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Aquculture and Deforestation in the Peruvian Amazon

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I
Introduction

This thesis analyzes data collected from 184 families in ten different communities in the Condorcanqui region of the Peruvian Amazon (Figure 1) to determine if supplementing traditional subsistence farming with aquaculture would affect deforestation rates. Condorcanqui is a province with an area of over 18,000 square kilometers and a population estimated at 45,000 inhabitants. The land is virtually undeveloped and populated almost exclusively by small communities of Awajún and Wampí tribal people. These indigenous communities generally support themselves through subsistence agriculture, although many families also incorporate aquaculture on their farms. Five of the villages are situated along the banks of the Nieva or Santiago river systems, while the other five are located east of the town of Santa Maria de Nieva and are accessible by road. Data was collected with the assistance of the Research Institute of the Peruvian Amazon (IIAP, pronounced "yap"), which provided a guide who had previously established relationships with all ten communities. All of the families in the sample practice subsistence agriculture, but 104 of the respondents also supplement their agricultural crops with fish from aquaculture ponds. The participants answered a range of questions about the size of their farms and the productivity of their land. As noted above, the resulting data was analyzed to determine if supplementing traditional subsistence farming with aquaculture would affect deforestation rates.

Figure 1. Map of the Peruvian state of Amazonas and the province of Condorcanqui.

<u>The People</u>

The roots of the Awajún and Wampí indigenous tribes of the northern Peruvian Amazon can be traced back to pre-Incan times. Ethno-historians classify these communities as part of the Jivaroan complex (Carrasco 2010). At their height in the late-fourteenth century, Jivaroan speaking people occupied a vast territory that stretched from the highlands in the Ecuadorian Andes to the jungle in the Peruvian Amazon. While the Andean Jivaros were conquered by the Incan Empire and have since assimilated into Andean Quechuan culture, the Amazonian Jivaros were able to resist the attacks of the Incans, and have been able to maintain much of their culture to this day (Carrasco 2010). The 2007 Peruvian census reported over 55,300 Awajún and 10,100 Wampís living in the northeastern Amazon.

The Awajún and Wampí lived nomadic lifestyles until the early 1960's but during the last half century they have settled into agricultural communities like those visited during this study (Yutupis 2009). A chief, called an Apu, leads each community, and land is divided among the families based on necessity and seniority. Although there are various basic jobs within the communities (e.g. teachers, storeowners, community officials) the majority of the population work solely as subsistence farmers. This indigenous lifestyle is one of the poorest in the world; many families earn no money whatsoever, while monthly family income in Condorcanqui averages just $35 (Alcántara et al. 2004).

All the families in this study live in thatched roofed huts, with floors raised 3-4 feet above the ground. The materials used to construct these homes are obtained from the family's land. In rare instances, families are able to afford small generators to provide electricity during the night. The families all use multiple agricultural fields, called *chacras,* to produce a variety of crops. The crops are grown together in each of the chacras, and the main products are yuca, bananas, potatoes, rice, and papaya. In order to harvest fish on their land, the native families construct ponds called *piscigranjas*, which are created by building small dams on creeks. After building the small dam, the resultant pond is equipped with an overflow pipe and is filled naturally with rainwater. The abundance of warm, sun-heated water, as well as the availability of inexpensive overflow pipes and fingerlings (baby fish), has made it possible for Awajún and Wampís to practice aquaculture in the Condorcanqui region (Molnar et al. 2006).

Fishing

Fishing is an essential part of the socio-economic system of the Peruvian Amazon. Fish are the most important source of animal protein in the region, and the main source of cash for indigenous people (McDaniel 1997). The fisheries and aquaculture of the Amazon

River basin are therefore fundamental to the survival and livelihood of its rural populations. Some previous specialists have speculated that aquaculture has the highest potential to nourish rural populations in the Amazon while at the same time implementing minimal levels of environmental degradation (Araujo-Lima and Goulding 1997).

Freshwater fisheries throughout the Amazon have been subject to extreme overexploitation in the past few decades (Rainforest Conservation Fund, 1999). Boats equipped with the latest technology and large-scale storage capacity have threatened native fish stocks in local rivers and oxbow lakes, which in turn has affected the ability of small-scale, native fisherman to support themselves (Rainforest Conservation Fund, 1999). Under the present conditions, it appears certain that the natural fish supplies supporting the rapidly growing Amazonian population will not be accessible for long (Molnar et al. 2000). The depletion of river fisheries, in turn, has encouraged native farmers to supplement their fishing with increased agriculture, wood extraction, and the production of cash crops. Many communities, however, have also turned to aquaculture as a farm-based activity that compliments traditional cultivation techniques (Molnar et al. 2000).

It has been recognized that aboriginal populations in the Amazon have historically been known to have kept fish and other native aquatic animals in large ponds for personal consumption. Interestingly, it does not appear that past Amazonian cultures were able to utilize reproductive techniques on their captive fish populations (Molnar et al. 2000). Recently, however, various institutions and NGOs have begun introducing various aquaculture techniques in the region that have led to an elevated level of knowledge and interest in aquaculture. IIAP is one of the leading research institutes that is assisting the development of fish-farming in the Condorcanqui region.

In fact, IIAP is now the leading governmental organization involved with fisheries research and aquaculture in the Peruvian Amazon, and works to provide fingerlings and educational courses to native aquaculturists. The majority of the respondents in this study were assisted by IIAP with the construction of their fish farms, and most had purchased fingerlings from IIAP's *Colossoma macropomum* (called gamitana in Peru) breeding facility in Nieva. The majority of fish produced in conjunction with subsistence agriculture is consumed in local markets (Martínez 1999), and therefore the aquaculture in Condorcanqui provides a source of protein for the local communities and revenue for aquaculturists.

Deforestation

The Peruvian Amazon's natural resources are subject to extreme pressures due to regional increases in subsistence farming, cattle ranching, and logging. This shift in long-standing land-use practices has resulted in a loss of biodiversity that has affected the delicate soil balance characteristic of the Amazon, and has contributed to water pollution and erosion (Guerra et al. 2001). These land-use changes in the Amazon basin -- and the consequent deforestation rates -- have global as well as local effects. In addition to lowering biodiversity levels, deforestation in the Amazon creates changes in greenhouse gas fluctuations and regional hydrological regimes (Salimon et al. 2004, and D'Almeida et al. 2007). One of the highest rates of deforestation in the Amazon basin is found at the foothills of the Eastern Andes (Lepers et al. 2005), which includes the area in this study, located in the Peruvian state of Amazonas. In this part of the Amazon, deforestation is caused mainly by small-scale subsistence agriculture (Achard et al. 1998) such as the type practiced in the communities of Condorcanqui.

Subsistence Farming

Slash and burn agriculture is the method typically practiced by subsistence farmers in the Peruvian Amazon (Lindell et al. 2009). The farmers in the Condorcanqui region first clear a patch of forest and then burn the slashed organic material on top of the land. Despite significant nutrient losses caused by the burning process, the resulting soil is rich with minerals from the burnt biomass (Sommer et al. 2004). Unfortunately, the positive effects of the burning are depleted over time and, depending on a number of variables, the soil will remain productive for anywhere from a few years to a few decades after the original burning (Eden et al. 1991, and Farella et al. 2007). Most families in this study have multiple fields prepared in this fashion, and once the soil in a current field is depleted, the families slash and burn new areas of forest. The depleted soils of the previously used plots may over time support some vegetation, which can eventually be slashed and burned in order revitalize the soil (Cornell 2007). The vegetation they are able to support, however, is meager in comparison to the natural forest, and thus this secondary slashing and burning does not provide the same quality soil as the original burn (Cornell 2007). Consequently, the families in this study generally choose to clear new patches of land rather than attempting to cultivate on previously depleted soil. This slash and burn technique is extremely destructive to the natural habitat as it results in new forest being cleared every few years. The subsistence farmers have little choice but to continue their unsustainable land-use, as by definition they need to harvest their crops in order to support their families.

II
General Impressions

Although a more detailed anecdotal description of my time in the Amazon is included later in this thesis, it is useful to summarize my impressions of the general situation in Condorcanqui in order to establish a framework for interpreting the results of this study.

The sample area of this study spans three different regions, all of which are part of the Amazon watershed. The first is located along the Santiago river where I solicited surveys in three villages: Yutupis, Villa Gonzalo, and Huabal. These three villages are all situated on the banks of the Santiago and have limited market access. The villagers typically are able to bring their products only to the market in La Poza (one of the larger towns on the lower Santiago), although they can occasionally sell their goods to merchants who bring it to the larger market in Santa Maria de Nieva, on the Marañon River. Most farmers in this study, however, chose not to sell any of their food in markets, instead selling their surplus crops to other families in their village, or not at all.

The second region encompassed by this study is situated along the Nieva River, where I was able to obtain completed surveys from another two villages: Japaime, and Seasmi. The land-use and cultural practices in the villages along the Nieva are similar to the communities on the Santiago, although they were less willing to cooperate with my project. This lack of cooperation in perhaps attributable to strained relations between these villages and IIAP. As a result, some villagers declined to take the survey. Indeed, one entire village, Lower Japaime, refused to allow us to solicit any surveys. The village reasoned that if IIAP was not presently helping them, they weren't going to help IIAP.

Simply stated, if I was not providing them with any immediate assistance, they would not take my surveys. At times, it appeared that the villagers felt entitled to help from non-profit organizations and often people would simply state what kind of assistance they required. I was informed of a range of items that villages wanted given to them: some of the desires were modest, such as regular access to fingerlings and hand tools; while some were more excessive, like tractors and dredging machines.

The third group of villages in the study is situated along the road leading east from Santa Maria de Nieva. This road allows farmers to have access to the larger markets of Peru as large trucks traverse the road daily, transporting products into and out of the jungle. Access to larger markets provides an incentive for farmers in these villages to produce more cost-effective goods, including the selective logging of hardwoods and the raising of livestock. Neither of these extremely environmentally destructive land-use methods is common in the less accessible river communities. In communities located along the road, greater opportunity also exists for farmers to supplement the income from their farm with other forms of income by working in stores, restaurants, mechanic's garages, gas stations, and other businesses catering specifically to travelers along the road.

The main cash crop existing in this region is cacao, which is first sold to middlemen for 5 soles per kilo, and then resold to chocolate producers. Most of the cacao production in these villages has been established fairly recently, with many farmers still waiting for their first harvest. The recent growth in cacao production came about as various NGOs assisted farmers in the development of cacao production as a way to alleviate poverty in the area. It is not unusual for farmers to have as much land devoted to cacao as they have for all their other agricultural crops.

Significantly, every family I spoke with in every community I visited either already had a fishpond or wanted to build one. Although many people were frustrated by the struggles associated with aquaculture (e.g., lack of fingerlings, maintenance of ponds), they all seemed to view fish-farming as worthwhile and beneficial. The process of building a fishpond is highly labor intensive, and usually families will work together in order to build new ponds. After clearing the chosen area of vegetation, villagers will spend weeks constructing an earth wall that functions as a dam on a small creek. Equipped with little more than shovels and the occasional wheelbarrow, the farmers must make sure that the wall is sturdy enough to withstand heavy rains and the pressure from the pond. The farmers then outfit the area upstream of the dam with an overflow pipe and compress the soil so that there is minimal absorption of the water into the ground. The pond is then allowed to fill naturally with rainwater and new rains continually flush out any algal buildup, eliminating the problem of eutrophication. Fingerlings are either captured from nearby rivers or, more often, are purchased from an institute such as IIAP. The fish are fed a mixture of agricultural products from the family's farm and in about 3 months they grow to weigh about a kilogram each and are ready for harvest.

This process of aquaculture is highly dependent on the availability of fingerlings, since it is less profitable and more difficult to capture and harvest fish from local waterways. Consequently, IIAP plays a fundamental role in the fish-farming regime in Condorcanqui. During the time period of this study, there was a major shortage in fingerling production by IIAP. Since IIAP was in the process of moving to a newly built fish-breeding facility, and because the breeding facility at Villa Gonzalo was not yet functioning, many of the aquaculturists were unable to acquire fingerlings during the months leading up to the research conducted for this study. These farmers were thus forced to live solely off of their agricultural production.

All of the river communities visited in this study shared the same type of diet. The food staples comprising the Awajún and Wampí diets consists of: yuca*,* a starchy tuberous root that is the main source of carbohydrates; sachapapa, an Amazonian potato; banana, which is eaten boiled because of possible infestations; eggs, from chickens (only rarely were the chickens eaten); rice; and, occasionally corn or fish. The villagers use salt and chilies to spice their food. Since reliable sources of animal protein are scarce in these communities, fish is an integral component of the villagers' diet. IIAP estimates that fish-farming families consume 21 kilograms of fish meat per person annually (Guzman et al. 2011), which translates to 4.4 kilograms of protein per year.

As can be seen from this brief overview, it is clear that aquaculture is beneficial for both the health and economic well being of families in Condorcanqui.

III
Theoretical and Conceptual Framework

Amazonian subsistence farming, aquaculture, and deforestation are topics that have been thoroughly studied over the years. The importance of aquaculture to the livelihood of indigenous populations is manifest (McDaniel 1997), and the ecological degradation due to deforestation is a well-documented and pressing environmental concern (Guerra et al. 2001). This paper addresses the next logical step in Amazonian research, as it links well-studied facets of society by illustrating how the integration of aquaculture affects deforestation.

A key factor that affects the dynamics of Amazonian communities is whether or not there is access to a road. It has been shown that there is a strong positive correlation between road densities and deforestation rates (Mena et al. 2006). The presence of a route through which one can easily export goods to outside markets drastically changes a family's land-use incentives. Roads function to link Amazonian communities with the world's cash economy as villagers with access to roads can produce goods to be sold in outside markets. Roadside towns also have a greater number of non-agricultural jobs available for locals; restaurants, car repair shops, convenience stores, and formal schools all provide jobs along roads that seldom exist in more remote communities.

On the other hand, river communities have a more limited access to markets, and consequently families do not have as many options in utilizing their land. Since the economies of river communities are more isolated they function on a subsistence basis with relatively few imports and exports. While roadside towns attempt to maximize their income by selling surplus products, river communities simply attempt to reach their level of subsistence (Capentier et al. 2000). This dichotomy -- separating roadside and river communities -- is clearly shown when comparing the effect of aquaculture on deforestation in the two community types.

The relationship between aquaculture and deforestation is relatively straightforward in river communities because they are basic subsistence farming societies. These communities survive directly off the crops that they produce, and the resources that they take from the environment. This creates an extremely close relationship between the villagers and their land. Because a family's resources are limited by the amount of land allotted to them by the village, each family must choose carefully how they will use their land and exactly how much they will clear for agriculture. Families deforest their lands for a variety of reasons, including building huts, canoes, and furniture, gathering firewood and, most importantly, growing crops. Each field of crops can only be cultivated for a few years, until the nutrients in the soil are depleted. Without fertilizers or other sources of nutrients the soil becomes unproductive and new fields must continually be cleared for cultivation.

Fish-farming provides another valuable land-use option for subsistence farmers in these river communities. Instead of agriculturally cultivating all of the food necessary for a family, farmers can substitute some of their crops with aquaculture in order to reach their subsistence level. Cultivating fish in man-made ponds thus has the potential to provide food (and a source of income) in the same way as more customary crops. Therefore, when a subsistence farmers practice aquaculture they can farm less land in order to meet their level of subsistence. It simply becomes a question of replacing some land used for agriculture with fishponds. A family that takes into account the expected yield from a fishpond will not need to use as much land for agricultural purposes in order to sustain itself.

In roadside communities the relationship between aquaculture and deforestation is more complex. These towns do not function on strict subsistence levels, but interact with markets in order to maximize profits. Families living along roads have access to markets where they are able to buy and sell food and therefore do not need to rely solely on their own crops for sustenance. Villagers are able to produce cash crops, raise livestock, harvest timber, or even earn incomes working non-agricultural jobs in order to provide for their families. In this market-based system, where opportunities exist to provide food for one's family indirectly, aquaculture is not simply a way to reach a subsistence level, but is a vehicle for increasing income.

The adoption of aquaculture, however, still plays a major role in the rate of deforestation in roadside communities. Market-based economies, such as the road villages in this study, are subject to land and labor constraints that affect the rate of deforestation. Villagers face the decision of how best to use their limited amount of labor in order to maximize profits, and when a villager chooses to practice aquaculture there is an opportunity cost associated with that decision. The labor used to build and maintain a fish farm would have been used in a different way if the owner had chosen not to practice aquaculture. This opportunity cost of building a fish farm (i.e., the activity given up when you build a fishpond) could in fact deforest much more land than aquaculture. Therefore, fish-farming could possibly be used in place of other activities that result in major deforestation. Since there are a variety of land use types that could be utilized by villagers in roadside communities, it is difficult to discern what exactly is being substituted for aquaculture. Therefore, the relationship between aquaculture and deforestation in roadside areas is less clear than in river communities.

While the models of roadside and river communities described above establish why there is a connection between aquaculture and deforestation in the Peruvian Amazon, there are many variables that can affect the exact nature and magnitude of this relationship. For instance, factors such as family size and the productivity of the soil greatly affect the rates of deforestation, while land demographics and market access can influence the impacts of a fishpond.

The survey instrument used in this study delineates five main variables that could affect a family's deforestation rate:

(1) The size of the family: Larger families need to grow more food in order to support themselves and therefore it is logical to conclude that larger families need to deforest more land than smaller families for agricultural purposes.

(2) The number of years the family has practiced fish-farming: The decrease in deforestation caused by integrating aquaculture is not immediate. Only after the pond starts producing fish will families be able to gauge how much agricultural produce can be substituted with the harvests from their fish farms. The families can then adjust for this new source of income when they decide how much land to clear for future harvests. Families also may be able to harvest more fish from their ponds as they gain experience with aquaculture, changing the amount of agricultural land they are able to substitute with fishponds.

(3) The productivity of a family's land: the number of years that a family is able to cultivate the same plot of land, as well as how intensively it can be harvested, greatly affects the family's total rate of deforestation.

(4) The total amount of land owned by the family: if a family has an abundance of land, they might be less careful with the amount they choose to deforest.

(5) The amount of fish that the family sells: If a family chooses to sell their fish rather than consume it, then the harvest from their fishpond would be increasing their income and not directly replacing their agriculture.

While my analysis takes into account these variables, it is important to note that the results of this study may still be skewed by the presence of selection bias. Selection bias functions as a variable that is not accounted for in this study, but that could nevertheless change the observed relationship between fish-farming and deforestation. One key variable that could contribute to a selection bias is the level of kinship that exists in a given community. Since the establishment of a fishpond is a labor-intensive process, access to labor, either through strong kinship groups or personal wealth, makes it much easier for close-knit, large, or wealthy families to build fishponds. A strong kinship group that makes it easier to institute aquaculture could also correlate with different deforestation activities, distorting the direct relationship between aquaculture and deforestation. Other variables, such as the suitability of land for aquaculture or the accessibility of overflow pipes, could also add to a selection bias in similar ways. It is unlikely, however, that land dynamics or pipe access would have a major impact on the selection bias because these inputs are cheap and can be easily found in the region and, thus, are available to virtually all of the families in the study.

A fairly comprehensive view of the relationship between fish-farming and deforestation is established when the above-mentioned variables and societal models are taken into consideration. This view, however, will only give you a snapshot of what is happening in these communities at any given time. For example, a farmer in a subsistence river community might substitute a quarter of his agricultural lands with aquaculture. In some cases, the area of the fishponds would be less than the area of the agricultural land that it is replacing, while in other cases it could be more. The results of this study, however, show that on average, the rate of substitution from agriculture to aquaculture occurs approximately at a one-to-one ratio. Hence the farmer would probably replace a quarter of his farmland with about the same area containing fishponds. When looking at this land use conversion at a given point in time it would seem that the incorporation of aquaculture does not in fact lower the rate of deforestation, as it directly replaces the agriculture on approximately a one-for-one basis.

Over time, however, this one-for-one substitution would significantly reduce the levels of deforestation because the agricultural land only remain fertile for a few years, while the fishponds can remain productive for as long as they are maintained. The farmer who substitutes a quarter of his agricultural land for aquaculture will have to clear more land for agriculture once his crops deplete the soil. When the farmer does deforest more land, he will only have to clear enough forest to replace the area of land that is used agriculturally, while the fishponds can remain in the same location and require no new deforestation. While the total area he is farmed at any given time might be exactly the same as it was before the incorporation of aquaculture, the amount of crops that unsustainably deplete the soil and need to be repeatedly moved onto newly deforested land is lowered. This creates a situation where, over time, the incorporation of aquaculture can greatly lower a family's rate of deforestation.

IV
Methods and Materials

Sample and Data Collection

Survey instruments were designed to gauge the level of productivity and the amount of deforestation associated with each respondent's farm. In order to measure the productivity of the farm, each participant would first name all of the crops that had been cultivated within the last year. The respondent would next estimate to the best of their ability how much of each crop was produced on their farm. The units would differ for each crop, for instance bananas were recorded in *racimos* (or stalks) collected per week, while yuca was recorded in kilograms harvested daily, and annual crops such as sachapapa were recorded in the number of 25 kilograms sacks collected during the harvest period. Once the amount of each crop was estimated, the respondent would then specify how much was consumed by the household and how much was sold.

In order to measure the amount of agricultural deforestation associated with the farm, respondents were first asked how many *chacras* (or plots of land) the family had cleared for agricultural purposes. The participant was then asked to estimate to the best of their ability the dimensions (length and width in meters) of each plot. It seemed that most farmers knew fairly accurately the size of each of their plots. If participants had trouble understanding the questions about their farmland, or gave unsure or conflicting answers, they were asked to draw a sketch of their land, complete with the locations of the different plots as well as their relative dimensions. The sketches often helped families estimate the area of their fields.

The surveys also recorded the following variables that did not deal directly with productivity or deforestation, but that could be related to production and/or deforestation rates:

1. The number of family members;
2. The name of the community;
3. The number of days per week spent working on the farm;
4. The amount of land owned by the family;
5. The amount of wood sold; and
6. The number of years that the land remains productive.

For those families that practiced aquaculture, the survey instrument also recorded the following variables about the family's fish farms:

1. The number of years that the family has farmed fish;
2. The number of days per week spent working with the fishponds;
3. The number of functioning ponds on the land;
4. The dimensions of each pond (length and width in meters);
5. The amount of fish harvested per year;
6. The amount of fish sold per year;
7. Whether the family wants to build more fishponds; and
8. The amount of food fed to the fish per week.

As previously noted, the sample of 184 families was drawn from 10 villages where IIAP provides technical assistance to fish farmers. In each village the survey was solicited to as many families as possible, usually within the family's home. Without question, the close relationship between IIAP and the fish farmers made it easier to meet with aquaculturists, and therefore 104 surveys were collected from families that incorporated fishponds into their farms, while only 80 surveys were collected from families that solely had agricultural crops.

Analysis

The basic analysis was conducted by comparing the means of families that utilized both fish-farming and agriculture to those who utilized only agriculture. This comparison illuminates the general impact of aquaculture in the sample group by illustrating the differences in deforestation, production, and family dynamics that are associated with the incorporation of fish-farming.

More in depth analysis of the data is also done with a variety of regressions. These regression-based approaches are used to determine how incorporating aquaculture into subsistence farmland affects deforestation rates while controlling for various socioeconomic and farm characteristics.

V

Results

General Results

In order to illustrate the general dynamics of the study group it is pertinent to first look at the descriptive statistics from the collected surveys. A selected subset of the most important questions is summarized in the table below (Table 1). The variables described in Table 1 are defined in the following table (Table 2)

Table 1. Descriptive statistics of the data set. Total average results from surveys are tabulated. Results for each variable include the number of surveys (Obs.), the average result (Mean), the amount the data deviates from the mean (Std. Dev.), the lowest response (Min) and the highest response (Max).

Variable	Obs.	Mean	Std. Dev.	Min	Max
famsize	184	6.08	2.55	1	18
fishyear	104	5.44	6.64	1	35
fishdays	104	4.66	2.51	0	7
ponds	104	1.54	0.76	1	5
pondsize	104	2,689.21	2,409.54	402	12,400
totfish	104	94.68	113.80	0	690
fishsold	104	46.64	89.40	0	600
morepond	104	2.14	1.02	0	3
agridays	184	6.14	1.69	1	7
agriland	184	18,488.15	17,760.77	1,000	120,000
totland	184	101,869.6	193,357.6	0	1,700,000
yearsuse	184	3.59	2.06	1	12
trevenue	184	4,590.76	3,430.15	182.50	18,612.50
town	184	3.20	2.11	1	10

Table 2. Definitions of Key Variables. Each variable in Table 1 is defined.
(Continues on next page)

Variable	Description
famsize	Number of people in the family.
fishyear	Number of years the family has been fish-farming for.
fishdays	Number of days a week the family practices fish-farming.
ponds	Number of fishponds on the family's land.
pondsize	Area of the ponds in square meters.
totfish	Total weight of fish produced per year in kilograms
fishsold	Total weight of fish sold per year in kilograms
morepond	Whether or not the family wants to construct more fishponds: if 0 then no, if 1 then they want to increase by less than two times, if 2 then they want to double the number of pondsize, if 3 then they want to more than double.
agridays	Number of days a week the family practices subsistence farming.

agriland	Area of the subsistence farming land in square meters.
totland	Area of unused forested land that the family has in reserve.
yearsuse	Number of years the family is able to use a plot of subsistence farmland before it is infertile.
trevenue	The total value, in Nuevo Soles, of all fish and agricultural products produced on the family's land in 1 year
town	Towns 1 – 5 are located next to rivers, and towns 6 – 10 are alongside to roads.

Some interesting insights can be drawn from the values depicted in Table 1. It is interesting to note the difference between "fishdays" and "agridays" (denoting the number of days per week the family practices fish-farming and agriculture, respectively). The mean values show that people practice aquaculture fewer days per week than they do agriculture.

Another key variable is the mean "yearsuse", which is the number of years a family is able to practice agriculture on a plot of land before the soil is depleted. The average from the respondents is 3.59 years, and there is a fairly large range with a minimum of 1 year and a maximum of 12. This demonstrates that, on average, farmers in Condorcanqui need to move their crops onto newly slashed and burned land every three and a half years. Some farmers, however, claim to be able to continue harvesting crops off of their land for a dozen consecutive years, while others could only grow crops for a single year before the soil became infertile. This variation in responses could be due to differences in soil quality and harvesting intensity, or possibly some farmers simply attempted to brag by exaggerating the productivity of their land.

Comparison between Fish Farmers and non-Fish Farmers

In order to tell whether there is an obvious selection bias associated with the data set, the study examines the means of the two major sample groups: those who practice aquaculture as well as agricultural farming, and those who only raise crops on their land.

This analysis need to be done in order to see if there are key differences between the fish farmers and the solely subsistence farmers that could affect the rate of deforestation and therefore distort the results. Some striking differences between the two survey groups are shown in Table 3.

Table 3. Separated average results from the surveys. The average results for each variable are shown for the two study groups. Number of surveys in parenthesis.

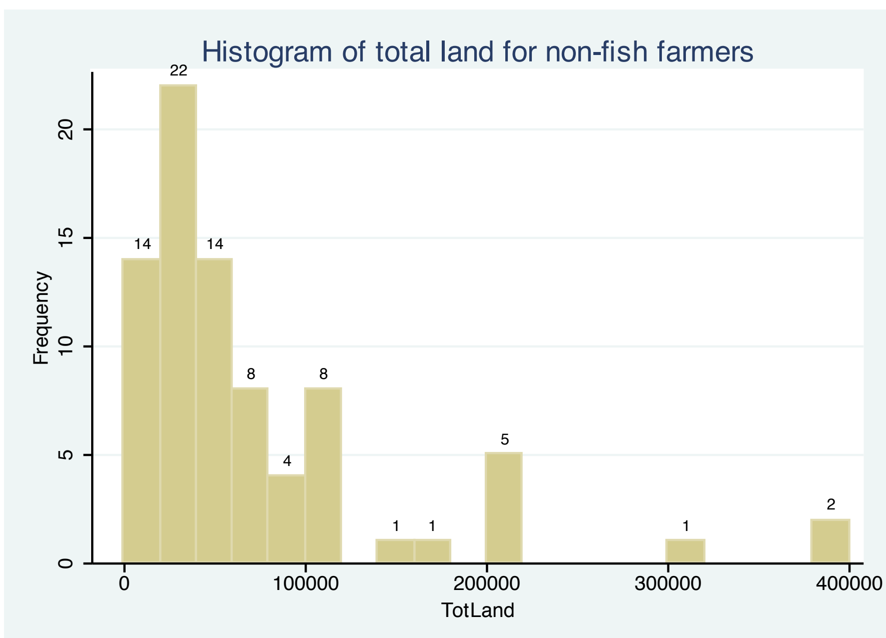
Variable	Means for Fish Farmers (104)	Means for non-Fish Farmers (80)
famsize	6.41	5.64
agridays	6.25	5.99
agriland	15,697.36	22,116.19
totland	128,730.80	66,950
yearsuse	3.59	3.58
trevenue	5,296.41	3,673.42
town	3.36	2.99

The average size of fish-farming families is slightly larger than that of non-fish farmers, and this difference might be attributed to the fact that additional family members would increase the amount of available family labor, thus making it somewhat easier to construct the fishponds. Interestingly, the fish-farming families don't seem to have to sacrifice any of their time spent on their farms in order to maintain their fishponds. In fact, they seem to work on their agricultural land marginally more than do the non-fish farmers, although this doesn't take into account time spent per day. The difference in total revenue between the two groups is largely due to the revenue that is created by harvesting fish, which can be sold in Condorcanqui at a price of 10 soles per kilo.

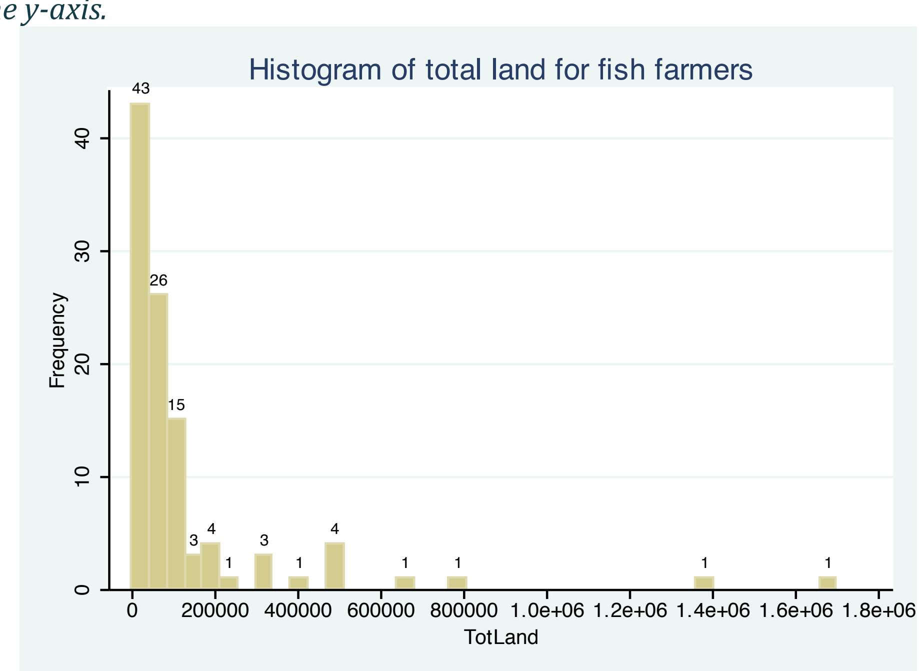
The largest dichotomy between the two groups is in the land quantities. The difference in agricultural land was as expected, with fish farmers using over 6,000 square meters less land for their crops. This supports the theory that because of the revenue created from aquaculture, families with fishponds will not need to use as much agricultural land in order to reach their subsistence level. The difference in total land, however, where fish farmers have nearly double the amount of forested land as non-fish farmers, is surprising.

The families in these communities are given land on a communal basis, supposedly receiving plots of land as they need. Accordingly, it was believed that families of the same size would have roughly the same amount of land. However, for some reason, the families that constructed fishponds received much more land on average, despite having only slightly larger families. In order to further examine this difference in total land, I created two histograms that show the amount of total land owned by families in each of the groups.

Graph 1. Histogram of total land for non-fish farmers. Total property holdings are shown in square meters on the x-axis. The number of families with the corresponding amount of land is shown on the y-axis.



Graph 2. Histogram of total land for fish farmers. Total property holdings are shown in square meters on the x-axis. The number of families with the corresponding amount of land is shown on the y-axis.



As shown in Graphs 1 and 2, the majority of the families in this study are clustered on the lower end of the total land scale. The bulk of the families with over 250,000 square meters of land also practiced aquaculture. Specifically, there were 11 fish-farming families above that threshold compared to only 3 non-fish-farming families. These extreme observations, which vary so greatly from the majority of family landholdings, cause the large discrepancy in total land existing between the means of fish farmers and non-fish farmers. In other words, the largest landholders (many whom have immense areas of land for animal pasture) overly influence the mean amount of total land for fish farmers. A better examination of mean total land holdings is found by excluding the families that have over 250,000 square meters of property in order to look at only the ordinary landholders. After taking out the 13 families with more than 250,000 m^2 the means seem to converge to our expectations, with fish farmers averaging 60,304.35 m^2 of land and non-fish farmers averaging only slightly less, with 55,272.73 m^2.

Regressions

A variety of regressions were used in order to determine exactly how the incorporation of aquaculture into subsistence farmlands affects deforestation rates. The regressions demonstrate the relationship between land used for aquaculture (which does not deplete in value) and agriculture (which turns the soil infertile after a few years), while controlling for different socioeconomic and farm characteristics. The following regressions confirm that farmers are substituting agricultural land with fishponds on approximately a one-to-one basis.

The first regression attempts to describe this ratio in as simple of terms as possible. To do this, the study first examined only "pondsize" and "totland" in the following regression:

Table 4. Summary of Regression (1).

$$agriland_i = \beta_0 + \beta_1 pondsize_i + \beta_2 totland_i + \varepsilon_i \qquad (1)$$

Summary of Regressors

Variable	Coefficient	Robust Std. Error	T-Statistic	P-Value
pondsize	-.9054	.4903	–1.85	0.066
totland	.0216	.0084	2.58	0.011
_cons	17658.1	1789.2	9.87	0.000

Summary of Regression Results

Num. of Obs.	R^2	F-Stat	Prob > F
184	0.069	4.55	0.0118

This straightforward regression shows the basic negative relationship between pond size and agricultural land. This is demonstrated by the negative coefficient on “pondsize”, which is significant at a 90% confidence level. This indicates that as a farmer increases his pond size by 1 square meter, he decreases his agricultural land by .9 square meters, more or less directly replacing it. The regression also demonstrates that total land is a significant determinant of agricultural land, having a p-value of just .011. We also see a high F-statistic, indicating that the likelihood that all the coefficients are jointly equal to 0 is very low.

While the above regression illustrates the fundamental connection between agricultural land and pond size, it is useful to include additional pertinent variables in order to refine the regression results. Further analysis therefore included the “famsize” variable, which should be associated with agricultural land because larger families logically would need more agricultural land to reach their subsistence level. The analysis also uses the “fishsold” variable, which should be related because if a family were selling their fish produce instead of eating it, then it would not be directly affecting their agricultural needs. In other words, “fishsold” may indicate that a family’s fish production is being used as an additional source of income, rather than an additional food source. If so, fish production would not directly replace agricultural land. Lastly, the study includes the “yearsuse” variable, which should be associated because more productive and longer lasting land should lower the amount of agricultural land required by individual families. The following regression examines these variables:

Table 5. Summary of Regression (2)

$$agriland_i = \beta_0 + \beta_1 pondsize_i + \beta_2 totland_i + \beta_3 famsize_i + \beta_4 fishsold_i + \beta_5 yearsuse_i + \varepsilon_i \qquad (2)$$

Summary of Regressors

Variable	Coefficient	Robust Std. Error	T-Statistic	P-Value
pondsize	-1.0937	.5234	-2.09	0.038
totland	.0180	.0079	2.28	0.024
famsize	318.2859	502.3443	0.63	0.527
fishsold	17.3104	11.6384	1.49	0.139
yearsuse	-1504.275	466.6847	-3.33	0.002
_cons	21328.47	4368.312	4.88	0.000

Summary of Regression Results

Num. of Obs.	R^2	F-Stat	Prob > F
184	0.104	7.09	0.0000

This regression appears to do a better job of explaining agricultural land usage, with an increased R-squared value of .104, and a higher F-statistic. The association between agricultural land and pond size, ceteris paribus, is now strictly negative at a 95% confidence level. The relationship with total land remains small and significant, and the "yearsuse" variable is shown to be highly significant with a large negative coefficient. The coefficient on "yearsuse" demonstrates that a one-year increase in soil productivity decreases agricultural land by over 1,500 square meters.

Interestingly, both the "famsize" and "fishsold" variables do not end up being significant in this regression. It appears that the lack of significance of the "famsize" variable is caused by its close connection with the "pondsize" variable. A simple regression between "pondsize" and "famsize" reveals that the two are strongly related, with a p-value of .000, a coefficient of 282.66, and a R-squared of .103. This indicates that the main visible effect of larger families in this regression is that they have larger ponds. Therefore, the "pondsize" variable is already capturing the main effect of family size, making "famsize" insignificant in relation to agricultural land.

The reason that the "fishsold" variable is insignificant is less clear. It could be that the revenue from fish sales could be used in many different ways, which may or may not affect the family's use of agricultural land. It is, however, close to being significant on the 10% level, and its coefficient is positive, which supports my theory that if a family is selling its fish rather than eating them, the fishpond would not be directly replacing agricultural land. It is possible that the sample size in this study is just too small to explain the relationship between fish sold and agricultural land at a significant level.

Another interesting regression was created by examining how agricultural land is affected by the number of years that a family had been fish-farming. This is important to note because the amount of agricultural land that fishponds replace could vary depending upon the age of the pond. The following regression tested this theory by incorporating the "fishyear" variable into the previous regression (2):

Table 6. Summary of Regression (3)

$$agriland_i = \beta_0 + \beta_1 fishyear_i + \beta_2 pondsize_i + \beta_3 totland_i + \beta_4 famsize_i + \beta_5 fishsold_i + \beta_6 yearsuse_i + \varepsilon_i \qquad (3)$$

Summary of Regressors

Variable	Coefficient	Robust Std. Error	T-Statistic	P-Value
fishyear	-296.22	130.53	-2.27	0.024
pondsize	-.9026	.4899	-1.84	0.067
totland	.0183	.0075	2.45	0.015
famsize	435.08	505.41	0.86	0.390
fishsold	22.17	10.74	2.06	0.040
yearsuse	-1518.18	466.50	-3.25	0.001
_cons	21121.26	4332.807	4.87	0.000

Summary of Regression Results

Num. of Obs.	R^2	F-Stat	Prob > F
184	0.1106	7.64	0.0000

This regression supports the theory that families who have been practicing aquaculture for more years are able to substitute ponds for more agricultural land. This can be seen by the significant negative coefficient of the “fishyear” variable. The coefficient indicates that each successive year a family practices aquaculture, their agricultural lands decrease by a further 296.22 square meters. The results for the other variables in this regression remain similar to what they were in the previous regression, while the R-squared and F-statistic rise slightly. Interestingly, the “fishsold” variable becomes significant in this regression, again with a large positive coefficient. This further supports the theory that as more fish are sold, the fishponds do not replace as much agricultural land.

A fourth regression illustrates how agricultural land usage is changed when looking at aquaculture in roadside villages. This is an important regression because it shows how aquaculture affects agriculture differently in villages along roads, where fish-farming could be replacing a range of activities other than subsistence farming. To perform this regression, a dummy variable (0 or 1) was created based on whether the family lived in a roadside village. The dummy variable was then multiplied by the pond size in order to create a new variable called “pondroad”. Finally, a regression was performed between agricultural land and “pondroad”, again including the same variables as in regression (2):

Table 7. Summary of Regression (4)

$$agriland_i = \beta_0 + \beta_1 pondroad_i + \beta_2 pondsize_i + \beta_3 totland_i + \beta_4 famsize_i + \beta_5 fishsold_i + \beta_6 yearsuse_i + \varepsilon_i \qquad (4)$$

Summary of Regressors

Variable	Coefficient	Robust Std. Error	T-Statistic	P-Value
pondroad	-1.633	.6297	-2.59	0.010
pondsize	-.6869	.5500	-1.25	0.213
totland	.0181	.0079	2.29	0.023
famsize	208.84	511.10	0.41	0.683
fishsold	15.48	11.288	1.37	0.172
yearsuse	-1621.59	477.88	-3.39	0.001
_cons	22293.06	4492.665	4.96	0.000

Summary of Regression Results

Num. of Obs.	R^2	F-Stat	Prob > F
184	0.1131	7.33	0.0000

This regression suggests that the variable "pondroad" is significant at a 99% confidence level, with a p-value of .01. The R-squared and F-stat statistics are similar to regression (3) as are the results for most of the variables. There is a change in the significance of both the "pondsize" and "famsize" variables, which have much higher p-values. The reason for this lack of significance is similar to why the "famsize" variable is not significant in regression (2), and is attributable to the strong association between "pondsize" and "pondroad". A simple regression between "pondsize" and "pondroad" shows that the two are strongly related, with a p-value of .000, a coefficient of .7498, and an R-squared of .157. This indicates that the "pondroad" variable is already capturing the main effect of pond size, making "pondsize" insignificant in relation to agricultural land.

The "pondroad" coefficient of –1.633 indicates that when the size of a pond in a road village is increased by 1 square meter, the agricultural land is decreased by more than 1.6 square meters. This is a considerable change from the -1.0937 coefficient that was found for the "pondsize" variable in the second regression, which did not include a dummy variable for road villages. The difference in coefficient size supports the conclusion that agricultural land is replaced by aquaculture on approximately a $1^2/_3$-to-one basis in road villages, while only on a one-to-one basis when examined against the entire data set. This increased ratio could be because the land-use activity that is being replaced by fish-farming in road villages takes up roughly one and two thirds the amount of land as the activity being replaced in the average community. This makes sense because families in road villages are more likely to perform land intensive practices such as logging, raising cattle, and growing cash crops because they are able to sell these products in external markets.

Longitudinal Model Predicting Agricultural Deforestation

Regression 2 convincingly suggests the theory that subsistence farmers in Condorcanqui replace their agricultural lands with fishponds on a one-to-one basis. This conversion of land use types would not immediately change the rate of subsistence farming deforestation, as it is simply a direct change in the use of already deforested land. However, as previously observed, the land that is used agriculturally must be moved to newly cleared land every few years; whereas fishponds can remain productive indefinitely. Therefore, farmers are able to lower their deforestation rates by converting agricultural land into fishponds because aquaculture is a more sustainable land use activity.

If the conclusions drawn from the results above are true, and the regressions are able to capture a valid causal effect between aquaculture and subsistence agriculture, then the results can be used to create a model demonstrating the size of this effect. The following model does this by using the averages found in the data to simulate the deforestation associated with a family's subsistence farming over an 11-year time period. In particular, the model uses the averages found in the data for the number of years that a plot of land can be used agriculturally (3.59 years), the size of a family's of agricultural land (18488 square meters), and the size of a family's fishpond(s) (2698 square meters).

Table 8. Longitudinal Deforestation Model. Deforestation values shown in square meters.

Years	Deforestation with Pond	Deforestation without Pond	Difference
0	18488 m^2	18488 m^2	0 m^2
3.59	34278 m^2	36976 m^2	2698 m^2
7.18	50068 m^2	55464 m^2	5396 m^2
10.77	65858 m^2	73952 m^2	8094 m^2

This model is a simplified version of the actual situation, as it does not include such variables as the age of the pond, which would increase the deforestation impact as the pond gets older. It also does not take into account whether or not the farm is accessible by a road, which would affect the overall deforestation rate. Nonetheless, the simulation illustrated in Table 8 shows how, on average, integrating aquaculture into subsistence farmlands can drastically reduce a family's rate of deforestation. In a span of 11 years (which includes 3 successive slash-and-burn cycles), an average family is able to save an average of 8,094 square meters of rainforest by substituting a portion of their agricultural land with an average sized fishpond.

Possible Sources of Error

It is important to note that the data used in this study may contain fundamental flaws due to sampling bias. The language barrier that was present during the survey process may have led to some defects in the data. The surveys were administered in Spanish, which is my own second language and the second (or third) language of the individuals providing the data. Therefore, the possibility of miscommunication and misunderstanding cannot be dismissed. One also must consider that the respondents gave the data as estimates, rather than hard measurements. This may indicate inaccuracies in their responses that would distort the data.

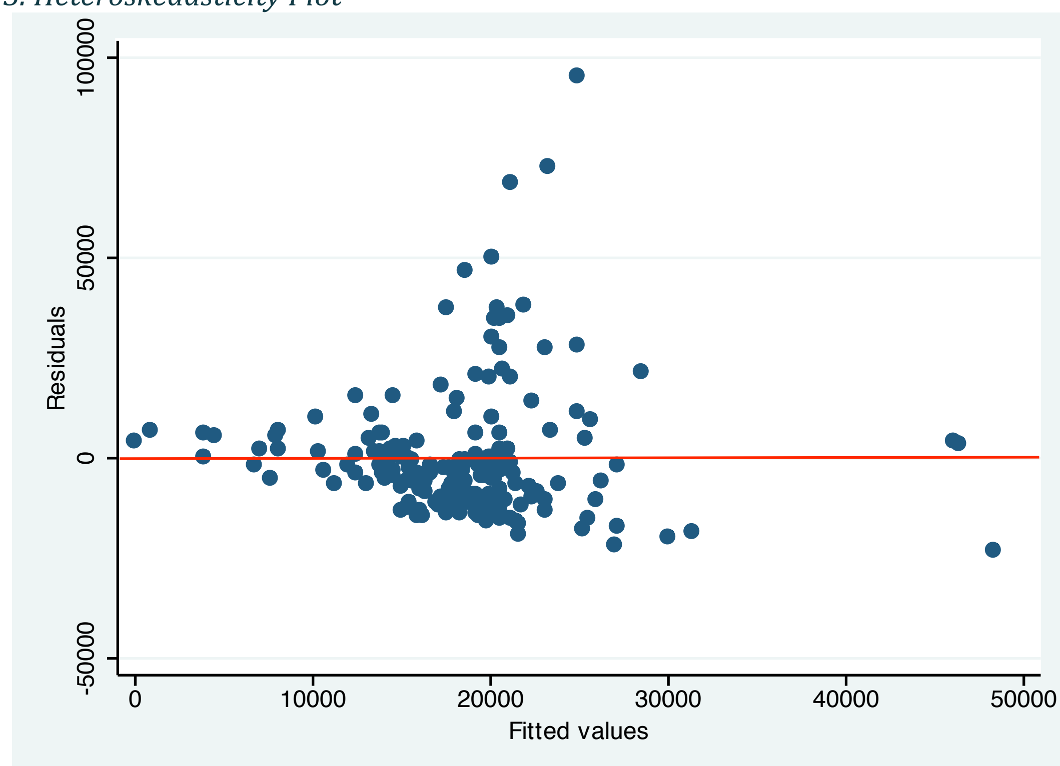
With these important limitations in mind, one can than search for errors in the results caused by multicollinearities or heteroskedasticity. Multicolinearities have been searched for by creating the following cross correlation matrix, which includes all of the key variables used in the regressions.

Table 9. Cross-Correlation Matrix.

	agriland	pondsize	totland	famsize	fishsold	yearsuse	pondroad	fishyear
agriland	1							
pondsize	-.1136	1						
totland	.2353	.0044	1					
famsize	-.0320	.3210	-.0708	1				
fishsold	.0788	.3182	.0215	,0215	1			
yearsuse	-.2167	.0727	0.1675	.1198	-.0721	1		
pondroad	-.1119	.3956	.0328	-.0100	.0918	-.1050	1	
fishyear	-.0793	.3771	.0783	.2588	.3010	.0006	.1534	1

In Table 7, it is shown that none of the variables are significantly correlated with each other, and therefore our model does not suffer from multicollinearities. Heteroskedasticity can be checked by creating an RVF plot from the variables, as is shown below:

Graph 3. Heteroskedasticity Plot



Graph 3 reveals that the model suffers slightly from heteroskedasticity, as the residuals somewhat seem to follow a pattern. This is to be expected, however, because of the small sample size and the imperfect nature of the data set.

VI

Conclusion

The results of this study suggest that incorporating aquaculture into subsistence farmland significantly reduces the rate of agricultural deforestation. Among other things, the analysis suggests that an extra square meter of aquaculture reduces the area deforested to grow crops on approximately a one-for-one basis. Although this may appear to be an even land conversion (one square meter added to aquaculture versus one square meter taken away from traditional agriculture), this study's analysis demonstrates that substituting aquaculture for agriculture would, in fact, greatly reduce deforestation rates in the Amazon.

This apparent contradiction is explained by the fact that the agricultural techniques practiced require continual deforestation of new land because they exhaust the fertility of the soil over time. Aquaculture, on the other hand, is able to use the same plot of land with virtually no temporal limitations. Due to the greater sustainability of aquaculture, simulations from the deforestation model demonstrate that aquaculture would reduce the total amount of a single family's agricultural deforestation by more than 8 hectares over an 11-year period.

In interpreting this result, one must take into account the many different factors that affect deforestation in the region. Furthermore, it is clear that the connection between aquaculture and agricultural land use is complex. Indeed, this study highlights the fact that there are many variables significantly associated with the relationship between aquaculture and agriculture, including the size of the fishponds, the total amount of land owned by the family, and the number of years the soil remains productive. While the results also suggest that the size of the family and the amount of fish sold are also associated with this relationship, the present study struggles to illustrate these connections significantly due to the small dataset. Nevertheless, these results provide strong, credible evidence to support the theory that aquaculture reduces the rate of deforestation in the Amazon basin.

Interestingly, the results provide evidence to support the theory that the amount of forested land saved by aquaculture is greater in roadside villages than river communities. It appears likely that this finding is attributable to the fact that the adoption of aquaculture is substituted for more land intensive practices in the villages that are located along roads. Another interesting finding revealed by this study is that the impact of aquaculture on deforestation increases as a function of the age of the fishpond. This suggests that as farmers gain experience and knowledge about fish-farming, they are able to substitute their fish revenue for greater amounts of agriculture.

These conclusions are important as they show how aquaculture could be used as a tool to significantly reduce deforestation rates, especially in areas where soil supports only a few years of subsistence crops. Absent immediate conservation efforts directed at reducing deforestation in the Amazon basin, the long-term outlook is bleak. As has been widely documented, this unique ecosystem is increasingly being degraded through the use of slash-and-burn agriculture. If the rainforest in the Amazon is not conserved, the very future of these people living in this area is problematic. If the findings of this study are accurate, the substitution of aquaculture can reduce the loss of rainforest in the basin and thus benefit the economic viability, as well as the health and safety of the inhabitants, through the preservation of vital rainforest.

These findings, however, should be regarded as only preliminary results. The convenience-based sampling approach used in the study, as well as the small size of the data set, create the possibility that the results were affected by selection bias or distorted by other undetermined factors. Accordingly, although these results suggest that aquaculture could be useful in limiting deforestation, additional research should be done using either experimental methods or more in-depth surveys to more accurately measure the effect of aquaculture on deforestation.

The Journey

The data collection portion of this thesis was by far the most challenging, intense, and awesome part of the process. With the help of a research stipend from Pomona College, I was able to travel to the Amazon and administer the surveys, which I specifically designed for this study. The story of how I got there and my struggle to collect surveys from over 180 families will be told shortly, but first some background information is in order.

Sixteen short months ago, in the summer of 2010, I was working as a research assistant for Nature and Culture International (NCI), a non-profit conservation group, which works to create protected areas throughout parts of Central and South America. NCI, with whose members I spent the majority of my time that summer, has a close relationship with the Research Institute of the Peruvian Amazon (IIAP, pronounced “yap”). Near the end of this first summer in Peru, I found myself accompanying Dr. Wagner Guzman Castillo, the researcher at NCI with whom I was working, to an environmental conference in Nieva, a small town in the Peruvian Amazon. While in Nieva, I stayed at IIAP’s fish-breeding facility and got to know the biologists and employees who were in charge of breeding and distributing fingerlings (baby fish) to fish-farming beneficiaries in the region.

Through Wagner’s connections with IIAP, I was given the opportunity to analyze a set of surveys that had recently been obtained from the fish-farming beneficiaries. I stayed in Nieva for about a week examining the data, getting to know IIAP’s employees, and being constantly bitten by mosquitoes. The biologists at IIAP hoped that by analyzing the surveys I would be able to find a negative relationship between their aquaculture projects and local deforestation. What I discovered, however, was that the surveys were poorly designed and unlikely to produce significant results. The data that I tabulated often was not complete, and it was clear to me that any connection between fish-farming and deforestation drawn from these surveys would have little to no evidential support.

Nevertheless, my time in Nieva was extremely valuable as I was able to learn the theory behind why aquaculture should be affecting deforestation in the region. Discussions with biologists and local fish farmers had led me to believe that aquaculture did in fact lower the rate of deforestation. Unfortunately, the surveys I was given did little to explore this hypothesis, and provided next to no evidence to either support or reject the proposed theory. I believed, however, that had the surveys been designed and distributed correctly, there was a good chance that they could explain the relationship between aquaculture and deforestation in a scientific manner.

Over the next ten months, I stayed in close contact with both NCI and IIAP, and explored ways that would allow me to return to Nieva in order to conduct a true scientific impact of aquaculture on deforestation. The contacts that I had made in Peru the previous summer were supportive of my return, and I was able to obtain a stipend from Pomona College to return to Peru and collect the data necessary to complete this thesis.

In June of 2011, I returned to NCI's office in Chachapoyas, where I reunited with Dr. Wagner Guzman Castillo. I had already thought out the general design of my surveys, and Wagner helped me put my questions into terminology that would pertain to the communities in the jungle. After printing out over 200 surveys, I left Chachapoyas and headed for the jungle, where I would meet up with IIAP's staff in Nieva, who had agreed to help me distribute the surveys. It was at this time that I said farewell to my comfort zone, and began to embrace the adventure that lay ahead.

The journey from Chachapoyas to Nieva started with a 3-hour "colectivo" ride to Bagua Grande. A colectivo is a shared taxi where passengers pay a set fee in order to get to their destinations. Peruvian colectivos are notorious for dangerous driving, and they do not leave until all of the seats are full. I knew I had a long day ahead of me, and so I got on the first colectivo of the morning, which left shortly before sunrise. We snaked through the Andes, zooming down mountain passes as the driver tried to make good time. After a few stops for roadwork and over 5,000 feet of descent, the colectivo arrived in Bagua Grande around 9 a.m. From there I took another colectivo to Bagua Chica (colloquially known as Bagua), which was a short 30-minute ride and brought me to the edge of the Amazon. From Bagua it would be a straight shot to Nieva, which as the bird flies is less than 100 miles. Despite the relatively short distance, the roads through the jungle are so sparse and in such poor condition that the drive from Bagua was scheduled to take about 7-hours.

I was the first passenger to arrive for the colectivo to Nieva, and I was told I would have to wait until the whole car filled up. After a small breakfast and another hour of waiting, one other passenger had arrived. He was a fifteen-year-old kid named José, whose family lived in Nieva. He was returning home after spending a few months working on a coffee plantation outside of Bagua. We spent the next several hours waiting for more passengers and discussing the only thing we seemed to have in common, a passion for soccer. As the day wore on it became less and less likely that the two additional passengers we needed were going to show up. The cheery and chubby driver told us that we might have to stay in Bagua for the night if the colectivo did not fill up soon.

At this point I asked the driver how much it would cost for us to leave then and there, with two empty seats. His price did not budge; no less than four full fairs would have to be paid before the journey was made. At 80 Peruvian *soles* per person (about 30 dollars), this sum was a large amount for my small budget, and probably about a week's wages for José on the coffee plantation. I did not want to spend the night in Bagua, however, and my contacts in Nieva were expecting me that evening, so I was determined to find a way to make it work. I convinced José to pay 100 *soles*, put up the cost of two full tickets myself, and had the driver find a passenger that we could drop off along the way to add the 60 additional *soles* needed to complete the fare. Finally, at around 1 p.m., we piled into the car and headed northeast, into the jungle.

Our colectivo, which I have since dubbed "El Carro de Mierda," was ill equipped to traverse the jungle roads. After getting in the front seat I noticed not only that it was impossible to see out a broken windshield on the passenger's side, but also that the seat was tied with its own seatbelt into a rigidly upright position. Graciously, I offered to give up the front to José, who excitedly jumped in. After a few minutes riding in the back, I realized just why José was so excited to take the front. Looking down at my feet, I could see straight through the rusted floorboard and onto the road rushing underneath. The unpaved roads in the jungle are almost always wet, and before long the backs of my legs were caked with mud as we splashed through puddle after puddle.

About an hour outside of Bagua the paved road, such as it was, came to an end, and we started onto what must be one of the worst roads of all time. The idea of a pothole presumes that some type of level surface surrounds it, but this certainly could not describe the road to Nieva, as there were no flat parts to be found; the highway was simply muddy potholes adjacent to muddy potholes. For the next few hours we bounced along good-naturedly, and amazingly the CD player in the car worked well enough to provide some background music for our ride. We must have made it about half way to Nieva before the car really began to fall apart.

Somewhere in the midst of the jungle we had begun to hear a loud rattling towards the back end of the car. Luckily, we reached a small town shortly after the rattling began, and our driver stopped to see what was wrong. It seemed that the problem was just some loose screws, and our driver was able to find the right sized wrench in the back of a restaurant. After about half an hour, during which I drank copious amounts of the restaurant's delicious pineapple juice, we were back on the road.

Soon afterwards, though, the transmission started jamming every time the driver tried to shift gears. This made the driving considerably slower, and we had to stop every few miles for him to fiddle with the clutch and whenever possible add more transmission fluid. It also started raining, which increased the amount of slush being splashed on my legs and undermined the road so that we had to get out and push the car through rough spots on three or four occasions.

Just as we were getting used to the impossibly slow pace, there began a loud scratching noise below the car. We stopped to discover that a shock had broken off of the rear axle and was now dragging along the road, gouging a trail in the mud. With no means of fixing such a problem where we were, the driver told us we had no choice but to keep going to the next village. Twenty or so tense minutes passed as we scraped our way through the jungle to the next town, which by some divine happenstance possessed a mechanic.

When I say mechanic, though, I really mean a man whose house is connected to a shed full of tools. The "mechanic" worked for the next few hours welding the shock back in place as best he could. I passed the time juggling volleyball in the street with the mechanics twelve-year-old daughter, eating dinner in the village's one-and-only restaurant, and showing some tunes to José, who was flabbergasted by the incredible powers of my iPod. By the time we got back on the road, it was well into the night, and we still had many hours of driving ahead of us.

We ended up driving straight through the night, the bumpiness of the road making it impossible to sleep. José and I had to push the car out of more than few ditches and up a couple of steep hills which it had not quite enough power to summit. After a few more stops to fix the transmission and one flat tire, the worst car ride of my life was over; we had finally made it to Nieva. It was close to 5 a.m., a full twelve hours later than when I had told the staff at IIAP to expect me.

The fish-breeding facility, where I had stayed the summer before and where I was to meet my contacts from IIAP, is a good 20-minute hike outside of Nieva. It was still dark out when I arrived and so I figured my chances of walking through the jungle and finding the place were slim. Fortunately, José offered to help me out and he took me to the police station next to his parents' house. After José explained the situation, the policeman on duty agreed to drive me in his police "mototaxi" to the fish-breeding facility for a small fee. A mototaxi is the standard means of local transportation in many towns of the Peruvian Amazon, and is basically just a three wheeled vehicle made from the front half of a motorcycle combined with a chariot-esque two seat bench welded to the back.

The policeman let me off outside the facility and I weaved my way through the fishponds and got to the main building around 5:30 a.m. The head biologist, Dr. Nixon Nakagawa, was already awake, standing in a towel outside his room having just taken a shower. He stopped brushing his teeth as I walked up and he asked me where I had been. I gave a brief explanation of why I was so late, and he clearly saw the affects of the long sleepless trip on my face.

He gave me a key to the building and showed me to my room, but before he left me to get some rest, he mentioned that he was leaving. He was going to a convention and would be gone for a few days. I told him that that was fine, and that I would therefore talk to his assistant, Moisés, later in the morning. Nixon replied that he was taking Moisés with him to the convention, but that Pancho, the third and final full-time staff member at the facility, was at my service and would help me with anything I needed.

It was at about this point that I first thought, Oh Shit. Nixon and Moisés, the only two people who I actually knew in the Amazon, were leaving. The next day I would be the boss; it would be all up to me to figure out what to do, and how to do it. Thankfully, I did not dwell too much on these worrying thoughts, as not even the prospect of my being virtually alone in the middle of the Peruvian Amazon could keep me from passing out as soon as I hit the mattress.

I awoke at around ten in the morning and set off to find Pancho. Luckily, he was just on the other side of the facility watching as his kids tried to learn how to ride IIAP's motorcycle, which he himself had no clue how to use. Pancho is an indigenous Amazonian in his late forties, about 5-feet tall, stocky, and speaks his native tongue of Awajún much better than he does Spanish. He greeted me warmly and told me that Nixon had instructed him to assist me.

I spent the next few minutes explaining the project to Pancho. The plan was to complete up to 200 surveys, around 100 from families that have fish farms, and another

100 from families that don't. Pancho was not fazed by the task at hand, and told me that he could take me to enough villages to meet my goal. Heartened by Pancho's confidence, I asked him to sketch a map of where we were going to go. He squiggled three rivers in my notebook, the Marañon and two of its tributaries, the Nieva and Santiago. He then denoted a few villages on the banks of each river and claimed that if we went to all of the villages he drew, we could definitely complete all of the surveys (a photocopy of the map is included in the appendix on page 63).

Convinced that Pancho would be a knowledgeable guide, and with no other options in any case, I told him that I would pay him if he would help me collect all the surveys. He accepted, and then suggested that we start on the Santiago River, which is a 3-hour boat ride from Nieva. I asked him when we could leave for the Santiago, expecting him to say the next morning, and he replied that we could catch a boat in about an hour. With no time to think, I packed my backpack with the essentials: a GPS, a change of clothes, all of my surveys, a pack of pens, and American Gods by Neil Gaiman.

Before I knew it, Pancho and I were side by side in a large passenger boat, skimming along an Amazonian river. The boat rides, especially in the motorized canoes we would take from village to village, were my favorite times in the Amazon. With no surveys to give out or villagers with whom to talk, I was free to take in the beauty of my surroundings. The fresh breeze on the rivers offered a much welcomed respite from mosquitoes, and I cherished the hours I was able to spend watching the banks slip past, the sunrises and sunsets over the trees, and the incredible expanse of jungle that was visible climbing hillsides for as far as the eye could see.

That first boat ride took us to Poza, the largest town on the Santiago, which would serve as a sort of jumping-off point for our trips to the nearby villages. There was a hotel in Poza where Pancho and I got two rooms for a whopping $3 dollars each, and a single restaurant where we ate the only thing on the menu, chicken and rice.

The next morning Pancho hired a canoe to bring us to the nearby community of Yutupis, where he had arranged for a meeting with IIAP's promoter in the village. Each village seemed to have a "promoter" from IIAP, a member of the town who would be in contact with IIAP to find out about aquaculture events. I expected to meet the promoter and convince him to introduce us to all of the families in the village so that I could give each one a survey. Upon arrival in Yutupis, however, I found out that just about everything I had expected the surveying process to be was completely and utterly wrong.

The promoter met Pancho and me as we stepped onto the riverbank. He was excited to meet me and quickly ushered us both towards the center of town. It became apparent that we were walking towards a large cement building where a few people were milling about next to the door. Once inside I was greeted by the stare of more than 100 Awajún people, mostly seated on low wooden benches. A hushed chatter spread through the room, as I was steered towards the small stage at the front of the hall.

I had not prepared anything for the occasion and my Spanish was rusty at best, but there I was, standing in front of an assembled village of indigenous Amazonians, all of whom were waiting to hear the gringo speak. Thankfully, I had a few moments to think of what to say while Pancho introduced me in their native tongue and told the assembly what we were here to do. It was then my tern to speak, and I nervously greeted the crowd and began to stumble over my Spanish. I eventually pulled myself together enough to thank the villagers for coming, and to ask them for their help in filling out my surveys.

As soon as I finished speaking, about a third of the assembly rose to their feet and the room filled with noise. It seemed that the villagers were frustrated with the amount of help they were receiving with the fishponds, and they thought I was somehow responsible for the lack of assistance. People started shouting things at me that I could not understand, and it took a few minutes before the promoter was able to calm things down. Some of the leading figures in the crowd then began to ask me questions; mostly they wanted to know what exactly I was going to do to help them. Equipped with only pens and a pack full of surveys I certainly was could not provide technical assistance, but after a good half hour or so I was able to assure them that I would bring my results back to the United States, from where I would try to help them. I told them that when I returned to the U.S., I would present my findings (in this thesis at first, and later hopefully in a respected journal) to people who were interested in the aquaculture programs of Condorcanqui, and convince them to invest in future fish-farming programs.

After a few hours of loud discussion, the villagers decided that they would permit me to give out my survey. I took a seat, somewhat relieved, behind a desk in the corner and asked for a member from each family to see me at some point during the day to complete the survey. Immediately the desk was surrounded by dozens of villagers, all demanding to be given the survey immediately; others said they had things to do and simply left. It was clear that they were not going to wait around for me to fill out the surveys one by one, and so I reluctantly agreed to let them fill out the surveys on their own, on the condition that they allow me to check to see if their survey was complete before they left.

I continued assisting participants who could not read or write, and the rest of the villagers quickly filled out their own surveys. A few let me look over their surveys before they left, but the great majority simply handed their “completed” surveys to Pancho as they walked out the door.

That evening, back at the hotel in Poza, I asked Pancho to join me on the balcony. Before we went to dinner, I told him that we needed to go over the surveys so that he could see exactly what I needed. One by one we went through the 40 or so surveys that we had collected that day, and I showed him that almost all were unusable. Most people didn’t understand or even try to answer many of the questions, and only the ones that I personally explained were complete. I told Pancho that giving out all the surveys at once would not work, and that from that point on I did not want to do the surveys in groups, but rather go from house to house and distribute the surveys one by one. Unfortunately, I had no idea how hard this would be.

The next morning Pancho arranged for us to be brought up to Villa Gonzalo, another riverside community, about a 3-hour canoe ride up the Santiago. We arrived about midday and met the promoter, Aldo, who led us to the town hall whose wooden benches would serve as our beds. Aldo then showed us to the newly finished fish-breeding facility that had been built in a clearing just outside the town. The facility was complete with a network of eight large tanks, which could be used for the breeding and harvesting of fingerlings. It was built by hand and had clearly taken an incredible amount of time and effort to construct. Unfortunately, it was not working. Because of lack of funding, the facility was not able to pay a biologist or workers to initiate the breeding process.

Aldo was understandably upset that the facility was sitting idle, and he implored me to do what I could to get it working. I assured him I would talk to IIAP about the situation. We walked back through the jungle paths to the town where one of Aldo's friends graciously offered Pancho and me a meal of yuca, hardboiled eggs, and boiled bananas. Once again the village insisted that we hold a town meeting in the morning before I should be allowed to distribute any surveys, so the rest of the day Pancho and I wandered around the muddy village, followed everywhere we went by wide-eyed children.

The next morning the villagers showed up to the town hall around 7 a.m., and once again they let out their pent-up frustration on me. It was the same in every village. Each town would assemble in a central hall, listen to my spiel, which became more and more fluid with practice, and would then lambast me with questions and problems. I think the villagers thought that because I was a white man from the United States working with IIAP on their fish-farming projects, that I must be in control of all of the things that IIAP was helping them with. They, therefore, would demand that I help them in all kinds of different ways. In Villa Gonzalo, as with almost all of the villages I visited, after a few hours of discussion the villagers eventually allowed me to give out the surveys.

For the next few days, Pancho, Aldo, and I walked from hut to hut, where I would fill out a survey as Pancho and Aldo chatted with the family or translated my words into Awajún when necessary. Each house would offer us a gourd-full of chicha, which is a drink made from boiled down and fermented yuca root. I drank as little chicha as possible, but often families insisted on my finishing the entire gourd. The family would then ask me how I liked it; wasn't their chicha the best? It all tasted the same to me but nonetheless I would swear each family's was the greatest that I had ever had the pleasure of tasting. It took me only 5-10 minutes to complete each survey, but with chicha and conversation, we ended up staying in many huts much longer.

It was around this time that I started to fall ill. Each night I shivered myself to sleep despite an ambient temperature of around 90 degrees F°, and the days walking around the jungle drained all my energy. My health was not helped by the sparcity of food I was eating. Pancho and I had brought no food of our own up the Santiago, and we ate only what families graciously offered us, which usually was very little and always was tasteless. My main sustenance while in the jungle came from bananas, which had to be boiled because of parasites (taking all flavor out of them and reducing them to a chalky texture), and yuca roots. Throughout my stay in the jungle I was constipated, dirty, hungry, and weak. Thus it became somewhat of a race to see if I could finish the surveys and get back to civilization, a bed, and a warm meal before having to be carried out on a stretcher.

After a tiring few days in Villa Gonzalo, we headed to the next village, called Huabal. The people of Huabal are of the Wampí tribe, and Pancho was a bit nervous about how we were going to be received as confusion can arise when Awajún and Wampís converse. Thankfully Aldo, who knows Wampí as well as Awajún, agreed to accompany us to the community.

We climbed the banks of the Santiago and were greeted by the Apu, or chief, of Huabal. The Apu seemed to be about 30 years old, was well built, and was wearing a plain white tank top, rolled up blue slacks and running shoes. He jovially shook our hands and invited us into a raised hut where he motioned for us to sit on a single low bench. The Apu then called for his own chair and a few moments later a small girl hurried in to present the Apu with a tiny wooden yellow chair. The chair had clearly been built for a toddler, but it was factory-made as opposed to hand-built and was brightly painted. These attributes transformed the miniature seat into a throne fit for an Apu. He leaned the chair against the wall so that it stood on just two tiny legs and carefully sat down. Aldo then explained to the Apu our situation, and after a bit of discussion in mixed Awajún and Wampí, the Apu led us across a clearing to a long and narrow wooden building.

The main section of the building was used as the village's school, but the Apu led us to a small room attached to one end, in which there was an antique-looking radio system. He told us we could stay on the floor in this room, and then he used the radio, which was hooked up to a megaphone on a pole outside the door, to broadcast our presence to the rest of the village. He explained that there was a gringo in town, and that he had arranged for a meeting to take place in the morning to meet me. He then went outside, turned the megaphone around 180 degrees, came back in, and repeated his exciting news to the other side of town.

The meeting the next morning was held below a building that was raised about five and a half feet off the ground, where a bunch of benches were placed. The meeting went comparably to the one in Villa Gonzalo, and the village thought it was quite humorous that I had to stoop to fit beneath the ceiling (none of them were similarly impeded). My speech was even smoother the third time around, and after another discussion filled with requests and demands, Pancho and I began our surveys of Huabal. Later, I had lunch with the family of the Apu, an occasion that remains my fondest memory of Huabal. They gave me the best meal that I had seen in many days, which consisted of fish soup, papaya, sachapapa, and coconut juice, with sugar cane for dessert. The community was not as large as Villa Gonzalo, and the next day Pancho and I headed back to Poza, where my $3 hotel room seemed ridiculously luxurious.

I collected about 100 reliable surveys during my time on the Santiago, which was halfway to my goal of 200. Pancho and I took the boat back to Nieva and after a day of rest and food at IIAP's fish-breeding facility, we set off up the Nieva River in search for the final hundred respondents. The Nieva River is much smaller than the Santiago, and therefore we were able to return to the town of Nieva each night to sleep. To further ease the journey, I hired Pancho's son Christian, who had his own motorized canoe, to be our personal captain taking us up to the communities and back each day.

The communities along the Nieva were for one reason or another less willing to participate in my study. They seemed to be upset with the level of assistance they were receiving from IIAP, and two separate villages declined to allow me to distribute any surveys whatsoever. Nonetheless, I was able to solicit surveys in two other communities, Japaime and Seasmi.

The villagers in Japaime were the most helpful of all the communities that I visited. After hearing my speech they brought me a table and a chair, and allowed me to sit there instead of walking from house to house, with a member from each family coming to see me at some point throughout the day. At lunchtime they even arranged for a picnic to take place in my honor. Banana leaves were laid on the ground and given out as plates, and families arrived with food to eat, each giving me a little of what they had prepared.

During lunch one of the villagers asked me what countries, other than Peru I had visited in my lifetime. I tried to shrug off the question with simple replies of "many", and "a bunch", but he persistently asked me to name the countries I had visited. Their mouths hung wide open as I named the various European, African, and American nations that I have been privileged enough to have seen. When I was done I asked whether any of them had ever been to another country, Ecuador was in fact only a days boat ride north. None, however, had even left the Amazon.

After almost a week traversing the Nieva, surveying at various houses where Pancho's friends live as well as throughout the two communities, I had completed about another 50 surveys, and I was running out of steam. Wagner, my contact in NCI, was coming to Nieva in a few days for an environmental conference, and I was desperate to catch a ride back to Chachapoyas with him and so ensure that I wouldn't have to repeat the taxi ride from hell.

Back at the fish-breeding facility I asked Nixon, who was back from his conference, how I might be able to finish the rest of my surveys before Wagner arrived. He proposed that instead of traveling to the other villages along the Marañon with Pancho, I could have one of IIAP's other employees, Manuel, take me to a few of the villages along the road. That evening I met up with Manuel in the center of town, and he agreed to help me finish collecting my surveys in the morning in exchange for a sizable fee.

The next morning Manuel woke me up shortly before dawn. We found IIAP's motorcycle underneath one of the facilities raised huts and I rode on the back of it into town. After a few cheese sandwiches, we muscled the bike down a ramp and onto a large canoe-taxi that took us across to the other side of the river where the road leads east from town. We shoved the motorcycle back off the boat, up a ramp and onto the road, and then set off. My first survey was given as Manuel screeched to a halt just as we were leaving town, hailing a man who was walking to work. Manuel knew the man had a fishpond at home, and thus I gave him a survey and we continued on down the road.

That day was my first real experience on a motorcycle, and quite an experience it was. About twenty minutes after I gave that first survey, we were riding down a fairly steep hill when Manuel ran over a branch in the road. The front wheel slid out, and I hit the ground hard, my right leg stuck beneath the bike. Cursing, Manuel lifted the bike off of me and I scrambled out from under it. My leg was bruised and my hands scraped, but my pain was of little consequence compared to the damage done to the bike. The front brake-line had broken and was wrapped tightly around the disks on the front wheel. It took Manuel a good fifteen minutes to unwrap the cord, which he then simply tied to the body of the bike. He then claimed that we were ready to keep going; needless to say, I was quite skeptical. Not only had we just bitten the dust, but now we were going to continue with no front brake. Manuel, however, assured me that it was fine to only use the back brake, and promised me we wouldn't crash again.

Throughout the rest of the day we stopped at numerous houses alongside the road, and even gave surveys out to men who were working on road construction as we passed by. Manuel seemed to know just about everyone we passed along the way and in the few villages that we passed through. It was quite striking as we zoomed along the bumpy jungle road just how much deforestation had occurred alongside it. Huge tracks of land were cleared for cattle grazing and corn cultivation, land-use activities that were extremely rare in the villages I had visited along the rivers.

Throughout the day Manuel and I had to push the bike through some of the more muddy portions of the road, and we even drove alongside a creek on a path barely wide enough for us to pass through, but true to Manuel's word, we stayed upright and unbloodied. I was able to administer over 30 more surveys, bringing my total to 184 – just 16 short of my goal and enough to be able to conduct an appropriate scientific analysis.

The day after I was thus able to catch a ride back to Chachapoyas with Wagner. The journey was much more pleasant in his four-wheel-drive truck, although it was still long and bumpy. Back in Chachapoyas I slept better than I had in weeks, and ten days later I was back home in San Diego.

I have traveled to many places, but the culture shock that I experienced upon my return home from this journey was unlike anything I have ever experienced. The amount of luxury with which we live truly blew my mind like never before. I fell into the soft cozy cocoon that is my home and never wanted to leave. My mother's home cooked meals, my father's entertainment systems, and my comfy bed put me into a blissful coma after my experiences in the jungle.

As time has passed, however, I have once again become accustomed to my first world lifestyle. No longer do I find amazement in the softness of a pillow, or the presence of the Internet. Perhaps, if I had stayed in the Amazon longer I would have become accustomed to a more simple way of life. For now, however, I shall have to rely upon memories of my incredible journey to put my present life into perspective.

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APPENDIX

Survey Instruments

Survey Instrument for Families That Practice Solely Subsistence Agriculture

Encuesta Piloto Sobre Impacto de La Agricultura En Condorcanqui

N° de Encuesta:……………………………………… Comunidad:……………………………………..

Encuestador:…………………....………………….. Fecha:……………………………………………...

Encuestado:…………………………………………. N° Miembros de la Familia:………………..

Edades de los hombres…………………………………… y las mujeres…………………………………...

Esta encuesta tiene como propósito evaluar el impacto de la piscicultura a fin de apoyar las acciones que en el futuro realizará el IIAP en sus proyectos.
Preguntas sobre agricultura:

1. ¿Qué tipos de cultivos Usted se produce?

2. ¿Cuánto tiempo dedica Usted a la agricultura? (días al mes)

3. ¿Aproximadamente cuánta superficie Usted se utiliza para cada tipo de cultivo y cuál es el tamaño de su chacra? (en hectáreas si es posible, o en metros).

4. ¿Cuánto ha sido su producción por cada tipo de cultivos y en qué años?

5. Por cada tipo de cultivos, ¿Ha vendido o ha sido solo para consumo familiar?

6. Por cada tipo de cultivos que vendió, ¿a cuanto vendió y a qué precio?

7. ¿Cuántos años puede cultivar en la misma parte de su chacra?

Preguntas sobre de tala de madera:

1. ¿Usted entre al monte para sacar madera? (si la respuesta es Sí, continúe en las siguientes cuatro preguntas)

2. ¿Cuánto tiempo dedica Usted para sacar madera? (días al mes)

3. ¿Aproximadamente cuánto madera Usted vende y a qué precio?

4. ¿Aproximadamente, cuánto área de bosque Usted ha cortado para tener la madera? (en hectáreas si es posible, o en metros)

5. ¿Cree Usted que la crianza de peces le permite o evita que Usted corta más madera? (si la respuesta es Sí, ¿cuánto de área cree Usted?)

Por último, si es posible, haz un dibujo de su chacra, dividiéndola en las diferentes áreas de uso de la tierra. También, por favor escriba aproximadamente cuánta tierra Usted tiene en total (en hectáreas si es posible, o en metros). Usted puede hacer esto por debajo o en el otro lado del papel. Gracias.

Survey Instrument for Families That Practice Aquaculture as well as Subsistence Agriculture

Encuesta Piloto Sobre Impacto de La Piscicultura En Condorcanqui

N° de Encuesta:…………………………………………… Comunidad:……………………………………………

Encuestador:……………………………………………… Fecha:………………………………………………….

Encuestado:………………………………………………… N° Miembros de la Familia:…………………..

Edades de los hombres…………………………………………. y las mujeres………………………………………...

Esta encuesta tiene como propósito evaluar el impacto de la piscicultura a fin de apoyar las acciones que en el futuro realizará el IIAP en sus proyectos.

Preguntas sobre piscicultura:

1. ¿Desde cuándo Usted se dedica a la crianza de peces?

2. ¿Cuánto tiempo dedica Usted a la crianza de peces? (días al mes)

3. ¿Cuántos estanques tiene y qué dimensiones tiene aproximadamente? (en metros)

4. ¿Cuánto ha sido su producción en cada uno de los estanques y en qué momento o año?

5. Si dejó de producir, ¿Cuándo sucedió (año)? ¿Cuáles fueron los motivos?

6. ¿Ha vendido o ha sido solo para consumo familiar o las dos cosas?

7. Si vendió, ¿Cuánto vendió y qué precio? Y si fue solo consumo familiar ¿Qué cantidad fue para el hogar?

8. ¿Piensa Usted en tener más Posas?. Si la repuesta es si ¿Cuántas y de qué dimensiones?
<u>Preguntas sobre agricultura:</u>

1. ¿Qué tipos de cultivos Usted se produce?

2. ¿Cuánto tiempo dedica Usted a la agricultura? (días al mes)

3. ¿Aproximadamente cuánta superficie Usted se utiliza para cada tipo de cultivo y cuál es el tamaño de su chacra? (en hectáreas si es posible, o en metros).

4. ¿Cuánto ha sido su producción por cada tipo de cultivos y en qué años?

5. Por cada tipo de cultivos, ¿Ha vendido o ha sido solo para consumo familiar?

6. Por cada tipo de cultivos que vendió, ¿a cuanto vendió y a qué precio?

7. ¿Cuántos años puede cultivar en la misma parte de su chacra?

8. ¿Cree Usted que la crianza de peces le permite o evita que Usted produce más cultivos? (si la respuesta es Sí, continúe en las siguientes dos preguntas)

9. ¿Qué tipos y cantidades de cultivos habría producido sin piscicultura?

10. ¿Cuánto más tierra Usted cree que habría utilizado para este producción?

<u>Preguntas sobre de tala de madera:</u>

1. ¿Usted entre al monte para sacar madera? (si la respuesta es Sí, continúe en las siguientes cuatro preguntas)

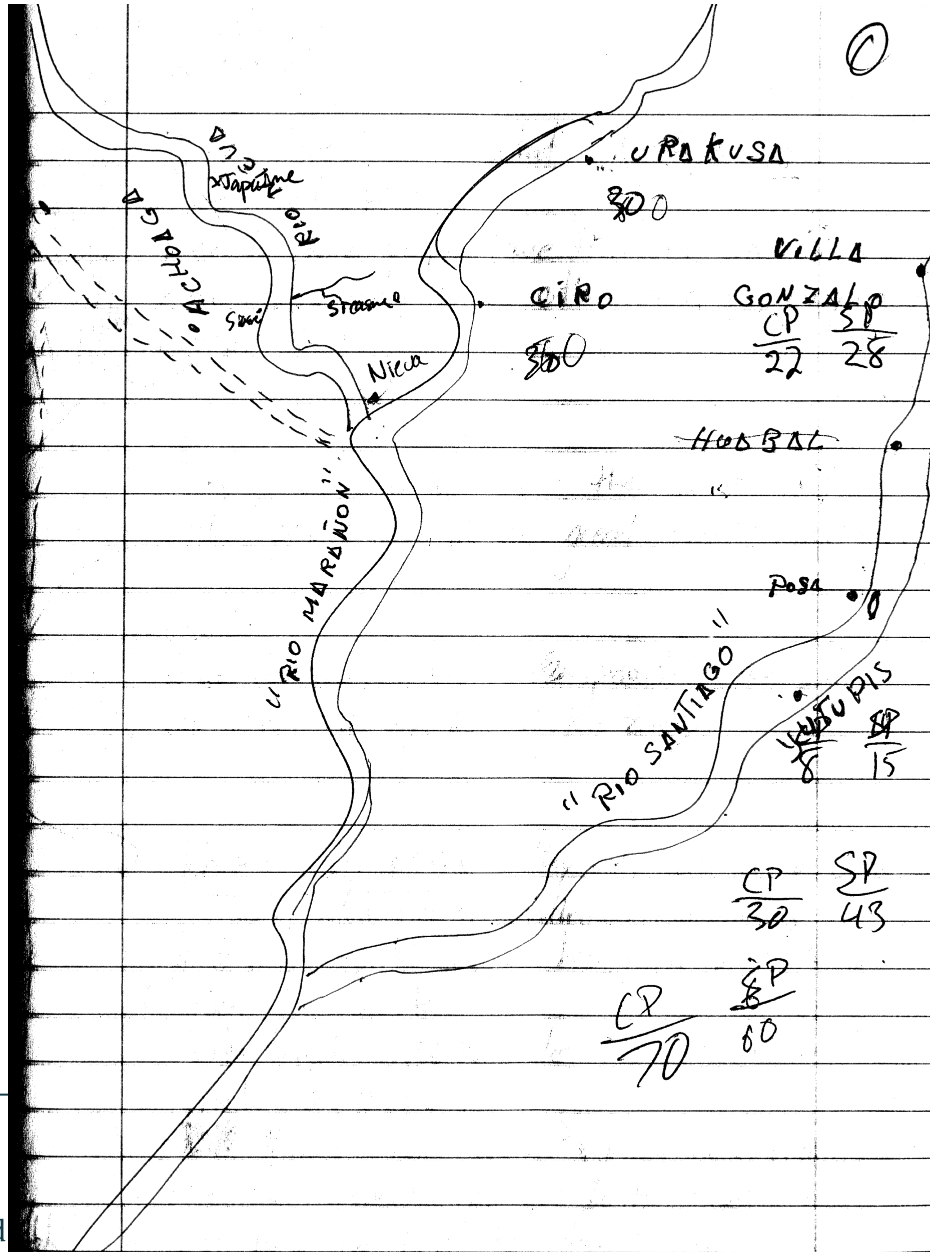
2. ¿Cuánto tiempo dedica Usted para sacar madera? (días al mes)

3. ¿Aproximadamente cuánto madera Usted vende y a qué precio?

4. ¿Aproximadamente, cuánto área de bosque Usted ha cortado para tener la madera? (en hectáreas si es posible, o en metros)

5. ¿Cree Usted que la crianza de peces le permite o evita que Usted corta más madera? (si la respuesta es Sí, ¿cuánto de área cree Usted?)

Por último, si es posible, haz un dibujo de su chacra, dividiéndola en las diferentes áreas de uso de la tierra. También, por favor escriba aproximadamente cuánta tierra Usted tiene en total (en hectáreas si es posible, o en metros). Usted puede hacer esto por debajo o en el otro lado del papel. Gracias.



Pancho and go and

Nieva Rivers. I finished my surveys along the road shown by the dashed lines on the upper left side of the map, and therefore never travelled to the villages shown on the Marañon.