The Spatial Extent And Composition Of Wildlife Harvests Among Three Villages In The Peruvian Amazon

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Introduction

The sustainability of human communities in the Peruvian Amazon is a particularly complex issue because of the great variation in household adaptive strategies and due to seasonal and spatial variations in biotic resources. Rural Amazonian households have mixed subsistence strategies involving a combination of swidden-fallow agriculture, hunting, fishing, gathering, animal husbandry, and wage labor activities. These households also depend on an extensive network of relatives and friends for accessing seasonal resource areas such as lakes, fruiting palm stands, and hunting grounds. These social networks and diverse subsistence activities provide households with the means to sustain themselves despite seasonal resource shortages, resource depletion, crop failure, and market price fluctuations. However, the fact that such rural subsistence strategies have led to the local depletion of soil, plant, and wildlife resources draws into question the long-term sustainability of Amazonian settlements.

Hunting may have been a sustainable activity by many tribal peoples prior to European contact. However, since European contact, many factors have contributed to non-sustainable harvest rates including: human population growth, increased sedentism, market valuation of wildlife products, technological introductions, reduced areal extent of community land holdings, the loss of traditional authority over resource access and exploitation, increased access to wildlife habitat, and habitat alteration (Hames, 1991:179,191-193). As a result of these factors, peasant hunting practices in Amazonia have caused local scarcities and extinctions of preferred game species surrounding both Amerindian and ribereño[1] communities (Hames, 1991:182-183; Pinedo-Vasquez et al.;1992:80; Vickers, 1991:77). Non-primate mammalian game densities in areas subject to moderate hunting can be up to 81% lower than in unhunted sites and 94% lower in heavily hunted areas. Researchers have noted similar decreases in primate and avian game species densities (Redford, 1992:417-418). Studies of some Amazonian hunters have demonstrated that they are generally opportunistic hunters and will harvest wildlife despite a perceived scarcity of some species. One study of fifteen Amazonian tribal populations concluded that these populations made no active or concerted effort to conserve fish and game resources" (Hames, 1991:182). This conclusion was based on an analysis of the correlation between observed hunting behaviors and the predicted behaviors of conservation-minded hunters.

Because subsistence hunting practices often lead to the depletion of certain wildlife species, it is important that persons evaluating the sustainability of human settlements understand what factors influence over-harvesting and how communities and households adapt to depleted resources. This paper examines the composition of wildlife harvests and the spatial extent of hunting activities in three villages in the Peruvian Amazon. All three villages have official tenure to community lands and practice a similar array of subsistence activities. The villages differ in terms of age, size, and in their local diversity of game species. Wildlife harvest data and household interviews were analyzed to assess the level of hunting pressure in each village and the factors which affect it. The spatial extent of hunting activities was examined to critique the adequacy of community territories for conserving wildlife and human subsistence activities.

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[1] Ribereños are descendants of Amerindian unions with Europeans or with other early immigrant groups (Hiraoka, 1992: 135). Ribereños do not maintain any tribal affiliations and many would identify themselves as "ribereños".

Study Area

This study was conducted in the villages of Iquique, Palmeras II, and Catalan in the northeast Peruvian Amazon (Figure 1). All three villages are located along the Amazon river east of the city of Iquitos, Peru. Iquique is located on the Amazon river three hours by public river taxi, "colectivo", downriver from Iquitos. Palmeras II is located 1 km north of the Amazon river along a 15m wide tributary four hours downriver from Iquitos. Catalan is located 5-6 km south of the Amazon river along a 30m wide tributary nine hours downriver from Iquitos. The villages examined in this study were selected during an 9-week field visit to the region from June through August, 1996. Palmeras II was the first village selected due to its involvement in tourism activities. The villages of Iquique and Catalan were selected as comparison sites after consideration and field visits to five other villages: Santa Rosa, Pucallpa, Nueva Esperanza, Vainilla, and Yaguas de Tipishca. Iquique and Catalan were selected based on their ethnic, demographic, locational, and environmental similarities and differences compared to Palmeras II (Table 1).

Table 1. Village characteristics.

	Iquique	**Palmeras II**	**Catalan**
Age (years)	79	40-50	42
Population (persons)*	261	307	133
Number of households	45	33	23
Ethnicity	ribereño	ribereño and Yagua	ribereño and Yagua
Environment	upland	upland and seasonally flooded land	upland and seasonally flooded land
Diversity of game species	low	moderate	high
Distance to market† (km)	45	56	82

* source: Instituto Nacional de Estatísticas e Informática, 1994. Censos Nacionales 1993 IX de Poblacion IV de Vivienda, Tomo II. Directorio Nacional de Centros Poblados Segun Codigo de Ubicacion Geografica, Lima, Peru.
† distance to market equals the distance from each village to the city of Iquitos, Peru (the major commercial center in the Peruvian Amazon).

Iquique

Iquique is located on the land peninsula formed between the Napo and Amazon rivers. A mixture of landforms form the border between Iquique and the Amazon river including mud bars, seasonally flooded lands, and a steep 15m high bluff. Most of the households are located on the bluff. Inland, the topography is hilly and is dissected by several permanent and intermittent streams. Iquique was founded 79 years ago by several Yagua and Santa Rosa Amerindian families, the descendants which recently formed their own village immediately downriver from Iquique. Iquique is a ribereño community with a surveyed population of 261 people consisting of 45 households. Like most rural Amazonians, the people of Iquique practice mixed subsistence strategies, engaging in a combination of swidden-fallow ("slash and burn")

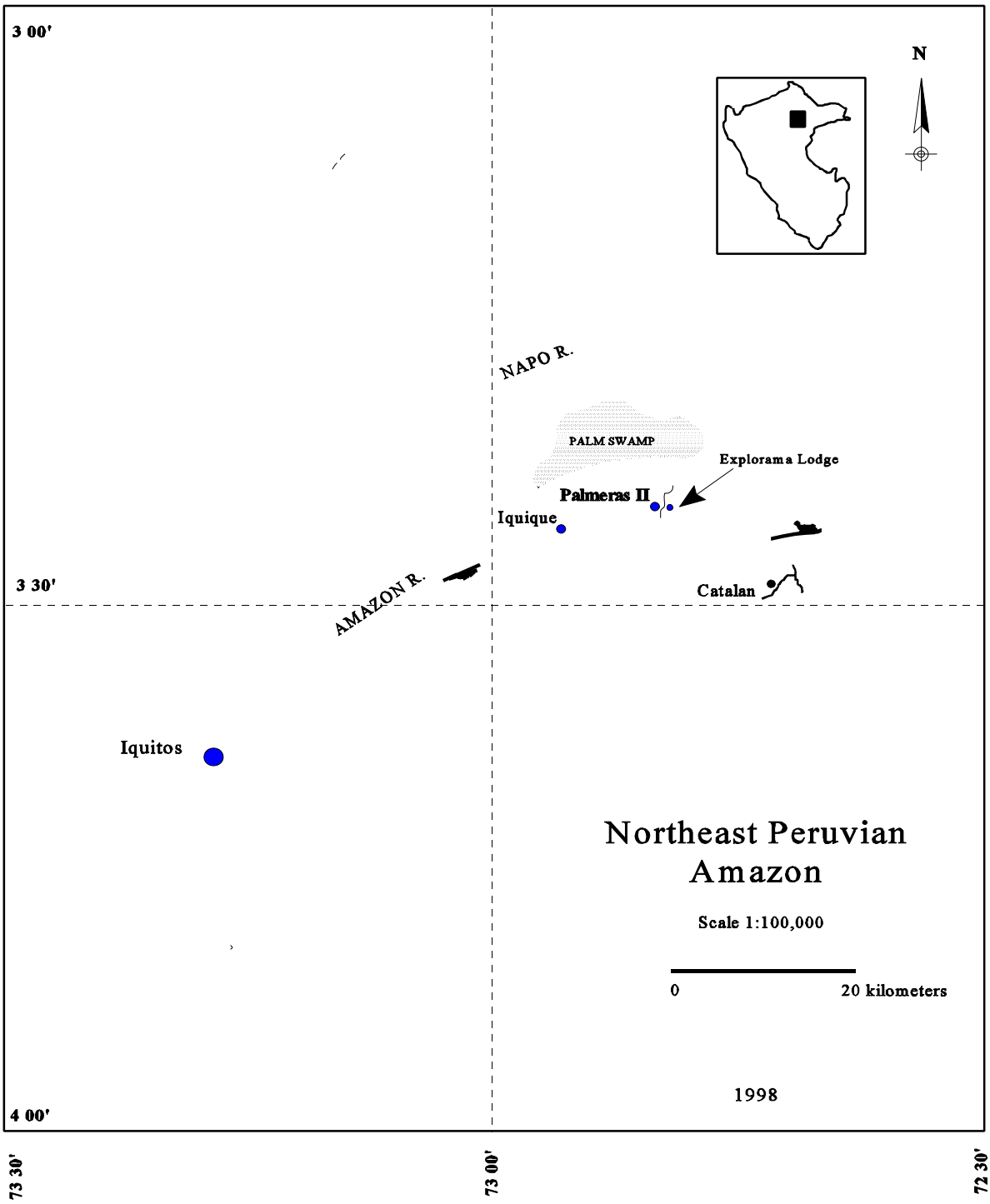

Figure 1. Study Area

agriculture, fishing, hunting, gathering, animal husbandry, and wage labor activities. Several households cultivate rice as a cash crop and a few produce handicrafts for sale in Palmeras II. Most households practice agriculture complemented by some fishing and hunting. More people fished in Iquique than hunted. Only 38% (19/45) of the households engaged in hunting activities while at least 58% engaged in fishing activities. Fishing was mostly practiced in the Amazon where large catfish weighing 10-30 kg could be harvested and sold in Iquitos or to commercial river traders. Marketable game species near Iquique were scarce. According to several hunters, large game such as white-lipped peccaries, collared peccaries, tapir, ocelots, pumas, woolly monkeys, and currasows used to be encountered in the forest north of Iquique but are now either scarce or absent[2].

Iquique has communal title to approximately 2000 has. of land part of which is divided into 53 ten hectare parcels (100m in width and extending 1000m into the forest). The land was divided over 20 years ago so that it could not be sold[3]. Each family has usufruct rights to two parcels and are not allowed to sell the land. All lands extending 2 km into the forest from the Amazon river are "owned" in this manner and consist of active and fallow agricultural fields. Only a few patches of 30-40 year old secondary forest remain within 2 km of the village.

Palmeras II

Palmeras II is located on the same land peninsula as Iquique however the topography is less hilly. The undulating landscape is also dissected by numerous small intermittent and permanent streams. Like Iquique, most of the land surrounding Palmeras II consists of active and fallow agricultural fields. However, more late-secondary forest is located within 2 km of Palmeras II compared to Iquique. An expansive palm swamp is located 3-4 km. inland from the Amazon river which was difficult for people to penetrate. If hunters want to travel to more pristine forest they must travel to areas beyond the peninsula. Palmeras II hunters said that peccaries were scarce in the area and tapir could only be found in the palm swamp. One hunter said that when he moved to Palmeras II in 1978 many more monkeys and peccaries could be encountered during a 30 minute walk from the village but now he has to walk three hours to encounter peccaries. Two hunters said there used to be woolly monkeys and brown capuchin monkeys in the area. One of those hunters also said that squirrels, armadillos, agoutis, and a variety of game birds still existed around the village.

Palmeras II is an official native Yagua community and consists of 307 Yaguas and ribereños representing 33 households. All community members are fluent in Spanish. The two main Yagua clans represented are the "Huacamayo Rojo" (Scarlet Macaw) and the "Murcielago" (Bat) clans. The village of Palmeras II holds title to approximately 3400 has. of land and the community has existed for about 40-50 years. To provide for their subsistence needs, households engaged in swidden-fallow agriculture, fishing, hunting, gathering, animal husbandry, handicraft

[2] The scientific names of species hunted in the three villages are provided in Appendix A.

[3] The land may have been parceled due to a scarcity of available land close to the village. Dividing the land into long, narrow, rectangular parcels serves to maximize the number of households having access to land close to the village and river and would therefore serve to minimize conflicts over the reuse of fallow fields near the village. However, preventing the land from being sold was the only reason stated for the parcellation.

production, and wage labor activities. Fishing was only practiced by a few households and 58% (19) of the households were engaged in hunting activities. Almost all of the households practiced agriculture except a few that were strictly engaged in wage labor activities. Local wage labor opportunities were provided by an ecotourism lodge and health clinic adjacent to the community and by a sugar cane rum factory that had been operating in the area prior to the formation of the village. The ecotourism company, Explorama Tours, has maintained a lodge adjacent to the community since 1964 (Jensen, P., pers. comm.). The Lodge consists of six or seven buildings with a total of 67 rooms and 138 beds. Explorama holds title to 200- 300 has. of land to the north of the lodge with trails for tourists. No hunting is permitted on the property but residents of Palmeras II are allowed to pass through Explorama property en route to their fields or to hunting grounds further into forest. The Yaguas of Palmeras II are primarily involved in ecotourism through the production of handicrafts that are sold or traded (for western apparel) directly to tourists who visit the community several times a week during the peak tourist season in July, August, and December[4]. Only two households raised pigs in Palmeras II because in 1990 Explorama requested that the village prohibit the raising of pigs due to the amount of pig excrement that littered the village.

Traveling salespersons ("vendedores") selling game meat, fish, clothes, crafts, sugar, flour, and other products visit Palmeras II on a weekly basis. These sellers trade their goods in the village for western apparel or sell them for cash. Vendedores visit Iquique and Catalan less frequently and rarely sell game meat and fish there.

Catalan

Catalan is located in a distinctly different landscape than Iquique and Palmeras II. The land surrounding Catalan is flatter than in Palmeras II although still undulating as a result of the numerous intermittent streams and several large permanent streams in the area. Between the large permanent streams the land consists of seasonally flooded forests and swamps most of which are inaccessible for farming. Land within a 1 km radius of Catalan is composed of active and fallow agricultural fields, pasture, seasonally-flooded land, and secondary forest. The number of large streams, extent of seasonally-flooded forest, and the expanse of forest to the south of Catalan distinguish the landscape from that found in Iquique and Palmeras II and provide ample habitat for a variety of wildlife no longer found in the other villages. Hunters in Catalan spoke of herds of white-lipped peccaries roaming close to the village as recently as 1996 and peccaries frequently appeared in the harvest data for Catalan. Seasonal flooding of the main river and its tributaries in Catalan permits hunters to travel three to four days upstream to areas which had not been heavily hunted since the previous year when river levels were high.

Catalan is also an official native Yagua community consisting of 133 Yaguas and ribereños representing 23 households. All community members are fluent in Spanish and the older Yaguas are also fluent in Yagua. Catalan has existed for 42 years and its Yagua founders belong to the "Huacamayo Amarillo" (Blue and yellow macaw) clan. Catalan was originally situated 2 km

[4] Of the 34,814 visitors who arrived in Iquitos in 1996, 53% came from the United States and 29% came from European nations. Most foreign tourists arrived in the months of December, July, and August, corresponding with summer and winter school holidays in the United States (Dirección de Industria y Turismo, Iquitos, Peru).

further south- into the forest- however, the community relocated to its present location in 1970 to improve communication with other villages and access to markets. The community of Catalan holds title to approximately 7700 has. of land. As in Iquique and Palmeras II, households in Catalan engage in swidden-fallow agriculture, hunting, fishing, gathering, animal husbandry, and occasional wage labor activities to provide for their subsistence needs. More households engage in fishing compared to households in Palmeras II and 74% (17) of the households engage in hunting activities. Wage labor opportunities are rare in Catalan, however, in 1996 many men from the village worked on a government funded project to construct foot bridges across two ravines bisecting a trail from Catalan to a neighboring village along the Amazon. Many families in Catalan raise chickens and pigs and four households own water buffalo[5].

Levels of game depletion

Based on the harvest data from this study and a review of a 1987 Landsat Thematic mapper image for the study area, the diversity of game species near the three communities varied as did the degree of wildlife habitat alteration from agricultural activities. The degree of habitat alteration and game species depletion is relative to the age and number of households in a community and to the impacts of local hunting over time. Iquique has the greatest extent of fallowed agricultural land reflected by the fact that all lands within 3 km of the village were parceled 20 years ago. The area around Iquique has been hunted by a sedentary local population for 80 years explaining the minimal presence of large ungulates in the harvest data for Iquique. Palmeras II is a smaller and younger community than Iquique and ungulates appear more frequently in their harvest data. Catalan is the smallest and youngest community. Although the forests near Catalan have been altered by agricultural practices, large ungulates and primates are still prevalent in the harvest data and Catalan hunters report traveling shorter distances to forested areas compared to hunters in the other two villages. Therefore, wildlife habitat was least altered in Catalan which had a more diverse community of game species represented in their harvest data compared to the other two villages. In relative terms, the game community around Iquique is the least diverse and wildlife habitat is the most altered. Wildlife habitat near Palmeras II is moderately altered and the game community there is slightly more diverse than near Iquique.

Methodology

Preliminary fieldwork was conducted from June through August, 1996. During this period the research objectives and study sites were defined. Informal household interviews were begun in Palmeras II and background information was collected on Iquique and Catalan. Hunting data was collected from January 8 through July 25, 1997.

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[5] Eighteen head of water buffalo were owned by five households in Catalan as part of a water buffalo promotion project established around 1992 with aid from the Ministerio de Agricultura. The government loaned the animals to Catalan for breeding in anticipation that the animals would multiply sufficiently in several years for Catalan to return eleven animals to the government so that they could be lent out to other communities. The people of Catalan accepted the project in order to pay back $20,000 of loans from a previous government project to promote the cultivation of oil palm seeds. The oil palm project failed because a government funded processing plant was never built in a neighboring village as planned.

Hunting practices were surveyed in Iquique for 50 consecutive days from January 30 through March 20, 1997. In Palmeras II, hunting practices were surveyed for 184 consecutive days from January 2 through July 4, 1997. In Catalan, hunting practices were surveyed for 131 consecutive days from March 3 through July 11, 1997. The survey data was conducted with the aid of a Peruvian field assistant with a bachelor's degree in biology. The field assistant and the researcher composed the survey team which interviewed hunters in the morning and evening about their latest hunting activities while the team was residing in a village. Occasionally, the field assistant surveyed hunters independently. To survey hunting practices concurrently among the villages, a resident of Palmeras II and a resident of Catalan were periodically employed to conduct the survey in their respective villages when the survey team was not residing there.

Because wildlife habits and household demand for game vary seasonally, only hunting data collected in the villages during overlapping time periods were analyzed to assess differences in village hunting practices. Hunting data for Palmeras II and Iquique were collected concurrently over 50 consecutive days from January 30 through March 20, 1997. Hunting data on Palmeras II and Catalan were collected concurrently over 124 consecutive days from March 3 through July 4, 1997. Hunting data on Iquique and Catalan were collected concurrently over 18 consecutive days from March 3 - 20, 1997. Because of the limited amount of overlapping data between Iquique and Catalan, a direct comparison of the raw data from Catalan and Iquique would be misleading. In order to directly compare hunting practices in Palmeras II to hunting practices in Iquique and Catalan the data set for Palmeras II was divided into two parts that were analyzed separately. "Palmeras II-E" refers to data collected "early" in the field season from January 30 and March 20, 1997 and are directly comparable with the data for Iquique. "Palmeras II-L" refers to data collected "late" in the season between March 3 and July 4, 1997 and are directly comparable with data for Catalan.

Data were collected on all hunts[6] conducted during the above specified periods and included: date and duration of hunt; hunter(s) names; identity, quantity, size and sex of species killed or captured; use of game (sale, consumption, both); time of kill/ capture; weapons used; and location of kill. This information was based on the information provided by hunter informants. Only the hunt date and duration were directly measured. For hunts under 24 hours, hunt duration was measured by the difference between the departure time and the return time. For hunts over 24 hours, hunt duration was calculated by assuming hunters spent a maximum of six hours hunting each day that they were away from the village[7]. The six hour per day hunting standard was also

[6] Data was collected on all activities involving the kill or capture of an animal, however, for the purposes of data analysis only efforts to pursue and capture an animal for consumption or market sale were considered "hunts". Animals caught during fishing expeditions, communal work parties, and animals captured as pets or captured by children near the village were excluded from the data set. Excluded data only represented a small proportion of the total data set. All individuals engaged in hunts were termed "hunters" even though they may have dedicated more time to agriculture, fishing, or wage labor than to hunting.

[7] Six hours was selected based on discussions with several hunters who frequently participated in multi-day hunts and hunted mostly at night. While these hunters could conceivably hunt for the entire night (7pm - 5 am), they often slept or rested for part of the night because during the day they were engaged in a variety of activities (i.e., cooking meals, skinning game, smoking meat, fishing) besides sleeping.

applied to days spent traveling to remote hunting sites if travel was by dugout canoe or on foot and if the hunter traveled through areas suitable for hunting. To determine prey size, hunters were asked if the animals they killed were large adults, small juveniles, or babies. Hunt location was recorded in terms of distance (walking time from the village to the site) and cardinal direction from the village. Place names for specific hunt locations were provided by some hunters in Palmeras II and Catalan. The locations of hunts conducted in the forest were described based on their relative location to bridges, ravines, intersecting trails, palm stands and other notable forest features. The location of hunting campsites situated along streams were described relative to the location of intersecting tributaries and pronounced meanders in the streams.

Additional statistics for each hunter were calculated from the above data including: number of hunts conducted, number of animals harvested, kilograms of animal biomass harvested, kilograms of animal biomass consumed and sold, total hunting effort (hours), average hunting effort per hunt, average hunting effort per hunting-day, and hunting efficiency (kilograms of animal biomass harvested/ total hunting effort). The quantity of animal biomass (species live weights) harvested by each hunter was calculated by multiplying the mean weight of each species harvested by the number of each "large-adult" species harvested. The juvenile and infant size classes were combined and their weights grossly approximated by multiplying the mean weight of adults by 65%. Mean species weights and the scientific and English common names of all hunted species were derived from the literature and listed in Appendix A. Animal biomass was used in the data analyses based on the assumption that the edible portion of animal biomass that was either sold or consumed was proportional to the total animal biomass (species live weight). This generalization was justified because the data were not used to calculate caloric intake rates or income generated from hunting activities[8]. To estimate the quantity of animal biomass consumed or sold, it was assumed that 100% of the total animal biomass was consumed or sold if hunters indicated that they either consumed or sold an animal. If hunters indicated that an animal was both consumed and sold, it was assumed that half of the animal was consumed and the other half sold.

Informal household interviews were conducted in all three villages regarding household age and history, ethnic background, demographics, kinship relations, pets and livestock, fishing, hunting, agriculture, wage labor and other economic activities. Seventy-six percent (34/45) of the households in Iquique were surveyed, 85% (28/33) in Palmeras II, and 100% in Catalan. Participant observation techniques were used to gather hunting data during two hunts in Palmeras II on January 14 and 28, 1997 and during one hunt in Iquique on March 17, 1997.

Physical and Biotic Environment

The Peruvian Amazon is a humid tropical lowland forest and encompasses an area 770,000 km2 most of which is flat to undulating in topography although 23.4% of the area is considered hilly (Kalliola and Puhakka, 1994: 9). Mean monthly temperatures range from 27EC to

[8] Hill and Hawkes (1983:158) multiplied species' live weights by 65% to calculate the minimal edible portion of species harvested by the Aché people of eastern Paraguay. Smoking game meat significantly reduces the weight of species consumed or sold species. Because species weights were not measured in the field and much of the meat harvested for market sale was smoked, the study data can not be used to estimate caloric intake rates or income generated from hunting activities.

30EC and mean monthly precipitation ranges from 180mm to 700mm (Servício de Hidrográphia y Navegación, Iquitos, Peru). The average annual precipitation in the region is approximately 3000mm. There are no pronounced dry seasons although changes in precipitation combined with substantial changes in river levels define winter and summer seasons. The winter season occurs from March through June and is characterized by rising river levels and mean monthly precipitation ranging from 400mm to 700mm (Villarejo, 1988, 21). During the winter, the water level of the Amazon river normally rises 3-5m above its annual average level, flooding forests and villages and causing severe bank erosion. Flooded fields and villages may be abandoned during this period and some people dedicate more time to fishing and hunting in the flooded forests than to agriculture. The summer season occurs from July through October during which river levels are as much as 3-5m below their annual average levels, mean monthly precipitation ranges between from 200 to 500mm, and temperatures may be slightly higher than normal. In the summer, mud and sand bars are exposed along river islands providing fertile grounds for the sowing of rice and beans. Local people also take advantage of the nutrient rich alluvial soil deposited along the river banks for the planting of corn, bananas, and manioc as river levels begin to fall in June. The location of river islands, mud and sand bars, and extent of floodplain habitats continuously change from year to year due to the strong fluviodynamic activity of the upper Amazon (Pinedo-Vasquez, 1996:22).

The Peruvian Amazon contains some of the most diverse assemblages of plants and animals on earth and is one of the most species rich regions in Amazonia (Tuomisto, 1993:103; Emmons, 1983:221). The plant community is composed of a mixture of trees, palms, vines, and epiphytes which are utilized by local peoples as sources of food, fibers, oils, fuel, dyes, pesticides, medicines, latex, and resins. Since most plant species occur at low densities and are widely scattered they only provide limited potential for supporting large animal populations (Kellman and Tackaberry, 1997:119). The populations of most neotropical mammal species are low in density and widely dispersed (Kikkawa and Dwyer, 1992, 304; Chibnik, 1994, 21; Gross, 1975:527-529).

Only a small percentage of the avian and mammalian diversity in the Amazon is harvested for meat, skins, leather, and feathers or captured for pets. However, game species comprise a significant portion of the animal biomass in the forest because human hunters generally target large bird and mammal species (Bodmer, 1995:873). In a survey of 319 avian species in the Peruvian Amazon, only 9.1% (29 species) were hunted comprising over 52% of the estimated total avian biomass in the region (Redford, 1992:417). In a survey of 67 non-volant mammalian species in southeastern Peru, 18% (12 species) were hunted comprising roughly 75% of the estimated total mammalian biomass (Ibid). Species taxa targeted for hunting include: rodents (e.g., paca, agoutis, capybara, squirrels), carnivores (felines, coatis, kinkajous), edentates (e.g., anteaters, sloths, and armadillos), primates (e.g., woolly, spider, howler, and capuchin monkies), artiodactylas (e.g., deer and peccaries), perissodactylas (e.g., tapirs), and marsupials (e.g., opossums). A complete list of species hunted in the three villages is provided in Appendix A.

Ribereño and Yagua Amerindian survival strategies

The majority (85%) of the rural population in the Peruvian Amazon are known locally as “ribereños”, literally translated as “riverine peoples” (Bodmer, et al.,1997:461). Ribereños speak

Spanish and most practice a combination of swidden-fallow agriculture, hunting, fishing, gathering, animal husbandry, and wage labor activities. Given their large population, ribereños conduct the majority of agricultural, hunting and fishing activities in the Department of Loreto, Peru (Bodmer, 1995:23). Fishing provides the majority of protein for most ribereño communities along major waterways due to the high rates of return from fishing compared to the relatively low rates of return from hunting (Chibnik, 1994:25). Although some indigenous groups may hunt more than most ribereño communities, the distinction between "native" and ribereño communities is often unclear. Official "native" communities like Palmeras II and Catalan have a mixture of ribereño and Amerindian members all of whom speak Spanish, wear western-style apparel and engage in similar subsistence activities.

There are sixty-four different Amerindian ethnic groups living in the Peruvian Amazon ranging in size from 15 to 25,000 families (Brownrigg, 1996:186; Villarejo, 1988:). The total population of Yagua Amerindians in the Amazon basin is approximately 3000 to 3,300 (Chaumeil, 1984:3). Yagua society is organized into patrilineal, exogamous clans associated with the names of animals or plants. Currently there are around 57 Yagua communities in the Peruvian Amazon most of which are scattered along the lower Napo and Orosa rivers, around the town of Pebas, and along the Atacuarí river. Two of these communities, Palmeras II and Catalan are part of this study. Linguistically, the Yaguas are the only remaining representatives of the Peba-Yagua language family (Chaumeil, 1984:4). The Yagua language is still spoken in some villages and by older Yaguas in most villages. However, Spanish is quickly replacing Yagua as the common language.

Traditionally, Yaguas have inhabited forested, inter-fluvial, upland environments (Fejos, 1943:43; Chaumeil, 1991:27,32). Since Yagua villages were mainly located inland from major waterways, fishing activities played only a minor role in traditional Yagua subsistence strategies. To procure food, Yaguas mainly engaged in hunting, gathering, and swidden-fallow agriculture (Chaumeil, 1984:20; Chaumeil, 1991:67). In addition, Yaguas participated in a variety of wage labor activities to pay for transportation, medicine, school supplies, clothes, kerosene and other household necessities.

Hunting methods

The Yaguas in Palmeras II and Catalan no longer hunt with blowguns and spears although blowguns are manufactured for sale to tourists. Today, the most frequently used weapon is the 16-gauge breach loaded shotgun which has virtually replaced the use of traditional weapons for killing large game. The Yaguas and ribereños who hunted in Iquique, Palmeras II and Catalan were almost exclusively male, hunted with shotguns, and usually hunted alone. Only a few hunters were occasionally accompanied by partners and these hunters usually engaged in extended, market oriented hunts requiring the assistance of a partner to smoke meat, prepare meals, and to assist with transporting the harvest back to the village. Hunters in all three villages exhibited opportunistic behavior as evidenced by their harvesting game animals while en route to or returning from a hunting campsite regardless of the sex of the animal and current level of game depletion in that area. This conclusion is further supported by the fact that hunting success rates were high in all three villages despite differences in the availability of preferred game species. Other studies conducted on peasant hunting behavior have also supported this contention

(Bodmer, et al., 1997:465).

Hunting styles varied seasonally and individually among hunters. Some hunters preferred to hunt during the winter (high-water season) when they could penetrate deep into the forest by canoe thereby accessing lands less heavily hunted and facilitating transport of game back to the village or to market. In addition, during the winter animals residing in seasonally flooded areas were sometimes stranded on temporary islands where they could be easily hunted. Other hunters preferred to hunt during the summer when precipitation was less frequent and animals reportedly congregated near watering holes. Moreover, during periods of infrequent rainfall the forest leaf litter is dry enabling hunters to hear animals' footsteps and enabling their hunting dogs to detect the scent of animals. Regardless of the season, hunters preferred to hunt when the forest leaf litter was dry.

Among individual hunters, there were those who preferred to engage in frequent hunts lasting only a few hours and those who preferred to engage in infrequent hunts lasting from several days to weeks. Hunters who engaged in short, frequent hunts generally hunted close to home while hunters who engaged in extended trips generally traveled great distances to areas known to be rich in game. To navigate through the forest, hunters followed well worn trails connecting neighboring villages or they canoed up local streams to their "campamentos" or "tambos" (campsites, huts). Near these campsites, hunters cut their own hunting trails which traversed salt licks, watering holes, ravines, fruiting trees, and other places where animals might be encountered. Hunters searched for evidence of animals based on their trails, footprints, teeth marks on partially-eaten fruit, and odor. Prior to siting an animal, some hunters could identify animal species based on the sound of their footfalls, walking tempo, grunts and calls, and by their vertical position in the forest. At night hunters could also distinguish prey based on the size and color of animals' eyes[9].

Villagers from all three study sites recognized and had names for different wildlife habitats and foraging sites where they expected to encounter game animals (Table 2). Hunters in Catalan and Palmeras II named particular salt licks, watering holes, hunting platforms, and campsites where they preferred to hunt. The most extensive list of names for came from hunters in Catalan and the places named and locations described were fairly consistent among different hunters. Place names and locations provided by hunters in Palmeras II varied considerably. The longest list of names were recorded for "colpas" (salt licks or watering holes) followed in length by the list of "quebradas" (creeks and ravines) and the list of (campsites). Colpas, quebradas, and campamentos were commonly named for plants, animals, or people.

Individual hunting practices also differed based on the time of day that hunts were conducted. Because several preferred game species are nocturnal (e.g., armadillos, paca, brocket deer) about half of all hunts in the three villages were conducted at night. Night hunting requires the aid of a shotgun and headlamp (a flashlight strapped to the hunter's head). Several hunters said that animals only come out when it is very dark. For this reason they would often wait until after 7:00pm to hunt, hunt during the new moon, or wait for the moon to sink low on the horizon before hunting. However, one hunter in Catalan said hunting during the full moon was good

[9] When spotted with a flashlight at night, the eyes of deer reflect blue, feline eyes reflect white, tapir reflect brown, and most other animals reflect red according to a hunter in Palmeras II.

Table 2. Local habitat types and foraging sites.

Habitat type/ Foraging site	Local Name*	Animals encountered**
High-ground, upland forest^	Monte Alto, Terre Firme	paca, armadillo, feline carnivores, peccaries
Active agricultural field	Chacra	rat, agouti, three-toed sloth, birds
Fallow agricultural field	Purma	opossum, coati, paca, tamarin, tayras
Transitional, seasonally flooded forest^	Restinga	rats, agouti, armadillo, acouchy, paca
Palm swamp/ forest^	Aguajal, Yarinal, Irapayal^^	peccaries, tapir
Swamp forest^	Tahuampa	tapir
Mud wallow, salt lick, watering hole	Colpa	paca, armadillo, brocket deer
River margin dominated by *Cyperus spp.*^	Cañal, Piri-piral	capybara
Forest stream	Quebrada	lagarto
Fruiting trees or palms that attract wildlife	Machimango, Pihuayo, Aguaje, and others^^^	agouti, paca, tortoise

* Local names were derived from informal conversations with residents in the three study sites. Direct questioning of villagers on this topic would likely reveal additional locally recognized habitat types and landforms not recorded as part of this study.

** Animal species which hunters said they expected to find in the corresponding habitat type.

^ Wildlife habitats in the southeastern Peruvian Amazon recognized by Janson and Emmons (1990: 320).

^^ Commonly recognized palm forests include aguajals, yarinals, irapayals. Aguajals are dominated by aguaje palm (*Mauritia flexuosa*), and yarinals are dominated by yarina palms (*Phytelephas macrocarpa*) and chambira palms (*Astrocaryum sp.*) (Tuomisto, 1993, 108-109). Locally recognized irapayals are dominated by irapay palms (*Lepidocaryum tessmannii*).

^^^ According to hunters in the villages, some of the fruits consumed by animals were from the following trees: machimango *(Eshweilera spp.),* pihuayo *(Bactris speciosa),* aguaje *(Bactris ciliata),* quinilla caimitillo *(Pouteria spp.),* andiroba *(Carapa spp.),* cumala *(Virola spp.),* and metahuayo (*caryodendron spp., Loretoa spp.*).

because animals come to watering holes and to rivers to see their reflection in the water. The use of shotguns at night required access to a gun and the purchase of 3-4 shotgun shells, flashlights, two sets of batteries, and a few extra flashlight bulbs. The cost of these items combined with limited access to them caused some hunters to hunt more during the day. Day hunts were also conducted by several older hunters who had difficulty seeing at night and by others who feared encountering poisonous snakes, many of which are nocturnal. Hunters often relied on dogs to locate and pursue small diurnal game (e.g., achunis and agoutis)[10]. Hunters engaged in extended

[10] Dogs were used to chase animals back into their burrows at which point the hunter would block off all exits to the den and dig the animal out or he would leave one exit open, waiting for the animal to emerge, machete

hunting trips lasting several days to weeks would usually hunt at times during the day and night depending on what species were determined to be present in the area.

Individual motivations for hunting also influenced hunting practices. Market-oriented hunters were more likely to travel further and longer compared to consumption-oriented hunters. For example, one hunter from Palmeras II traveled with a friend to the upper reaches of the Ampayacu river to pursue large marketable species seldom encountered near Palmeras II. Together they harvested a total of 322 kg. of animal biomass, selling 84% of their harvest (100 kg. of smoked meat) in Iquitos and consuming the remainder in the field. Although only a few hunters in each village were responsible for harvesting most of the game that was sold, the majority of hunters sold a portion of their harvest and consumed the rest. Consumption-oriented hunters usually hunted close to home and engaged in more frequent hunting trips compared to market-oriented hunters.

Results

General

There was a difference in the percentage of households engaged in hunting activities (hunter-households) among the three villages (Table 3). The majority of households in Catalan engaged in hunting activities while in Palmeras II slightly more than half of the households engaged in hunting and less than half of the households hunted in Iquique. Hunters in Iquique and Palmeras II-E engaged in a similar number of hunts over the same time period however, hunters in Palmeras II-E engaged in longer hunts, devoting 40% more time to hunting. Hunters in Palmeras II-L conducted over twice as many hunts as Catalan hunters although they both devoted similar time to hunting. However, Catalan hunters engaged in significantly longer hunts than hunters in Iquique and Palmeras II. Iquique hunters had the highest success rate (percentage of hunts during which at least one animal was killed and retrieved) although the success rates in all three villages were generally high. Hunters in Iquique harvested the smallest animals, averaging 4.4 kg live body mass. Hunters in Palmeras II-E and Palmeras II-L harvested slightly larger species and hunters in Catalan harvested the largest species, averaging 9.9 kg live body mass. Despite harvesting the largest species and significantly more animal biomass than hunters in Palmeras II-L, Catalan hunters did not have higher median efficiency rates than hunters in Iquique or Palmeras II because only a few hunters were responsible for harvesting the largest animals as was true in Palmeras II.

Table 3. General Hunt Characteristics.

	Iquique	**Palmeras II-E**	**Palmeras II-L**	**Catalan**
Data collection period	1/30/97 - 3/20/97 (50 days)	1/30/97 - 3/20/97 (50 days)	3/3/97 - 7/4/97 (124 days)	3/3/97-7/4/97 (124 days)
Diversity of game species	low	moderate	moderate	high

in hand. Dogs were not used during extended day hunts in pursuit of white-lipped peccaries because dogs could easily be injured by peccaries. In the pursuit of small, nocturnal game hunting dogs were not used much because they are noisy and would scare away game, and because dogs are more likely to get bitten by poisonous snakes at night.

Percentage of hunter-households	38%	48%	58%	74%
Mean hunt duration (hrs.)	5.8	7.3	6.0	13.6
No. of hunts	60	66	188	86
Total hunting effort (hrs.)	345	485	1136	1169
Success rate	90%	68%	80%	81%
No. of animals harvested	84	60	179	169
Mean animal weight (kg.)	4.4	7.0	5.4	9.9
Total Animal biomass harvested (kg.)	370	417	970	1677
Hunting efficiency (kg./hr.)	0.91	0.81	0.74	0.73

Species composition of harvests

The majority of species harvested in Iquique and Palmeras II-E were rodents and edentates, e.g., armadillos, sloths, anteaters (Figures 2a and 2b). Rodents and edentates comprised 63% of the species and 62% of the animal biomass harvested in Iquique. In Palmeras II-E, rodents and edentates comprised 76% of the species and 67% of the animal biomass harvested. Most of the rodents killed in Iquique were agoutis (57%) and pacas (29%). In Palmeras II-E, most of the rodents killed were pacas (63%) followed by agoutis (34%). Armadillos dominated the edentate category in both villages comprising 96% of the edentates harvested in Iquique and 71% of the edentates harvested in Palmeras II. Although only 60 animals were harvested in Palmeras II-E compared to 84 in Iquique, hunters in Palmeras II-E harvested more animal biomass due to their harvest of a greater number of large species, e.g, deer, peccaries, pacas.

The majority of species harvested in Palmeras II-L were rodents and edentates (Figure 2c). Most of the rodents killed in Palmeras II-L were agoutis followed by pacas. Armadillos consisted of 83% of the total number of edentates harvested. In Catalan rodents dominated the other taxa in numbers however Catalan hunters harvested more ungulates (e.g., deer, peccaries,

and tapir) and primates than edentates (Figure 2d). Ungulates contributed close to 60% of all animal biomass harvested in Catalan, almost as much as the total animal biomass harvested in Palmeras II-L. White-lipped peccaries were the most frequently harvested ungulates in Catalan contributing to 44% of the ungulate biomass harvested. Two tapirs were harvested in Catalan contributing to 33% of the harvested ungulate biomass. Hunters in Catalan harvested the greatest proportion of large species (e.g., peccaries, deer, tapir, and pacas) as evidenced by the fact that Catalan hunters harvested fewer animals than Palmeras II-L hunters but harvested close to 60% more animal biomass. Catalan hunters harvested over five times as many ungulates compared to hunters in Iquique and Palmeras II. Iquique hunters harvested the greatest proportion of small species.

Market impacts

Hunters in Palmeras II-E sold the majority of their harvest and sold 60% more animal biomass than hunters in Iquique. Catalan hunters sold over 200% more animal biomass as hunters in Palmeras II-L (Table 4). Pacas were the most frequently sold animals in all three villages (Table 5). Paca meat was prized for its taste and commanded the highest market price of all game meat sold in Iquitos[11]. The live weight of pacas ranges from 5 kg. to 13 kg. (Emmons, 1997:224) and their meat can be sold for as much as $3.00 - $4.00 per kg. in Iquitos or for $1.00 - $2.00 per kg. in rural villages. Agouti and armadillo meat was also commonly sold in Iquique and Palmeras II but was less common in Catalan. Small mammals were more often sold within the community than in Iquitos. White-lipped peccary and collared peccary were the second most commonly sold species in Catalan. The live weights of both peccary species can exceed 20kg. and their meat also had a high market value. White-lipped peccaries were equally valued for their hides which could be sold in Iquitos for $10.00 each. Few hunters sold all of the animal biomass they harvested. Most hunters consumed a portion of their harvest or would consume any small animals harvested while selling the larger ones. Several hunters said that they always sold a portion of their harvest if they collected over 20 kg. of meat during a hunt.

[11] The harvesting of game meat for commercial sale in cities containing more than 3000 inhabitants was prohibited in the Peruvian Amazon in 1979 (Bodmer, et al., 1988:304). According to village hunters, the laws were only enforced on the rivers and at the docks in Iquitos. During the study period, game was observed being sold openly in the Belen market in Iquitos and reportedly large quantities of game meat are illegally sold there at present (Ibid:309).

Table 4. Proportion of animal biomass sold and consumed.

	Iquique	Palmeras II-E	Palmeras II-L	Catalan
Animal biomass sold (kg.)	152	245	395	986
Ratio of biomass sold (kg.) to biomass consumed (kg.)	0.7: 1	1.4: 1	0.7: 1	1.4: 1

Table 5. Species and number of individuals sold.

Iquique		Palmeras II-E		Palmeras II-L		Catalan	
Paca	5	Paca	11	Paca	19	Paca	41
Nine-banded armadillo	3	Black agouti	6	Black agouti	8	White-lipped peccary	7
Black agouti	2	Nine-banded armadillo	4	Nine-banded armadillo	8	Collared peccary	7
Brocket deer	1	Brocket deer	2	Brocket deer	2	Nine-banded armadillo	4
Yellow-footed tortoise	1	Collared peccary	1	Collared peccary	2	Brocket deer	2
		Yellow-footed tortoise	1	Achuni	2	Black agouti	1
		Capybara	1	Capybara	1		
				Titi monkey	1		

Spatial extent and location of hunting activities

Rats, agoutis, armadillos, three-toed sloths, and a several bird species were killed in active agricultural fields (fields generally less than two years old). A greater variety of species were killed in fallow agricultural fields (fields that have been left fallow after two years). Species killed in fallow fields included opossums, achunis, pacas, squirrel monkeys, tamarins, tayra, tamanduas, jaguarundis, deer, capybara, and a large variety of bird species. Agoutis were especially common in agricultural fields during the fruiting of cultivated “pihuayo” palms which were fruiting during the study period. No species were harvested in pasture. The majority of animals harvested in the three villages, particularly ungulates, were killed in late-secondary and primary forest (Table 6). Late-secondary and primary forests were encountered several kilometers from the villages. Over half of all the hunts in Catalan were conducted in areas farther than a two hour walk from the village and hunters in Catalan harvested over five times as many ungulates compared to hunters in Iquique and Palmeras II (Table 7).

Table 6. Proportion of kills in forest clearings.

Location of Kill	Iquique	Palmeras II-E	Palmeras II-L	Catalan
Active field	1%	2%	4%	2%
Fallow field	42%	35%	22%	20%
Forest	57%	63%	74%	78%

Table 7. Distance from village to kill sites (hours walking)

	Iquique	Palmeras II-E	Palmeras II-L	Catalan
Kill sites within 0 - 1 hour	64%	47%	69%	26%
Kill sites within 1 - 2 hours	15%	48%	26%	12%
Kill sites over 2 hours	20%	5%	5%	62%

All hunting activities in Iquique and most hunts in Palmeras II were conducted within their respective community territories. However, in Iquique one person said that in late March he would hunt for several weeks along the upper Manati river (40 km to the south of Iquique) to harvest peccaries and woolly monkeys. The hunt was not included in the data set because it was scheduled to occur after the survey team had already departed from Iquique. In Palmeras II, one hunter engaged in periodic extended hunts lasting over four weeks. These hunts were conducted in the upper reaches of the Ampayacu river which lies 70 km to the east of Palmeras II and requires ten days to reach via canoe. This hunter traveled there to harvest large marketable species. On one trip he and a friend harvested over 322 kg. of animal biomass consisting mostly of collared peccaries and paca[12]. Another hunter from Palmeras II periodically traveled across the Amazon to hunt capybara foraging along the grassy river margin. In Catalan, the majority of hunting activities were conducted outside the community territory. Most hunters in Catalan were familiar with numerous hunting campsites established deep in the forest to the south of the village. They named 29 different hunting campsites, 93% of which were located south of their community territory. These sites were rich in large game and were located one to three days south of Catalan via canoe.

Discussion

Response to game depletion

The village characteristics and faunal composition of harvests in Palmeras II and Catalan reveal that village age and size are related to degree of hunting pressure and habitat alteration on lands surrounding the village. The dominance of small mammals and relative absence of large mammals in the harvest data for Iquique and Palmeras II was probably due to persistent hunting

[12] Data from this hunt were excluded from the analysis because this hunt was not representative of the majority of hunting activities in Palmeras II and because it was so productive that it significantly skewed the harvest statistics for that village.

pressure over time which tends to initially decimate populations of preferred species (e.g., large birds and mammals) and can also facilitate increases in the populations of small mammals (Robinson, 1996:118). However, the absence of white-lipped peccaries in the harvest data from Iquique and Palmeras II could have resulted from temporal variations in the movements of herds which are known to have extensive home ranges[13]. The absence of large primates from the data on Iquique and Palmeras II was most likely due to their vulnerability to hunting pressures[14]. The lower total hunting effort and shorter distances traveled by hunters in Iquique compared to those in Palmeras II might have also contributed to the particularly low number of ungulates harvested in Iquique because these species were only encountered during extended hunting trips in Palmeras II and Catalan. However, the probability of encountering large species on long hunts near Iquique might be so low as to provide a disincentive to engaging in extended hunting trips near those villages. Moreover, the presence of an extensive palm swamp in the middle of the land peninsula between the Napo and Amazon rivers prevents Iquique and Palmeras II hunters from traveling very far into the nearby forest. Hunters in Iquique and Palmeras II who engaged in long hunts said that they traveled to remote villages in order to encounter large game.

Hunters in both Iquique and Palmeras II commented on the scarcity of large game species near their villages. While large game was also scarce near Catalan hunters there had unrestricted seasonal access to game rich areas south of the village. Unrestricted access to game rich areas provided an incentive for Catalan hunters to travel days into the forest to harvest marketable species. For this reason, Catalan hunters engaged in longer hunts, traveled further, hunted mostly in forested areas, and harvested larger species than hunters in Palmeras II and Iquique. In contrast, because populations of large game species were depleted in areas accessible to Iquique and Palmeras II hunters, they targeted smaller, less marketable species that were locally abundant. This behavior partially explains why hunters in Iquique and Palmeras II hunted more efficiently than hunters in Catalan. Hunters in Catalan engaged in multi-day hunts that were less efficient than short hunts considering the amount of time spent smoking meat, procuring daily rations and preparing meals during long hunts. Hunters in Iquique were more efficient than Palmeras II hunters largely due to their reliance on traps which were quick to set up and very reliable.

The scarcity of game species near Iquique and Palmeras II also influenced the low percentage of households engaged in hunting in those villages. In Catalan, the village with the most abundant game populations, the majority of households engaged in hunting and several households reported that they moved to Catalan because the area was rich in game species. Other factors influencing the low percentage of hunter-households in Iquique and Palmeras II were the availability of attractive alternative income and protein sources, lack of access to shotguns, and unfamiliarity with hunting. For example, Iquique was located immediately adjacent to the Amazon river and many households there were engaged in market-oriented fishing in the Amazon whereas

[13] Ten years of harvest data on the Siona-Secoya in northeastern Ecuador demonstrated that harvests of white-lipped peccaries declined from 1973 to 1975 only to rebound from 1979 to 1982 (Vickers, 1988:1521).

[14] Species that have low intrinsic rates of natural increase, long life-spans, and long generation times, e.g., primates and tapirs, are more vulnerable to over-hunting than short lived species with high intrinsic rates of natural increase and short generation times, e.g., peccaries, paca, agouti (Bodmer, et.al., 1997:463).

few households fished for the market in Palmeras II or Catalan. Furthermore, in Palmeras II all but one of the households earned cash income from the production and direct sale of handicrafts to tourists. Fewer households were engaged in craft production in Iquique and Catalan and they were only able to sell crafts indirectly to tourists, usually via relatives in Palmeras II. Yagua heritage was not a significant factor affecting the popularity of hunting among the three villages because ribereño village members were just as likely to hunt as Yagua members.

Market influence on harvest yields

Households in the three villages engaged in market-oriented hunting to earn cash income. Some of the factors influencing household income demand were: household size, household needs, familial obligations, and entrepreneurial activities. Household needs include such things as clothes, medicines, school supplies, fishing and hunting supplies, kerosene, cooking oil, etc. Familial obligations refer to informal or formal relationships between related households for distributing food and income resources. For example, four households in Palmeras II supported relatives in Iquitos by sending them food and/or cash. An example of a household entrepreneurial activity is a family store which several people operated out of their homes in each of the villages. One hunter from Palmeras II explicitly stated that hunting was an ideal complement to his family store and that the reason he engaged in month-long hunts was to earn enough money to resupply and expand his store.

Market orientation exerted the greatest influence over household harvest rates. Hunters who sold the most animal biomass harvested more animal biomass, spent more time hunting, and traveled greater distances than those who hunted for consumption purposes. Data on two hunters in Palmeras II were notable exceptions to these correlations. Both hunters devoted much time to hunting and harvested large quantities of animal biomass, however the amount of time devoted to hunting was due to the frequency of their hunts rather than to their duration. These hunters generally hunted close home and mainly harvested small game such as agoutis and armadillos[15].

Market-oriented hunters in Catalan and Palmeras II targeted large species with high market value like peccaries, tapir, paca, and woolly monkeys. Some of these species, e.g., primates and tapir, are often quickly extirpated from areas under light to moderate hunting pressure (Bodmer, et.al., 1994:32; Robinson and Redford, 1994:306, 311). White-lipped peccaries may also be vulnerable to over hunting as evidenced by their absence from the harvest data for Iquique and Palmeras II and the depression of age structure curves of white-lipped peccaries in some areas of the Peruvian Amazon that experience light hunting pressure from

[15] Both of these hunters were very reserved in discussing their family background and hunting practices. Therefore little is known or can be deduced as to their hunting motivations. One hunter was particularly reserved in revealing information on the animals he sold and on the frequency of his trips to Iquitos. Potentially they sold more meat than was revealed in the survey. However, both hunters were the only ones procuring game meat in their families and may have focused on hunting consumption due to the demand for meat in their household . They also might have just enjoyed hunting and restricted themselves to hunting small game because they preferred to only spend a small part of every day hunting. One of the hunters routinely carried his shotgun with him on the way to his agricultural fields which might account for a number of his diurnal hunting trips.

ribereños[16]. There is a high probability that market pressures will to lead to the extirpation of species vulnerable to over-hunting around most permanent settlements in the Peruvian Amazon. Hunting pressure from households in Palmeras II and Catalan was influenced by market-driven motivations to a greater extent than in Iquique. Iquique hunters did not hunt as much for the market due to the scarcity of large marketable species near their village and due to the availability of more attractive income generating activities such as fishing and rice cultivation. More people sold their game in Palmeras II compared to Iquique because marketable species were more frequently encountered in Palmeras II and potentially because the people of Palmeras II were already making frequent trips to the market in conjunction with their involvement in tourism. Catalan is located furthest from the market yet hunters there sold over twice the amount of animal biomass as hunters in Palmeras II because they could easily access areas rich in large game and because of the lack of many income generating alternatives.

Spatial extent and location of hunting activities

Hunting for the market was the most important factor influencing the spatial extent of hunting activities. Hunters from all three villages who desired to harvest large quantities of marketable species would travel for many days to reach game rich areas. Once there, they hunted for several days to weeks in order to harvest as much meat as possible for eventual sale in Iquitos. Community land holdings were insufficient to contain market-oriented hunting activities in all three villages. In Iquique and Palmeras II hunters traveled to remote villages in order to access areas rich in marketable game. Catalan hunters did not have to travel to remote villages because they had unrestricted access to extensive forested lands south of their village even though those lands were outside their community territory. This "open" forested area was also visited by hunters from neighboring villages who had to travel upriver, through Catalan, to access the forest. Catalan has established regulations for charging access fees to neighboring villagers and has police to enforce those regulations. However, neighboring villagers traveled upriver at night to avoid the fees and the people of Catalan were reluctant to enforce the rules in part because of the fear of retribution during the winter season when they had to travel to neighboring villagers to access fishing lakes, palm stands, or other seasonal resource areas.

Data on the location of kills suggest that swidden-fallow agricultural practices in the three villages create foraging habitat for small mammals and several bird species as evidenced by the species killed in active and fallow agricultural fields. Agoutis were especially plentiful in agricultural fields and the practice of building hunting platforms near particular fruit trees in fallowed fields was evident in both Palmeras II and Catalan. Similar practices have been observed of the Bora Indians in Peru (Redford, et.al., 1992:336), Kayapó Indians in Brazil (Posey, 1983:244,246), and of other indigenous groups throughout Latin America (Clay, 1991:11). Agricultural practices also eliminated foraging and breeding habitat for arboreal and interior forest species. Some species were killed exclusively in late-secondary and primary forest including white-lipped and collared peccaries, tapir, caiman, two-toed sloths, large monkeys and carnivores,

[16] Additional evidence for the vulnerability of white-lipped peccaries to over harvesting is provided by the potentially unsustainable harvest of white-lipped peccaries by the Chimane and Yuquí Amerindians (Robinson and Redford, 1996:309,311).

guans, and currasows. Most of these species are conspicuous and large in size causing them to be easy and sought after prey by hunters (Redford, 1992:417; Bodmer, 1995:873). For these reasons, the impacts of habitat alteration on these species cannot be separated from the impacts of hunting pressure. In the absence of hunting pressure, agricultural fields might provide suitable foraging habitat for some large, non-arboreal species like peccaries, tapir, currasows, and large carnivores.

Conclusion

This study only examined hunting practices during the winter high-water season in the Peruvian Amazon and only focused on hunting activities during a relatively short period. Subsistence activities among peasant households vary seasonally as due wildlife habits so therefore it is difficult to make broad generalizations based on the data from this study. However, several conclusions are supported by the data. Hunters in the three villagers exhibited opportunistic hunting behavior and appeared to maximize their returns by preferring to harvest large animals and through their willingness to harvest any game animals wherever and whenever encountered. However, data from this study suggest that peasant hunters do not maximize their hunting efficiency.

The results from this study also suggest that peasant hunters respond to the depletion of large game by targeting less preferred but more common species, dedicating less time to hunting in favor of alternative income-generating activities, and by traveling to remote areas rich in marketable game species. Through these responses, hunting efficiency rates are maintained. By targeting smaller, less preferred game hunter-households in villages depleted of large game are able to obtain the same quantity of meat per unit effort as hunters in game rich areas. Another consequence of these responses is that subsistence hunting in game depleted areas may be more sustainable than hunting practices in game rich areas. The hunting of small game species is more likely to be sustainable because many small mammals are less vulnerable to hunting pressure than larger species. Small species like agoutis and armadillos have high intrinsic rates of natural increase, short life-spans and short generation times indicating that more such species can be harvested without adversely impacting their population compared to most large species. Data on Iquique and Palmeras II suggest that hunting for consumption will continue to be practiced as one aspect of their survival strategies despite local game depletion from over-hunting. However, as game depletion persists, hunting will become less attractive causing some households to exert more pressure on fish, soil, and forest resources.

Hunters who respond to game depletion by extending the range of their hunting activities will increase the pressure on wildlife populations inhabiting the “open” forest and cause hunting to be a temporally exclusive activity rather than one which complements farming, fishing, and gathering on a daily basis. For hunter-households unwilling to travel far and devote substantial blocks of time to hunting, the depletion of marketable game species near their village will virtually eliminate hunting as an income-generating option causing them to become more dependent on alternative income sources.

The extension of household hunting ranges is also likely to lead to the “tragedy of the commons”. As human populations increase, the number of villages outlining Amazonian rivers multiply, and local game becomes scarce, large marketable species will become concentrated in

remote interior forests. The presence of large game in these areas will attract a growing number of hunters as is currently occurring south of Catalan. Continuation of this trend will not only lead to the extirpation of vulnerable species but also to the extirpation of market hunting as an income earning option for Amazonian peasants. This same scenario is occurring in regards to fishery and timber resources and has prompted the creation over 44 community managed forest and lake reserves in the Peruvian Amazon (Pinedo-Vasquez, et al.,1992:79). However, these reserves were mainly created to combat the commercial exploitation of timber, game, and fish resources (Ibid), rather than to combat over-harvesting from numerous peasant households based in different communities. To conserve wildlife resources and to preserve hunting as an income earning option for Amazonian peasants, multi-community access rights to resource areas need to be established and sustainable harvest rates need to be enforced. It is not necessary to expand community territories to address this problem even though current land holdings in Iquique, Palmeras II, and Catalan are insufficient to contain most hunting, fishing, and some gathering activities. These activities exploit seasonal resources which many communities depend on. Therefore, multi-community access rights and regulations are needed to help ensure the sustainability of all Amazonian peasant communities rather than favoring the ones that are located closest to the resource in question.

Appendix A

Names and Live Weights of Hunted Species

Taxon	Species Name*	English Common Name	Adult Body Mass (kg)**	Juvenile Body Mass (kg.)†
Birds	*Ardeidae?*	Herons, Egrets, Bitterns	0.500[a]	0.325
	Buteo magnirostris	Roadside hawk	0.290	0.189
	Cochlearius cochlearius	Boat-billed heron	0.600	0.390
	Columba cayannensis	Pale-vented dove	0.250	0.163
	Crax mitu	Razor-billed curassow	3.061[b]	1.990
	Ortalis guttata	Speckled chachalaca	0.450[b]	0.325
	Penelope jacguacu	Rofous-breasted guan	1.325[b]	0.975
	Pipile cumanensis	White-headed piping guan	0.950[c]	0.618
	Daptrius americanus	Red-throated caracara	0.550	0.358
	Coccopis gularis	Red-capped cardinal	0.045[d]	0.029
	Cacicus spp.	Cacique	0.130[b]	0.085
	Psarocolius decumenus	Crested oropendula	0.225 [e]	0.146
	Psophia leucopter	Trumpeter	0.650[f]	0.423
	Brotogeris sanctithoniae	Tui parakeet	0.065[g]	0.042
	Brotogeris spp.	Other parakeet	0.065[g]	0.042
	Thraupis episcopus	Blue-gray tanager	0.032	0.021
	Tinamus osgoodi	Black tinamou	1.100[h]	0.715
	Crypturellus undulatus	Undulated tinamou	0.500[i]	0.325
	Pitangus sulphuratus	Great kiskadee	0.068	0.044
Reptiles	*Paleosuchus trigonatus*	Schneider's smooth-fronted caiman	20.000[j]	13.000
	Chelus fimbriatus	Matamata	4.000[k]	2.600
	Caiman crocodilus	Spectacled caiman	25.000[j]	16.250
	Geochelone denticulata	Yellow-footed tortoise	6.000[k]	3.900
Marsupialia	*Didelphis marsupialis*	Common opossum	1.041	0.677
Perissodactyla	*Tapirus terrestris*	Brazilian tapir	148.950	96.818

Taxon	Species Name	English Common Name	Adult Body Mass (kg)*	Juvenile Body Mass (kg.)†
Primates	*Saguinus fuscicolllis*	Saddleback tamarin	0.364	0.237
	Saguinus mystax	Black-chested mustached tamarin	0.517	0.336
	Alouatta seniculus	Red howler monkey	6.185	4.020
	Aotus spp.	Night monkey	0.873	0.567
	Callicebus spp.	Dusky titi monkey	1.166	0.758
	Cebus albifrens	White-fronted capuchin monkey	2.005	1.303
	Cebus apella	Brown capuchin monkey	3.445	2.239
	Lagothrix lagothricha	Woolly monkey	10.000	6.500
	Pithecia monachus	Monk saki monkey	1.800	1.170
	Saimiri sciureus s.	Common squirrel monkey	0.688	0.447
Artiodactyla	*Mazama spp.*	Red or Gray brocket deer	26.100	16.965
	Tayassu pecari	White-lipped peccary	28.550	18.558
	Tayassu tajacu	Collared peccary	17.520	11.388
Carnivora	*Herpailurus yaguarondi*	Jaguarundi	5.000	3.250
	Leopardus pardalis	Ocelot	10.460	6.799
	Leopardus wiedii	Margay	8.000	5.200
	Eira barbara	Tayra	3.980	2.587
	Nasua nasua	South american coati	3.880	2.522
	Potos flavus	Kinkajou	2.490	1.619
Edentates	*Bradypus variegatus*	Brown-throated three-toed sloth	3.725	2.421
	Cabassous unicintus	Southern naked-tailed armadillo	4.800	3.120
	Dasypus novemcinctus	Nine-banded long-nosed armadillo	3.544	2.304
	Choloepus spp.	Southern two-toed sloth or Hoffmann's two-toed sloth	4.150	2.698
	Cyclopes didactylus	Silky or pygmy anteater	0.400	0.260
	Tamandua tetradactyla	Southern tamandua	4.560	2.964
Rodentia	*Agouti paca*	Paca	8.227	5.348
	Dasyprocta fuliginosa	Black agouti	4.750[l]	3.088
	Myoprocta pratti	Green acouchy	1.000[l]	0.650
	Coendou spp.	Bicolor-spined porcupine or Brazilian porcupine	3.360	2.184
	Hydrochaeris hydrochaeris	Capybara	31.500	20.475
	Muridae	Miscellaneous rats	0.050[m]	0.033

* The scientific names of species were identified based on descriptions of the local common names provided in Villarejo (1988).

** Unless otherwise noted, the body masses of bird species were derived from Stiles and Gardner (1989). The body masses of bird species not found in Stiles and Gardner (1989) were derived by comparing the length of the species found in Hilty and Brown (1986) with the lengths of similar species found in Stiles and Gardner (1989). Body masses for mammal species were taken from Robinson and Redford (1986).

†Juvenile weights were calculated by multiplying the adult weights by 0.65%.

[a] based on general weights of small herons, egrets, and bitterns described in Stiles and Gardner (1989:80-87).
[b] based on weights reported in Karr, et al.(1990:254, 268).
[c] based on weight of a slightly smaller Guan, *Chamaepetes unicolor* (25") compared to *Pipile cumanensis* (27").
[d] based on weight of same sized (7") species (*Pheucticus ludovicianus*) in same family.
[e] based on weight of *Psarocolius wagleri*
[f] based on comparison with similar sized (22") and shaped bird, *Ortalis vetula*.
[g] based on weight of *Brotogeris jugularis*
[h] based on weight of *Tinamus major*
[I] based on weight of *Crypturellus boucardi*
[j] based on weights———
[k] based on weights reported in Prichard and Trebbau (1984:104-105, 230).
[l] weight derived from averaging the weight range for adults of this species reported in Emmons (1997).
[m] weight based on the observed length of rats killed by hunters compared to similarly sized rats described in Emmons (1997).

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