FROM: Scientists Concerned for Yasuní National Park

TO: Ingeniero Lucio Gutiérrez
President of the Republic of Ecuador

Luiz Inácio Lula da Silva
President of the Federative Republic of Brazil

José Eduardo de Barros Dutra
President and CEO of Petrobras

CC: Ingeniero Eduardo López
Minister of Mining and Energy, Republic of Ecuador

Dr. Fabián Valdivieso
Minister of the Environment, Republic of Ecuador

Sebastiao Manchineri
President, COICA

Leonidas Iza
President, CONAIE

Juan Enomenga
President, ONHAE

Rodrigo de Rato y Figaredo
Managing Director of the International Monetary Fund

The Courts of the Republic of Ecuador, including the Constitutional Tribunal of Ecuador

RE: **Proposed Petrobras road into Yasuní National Park**

DATE: November 25, 2004

Distinguished Leaders:

We respectfully write you to express our opposition to the approved Petrobras plan to construct a 54-kilometer road from the Napo River into Yasuní National Park to facilitate oil extraction. Yasuní is the largest national park in Ecuador, and has been internationally recognized for its importance, receiving designation as a UNESCO Man and The Biosphere Reserve in 1989. The road will extend 24 kilometers into one of the most intact portions of the park.

We represent leading scientists of Yasuní National Park, and other tropical researchers concerned for the future of Yasuní. We come from Ecuador, Panama, Peru, Denmark, England, Germany, Greece, Scotland, Spain, and from across the United States including Puerto Rico. Together we have well over 100 years of experience conducting research in the park. We have studied many aspects of its biodiversity — plants, amphibians, insects, birds and mammals — as well as the impacts of the Maxus Road, which was built in 1994 into northwest Yasuní for petroleum activities. We have also studied the cultural, economic, and hunting systems of peoples living in the area.

We feel it is our duty as scientists to inform you of our three central conclusions about Yasuní, drawn directly from our own and others' research, and synthesized at the Yasuní Day Research Symposium in Mindo, Ecuador, October 11–13, 2004.

Our first conclusion is that Yasuní National Park protects a region of extraordinary value in terms of its biodiversity, cultural heritage, and largely intact wilderness. This region — the Napo Moist Forests of the Western Amazon — has levels of diversity of many taxonomic groups that are locally and globally outstanding. For example, with an estimated 2,274 tree and shrub species, Yasuní protects a large stretch of the world's most diverse tree community. In fact, there are almost as many tree and shrub species in just one hectare of Yasuní's forests as in the entire United States and Canada combined. Yasuní has 567 bird species recorded — 44% of the total found in the Amazon Basin — making it among the world's most diverse avian sites. Harboring approximately 80 bat species, Yasuní appears to be in the world's top five sites for bat diversity. With 105 amphibian and 83 reptile species documented, Yasuní National Park appears to have the highest herpetofauna diversity in all of South America. Yasuní also has 64 species of social bees, the highest diversity for that group for any single site on the globe. Overall, Yasuní has more than 100,000 species of insects per hectare, and 6 trillion individuals per hectare. That is the highest known biodiversity in the world.

Reflecting its biological uniqueness, World Wildlife Fund scientists have declared this region one of the 200 most important in the world to protect. Yasuní also conserves one of the larger contiguous tracts of the Amazonian rainforest, a broader region identified as one of the world's 24 wilderness priority areas. Furthermore, Yasuní and adjacent areas are home to the indigenous Huaorani, who have relatively uncontacted communities in the park.

Our second conclusion is that Yasuní National Park has major global conservation significance, for the following reasons. The park is one of the few "strict protected areas" in the whole region of the Western Amazon (National Parks of IUCN Category II). Only 8.3% of the Amazon currently falls within any type of protected area. The park harbors a total of 25 mammal species protected under CITES and/or listed as Endangered, Vulnerable, or Near Threatened, as well as many other "species of concern" in groups such as amphibians, reptiles, birds, and plants. For example, the park is one of the most important refuges for the Giant Otter (*Pteronura brasiliensis),* a Critically Endangered species within Ecuador and Endangered globally. The Giant Otters use a large part of the Tiputini River and watershed in Yasuní, and one of the confirmed populations is very close to the construction zone of the proposed Petrobras road. Yasuní also harbors the Amazonian Manatee (*Trichechus inunguis*), another Critically Endangered species within Ecuador that is Vulnerable globally.

If Yasuní is strongly protected, it could be one of the few places to provide long-term protection to viable populations of these and thousands more Amazonian species in the region. Yasuní is in a section of the Amazon predicted to experience minimal weather changes from global warming. The intact forest that Yasuní protects will only increase in value as the surrounding forests are subjected to climate changes and are destroyed for agriculture and other uses.

Our third conclusion is that the negative impacts of roads have proven largely uncontrollable in Yasuní National Park and surrounding forests. Yasuní National Park is at the edge of one of 14 major deforestation fronts in the world. The northern Ecuadorian Amazon is being deforested at a rate of approximately 0.65% per year (40,000 ha per year). At this pace, within the next 150 years, approximately 70% of the region's forest will be gone. Potentially irreversible impacts on the region's biodiversity can be expected much sooner due to habitat fragmentation and disproportionate clearing of areas with better soils.

Roads are among the main catalysts for the deforestation. A recent study suggests that for every new kilometer of road built in the region, an average of 120 hectares of forest are lost to agriculture. Forests near Yasuní are under tremendous land use pressure as a result. For example, the Canton of Shushufindi lost 19.3% of its forests between 1986 and 2001.

Although Yasuní is supposed to be a "strict protected area," the building of the Maxus Road into the park has provided an entry point for migration, colonization, and deforestation. While rates for these activities are slower within the park boundaries, they are still significant. Analysis of satellite images spanning the 10 years since the road's construction illustrate that, if present trends continue, half of the forest within 2 km of the road will be deforested within 50 years. Many farms and entire towns have been constructed in the park along the road. Additionally, on roads just to the north and west of Yasuní, there have been large-scale deforestation and increasing resource extraction, including illegal logging, which threaten to encroach on the park.

Furthermore, the Maxus Road and oil company activities are causing substantial changes to the Huaorani's economic activities, diet, and culture. The road has also led to increased subsistence and illegal commercial hunting within the park. These documented impacts indicate the proposed Petrobras road will be a catalyst for migration, colonization, deforestation, illegal logging, and increased subsistence and illegal hunting inside Yasuní. Thus, the proposed new road represents a grave threat to the park's biodiversity and cultural heritage.

Based on these three conclusions, we strongly oppose the construction of a new road into Block 31 and any other parts of the park. We advocate enactment of an Ecuadorian law prohibiting road-building in national parks for resource extraction, so that the parks maintain their biodiversity over the long-term.

We recommend that the Ecuadorian government require companies to implement "off-shore" drilling techniques to access Yasuní and other environmentally sensitive areas, using helicopters or monorails for transport. The "off-shore" oil drilling model is currently implemented in oceans around the globe, and is an industry standard with which companies have long-term experience. These practices are already being implemented in Ecuador's Block 10 in Amazonian forest near Yasuní, and were nearly implemented by Shell in the Camisea project in Peru with advice from the Smithsonian Institution.

We also urge you to fully consider the economic opportunities presented by tourism and research in Yasuní National Park. Significant revenues and employment are generated by the ecotourism lodges already operating in the park's buffer zone and by the national and international institutions conducting long-term scientific research in Yasuní. The continuation of these activities depends upon maintaining the park's biodiversity and natural ecology. While, at current extraction rates, the oil under Yasuní and its associated revenues will be gone within 50 years, the park itself and its species could serve as long-term economic resources for Ecuador if safeguarded from further road-building and associated impacts.

We have written the attached technical advisory report on Yasuní's biodiversity and conservation significance, the known impacts of roads, and our formal position. We respectfully inform you that we are submitting it to both you and the Ecuadorian courts, where there are cases pending on the Petrobras license for Block 31.

We hope this letter and report will be useful in your decision-making about Yasuní. Those decisions will have major long-term positive or negative ramifications for the park and the conservation of biodiversity in the Western Amazon. We would be pleased to provide you with additional information, and look forward to your reply.

Sincerely,

Scientists Concerned for Yasuní National Park
(*The institutional affiliations of the following 59 scientists are included for reference, and do not imply an institutional stance on this issue.)*

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TECHNICAL ADVISORY REPORT: THE BIODIVERSITY OF YASUNÍ NATIONAL PARK, ITS CONSERVATION SIGNIFICANCE, THE IMPACTS OF ROADS THEREIN, AND OUR POSITION STATEMENT

By the Scientists Concerned for Yasuní National Park
November 25, 2004

Prepared for: Ingeniero Lucio Gutiérrez
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Luiz Inácio Lula da Silva
President of the Federative Republic of Brazil

José Eduardo de Barros Dutra
President and CEO of Petrobras

Ingeniero Eduardo López
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Rodrigo de Rato y Figaredo
Managing Director of the International Monetary Fund

The Courts of the Republic of Ecuador
This report serves as our Amicus Curiae for court cases pending on the Petrobras license for Block 31, including the Constitutional Tribunal Case #994-04-RA.

This report is written and/or endorsed by all of the following
Scientists Concerned for Yasuní National Park:
(*The institutional affiliations of the following 50 scientists are included for reference, and do not imply an institutional stance on this issue.)*

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i. INTRODUCTION & REPORT SUMMARY

We respectfully write this report in support of our letter of November 25, 2004. The letter expresses our opposition to the approved Petrobras plan to construct a 54-kilometer road from the Napo River into Yasuní National Park to facilitate oil extraction. The letter is addressed to the President of Ecuador Ing. Lucio Gutiérrez, the President of Brazil Luis Inácio Lula da Silva, and to the President and CEO of Petrobras José Eduardo de Barros Dutra.

This report also serves as our technical advice to Ecuador's Minister of Mining and Energy, Ing. Eduardo López, and its Minister of the Environment, Ing. Fabián Valdivieso. We are also submitting this report as our *Amicus Curiae* for the current court cases regarding the Petrobras license for Block 31, including the Constitutional Tribunal Case #994-04-RA.

We represent leading scientists of Yasuní National Park, and other tropical researchers concerned for the future of Yasuní. We come from Ecuador, Panama, Peru, Denmark, England, Germany, Scotland, Spain, and from across the United States including Puerto Rico. Together we have well over 100 years of experience conducting research in the park. We have studied many aspects of its biodiversity — plants, amphibians, insects, birds and mammals — as well as the impacts of the Maxus Road, which was built in 1994 into northwest Yasuní for petroleum activities. We have also studied the cultural, economic, and hunting systems of peoples living in the area.

This report addresses three major conclusions we reached about Yasuní National Park during Yasuní Day Research Symposium from October 11–13, 2004, at the Mindo Biological Station in Ecuador. That conference was organized by Maria De Angelo of Yale University, Tom Quesenberry of the Mindo Biological Station, Matt Finer of Environment 2004 (now with Save America's Forests), and Margot Bass of Finding Species.

Yasuní is the largest national park in Ecuador, and has been internationally recognized for its importance, receiving designation as a UNESCO Man and The Biosphere Reserve in 1989. The approved Petrobras road will extend 24 kilometers into one of the most intact portions of the park.

Section A of this report addresses research about the biodiversity and conservation significance of Yasuní. Our first major conclusion is that Yasuní National Park protects a region of extraordinary value in terms of its biodiversity, cultural heritage, and largely intact wilderness (Section A.1). This region — the Napo Moist Forests of the Western Amazon — has levels of diversity of many taxonomic groups that are locally and globally outstanding. For example, with an estimated 2,274 tree and shrub species, Yasuní protects a large stretch of the world's most diverse tree community. In fact, there are almost as many tree and shrub species in just one hectare of Yasuní's forests as in the entire United States and Canada combined. Yasuní has 567 bird species recorded — 44% of the total found in the Amazon Basin — making it among the world's most diverse avian sites. Harboring approximately 80 bat species, Yasuní appears to be in the world's top five sites for bat diversity. With 105 amphibian and 83 reptile species documented, Yasuní National Park appears to have the highest herpetofauna diversity in all of South America. Yasuní also has 64 species of social bees, the highest diversity for that group for any park on the globe. Overall, Yasuní has more than 100,000 species of insects per hectare, and 6 trillion individuals per hectare. That is the highest known biodiversity in the world. Most of these insect species are new to science, and many new genera are being discovered as well.

Reflecting its biological uniqueness, World Wildlife Fund scientists have declared this region one of the 200 most important in the world to protect. Yasuní also conserves one of the larger contiguous tracts of the Amazonian rainforest, a broader region identified as one of the world's 24 wilderness priority areas. Furthermore, Yasuní and adjacent areas are home to the indigenous Huaorani, who have relatively uncontacted communities in the park.

Our second major conclusion is that Yasuní National Park has major global conservation significance (Section A.2), for the following reasons. The park is one of the few "strict protected areas" in the whole region of the Western Amazon (National Parks of IUCN Category II). Furthermore, the broader Amazon as a whole has been identified as one of the world's 24 priority wilderness areas. While only 8.3% of the Amazon currently falls within any type of protected area, Yasuní conserves one of the larger contiguous tracts of this rainforest.

The park's value as a protected area is exemplified by the fact that it harbors a total of 25 mammal species protected under CITES and/or listed as Endangered, Vulnerable, or Near Threatened, as well as many other "species of concern" in groups such as amphibians, birds, and plants (Section A.3). For example, the park is one of the most important refuges for the Giant Otter (*Pteronura brasiliensis),* a Critically Endangered species within Ecuador and Endangered globally. The Giant Otters use a large part of the Tiputini River and watershed in Yasuní, and one of the confirmed populations is very close to the construction zone of the proposed Petrobras road. Yasuní also harbors the Amazonian Manatee (*Trichechus inunguis*), another Critically Endangered species within Ecuador that is Vulnerable globally.

We also find that Yasuní is a site of scientific research of national and international importance. Furthermore, this research is generating economic value for Ecuador that could continue over the long-term. However, much of this research depends upon the continued protection of the park so as to maintain its ecosystems relatively undisturbed by humans (Section A.4).

If Yasuní is strongly protected, it could be one of the few places to provide long-term protection to viable populations of thousands of Amazonian species in the region (Section A.5). Yasuní is in a section of the Amazon predicted to experience minimal weather changes from global warming. The intact forest that Yasuní protects will only increase in conservation and scientific value as the surrounding forests are subjected to climate changes and are destroyed for agriculture and other uses.

Section B of this report summarizes the known impacts of roads on the Yasuní region. Yasuní National Park is at the edge of one of 14 major deforestation fronts in the world. The northern Ecuadorian Amazon is being deforested at a rate of approximately 0.65% per year (40,000 ha per year). At this pace, within the next 150 years, approximately 70% of the region's forest will be gone. Potentially irreversible impacts on the region's biodiversity can be expected much sooner due to habitat fragmentation and disproportionate clearing of areas with better soils.

Roads are among the main catalysts for the deforestation. A recent study suggests that for every new kilometer of road built in the region, an average of 120 hectares of forest are lost to agriculture. Forests near Yasuní are under tremendous land use pressure as a result. For example, the Canton of Shushufindi lost 19.3% of its forests between 1986 and 2001 (Section B. *Overview*).

While roads cause significant direct harm to tropical forest wild flora and fauna (Section B.1), the secondary impacts of roads cause more serious negative impacts over the long-term (Section B.2–B.7).

Although Yasuní is supposed to be a "strict protected area," research shows that the building of the Maxus Road into the park has provided an entry point for migration, colonization, and deforestation (Section B.2). While rates for these activities are slower within the park boundaries, they are still significant. Analysis of satellite images spanning the 10 years since the road's construction illustrate that, if present trends continue, half of the forest within 2 km of the road will be deforested within 50 years. Many farms and entire towns have been constructed in the park along the road. Additionally, on roads just to the north and west of Yasuní, there have been large-scale deforestation and increasing resource extraction, including illegal logging, which threaten to encroach on the park (Section B.3).

In addition, the Maxus Road has led to increased subsistence and illegal commercial hunting within the park (Section B.4). These and the other human activities that have been introduced by the road are likely to be reducing the conservation value of Yasuní in protecting Vulnerable, Threatened, and Endangered Species (Section B.5). The Maxus Road and oil company activities are also causing substantial changes to the Huaorani's economic activities, diet, and culture (Section B.6).

In sum, the negative impacts of roads have proven largely uncontrollable in Yasuní National Park and surrounding forests. We conclude that the proposed Petrobras road will be a catalyst for migration, colonization, deforestation, illegal logging, and increased subsistence and illegal hunting inside Yasuní (Section B.7). There is no evidence that Petrobras will be more successful in controlling these road-associated impacts, as the underlying economic and social conditions driving them are ongoing. Thus, the proposed Petrobras road represents a grave threat to the park's biodiversity and cultural heritage.

Section C of this report provides our formal position strongly opposing the construction of a new road into Block 31 and any other parts of the park. We advocate enactment of an Ecuadorian law prohibiting road-building in national parks for resource extraction, so that the parks maintain their biodiversity over the long-term. These policy positions draw directly from the research and conclusions presented in Section A and Section B.

We recommend that the Ecuadorian government require companies to implement "off-shore" drilling techniques to access Yasuní and other environmentally sensitive areas, using helicopters or monorails for transport. The "off-shore" oil drilling model is currently implemented in oceans around the globe, and is an industry standard with which companies have long-term experience. These practices are already being implemented in Ecuador's Block 10 in Amazonian forests near Yasuní, and were nearly implemented by Shell in the Camisea project in Peru with advice from the Smithsonian Institution.

We also urge you to fully consider the economic opportunities presented by tourism and research in Yasuní National Park. Significant revenues and employment are generated by the ecotourism lodges operating in the park's buffer zone and by the national and international institutions conducting long-term scientific research in Yasuní. The continuation of these activities depends upon maintaining the park's biodiversity and natural ecology. While, at current extraction rates, the oil under Yasuní and its associated revenues will be gone within 50 years, the park itself and its species could serve as long-term economic resources for Ecuador if safeguarded from further road-building and associated impacts.

We hope this report will be useful in the ongoing decision-making about Yasuní. Those decisions will have major long-term positive or negative ramifications for the park and the conservation of biodiversity in the region.

A. The Biodiversity and Conservation Significance of Yasuní

We set forth key results from our research and others' on the biodiversity and conservation importance of Yasuní, as follows:

A.1. Yasuní National Park protects one of the most biologically diverse regions in the world.

Overview Yasuní National Park protects exceptionally high levels of biodiversity across many taxonomic groups. Scientists have documented both very high total numbers of species in the park (species richness), and very high numbers of species found within limited local areas (alpha diversity). Notably high levels of biodiversity have been documented for trees, shrubs, epiphytic plants, amphibians, reptiles, freshwater fish, birds, bats, and insects. Reflecting its biological uniqueness, World Wildlife Fund has declared this region — "The Napo Moist Forests" — one of the 200 most important areas to protect in the world (a Global 200 Priority Ecoregion for Global Conservation).[1,2]

Plants On a global scale, the Western Amazon is one of only 20 areas in the world that have more than 3,000 species of vascular plants per 10,000 square km.[3] Furthermore, this region has diversity levels of trees, epiphytes, and lianas that are exceptionally high, as described below.

Yasuní protects a large stretch of the world's most diverse tree community, which extends from eastern Ecuador and northeastern Peru to Brazil.[4,5,6] At least 1,813 named and described tree and shrub species occur in Yasuní,[7] along with approximately 300 as yet unnamed ones (many of which constitute either new records for Ecuador or species completely new to science).[8] The southern part of the park, known as the Untouchable Zone, is not well explored, but 161 additional species of trees and shrubs have been collected from surrounding provinces.[9] Thus an estimated 2,274 species of trees and shrubs are protected by Yasuní.

Studies from Yasuní and other sites within this megadiverse tree community highlight its global importance. The Catholic University of Ecuador (PUCE), the Smithsonian Tropical Research Institute's Center for Tropical Forest Science (CTFS), and the University of Aarhus established a 50-hectare research plot in Yasuní in 1996 to study forest composition and dynamics. There are 17 other such plots located in various rainforests around the world that follow the same general methods, allowing for direct comparison of tree diversity in the rainforests of Central America, Africa, and Asia, with that of Yasuní.

Thus far, 25 of the 50 hectares in Yasuní have been fully censused, revealing a total of 1,104 species of trees and shrubs.[10] This compares with 494 total species in a 50 ha plot in the African rainforests of Cameroon, and 300 species in the Central American forests of Panama. The only CTFS plot with comparable diversity to Yasuní is located in Lambir Hills National Park in Malaysia, where 1,182 species have been found in a 52 hectare plot.[11] However, when Yasuní's plot is fully censused, it is projected to contain around 1,300 species, which would make Yasuní the most diverse plot among these tropical plots (*see* Table 1).[12]

Additionally, within just one hectare of Yasuní's plot, there are 644 tree species. The diversity of the area is highlighted by comparisons: the Panamanian plot has only 168 species per hectare, and the Pasoh Forest Reserve plot in peninsular Malaysia has 497 species per hectare.[13] To further put this number in perspective, there are nearly as many shrub and tree species in one hectare of Yasuní's Forest Dynamics Plot as there are trees native to *all* of North America (an estimated 680 species).

Table 1. *Center for Tropical Forest Science research plots.*[14]
Parcelas de investigación del Center for Tropical Forest Science.

Site	Country	Tree Species (Total)	Area (Hectares)
Yasuní National Park	**Ecuador**	**1,104**	**25**
Lambir Hills National Park	Malaysia	1,182	52
Pasoh Forest Reserve	Malaysia	816	50
Khao Chong Wildlife Refuge	Thailand	602	16
Korup National Park	Cameroon	494	50
Okapi Faunal Reserve	D. R. of Congo	446	40
Palanan Wilderness Area	Philippines	335	16
Barro Colorado Island	Panama	300	50
Huai Kha Khaeng W. Sanctuary	Thailand	251	50
La Planada Nature Reserve	Colombia	228	25
Sinharaia World Heritage Site	Sri Lanka	204	25
Luquillo Experimental Forest	Puerto Rico	138	16
Mudumalai Wildlife Sanctuary	India	71	50

The park is very rich in other plants as well. More than 450 liana species (vines) have been documented,[15] making Yasuní one of the richest areas sampled for liana diversity in the Neotropics.[16] In addition, 313 species of vascular epiphytic plants are documented for Yasuní.[17] (Epiphytes are plants that grow independently on other plants without roots going to the ground soil. For example, many orchids are epiphytes.)

Furthermore, Yasuní appears to hold the lowland forest world record for the number of epiphytes for the plot size studied (146 species in only 0.1 hectares).[18] The species density and abundance of epiphytes in Yasuní even surpasses literature data from Andean forests, which had previously been thought to carry the highest abundance and alpha-diversity of vascular epiphytes.[19] Moreover, the endemism for epiphytes in this region is considerably higher than previously estimated based upon national accounts for Ecuador. Recent data suggest that at least 10% of the epiphyte species of Yasuní are endemic to the region of the Upper Napo, which comprises only a small portion of the Western Amazon.[20]

Birds With 567 bird species recorded, Yasuní is among the most diverse sites for birds in the world,[21] along with several other Amazonian sites at the base of the Andes. Yasuní is unique among these in being so accessible to birdwatchers, ecotourists, and scientists via a relatively short canoe trip from Coca.[22] The ecology of the species inhabiting the park allow for phenomenal bird-watching: mixed-species flocks in Yasuní have been seen with approximately 120 bird species at one time.[23] Yasuní's key value as a conservation site for birds is highlighted by the fact that it protects 44% of the 1,300 species found in Amazonia,[24] the region with the highest overall bird diversity in the world.[25,26,27]

Mammals, including Primates and Bats Yasuní's value as a haven for mammals is very important both on a national and international level. It harbors at least 173 mammal species,[28] representing 40% of all mammalian species found throughout Amazonia's forests.[29] This high percentage is remarkable considering that Yasuní's size of 9,820 square kilometers is dwarfed by the Amazon Basin forests' size of 6,683,926 square kilometers.[30] Furthermore, Yasuní protects over 90% of the mammals found in the Ecuadorian Amazon.[31] The value of Yasuní is further highlighted by the fact that it harbors over 46% of all mammal species of Ecuador, which as a country ranks 9th in the world for mammal species richness.[32]

The park harbors at least ten species of nonhuman primates, making it among the more diverse sites for primates in the world.[33,34,35] It is also one of the few forests that contains all three of Amazonia's largest and most heavily hunted ateline primates: Howler Monkeys (*Alouatta seniculus*), Woolly Monkeys (*Lagothrix lagotricha*), and Spider Monkeys (*Ateles belzebuth*).[36,37,38]

Yasuní has among the highest bat species richness in the world. A recent study, produced for the Ecuadorian Government as part of Yasuní's management plan, documented 81 species of bats for the park.[39] This represents nearly 10% of the world's 986 known species.[40] If confirmed by scientific peer review, Yasuní will rank as the site with the second highest recorded number of bat species in the world. The only reserve with higher richness is the Iwokroma Forest in Guyana, with 86 species.[41] For comparison, the other reserves in the top five include Paracou in French Guiana with 78 species,[42] Lacandona in Mexico with 64 species,[43] and Jenaro-Herrera in Peru with 62 species.[44] Sixty-one of the Yasuní species are from the exclusively Neotropical family Phyllostomidae, which includes species with a phenomenal variety of feeding habits, from nectarivorous (nectar-eating), frugivorous (fruit-eating), insectivorous (insect-eating), carnivorous (meat-eating), to hematophagous (blood-drinking).

Amphibians and Reptiles Yasuní is prime habitat for frogs, snakes, and other amphibians and reptiles. It is widely noted in the biological literature that the Western Amazon has the greatest amphibian diversity in the world.[45,46,47,48,49,50] With documented reports of 105 amphibian species,[51] and 83 reptile species,[52] Yasuní National Park appears to be the area with the highest herpetofauna diversity in all of South America.[53] It is relevant to note that Santa Cecilia in Sucumbios Province in Ecuador had been the prior record holder with 177 species of herpetofauna. That habitat was destroyed by the influx of colonizing farmers along roads built by the Texaco Oil Company.[54]

Fish Other vertebrate groups are also very diverse in Yasuní. Its rivers, streams and lakes support at least 382 species of freshwater fish.[55] This number will increase with additional sampling.[56]

Insects Yasuní National Park has the highest documented biodiversity of insects in the world. Research by Dr. Terry Erwin and his colleagues demonstrate that Yasuní has more than 100,000 species of insects per hectare, and 6 trillion individuals per hectare ($6x10^{12}$ individuals),[57] the highest known biodiversity. Most of these insect species are new to science, and many new genera are being discovered.[58]

Furthermore, Dr. David Roubik of the Smithsonian Institute has found 64 bee species in Yasuní, representing the richest assemblage of social bees known from any single site in the world. They are on par with the highly eusocial *Apis* species, but are all stingless bees (Meliponini). Several new bee species have been discovered recently in Yasuní, including *Oxytrigona huaoranii* (the Huao Fire Bee), and *Euglossa tiputini*, one of the largest euglossine orchid-visiting bees known in its genus. These two species have only been found in the Yasuní area.[59]

Yasuní also has an impressive level of diversity of ants. During her Ph.D. research, Amy Mertl has encountered 94 species of twig-nesting ants in the park.[60] Dr. Sean O'Donnell and his colleagues have also conducted various studies of ants at Yasuní and other sites. In a survey of litter-nesting ants, approximately half of the species they collected in Yasuní were new to science. In a survey of ants at 15 sites along a productivity gradient ranging from deserts to rainforests (including Monteverde Reserve in Costa Rica, Barro Colorado Island in Panama, Fort Sherman in

Panama), Yasuní was the most species-rich, and had the highest army ant raid rates. In fieldwork at Tiputini Biodiversity Station in the fall of 2003, they found Yasuní to have the highest army ant richness per sample effort as compared with three other lowland tropical wet forest sites (La Selva in Costa Rica, Barro Colorado Island in Panama, and Santa Maria in Venezuela). In addition, at Tiputini Biodiversity Station they also discovered two new species of army ants (one of *Neivamyrmex* and one of *Labidus*), and obtained behavioral data on another very rare species (*Cheliomyrmex andicola*).[61,62,63]

This section has summarized are only a few of the outstanding scientific findings on Yasuni's insects.

Conclusions This review demonstrates that Yasuní protects one of the most species-rich regions on the planet. The biodiversity in Yasuní is even greater when one takes into account the fact that we expect to find hundreds or thousands more unnamed species that are new to science.

A.2. Yasuní is a park of global conservation importance.

Yasuní Protects Western Amazon Diversity As one of the few parks protecting this high diversity Western Amazon region, Yasuní is a "lonely" park. To the north of Yasuní in the Colombian Amazon, the long-term viability of the closer parks is questionable because of political instability.[64] To the east, one has to travel over 500 km (all the way across northern Peru into Brazil and eastern Colombia) before encountering the next national park: the Amacayacu National Park near Leticia. However, Amacayacu is not comparable to Yasuní, because it is smaller, has poorer soils, and a different flora. To the south, the closest national park, the Cordillera Azul, is also more than 500 km away and comprises mostly high elevation forests rather than lowland moist forest. To the west are the foothills of the Andes, and the species composition changes significantly. The lack of any other "strict protected areas" (IUCN Category II) in this region that holds several world biodiversity records makes Yasuní particularly important for global conservation.[65]

Value in Protecting Key Wilderness Region Yasuní National Park is a key area to keep intact because of its wilderness value. It lies within Amazonia, which has recently been identified as one of the world's 24 wilderness priority areas.[66] At almost 1 million hectares in area, Yasuní is among the significant parks protecting the Amazonian wilderness. Only 8.3% of Amazonia is currently protected under any of the IUCN Categories 1–1V.[67] Large tracts of forest are necessary to maintain large predator species and/or rare, widely distributed species. For example, a study of raptor species in French Guiana suggested that patches of up to 300,000 hectares may be needed to maintain all raptor species in a tropical rainforest region.[68]

Yasuní has intact populations of many large predator species and/or rare, widely distributed species which indicates that it is still an intact healthy wilderness areas, including Jaguars, multiple species of primates, Bush Dogs, Short-eared Dogs, Tapirs, Peccaries, Harpy Eagles, Black Caimans, Arapaima, and Cedro. Because of its value for maintaining such species, Yasuní has been selected by the Wildlife Conservation Society for its Living Landscapes Program.[69]

Furthermore, the area where the proposed Petrobras road would go is one of the most important regions to protect within Yasuní National Park. This northeastern portion of the park is not currently being impacted significantly by humans, other than by a few isolated oil activities.[70] Because this area is almost completely intact, it has an even higher value in protecting Yasuní's ecology and biodiversity.

Global Warming Threat Makes Yasuní Even More Important A recent study has examined how Amazonia's climate will change due to predicted human-induced global warming, and how plants will be affected.[71] The model indicates that there will be changes in the amounts of moisture in northeast and central Amazonia, and changes in seasonality throughout most of Amazonia except in northwestern Amazonia. The northwestern Amazon, including Yasuní National Park, is likely to be one of the regions *least* affected by climate change. The study concludes that the forests of the western Amazon are likely to serve as a refuge for the moist forest species of the Amazon, whereas a large percent of the plant populations in other areas are predicted to become "nonviable." This study demonstrates that protecting Yasuní is crucial on the global scale, because it may serve as a refuge for thousands of Amazonian species that cannot continue to thrive in other parts of the Amazon Basin.

Conclusions Yasuní National Park is a park of global conservation importance, and must be protected from further anthropogenic disturbance. Currently, it is, in name, one of the few "strict protected areas" (National Parks of IUCN Category II) conserving an area of global biodiversity significance: the Napo Moist Forests of the Western Amazon. Furthermore, Yasuní's boundaries encompass a large piece of a global priority wilderness area: Amazonia. The location within Yasuní which the Petrobras road would penetrate is currently one of the most intact sections of the park, and thus of especially high value in conserving the region's biodiversity and wilderness. Furthermore, Yasuní is located in one of the parts of Amazonia predicted to be least affected by human-induced global climate change, and thus has the potential to serve as a refuge for Amazonian species.

If Yasuní is further fragmented by roads, this will mean another serious encroachment on the Amazonia wilderness, and a major setback in protecting the species of the Western Amazon. On the other hand, if Yasuní is strongly protected, it could be one of the few places to provide long-term protection to viable populations of thousands of Amazonia species in the region.

A.3. Yasuní protects "species of concern."

Overview Yasuní protects many healthy, intact populations of species widely recognized as urgent conservation priorities. These are species that have been recognized as "of concern" by Red-List books in Ecuador, by the global Red Lists produced by IUCN, or by their inclusion in the Appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Appendix I species receive highest protection under CITES, with Appendix II species the next-highest. Here we highlight information on mammals, amphibians, and reptiles, the groups for which we have the most detailed information (Table 2–4). Additional reviews for plants and birds are likely to greatly increase the number of species of concern.

Protection for Critically Endangered and CITES Appendix I Mammals Yasuní's rivers support two species Critically Endangered within Ecuador: the Giant Otter (*Pteronura brasiliensis*) and the Amazonian Manatee (*Trichechus inunguis*). They are each also included in CITES Appendix I.

The Giant Otter is listed as globally Endangered, making it Yasuní's most important species of concern. It has been hunted out throughout most of its range for its fur. Yasuní National Park and the Pastaza River are considered the Giant Otter's most important refuge in Ecuador,[72] as there are less than 250 sexually reproductive individuals left in the country.[73] Yasuní is estimated to harbor approximately 100 individuals, with 20 reproductive pairs. (There are an estimated 20 groups in Yasuní, with an average of 5 individuals per group.)[74] Giant Otters have been observed in the Tiputini, Tivacuno, Yasuní, Cononaco, Curaray river systems in the park and its area of influence.[75] They use a large part of the Tiputini River and watershed, which the proposed Petrobras road will cross. One of the confirmed population groups is very close to the construction zone of the proposed road.[76] The main threats to this species are contamination of rivers and lakes, particularly from oil spills, and commercial hunting.[77]

The Amazonian Manatee is listed as Vulnerable globally. Yasuní National Park is one of its refuges: There are confirmed registrations of it in the Añangu Lake and watershed, and the Yasuní River, including in the Jatuncocha and Tambococha Lakes.[78] Victor Utreras, an expert on Ecuadorian freshwater mammals from the Wildlife Conservation Society–Ecuador, does not have confirmed registrations of it in the Tiputini River or other water bodies where the proposed Petrobras road will go. Nevertheless, he expects that the Amazonian Manatee uses the rivers in that region for travel routes. The species has historically been threatened by intensive commercial hunting, and populations have become highly fragmented.[79,80] More recently, the major threats to this species are hunting, dynamite fishing (especially for populations near indigenous communities, where this is often practiced), pollution from petroleum activities, and motor boats.[81]

Yasuní's rivers are also inhabited by the Gray River Dolphin (*Sotalia fluviatilis*), which is listed as CITES Appendix I and Endangered in Ecuador.[82] The park also protects the Neotropical River Otter (*Lontra longicaudis*), which is listed on CITES Appendix I and Vulnerable in Ecuador.

Of feline and canine species, Yasuní protects the Jaguar (*Panthera onca*) and Little Spotted Cat (*Leopardus tigrinus*), which are both listed on CITES Appendix I, Vulnerable in Ecuador, and Near Threatened globally. It also protects the Ocelot (*Leopardus pardalis*) and Margay (*Leopardus wiedii*), which are in CITES Appendix I and considered Near Threatened in Ecuador.[83] The park also has populations of the Bush Dog (*Speothos venaticus*), which are listed as CITES Appendix I and Vulnerable for Ecuador.[84]

Protection for Endangered and CITES Appendix II Mammals Yasuní has populations of the Pink River Dolphin (*Inia geoffrensis*), which is Endangered in Ecuador, and is on CITES Appendix II. It protects the Puma (*Puma concolor*), which is listed in CITES Appendix II and Vulnerable in Ecuador. Yasuní also has populations of the Amazonian Tapir (*Tapirus terrestris*), which is listed as CITES Appendix II and Near Threatened, both globally and in Ecuador.[85]

Yasuní also provides important protection for primates. Yasuní is the only large protected area in the world for the golden-mantle tamarin (*Saguinus tripartitus*),[86] which is listed in CITES Appendix II and is Near Threatened in Ecuador.[87] While this primate can be common where it occurs, it is known from only a few records in a small region.[88] Yasuní also has many populations of the White-bellied Spider Monkey (*Ateles belzebuth*) and the Woolly Monkey (*Lagothrix lagotricha*)[89] which are listed in CITES Appendix II, Vulnerable in Ecuador, and Near Threatened globally.[90]

Protection for Vulnerable and Near Threatened Mammals Yasuní protects the Bush-tailed Opossum (*Glironia venusta*), listed as Vulnerable both in Ecuador and globally.[91] In addition, it protects the Water Opossum (*Chironectes minimus*) and the Little Rufous Mouse Opossum (*Marmosa lepida*), which are Near Threatened in Ecuador and globally. It also protects the Great False Vampire Bat (*Vampyrum spectrum*), which is Near Threatened in Ecuador and globally.

Table 2. *Threatened Mammals of Yasuní according to IUCN Categories and CITES Appendices.*[92,93]
Mamíferos Amenazados de Yasuní, según los categories de IUCN y los Apéndices de CITES.

Nombre Vulgar	Common Name	Genus and Species	IUCN		*CITES*
			Ecuador	Globally	
Nutria gigante, Lobo de río	Giant otter	*Pteronura brasiliensis*	CR	EN	I
Manatí Amazónico, Vaca de agua Vaca del Amazonas	Amazonian manatee, Water cow	*Trichechus inunguis*	CR	VU	I
Delfín rosado, Delfín Amazónico, Bufeo de río	Amazon river dolphin, Pink river dolphin, Boto	*Inia geoffrensis*	EN	VU	II
Delfín gris de río, Tucuxi	Gray river dolphin	*Sotalia fluviatilis*	EN	DD	I
Guanfando, Perro vinagre	Bush dog	*Speothos venaticus*	VU	VU	I
Mono araña de vientre amarillo, Maquisapa	White-bellied spider monkey	*Ateles belzebuth*	VU	VU	II
Raposa de cola peluda	Bushy-tailed opossum	*Glironia venusta*	VU	VU	-
Tigrillo chico	Oncilla, Little spotted cat	*Leopardus tigrinus*	VU	NT	I
Jaguar, Pantera, Tigre Americano	Jaguar	*Panthera onca*	VU	NT	I
Puma, León americano	Puma, Mountain lion	*Puma concolor*	VU	NT	II
Chorongo, Mono lanudo común, Mono choro	Common woolly monkey	*Lagothrix lagotricha*	VU	LC	II
Nutria común, Nutria Neotropical, Perro de río, Lobo de agua	Neotropical river otter	*Lontra longicaudis*	VU	DD	I
Tapir Amazónico, Danta	Amazonian tapir	*Tapirus terrestris*	NT	VU	II
Raposa de agua, Zorra de agua, Comadreja de agua	Water opossum	*Chironectes minimus*	NT	NT	-
Raposa chica radiante, Zorra chica radiante	Little rufous mouse opossum	*Marmosa lepida*	NT	NT	-
Gran falso vampiro	Great false vampire bat, Spectral vampire	*Vampyrum spectrum*	NT	NT	-
Tigrillo, Ocelote	Ocelot	*Leopardus pardalis*	NT	LC	I
Tigrillo de cola larga, Burricón, Margay	Margay	*Leopardus wiedii*	NT	LC	I
Chichico de manto dorado, Chichico amarillo	Golden-mantle tamarin	*Saguinus tripartitus*	NT	LC	II
Armadillo gigante, Armadillo trueno, Cutimbo	Giant armadillo	*Priodontes maximus*	DD	EN	I
Oso hormiguero gigante, Oso banderón	Giant anteater	*Myrmecophaga tridactyla*	DD	VU	II
Murciélago de ventosas de La Val	La Val's sucker-footed bat	*Thyroptera lavali*	DD	VU	-
Raposa lanuda Amazónica, Zorra lanuda de oriente	Amazonian woolly opossum	*Caluromys lanatus*	DD	NT	-
Murciélago orejudo mayor	Great big-eared bat, Davies' big-eared bat	*Micronycteris daviesi*	DD	NT	-
Parahuaco ecuatorial	Equatorial saki monkey	*Pithecia aequatorialis*	DD	LC	II

Códigos/ Codes:
CR = En Peligro Crítico / Critically Endangered; EN = En Peligro / Endangered; VU = Vulnerable / Vulnerable; NT = Casi Amenazado / Near Threatened; LC = Preocupación Menor / Least Concern; DD = Datos Insuficientes / Data Deficient

Mammals where Data is Deficient There are six additional mammal species which are globally listed as Endangered, Vulnerable, Near Threatened, or Least Concern (*see* Table 2), but lack sufficient data in Ecuador to be categorized. The most at-risk of these species is the Giant Armadillo (*Priodontes maximus)*, which is globally Endangered and listed in CITES Appendix I. Further research needs to be done on these species to determine their status in Ecuador. The presence of these species in Yasuní further illustrates the park's global conservation value.

Threatened Amphibians and Reptiles Ecuador is home to 163 species of threatened amphibians, the third largest number in the world.[94] At least 10 of these species are known to be protected within Yasuní (Table 3). One of them, *Atelopus spumarius*, belongs to that genus with approximately 100 species of frogs that have experienced widespread population declines and even extinctions throughout their distribution ranges in Central and South America. In fact, the population of *A. spumarius* in Yasuní is particularly important because it is one of the few Ecuadorian populations of this species for which live individuals have been reported during the last 10 years.[95] Of the other threatened amphibians in Yasuní, eight are poison dart frogs, which are widely recognized for their brilliant colors and skin toxins (in the Dendrobatidae family, which includes the genera *Dendrobates* and *Epipedobates*). They are often collected and sold illegally on international markets for private collections.[96] Further research in the less explored eastern and southern parts of the park is likely to turn up more of the listed amphibian species.

Table 3. *Known amphibian species of concern in Yasuní National Park.*[97,98]
Los anfibios conocidos del Parque Nacional Yasuní que son "especies de preocupación."

Genus and Species	CITES	IUCN — Globally
Atelopus spumarius	Not listed	Vulnerable
Rhamphophryne festae	Not listed	Near Threatened
Allobates femoralis	Appendix II	Least Concern
Allobates zaparo	Appendix II	Least Concern
Dendrobates duellmani	Appendix II	Least Concern
Dendrobates reticulates	Appendix II	Least Concern
Dendrobates ventrimaculatus	Appendix II	Least Concern
Epipedobates bilinguis	Appendix II	Least Concern
Epipedobates hahneli	Appendix II	Least Concern
Epipedobates parvulus	Appendix II	Least Concern

Yasuní also has a number of reptile species that are known to be at risk from illegal collecting, and from the national and international commercial trade in live animals, meat, and parts such as skin. For these reasons, the following species are protected under CITES, with listings in Appendix II (Table 4).

Table 4. *Reptile species in Yasuní threatened by commercial international trade.*[99,100]
Especies de reptiles de Yasuní que son amanezadas por el comercio internacional en especies.

Order	Family	Nombre Vulgar	Common Name	Genus and Species	IUCN – Globally	CITES
Crocodylia	Alligatoridae	Caimán Negro, Lagarto Negro	Black Caiman	*Melanosuchus niger*	Lower risk	II
		Caimán Blanco, Lagarto Blanco	Common Caiman, Spectacled Caiman	*Caiman crocodilus*	Least concern	II
		Jacaré Pagua	Cuvier's Smooth-Fronted Caiman, Dwarf Caiman	*Paleosuchus palpebrosus*	Least concern	II
		Jacaré Coroa	Schneider's Smooth-Fronted Caiman, Smooth-Fronted Caiman	*Paleosuchus trigonatus*	Least concern	II
Sauria	Teiidae	Iguana	Northern Caiman Lizard, Guyana Caiman Lizard	*Dracaena guianensis*	-	II
		Lagarto Común, Lagartija Overa	Black Tegu, Golden Tegu	*Tupinambis teguixin*	-	II
Serpentes	Boidae	Boa Constrictor	Boa Constrictor	*Boa constrictor*	-	II
		Boa Esmerelda	Emerald Tree Boa	*Corallus caninus*	-	II
		Boa Arborícola De Jardín	Garden Tree Boa	*Corallus hortulanus*	-	II
		Boa Irisada	Rainbow Boa	*Epicrates cenchria*	-	II
		Anaconda, Sucury	Anaconda	*Eunectes murinus*	-	II
	Colubridae	Masurana, Mussurana	Mussurana	*Clelia clelia*	-	II
Testudines	Testudinidae	Morrocoy, Motelo	Yellow-footed Tortoise	*Geochelone denticulata*	Vulnerable	II

Conclusions Yasuní plays an important role in maintaining viable populations of at least 25 mammal species that are protected under CITES and/or listed as Endangered, Vulnerable, or Nearly Threatened in Ecuador or globally. Three species of particular note are the Critically Endangered Giant Otter and Amazonian Manatee, and the Golden-mantle Tamarin (for which Yasuní is its only large area of habitat with legal protection). These and the 22 other mammals of concern have been impacted by declines in pristine habitat, by oil spills, and/or by the international commercial trade in species. Yasuní also has a number of species of reptiles and amphibians at risk from commercial trade, and protects a viable population of *Atelopus spumarius,* which is Vulnerable globally. A new road into Yasuní is likely to greatly diminish Yasuní's value in protecting its species of concern by increasing the likelihood of these impacts (*see* Sections B.1, B.4, and B.5).

A.4. Yasuní is a very important site for research of intact tropical forest ecosystems.

National and International Research Institutions Yasuní provides a unique opportunity to study ecological, climatic, and evolutionary processes of Neotropical forests. It has two premier research facilities, the Catholic University of Ecuador's Yasuní Scientific Research Station (inside the park), and San Francisco University of Quito's Tiputini Biodiversity Station (on the park's border). The park is the site of long-term research by the Catholic University of Ecuador; the San Francisco University of Quito; the Natural History Museum of London; the Smithsonian Tropical Research Institute; Finding Species; the Wildlife Conservation Society; Boston University; King's College London; New York University; the University of Aberdeen; the University of California, Berkeley; the University of California, Davis; the University of Illinois, Urbana-Champaign; the University of Missouri-St. Louis; and the University of North Carolina, Chapel Hill.

Studies Provide National and International Scientific Value These research studies are of key national and international interest and scientific value. Many focus on theoretical ecology, which provide an understanding of the ecology and evolution of tropical species and ecosystem processes. Many also provide essential information for successful long-term conservation of species and ecosystems. Such studies require that the ecosystems in Yasuní remain relatively free from human impacts such as hunting, deforestation, and other such activities.

Studies Provide Economic Value The institutions conducting research in Yasuní have spent millions of dollars on setting up their research sites in Yasuní, conducting their research, and employing assistants. Thus they have significant investments in Yasuní, and provide significant income to Ecuador.

Conclusions There are many national and international institutions conducting research in Yasuní that are important scientifically. These projects and others are a long-term source of employment and income for Ecuador, but many require that Yasuní remain relatively free from human impacts such as hunting, deforestation, and other such activities that are fostered by roads.

A.5. Our Conclusion: Yasuní is a national park of global importance, protecting an area of globally exceptional biodiversity and a priority wilderness area.

We conclude that Yasuní National Park protects a region of biodiversity that is exceptional on a national, international, and global scale. It protects a section of one of the world's 24 priority wilderness areas (the forests of Amazonia) and one of the world's 200 priority ecoregion areas (the Napo Moist Forests). It has intact populations of numerous Endangered and Vulnerable species. Because the park is one of the few "strict protected areas" in this region (National Parks of IUCN Category II), we conclude that Yasuní National Park has major global conservation significance.

B. The Impacts of Roads on Yasuní Biodiversity and Indigenous Cultures

Overview of Deforestation and Impacts of Roads in the Ecuadorian Amazon Yasuní National Park and the Napo region as a whole are at the edge of one of 14 major deforestation fronts in the world.[101] In the northern Ecuadorian Amazon, deforestation is occurring at a rate of between 0.65% and 0.7% per year.[102,103] At this pace, within the next 150 years, approximately 70% of the forest in this region will be gone. Potentially irreversible impacts on the region's biodiversity can be expected much sooner due to habitat fragmentation and disproportionate clearing of forests with better soils. There is large variability in deforestation rates depending upon various factors such as proximity to markets. Deforestation in some of the cantons close to Yasuní is particularly high (*see* Section B.3). Overall, the Ecuadorian Amazon lost 7.2% of its forest between 1986 and 2001, with 86.5% remaining.[104]

Roads built for oil exploration and production have become a major factor in migration, agricultural expansion, and deforestation in the Ecuadorian Amazon. Since the 1970s, oil companies and the government have constructed a major road network. From 1985 to 1996, the road network in the Amazon grew by 400%, from 1,830 km to 7,250 km.[105,106]

While colonization in other parts of Ecuador has begun to subside, it has increased in the northern Amazon.[107] In 2001, almost 4 of every 10 people living in the region were migrants (i.e., place of birth different from place of residence). Population growth rates have been nearly three times the national rates for several decades (around 6–8% per year), mostly due to migration. The share of Ecuador's population in this region has increased from 1.5% in 1950 to 4.5% in 2001.[108]

Most deforestation and agricultural expansion have occurred near major roads. Recent estimates indicate that, for each kilometer of road built in the Ecuadorian Amazon, roughly 120 hectares are deforested for agricultural land use. By 2001, nearly 33% of the Ecuadorian Amazon was within 5 kilometers of a road,[109] the maximum distance for the practice of successful agriculture.[110] Remaining forests close to roads are being lost and fragmented.[111]

As a result of the roads and associated deforestation, total forest cover in the Ecuadorian Amazon is decreasing rapidly. The total deforested area increased from 6.8% in 1986 to 13.5% in 2001.[112] In the northern Ecuadorian Amazon, 40,000 hectares were cleared each year, an annual rate of loss of 0.65% per year.[113] Between 1986 and 2001, the rate of deforestation increased to 0.7% per year. Unlike Brazil, agricultural lands in this region do not appear to be abandoned over time, but remain in use by colonists while more areas are cleared.[114]

Of concern for conservation, 5.6% of lowland tierra firme forests (the vegetation type which Yasuní predominantly protects) in the Ecuadorian Amazon were lost between 1986 and 2001.[115] Currently 90.1% of these forests remain, but at that deforestation rate, nearly half will be gone within the next 150 years.[116] Potentially irreversible impacts on the region's biodiversity can be expected much sooner due to habitat fragmentation and disproportionate clearing of areas with better soils. Indigenous reserves cannot be assumed to provide reliable long-term protection for the forests; significant deforestation occurred in areas under indigenous control from 1986 to 1996.[117]

Below, we summarize key results from our research and others' on the specific impacts of roads on the biodiversity and indigenous cultures of Yasuní.

B.1. Roads cause significant direct harm to tropical forest wild flora and fauna.

Overview There is a growing body of scientific knowledge on the extensive impacts of roads in tropical forests and protected areas.[118,119] These five main impacts are briefly summarized here.

Loss of Forest Habitat and Contamination The most direct impact of roads on tropical forest species is the clearing of their forest habitat for road-building. For the proposed Petrobras road of 54 kilometers with an estimated 25 meters width, this would be an immediate loss of 135 hectares of forest, with 60 of these inside Yasuní. (That does not include the additional clearings required for the two drilling platforms and the processing plant that are proposed within the park.) Species that typically live in the forest interior will cease to occupy the deforested area altogether. Loss of forest cover also affects freshwater species. For example, fish beta-diversity in the Napo River Basin is lower in streams in deforested areas as compared to in forested areas, and the number of rare species increases with the amount of forest canopy cover.[120]

In addition, stream and river habitats near the roads can be affected by erosion, sedimentation, and altered flow patterns, and can be polluted by chemicals from road surface runoff and maintenance.[121] Such impacts could reduce the viability of freshwater species such as the Giant Otter (*Pteronura brasiliensis*) and the Amazonian Manatee (*Trichechus inunguis*), and could change the species composition in freshwater communities.

Effects along the Edge of Roads Roads also cause "edge effects" — such as changes in light, wind, and species composition — along the border of the forest. In Amazonian rainforest fragments, changes in the microclimate up to 100 meters from the edge have been documented, as well as penetration of light-loving butterflies into the forest up to 300 meters from the edge.[122]

The edges of roads are frequently subject to changes in species composition, and can be an access route for non-native or weedy species. For example, roads provide corridors for a limited pool of species of plants that are rapid colonizers and thus homogenize an otherwise astoundingly diverse region.[123] Furthermore, the trees along Amazonian tropical forest edges are likely to be significantly more infested with vines (lianas) than trees in the forest interior. All three major vine guilds have been found to be significantly more abundant along these forest edges, and more diverse. These and other aspects of the liana community along edges can have important impacts on forest dynamics and the functioning of fragmented rainforests. Because they create physical stresses on trees and compete for light and nutrients, liana infestations seem to be partly responsible for the much-elevated rates of tree mortality and damage found along edges of Amazonian forests.[124]

Such changes have been documented in the region of Yasuní. For example, total amphibian richness in upper Napo Basin forests has been found to decline with increasing proximity to pastures, and fewer interior-forest species are found in forests penetrated with roads.[125]

The cumulative edge effects of the proposed road are not likely to be minor. If effects extend only 100 meters from the road, then the proposed Petrobras road of 54 kilometers would have direct impacts on an area of 1,080 hectares of forest, in addition to the 135 hectares cleared for road-building. If the edge effects extend 500 meters on average,[126] then 5,400 hectares will be affected in addition to the forest cleared, for a total of 5,535 hectares of forests lost or seriously impacted. Of these, 2,460 hectares would be within Yasuní National Park.

Noise, Dust and Other Stimuli Impact Species In addition to edge effects, visual, acoustic, and mechanical stimuli from human use of the roads can also affect species' behaviors and distributions.[127] For example, noise from vehicles and machinery on the Maxus Road can be heard up to 1.5 kilometers into the forest. Bird diversity near the road is reduced as a result.[128] The clouds of dust from the Maxus Road and other roads in tropical forests may negatively affect the health of amphibians and other groups, but have not, to our knowledge, been evaluated.[129,130]

Mortality of Animals by Vehicles Vehicle traffic on roads can also result in extensive mortality of slow-moving animals and other species unable to react to vehicles. A significant death toll of snakes and frogs has been documented on the Maxus Road that were run over by trucks and other vehicles. It is possible that such kills have depleted snake populations in the vicinity of the Maxus Road.[131] We have also observed the killing of an Ocelot (*Leopardus pardalis*) by a truck on the Maxus Road.[132] Further research is needed to quantify these effects along the Maxus Road, but they are likely to reduce populations of certain species over the long-term.[133] Similar kills are likely to occur on the proposed Petrobras road, as trucks and other vehicles will be traveling on it.

Fragmentation of Populations Roads also act as barriers to many species, fragmenting their populations. For example, many rainforest mammals, including a number of species of primates, do not like to cross roads. This can create isolated populations which are prone to local extinction and loss of genetic variation.[134] Road clearings are especially difficult for small mammals, army ants, and interior forest birds, which require canopy cover to disperse.[135,136,137,138]

Conclusions There are numerous significant direct impacts associated with roads, including edge effects which could impact thousands of hectares of forest along the proposed Petrobras road, and contaminate rivers and streams. Other effects include noise, dust, and other stimuli from the road, mortality of animals killed by vehicles, and fragmentation of populations. These are all very likely to occur with the proposed Petrobras road.

B.2. The Maxus Road into Yasuní has allowed for significant deforestation, which we predict will worsen. The proposed Petrobras road is likely to generate the same problems.

Overview Even more serious than the direct impacts of roads are the long-term indirect (or "secondary") impacts. Roads open the forest to extensive human activities; amongst the most significant of these are deforestation for farmlands and towns, and facilitated access to pristine areas for wildlife poaching and illegal logging. We and other researchers have studied and observed the deforestation along the Maxus Road ("the Via Pompeya Sur–Iro"), which cuts through the northwest part of Yasuní National Park and was built for petroleum extraction activities in Yasuní. Some of the patterns of deforestation we have documented are summarized below. Based on regional trends, we predict similar problems for the proposed Petrobras road.

Building of Farms and Towns in the Park Several of us started research projects in Yasuní before or just after the 1994 construction of the Maxus Road.[139] In 1994, the first 32 kilometers of the Maxus Road were documented as being in "pristine" condition without any noticeable human presence.[140] The oil companies operating along the road have tried to control the road, and have had some success in doing so given that the pace of deforestation is not as fast as in surrounding areas. Nevertheless, since 1994, we have observed the building of farms and entire towns along the road inside the park, as well as growing colonist and indigenous migration into the park. This has resulted in extensive loss of forest.[141]

Deforestation from 1995–2001: 0.11% Per Year is Lost The loss of forest has been quantified in an analysis of satellite imagery between 1995 and 2001 of Yasuní National Park by Jonathan Greenberg of University of California, Davis. Along the Maxus Road, the overall rate of deforestation is increasing with time. It is thus, by definition, unsustainable. The increasing rate of deforestation within the park is likely a result of continuing in-migration and internal population growth of the Huaorani. The current rate of deforestation within Yasuní National Park along the Maxus Road is 0.11% forest lost/year. While this is still lower than regions immediately outside the park (0.6% forest lost/year), Greenberg estimates that 50% of the forest within 2 kilometers of the road will be lost by 2063 to unhindered colonization and anthropogenic conversion.[142]

These projections indicate that by 2063, the Maxus Road will result in deforestation of at least 148 square kilometers of forest (14,800 hectares), or an area twice the size of the island of Manhattan, New York City.[143] This estimate is conservative, because there is presently almost no commercial farming in the area. As commercial farming increases, farm sizes increase and the rate of deforestation will likely increase much faster than Greenberg's estimates.

Illegal Logging Functional roads are known to greatly increase unsustainable and illegal harvesting of forest resources, notably timber and wildlife.[144] There is extensive illegal logging facilitated by the Maxus Road, even though no logging trucks can use it. The road makes it possible for the Huaorani to get to any river the road crosses, and to cut trees and ship them out by canoe. (We discuss illegal logging coming from the Auca Road into Yasuní in Section B.3, and hunting in Yasuní in Section B.4.)

Conclusions Our observations and data show that deforestation along the Maxus Road has not been effectively controlled by the various parties that have attempted to manage it. This deforestation is significant and is unsustainable. The road is also facilitating illegal logging. We predict similar problems along the proposed Petrobras road, because the underlying social and economic conditions leading to the deforestation are ongoing.

B.3. Deforestation along roads is the pattern in the areas adjacent to Yasuní.

Overview In addition to the pattern of deforestation along the Maxus Road, patterns of forest loss from roads just north and west of the park demonstrate significant pressure on the area's forests to be converted to agricultural land. Grady Harper — a specialist in tropical forest mapping with Conservation International — has analyzed satellite imagery of the Ecuadorian Amazon, comparing the years 1990 and 2000. Dr. Richard Bilsborrow and his colleagues from the University of North Carolina have also done this, and confirm Harper's findings detailed below. In addition, University of Texas professor Dr. Rodrigo Sierra has done in-depth research on the Napo deforestation front. His results point to rapid deforestation in provinces north of the park.

Deforestation around Lago Agrio, Shushufindi, and Limoncocha Harper's analysis shows major losses of what were large intact forest tracts around the roads to and from Lago Agrio, Shushufindi, and Limoncocha, following road construction by oil companies and colonization by migrants.[145] Dr. Sierra has found wide variability in deforestation rates between cantons. Furthermore, his results confirm particularly high levels of deforestation in some of the cantons close to Yasuní. For example, the canton of Shushufindi lost almost 20% of its forest between 1986 and 2001, and has 72% of its forest remaining. The canton of Nueva Loja lost 23.7% of its forest in that time, and has 65% of its forest remaining. The canton of La Joya de Los Sachas lost 37% of its forest in the same 15 years, and has only 45% remaining.

Deforestation and colonization are having major impacts on the biodiversity of these areas. For example, the lake and forests of Limoncocha were once an international attraction for bird watching due to the area's outstanding diversity.[146] However, these sites are rarely visited now by bird watchers as deforestation, oil operation contamination and noise, and the introduction of motor boats have driven away the bird populations.[147,148]

Deforestation along the Auca Road The Harper analysis also shows large-scale deforestation along the Auca Road, which follows a north–south trajectory just west of the Park. Deforestation rates calculated by Dr. Sierra in the area around Joya de las Sachas and the Auca Road are well over 0.65% per year.[149,150] There is extensive deforestation not only along the existing main Auca Road, but also along the many feeder roads perpendicular to the Auca Road which have been built in an uncontrolled fashion. We do not yet have a total for deforested area along the Auca Road, but it is in the range of tens of thousands of hectares and is growing. [151]

Other Impacts along the Auca Road Illegal logging is already a serious problem along the Auca Road and is encroaching into Yasuní National Park.[152] Simultaneously, unchecked wildlife extraction is also seriously impacting populations. For example, in streams near the Auca Road, significant changes have been noted to the fish communities from overfishing.[153] Hunting impacts are also occurring along the Maxus Road within Yasuní, as discussed in the next section (B.4.).

Conclusions There is already extensive deforestation to the north and west of Yasuní, indicating there is intense deforestation pressure on Yasuní. The proposed Petrobras road's proximity to Quichua communities along the Napo River, Huaorani communities, and to the city of Nuevo Rocafuerte indicates that the proposed road will become the next access route for colonization and hunting activities by the Huaorani at a minimum, and, is very likely to allow for more extensive colonization and clearing by other population groups.

B.4. The existing road into Yasuní has caused dramatic increases in hunting of wildlife.

Overview Increased human presence along the Maxus Road has increased the impact of subsistence and illegal commercial hunting by indigenous communities, and by other communities. This occurs because roads allow easier access to a larger area of forest, direct access to local markets, and faster transport in vehicles for the hunters and the prey they have caught, in comparison with their former means of transport (on foot).

Heavy Subsistence Hunting and Some Illegal Commercial Hunting Researchers have documented that the Maxus Road has allowed for exponential increases in sizes of hunting territories. The three Huaorani communities along the Maxus Road currently report using a combined area of 720 km^2 for hunting, which extends along 106 kilometers of the 110-km road. Hunt locations used by the Huaroni in 2002 were on average 12 kilometers from the community, meaning that hunters would first travel an average of 12 kilometers in a car and then enter the forest to hunt.[154]

In the hunt areas used by two of the Huaorani communities along the Maxus Road, there is evidence of local depletion of two primate species — the Spider Monkey (*Ateles belzebuth*) and Woolly Monkey (*Lagothrix lagotricha*) — and possibly the Amazonian Tapir (*Tapirus terrestris*).[155] Models indicate that, for Woolly Monkeys, these rates are unsustainable.[156] An increasing number of species and individuals are being illegally sold for commercial consumption outside of the park. Oil company workers along the Maxus Road are facilitating unsustainable and illegal harvests by transporting hunters to new hunting grounds, as well as to markets along the Río Napo and in Coca where they can sell their hunted animals and their produce.[157,158,159]

There is also intensive hunting within and at the borders of Yasuní occurring from Quichua populations who have moved to live along the first several dozen kilometers of the Maxus Road. Though not yet quantified, it appears that the wildlife have been hunted out in this section of the road,[160] and may have been in other areas in the park to which the Quichua travel from rivers accessed by the road. Illegal hunting camps have even been found by park guards along the Tiputini River near the Yasuní Scientific Station.

Importance of Hunted Species Hunting is not only diminishing certain species' populations, but is also likely to be impacting the forest ecology. For instance, species such as Woolly and Spider Monkeys are important seed dispersers for more than 200 species of tropical trees, and for some large-seed species they are the only dispersers.[161] Therefore, over time, depletion of these primates is likely to reduce plant diversity in hunted areas.

Conclusions Our observations and data show that subsistence and illegal hunting along the Maxus Road has not been effectively controlled. We predict that the proposed Petrobras road will face similar problems, because human populations are likely to move there as they have along the Maxus Road and the Auca Road, and will use the wild species for subsistence and for commercial trade in Coca and/or Nuevo Rocafuerte.

B.5. A new road is likely to bring additional pressures on Yasuní's "species of concern."

Overview A new road into Yasuní is likely to diminish Yasuní's value in protecting the Critically Endangered, Endangered,Vulnerable, and Near Threatened species found in the park.

Serious Impacts Are Likely Many species of concern are impacted by habitat loss, contamination from oil spills, and hunting for the national and international wildlife trade. These are impacts that have occurred along the Auca and Maxus Roads and near Nuevo Rocafuerte. The Maxus Road is being used as an avenue for subsistence and commercial hunting, and for transport to commercial markets.[162,163,164] Both the Maxus Road and the Auca Road have fostered agricultural expansion and deforestation.[165,166] Illegal fishing is occurring intensively near Nuevo Rocafuerte.[167] Significant oil spills have occurred along the Maxus Road.[168] Populations of "species of concern" are likely to be affected by vehicle mortality on roads.[169]

The result of these impacts on "species of concern" has not yet been quantified. Given how intensive the impacts are, the result is likely to be significant to species with populations near the Maxus Road. The proposed Petrobras road is likely to have the same serious impacts on these species.

Particular Concern for Giant Otter and Amazonian Manatee Of particular concern are the impacts of the proposed Petrobras road on two species that are Critically Endangered within Ecuador, the Giant Otter (*Pteronura brasiliensis*) and the Amazonian Manatee *(Trichechus inunguis).*

Yasuní National Park and the Pastaza River have been identified as the Giant Otter's most important refuge in Ecuador (*see* Section A.3 above for details).[170] The species is critically endangered by hunting and water pollution, such as from oil spills.[171,172] Roads and associated effects are already known to have very negative impacts on the Giant Otter. The construction of the Auca Road, with its subsequent indirect impacts (e.g., logging, colonization, pollution, etc.), have converted this entire region from good habitat into marginal habitat for the Giant Otter, further restricting its distribution in Ecuador.[173]

With fewer than 100 Giant Otters estimated for the park,[174] any further impacts on this species must be minimized. The Giant Otter is known to use the majority of the Tiputini River and its watershed;[175] the proposed Petrobras road will cross this river, creating access for hunters. Furthermore, there is a confirmed group of Giant Otters in the Tiputini River very near the proposed construction zone for the Petrobras Road.[176] Disturbances from construction and subsequent hunting may threaten this population. In addition, contamination from road runoff and oil spills is likely to occur in the Tiputini River from the proposed Petrobras road and pipeline, which history has shown to be almost unavoidable even when rigorous safety policies are in place. Such contamination would threaten Giant Otter groups downstream.

The Amazonian Manatee is among the most seriously threatened of mammals in the Ecuadorian Amazon.[177] While it has not yet been registered for Tiputini River, it is likely to use that river as a travel route.[178] The major threats to this species currently are hunting, dynamite fishing, pollution from petroleum activities, and motor boats.[179] These activities are all likely to increase in the rivers near the proposed Petrobras road as a result of human migration to the area. Thus, the proposed road may increase threats to the Amazonian Manatee.

Concern for Primates and Amazonian Tapirs We are also very concerned about the impacts of significantly increased hunting of primates and Amazonian Tapirs (*Tapirus terrestris*) because of the proposed Petrobras road. The Amazonian Tapir and many of the primates are on Ecuador's red lists. We have discussed this issue in Section B.4.

Conclusions The proposed Petrobras road is likely to increase the threats to species of global conservation concern (as well as many others that are of national concern) by providing easy entry for hunters and colonists into previously inaccessible forest, rivers and streams inhabited by species of concern. This issue is so serious for the Giant Otter that it may be reason enough to halt the road-building until its populations in eastern Yasuní National Park can be fully mapped out, studied, and better protected. Using a roadless option for oil exploitation, such as through helicopters or a monorail, could avoid many of the impacts to the species of concern. While Yasuní currently has key global significance in providing long-term protection for critically endangered species and other species of concern, further roads could significantly reduce its value in doing so.

B.6. The Maxus Road and oil exploration in Yasuní have significantly impacted the Huaorani.

Overview In addition to the changes in hunting patterns of the Huaorani (described in B.4), the Maxus Road and oil exploration in Yasuní have led to other serious impacts on their culture and livelihood.

Impacts on the Economic Activities, Diet, and Culture of the Huaorani Professor Flora Lu Holt, Dr. Richard Bilsborrow, and their colleagues at the University of North Carolina, Chapel Hill, have studied the Huaorani inside and near the park for over a decade. They have found substantial impacts from oil company exploration, extraction activities, and roads, on the economic activities, diet, and culture of the Huaorani. For example, oil company provisions given to the communities (such as rice, canned tuna, sugar, and noodles) have led to deterioration in their traditionally healthy diet, and have reduced sharing among families of food from the forests and rivers. These impacts appear permanent, and are magnified when oil activities and roads are combined.[180,181]

Migration and Hunting Along the Maxus Road Indigenous Huaorani communities have increased in number and population size along the Maxus Road in the ten years of the road's existence. Communities have migrated to the road to collect free provisions from the oil company, and have settled there, building permanent houses and towns. The road has also significantly influenced Huaorani hunting patterns. They now conduct intensive hunting along the full length of the road, taking advantage of the free transport provided by the oil company, rather than only hunting in the forest around their communities.[182,183,184]

Water Pollution If the history of petroleum activities elsewhere in the northern Ecuadorian Amazon over the past three decades can be taken as an example, then water sources which the Huaorani rely upon for drinking water and bathing are very likely to have been contaminated by road runoff and oil spills from the pipeline along the Maxus Road. We have seen oil spills in the rivers along the Maxus Road. However, as far as we know, such data has not been collected in Yasuní, and information on oil spills in the park has been strictly guarded by oil company officials.

Conclusions Changes to the Huaorani economy and culture are very significant from the oil company activities and the Maxus Road. The road, company transport, and free provisions are changing the diet and allowing for hunting over an increased area. Even if all other forms of human migration to the proposed Petrobras road were to be successfully controlled by checkpoints in the short term, migration of Huaorani families to the proposed Petrobras road is likely to occur, because it has happened at sites along the Maxus Road, from kilometer 32 to its terminus. The proposed Petrobras road is thus predicted to further impact the Huaorani way of life and health, and facilitate increased migration and deforestation within the park.

B.7. Our conclusion: New roads into Yasuní cannot be effectively controlled.

We conclude that existing and future roads in and around Yasuní National Park cannot be fully controlled or managed. Research shows that the Maxus Road has not been controlled by the various oil companies and government actors that have attempted to manage it. We find no evidence that Petrobras will be more successful, because the same underlying conditions driving the deforestation, subsistence and illegal hunting, and agricultural expansion in the Ecuadorian Amazon will continue to persist.

C. OUR RECOMMENDATIONS FOR YASUNÍ NATIONAL PARK

Based on all of the above evidence and conclusions, we as a group of scientists concerned for Yasuní National Park respectfully request that you:

C.1. Prohibit any road-building by Petrobras and other oil companies to extract oil from within Yasuní National Park.

We recommend that all planned and future oil extraction in Yasuní occur without any road-building. We strongly urge you to consider the alternatives to roads for oil extraction, such as helicopters or monorails. Such alternative methods are already in use in the nearby Block 10 by the ARCO-Agip partnership.[185] A roadless method was also extensively researched and was ready for implementation at the Shell Camisea project in Peru.[186] Furthermore, the roadless "off-shore" oil drilling model currently implemented in oceans around the globe is an industry standard with which companies have long-term experience, and should be fully evaluated as a strategy for petroleum extraction in any environmentally sensitive area.

We also urge you to fully consider the economic opportunities presented by tourism and scientific research in Yasuní National Park. The Napo Wildlife Center at the border of Yasuní National Park has had excellent success in its first few years of operation and has generated significant revenues for the Ecuadorian Government for park management.[187] There are also several other ecotourism lodges that operate in the buffer zone of the park, expanding the total protected area while providing additional employment and income to Ecuador. These include the Sani Lodge (100% Quichua owned), La Selva Jungle Lodge (with about 20 years in the area), Sacha Lodge, Yuturi Lodge, and several smaller ones, including one being started by the Huaorani.[188] Several of these depend directly upon Yasuní for some of their wildlife viewing;[189] others may benefit by having the birds and other species from Yasuní travel through the area. If more road-building occurs in the park, with associated increased hunting and deforestation, these operations could experience greatly reduced success.

In addition, the research institutions currently working in Yasuní have together invested millions of dollars in their facilities and research in Yasuní, and also create employment opportunities. Thus there are already significant revenues and employment generated through scientific research and ecotourism, but the continuation of these activities depends upon maintaining the park's biodiversity and natural ecology.

Perhaps most importantly, it is critical for policymakers to look at this issue in the long term; in less than 50 years, at current drilling rates, the oil under Yasuní will be gone, along with its economic benefits.[190] However, if care is taken now to preserve the biodiversity of the park by minimizing human impacts, in 50 years, Yasuní may be one of the few sites left in which scientists and ecotourists can find Amazonian Tapirs, Jaguars, Harpy Eagles, Giant Otters, Amazonian Manatees and other rare, wide-ranging species. If Yasuní's species and habitats are properly protected, the park is likely to serve as long-term economic resource for Ecuador.

C.2. Enact a law prohibiting the building of roads into any National Park in Ecuador for extraction of resources.

Many countries already have such laws. We encourage you to show leadership in lawmaking for the long-term protection of Ecuador's biodiversity resources for Ecuadorians and the world. All of our above data on the impacts of roads supports such an approach.

Thank you for your time and careful consideration.

Most sincerely,

Scientists Concerned for Yasuní National Park

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[158] Margot Bass: *Personal observations.* M. Bass has seen oil company workers allow colonists and/or indigenous people who are carrying live Woolly Monkeys and tortoises to pass through company security clearance at Pompeya Sur, and to allow them onto their boats to Coca. She has also seen oil company workers transport hunters with their guns in company trucks.

[159] Romel Montufer. *Personal communication to M. Bass.* R. Montufer has seen bags of baby parrots being transported by people from inside the park to areas outside the park.

[160] Nigel Pitman: *Personal observation.*

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[164] Bruce Farnsworth: *Personal communication to M. Bass.*

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