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Determinants of Wild Fish Consumption in Indigenous Communities in the Ecuadorian Amazon

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ABSTRACT

This paper analyzes the socioeconomic determinants of consumption of wild fish among the Kichwa and Shuar indigenous peoples in the Ecuadorian Amazon. The results of a random-effect linear model show that the consumption of wild fish is higher for households with younger heads that do not have off-farm work and reside far from urban centers, in communities with low population densities. Although various actors promoting aquaculture in the region often claim that it helps to relieve the pressure on wild fish stocks, no statistically significant effect of the consumption of cultivated fish on the consumption of wild fish could be shown. Thus, our analysis suggests that public policies and development interventions which increase access to off-farm employment can both improve local livelihoods and conserve biodiversity, but that the same affirmation cannot be made for the promotion of aquaculture.

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Aquaculture; Ecuadorian Amazon; fish; Kichwa; off-farm employment; Shuar

Introduction

Wild fish is, since ancient times, a crucially important natural resource for riverside populations in the Amazon (Salo, Sirén, and Kalliola 2014), providing high-quality dietary protein and fat as well as cash income, but as catches often are underreported its full economic importance is often neglected (Camburn 2011; Lasso-Alcala 2011; Sirén 2011). In particular, fishing is essential for the food security of Amazon indigenous peoples (Peixoto Boischio and Henshel 2000; Apaza et al. 2002; Ferrer et al. 2013). Fishing is, however, often poorly regulated, and in many parts of the basin, there are signs of overexploitation of fish stocks, such as decreasing catch per unit of effort and a trend towards smaller-sized fish in the catch (IIAP 2002; De Jesús and Kohler 2004; van Brakel 2006). Although most studies on overfishing in the Amazon basin focus on commercial fisheries in the larger rivers, it is quite likely that also subsistence fishing in the headwaters and smaller tributaries contribute to this process, especially when human population densities are relatively high and destructive fishing methods are employed, such as using explosives or ichtiotoxic plants. A particular challenge to sustainable management of fish resources in the Amazon is that most of the fish catch consists of species that move over vast distances, in complex patterns involving life stage-related as well as seasonal migrations (Agudelo-Córdoba et al. 2000; Anderson et al. 2009),

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meaning that fishing in one place can have impacts on fish stocks also in other places hundreds, or even thousands, of kilometers away.

Little research has been done on the socioeconomic drivers of fishing in tropical freshwater systems. Among the few studies published, Apaza et al. (2002), studying the effect of beef prices on the consumption of game and fish among indigenous peoples in the Bolivian Amazon, found that the consumption of fish is positively correlated with beef prices, a doubling in the price of beef leading to a doubling in the consumption of fish. Also in Bolivia, Godoy et al. (2010) found a positive association between wealth and fish consumption and attributed this to that wealthier households can access better fishing equipment (i.e., boats and fishing nets), leading to larger catches. In Ecuador, Gray, Bozigar, and Bilsborrow (2015) found that fish harvesting was higher for larger and wealthier households whose head was born in the same community as where currently residing. Considerably more research has been done on the socioeconomic drivers of wildlife hunting in tropical forests. The results of such research are also inconclusive, however, as increased income and wealth in some situations seem to lead to an increase of hunting, and in others to a decrease (Shively 1996; Wilkie and Godoy 2001; Apaza et al. 2002; Foerster et al. 2012; Godoy et al. 2010; Overman and Demmer 1999). With this background, this paper is aimed at identifying the socioeconomic drivers of fishing in indigenous communities in the Ecuadorian Amazon.

Materials and Methods

The Study Area

The research took place in the province of Pastaza, in the central Ecuadorian Amazon region (Figure 1). Pastaza is the least populated province of Ecuador with a population density of about 2.9 inhabitants/km^2, but population growth is rapid, the rural population having increased by 34% between 2001 and 2010, according to official sources (INEC 2010)[1]. Most of the population is concentrated in the westernmost part of the province, near the provincial capital, Puyo, in particular the non-indigenous colonists, who account for 42% of Pastaza's rural population (INEC 2010), and engage in

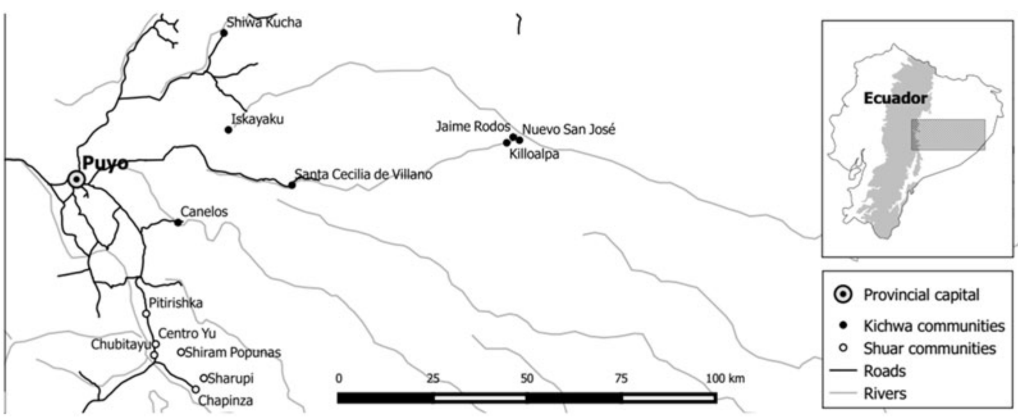

Figure 1. Map of the study area showing the location of the different communities in relation to major roads and rivers.

cultivation of cash crops and cattle ranching. Since around the turn of the century, there has been a boom in aquaculture among the colonists, mainly based on the exotic *tilapia* fish (*Oreochromis* sp.), and largely for commercial purposes, tilapia nowadays being one of the most common dishes in restaurants in Puyo.

Indigenous peoples account for 58% of Pastaza's rural population, with the Kichwa and the Shuar the most numerous ethnic groups. Some of them live within the colonized area in the west and others in small villages dispersed in the vast and sparsely populated forest areas in the east. The Kichwa of Pastaza derive from the fusion of several Amazon peoples (Achuar, Zápara, Shuar and Andoas) as well as highland Kichwa who migrated to the Amazon to escape Spanish colonial oppression[2] (Restrepo and Cabrejas 1998; Guzmán-Gallegos 1997). In the 1970s and 80s, some Shuar migrated from their traditional lands in the Morona Santiago and Zamora Chinchipe provinces, to Pastaza, or even further north, due to land scarcity caused by high rates of population growth in their communities and the intense influx of nonindigenous settlers[3] (Rudel, Bates, and Machinguiashi 2002; Bremner and Lu 2006; Gray et al. 2008; Prefectura de Pastaza 2012). Most of the Shuar communities are located along the route south to Morona Santiago, the province they originally migrated from. Indigenous communities located near the road network, including most Shuar, and some Kichwa, communities are highly integrated into the market economy, similar to the non-indigenous settlers (Gray et al. 2008; Vasco, Tamayo, and Griess 2017), livelihoods being based principally on cash cropping and cattle ranching (Rudel, Bates, and Machinguiashi 2002), timber harvesting (Muzo et al. 2013) and wage work (Vasco Pérez, Bilsborrow, and Torres 2015; Vasco and Bislborrow 2016). In remoter Kichwa villages away from the road network the local economy is still – to a considerable extent – a subsistence economy based on small-scale agriculture, fishing and hunting (Sirén and Machoa 2008). Whereas fishing for commercial purposes is very limited in the area, subsistence fishing is an important source of food in indigenous communities (Jácome et al. 2008), with the per capita consumption of wild fish in different Kichwa communities having been estimated to between 49 $g day^{-1}$ (Morales-Males and Schjellerup 1999) to 249 $g day^{-1}$ (Sirén 2004; Sirén and Machoa 2008), this latter figure corresponding to almost half of the average intake of protein and almost two-thirds of the fat in the community in question.

Not only the colonists, but also many indigenous households have built fish ponds, starting in the 1990s and often with the support of NGOs and oil companies (MDGIF 2011). Whereas some indigenous communities, principally those located in the surroundings of Puyo, have engaged in commercial aquaculture taking advantage of their location and the relatively high demand for cultivated fish in urban areas (Espinosa 2016), most of the aquaculture ventures in indigenous communities are low-tech and mainly for self-consumption (MDGIF 2011).

Data Collection

Field work, based on a household socioeconomic survey, took place between May and October 2013. The questionnaire included questions about household demographic characteristics, land use, household assets, social capital, on-farm and off-farm employment, harvest of terrestrial and aquatic wild plant and animal resources, as well as productive activities within agriculture, aquaculture and livestock production. Additionally, a community survey was administered to community leaders –who had previously been asked for permission to administer the survey to the households in their communities- to gather information on population, infrastructure and social organization. The questionnaire was written in Spanish. However, it was not an issue when collecting data as almost all the household heads in the sample were fluent in Spanish, and our survey team included Kichwa and Shuar undergraduate students who were able to translate questions when required.

Households were selected using two-stage sampling. So, 13 communities were selected following criteria of ethnicity, distance to markets and infrastructure, population density and availability of off-farm employment (Figure 1). In terms of ethnicity, we included Shuar as well as Kichwa communities, and as for the rest of the criteria, we intended to cover communities near and far from Puyo, near and far from roads, with low and high population densities, and with low and high availability of off-farm work. To illustrate, some of the communities near Puyo such as Canelos (Kichwa) and Chubitayo (Shuar) are larger and more integrated into the market economy so that they offer more off-farm job opportunities. Such jobs are not available in smaller communities near Puyo, such as Pitirishka and Centro Yu (Shuar), where people mostly obtain their livelihoods from cash crops. In contrast, in Chapintsa and Sharupi (Shuar), and Santa Cecilia de Villano (Kichwa), where roads were opened recently and forested areas still exist, incomes from logging are likely higher than elsewhere. In settlements farther from Puyo such as Shiram Popunas (Shuar) and Killoalpa, Jaime Roldos and Nuevo San Jose (Kichwa), people tend to rely more on subsistence farming and forest products, including wild meat and fish. This sampling procedure ensures diversity of communities in the sample, improves the robustness of the results (Cavendish 2003) and has been widely used in tropical environments when the use of probabilistic sampling is unfeasible (Torres et al. 2018; Porro, Lopez-Feldman, and Vela-Alvarado 2015; Vasco, Torres, et al. 2017). Next, households within a community were selected using random sampling. A total of 218 households were surveyed in 13 communities (Table 1).

Statistical Methods and Specification

In order to identify the determinants of wild fish consumption, we used two different statistical approaches, namely an ordinary least squares (OLS), and a random-effect linear model. The results from the OLS must be interpreted with caution, because household decisions concerning wild fish consumption may be affected by contextual variables, which are inherent to each community. Households within a community may exhibit similar fish consumption patterns based on a common background in terms of ethnicity, economic well-being, market integration and environmental endowments (Pan and Bilsborrow 2005; Gray et al. 2008). As controls for the hierarchical nature of the data are absent in the OLS analysis, the results may lead to misleading interpretations of the effects of household variables. We therefore use the OLS analysis as a robustness test only. To analyze the socioeconomic drivers while controlling for the contextual effects on household fish consumption decisions, we use a random-effect linear model of the following form:

$$y_{ij} = \alpha + H_{ij}\beta + C_j\eta + \varepsilon_{ij} + \nu_i \quad (1)$$

Table 1. Communities in the sample.

Ethnicity	Community	Households (total)	Surveyed households	Density (inhabit./km^2)	Accessible by	Travel time to Puyo (hours)	Wild fish per ca pita consumption g/day (overall)	Cultivated fish per capita consumption g/day (overall)	Cultivated fish per capita consumption g/day (only for households with fishponds)
Shuar	Centro Yu	15	7	0.6	Dirt road	1.5	68	1.0	6
	Chapintsa	40	12	26.2	Dirt road	2.0	14	0.4	4
	Chubitayu	85	43	11.4	Paved road	1.0	39	2.8	3.0
	Pitirishka	49	26	4.5	Paved road	0.75	16	32	36
	Shiram Popunas	12	7	4.2	Trail	6.0	92	0	–
	Sharupi	18	8	1.5	Trail	3.0	180	0	–
	Mean Shuar	–	–	–	–	–	**48**	**14**	**18**
Kichwa	Canelos	75	41	4.0	Dirt road	1.0	72	0.6	8
	Iskayaku	14	11	1.5	Trail	3.5	78	0	–
	Jaime Roldos	23	12	0.15	River	8.0	150	0	–
	Killoalpa	11	4	0.3	River	8.0	104	0	–
	Nuevo San José	31	12	0.5	River	8.0	224	0	–
	Santa Cecilia de Villano	50	20	0.5	Dirt road	3.5	142	68	136
	Shiwa Kucha	18	15	7.7	Dirt road	2.0	40	8	18
	Mean Kichwa	–	–	–	–	–	**104**	**6**	**8**

where y_{ij} stands wild fish consumption of household i in community j, in each case, $\boldsymbol{H}$ and $\boldsymbol{C}$ are vectors of household and community-level covariates to be described later on, β and η are vectors of household and community coefficients, respectively, ε_{ij} is the household-level error term, and v_j is the community-level error term. We use robust standard errors to control for heteroskedasticity in the model.

Table 2 shows the definitions and descriptive statistics of the variables used in the analysis. The dependent variable of interest is the natural logarithm of the daily wild fish consumption per capita estimated by dividing the total amount of wild and cultivated fish ingested by the household in the 12 months preceding the survey by 365 and the total number of persons in the household. We first asked respondents the average number of fishing events in a week and multiplied this value by the average weight of a catch during the rainy season to obtain the aggregate value of fish collected during a week in the rainy season and further obtained the aggregate value for the whole rainy season. We replicated this procedure this time using the average catches during the dry season. Finally, we added the aggregate values of the rainy and dry seasons to obtain the total amount of fish harvested during the 12 months preceding the survey. A similar procedure was utilized to collect information about cultivated fish consumption. We logged the values of wild fish in order to avoid the effect of outliers.

The list of predictors includes sets of household and community characteristics. Household-level characteristics include the age and years of formal education of the household head. We also include the head's age squared to control for any possible non-linearity between age and wild fish consumption. Ethnicity is controlled for with a dummy variable taking the value of 1 if the household head is Shuar and 0 otherwise. A wealth index constructed from household assets controls for the effect of wealth on the dependent variables. This index is the first principal component of ownership of a radio, TV, cell phone, computer, gas stove, refrigerator, spray pump, car, motorcycle and solar panel. Such an index gives higher weight to assets that provide more information about household wealth, and is preferred to simple count indexes

Table 2. Variables, definitions and descriptive statistics.

	Description	Mean	Standard deviation	Min.	Max.
Dependent variable					
Wild fish	Wild fish consumption per capita (g/day)	75.7	150.6	0.0	623.6
Household-level predictors					
Age	Age of household head (years)	40.5	12.7	20	80
Education	Education of the household head (years)	8.6	4.1	0	18
Ethnicity	Household head is Shuar (0/1)	0.48	–	–	–
Wealth	Wealth index	−0.28	1.83	−3.88	3.72
Off-farm employment	Share of income from off-farm work	0.523	0.367	0	1
Cultivated fish	Cultivated fish consumption per capita (g/day)	11.6	76.7	0.00	504.4
Community-level predictors					
Travel time to Puyo	Travel time from the community center to Puyo (minutes)	198	214	45	1460
Population density	Inhabitants/km^2	8.09	8.00	0.37	30

Note: (0/1) identifies dummy variables.

that assign equal values to every asset (Filmer and Pritchett 2001). The share of household income from off-farm work controls for the effect of livelihood diversification on fish consumption.

At community-level, the natural logarithm of the travel time from the community center to the provincial capital is included as a proxy of distance to market and market integration. The model also includes the population density obtained by dividing the community's population by the number of square kilometers over which the community holds official rights. We use this value as a proxy of the effect of population pressure on the availability of fish.

Results

Descriptive Analysis

On average, the Kichwa consume twice as much wild fish (104 g/person/day) as the Shuar (48 g/person/day). The per capita consumption of wild fish is six times as large as that of cultivated fish (see Table 2). While 80% of the households in the sample harvest wild fish, only 25% of the households have fish ponds and harvest cultivated fish. Table 1 shows the mean values of wild and cultivated fish consumption.

Wild fish consumption seems to be influenced by the travel time to urban areas, with households in communities near Puyo consuming less wild fish. While modest compared to wild fish consumption, the consumption of cultivated fish appears to be larger near Puyo. Descriptive statistics also suggest that wild fish consumption is higher in communities with low population densities. While these findings are plausible, we must take into account that Shuar communities are located nearer Puyo and have higher population densities so that ethnicity may be reflecting the effect of proximity to urban areas and population pressure. In order to disentangle the effect of these and other household and community-characteristics, we incorporate multivariate regressions to the analysis in the following section.

Multivariate Analysis

Table 3 shows the results of both an ordinary least squares (OLS) and a random-effect linear model, with the daily per capita consumption of wild fish, as the dependent variable of interest. The likelihood-ratio test (LR test versus linear model) shows that there are significant differences between the OLS and the random-effect model when community-level predictors are excluded (column III), but when community-level predictors are included, on the other hand, this test fails to reject the null hypothesis that there are differences between the OLS and the random-effect model (column IV). Accordingly, there are no differences in the size and direction of the coefficients between the OLS (column II) and the Random-effect model (column IV). As a robustness test, we use the OLS regression without community-level variables (column I) resulting in the coefficient of the Shuar dummy and the wealth index statistically significant and the share of income from off-farm work non-significant. The same specification was run with random-effects (column III), with the coefficient of the Shuar dummy and wealth becoming nonsignificant and off-farm employment

Table 3. Socioeconomic determinants of wild fish per-capita consumption (ordinary least squares and random-effect model) (coefficients and significance values).

	OLS		Random-effect linear model	
	I	II	III	IV
Household-level predictors				
Age	−0.059	−0.074*	−0.065*	−0.074**
Age square	0.000	0.000	0.000	0.000
Education	−0.009	−0.010	−0.011	−0.010
Ethnicity	−0.464**	−0.246	−0.296	−0.246
Wealth	−0.160**	−0.077	−0.077	−0.077
Off-farm employment	−0.253	−0.489*	−0.396*	−0.489**
Cultivated fish	−0.012	−0.067	−0.055	−0.067
Community-level predictors				
Travel time to Puyo	–	0.284*	–	0.284*
Population density	–	−0.045**	–	−0.045**
Intra-class correlation	–	–	0.13	0.000
LR test versus linear model (χ^2)	–	–	5.62**	0.00
Number of observations	218	218	218	218
χ^2 ($p > 0.000$)	7*	11**	20**	74**

Notes: * and ** stand for statistical significance at 5% and 1%, respectively. All models were estimated with robust standard errors.

statistically significant again. This reflects that once contextual effects are controlled for, ethnicity does not play any role on wild fish consumption. Furthermore, the intra-class correlation, drops from 13% in the random-effect model without community controls (column III) to 0% in the model with aggregate community variables (i.e. travel time to Puyo and population density) (column IV), reflecting that the inclusion of community-level predictors is useful in reducing community-effects on wild fish per capita consumption at household-level.

The results presented in column IV show that whereas the consumption of cultivated fish is negatively correlated with wild fish consumption, this effect is not statistically significant ($p = .497$).

One of the most significant results was that consumption of fish decreased with off-farm income, with a 1% increase in the share of income from off-farm leading to a 0.49% decrease in the consumption of wild fish.

Wild fish consumption was also affected by travel time to the town of Puyo, by population density, and the age of the household head. An increase of 1% in the travel time from the community of residence to town, leads to an increase of 0.28% in the per capita consumption of wild fish at household-level. On the other hand, one extra inhabitant per square kilometer reduced wild fish consumption at household-level by 0.5%. The older de household head, the lower the per capita consumption at household level, with each year of age leading to a decrease of 1% in the consumption of wild fish.

Discussion

That the consumption of wild fish is higher in households located in more remote areas, far away from the provincial capital, probably reflects that households located nearer urban areas can access alternative food sources whereas those residing in more remote areas depend more on river fish to meet their dietary needs.

That wild fish harvesting decreases with off-farm employment stands in contradiction to the findings of Godoy et al. (2010), who showed that, among the Tsimane people of the Bolivian Amazon, wild fish harvesting instead increased with income, and attributed this to that cash income increases indigenous peoples' ability to fish by allowing them to buy improved fishing equipment. On the other hand, this finding is consistent with other studies (Shively 1996; Vasco and Sirén 2016) which reported that off-farm income has a negative effect on wild life harvest, likely because households with access to cash income can access alternative food sources and so do not heavily rely on wild life harvesting, or because off-farm employment increases the opportunity cost of labor time for fishing, with those engaged in off-farm work having little or no time available for fishing.

Regarding the effect of population density, it is natural that increased competition for limited fishery resources leads to lower per capita consumption. One may indeed speculate that also stock reduction due to overfishing may play a role, but this is actually less likely, given that most fish are migratory, such that fish stocks can be expected to be influenced more by basin wide than local population densities. Moreover, it should be noted that the effect of population density, in spite of showing strong statistical significance, is quite low in magnitude.

Despite the rapid adoption of aquaculture in the Ecuadorian Amazon during the last two decades (MDGIF 2011), it is still a marginal livelihood activity in the communities we studied, as it has been adopted only by a small share of the population (25% of the respondents) and provides only a small amount of fish in comparison with capture fishery. The descriptive statistics show that cultivated fish consumption is larger in communities located nearer to roads and nearer to Puyo (e.g., *Pitirishka*, *Shiwa Kucha* and *Santa Cecilia de Villano*). It is also worth noting, that all these communities have received some kind of financial and technical assistance from either NGOs or oil companies. No significant correlation was found between consumption of wild fish and that of cultivated fish. The discourse used by NGO's, local politicians and representatives of indigenous federations, in order to promote projects for implementing aquaculture in the study area, often involves not only the argument about food security, but also the argument that aquaculture is nature-friendly because it leads to reduced pressure on wild fish resources. However, our results do not support such an affirmation. This could of course be an effect of our limited sample size, and also because of the modest levels of aquaculture production in the communities studied. Further research with larger sample sizes and including places with higher levels of aquaculture production could shed more light on these questions.

Reducing catches of wild fish is not necessarily a purposeful conservation goal in itself. Management measures that restrict the place and timing of fishing, as well as the gear and methods used, and the sizes and species targeted, may lead to increased fish stocks and the possibility to even increase catches on a sustainable basis. In the Ecuadorian Amazon, however, such management measures are virtually absent. Just in recent years researchers have begun to do interdisciplinary research, integrating biological and societal aspects, in order to identify feasible paths toward such sustainable management of fish and other aquatic resources in the Amazon, (e.g., Castello et al. 2009; Pinho, Orlove, and Lubell 2012; Harju, Sirén, and Salo 2018) and much more such research is needed. Meanwhile, however, it is important to reach a better understanding of the socioeconomic drivers of the current, basically unregulated, fishing.

Caution is needed when using household survey data since information provided by respondents sometimes may be biased, for example, if the topic under investigation is either sensitive or illegal, leading to *social desirability bias* (Nuno and ST. John 2015), or in other words, respondents may be tempted to hide/underreport when asked about controversial activities (e.g., wild life harvesting and logging). This is not an issue in this case, however, as fishing is considered an uncontroversial activity among indigenous peoples, who are actually permitted to fish without restrictions within their territories. One potential weakness of the research approach applied is that it does not take into account local, intra-community trade or gifts. However, only 4% households in the sample reported having sold/bartered cultivated fish. Also, a previous study in the area showed that only 2% of the wild fish caught was sold or given away, in contrast to as much as 17% of hunted wild meat (Sirén and Machoa 2008).

Obviously, recall questions covering a 12-month period cannot give very precise estimates. For the analysis, however, it was not necessary that estimates were accurate in absolute terms, as long as they were accurate in relative terms, that is, that there was a close correlation between reported catches and real catches. The estimates, furthermore, definitively seem to be in the right ballpark when comparing to previously made estimates, which for different Ecuadorian Amazonian peoples range between 49 and 545 g/capita/day, with the median value being 105 g/capita/day, not far away from our estimates of 104 g/person/day for the Kichwa and 48 g/person/day for the Shuar.

Conclusion

This paper has analyzed the determinants of fish harvesting among Kichwa and Shuar peoples in the Ecuadorian Amazon. The results show that wild fish is an important source of livelihood for a large share (80% of our sample) of indigenous households. The multivariate analysis show that harvest of wild fish decreases with off-farm employment and population density, and increases with remoteness, that is, travel time to the regional urban center. Our analysis suggests that public policies and development interventions that increase access to off-farm employment can both improve local livelihoods and conserve aquatic biodiversity. It cannot be ruled out that aquaculture under certain circumstances can lead to a reduced pressure on wild fish stocks, but in this particular study no such effect could be revealed. Therefore, and considering that aquaculture can have several negative impacts on the environment (Naylor et al. 2000), inflated claims about the nature-friendliness of introducing aquaculture in Amazonian indigenous communities ought to be avoided.

Notes

1. However, this figure may be affected by considerable errors in the procedures of the censuses, as Sirén (2004, p. 138) reported that the population in one indigenous community in the Pastaza province was underestimated by as much as 19% in the 2001 census.
2. Despite the fact that the Kichwa are mostly associated with the Andes, the lowland Kichwa are Amazonian in their origin, kinship, philosophy and knowledge of the forest (Whitten

1976). Whitten has also argued that the Kichwa language was probably spoken in the Amazon long before the Inca conquest.

3. In fact, 67% of the Shuar household heads in our sample were born in the province of Morona Santiago.

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