Stopping the Tide:

A Strategy for Maintaining Forest Connectivity within the Mesoamerican Biological Corridor

Prepared for the Wildlife Conservation Society

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List of Acronyms

Acronym	Name Spanish/English
BAKINASTA	Butuka Awayala MayaraIwi Idianka Asla Takanka (Organización de los Indigenas de Patuca Medio/Middle Patuca Indigenous Organization)
FINZMOS	Federacion de Indigenas Nativos de la Zona Moccoron-Segovia/ Indigenous Federation of the Moccoron-Segovia Zone
FITH	Federación Indígena Tawahka de Honduras/Indigenous Federation of the Tawahka of Honduras
GTI	Gobierno Territorial de Région Especial de Alto Wanki y Bocay/Territorial Government of the Special Region of Alto Wanki and Bocay
GoH	Government of Honduras
GoN	Government of Nicaragua
ICF	Instituto Nacional de Conservación y Desarrollo Forestal/ National Institute of Conservation and Forest Development
INCEBIO	Fundación de Ciencias para el Estudio y la Investigacion de la Biodiversidad/ Scientific Foundation for the Study of Biodiversity
KST	Kipla Sait Tasbaika
LLTK	Li Lamni Tasbaika Kum
MARENA	Ministerio del Ambiente y Los Recursos Naturales/ Ministry of the Environment and Natural Resources
MASTA	Moskitia Asla Takanka – Unidad de la Moskitia/Miskitu Indigenous Federation of the Mosquitia
MITK	Miskitu Indian Tasbaika Kum
MSA	Mayangna Sauni As
MSB	Mayangna Sauni Bu
MSBas	Mayangna Sauni Bas (Sikilta)
RAAN	Region Autonoma del Atlantico Norte/North Atlantic Autonomous Region
SERNA	Secretaría de Recursos Naturales y Ambiente/ Secretariat of Natural Resources and Environment

WCS	Wildlife Conservation Society

Executive Summary

The Mosquitia forest corridor between the Rio Platano and Bosawás Biosphere Reserves in Honduras and Nicaragua is a dynamic region with a patchwork of diverse historical, ethnic, legal, and social issues that affect the connectivity of the corridor. Connectivity loss caused by ongoing deforestation within the corridor will have negative and irreversible impacts on the persistence of key and endangered species which require large areas of forest cover, such as the jaguar, and threatens the livelihoods of indigenous groups whose territories are within the Mosquitia. Effective and equitable strategies to maintain adequate forest cover for wildlife connectivity are urgently needed.

The aim of this white paper is to identify the current state of deforestation within the forest corridor, as well as practical tools and opportunities for the Wildlife Conservation Society (WCS) to mitigate deforestation and maintain forest connectivity within a near-term timeframe. The success of the conservation recommendations given here should be evaluated through 1) forest cover loss and its decline over time 2) reduction in the movement of non-indigenous settlers into the region 3) reforestation of hardwood forest in deforested areas through forest restoration and 4) the observation of important indicator species of conservation importance, such as the white-lipped peccary and the jaguar, to the region.

Conclusions
1. This analysis identified four "pinch points" in Honduras and Nicaragua where conservation efforts should be concentrated. These represent the areas with the most potential for maintaining forest connectivity in the Mosquitia forest corridor.
2. Honduras and Nicaragua have legal regimes governing property rights that are ill-defined, conflicting, and thus far, inadequate for protecting communal properties held by the corridor's groups.
3. The major causes of deforestation in the Mosquitia forest corridor are the settlement and occupation of land by mestizo cattle-ranchers, illegal timber harvesting, poor land-use practices, and weak institutional presence and enforcement of legal norms.
Recommendations
1. This analysis identifies lines of action through which the WCS can make a positive impact on forest conservation. They include: 1) capacity building, 2) promoting livelihoods that depend on an intact forest, 3) encouraging the enforcement of existing laws and regulations, and 4) legal assistance.
2. Recommended actions in capacity building include: a) further assessments on the state of deforestation in collaboration with local residents, b) SMART training, c) development of workshops to assist community members in presenting relevant complaints, d) development of workshops to assist communities in obtaining funding for conservation initiatives, and e) partnerships with international companies.
3. Recommended actions in promoting livelihoods that depend on an intact forest include: a) promotion of cacao farming through connecting with chocolate manufacturers, b) timber certification, c) cacao certification, and d) development of research stations.
4. Recommended actions in enforcement include: a) advancing proceedings to remove and re-settle illegal settlers within indigenous territories, b) providing low-cost technologies to record and monitor land sales and community disputes, c) bringing together state government officials, national park and reserve officials, and local community leaders to develop an action plan, and d) conservation easements or the establishment of community conservation areas within protected areas.

5. Recommended actions in legal assistance include: a) supporting the Miskitu indigenous federation of the Mosquitia (MASTA) in passing the law to remove illegal settlers in indigenous territories, and b) legal assistance to indigenous federations in Honduras in obtaining land rights and secure tenure in the corridor.

PART I: Introduction to Study Landscape

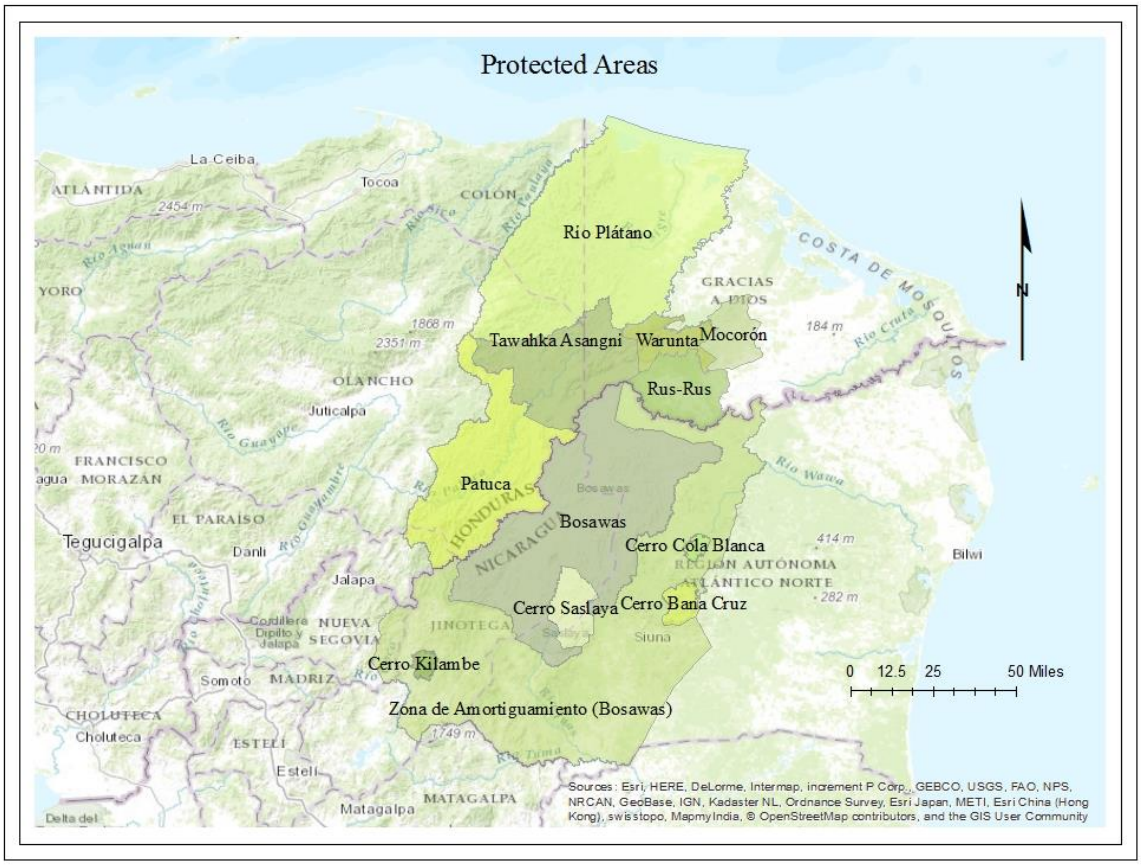


Figure 1: Study Landscape

Introduction

The second largest area of contiguous moist tropical forest in Central America stretches from eastern Honduras to northeastern Nicaragua.[1] Known as the Mosquitia forest corridor, this 20,234 km^2 of forest harbors important ecoregions and species of trees, plants, and wildlife and is considered a biological hotspot.[2] Four connected protected areas covering a total area of approximately 2,500 km^2 constitute a transboundary conservation complex within this forest: the

[1] Herlihy 1997, Hayes 2007
[2] Myers, 1990

Bosawas Biosphere Reserve[3] in Nicaragua, and the Patuca National Park[4], Tawahka Asangni Biosphere Reserve[5], and Rio Platano Biosphere Reserve[6] in Honduras. These protected areas are notable for their varied and complex tenure regimes, demographics, and the histories of titled and untitled indigenous territories on which they were established, and which are presently inhabited by both indigenous and non-indigenous (*mestizo* or *ladino*) communities in both countries.

Figure 2: The Rio Coco divides Honduras and Nicaragua

Because of this complexity and despite conservation efforts in these protected areas, deforestation within the core, buffer, and cultural zones has advanced rapidly.[7] In Honduras, deforestation threatens to fragment the contiguous Tawahka and Rio Platano Reserves and Patuca National Park and endangers connectivity with the Bosawas Reserve in Nicaragua.[8] Forest connectivity is critical to ensuring the persistence of important wildlife species for which

[3] 8000 km^2 (Cordon et al. 2008) refers to the Core Zone of Bosawas. The total area of the Bosawas Biosphere Reserve is 20,000 km^2; approximately 8000 km^2 are designated as the interior core or nuclear zone (zona nucleo) and 12,000 km^2 are designated the outer buffer zone (zona amortiguamiento); Unlike other Biosphere Reserves, Bosawas lacks a transition zone commonly found in other biosphere reserves (UNESCO 2015)
[4] 3764.52 km^2 (UNEP and IUCN, 2017)
[5] 2331.42 km^2 (Herlihy, 1991)
[6] Estimates of reserve area range from 8150 km^2 (Mollett 2011) to 8323.55 km^2 (SERNA, 2014)
[7] Collins and Mitchard 2017, Stocks et al. 2007, Sunderlin 1997
[8] Flesher 1999

these protected areas in Nicaragua and Honduras make up a large part of their range.[9] Amongst its other floristic and faunal biodiversity characteristics, this area of the Mosquitia is the second largest jaguar conservation unit in Central America[10] and provides important habitat for the wide-ranging white-lipped peccary.[11] Strategies to prevent forest connectivity loss in the Mosquitia are urgently needed to ensure the continued persistence of this forest and the species that live here.

Figure 3: An ornate hawk eagle and green macaw inside the core zone of the Rio Platano Reserve, near the famous "White City"(photo WCS and Conservation International)

Objectives of the Study

The mission of the Wildlife Conservation Society's Mesoamerica and Western Caribbean program is to protect and conserve wildlife in this region. This white paper aims to support WCS' mission by providing a comprehensive strategy to maintain forest connectivity between Nicaragua and Honduras within the Mosquitia forest corridor. Based on the current state of knowledge and up-to-date information on deforestation in specific management units within the Mosquitia, it identifies critical endangered areas of forest cover to target for conservation efforts to maintain forest connectivity (referenced throughout this study as "pinch points"). Distinguishing between proximate and underlying drivers in these pinch points, this paper sets

[9] Rabinowitz and Zeller 2010, Crooks and Sanjayan 2006
[10] see Sanderson et al. 2002, Zeller 2007
[11] Altrichter et al. 2012

forth a strategy comprised of recommendations that cover actions to be taken at the local, national, binational, and international scale that WCS can use to inform its actions in the region.

The remaining sections of Part I demarcate the study landscape into specific management units within the four protected areas in Nicaragua and Honduras. Part II outlines the methodology used to generate the strategies and recommendations to maintain connectivity. Part III presents the current state of knowledge of these management units from an in-depth literature review, in the process defining the proximate and underlying drivers of deforestation. Part IV identifies the pinch points. Part V concludes by stating the strategy and recommendations resulting from the methodology and analysis.

Demarcating the Management Units

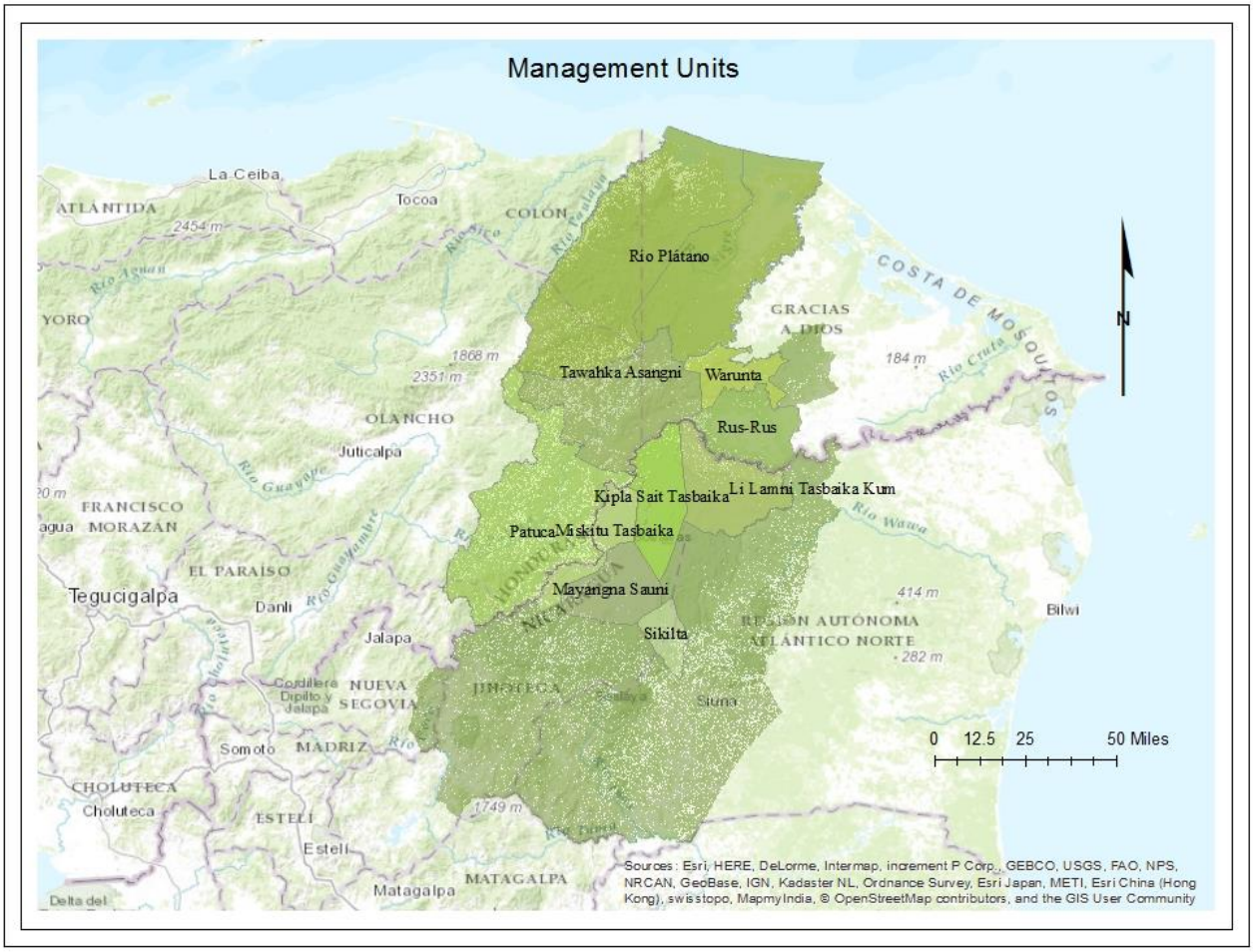


Figure 4: Location of management units within Honduras and Nicaragua

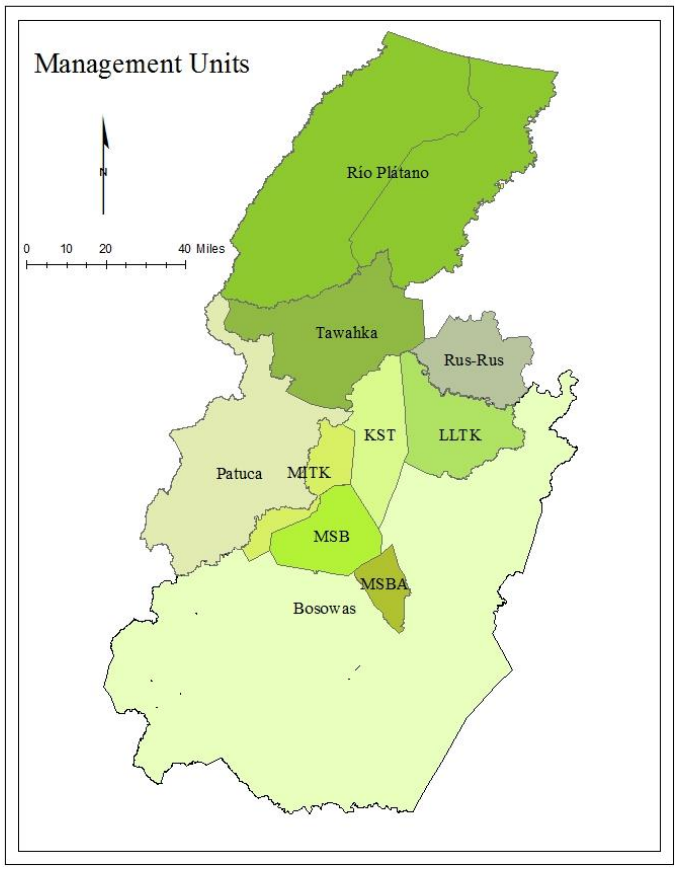


Figure 5: Highlighted management units

The four protected areas that form the basis of this study — the Rio Platano Biosphere Reserve, Tawahkha Asangni Biosphere Reserve, Patuca National Park and Bosawas Biosphere Reserve — are internally divided into a number of smaller territories, and are adjoined by the important surrounding forests in Rus Rus and Mabita in Honduras. These smaller territories differ in demographics and form of governance, and thus are treated separately in this paper as the 'management units' which make up the study landscape (see figure 3). Considering these management units separately allows for a deeper understanding of the social and legal contexts of each unit as a part of a larger landscape towards which to target conservation interventions for connectivity.

Management Units

In Honduras, eight management units have been demarcated: the core, buffer, and cultural zones of the Rio Platano Reserve, as well as Patuca National Park, Tawakha Asangni

Biosphere Reserve, Rus Rus, and Mabita. In Nicaragua, the six indigenous territories within Nicaragua's North Atlantic Autonomous Region (RAAN in Spanish), which all fall within Bosawas, were considered: Kipla Sait Tasbaika (KST), Miskitu Indian Tasbaika Kum (MITK), Mayangna Sauni Bu (MSB), Mayangna Sauni Bas (MSBas), Mayangna Sauni As (MSA), and Li Lamni. An additional management unit outside of Bosawas, Jinotega, was also included.

PART II: Methodology

To create a strategy through which WCS can preserve forest connectivity in the Mosquitia, we used a stepwise approach to review, obtain, and analyze data on current drivers of deforestation in the Nicaraguan and Honduran management units and combined this with a mapping and pinch point analysis of deforestation in the region. From this analysis, we generated a set of recommendations (see Part V).

Step 1: Literature Review

We reviewed relevant literature related to the Mosquitia forest corridor in order to assess the current state of knowledge on forest connectivity loss in this region. We focused on socioeconomic conditions in each management unit, proximate and underlying drivers of deforestation, and the legal context of the management units, as well as the history and challenges of conservation in the Mosquitia forest corridor. Our aim was to better understand the current situation in each management unit, the gaps in available data, and the conservation challenges. We then interviewed several subject matter experts and influential actors in the field to partially mitigate data gaps and confirm our assessment.

Step 2: Defining Forest Connectivity

Species loss is predominantly driven by habitat loss[12]; therefore, conservation must address habitat loss.[13] Large animals, including apex predators like jaguars, typically require large home ranges; loss of habitat then threatens animals that depend on having a large area of connected habitat in order to survive.[14] For wide-ranging endangered species like the jaguar and the white-lipped peccary, deforestation in corridors that connect habitat patches reduces the size of potential home ranges, which threatens population persistence and recovery after disturbance, the exchange of individuals and genes in a population and the occupancy of habitat patches.[15,16] Forest connectivity, in contrast, maintains the linkage of habitats, communities and ecological

[12] Fahrig, 2003
[13] Lindenmayer 2006
[14] Laurence et al 2000
[15] Lamberson et al. 1994
[16] Villard and Taylor 1994

processes[17] and is a critical factor for promoting gene flow, population persistence, and biodiversity.[18] For the purposes of this white paper, we define forest connectivity through 1) the contiguity of areas of high forest cover and 2) as an area of high forest cover suitable for populations of the endangered white-lipped peccary (having a width of at least 10km).

Figure 6: Jaguar, Kipla Sait Tasbaika, la Mosquitia, Nicaragua (Photo: WCS)

Using the White Lipped Peccary as a Proxy for Connectivity

What constitutes suitable connectivity, stand complexity, landscape heterogeneity, and aquatic ecosystem integrity is species-specific and can vary markedly between species; conditions needed by different species should then be provided in at least some parts of a forest landscape.[19] Following Lindenmayer, we focused on the white-lipped peccary as a proxy for forest connectivity under the view that if habitat is suitable for the white-lipped peccary it is

[17] Noss 1991
[18] McRae 2008, Crooks and Sanjayan 2006
[19] Lindenmayer et al. 2006

likely to be suitable for most other species. The white-lipped peccary is an endangered species, and all of the management units here fall within its current range (though not all areas are currently occupied by white-lipped peccary populations). While each herd needs a minimum of 80 km^2 to 100 km^2 of forest, a forest cover width of 10-15 km is likely sufficient to ensure connectivity in this challenging landscape.[20] Thus, we chose a minimum width for habitat corridors of 10km, based on the habitat requirements for the white-lipped peccary.

Figure 7: Herd of White Lipped Peccaries, Saslaya National Park, Nicaragua (Photo: WCS)

[20] Polisar, personal communication

Step 3: Mapping Deforestation

Recent data on area and rates of deforestation in the management units identified in this paper is lacking; sources referenced in the literature review had data up to 2006[21], and a more recent (2013) global analysis of deforestation emphasized the rapid rate of deforestation in Honduras and Nicaragua.[22] To provide a more up-to-date understanding of rates and locations of deforestation in this region, we produced maps illustrating deforestation in the region in 2013 and 2016.

Mapping Deforestation in the Management Units 2013-2016

The most recent estimates of deforestation from Hansen et al. (2013) used the University of Maryland's Global Forest Change data. We supplemented the Hansen dataset with three Landsat images from the winters of 2014, 2015, and 2016 (USGS) to generate more recent estimates of deforestation rates. The images were subset and processed following Hansen et al. (2013)'s methodology and included: a) image resampling, b) raw DN conversion to TOA reflectance, c) cloud screening and quality assessment, and d) image normalization. Further data processing involved both supervised and unsupervised classification using the ENVI software suite and ArcGIS software suite. After classification, the images were aggregated and smoothed.

Step 4: Identifying Pinch Points

To delineate the areas of greatest importance with respect to connectivity of the forest and the preservation of endangered species, we conducted a qualitative analysis of our updated deforestation maps to determine pinch points while incorporating the range estimates and forest cover needs of the white-lipped peccary to approximate minimum pinch point areas. This pinch point analysis identifies regions where the loss of a small area of forest cover would seriously jeopardize the landscape connectivity between management units for the white-lipped peccary as well as other wildlife.[23]

Pinch Point Analysis

To identify and analyze the pinch points, we focused on tile 20N, 90W from the Hansen et al. (2013) dataset in order to observe landscape-level deforestation between the years of 2000-2014 and identify areas where deforestation threatened forest connectivity. Data analysis involved a qualitative assessment of the landscape to identify areas where deforestation threatened to cut off connectivity—the pinch points. We selected areas of ~10 km width that had the lowest rates of deforestation and highest levels of forest cover. An analysis of the most

[21] see Smith 2003, Stocks et al. 2007
[22] Hansen et al., 2013
[23] McRae, 2008

recent (2016) dataset indicates that deforestation has continued at a rapid pace, encroaching on all the identified pinch points.

We then created least-cost path models in the open source software R (v. 3.3.2) in order to test whether these pinch points also served as least-cost path corridors. To define the "cost" of the landscape, we averaged the forest cover in the surrounding 1km of each grid cell, under the assumption that forest animals prefer more highly forested areas and that low forest cover serves as a barrier to movement. We weighted each path by its total length (the distance it covers) in order to obtain more realistic, direct paths likely to be similar to those used by animals migrating in the forest. We then chose a set of starting points in each major protected area (Bosawás, Patuca, Tawakha, Rus-Rus, and Rio Platano). For each pair of starting and ending points, we calculated the least-cost path between them according to our "cost" matrix based on the degree of forest cover weighted by distance.

Step 5: Ground Truthing

Between May 1st and June 5th, 2017, we conducted interviews with relevant stakeholders, government officials, NGOs, and local community members in both Nicaragua and Honduras to present our recommendations, discuss them with local community members, and verify our findings related to the drivers of deforestation in the pinch points obtained through the literature review and pinch point analysis. We visited two of the pinch points (#2 and #4) identified by our pinch point analysis, and performed rapid on-site assessments of land use and threats to forest connectivity loss. We also identified potential local partnerships for conservation efforts, as well as external businesses opportunities that promote conservation in the region.

Field Interviews

Field interviews consisted of unstructured and semi-structured interviews with community members in specific management units within Nicaragua and Honduras, in particular in Bosawás (Nicaragua), Tawakha (Honduras), and Rio Platano (Honduras). The interviews pertained to perceptions of deforestation and drivers of deforestation, attitudes towards conservation, and local people's recommendations for conservation action and strategies. Interviews focused on perceptions and suggestions sensitive to the insecurity faced by those who directly report land clearing and land sales.

Figure 8: Store owner interviewed in Rio Platano Biosphere Reserve

On-Site Assessment

Observations and rapid appraisals of deforestation while in the field provided an on-site assessment of forest cover, deforestation, and drivers of deforestation in the field sites visited and allowed for a partial ground-truthing of the data gathered and pinch points identified remotely. For pinch point #2, we visually documented the Honduran side of the pinch point and identified anthropogenic activities on both sides of the pinch point. For pinch point #4, during travel along most of the length of Wampusirpi to Krausirpi, we identified all human-derived activities on both sides of the river in order to map the prevalence of burning, settlements, and pasture/farming throughout the pinch point. We took waypoints during the trips using a Garmin eTrex 20 hand-held GPS unit.

Part III: Drivers of Deforestation

Deforestation in this case is driven both by direct short-term changes to forests due to human activities, as well as indirect long-term structural events, policies, and activities that lead to increased human presence in the Mosquitia. These short-term proximate drivers include local-scale activities such as clearing land for pasture and subsistence agriculture, small-scale and large-scale cattle ranching, forest fires, and timber harvesting that originate from intended land use and directly impact forest cover.[24]

[24] Geist, 2002

Long-term underlying drivers of deforestation and forest degradation can be grouped into categories of institutional policies, political-economic contexts, and social settings.[25] Underlying driving forces are fundamental political processes, such as drug trafficking and money laundering, rural migration into protected areas, agricultural policies that fail to protect the environment, and weak institutional management of protected areas and land tenure that underpin the proximate causes. The latter operate at the local level or have an indirect impact from the national or global level.[26] They act at multiple scales: international (markets, commodity prices, and trade agreements), national (population growth domestic markets, national policies, governance) and local circumstances (local institutions, subsistence livelihoods and poverty).[27]

While proximate drivers of deforestation are easiest to establish, it is often more difficult to establish clear links between underlying drivers and forest loss.[28] A comprehensive understanding of both proximate drivers and their underlying causes is a fundamental prerequisite for developing effective policy responses.[29]

Deforestation and Protected Areas in the Mosquitia

Honduras and Nicaragua experience the highest rates of deforestation in Central America, and some of the highest rates in the western hemisphere.[30] Between 2000 and 2010, the annual deforestation rate (nationally, not restricted to only protected areas) in Honduras was estimated at 2.1% a year; in Nicaragua, at 2.0% annually[31,32]. Titling and secure tenure in indigenous territories can help slow deforestation rates if part of a larger conservation strategy; in the Nicaraguan management units, titled indigenous territories undergo lower rates of deforestation and loss of forest connectivity than in untitled territories within Bosawás like Jinotega.[33] In the six indigenous management units in Nicaragua, the percentage primary rainforest cover in 2007 was above 84% in each area, with the highest percentage in KST with 94.2% and the lowest in Mayagna Sauni Bas with 84.4%.[34] Still, neither protection nor land titling alone are a guarantee for the maintenance of forest cover.

[25] Nguon, 2013
[26] Geist, 2002; Lambin et al 2009
[27] Kissinger, 2012
[28] Simula, 2009; Mertz et al, 2012; Hosonuma et al. 2012
[29] Simula, 2009; Thompson et al, 2013
[30] FAO 2005
[31] These estimates are highly variable. For example, in 2005, the national average for deforestation for Honduras was 1.21% (World Bank 2005); in 2016 it is estimated at 3.1% per year
[32] Rivera et al. 2013
[33] Stocks et al. 2006, Stokes 1996
[34] Stocks et al 2007

Figure 9: Slash and burn activities were a common site along the Patuca River in Honduras

In recent years in Nicaragua, over 60% of all national deforestation (70,000 ha per year average) occurred in Bosawás.[35] In terms of potential use or land use change, it is estimated that agriculture has seized approximately 40% of forest soils.[36] Nicaragua's protected areas are losing forest cover at a rate of 1% a year, the highest rate of deforestation in protected areas globally.[37] In Honduras, where the titling of indigenous lands is still nascent, the protective effect of legal protection in reserves is non-existent, with forest loss only lower in protected areas with higher elevations and steeper slopes than the surrounding region.[38] Despite its status as a protected area, Patuca National Park lost 14.9% of its forest cover from 2000-2012, the largest loss of any protected area in Honduras.[39] In terms of connectivity, the forest corridor with the highest rate of deforestation in Central America is the Bosawás-Cerro Silva corridor in Nicaragua at 10.6%; and although protected sections of corridors experience lower rates of deforestation than unprotected sections, Honduran forest corridors and jaguar conservation units show higher forest loss in protected sections.[40]

While credible estimates of deforestation rates in each management unit identified here are not available, in both Nicaragua and Honduras deforestation within protected areas continues to be a problem and threaten forest connectivity.

[35] CIFOR 2016
[36] World Bank 2007
[37] Spracklen et al. 2015
[38] ibid.
[39] Collins and Mitchard 2017
[40] Olsoy et al. 2016

Transboundary Conservation in the Mosquitia: Challenges

While projects within and between these protected areas of Nicaragua and Honduras promoted participatory measures like participatory mapping and in some cases community consultations, in general regional governments and indigenous authorities have been left out of decision-making processes.[41,42] Local people and authorities can be distrustful of conservation initiatives due to an association between protected areas and forced evictions like those carried out in Bosawás in 2003.[43] Current demands of local communities (both indigenous and non-indigenous) within the Mosquitia to control, use, and access natural resources may not be aligned with the plans for local participation in externally-driven conservation projects and initiatives.[44] Moreover, discussions with beneficiaries of previous conservation initiatives reveal a common perception of a cycle that includes a lack of continuity between different projects that are initiated for long-term scales yet end prematurely.

Furthermore, conservation in binational forests like the Mosquitia faces the challenge of increasing conflicts at borders within a context of general inter-state stability and cooperation.[45] Border areas are often sites of illicit outcomes of globalization (in Nicaragua and Honduras, narco-trafficking) that tie people living on borders with regional markets and conflicts.[46] Efforts that promote binational cooperation to prevent deforestation and protect biodiversity have to grapple with elements of conflict that are not easily or readily addressed by national governments.

Finally, transboundary conservation in the Mosquitia must account for the different national and regional laws and regulations pertaining to land, tenure, natural resources, and environmental governance in both Honduras and Nicaragua. In the absence of transnational biodiversity law, conservation efforts to maintain connectivity in transboundary areas must operate within the current legal paradigms of each relevant state.[47]

Proximate Drivers

Agricultural Expansion and the Conversion of Forest to Pasture

The major proximate driver of deforestation in Nicaragua and Honduras is agricultural expansion and encroachment into protected areas by mestizo or ladino settlers.[48] Land sales to

[41] Kelly et al. 2017
[42] Finley-Brook 2007
[43] Hansen et al. 2013
[44] cf. Neumann, 1997
[45] Centeno 2002
[46] McSweeney et al 2014, Duffy 2005
[47] cf. Kotze and Marauhn, 2014
[48] Mollett 2011; Carr 2009; Hayes 2010; Herlihy 1997

mestizo newcomers by indigenous residents, the tradition of squatters' rights to apparently unoccupied lands, and government colonization programs all encourage farmers to settle in Río Plátano, Patuca National Park, and Bosawas.[49] In Bosawas, especially in the southwest, advancement of the agricultural frontier is rapid and includes mixed farming.[50]

Small and Large-Scale Cattle Ranching

The migration of mestizos into protected areas results in the clearing of forest for pasture and both small and large-scale cattle ranching and dairy farming by poor landless farmers, cattle ranchers, and land speculators.[51] In Patuca National Park, many of the inhabitants have migrated from other departments and now farm large cattle ranches typically covering 140-350 ha, where they maintain connections with their family members elsewhere.[52] An analysis of Landsat images suggested that, in Honduras, cattle ranching is done at a larger scale, using larger areas of land than in Nicaragua, where patches are smaller in comparison. While large-scale cattle ranching supplies beef both locally and through international exports to other Central American countries, much of the cattle in Nicaragua is raised for the dairy industry, which has grown substantially for local consumption and international exports.[53,54]

Illegal Logging and Timber Harvesting

In Nicaragua, timber harvesting appears to be an issue in large part linked to uncertainties over rights and permits to concessions. Communities in the core zone are required to apply for permits for the use of live standing or dead fallen wood, however the permitting process is slow.[55] According to the Honduran Public Prosecutor's office, from 2003-2004, two million board feet of mahogany were illegally harvested in the Rio Platano Biosphere, a loss in tax revenue to the government of about $3 million dollars. The main hardwood illegal logging hotspots were around the Patuca River, Sico-Paulaya Valley, and the southern area of the reserve in Olancho. Illegal logging also occurs during the conversion of forest to pasture for agricultural expansion, where land speculators clear areas of forest and sell the timber for profit.[56]

Fire

In 2008 in Honduran protected areas, there were 3,000 forest fires annually affecting 1,000,000 ha, initiated by arsonists (56%), accidents (25.5%), cattle ranchers (11.5%), and

[49] Hayes 2007, Stocks et al. 2007, Abu-Lughod 2000
[50] Stocks 2016, personal communication
[51] CIFOR 2016, Hayes 2007, Sunderlin and Rodriguez 1996
[52] Hecht et al 2012
[53] CIFOR 2016
[54] Radachowsky, personal communication
[55] CIFOR 2016
[56] World Bank, 2013.

farmers (7%).[57] In Nicaragua forest fires occur both from natural causes, such as the forest fires that resulted from prolonged drought during El Niño, as well as being used for clearing land for agriculture or cattle ranching in the advancement of the agricultural frontier.[58,59]

Hurricanes

Natural disturbances are an important factor, such as the destruction caused by Hurricane Mitch.[60] In the aftermath of Hurricane Mitch, many destroyed cacao plantations were abandoned or converted to land for other purposes, including cow pastures.[61]

Underlying Drivers

Deforestation in protected areas in Nicaragua and Honduras has escalated in recent years, and any attempt at long-term conservation of the Mosquitia must address not only proximate drivers in the pinch points but also underlying structural factors that have encouraged deforestation. [62] We have identified three primary underlying drivers of the increase in deforestation rates: 1) drug trafficking in protected areas, 2) lack of indigenous control over their land titles and resource management, and 3) poor enforcement of existing laws by national governments.

Narco-trafficking

Narco-trafficking is common the Mosquitia, as it is in many protected areas throughout Central and South America. It is estimated that 86% of all cocaine traffic flows through Central America.[63] In Honduras, drug trafficking has increased greatly since 2009[64], and increases in deforestation rates are strongly correlated with rates of cocaine trafficking.[65] Cocaine trafficking could account for between 15% and 30% of annual national forest loss and 30% to 60% of loss occurred within nationally and internationally designated protected areas.[66]

Narco-trafficking causes deforestation through the creation of landing strips for physical drug movement as well as narco-trafficking activities that are at odds with conservation, such as

[57] USAID 2009
[58] CIFOR 2016
[59] Hansen et al. 2013, see also USAID 2016
[60] Hansen et al. 2013
[61] Personal communications with indigenous leaders in pinch point 2
[62] Sesnie et al 2017
[63] UNODC 2012
[64] ibid
[65] Sesnie et al 2017
[66] Sesnie et al 2017

cattle ranching and oil palm production.[67] Cattle ranching in this region is both an important conduit for drug laundering, as are the cattle (both living and carcasses) for the physical transportation of drugs, via meatpackers, to international markets such as the United States.[68] Studies also show the strong linkages between drug policy and conservation, where an overemphasis on supply-side policies and interdiction lead narcotraffickers to shift to more ecologically sensitive areas.[69]

Indigenous Land Titles

Land titles are a key yet poorly understood component of protecting the Mosquitia's forest cover, yet they also attract political risks. Within the Rio Platano and Bosawás Biosphere reserves, there is a mix of formal and informal property regimes; in the legal system, national definitions of property interact with indigenous definitions of property. For the latter, communal ownership of property has been the norm for centuries. Instead of acquiring land through sales, these communities allocated parcels of land and usufruct rights to community members which were passed down within families across generations. This poses significant problems as the market-oriented traditions of property upon which non-indigenous settlers operate have clashed with indigenous concepts of property, putting at risk the integrity of indigenous territories.

Whereas in Nicaragua indigenous communities have already obtained titles to their land, in Honduras indigenous groups are going through a process of obtaining titles that has made them face the legacy of definitions of property and productive land upon which non-indigenous settlers and federal law operates. National governments in both countries currently provide negligible support for enforcing and supporting indigenous rights over land and resources, even as they legally recognize indigenous land titles.

Enforcement of Existing Laws

The legal and institutional frameworks in both Nicaragua and Honduras have evolved and diverged in several significant ways. As a result, the problem of how to best conserve the wildlife corridor must consider this challenge through a prism of legal and institutional frameworks. Both countries have different systems for dealing with questions around land tenure and conservation measures. Nevertheless, in both Honduras and Nicaragua the legal regimes continue to be marred by contradictions and conflicts of interest between local and national agencies and officials, legal gaps, poor coordination, and weak regulations and law enforcement.[70] When it comes to environmental regulations, the legal system also suffers from

[67] McSweeney et al 2014
[68] ibid
[69] See especially graph 1 in McSweeny et al 2014
[70] USAID 2014

weak enforcement. This has exacerbated conflicts between natural resource management projects, development of infrastructure, environmental policies, and indigenous groups.

Land Tenure and Legal Framework

Tenure Regimes

The tensions between these different land tenure regimes and conservation/biodiversity laws in Nicaragua and Honduras are problematic for indigenous communities within the reserves who aim to sustainably extract forest resources for individual, communal, or commercial purposes. To do so, they must possess clear statutory rights to use and manage resources and legal and political support at the federal, municipal, and regional levels. However, laws around land tenure and natural resource management in both countries demonstrate contradictory attitudes towards indigenous rights in writing and in practice.

Nicaragua

In Nicaragua, there are four types of land rights. These include: (1) national or state lands, (2) private lands owned by individuals or groups, (3) communal lands of indigenous communities, and (4) *ejidal* land owned by municipalities.[71] As a result, there are three separate forms of land tenure. The first form is land ownership, which is either at the individual or communal level (for example cooperatives). The second form is leaseholds, whose details are governed between two or more parties. The final type of land tenure is informal occupation, which is commonly found yet outside the formal rules of land tenures.

The main laws and decrees which affect indigenous land tenure in the Nicaraguan Mosquitia forest include the Autonomy Statute (Law 28) and the Law of Communal Property Regimes (Law 445), in which indigenous communities' traditional authorities have the right to oversee and adjudicate access to land by community members in indigenous territories. The General Policy for Territorial Ordering (Decree 90), which supports the decentralization of authority over land management and administration to local levels such as municipalities (see Law 40), is also important. Implementation of this latter policy is slow and incomplete, given the difficulty in decentralization in a country where state agencies have historically exercised control.[72]

For Nicaragua, laws pertaining to land and natural resource management regulations include: the Forest Law (Law 864), the Law Prohibiting Logging (Law 585), the National Policy for Sustainable Development of the Forest Sector (Decree 69), and the Law of Communal

[71] Freguin-Gresh 2014
[72] Freguin-Gresh 2014

Property Regime (Law 445).[73] Laws at the national level specify who has access to timber and other natural resources; these include the General Law for the Natural Resources and the Environment (Law 217), the National Human Development Plan 2012-2016 (PNDH), and the Agro-Ecological and Organic Production Law (Law 765).

Honduras

In Honduras, land rights are held in three separate categories: (1) land which is legally the property of the national government, (2) private lands which cover a large percentage of the country, and (3) ejidal lands which are communal and awarded to either a municipality or indigenous community for the use of the inhabitants of these jurisdictions.[74] This has resulted in three forms of land tenure. The first form is individual and collective ownership, the second form is usufruct (which is issued by local authorities), and the final form is leaseholds.

The main laws and policy documents which govern land tenure in Honduras include the Law for Agrarian Reform, the Law of Territorial Ordering (Decree 180), the General Law of the Environment (Decree 109), and the Law for Sustainable Rural Development (Decree 12).[75] Unlike in Nicaragua, the only mention of indigenous rights to land and natural resource management is in article 346 of the Constitution of Honduras. While Honduras has ratified the main international and regional human rights treaties, including the International Labour Organisation Convention 169 on the rights of indigenous and tribal peoples, and has voted in favor of the United Nations Declaration on the Rights of Indigenous Peoples, no secondary national legislation has been established to implement these rights within Honduras. Under Agrarian Law, indigenous communities who can prove that they occupy their lands can obtain title from the National Agrarian Institute. The Property Act (Decree 82) provides for the registration of indigenous lands by the Property Institute and recognizes traditional forms of land tenure on indigenous lands; however, it allows communities to sell or lease communally held lands and grants ownership rights and the right to compensation for improvements made to the land to the third party buyer or leasee, which legitimizes the presence of outsiders in indigenous territories and impinges on the inalienability of indigenous title.[76]

Laws, mandates, and policy documents which are particularly important for land and natural resource management include: Forest Law (Law 98), the Law of Protected Areas and Wildlife (Decree 78); the Manual on Administrative and Technical norms of the National System of Protected Areas and Wildlife of Honduras, The Methodology for the Monitoring of

[73] Personal communications with indigenous and government leaders
[74] ibid.
[75] ibid.
[76] Tauli-Corpuz 2016

Management Effectiveness of the ICF, and the ICF Rules for the Management and Protection of Natural and Cultural Resources of the Rio Platano Reserve.[77]

Conclusions

The underlying drivers of deforestation in Nicaragua and Honduras are complex, and involve not only local factors (such as the connectivity of local markets with global markets, and the lack of indigenous land tenure rights), but also national factors (enforcement of existing laws) and international factors (drug trafficking, and connectivity of local markets with global markets). Understanding these dynamics provides an opportunity for targeting underlying drivers in a large-scale vision of conservation of the Mosquitia forest. In this document, we focus on proximate drivers that are threatening the pinch points, as preservation of any existing forest cover in the pinch points is essential to long-term survival of the habitat corridor in the Mosquitia. However, we urge a careful consideration of these underlying drivers as a longer-term strategy for forest conservation is developed and, especially, implemented.

[77] ICF 2014

PART IV: Pinch Points

Locating the Pinch Points

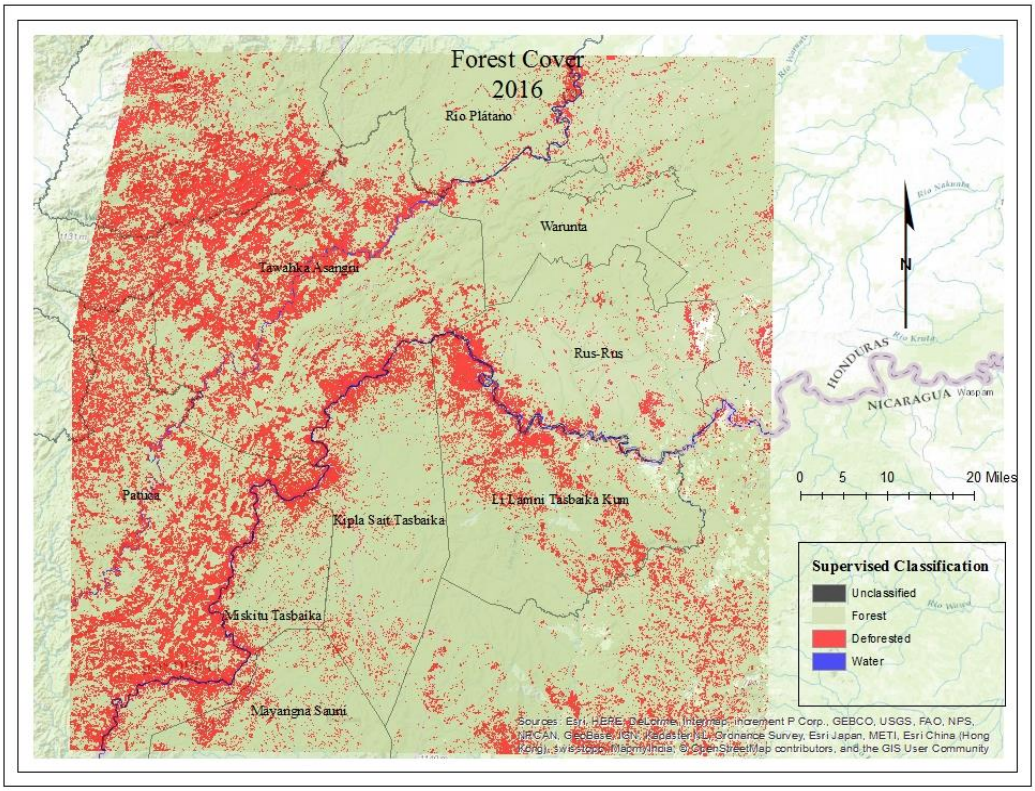


Figure 10: Forest cover in management units

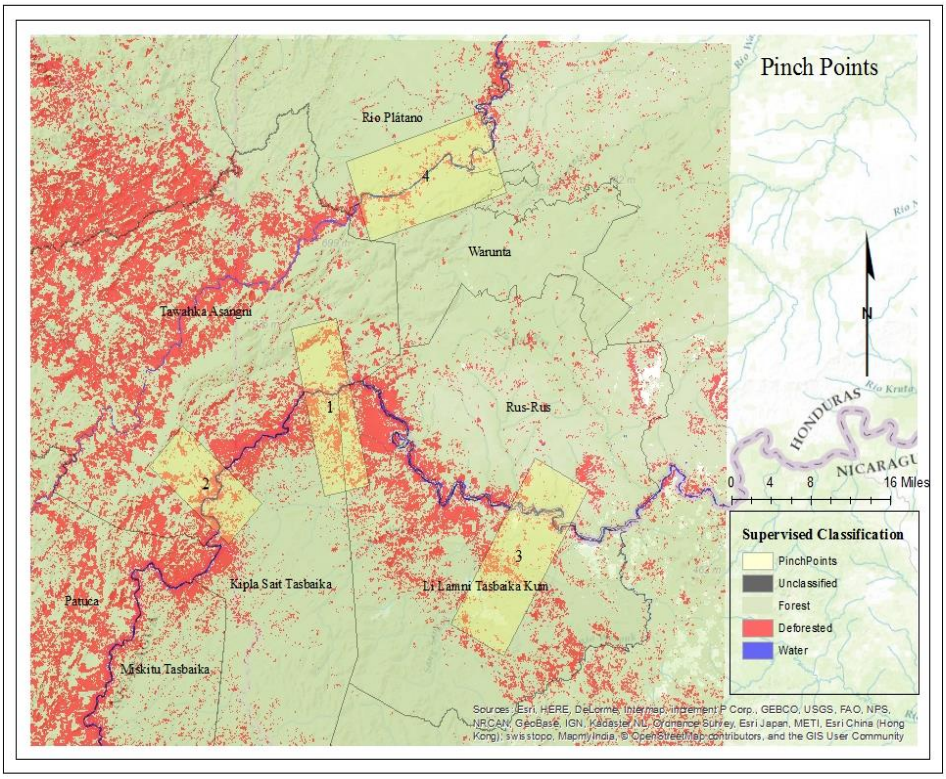


Figure 11: Pinch points 1-4

Pinch Points in the Management Units of the Mosquitia

Through our pinch point analysis, four pinch points were identified:

1) At intersection of KST, Li Lamni, and Tawakha from (14.81438, -84.90028) to (14.825, -84.83814) along the Rio Coco
2) Border between KST and Tawakha from (14.62644, -85.02731) to (14.71113, -85.01976) along the Rio Coco
3) Border between Li Lamni and Rus Rus from (14.66032, -84.6009) to (14.6364, -84.5137) along the Rio Coco
4) Border between Rio Platano and Warunta from (15.06723, -84.82231) to (15.14239, -84.62528) along the Rio Patuca

Within each management unit (e.g., Patuca[78]) connectivity is maintained, while deforestation proceeds from the outside in. This pattern of deforestation likely occurs because the borders of many of the management units are rivers, which provide easier access to the areas

[78] Proyecto Pro-Patuca, 2017

along the borders of the parks. Since deforestation is often stronger along the borders between management units, our pinch points span these boundaries to find the areas where deforestation is occurring at a lower rate than in surrounding areas. Thus, these pinch points appeared to maintain connectivity between the various management units discussed here, and to have the lowest rates of deforestation along the boundaries between these management units. We tested the validity of these pinch points using a least-cost path analysis, which identified each pinch point as containing a least cost path between points in adjacent protected areas (Figure 9). However, it is important to note that each of these pinch points contains its own particularities (discussed further below) that may affect their suitability as habitat corridors. For instance, Rus Rus largely consists of pine savanna; while pine savanna is forest, it differs from the broad-leaved forest found throughout much of the rest of the Mosquitia.

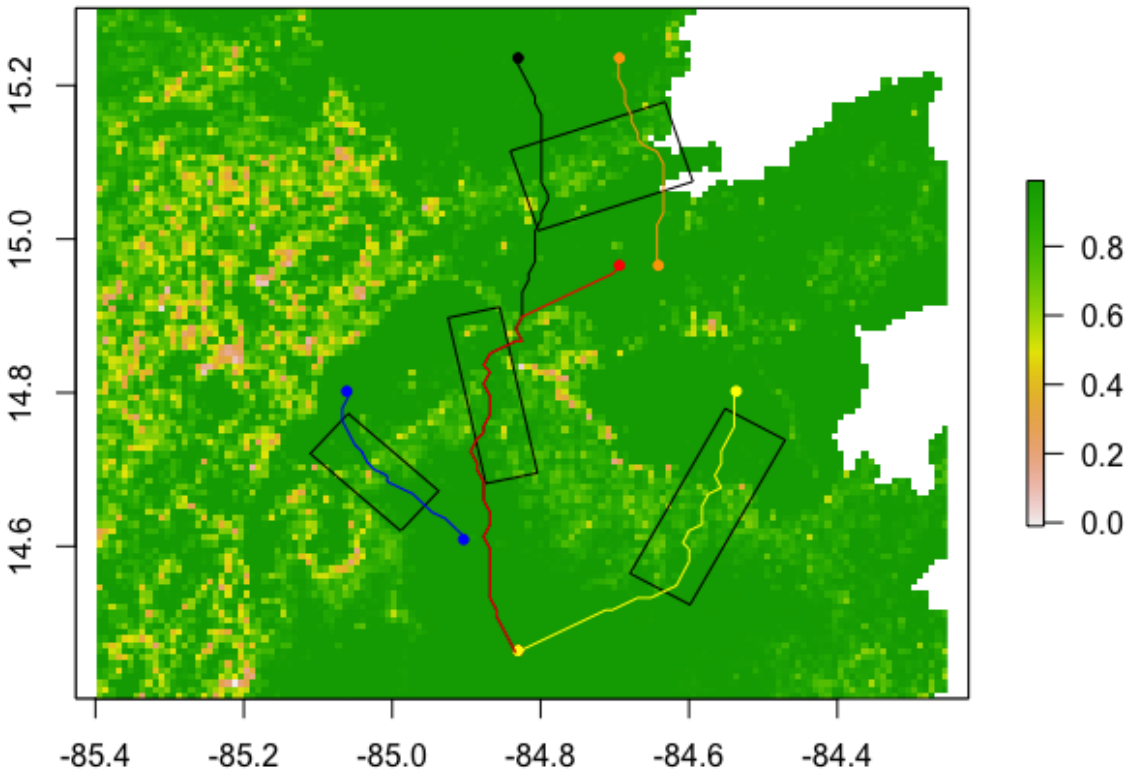
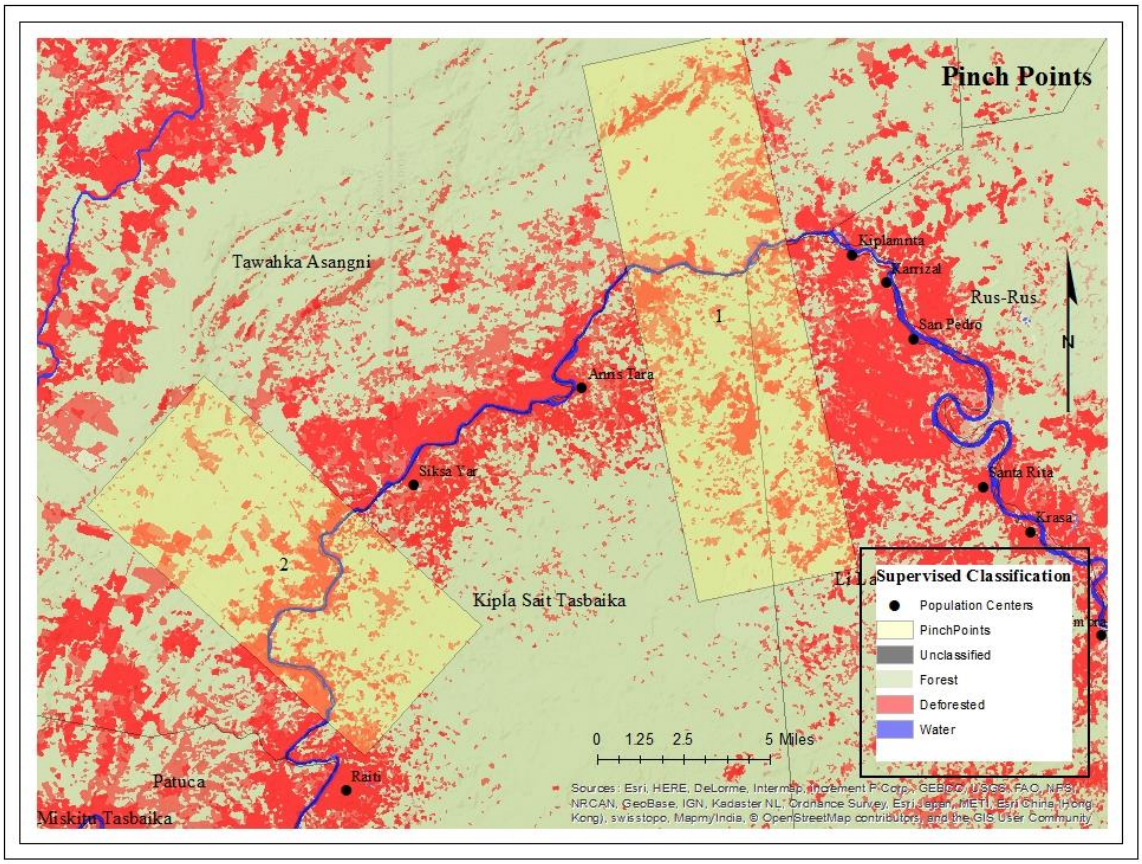


Figure 12: Results of least-cost path analysis, where green indicates heavy forest cover and other colors indicate less forest cover. Points were chosen within each of the protected areas (Bosawas, Patuca, Tawahka, Rus Rus, and Rio Platano) in order to estimate the paths with the least "cost". In this case, the cost of any given grid cell was calculated as a function of the amount of forest cover in the surrounding 1km. Thus, the least costly paths represent paths of greatest forest cover between each pair of points. Depending on the starting and ending points, each pinch point contains within it a least cost path traversing the boundary between protected areas, suggesting that these pinch points could serve as connectivity corridors.

Closer analysis of these pinch points revealed that each pinch point presented different challenges. From our literature review, analysis of the maps and deforestation rates, and interviews conducted in the field, we identified the most interesting features, potential drivers, challenges and opportunities of each pinch point. During our field visit, we visited the entirety of two pinch points (#2 and #4) and interviewed local people in multiple towns throughout the pinch point area. However, pinch points #1 and in particular #3 are extremely remote and little knowledge exists about what is happening in these areas.

For the purposes of this discussion, we have grouped the pinch points according to the river drainage that they occur on: pinch points #1-3 occur on the Rio Coco along the border between Honduras and Nicaragua, while pinch point #4 occurs on the Rio Patuca, entirely within Honduras, but along the border of the Rio Platano Reserve. We did not visit pinch points #1 and #3, so we focus our discussion on the two pinch points that we did visit.

Pinch Point #1: Tawakha to KST and Li Lamni



Pinch point #1 spans the border between Tawakha Asangni Biosphere Reserve (Honduras), KST (Nicaragua), and Li Lamni (Nicaragua). Management areas: KST/Tawahka/Li Lamni. From an analysis of the maps, the primary threat to this pinch point is deforestation from

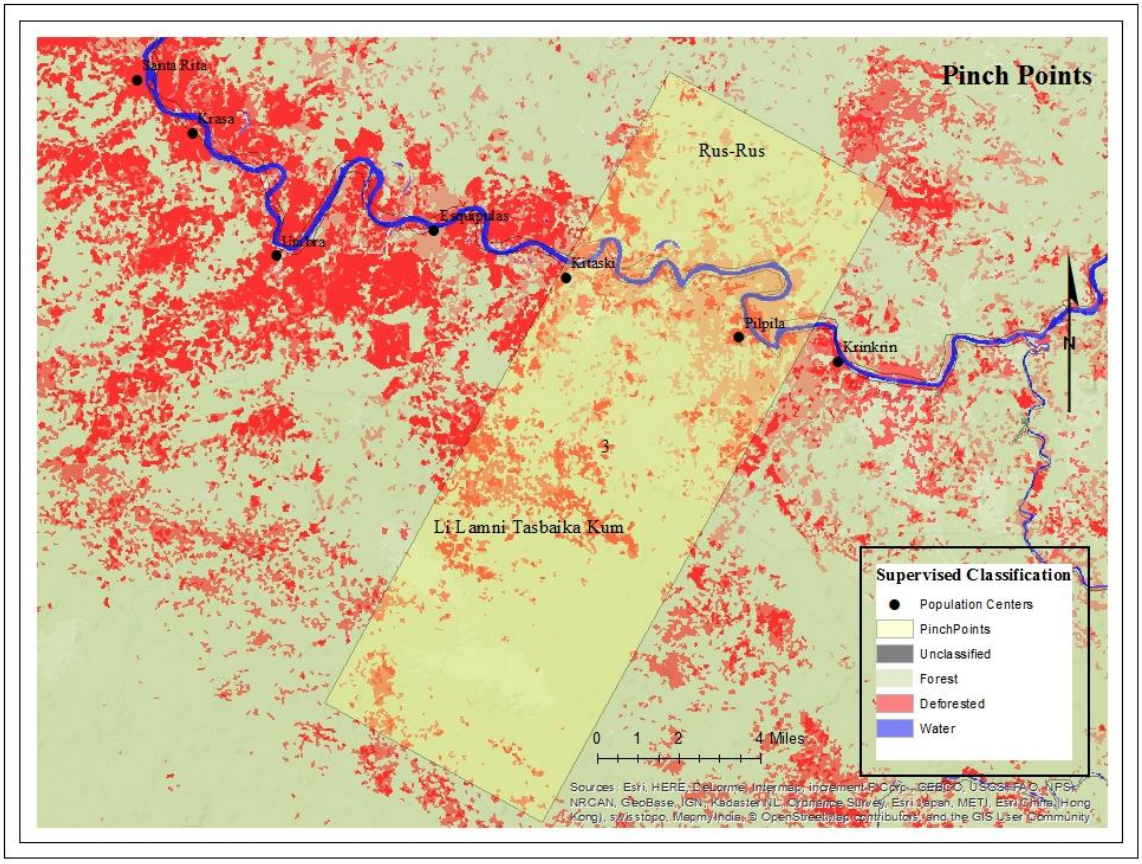
the east and the west. From the east, small land clearings are degrading the forest. These seem to stem from the nearest town Karvizal. Two factors make this pinch point interesting. North of the pinch point there is a line of deforestation that seems to stem from either a road, a river, or a valley, which may provide easier access to this region. Around 7km north of the pinch point there is a ridge with a large bare patch, perhaps the beginnings of a large farm or simply natural erosion. On the Nicaraguan side, there is a large farm 5km south of the pinch point that seems to be expanding. From our analysis, we would assume that here both the settlement and the road pose the biggest threats to continued advancement. At present, WCS has no information as to the riverside land ownership and land use dynamics in pinch point #1. Due to current field work with the indigenous territory KST, exploring patterns of residence and challenges and opportunities for connectivity on the Nicaraguan side can be explored more easily that the Honduran side. The extra effort of obtaining a detailed understanding of land ownership and land use patterns on Honduran side of pinch point #1 is an urgent high priority.

Pinch Point #2: Tawakha to KST

Pinch point #2 spans the border between Tawakha Biosphere Reserve (Honduras) and KST (Nicaragua). This area is on the southeast of KST on the Rio Coco just north of Patuca reserve. The pinch point lies between two towns, Siska Yari to the east and Raiti to the southwest. North of this settlement on the Honduran side are a series of straight lines that run down the mountain, that may be roads. There is also a river running south from pinch point #2 along which deforestation is rapidly increasing. Discussions with cattle-ranchers near this pinch point indicate that roads are currently being built in the direction of this pinch point, with funding coming from the ranchers themselves. In recent years, new road construction seems to have rapidly expanded. We witnessed a large vehicle along a section of the river leading to this pinch point, with the implication that, in addition to ancestral foot paths crossing the mountains between Rio Patuca and Rio Coco, at least one road has recently been constructed crossing Honduran protected areas for the purpose of transporting cattle. Obtaining a better understanding of the patterns of ownership and land use on the Honduran side of pinch point #2 is a high priority, as well as elucidating recent and current momentums, as well as the legal and regulatory restrictions, on roads in protected areas.

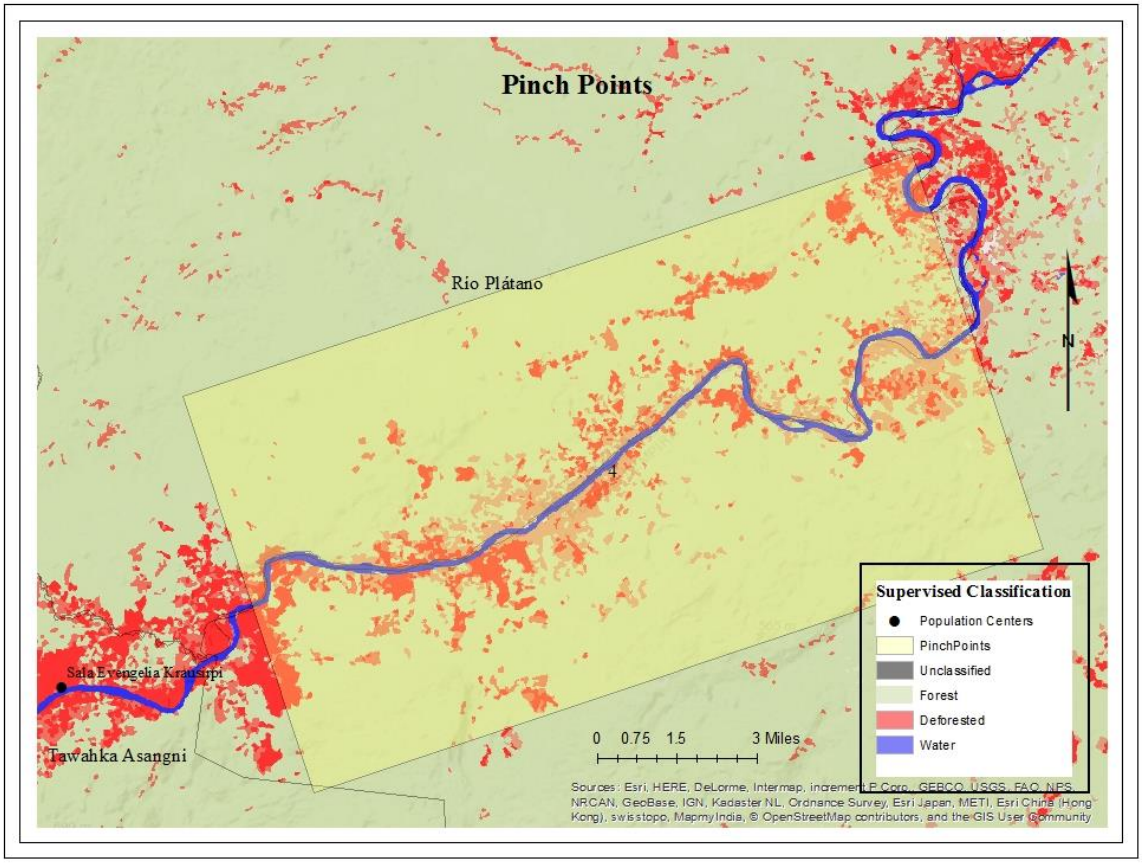
Figure 13: Large vehicle parked on Honduran side of Rio Coco, near pinch point 2

Pinch Point #3: Rus Rus (Honduras) to Li Lamni (Nicaragua)



Pinch point #3 spans the border between Rus Rus (Honduras) and LLTK (Nicaragua). This area is on the east of LLTK between the town of Kitaski to the west and Tulingbila to the east. A road seems to run through Rus Rus and a smaller road seems to branch off and end in Kutaski. Although Rus Rus has relatively intact forest remaining, as can be seen in our analysis of deforestation rates, this forest is largely pine savanna rather than broad-leaved forest and thus is less directly related to the conservation of the habitat of lowland tropical broad-leaved forest in the Mosquitia. However, a large corridor of gallery forest could provide habitat connectivity between the core areas of Bosawas and Rio Platano, and as this gallery forest seems to be relatively intact today, may provide an important source of connectivity. Unfortunately, very little is known to WCS about what is happening on either side of the international border between Li Lamni and Rus Rus, and more knowledge about this area is desperately needed if the gallery forest is to serve as a successful habitat corridor. Researchers in INCEBIO and the titled Miskitu territory of FINZMOS are likely allies to understand issues on the Honduran side of pinch point #3. The entire Nicaraguan side of pinch point # 3 is in Li Lamni and the Nicaraguan side of pinch point # 1 lays along the border of Li Lamni. Ground-truthing Li Lamni to understand actors, factors, and allies for is important to address connectivity issues along the border.

Pinch Point #4: Rio Platano to Warunta (Honduras)



Pinch point #4 is the only pinch point entirely within Honduras, spanning the border of the Rio Platano Biosphere Reserve and Warunta, a former national park. The Rio Patuca provides an essential source of connectivity throughout this region, and as such deforestation appears to begin along the banks of the river and then expand inland. During our visit to this pinch point, we identified only three areas along the banks of the Rio Patuca that still had relatively intact forest on both sides of the river. Although forest is still quite common along the river, it tends to occur on one side only while the other side has been converted to houses, pastures, or banana farms. We also counted 28 instances of active or very recent burning along the banks of the river, suggesting human presence is growing in this region and that more and more land is being converted to pasture. Interviews with local people in Krausirpi, Kurpa, Tukrun, and Wampusirpi suggest that locals feel significant pressure from *mestizo* settlers. The southwest part of pinch point #4 lays in areas where the Tawahka (FITH) are working to obtain community land title. Much of the remainder lies in the titled Miskutu territory of BAKINASTA. South of this pinch point near Krausirpi on the river bend there seems to be a

road connecting Rio Patuca and Rio Coco. This area has seen increased forest degradation and should be monitored as well.

Least cost path analysis

The least cost path analysis revealed that the pinch points we identified could all serve to maintain connectivity. Unfortunately, our on-the-ground knowledge of the state of deforestation in pinch point #4 is lacking, and in pinch point #3 our trip down the river revealed widespread deforestation along at least one side of the river for most of the pinch point. Thus, immediate conservation of these pinch points is especially important to preserving connectivity, especially as they may be more useful for connectivity than pinch points #1 and #2.

PART V: Strategies and Recommendations

Successful conservation strategies require local buy-in, a knowledge of the history of the region, sustainable funding models, clearly stated goals, and institutional support within the federal and departmental governments.[79] Our strategies span multiple scales (local, national, binational, and international) to tackle the problem of deforestation from multiple angles.

The primary problem facing this forest corridor is the threat of wide-scale forest fragmentation, driven largely by cattle ranching on the agricultural frontier, which will divide the forest into its two primary parts, Rio Platano and Bosawas. This agricultural frontier is especially problematic in the western areas of Honduras' Patuca and Tawakha, as well as on the border between Nicaragua and Honduras. Although we focus here on short-term strategies that WCS can implement specifically in the pinch points in order to preserve forest cover in these regions of highest importance, longer-term options are highlighted where appropriate. Although the long-term success of conservation of the pinch points will require addressing underlying drivers, the rate of deforestation is so rapid that immediate action in the pinch points is essential to have any success at maintaining a habitat corridor in this region.

Objectives and goals

The main goal is to slow the rate of deforestation, particularly in the pinch points. The success of the following conservation strategies should be evaluated by their effects on 1) the rate of deforestation and its decline over time, 2) reduction in the movement of settlers into the region, 3) regrowth of hardwood forest into previously deforested areas, and 4) return of locally extirpated indicator species of conservation importance, such as the white-lipped peccary.

Strategies

[79] Dasgupta, 2016

We have identified four primary areas where actions by WCS can make a positive impact on forest conservation: 1) Capacity building (information sharing and training), 2) Promoting livelihoods that depend on an intact forest, 3) Opportunities for enforcement of existing laws and regulations, and 4) Legal Assistance. For each of these four primary areas, we have then suggested specific actions that WCS can take to promote forest conservation. Finally, we conclude with a discussion of some of the underlying drivers and the potential to mitigate these drivers to better ensure long-term forest survival and connectivity.

(1) Capacity building

A major challenge in the conservation of the Mosquitia forest is a lack of current information, a lack of access to the information that does exist by local residents and extra-local partners, and the training to help local communities organize and make a case for action based on this information. We describe here five actions that WCS can take to help build capacity among local communities to gather information that will help communities and individuals take conservation action and ask for resources and enforcement by the state, as well as workshops and training that WCS can provide to fill these gaps.

a. Further assessment of the state of deforestation. As we found in this paper, the rate of deforestation in this region is high and forest cover changes dramatically year to year. WCS should distribute information about the rate of recent deforestation in these pinch points and their geographic location. Interviews to obtain qualitative data should also be conducted; for example, during our trips we discovered that some mestizo cattle ranching associations have disregarded the law to an extent that appears at best poorly understood by state agencies. Interviews with Honduran ranchers revealed that one association alone sold the "rights" to plots of land spanning 100 kilometers along protected land bordering the Rio Coco, from approximately the Boca Español (community on Honduran side) downstream to a point approximately across the river from Raiti (community on Nicaraguan side), spreading towards two of the identified pinch points. It is not clear if additional similar sales have taken place in the pinch points themselves. This information should be collected, systematized, and disseminated to relevant government officials and all interested parties. Future landsales in protected areas should be avoided, and mechanisms to leverage conservation outcomes with existing ranches in the protected areas, especially in the pinch points, should be explored.

b. SMART training. Although local peoples know a great deal about where deforestation is happening in and around their lands, proper identification of new farms and pastures is essential to understanding and tracking the rates of deforestation. WCS has already conducted workshops to train individuals in eastern Bosawás in the use of SMART protocols for using hand-held GPS units; future workshops and training could include individuals from the western sections of Bosawás. Training could also be implemented in Honduras to train local individuals to help identify and track new deforestation. Some of that training could perhaps

coincide with ground-truthing of the threatened sections of connectivity along the Honduran border with Rio Coco.

c. Development of workshops to assist local community members in presenting complaints about illegal land seizure, forest clearing, or timber harvesting. While previous projects within the wildlife corridor have promoted participatory measures in mapping and community consultations, there is a general feeling of disconnection between national policies, regional governments, and indigenous authorities who may feel as though they have been left out of decision-making processes.[80] Although indigenous communities have made advances in securing communal-property rights, these are applied unevenly across different groups within the reserves and communities have difficulty in expressing their grievances with a unified voice. Breakthroughs occurred in late April 2017, when leaders of the Mayangna and Miskito tribes of the Bosawás Reserve met and for the first time created a manifesto that listed 10 actions needed to coordinate activities to prevent deforestation. These included measures for more patrolling and training, as well as measures to use the justice system to enforce *saneamiento*, or the forced eviction of illegal land settlers.[81]

d. Development of workshops to assist local communities in obtaining and managing funding for conservation initiatives. In conversations with indigenous leaders, it became evident that several indigenous groups in Nicaragua and Honduras are not able to directly receive funds; for example, in Nicaragua indigenous groups and territorial governments do not have a RUC number to be able to receive and manage funding independently. Furthermore, discussions with indigenous leaders indicate several issues in intra-community partnerships, including distrust amongst indigenous leaders who suspect one another of colluding with land settlers to obtain money, as well as a complete lack of knowledge regarding how to finance these measures.[82] When asked about sources of financing, the GTI in Nicaragua responded that the only sources they knew of were one-off grants by organizations like USAID and GIZ, which do not guarantee any degree of continuity. WCS can mitigate this situation by conducting training on receiving and managing funding, decision-making processes around the use of funds for conservation and sustainable livelihoods, and obtaining an RUC number.

e. Partnerships with international companies whose products can contribute to preserving forest connectivity. WCS should consider partnering with private companies who may be willing to help provide funding for forest conservation. For example, Garmin, one of the largest GPS manufacturers in the world, has been active for several decades in charitable efforts that rely on their equipment. Recently, Garmin partnered with the Maasai Wilderness Conservation Trust in Kenya, whose mission is to preserve biodiversity and forest conservation

[80] Kelly et al., 2017
[81] The process of saneamiento is embedded in both Honduran and Nicaraguan law, yet there are only a handful of cases of settlers being brought to court, most of which have occurred in the past two years.
[82] Interview with GTI (May 9, 2017) and MASTA (May 12, 2017)

within the tribal lands of the Maasai. Given the importance of Garmin GPS devices for WCS's conservation work, a WCS/Garmin partnership could easily be promoted and marketed as a positive endeavor for both parties.

(2) Promoting livelihoods that depend on an intact forest

WCS can play an important role in promoting livelihoods that depend on an intact forest. A major concern among many of the indigenous people we interviewed was a balance between economic opportunities that were afforded by cattle, and a desire to preserve the forest. Thus, WCS can help to promote livelihoods and economic opportunities that not only enable indigenous communities to gain access to resources through economic development, but do so in a way that requires that the forest remain intact. We discuss here four avenues through which WCS can promote livelihoods in keeping with conservation goals.

a. Promotion of cacao farming by connecting with chocolate manufacturers who sell sustainable and/or organic chocolate. Cacao plantations can be integrated into conservation schemes as they can provide habitat and forest cover for animals in the pinch point areas that would otherwise be pasture or reserved for human use. Studies have shown that the shade provided by crops like cacao help provide habitat for bird species, though they could also provide safe passageways for large mammals such as jaguars and peccaries. One strategy for promoting the connectivity of the corridor could be for WCS to partner with companies that use cacao from the Rio Platano Reserve in products sold to international markets. This is currently being done in the island of Roatan, where beans from Wampusirpi are sold to tourists who visit the island throughout the year. One company, the Roatan Chocolate Company, exclusively buys cacao beans from Wampusirpi, in and around pinch point 4, and turns them into a variety of high-end chocolates that are mainly sold to cruise ship passengers. During the high season of November to April, the Roatan Chocolate Factory produces ten to twelve thousand bars of chocolate per month. The company has partnered with Carnival Cruises and arranges tours of their facilities and stores that range from 50 to 170 people per tour, with multiple tours occurring 4 days a week (during the low season this reduces to 2 days a week).

Figure 14: Cruise ship passengers listen to a presentation on beans originating from the Rio Platano Reserve

It would not be difficult to create inspiring messages targeted at these customers for how they can both consumer products from the Rio Platano Reserve while helping protect biodiversity and prevent deforestation. This could be included in the tours that visit the chocolate facilities in Roatan, as well as through the creation of a new type of chocolate that specifically promotes certain animals of the wildlife corridor, such as “Jaguar Chocolate Bars”, that could be sold on cruise ships or in zoos in the United States. These bars could also include information on how cacao helps the conservation of these species, and may be priced at a slightly higher price to raise funds for conservation measures. Discussions with both the owners of Roatan Chocolate Factory, cruise ship passengers, and a representative from Carnival Cruises indicate a willingness to see this idea come to fruition. Moreover, Roatan Chocolate Factory will soon be exporting their product overseas via chocolate sold through their website, and have communicated that they would be willing to partner with WCS to promote forest connectivity through their products.

Figure 15: Cacao beans from the Rio Platano Reserve are used to produce chocolate sold in Roatan

b. Timber certification. WCS should capitalize and expand the small yet important timber certification schemes that already exist in Honduras, keeping in mind ways to address existing criticisms. Timber harvesting appears to be an issue in large part linked to uncertainties over rights and permits to concessions. Communities are required to apply for permits for the use of live standing or dead fallen wood; however, the permitting process is slow. Timber certification schemes in Honduras have proceeded through what are known as community forestry enterprises (CFEs), which have produced evidence supporting their efficacy in reducing rates of deforestation and producing important sources of income. A 2013 case study examined the effect of 12 active CFEs managing nearly 107,000 hectares of broad-leaf tropical forest in or near the reserve.[83] Of these, seven had been certified by the Forestry Stewardship Council (FSC). The study concluded that areas under CFEs inside the reserve have less deforestation than the parts of the reserve not involved in such initiatives (.96% versus 1.62%).[84]

If WCS were to expand timber certification schemes, they would have to address criticisms of the CFEs by implementing stronger monitoring efforts throughout the timber value-chain and working with the GoH and GoN in streamlining legal hurdles. For example, a 2005 joint effort between the Rainforest Alliance and Gibson Guitars Corporation worked with CFEs to prepare and export prefabricated mahogany pieces from the Rio Platano Reserve that had FSC certification. Independent watchdog reports emerged in 2010 expressing concerns that the CFEs could only produce evidence of increased incomes and expedited mahogany shipment times,

[83] Forest Trends, 2013
[84] Del Gato, 2014

with no mention of good practices in forest management. The reports also claim that the CFEs in the scheme were also responsible for illegal timber harvesting, undermining the overall effectiveness of this program.[85] Despite the challenges, when managed well, timber certification can be an effective tool for maintaining forest cover, jaguars, and other wildlife.[86]

c. Cacao Certification: WCS should seek certification schemes for cacao that target both indigenous communities and cattle ranchers. Precedent exists for both cases. In 2017, an initiative that pursued certification schemes in cacao with indigenous communities was begun by the German development agency GIZ. Under this program, the GIZ facilitated a certification program between Chocolates Halba, a Swiss company that sells chocolates made from Honduran cacao in over 1500 stores. Farmers who participated earned 1 lempira more per pound produced (9 lempiras versus 8 lempiras). A total of 99 indigenous farmers in the Rio Platano Reserve participated thus far, with an additional 227 participants scheduled to join. In a separate example, between 2012-2015, the GoH initiated the Aprosacao project, which created a cacao cooperative formed by former cattle ranchers.[87] The ranchers introduced agroforestry practices in their pastures, in which they planted cacao trees within their parcels. By 2015, an estimated 200,000 trees had been replanted in parcels that were previously reserved for cattle-ranching, with ranchers reporting higher earnings.[88]

There are concerns regarding the sustainability of the cooperative model in the Rio Platano Reserve, as some previous cacao cooperatives have failed to last once the initial funding from international donors ran out. In Kurpa, for example, there sits a relatively new cacao processing plant that is abandoned. Discussions with both government employees, local indigenous leaders, and cacao producers indicate several problems with previous cacao initiatives, including poor administration of funds, distrust amongst partners, lack of ownership and agency, and a lack of transparency.

Cooperation with private companies operating in the reserve may be an option worth exploring. Near pinch point 4, there is an American-owned cacao fermentation facility that was begun as a philanthropic initiative to promote agricultural best practices and sustainable development. Biosphere Cacao has a business model that involves partnering with small-scale cacao producers in the

Figure 16:Biosphere Cacao worker drying beans in Wampusirpi

[85] FSC, 2011
[86] Radachowsky et al. 2012, Polisar et al. 2016, Roopsind et al. 2017
[87] Interview with GIZ, 2017
[88] Pur Project, 2017

Rio Platano Reserve. These producers are given training in agricultural best practices with an eventual aim of training them in appropriate business administration techniques, such as accounting.

d. Development of research stations. Knowledge of the cultural diversity, archaeology, and biodiversity of the Mosquitia is minimal, and construction of research stations within the Mosquitia would create local jobs as well as generate new interest in the region. WCS, which contains a significant scientific aspect to its conservation work, should push for the conversion of existing confiscated properties into research stations to serve local communities as well as international research communities. With respect to biodiversity, because biodiversity research depends on the conservation of the forest, research stations devoted in part to biodiversity research would provide an opportunity to create jobs that would also promote forest conservation.

Furthermore, knowledge of potential forestry trees in the Mosquitia is poorly understood, yet long-term sustainable timber harvesting programs require intimate knowledge of the ecology and demography of timber trees. Designing research stations in the reserves would thus not only provide jobs for local individuals, but the research conducted at those stations could also directly relate to the economic activities of local communities. With respect to cultural diversity and history, cultural groups and languages from the Mosquitia face the risk of extinction, and archaeological sites are abundant and largely unstudied. The fabled White City archaeological site[89], though controversial, nonetheless contains a wealth of archaeological information that has only barely begun to be studied. However, this settlement is but one example, and in Wampusirpi, a local library has collections of ceremonial dishes and jugs from the nearby town of Raya, none of which have been studied or described (see photos below).

[89] Yakam-Simen et al 1998; Preston, 2015; Tolley, 2012

Figure 17: Archaeological artifacts collected from near Wampusirpi, including ceremonial jugs, larger jugs, beads, and various other objects.

(3) Opportunities for enforcement

a. Collaboration with the GoH and GoN to advance saneamiento proceedings and raise the profile of these cases to signal to future illegal settlers that forced evictions are a real possibility, which could in the long-run deter future invasions. In 2017, the GoH initiated saneamiento proceedings against two cattle ranchers who had illegally settled into the Rio Platano Reserve.[90] These cases are in their initial stages, yet there are doubts over whether they will result in the eviction of settlers as the political will to convict settlers is low. The same lack of political will exists from politicians in Honduras and Nicaragua, who may not be particularly invested in indigenous communities whose autonomy and overall low numbers do not contribute much to their electoral successes. A longer-run question will therefore be in how to create incentives for politicians to care about enforcing rights in these regions.

b. Provision of low-cost solutions to help monitor and track the sale of land parcels, transfer of land parcels within communities, and the resolutions of disputes. Interviews with the leaders of the indigenous communities located within two of the four pinch points reveal weaknesses for settling disputes over these parcels. The boundaries between parcels are neither defined nor clearly marked, and when disputes arise indigenous leaders call upon witnesses who vouch for the party they believe was wronged.[91] These disputes sometimes extend into neighboring indigenous communities as well as with mestizo communities who are both legally

[90] Interview with GTI, 2017, and MASTA, 2017
[91] Interview with Mayagna Saun Bu Community leader, 2017

and illegally settled around communities. The community leader then records this decision, which is written on paper and kept with the leader (in one instance all records were kept inside a duffel bag). This tracking system has obvious flaws, including the precarious nature of maintaining all decisions in a bag that could easily be lost or destroyed by the elements. The WCS should introduce low-cost solutions to monitor and track these decisions, which would empower communities to have stronger institutional organization and to track violations of their communal property rights both within their territories and along the corridor. One simple way to do this would be to purchase Chromebooks, which are low-cost computers (retailing for under $150) which are specifically designed for long-battery life and simple functions like record-keeping. These computers have been successfully adopted in developing communities for creating greater institutional strength, and the WCS is in a strong position to lead such an initiative.[92]

c. Bringing together state government officials, national park and reserve officials, and local community leaders to develop an action plan. One recurring theme in both Honduras and Nicaragua was how few individuals within relevant decision-making institutions had visited the sites in question. In the case of the ICF, we spoke with several officials who expressed a willingness to visit the pinch point sites, in the process exposing them to the issues raised by this report. These visits could be linked to future WCS visits that coincide with the suggested workshops.

Figure 18: WCS-led meeting in Wampusirpi

[92] Weinberger, 2015

d. Conservation easements in protected areas. Conservation easements could allow private landowners to have a legal instrument to conserve and properly manage the natural resources on their land, and could be made permanent in theory if included in property deeds. Article 799 of the Civil Code of Honduras even mentions the need of a proper conservation easement system, yet this has not been implemented. [93] This will require a stronger level of coordination amongst indigenous communities and between indigenous communities and national governments, whose institutions will have to enforce property rights. Until then, WCS is limited in what legal changes it can advocate. In the long-run, conservation easements could be combined with zoning laws to protect ecologically sensitive areas of the buffer zones of the corridor, where mestizos can legally work and live. The concept of conservation easements instead of expulsion, but conditioned upon compliance with agreed upon conditions, may be a mechanism to enforce conservation objectives with residents and ranchers in pinch points on the Honduran side. Tax incentives within and around the corridor may eventually become a viable option as the country develops and the GoH and GoN are able to integrate all property titles in the region into a cohesive and enforceable framework. Collaboration with donors to incentivize easements on private property may be beneficial (for example, with the Rainforest Trust).

(4) Assistance with legal endeavors

a. Support MASTA's efforts at passing the Ley de Saneamiento. Meetings in May of 2017 with MASTA leadership revealed that MASTA is currently pursuing the passage of a Ley de Saneamiento which would assist in their efforts to protect the land to which they have tenure rights. Working with MASTA to help pass the Ley de Saneamiento would promote the ability of local communities to enact their land rights and expel settlers who come to illegal take their land. Through connections with lawyers in Nicaragua and Honduras, WCS should consider helping MASTA's efforts to pass the Ley de Saneamiento. Should this law be passed, WCS would then be able to assist in creating cases against settlers in the protected areas, beginning with invaders occupying the pinch points.

b. Provide legal assistance in obtaining and clarifying land tenure rights. The Tawahka communal lands are in danger of being consumed by invasions by larger scale ladino ranchers, and if FITH can obtain land title it will be a tool for forest conservation. Beyond that, the status of land titling throughout the regions we visited is characterized by widespread confusion over the legal norms that operate within national governments and indigenous communities. Indeed, nearly every agency or group of people we spoke to had different beliefs on what the laws regarding land titling and property entail. In recent years, the governments of both Nicaragua and Honduras have decentralized authority over the wildlife corridor and created new forms of land titles that are a hybrid of traditional communal property and private property. Many indigenous communities, especially in Nicaragua, now hold communal property titles to the forests they inhabit, which grants them exclusionary rights to the resources within them.

[93] ICF, 2014

However, they are not allowed to legally sell this land or divide the rights to this land within different sectors of their communities. This process has been a double-edged sword, as communities both gain agency yet lose the oversight and enforcement that the central governments can provide. This titling regime has led to a scenario that has been well-documented across societies in similar situations, as the deterioration of the ability to exclude outsiders has created a tragedy of the commons as mestizo populations move in at will under what are essentially areas of open access to natural resources.[94] WCS can provide legal assistance to individuals within local communities to obtain land tenure rights.

One long-term opportunity for enforcing property rights emerged from discussions with both the ICF and MARENA, who wish to set precedents for enforcing property rights despite acknowledging institutional limitations. Both agencies note that it will be incredibly difficult for the state to administer dispute-resolution functions at the village level, and even if they do intervene, informal institutions that are more robust on a local level such as kinship-based regimes can retain strong social influence that undermine local courts.[95] There is also a widespread view within indigenous communities that the national governments have abandoned the process of developing, allocating, and enforcing property rights and in the process fomented externalities in the form of social conflict. At the same time, interviews with cattle-ranchers who have purchased tracts of land along the Rio Coco indicate an expectation that the GoH will grant formal titles to the informal land settlers, which would effectively ratify these invasions post-hoc. The processes to achieve conservation solutions for post-hoc invasions might include; 1) expulsion; or 2) binding agreements that include mandatory conservation conditions that protect water sources and watersheds, preserve 50% of a property in forest that connects riparian areas with other forest blocks, and regulations on hunting. However, care should be taken to ensure that such concessions do not create perverse incentives for increased future colonization by individuals hoping to obtain tenure. The details of land tenure, and the defense of titled indigenous lands are important considerations in effecting conservation in the pinch points defined in this report.

[94] Fitzpatrick, 2016
[95] De Soto, 2000

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