esmeraldas	A very high amount of shrimp farms
San Jose de Chamanga	Esmeraldas	A very high amount of shrimp farms
Cojimies	Manabí	A very high amount of shrimp farms
Beche (and around)	Manabí	A very high amount of shrimp farms
Coaque	Manabí	A high amount of shrimp farms (all the way along the shore from Pedernales Churro beach to Coaque)
Jama	Manabí	A low amount of shrimp farms (right in Jama there is no shrimp farming along the river; towards the beach, the river is surrounded by shrimp farming)
San Andres de Canoa	Manabí	A very low amount of shrimp farms (abandoned shrimp farms closer to Biceño)
Biceño	Manabí	A small amount of shrimp farms
Bahía de Caraquez á Salinas	Manabí	A very high amount of shrimp farms
Ayampe	Manabí	Unreadable
Manglaralto	Guayas	Unreadable
Palmar	Santa Elena	A high amount of shrimp farms
Ayangue	Santa Elena	A high amount of shrimp farms
Monteverde	Santa Elena	A high amount of shrimp farms
Santa Elena	Santa Elena	A high amount of shrimp farms
Chanduy hasta Engunga	Guayas	A high amount of shrimp farms
all ports toward Isla Puna and Guayaquil	Guayas	A very high amount of shrimp farms
La Isla Puna	Guayas	A very high amount of shrimp farms (more on southern and north western parts of island)
Guayaquil	Guayas	An extremely high amount of shrimp farms
Guayaquil á Machala	El Oro	An extremely high amount of shrimp farms

Table 14-3 Secondary research data – Satellite image comparisons (Google maps)

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