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# Coca and Conservation: Cultivation, Eradication, and Trafficking in the Amazon Borderlands

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**Abstract**
The cultivation and traffic of coca, *Erythrolxylum coca*, and coca derivatives remain understudied threats to the conservation of the Amazon rainforest. Currently the crop is transforming land use and livelihoods in the ecologically and culturally rich borderlands of Amazonian Peru. The isolated nature of this region characterized by indigenous populations (both settled and uncontacted), conservation units, resource concessions, and a lack of state presence provides fertile ground for the boom and bust cycle of coca production and facilitates the international transport of the product to neighboring Brazil. This paper explores the social and environmental impacts of coca production, eradication, and transport through an analysis of both spatial and ethnographic data on land use and livelihood strategies along the Ucayali and Purús Rivers. Results map out the regional distribution and recent history of commercial coca fields and transboundary transportation routes and identify threats to the conservation of indigenous landscapes and borderland forests.

Keywords: coca, conservation, Amazonia, border, Peru, Brazil

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## Introduction

Tropical forests host a disproportionate amount of today's biological and cultural diversity (here after called biocultural diversity[1]): 70% of the world's floristic and faunistic species, and over 1,000 unique ethnic groups (Price 1990). With the largest remaining contiguous rainforest, Amazonia is of particular importance, playing a pivotal role in maintaining not only biocultural diversity (Lizzeralde 2001) but also carbon cycles, hydrology, and climate patterns (Laurance et al. 2001). In order to better understand and protect Amazonia, research has focused on the identification of threats to tropical forests and their inhabitants such as pasture expansion (Arima et al. 2006; Salisbury and Schmink 2007; Walker et al. 2009), fragmentation (Batistella et al. 2003; Ferraz et al. 2007), road building (Arima et al. 2008; Brown et al. 2002; Perz et al. 2007), commercial agriculture (Fearnside 2001; Hecht 2005), gold mining (Bastos et al. 2006; Bedoya 2004; Cleary 2000), fire (Cochrane and Laurance 2002; Nepstad et al. 1999), and resource extraction (Asner et al. 2005; Fagan et al. 2006; Watson 1996) to name a few. This study addresses drug production, one of the least understood threats to the biocultural diversity of Amazonia.

Drug production remains an understudied threat to biocultural diversity worldwide, despite the United Nations Office of Drug Control's (UNODC) (conservative) global estimates of 200 million drug users and 500,000 hectares of poppy, coca, and cannabis coverage (UNODC 2006a). Although all three of these crops are not only grown in previously forested areas of the tropics (UNODC 2006b) but are also highly mobile deforesters due to eradication efforts, they remain largely absent in recent literature identifying threats to tropical forests (Babin 2004; Brown and Pearce 1994; Laurance and Peres 2006; Miles et al. 2006; Rudel 2005). While the impact of drug crops on indigenous landscapes is slightly better documented, it also remains poorly understood (Gagnon et al. 1993; Morales 1994; Stearman 1996; Steinberg et al. 2004). In Amazonia, the conservation of indigenous landscapes and tropical forests have become increasingly linked (Cleary 2005; Fearnside 2003; Nepstad et al. 2006), even as drug production progressively threatens both. Here we will concentrate on coca, the crop with the greatest coverage and impact in Amazonia.

This study answers calls by geographers for 1) explanation of the environmental degradation and social disruption caused by the cultivation and traffic of coca and coca derivatives (Young 2004a) and 2) the need for geographic analysis to overcome the scarcity of meaningful quantitative and qualitative data and interpret the disparate facts and relationships influencing the cocaine trade (Allen 2005). Indeed, the geographic analysis here is immediately useful as historical maps and recently published studies show no evidence of coca cultivation in our Peruvian Amazon borderland study areas (Plowman 1984; UNODC 2005b).

[1] The term biocultural diversity is used to recognize the increasingly accepted interdependence between biodiversity conservation and indigenous landscapes (Maffi 2001; Nepstad et al. 2006; Nietschmann 1992; Posey 1999; Stevens and De Lacy 1997). This term's underpinnings can be traced to the Geographer Barney Nietschmann's Rule of Indigenous Environments: "Where there are indigenous peoples with a homeland, there are still biologically-rich environments" (Nietschmann 1992).

This analysis begins with an introduction to coca and a brief review of the literature to underscore the scarcity and contradictory nature of data on cultivation and coca-related impacts in the Amazon basin. This is followed by a description of the study sites and methodology used. Next, we synthesize our spatial and ethnographic data with results from other studies to highlight the social, environmental, and cultural impacts coca production, eradication, and transport have on two remote watersheds near the Peruvian border with Brazil. Particular attention is paid to the relationship between coca and protected areas, logging operations, and indigenous people. Finally, we conclude with a discussion of the future outlook of the region's forests and indigenous peoples in the context of current eradication policies and the movement of cultivators and traffickers into remote protected areas and indigenous lands.

**Coca Cultivation and Contradiction in Amazonia**

The sources of all cultivated coca are two closely related South American shrub species *Erythroxylum coca* and *Erythroxylum novogranatense* (Plowman 1984) adapted to environmentally distinct regions in Colombia, Bolivia, Peru (Ehleringer et al. 2000) and, most recently, Brazil (Duffy 2008). Each species has an additional variety, *E. coca* var. *ipadu* and *E. novogranatense* var. *truxillense*, with the former known for its traditional use by lowland Amazonian groups (Plowman 1981) and the latter a drought-resistant variety grown largely for commercial purposes in arid to semi-arid interandean valleys. Although E. *coca* var. *ipadu* has been cultivated in lowland Amazonia for many centuries, historically, its low alkaloid content has made it a poor choice for cocaine production; nevertheless, recent research on coca cultivated illegally in the Colombian Amazon indicates farmers to be increasingly cultivating high-producing hybrids of *E. coca* var. *ipadu* (Johnson et al. 2003). These hybrids would be well adapted and easily diffused to other parts of the Amazon (Duffy 2008).

Over four million Peruvians continue to practice traditional use of the coca leaf (Rospigliosi et al. 2004) as they have done for perhaps as long as five thousand years (Piperno and Pearsall 1998). Coca leaf chewing can alleviate hunger, cold and fatigue and is used both in traditional medicine and shamanic practices (Rospigliosi et al. 2004). Traditional use of the coca leaf appears to have no negative consequences (Duke et al. 1975; Morales 1994) while the sharing of leaves and participation in group sessions of coca chewing continues to create and strengthen ties between friends and family (Allen 2002; Andrews and Solomon 1975; Morales 1994; Young 2004a). Indeed, the economic interchange of coca leaf has also fortified ties between highland consumers and foothill producers for at least the last millennium (Morales 1994; Osborne 1952).

The eastern slopes and foothills of the Andes continue to be the principal source of Peruvian coca leaf with this Andean cultivation closely associated with roads and hillside agriculture (Young 2004a). In particular, the valleys of Alto Huallaga, Apurimac-Ene, and La Convención-Lares contained 88% of the UNODC estimated 50,300 hectares of Peruvian coca surface in 2004 (UNODC 2005b). These valleys dominate popular and academic understandings of Peruvian coca cultivation with a lack of published literature on coca cultivation in the Amazon borderlands studied here (Plowman 1984; UNODC 2005b).

Regardless of the location within Peru, the country's 50,300 hectares of coca fields place Peru second to Colombia in coca leaf production among countries worldwide. The UNODC estimates these 50,300 hectares capable of producing 190,000 of coca leaf (UNODC 2005b), well over the approximately 7,500 kilograms used by Peru's four million traditional users (Rospigliosi et al. 2004) and the small amounts needed for the pharmaceutical industry and as flavorants. Thus, the majority of coca leaf production is driven by the global demand for coca derivative drugs such as coca paste, cocaine, and crack.

Coca leaf can be processed into coca paste after soaking and trampling the leaves and their residues in treatments using acids, solvents, and neutralizers (Morales 1994; Young 1996). Coca paste is a drug used locally by farmers and processors, or nationally and in neighboring countries by the rural and urban poor (Geffray 2001; Maia 2005; Rojas 2002; Schonenberg 2001). The distillation of coca paste into cocaine hydrochloride requires another step often undertaken in laboratories that reduces the volume even as it increases significantly in value (Morales 1994). Once made into readily transportable cocaine, the drug can be moved at less cost and risk to North America and Western Europe, the two regions estimated to have consumed over 70% of global cocaine in 2001-3 (UNODC 2005a). Regardless of the end market, the Brazilian magazine, *Veja,* estimated 45% of cocaine produced in Colombia, Bolivia, and Peru to pass through the Brazilian Amazon (Peres and Coutinho 2004).

Unfortunately, the available data on coca remains highly speculative as research on cultivation, eradication, and trafficking is rife with contradiction. This is in part because the dangerous nature of field research limits the quantity and quality of data production. Messina and Delameter (2006) found both United States and United Nations data on eradication open to interpretation. Similar claims can be made about the environmental impacts of coca cultivation and processing where Alvarez (2007) argues empirical data insufficient for estimating coca related deforestation, chemical impacts, and biodiversity loss.

Empirical data are available on the increase in overlap between coca coverage and protected areas. Between 2003 and 2004 coca cultivation increased by 71% in the national parks of Bolivia's Chaparé region, as opposed to increasing only 22% outside national park boundaries (UNODC 2005c). In 2004, coca cultivation also appeared for the first time inside the Madidi National Park, which shares hundreds of kilometers of border with Peru (UNODC 2005c). In Colombia, 7% of coca cultivation takes place within national parks (UNODC 2005d). Thirteen of Colombia's 50 National Parks contain commercial coca cultivation for a total of over 5,000 hectares of coca fields (UNODC 2005d). Overlap of coca and national parks is particularly problematic in Colombia where aerial spraying is a common means of eradication, with a large margin for error (Messina and Delamater 2006) and thus a significant threat to conservation (Fjeldsa et al. 2005).

While there is little doubt coca cultivation has a negative environmental and social impact, a surprising number of basic questions remain unanswered about coca cultivation, eradication, and transport in the borderlands of Peru and Brazil. What is the extent of current cultivation? What are the social and environmental impacts of coca cultivation and eradication policy? Is eradication less damaging than coca cultivation?

And finally, does eradication policy relocate rather than permanently eradicate borderland coca cultivation?

**Study Site**

The region described here is the borderland area of far eastern Peru (Figure 1). The study was conducted on two sites within this region. The first site contains four watersheds of the Ucayali River: the Callería, Utiquinía, Abujao, and Tamaya[2]. The second is the larger Purús River watershed, which borders the Ucayali to the South.

Figure 1: The central borderlands of Peru and the Ucayali and Purús study sites

The Ucayali and Purús Rivers are separated by the rolling foothills leading to the eastern edge of the Andes. Water running westward off these hills drains into the Ucayali, which meanders north, roughly parallel to the Brazilian border, and eventually becomes the Amazon near Iquitos. The streams flowing in the opposite, eastern, direction drain into the Purús watershed. One of the largest tributaries of the Amazon, the Purús flows in a northeasterly direction into Brazil and joins the Amazon near Manaus.

This borderland region has experienced, and continues to experience, intermittent economic booms focused on products like rubber, animal skins, and more recently timber, gold, and coca. The four rivers comprising the Ucayali study site are home a mixture of Shipibo-Conibo, Asháninka, Aguaruna, and Isconahua indigenous people, mestizo, Brazilian, and Andean colonists, and loggers, miners, coca farmers, and other transient opportunists. The economy is driven largely by extraction, particularly logging, with most agriculture devoted to subsistence with the notable, and lucrative, exception of coca cultivation. Access to the remote upper reaches of these tributaries is difficult, but the mouths of all four rivers can be reached from the city of Pucallpa in a day or two depending on the boat. Pucallpa, a bustling frontier city of 300,000 inhabitants, serves as the economic and political hub of Peru's central borderland region.

The Purús site is even more remote, with no roads or rivers connecting it to the rest of Peru and access largely limited to chartered flights from Pucallpa to Puerto Esperanza, the provincial capital and economic hub of the Purús region. Seventy five percent of the Purús region's population of 4,000 belongs to eight indigenous groups (Cashinahua, Sharanahua, Culina, Mastanahua, Amahuaca, Chaninahua, Asháninka and Yine) living in 40 small riverside communities, making it among the most culturally diverse regions in all of Amazonia. The remaining 25% of the population are *mestizos* and, to a lesser extent, Brazilians living in Puerto Esperanza. Limited economic opportunities and isolation discourage immigration to the Purús. The exception is the booming logging industry which employs most *mestizo* migrants. The communities survive on subsistence activities such as hunting, fishing, and tending small garden plots (Fagan and Salisbury 2003), although in recent years some have agreed to exploitative trade agreements with the loggers for their mahogany trees.

Both sites are conservation priorities due to their relatively undisturbed condition and world-class levels of biodiversity (Leite-Pitman et al. 2003; Scarcello et al. 1998;

[2] Rivers and other place names are correctly identified in the text, but may be omitted from figures due to the sensitivity of the subject.

The Nature Conservancy 2006; Vriesendorp et al. 2006; World Wildlife Fund (WWF) 2005). The four Ucayali watersheds have their headwaters adjacent to Brazil's Serra do Divisor National Park, with three of the four also overlapping with the Sierra del Divisor Reserved Zone[3]. Together these two conservation units create a transboundary mosaic of 2.3 million hectares. The headwaters of the Purús watershed are protected as the 2.5 million hectare Alto Purús National Park. This is Peru's largest Park and is bordered by the Purús Communal Reserve, which buffers the Park from the titled indigenous lands located further downstream towards Brazil. Both study sites are bordered by territorial reserves for uncontacted[4] indigenous people, the Isconahua Territorial Reserve at the headwaters of the Ucayali Rivers, and the Mashco Piro, Madre de Dios, and Murunahua Reserves near the Purús. The presence of these uncontacted people, among the last such people on earth, underscores the unique levels of biocultural diversity present in these borderlands.

## Methodology

While the economic and environmental importance of coca cultivation in Amazonian Peru demands close study (Young 2004a; Young 2004b), there are numerous challenges to conducting coca-focused research in the field (Bradley and Millington 2008; Morales 1994). Here we describe the indirect methods we used to explore the impacts of coca cultivation in the context of our broader studies on land use, livelihoods, and conservation in the Ucayali and Purús watersheds. We use the term indirect methods to describe the necessary approach of developing a detailed understanding of a dangerous research topic through the triangulation of three categories of data sourcing: 1) direct observation and deliberate recording in the field, 2) secondary sources, and 3) passive reception of unsolicited input from a variety of informants. The provocative nature of the research material, associated confidentiality of the informants, and necessary indirect methodology mean this research does not lend itself to replication. Furthermore, due to the sensitivity of the topic, some place names have been altered in the text and omitted in figures.

We conducted research in the Ucayali and Purús valleys of Peru between 2002 and 2008, with a primary focus on 2004. In addition, we also carried out research in Brazil's Juruá and Purús valleys in 2002 and 2004. The in depth Peruvian field work took place in 19 communities with a primary focus on local use of land and natural resources such as logging, hunting, ranching, and farming to better identify threats to the conservation of neighboring protected areas.

Indeed, coca was not the original focus for either author's research, however, once in the field we realized the necessity of understanding this important driver of environmental and social change to reach our watershed scale research objectives. However, direct questions about coca cultivation could not be asked due to the dangers of showing interest in the illegal crop. Peruvian authorities' recent eradication efforts in 25

[3] Serra do Divisor and Sierra del Divisor mean the dividing mountain range in Portuguese and Spanish respectively with both the Brazilian and Peruvian protected areas covering half of the transboundary range.
[4] Uncontacted indigenous people, also called indigenous people in voluntary isolation, refers to indigenous people avoiding all contact with strangers, instead practicing the isolated hunting, gathering, and gardening based livelihoods they have practiced for centuries in the interfluvial zones of the most remote rainforests.

villages in the Ucayali field site made informants suspicious of outsiders. Local coca farmers referred to "gringos" with hostility, blaming North Americans for funding the eradication. Therefore, we avoided hostile villages, however, we still recorded details about commercial coca cultivation and traditional coca use gained from direct observation and from informants offering unsolicited information in less hazardous portions of the two study sites.

While all of our fieldwork indirectly informed this study, the field methods most useful to understanding the coca dynamic included landscape walks, ethnography, photography, GPS point collection, and semi-structured interviews. Interviews with expert informants in protected areas, indigenous territories, NGO offices, government offices, urban centers, and waterways were particularly useful in answering coca questions informed by field observation but unsafe to ask directly in the field.

Overflights, satellite remote sensing, GIS analysis, document research, and archival research provided additional data, analysis, and context for our interviews and in site field work. Two overflights (October 6, 2004 and August 29, 2006) were conducted exclusively in the Purús with the objective of locating logging camps and activity in the Alto Purús National Park and along its borders. While elevation varied throughout the flights, findings were documented between approximately 750 and 2000 feet with a digital camera and hand-held GPS unit. Remote sensing used four ETM+ Landsat 7 scenes (paths 5-6, and rows 65-67) from September 7 and 15 (the height of the dry season), 2002 purchased through the TRFIC (Tropical Rain Forest Information Center through Michigan State University) on May 3, 2004 in generic binary format. Image post-processing to UTM carried out by J.Lipton in the Digital Lab of the University of Texas at Austin Department of Geography. Satellite images were qualitatively analyzed based on existing maps, ethnography, GPS points taken in the field, and datasets obtained from secondary sources.

Field data were further complemented by an unpublished 2003-2004 eradication dataset of the Ucayali study area from the special project Control and Reduction of Coca Cultivation in the Alto Huallaga (CORAH) of the Peruvian Ministry of the Interior. This GIS vector file contained the polygons for 2,915 coca fields eradicated in 2003 and 2004. CORAH topographers constructed these polygons using laser range finding binoculars to measure the edge of the fields from a georeferenced center point. After establishing the polygon, the topographers used Auto Cad software to associate each polygon with tabular information observed in the field such as crop age, condition, and mix of crops before transforming the data into ArcView format on their return to CORAH headquarters. This dataset clarified greatly the extent and impact of coca cultivation observed in the field, and was supplemented further by informational interviews with CORAH topographers, geographers, and administrative personnel.

GIS analysis included use of spatial analyst, buffer creation, selection by attributes and location, and running descriptive statistics in ArcGIS software to best understand the relationship of coca fields to hydrological systems, indigenous territories, protected areas, elevation, and each other. To determine proximity to hydrological systems we used buffer wizard and vector files of the major rivers and coca fields to create a buffer 5 km distant from the midline of the hydrological systems. We selected coca fields according to whether their centroid location overlapped with the 5 km buffer. The overlap of coca fields with indigenous territories and protected areas, and the intersection of 2003 and 2004 fields, was also determined by whether the field centroid overlapped the respective polygons. To determine the elevation of coca fields we interpolated the coca vector files to raster and assigned elevation to the coca fields based on field centroid overlap with 90 meter resolution Shuttle Radar Topography Mission data downloaded in 2004 from NASA.

Our research on coca transportation routes began in 2002 when key informants sketched these routes on existing maps when queried about threats to borderland conservation initiatives. Two years later, while documenting illegal logging, we ground truthed two trafficking routes by hiking parallel to the border with local people who indicated trails used by traffickers, hunters, and loggers. Based on this field work and other key informant interviews we estimate each of the trafficking routes in figure 3 to be characterized by at least three trails: both locals and key informants described traffickers as alternating trails to escape ambush by bandits or rivals.

To best present as complete a picture as possible of the real and potential social and environmental impacts of coca cultivation in the Ucayali and Purús regions we have synthesized the data and analysis from our indirect methods and those from other studies in the subsequent section.

## Results

Traditionally coca has not been associated with the central borderlands of Peru. While the use of coca by the uncontacted indigenous inhabitants of both the Ucayali and Purús study sites is unknown, the settled indigenous inhabitants use little of the crop or none at all. From the Ucayali sites, only the Asháninka people produce coca, mainly for their own consumption, and this, only since their arrival in the region in the last hundred years. None of the indigenous inhabitants living on the Purús cultivate the plant commercially.

While coca cultivation has been an important crop for indigenous inhabitants of the study sites, we found significant economic reliance on the crop by the Andean *mestizo* colonists in the nine Ucayali sites. These colonists, or *cocaleros*, arrived in the region in the 1980s specifically to work with coca. We discovered two of the nine communities researched in the Ucayali watershed primarily dedicated to coca cultivation while two others had coca recently eradicated within their territory. Due to the economic importance of the crop, all nine communities had members either directly involved in coca cultivation and traffic or were at least aware of coca related activity in the region. In the Purús site we found no cultivation of the plant by mestizo or indigenous inhabitants. Instead, local people described the region as a transport route to Brazil by cultivators in the upper regions of the adjacent Ucayali watershed.

### *Eradication*

In Amazonian Peru the CORAH acronym is synonymous with the forced eradication of coca fields. CORAH's central goal is to reduce the cultivation of coca to levels commensurate with the legal use of the plant for traditional consumption and pharmacological purposes. The institution's objectives are three-fold: 1) to predict, execute, and control the reduction of illegal crops used by drug traffickers for the illicit production of cocaine paste and derivatives; 2) to prevent the expansion of coca by eliminating coca seed beds; and 3) to support policies that protect natural areas by eradicating existing plantings of coca within national parks and other state protected areas (Ministerio de Interior 2002).

CORAH was created in 1982 to work in the coca growing region of the Alto Huallaga Valley, but in 1994 expanded efforts across Peru and today is administered by the Office of Drug Control in the Peruvian Ministry of the Interior and entirely financed by the Narcotic Affairs Section of the United States Embassy in Peru (Ministerio del Interior: Oficina de Comunicación Social 2004). According to the Peruvian Ministry of Interior, the United States provided a nine million U.S. dollar budget for CORAH from September 2003 to October 2004 (Ministerio del Interior: Oficina de Comunicación Social 2004). The Peruvian government reported the total eradication of 11,312 ha in 2003 and 10,257 ha of coca fields in 2004. CORAH was responsible for eradicating 68% of these fields (UNODC 2005b; Ministerio de Interior 2003a).[5]

### *Cultivation in the borderlands*

Despite the absence of published accounts, our informants claimed coca to have been an important and lucrative crop with a significant distribution in the four Ucayali watersheds since at least the mid 1980s. The Truth and Reconciliation Commission of Peru corroborates these findings, defining 1985 as the year coca began to be openly traded and cultivated along the Tamaya and Abujao Rivers (Comisión de la Verdad y Reconciliación et al. 2004). Since then coca cultivation has expanded; in 2003 and 2004 alone, CORAH eradicated almost 3,000 fields containing over 4,000 hectares of coca plants in the four watershed Ucayali study area (Table 1).

Table 1. Number, size, and age of coca fields eradicated in 2003 and 2004 within the four watershed study sites on the Ucayali River.

GIS analysis of these eradicated fields reveals coca cultivation in the borderlands to be unlike the majority of Peruvian coca, as cultivation is neither associated with roads nor hillside agriculture (Young 2004b). Without roads, borderland coca relies on waterways, the traditional transportation routes of the Amazonian lowlands, with 95% of the fields eradicated in 2003-4 falling within five kilometers of a major river or lake (Figure 2). In addition, these three thousand fields average only 177 meters in elevation above sea level, perhaps the lowest published elevation for commercial coca cultivation. Despite the low elevation, the fields contain well drained soils, being located on *terra firme* (ONERN 1978) in a region with a pronounced dry season between July and October. Although the lack of roads and hillside agriculture preclude impacts such as deforestation driven by an expanding road network or accelerated soil erosion due to steep gradients, the amount of coca coverage in this sample, over 4,000 hectares eradicated, suggests borderland coca cultivation may have other social and environmental impacts.

[5] 7,022 ha and 7,604 ha in 2003 and 2004, respectively. The remainder was part of a voluntary eradication program.

Figure 2: Eradicated coca fields in the Ucayali site.

### *Social Impacts*

The social impacts of coca cultivation (Araujo 2001; Bedoya 2003; Geffray 2001; Morales 1994; Rojas 2002) are vastly understudied when compared to the extensive literature on the social impacts of coca consumption (Fryer et al. 2005; Rospigliosi et al. 2004; Sterk 1999). Our research uncovered significant social and cultural impacts of coca cultivation and eradication related to drug trafficking, boom and ghost towns, the economics of cultivation, and the existing and prospective connections of coca cultivation with loggers and indigenous peoples.

The Ucayali region felt the social impacts of coca production long before the arrival of regional commercial coca cultivation as the political boundary has historically served as a gateway for coca and other illegal goods smuggled to Brazil and beyond. While the air bridges connecting source countries to processing centers and international markets is the most widely known means of international coca traffic, coca, largely in the form of coca paste, has also moved across the border by water, foot, or a combination of the two (Bureau for International Narcotics and Law Enforcement Affairs 2000). The Purús River has been utilized as a transport route since at least the late 1990s.

The Ucayali study site, but not the Purús, have also experienced significant migration from coca farmers from the eastern Andes. The isolation, absence of law, and proximate international transportation routes of the borderlands proved attractive to the coca farmers and traffickers from the Andean regions of Huánuco, Ayacucho, and San Martín who arrived in the Ucayali region starting in the mid 1980s (Comisión de la Verdad y Reconciliación et al. 2004) and through the 1990s in part due to eradication and land scarcity in their previous cultivation centers (Bedoya and Klein 1996). Table 1's data on eradicated coca fields corroborates the arrival of the farmers showing fields averaging almost nine years of cultivation and 23% of the fields being cultivated for more than fifteen years. The influx of coca farmers from the eastern slopes of the Andes changed demographics drastically. Shipibo-Conibo informants who inhabit the floodplain region on the lower portion of these rivers depicted the new settlements upriver as organized by individual coca bosses controlling 30-40 workers farming 20-30 hectares of coca fields. Existing indigenous and mestizo settlements were transformed by the migrants, with one community even renamed after a locally famous drug trafficker (Comisión de la Verdad y Reconciliación et al. 2004).

These formerly isolated one and two family homesteads carved out of the upland rainforest exploded into coca hamlets, *caseríos cocaleros*, replete with coca cultivating colonists, bars, discos, brothels, alcohol, weapons, and associated drug use, alcoholism, and prostitution. Both our ethnography and published accounts (Comisión de la Verdad y Reconciliación et al. 2004) revealed an increase in violence after the arrival of coca. In 2003 and 2004, in the Abujao, Callería, and Utiquinía watersheds alone, informants told of coca farmers killing four coca buyers (*traqueteros*), two miners, and a Piassaba palm (*Aphandra natalia*) frond harvester while three traffickers died fighting amongst themselves.

Coca boomtowns and the transformation of livelihoods have been documented elsewhere in Peru (Rojas 2002) and Colombia (Muse 2005; González Posso 2000), although the transformation described here may be particularly acute due to the extremely isolated nature of these borderlands. Indigenous communities in particular struggle to control their land from well funded and well armed coca farmers, especially given the lack of investment in their territory and support by governmental and non governmental organizations in their borderland communities. Indigenous communities in the Ucayali study site have been offered both bribes and death threats to plant coca and clear airstrips. Some communities even tell of occupation by Colombians or Shining Path drug traffickers in the 1980s. While some indigenous people profited from coca related opportunities during this period, others drove off outsiders by forming aggressive defense committees. Our analysis of 676 eradicated coca fields near the indigenous dominated and locally renowned coca region of Lago Inés found 92% to be outside of indigenous lands with the other 8% predating the titling of the indigenous territory in question or located in remote areas closer to mestizo towns than indigenous villages. The continued resistance of indigenous people to coca cultivation and production is of critical importance to biocultural diversity due to the expanse of biodiverse lands inhabited by a wide range of indigenous groups and the documented dangers for indigenous cultures embracing the coca economy (Gonzalez Posso 2000).

Our fieldwork found the coca economy also brought opportunity to the borderlands as laborers could also earn a high daily wage working in the coca fields and access and afford better food, clothes, and medicine. The quality and quantity of river transportation also increased dramatically and the formerly isolated residents could now send their children to the new schools created to educate the children of the coca farmers.

However, the influx of coca dollars also caused inflation in these weak backwater economies and may have undermined local livelihoods formerly rooted in cooperative agricultural activity. Instead, former subsistence farmers turned to coca, a rational decision given how much a coca farmer can earn from the coca leaf produced by 1 hectare of land. Although we cannot reliably estimate coca leaf production in the study site directly, we can extrapolate production using published United Nations data from coca cultivation elsewhere on the Ucayali. According to the UNODC, one hectare could conservatively produce approximately 860 kg of sun dried coca leaf at an average farm gate price of 2.8 US $ per kg in 2004 (UNODC 2005b) or 2,350 US $[6] without the farmer even having to leave his farm. While conservative, this estimate dwarfs the income potential of alternative crops farmed close to the regional market city of Pucallpa (Table 2) even as the U.S. $ 2,350 per hectare accounts for as little as 2% of the U.S. street value for the same amount of leaf in cocaine form.[7]

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[6] While this estimate is extremely conservative it also does not incorporate production costs associated with weeding or harvesting at approximately 2.1 $ US a day during those work periods. This daily wage also usually includes breakfast and lunch for the laborer.

[7] Estimating the total worth of the coca production eradicated in the fields provides a window to the regional importance of coca cultivation to these borderlands. Since the coca plant does not reach full maturity until 18 months (Morales 1994), we estimate borderland production using only those fields of at least 2 years in 2004, or 3,183 hectares according to Table 1. To be conservative we deduct from this total the un-weeded coca fields eradicated in both 2003 and 2004 (1,660 hectares according to Table 1) to arrive at a total of 1,523 coca hectares with plants over 2 years old that are weeded or semi-weeded. Using the conservative UNODC estimate, 2004 annual production of sun dried coca leaf would be approximately

Table 2. Earnings generated by some of the most common crops in areas near Pucallpa.

While these conservative estimates underscore the economic importance of regional coca cultivation and the potential local impacts in terms of inflation and dollarization, the reality is these fields were eradicated in 2003 and 2004. Therefore, the regional coca boom must also be analyzed in terms of the subsequent bust. Table 3 shows the population for the middle and upper Callería River, one of our four Ucayali river watersheds, where the inhabitants resided almost exclusively in *caseríos cocaleros*, in 1999 and in 2004. Over this five year period population declined over 67%. However, data from a 2004 census by the local health official state the numbers to be even lower, at 416 people, an 81% decline from 1999. This demographic change transformed the *caseríos cocaleros* into ghost towns, *pueblos fantásmas*, with abandoned houses, under attended schools, and the remaining residents contemplating moving on, pursuing alternative livelihoods, or in some cases gambling on discontinued eradication and replanting their coca. Eradication disturbed both the professional coca farmers and the original residents of these *pueblos fantásmas* who now must re-adapt to life without coca.

Table 3. Population change after repeated eradication for the 13 coca farming towns on the Callería River.

Life without coca equated to a depressed economy, a reduction of transportation options, the flight of many of the schoolteachers, and a return to a largely subsistence livelihood. While CORAH believed they could win over the population and improve their image through donations and agriculture support to the communities (Ministerio de Interior 2003b), our own fieldwork and local media coverage (Staff 2004a) revealed a great deal of dislike for the institution. For example, one Callería community received a community rice peeler and seeds from CORAH to promote rice production as an alternative income earning activity to coca, however the majority of the community households showed little interest in farming rice. Key informants also noted the inability of the coca farmers elsewhere to successfully incorporate CORAH donations and extension into their livelihoods. Many of the remaining Callería residents hoped to continue farming coca, desiring to work with the Peruvian National Coca Enterprise,

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1,309,780 kg for these fields with an estimated worth of 3,667,384 US $ at the 2004 farm gate average price. However, this is just a fraction of the potential profits the *narcotraficantes* realize from these fields in coca paste or cocaine. Since UNODC data on the cocaine/leaf ratios is derived from oven dried rather than sun dried leaf estimates we must reduce the 1,309,780 kg of sun dried leaf by 70% to 916,846 kg of annual oven dried leaf. According to the UNODC, one kilogram of cocaine can be processed from 375 kg of oven dried leaf (United Nations Office on Drugs and Crime (UNODC) 2005c) allowing us to grossly estimate 2,445 kg of potential annual cocaine production from these borderland watersheds. This amount of cocaine would be worth approximately 53,988,045 $ US in the United States and 111,809,850 $ US in Europe at wholesale prices (United Nations Office on Drugs and Crime (UNODC) 2005e). Wholesale prices are of course just a fraction of the estimated street prices: 188,265,000 $ US in the United States and 215,160,000 $ US in Europe (United Nations Office on Drugs and Crime (UNODC) 2005e). Thus, although the coca leaf significantly improves the local farmer incomes, their potential earnings are less than 2% of the street value of the coca leaf product, cocaine.

ENACO,[8] to legally sell coca rather than switch to alternative crops. Others will likely move to either established or new coca cultivation centers to maintain a familiar lifestyle. The professional coca traffickers, however, may be moving into the more remote protected areas to continue their work, despite CORAH's mandate of protecting natural areas from coca activities.

Protected Areas

Migratory coca farmers target protected areas due to availability of arable land, low population levels, lack of state presence, and their often remote location. The subsequent trend of cultivation and trafficking in parks threatens the national parks in Peru even as expansion continues within the boundaries of parks in Colombia and Bolivia (UNDOC 2005a; 2005b). Our 2004 GIS analysis of the overlap of coca cultivation and Peru's National System of Natural Protected Areas (SINANPE) revealed cultivation to be immediately adjacent if not within the limits of the Peruvian national parks of Tingo María, Cordillera Azul, Bahuaja-Sonene, Alto Purús as well as Bolivia's Madidi National Park.

In April of 2006, the Peruvian government created the Sierra del Divisor Reserved Zone[9] to protect the biologically diverse region along the Brazilian border. The Zone includes the Isconahua Territorial Reserve for uncontacted people and is crossed by numerous drug trafficking trails leading from the aforementioned coca fields across the Sierra del Divisor mountain range and into Brazil (Figure 3). Table 4 reveals extensive coca eradication within the Zona Reservada along the Callería River with 422 fields eradicated in 2003 and 91 in 2004. Over 56% of the 2004 fields eradicated had been replanted in fields eradicated in 2003. Without alternative products or opportunities, coca will likely return rapidly to this biologically critical area and foreshadow future conflicts between coca and conservation.

Figure 3. Coca trafficking routes in Ucayali and Purús Sites. Arrows indicate the location of transboundary trafficking routes comprised of river connections and/or trail networks.

Table 4. Callería coca fields within the Sierra del Divisor Reserved Zone eradicated in 2003 and 2004.

Eradication efforts in the Ucayali study site may have caused coca farmers to move further into isolated and poorly protected conservation units like Brazil's Serra do Divisor National Park, as well into more remote areas in Peru like the Alto Purús National Park. Interestingly, the coca business also pulls from across the border: Brazilians living just south of the Serra do Divisor Park now work as coca processors in Peru (Maia 2005). While the Purús River has not yet experienced the in-migration of

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[8] ENACO or the Empresa Nacional de la Coca S.A. was created in 1949 and is a state company authorized to commercialize coca leaf and its derivatives. www.enaco.com.pe

[9] The reserved zone designation is a transitional category that could become a national park, communal reserve, or another definitive conservation category depending on the conservation threats and opportunities of various human and non-human stakeholders.

*cocaleros*, it has been used as a transport route for traffickers moving coca paste to Brazil (Figure 3). Extremely remote and difficult to access, the upper stretches of the river inside the Alto Purús Park National Park still lack effective monitoring for illegal activities such as mahogany extraction (Fagan 2005). Rough roads have been cleared to the border, logging camps established, and tractors used to haul logs from the Purús watershed to the Ucayali. Loggers initially built camps to explore for and extract high value timber, but some camps are now centers for the cultivation and processing of coca. Figure four shows the two year evolution of one camp from a clearing to a functional camp with semi-permanent structures and large plastic canisters associated with coca processing. These remote camps offer clandestine cultivation and processing, in addition to access to the Purús River and Brazil.

Figure 4. A logging and coca camp on the border of the Alto Purús National Park. The camp evolved from a clearing in 2004 (above) to a large camp in 2006 (below). The red square indicates the approximate area covered in the 2006 photograph.

The processed coca paste is carried from the camps into the Park via ancestral migratory trails (*varaderos*), still used by indigenous people living in both watersheds, to small tributaries of the Purús. Traveling at night, traffickers float downstream on homemade balsa wood rafts into Brazil.

<u>The Coca Caoba connection</u>

The relationship between mahogany (*Swietenia macrophylla*) (locally known as *caoba*) loggers and coca farmers may revolve around the trafficking and laundering of coca paste. Loggers possess the means of transport (barges etc.), geographic knowledge, and commercial and personal contacts that facilitate movement of goods in remote areas[10] (Araujo 2001). Araujo (2001) found logging bosses (*patrones*) invested in a transboundary cocaine trade in the Juruá valley in Acre, Brazil while just across the border in Peru, a Peruvian logging outfit controls the Peruvian portion of the valley through their 140 km illegal road stretching from the Ucayali River to Brazil in order to extract high grade hardwoods. However, this road could serve equally well to move coca derivatives to the Brazilian border, especially since, as an unsanctioned road, the road is not monitored by Peruvian authorities. An informant working on the Peru side of the valley reports that at least one of the logging companies on the Juruá (known as the Yurua in Peru) is also directly involved in coca trafficking. And members of the "mahogany mafia" in Puerto Esperanza coordinate the transport of coca paste on the Purús.

<u>Coca and the "Uncontacted"</u>

[10] The Amazon is not the only remote Latin American frontier to have demonstrated linkages between loggers and the drug trade. An example that also includes indigenous people is Shoumatoff's (1997) description of the nexus of logging, poppy, and marijuana cultivation and the Tarahumara in the Sierra Madre Occidental of Mexico.

It is difficult to estimate the impact of coca cultivation and trafficking on the uncontacted indigenous groups that live in the study sites, as coca workers would risk self-incrimination by reporting conflicts. We do know, however, that cultivation and trafficking occurs within the uncontacteds' homelands on the Purús (Figures 3, 4 and 5). While anthropologists have argued that members of the Isconahua tribe near the Ucayali study area were able to avoid the trafficking trails crisscrossing their homelands (Arbaíza Guzmán et al. 1995), our fieldwork found the amount of coca and logging trails too numerous to not have an impact on Isconahua annual migration patterns, hunting, and extractivism (Figure 3). On the Purús River, the number of conflicts between uncontacted tribes and both coca workers and loggers has increased in recent years resulting in deaths on both sides (Fagan and Shoobridge 2005). Whereas in the past the uncontacteds in the Purús would run from potential conflicts, local people believe the tribes have become more aggressive due to the exponential increase of logging activity in the Alto Purús National Park and adjacent lands. Forced to share their shrinking homelands with loggers, coca traffickers, as well as the other tribes, it is possible that the uncontacted people have decided to defend what remains of their territory. In 2002, on the upper Purús River two coca traffickers were killed by uncontacteds, presumably members of the Mashco-Piro tribe. According to local police, one of the smugglers was from Colombia the other from Sepahua. And in 2006, a smuggler was shot with an arrow on the upper Purús and received medical treatment downstream in Puerto Esperanza. Unfortunately, we have no way of knowing how many uncontacteds are killed in these conflicts. If we assume the results are similar to several documented conflicts between loggers and uncontacteds on the Purús, we can surmise more uncontacteds are killed than traffickers, as their bows and arrows are no match for the traffickers' modern weapons.

Figure 5. In October of 2004 an uncontacted indigenous group constructed this temporary shelter inside the Alto Purús National Park only 15 kilometers from the coca and logging camp shown in Figure 4.

### *Environmental Impacts*

The environmental impacts of coca cultivation remain uncertain in part due to the paucity of field research and data on the subject (Young 2004a; Young 1996). There is no question the initial establishment of coca cultivation has a severe negative impact on the old growth forests of the borderlands. However, once the initial forest is cleared further deforestation impacts are mitigated by the long growing cycle (20 years) of the perennial plant and the spatial clustering of coca fields. These attributes may make the deforestation impacts of a fixed number of *cocaleros* less than that of the colonists practicing legal agriculture (Salm and Liberman 1997). In addition, other agricultural options would require more land to make production commercially viable and would require more fertile soils than the hardy coca bush (Henkel 1995).

The clustering of coca fields seen in Figure 6[11] is not unusual in the Ucayali region and demonstrates the relative low level of deforestation impact in situ. These coca field clusters often surround the *caserío* centers and their individual fields are usually

[11] While Figure 6 shows data from an existing community, we use a pseudonym for this community in the figure given the sensitivity of the subject.

either adjacent to the next coca field or separated by another crop field or a band of secondary or primary forest. While both the intervening and surrounding forest likely lose species diversity due to edge and fragmentation effects, in addition to negative effects related to the extraction of timber, game and non-timber forest products (Laurance et al. 2002; Cochrane and Laurance 2002; Nepstad et al. 1999; Peres 2001), the biodiversity impact of coca cultivation may be minimized due to this clustered and localized spatial pattern.

Figure 6. Coca cultivation causes deforestation and forest fragmentation but the clustering of coca fields and the repeated replanting of the same fields lessen the negative environmental impacts.

While coca fields tend to multiply when prices rise, the limited supply of labor and clandestine nature of cultivation in the borderlands limit expansion. Even when fields are eradicated, some coca farmers continue planting as evidenced by 12% of the Ucayali fields eradicated in 2004 being newly planted within fields eradicated in 2003. However, those farmers relocating after eradication may pose the greatest threat to biocultural diversity as they establish the coca cycle in an even more isolated region. Current borderland *cocaleros* arrived in this remote region after eradication efforts forced them out of the Andean foothills in the mid-1980s (Bedoya and Klein 1996). Further eradication may just continue the cycle of relocation to even more remote and bioculturally diverse areas. Although we focus on the negative environmental impacts of relocation following eradication, other studies in Bolivia also found deforestation rates to increase following eradication (Bradley and Millington 2008; Henkel 1995) in addition to the means of eradication increasing deforestation (Messina 2004).

While manual eradication, not aerial spraying, is the primary eradication method used in Peru, coca related chemical inputs do exist in the study area. Given fieldwork did not record the use of herbicides or pesticides for borderland coca cultivation, and coca farmers in the nearby and more established cultivation region of Aguaytia do not use chemicals, it seems likely they are not present in the study site (UNODC 2005b). However, chemicals do enter the air, soil, and water system through the processing of coca on farm sites. While not every farmer processes coca leaf into coca paste, borderland coca is often processed *in situ* due to the proximity of the immediate destination: Brazil. Informants in both study sites report seeing *cocaleros* arriving with plastic drums full of acids, solvents, and neutralizers for coca processing and in the Purús then moving downstream with drums full of coca paste.

CORAH destroyed 21 processing pits in eight locations across all four Ucayali watershed sites in 2003 and 2004. Processors fill the holes with coca leaves before soaking and trampling them and their residues in a series of treatments using sodium carbonate, sulphuric acid, solvents (e.g. kerosene), and neutralizers (e.g. lime) (Morales 1994; Young 1996). If all of the coca leaf produced in the four Ucayali watersheds, an estimated 1,310,000 kg of sun dried leaf based on the coca fields eradicated, were processed, the result would be roughly 11,400 kilograms of coca paste[12]. But this amount

[12] The amount of chemical inputs per kilo of coca paste is impressive: roughly 1 kilo of sodium carbonate, 5 kilos of sulphuric acid, 7 gallons of kerosene, 8 kilos of lime, and 115 kg of coca leaves (Morales 1994). At 640 $ US per kg this 11,400 kilograms of paste would be equal to 7,296,000 $ US.

of coca paste could require as much as 11,400 kg of sodium carbonate, 57,000 kg of sulphuric acid, 80,000 gallons of kerosene, and 91,000 kg of lime. All of these chemicals then find their way into the environment through the processing pits.

Researchers in the Bolivian Chaparé have argued that the immediate environmental impact of these processing chemicals could be less than anticipated as the existence of holding ponds, the concentration of pollution at the processing site, the scattered distribution of these sites across the landscape, and the diluting effect of high levels of rainfall restricted biodiversity loss to soil microorganisms in the immediate vicinity of processing sites (Henkel 1995; Southwest Research Associates cited in Henkel 1995).[13] All of these characteristics also hold true for the borderland region; however, the long term effects of the chemicals on biological populations following chemical filtration into the groundwater and fluvial system are unknown. Kerosene is recognized to severely affect flora, fauna, and particularly plankton, in addition to reducing oxygen level in water while sodium carbonate and sulfuric acid are toxic substances (Dourojeanni 1989). Given the presence of these processing chemicals, the clustering of coca fields near waterways threatens the highly biodiverse floodplain forests essential to aquatic life (Goulding et al. 1996; Smith 1999). Further study is sorely needed as chemical residue threatens not only plant and animal biodiversity but also human populations, both rural and urban (e.g. Pucallpa and Iquitos), downstream of coca processing sites. Long term effects could follow the transboundary hydrological system as far as Brazil and beyond.

An additional pollution issue concerns human bodies as drug traffickers often employ local people, including children, to trample the leaves in the processing pits. The acidic solution can burn the feet of the laborers (Rojas 2002) and irritates the throat and eyes (Staff 2004b): to our knowledge a thorough study of the side effects of processing remains to be done.

## Conclusion

This analysis of the impacts of coca cultivation on the biocultural diversity of the Peruvian Amazon provides new data and insight into a topic poorly explored by geographers despite its real and potential influence on the landscapes and peoples of the Andes and the Amazon and the coca trade in general (Allen 2005; Young 2004b). Our first conclusion is to declare coca cultivation to be present in the Amazon borderland study region despite the lack of documentation (Plowman 1981; Plowman 1984; UNODC 2005b). Figure 2 is the first detailed map of coca cultivation in the central borderlands of Peru. Secondly, we find borderland coca cultivation to be distinct from cultivation documented elsewhere in Peru, relying on rivers rather than roads and lowlands rather than hillside agriculture (Young 2004a). Third, we argue borderland coca cultivation to be part of migratory cycle of eradication, relocation, boom, eradication, and relocation ignited by CORAH's coca elimination efforts in the Andean foothills. Dislocated Andean coca farmers transform borderland hamlets into coca boom towns, a process with important social and environmental impacts, before eradication pushes these *cocaleros* and their converts on to new fields leaving ghost towns in their wake. We hope additional research will further explore the coca eradication-migration cycle. Finally, we

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[13] The elusiveness of the Southwest Research Associates publication underscores the challenges and politics of coca research (Schmidt 1996; Henkel personal communication 2005).

argue current eradication efforts in the Ucayali study site encourages coca farmers to relocate to even more remote, and poorly protected, borderland landscapes like Brazil's Serra do Divisor National Park and Peru's Alto Purús National Park. The trend of increased coca coverage in protected areas deserves further inquiry. This pressure on critical ecosystems and conservation units creates a contradiction between CORAH's first goal, to control the reduction of illegal coca cultivation, and their third goal of supporting policies oriented towards the protection of natural areas.

The redirection of CORAH eradication funds to the conservation of borderland protected areas may prove a more cost effective means of combating the establishment of coca cultivation than eradication after establishment. However, these funds should first be invested in accessing local knowledge to improve our understanding of the human-environment dynamics of the borderlands, including coca cultivation, and trafficking. Top down projects seeking to provide alternatives to coca cultivation without appropriate borderland field data and analysis will not succeed in these poorly understood and complex boundary regions. Cabieses (2004) criticized similar initiatives in the coca growing regions of the Andean foothills, "A serious flaw in alternative development projects has been their tendency to consider the high jungle as an empty space where a social fabric barely exists…" This flaw is currently being replicated in the borderlands where the migratory cycle of eradication, relocation, boom, and bust has social and environmental impacts outside the core cultivating towns. Further research is needed to improve our preliminary research on the complex relationship between this cycle, associated trafficking, and the neighboring peoples (mestizo, indigenous, and indigenous uncontacted) and landscapes of the bioculturally diverse Amazon borderlands.

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**Coca and Conservation: Cultivation, Eradication, and Trafficking in the Amazon Borderlands**

Figures 1-6

Figure 1: The central borderlands of Peru and the Ucayali and Purús study sites

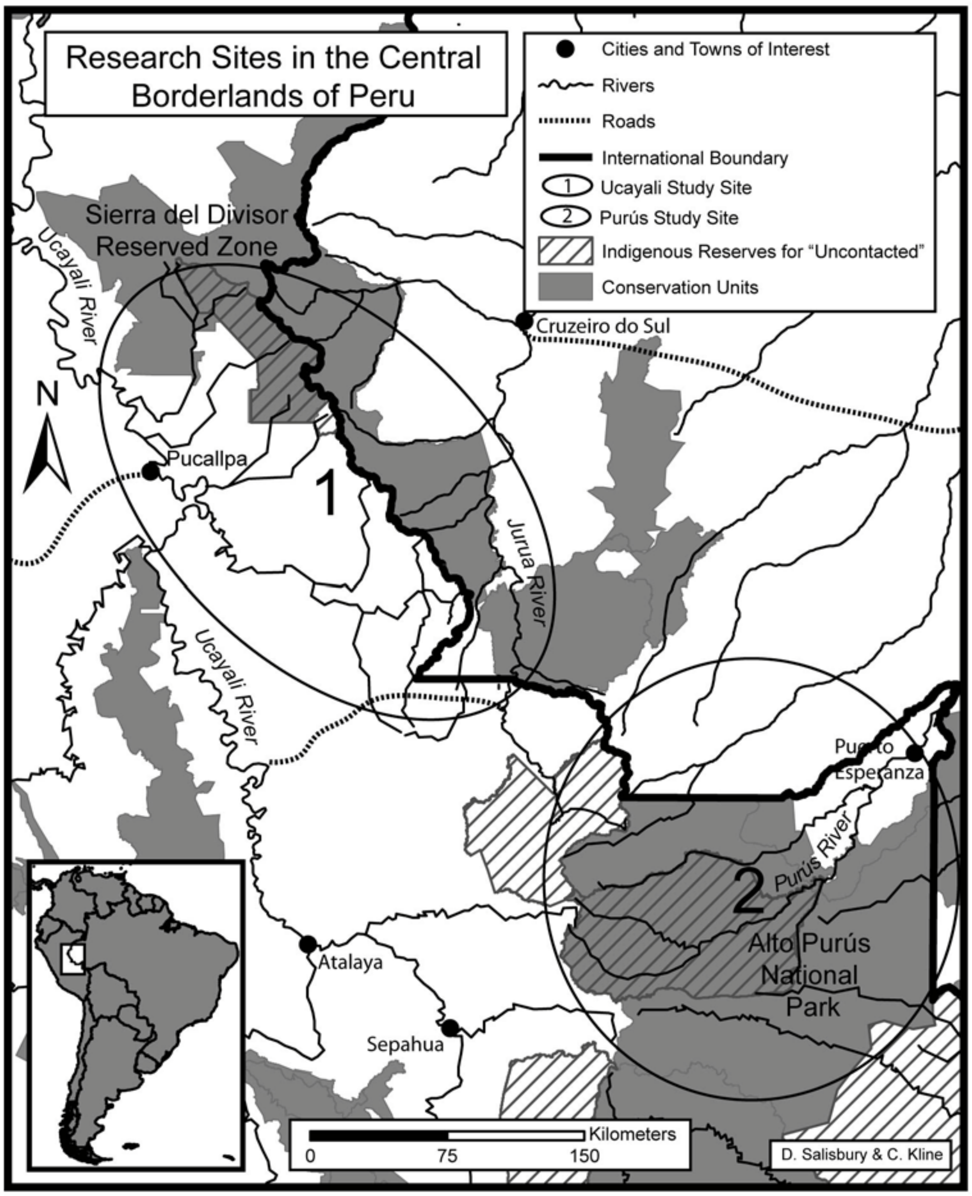


Figure 2: Eradicated coca fields in the Ucayali site.

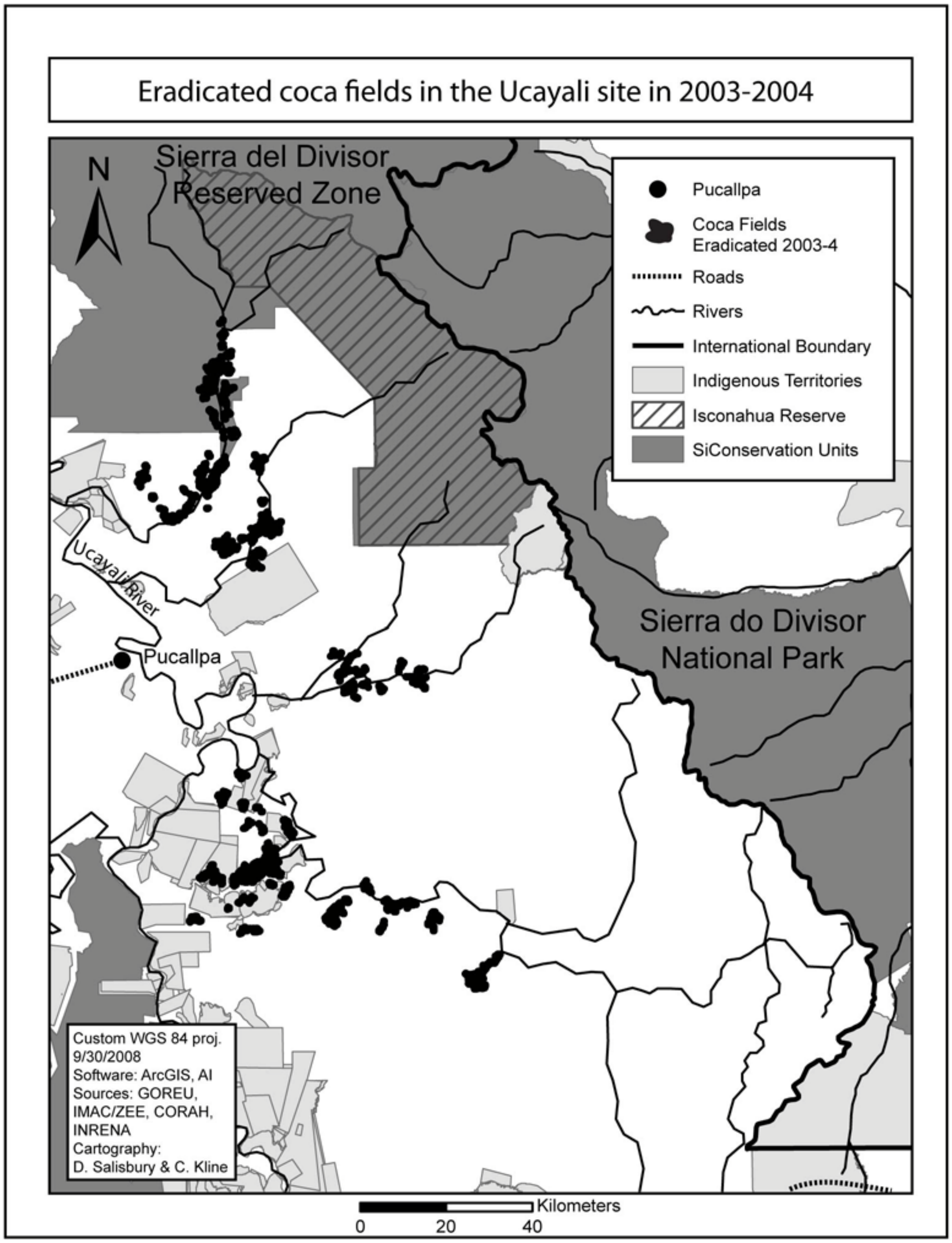


Figure 3. Coca trafficking routes in Ucayali and Purús Sites. Arrows indicate the location of transboundary trafficking routes comprised of river connections or trail networks.

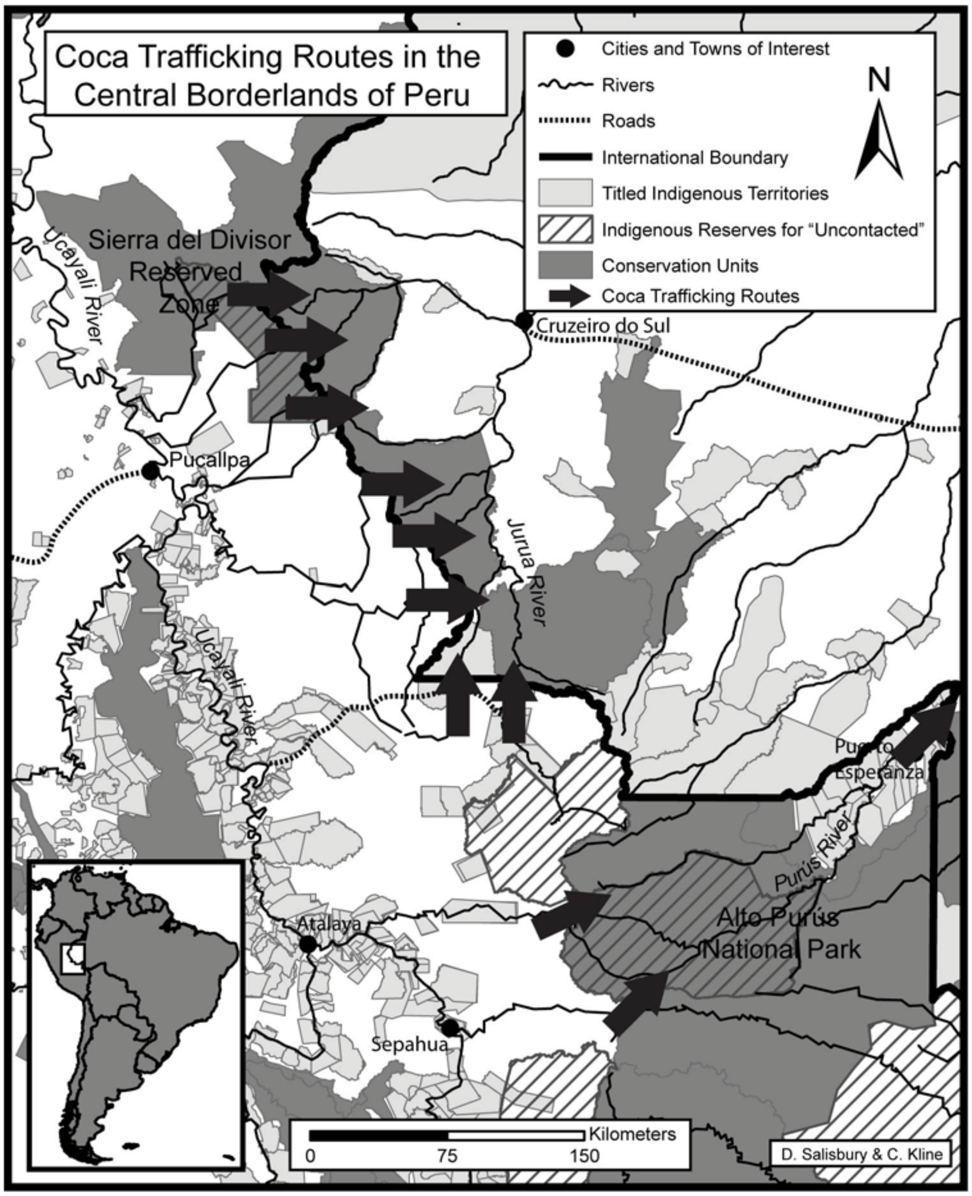
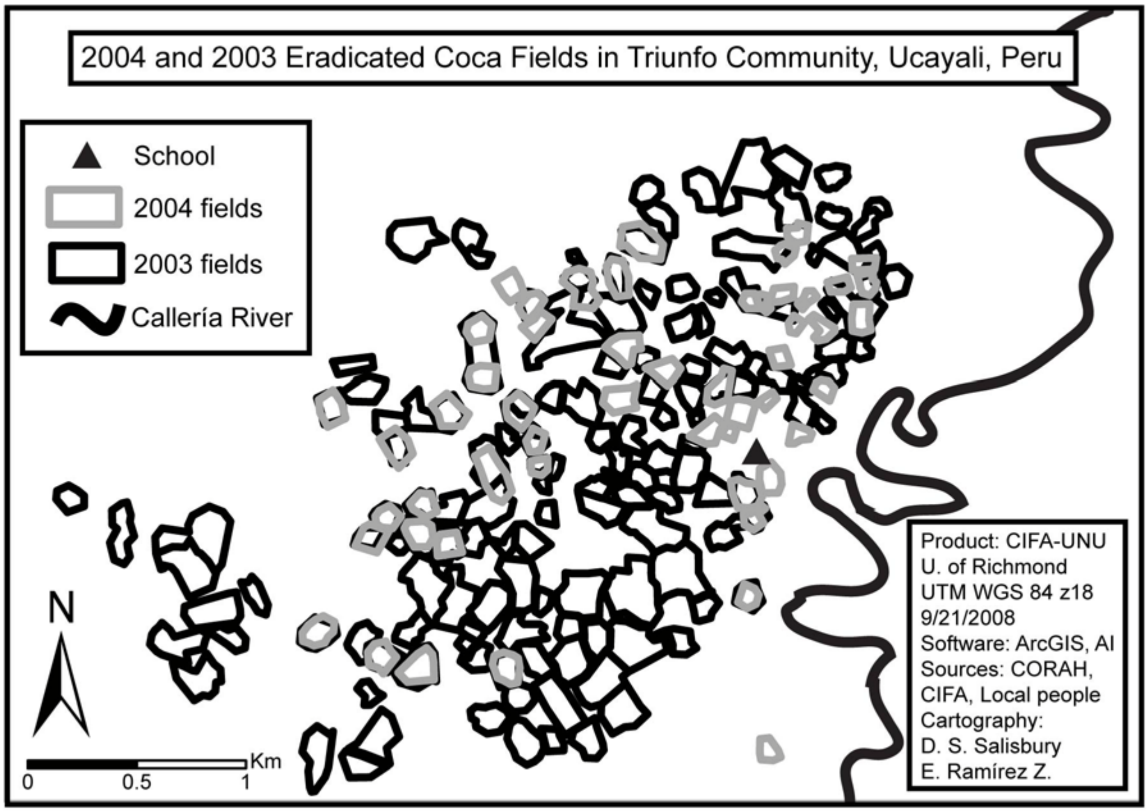


Figure 4. A logging and coca camp on the border of the Alto Purús National Park. The camp evolved from a clearing in 2004 (above) to a large camp in 2006 (below). The red square indicates the approximate area covered in the 2006 photograph.

Figure 5. These temporary shelters for the “uncontacted” Indians were found inside the Alto Purús National Park, 15 kilometers from the coca and logging camp shown in Figure 4.

Figure 6.  Coca cultivation causes deforestation and forest fragmentation but the clustering of coca fields and the repeated replanting of the same fields may reduce the negative environmental impacts.



**Coca and Conservation: Cultivation, Eradication, and Trafficking in the Amazon Borderlands**

Tables 1-4

Table 1. Number, size, and age of coca eradicated in 2003 and 2004 within the four watershed study site on the Ucayali.

| **Year** | **2003** | **2004** |
|---|---|---|
| Total Fields | 1,674 | 1,241 |
| Total Has | 2,227 | 2,020 |
| Avg. Has per Field | 1.45 ± 0.95 | 1.63 ± 0.87 |
| Avg. Age of coca crop in fields | 8.79 ± 5.64 | 8.66 ± 5.67 |
| # of fields wth coca >= 1 yr | 1,511 | 972 |
| # of hectares with coca >= 1 yr | 2,182 | 1,669 |
| # of fields wth coca >= 2 yr | 1,443 | 939 |
| # of hectares with coca >= 2 yr | 2,095 | 1,631 |
| % of fields with coca >= 15 yrs | 23% | 22% |

Data: CORAH

Table 2. Earnings generated by some of the most common crops in areas near Pucallpa.

| **Product** | **Scientific Name, Variety** | **Area** | **Production Costs * ($ **) (a)** | **Annual Production (Kg) (b)** | **2004 Price per Kg ($ **) (c)** | **Income ($ **) (d) = b x c** | **Earnings ($ **) d - a** |
|---|---|---|---|---|---|---|---|
| Corn | *Zea mays* var. *Marginal 28 Tropical* | 1 ha | 560 | 4,000 | .15 | 600 | 40 |
| Rice | *Oryza sativa* var *Maravilla* | 1 ha | 480 | 4,000 | .15 | 600 | 120 |
| Beans | *Vigna sinensis* var. *Caupí regional* | 1 ha | 290 | 1,200 | .36 | 430 | 140 |
| Peanuts | *Arachis hypogea* var. *Rojo Masisea* | 1 ha | 520 | 1,500 | .61 | 910 | 390 |

Data: J. W. Vela and N. Ramírez, Centro de Investigación de Fronteras Amazónicas, Universidad Nacional de Ucayali

*Production costs include soil preparation, seeds, equipment (e.g. bags for packing), labor for planting, weeding, harvesting, and post harvest processing. Costs do not include risks associated with pests, disease, flooding, or drought. Transportation costs vary widely and thus are also omitted.

** Price in US$ calculated using 2004 November exchange rate of 3.3 Peruvian soles to the U.S. dollar.

Table 3. Population change after repeated eradication in the 13 coca farming towns on the Callería River.

| Year | 1999 | 2004 | 2004* |
|---|---|---|---|
| Population | 2,228 | 773 | 416 |

Sources: Center of Epidemiology, Ucayali, Peru
*Key Informant: The health official for all 13 towns took a 2004 census.

Table 4. Callería coca fields within the Sierra del Divisor Reserved Zone eradicated in 2003 and 2004.

| Year | 2003 | 2004 |
|---|---|---|
| Total Fields | 422 | 91 |
| Total Has | 672 | 105 |
| Avg. Has per Field | 1.59 ± 1.02 | 1.16 ± 0.56 |
| Avg. Age of coca crop in fields | 8.26 ± 5.99 | 2.7 ± 5.15 |
| # of fields with coca <= 1 yr | 80 | 71 |
| # of fields replanted | No Data | 51 |
| # of fields with coca >= 10 yrs | 204 | 14 |

Data: CORAH