The Biodiversity of the Brownsberg

Authors: De Dijn, Bart P. E., Molgo, Iwan E., Norconk, Marilyn A., Gregory, L. Tremaine, O'Shea, Brian, et al.

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Rapid Assessment Program

RAP
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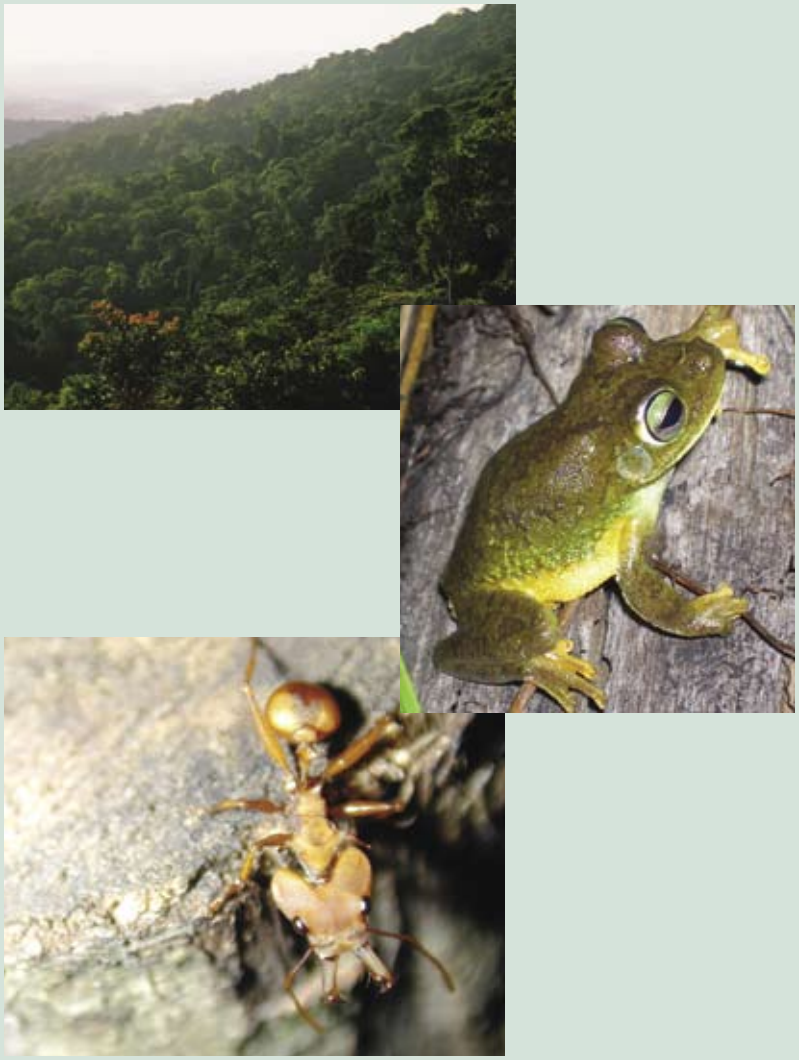
43

A Rapid Biological Assessment of the Lely and Nassau Plateaus, Suriname (with additional information on the Brownsberg Plateau)

Leeanne E. Alonso and Jan H. Mol (Editors)



Center for Applied Biodiversity Science (CABS)

Conservation International Suriname

Stichting Natuurbehoud Suriname (Stinasu)

Anton de Kom University of Suriname/ CELOS

BHP Billiton Maatschappij Suriname

Suriname Aluminum Company LLC (Suralco)

Cover photos

Top: The Lely Mountains.
Trond Larsen

Center: *Hyla crepitans*, a forest stream frog species found at Nassau.
James I. Watling

Botton: *Daceton armigerum*, documented on the Lely Plateau.
Jeffrey Sosa-Calvo

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Organizational Profiles

CONSERVATION INTERNATIONAL SURINAME

Conservation International Suriname (CI-Suriname) is a non-Profit, non-Governmental Organization established in 1992 in Suriname. Our goal is to promote biodiversity conservation and sustainable use of biodiversity through education, awareness and capacity building science projects, and by stimulating eco-tourism in tribal communities.
Our mission is to conserve Suriname's biodiversity, while demonstrating that humans can live harmoniously with nature.

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CONSERVATION INTERNATIONAL

Conservation International (CI) is an international, nonprofit organization based in Washington, DC. CI believes that the Earth's natural heritage must be maintained if future generations are to thrive spiritually, culturally and economically. Our mission is to conserve the Earth's living heritage, our global biodiversity, and to demonstrate that human societies are able to live harmoniously with nature.

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STICHTING NATUURBEHOUD SURINAME (STINASU), FOUNDATION FOR NATURE CONSERVATION IN SURINAME

Founded on June 17th 1969, Stinasu is the leading and authoritative nature protection organization in Suriname, contribution significantly to the protection of Suriname's existing nature (monuments) by supporting local and international partnerships in the fields of scientific research, nature education and nature tourism. Stinasu was founded by Dr.

Johan Schulz, the former Head Forester of the Forestry Department, as an effective way to conduct research and provide nature education without strict financial support from the government. Since it is a semi-governmental organization, funding is drawn from its nature tourism activities in the nature reserves and nature park in Suriname.

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ANTON DE KOM UNIVERSITY OF SURINAME

Anton de Kom University of Suriname was founded on 1 November 1968 and offers studies in the field of social, technological and medical sciences. There are five research centers conducting research and rendering services to the community. The Center for Agricultural Research (CELOS)is promoting agricultural scientific education at the faculty of Technological Sciences. Institute for Applied Technology (INTEC), Biomedical Research Institute, Institute for Development Planning and Management (IDPM), Institute for Research in Social Sciences (IMWO), The Library of ADEK, University Computer Center (UCC), National Zoological Collection (NZCS) and National Herbarium of Suriname (BBS).

The primary goal of the NZCS and BBS are to develop an overview of respectively the fauna and flora of Suriname and build a reference collection for scientific and educational purposes. The NZCS also conducts research on the biology, ecology and/or distribution of certain animal species or on the composition and status of certain ecosystems.

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BHP BILLITON MAATSCHAPPIJ SURINAME

BHP Billiton is the world's sixth largest producer of primary aluminium, with a total operating capacity in excess of one million tonnes of aluminium, approximately 14 million tonnes of bauxite and four million tonnes of alumina per annum. BHP Billiton is one of the world's largest non-integrated producer of primary aluminium. BHP Billiton is a shareholder in the Paranam alumina refinery and the Lelydorp III and Coermotibo bauxite mines in Suriname.

BHP Billiton is committed to sustainable development and approaches this in the context of society as a whole. For example, while a particular mine site will not be sustainable because the ore-body will be depleted over time, the mine can still make a valuable contribution to a society's overall pursuit of sustainable development. The mine creates employment, provides the opportunity for training and skills enhancement, pays taxes and royalties that can be contributed to government services such as education and health care and provides the opportunity for support and spin-off industries. Mining also contributes products that are essential to all modern societies and economies.

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SURALCO (SURINAME ALUMINUM COMPANY LLC)

Suralco is a subsidiary of Alcoa World Alumina and Chemicals. With its 2.2 million metric-tons-per-year (mtpy) alumina refinery and 100 megawatt hydroelectric facility, Suriname Aluminum Company (Suralco) is the largest private employer and taxpayer in Suriname and a key supplier of alumina to Alcoa facilities and markets throughout the United States and Europe. Alcoa's presence in Suriname extends back to 1916 with the formation of Surinaamsche Bauxite Maatschappij N.V. This early company (later to be renamed Suralco) was solely engaged in the development, mining, and export of the country's bauxite resources until the late 1950s. Then, in 1958, the Brokopondo Agreement created a joint venture with the Suriname government to develop hydroelectric power on the Suriname River and a fully integrated aluminum industry in the country. Today, Alcoa holds a 60% share of Suralco and manages the Afobaka hydroelectric facility and the Paranam refinery operations in Suriname. The refinery completed a 250,000 mtpy expansion in early 2005.

At Alcoa, sustainability is defined as using our values to build financial success, environmental excellence, and social responsibility through partnerships in order to deliver net long-term benefits to its shareowners, employees, customers, suppliers, and the communities in which we operate. Consistent with Alcoa's environmental policy and the company's published position on sustainable development, Suralco actively endorses the concept of conservation of biodiversity by operating in a manner that minimizes impacts on natural habitats and biological resources. Suralco's operations can play a positive role in conserving biodiversity by adopting appropriate land management practices and rehabilitating land disturbed by the operations in an appropriate manner.

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CI-Suriname and the RAP program also express their thanks to the scientists, students and logistical staff who participated in the RAP survey and produced this report. Special thanks goes to Kenneth Tjon, Jan Wirjosentono and Greg Love for their dedicated support for all logistical aspects of the survey and to Rosita Moeljosoewito and Kemisem Martowitono for keeping all the RAP participants well fed throughout the survey under less than ideal conditions. Likewise, sincere thanks go to the airstrip maintenance crew at Lely and BMS base camp personnel at Nassau for providing local logistical support and valuable insights into local habitats appropriate to survey.

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Jeffrey Sossa (ants) would like to thank Ryan Badal (IOL) for his help during the fieldwork, Eugenia Okonski for her help sorting, mounting, and databasing the specimens and John LaPolla (NMNH) for his help with statistics and discussions about ant diversity in the Guiana Shield. Ted Schultz (NMNH) made comments and suggestions on early versions of the ant report.

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Finally, CI-Suriname and the RAP participants would like to thank Dr. Leeanne Alonso and her RAP team in Washington, DC for all their support and enthusiasm throughout the entire process needed to make the RAP survey and final report possible.

In the project of the plant diversity of the three bauxite plateaus in North East Suriname many people were involved during the various stages. We want to thank everyone for their pleasant and fruitful cooperation. The fieldwork was made possible by the financial and logistical support of the Suriname Aluminum Company LLC (Suralco/Alcoa) (especially Jan Vandenbergh, Moedio Tirtotaroeno, and Erwin John) and the World Wildlife Fund (WWF) - Guianas Office (especially Michelet Fontaine and Gerold Zondervan). We also thank the Alberta Mennega Stichting, het van Eeden Fonds, and the Netherlands Foundation for the Advancement of Tropical Research (WOTRO grants W84580, W84581) for their financial support.

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Report at a Glance

A RAPID BIOLOGICAL ASSESSMENT OF THE LELY AND NASSAU PLATEAUS, SURINAME

Dates of RAP Survey

October 25 – November 6, 2005

Description of RAP Survey Sites

The Lely and Nassau Plateaus are two plateaus in eastern Suriname characterized by a solid and thick crust in the upper soil composed mainly of consolidated ferrite (Fe) and bauxite (Al). Lely contains a series of plateaus with maximum altitude of approximately 700 meters and Nassau is comprised of four plateaus ranging from 500 - 570 meters. The RAP survey focused on habitats above 500 m, including at Lely: mountain savannah forest, high dryland rainforest, palm swamp and secondary growth, and at Nassau: high dryland rainforest, some mountain savannah forest, limited patches of palm swamp, secondary forest and vegetation in areas cleared for infrastructure such as roads and an overgrown airstrip. These plateaus provide many watershed services for local and coastal communities, as well as important sources of employment (principally small-scale gold mining), food, medicine and building materials for local communities.

Reasons for the RAP Survey

The RAP biodiversity surveys of Lely and Nassau Plateaus were conducted in order to fill in gaps in biodiversity data for eastern Suriname. The 2002 Guayana Shield Priority-Setting Workshop determined that we lack essential biodiversity data for these plateaus needed for conservation planning. The RAP data collected for birds, mammals, fishes, amphibians and reptiles, ants, and dung beetles will contribute to a greater understanding of the fauna and flora of these two plateaus and enable comparisons of biodiversity value with the Brownsberg Plateau (see Executive Summary for comparisons) and other areas of the Guayana Shield. In addition, the data will be used by BHP-Billiton Maatschappij Suriname and the Suriname Aluminium Company LLC (Suralco) as part of their Mining Joint Venture (MJV) to incorporate biodiversity considerations in the earliest stages of decision-making for any mining operations that they may undertake in these areas. It is our aim to provide information so that any mining companies that work in this area can incorporate biodiversity conservation into their project planning.

MAJOR RESULTS

Lely and Nassau Plateaus

- High faunal diversity (see table below),
- At least 27 species endemic to the Guayana Shield region,
- At least 24 species new to science, illustrating how little we know of these areas and the Guayana Shield region overall,
- Many species and individuals of large mammals and large birds (e.g. parrots, guans), indicating that these areas may serve as refuges for larger species,

- While still in good condition, both sites are heavily threatened by human activities, particularly unregulated hunting which is having a direct impact on large mammals and birds, and illegal gold mining in the foothills.

Lely Plateau

- Higher species richness of plants, orchids, mammals, ants, birds, and dung beetles than Nassau, likely due to a combination of factors, including the fact that the Lely Plateau is larger and reaches a higher elevation so that the extent of each forest type is greater. Higher diversity of mammals and dung beetles may also be influenced by the more pristine condition of its habitats in comparison to Nassau,
- The Lely Mountains offer excellent conservation opportunities because of relatively low human impact, low human population densities, and relative lack of access.

Nassau Plateau

- Higher species richness and endemism of fishes in high altitude streams,
- *Harttiella crassicauda,* a rare catfish endemic to the Nassau Plateau, was documented for the first time since 1949,
- The Nassau Mountains have been more heavily impacted by human activities, particularly with regards to hunting and habitat fragmentation resulting from access routes created to facilitate small-scale mining activities and exploration activities for large-scale mining.

NUMBER OF SPECIES RECORDED

	Both RAP Sites	Lely	Nassau
Ants	169	136	79
Dung Beetles	42	37	27
Fishes	41	8	35
Amphibians	27	20	16 (31)**
Reptiles	22	16	13 (26)**
Birds (RAP)	121	67	79
Birds (2003) *		(152)	
Bats	24	14	19
Small Mammals	4	3	1
Large mammals (including primates)	17	13	8
Total	**467**	**314**	**277**

*O'Shea, Chapter 8

**( ) Total number after surveys in 2006 by Ouboter et al. (Chapter 11)

SPECIES NEW TO SCIENCE

Amphibians
Eleutherodactylus (4 species)
Adenomera (1 species)
Atelopus (1 species)

Fishes
Guyanancistrus (1 species)
Harttiella (1 (sub) species)
Lithoxus (3 species)
Trichomycterus aff. *conradi* (1 species)

Ants
Pyramica (1 species)

Dung Beetles
Anomiopus (~ 2 species)
Ateuchus (~ 2 species)
Canthidium (~ 3 species)
Eurysternus (~ 3 species)
Sylvicanthon sp. nov.
Uroxys (~ 2 species)

NEW RECORDS FOR SURINAME

Ants: Genera
Acanthognathus: A. lentus and *A.* cf. *ocellatus*
Cryptomyrmex cf. *longinodus*

Ants: Species
Pyramica auctidens
Pyramica cincinnata
Pyramica crassicornis
Pyramica halosis
Strumigenys cosmostela
Strumigenys trinidadensis

THREATENED SPECIES (IUCN 2006 CATEGORY)

Bats

Carriker's Round-eared Bat, *Lophostoma carrikeri* (Vulnerable)
Dark Fruit-eating bat, *Artibeus obscurus* (Lower Risk/Near Threatened)
Brown Fruit-eating bat, *Koopmania concolor* (Lower Risk/Near Threatened)

Primates

Guyanan Red Howler, *Alouatta macconnelli* (Vulnerable)
Red-backed bearded Saki, *Chiropotes chiropotes* (Data Deficient)

Large Mammals

Brazilian Tapir, *Tapirus terrestris* (Vulnerable)
Jaguar, *Panthera onca* (Lower Risk/Near Threatened)
Cougar, *Puma concolor* (Lower Risk/Near Threatened)
Brocket Deer, *Mazama* sp. (Data Deficient)
Giant Anteater, *Myrmecophaga tridactyla* (Vulnerable)
Dubost's Neacomys, *Neocomys dubosti* (Data Deficient)

SPECIES ENDEMIC TO THE GUAYANA SHIELD

Mammals:
Guyanan Red Howler, *Alouatta macconnelli*
Red-backed bearded Saki, *Chiropotes chiropotes*
Linnaeus's Mouse opossum, *Marmosa murina*
Red-handed tamarin, *Saguinus midas*
Red-faced Spider monkey, *Ateles paniscus*
Dubost's Neacomys, *Neacomys dubosti*
Guiana Neacomys, *Neacomys guianae*
Guyenne Spiny Rat, *Proechimys guyannensis*

Birds
Black Curassow, *Crax alector*
Marail Guan, *Penelope marail*
Caica Parrot, *Gypopsitta caica*
Black Nunbird, *Monasa atra*
Guianan Toucanet, *Selenidera piperivora*
Green Aracari, *Pteroglossus viridis*
Chestnut-rumped Woodcreeper, *Xiphorhynchus pardalotus*
Guianan Streaked-Antwren, *Myrmotherula surinamensis*
Brown-bellied Antwren, *Myrmotherula gutturalis*
Todd's Antwren, *Herpsilochmus stictocephalus*
Black-headed Antbird, *Percnostola rufifrons*
Rufous-throated Antbird, *Gymnopithys rufigula*
White-throated Pewee, *Contopus albogularis*
Guianan Cock-of-the-Rock, *Rupicola rupicola*
Capuchinbird, *Perissocephalus tricolor*
White-throated Manakin, *Corapipo gutturalis*
White-fronted Manakin, *Lepidothrix serena*
Finsch's Euphonia, *Euphonia finschi*
Golden-sided Euphonia, *Euphonia cayennensis*

Amphibians
Colostethus beebei
Colostethus degranvillei
Eleutherodactylus chiastonotus
Eleutherodactylu zeuctotylus
Chiasmocleis shudikarensis

Reptiles
Gonatodes annularis
Neusticurus rudis

Fishes
Harttiella crassicauda (endemic to Nassau Plateau)
Guyanancistrus 'big mouth'

CONSERVATION CONCLUSIONS FROM THE RAP SURVEY

(see Executive Summary for more details)

1. We recommend that the Lely and Nassau plateaus (and also Brownsberg- see Executive Summary) receive increased levels of biodiversity protection. All three areas contain a high proportion of Suriname's biodiversity and contain great habitat diversity that includes typical lowland forest habitats as well as more unique habitats at higher elevations (> 400 m) that are not widely found in the region. Global amphibian declines have resulted in the loss of many higher elevation amphibian faunas, so the presence of abundant, diverse, stream-associated amphibian assemblages at Nassau and Lely is of significant conservation value. These sites provide refuge for many threatened species and species endemic to the Guayana Shield.

Both the Lely and Nassau plateaus warrant conservation action:

Lely

- Lely has high habitat and species diversity for all taxa as well as pristine forest conditions. Lely has slightly higher richness for most taxa compared to Nassau, and slightly higher plant diversity (per plot) than Brownsberg.
- There are still high numbers of large mammals and large birds, indicating that Lely may provide a refuge for these hunted animals,
- Lely is fairly inaccessible with little human impacts, thus presenting an excellent opportunity to protect a large area of high biodiversity, pristine rainforest, and exceptional mountain savannah (moss) forest.

Nassau

- Nassau has been more heavily impacted, but also still contains high biodiversity and good populations of large mammals and larger birds.
- Nassau contains many endemic species (that are found nowhere else), particularly of fishes.
- Protection of the Paramacca Creek (with tributary IJskreek) catchment is critical to the survival of several rare fish species.
- Only 31% of the documented amphibian species were found at both sites, indicating that both Lely and Nassau are important for amphibian diversity, including many species new to science.
- The greater impacts and threats at Nassau call for immediate action.

2. The mechanism for conservation of these sites should be developed through a collaborative approach between public and private institutions, including local communities, to address and halt the threats currently and potentially facing these sites. Some possible mechanisms include:

- Empower and fund the Nature Conservation Division of the Suriname government to increase monitoring in all three areas, especially for hunting and illegal mining.

- Create a Nature Park on the Nassau Plateau to protect the unique Paramacca Creek watershed. Urgent action is needed at Nassau due to the higher level of human pressures there.
- Engage the local people including the traditional communities in the area, particularly the Paramaka Maroons (Nassau and Lely), Aukaner/Okanisi or Djuka Maroons (Lely), Saramaka Maroons (Brownsberg) and also the non-traditional communities such as the small-scale gold miners.
- Integrate the protection of key areas into any development plans for the plateaus (e.g. mining planning). Key areas include the Paramacca watershed at Nassau, the pristine higher elevation forests of Lely, and the vegetation along creeks at Brownsberg. The Lely and Nassau Plateaus are concessions of Suralco (Alcoa). Suralco is also involved in large-scale gold exploration by Newmont in the foothills of the Nassau and Brownsberg Mountains.
- Explore potential tourism opportunities in the two areas as an alternative income for local communities to reduce their dependence on the bushmeat trade, logging, and gold mining.

SPECIFIC CONSERVATION RECOMMENDATIONS

- Integrate the Lely, Nassau and Brownsberg plateaus into a regional conservation strategy and follow up on the IBAP recommendations in Chapter 2.
- Control hunting, which poses a significant threat to the large mammals, larger birds and dung beetles of both sites.
- Maintain the integrity of forest streams.
- Minimize fragmentation of the natural habitat, control access routes and limit logging, which accelerates habitat fragmentation and degradation and has already begun to impact several groups, especially dung beetles, ants, and mammals.
- Enhance protection of Brownsberg Nature Park and other parts of the plateau.
- Monitor to detect the presence of the chytrid fungus, Batrachochytrium dendrobatidis in adult frogs along forest streams.

- **Additional Research Priorities**
  - Biodiversity surveys during the rainy season,
  - Surveys of lowland streams in the foot hills (especially Paramacca Creek) and high-altitude streams on the Nassau and Lely plateaus,
  - Research on the biodiversity of the Paramacca Creek watershed, including the rare catfish *Harttiella crassicauda,*
  - Research on the population sizes and viability of key species,
  - Further plant inventories of Nassau and Lely,
  - Further research on the potentially new species for science.

Executive Summary

INTRODUCTION

The Lely and Nassau Plateaus are located in north-eastern Suriname and range in elevation from 500-700 m. They are covered mostly by high dryland rainforest on the plateaus and slopes and mountain savannah forest on the plateau. The Brownsberg Plateau is a third major plateau in this area, part of which is protected by the Brownsberg Nature Park (11,800 ha). The 2002 Guayana Shield Priority-Setting Workshop determined that these three plateaus are all important for biodiversity but that we lack essential biodiversity data, particularly for Lely and Nassau (Huber and Foster 2003). The plateaus provide many watershed services for local and coastal communities, as well as important sources of employment (principally small-scale gold mining), food, medicine and building materials for local communities. Lely and Nassau are still relatively intact owing to low human population density, which presents many unique opportunities for conservation over a relatively large landscape area. However, they all face a number of current and potential threats, including logging, hunting/poaching and small-scale (gold) and large-scale (bauxite and gold) mining.

Conservation International's Rapid Assessment Program (RAP)

RAP is an innovative biological inventory program designed to use scientific information to catalyze conservation action. RAP methods are designed to rapidly assess the biodiversity of highly diverse areas and to train local scientists in biodiversity survey techniques. Since 1990, RAP's teams of expert and host-country scientists have conducted 56 terrestrial, freshwater aquatic (AquaRAP), and marine biodiversity surveys and have contributed to building local scientific capacity for scientists in 26 countries. Biological information from previous RAP surveys has resulted in the protection of millions of hectares of tropical forest, including the declaration of protected areas in Bolivia, Peru, Ecuador, and Brazil and the identification of biodiversity priorities in numerous countries.

Project Initiation

Alcoa, through its successful partnership with Conservation International (CI) conducting a RAP survey in Guinea, suggested to the Suralco/BHPB Joint Venture that a similar exercise would be worthwhile in Suriname. Thus in June 2005, BHP-Billiton Maatschappij Suriname (BMS) invited CI to present recommendations on how its Rapid Assessment Program (RAP) could contribute to a greater understanding of the fauna and flora of the Lely, Nassau and Brownsberg plateaus. Suriname Aluminium Company LLC (Suralco) holds mining concessions on these three plateaus and has formed a Mining Joint Venture with BMS. The joint venture divides the mining process between the two companies: BMS to first carry out exploration on the plateaus and then if sufficient bauxite is found, BMS is to do the mining and then Suralco will refine the bauxite.

CI proposed that a strategic partnership be formed with the Mining Joint Venture of BMS and Suralco. A central component of this partnership involves utilizing CI's Initial Biodiversity Assessment Planning (IBAP) methodology to both increase understanding of

these areas' ecosystems and socio-economic dynamics and provides recommendations for incorporating biodiversity considerations in the earliest stages of decision-making for Suriname's next generation of mines (see Chapter 2).

RAP Survey of the Lely and Nassau Plateaus

As part of the IBAP process, CI's RAP program organized a RAP team of 18 scientists, students and logistical support to undertake rapid biodiversity surveys of the Lely and Nassau Mountains. Prior to this RAP survey, very little biodiversity data had been collected for the Lely and Nassau plateaus. Many studies have been conducted in the Brownsberg Nature Park on the Brownsberg plateau so the RAP team did not include this plateau in their survey. However, the biodiversity of Brownsberg is summarized in this report (see Chapter 13) and comparisons between the three plateaus are made below. The few studies that had been done on the Lely and Nassau plateaus are also included in this report (see Chapters 3, 4, and 8).

The RAP team surveyed the Nassau and Lely plateaus from October 25 – November 6, 2005, focusing on the same areas studied during previous plant surveys (Bánki et al. 2003, ter Steege et al. 2004, 2005). The RAP team, composed of specialists in ants, birds, dung beetles, fishes, mammals, and reptiles and amphibians, collected data on these taxonomic groups, generated a set of overall conclusions of the regions' biodiversity, and made recommendations on how their ecosystems can be conserved.

Criteria generally considered during RAP surveys in order to identify priority areas for conservation across taxonomic groups include: species richness, species endemism, rare and/or threatened species, and habitat condition. Measurements of species richness can be used to compare the number of species between areas within a given region. Measurements of species endemism indicate the number of species endemic to some defined area and give an indication of both the uniqueness of the area and the species that will be threatened by alteration of that area's habitat (or conversely, the species that may be conserved through protected areas). Assessment of rare and/or threatened species (IUCN 2006) that are known or suspected to occur within a given area provides an indicator of the importance of the area for the conservation of global biodiversity. The confirmed presence or absence of such species also aids assessment of their conservation status. Many of the species on IUCN's Red List of Threatened Species carry increased legal protection thus giving greater importance and weight to conservation decisions. Describing the number of specific habitat types or subhabitats within an area identifies sparse or poorly known habitats within a region that contribute to habitat variety and therefore to species diversity.

RAP SURVEY AREAS

The Lely and Nassau Mountains are two isolated plateau areas in eastern Suriname along the border with French Guiana and east of the Brokopondo Reservoir (see Map). The defining feature of these plateaus is the presence of a solid and thick crust in the upper soil that is composed mainly of consolidated ferrite (Fe) and bauxite (Al). Although the RAP survey of both areas was conducted during the dry season, both areas received rainfall during the survey, with Lely receiving more rainfall (at times heavy) than Nassau. Rainfall generally occurred in the late afternoon or at night.

Lely Mountains

The Lely Plateau is located within the Marowijne River Basin and contains a series of plateaus with maximum altitude of approximately 700 meters. In the Lely Mountains, six main vegetation types occur namely: high dryland rainforest on laterite plateaus, high marsh forest on laterite plateaus, mountain savanna forest, mountain savanna moss forest, vegetation on and near rocky creek beds, and high dryland rainforest on slopes. In places were human disturbance has occurred, (low) secondary forest and open vegetation is found (e.g. near the airstrip).

The RAP base camp was established at N 4°16'13", W 54°44'18" (UTM N 04.27043, W 054.73815), at an altitude of 640 meters. Vegetation types surveyed by the RAP team included savannah forest with smaller areas of high forest, palm swamp and secondary growth from clearing areas for infrastructure. The Lely Mountains is still an intact area since access to the plateau is difficult and mostly restricted to small airplanes. The infrastructure found on the Lely plateau is considerably less developed than that of Nassau, with no known roads connecting it to other areas of the country.

At present the only human activities in Lely Mountains are related to three to five personnel of the Aviation Service (Sur. Luchtvaartdienst) at the airstrip on the plateau and several camps of small-scale gold miners in the western foot hills. The airstrip staff are stationed in a few huts near the airstrip and have cleared vegetation around two radio towers located adjacent to the airstrip. A number of footpaths are found in the survey area.

Nassau Mountains

The Nassau Plateau is comprised of four plateaus ranging from 500 - 570 meters. In the Nassau Mountains, six main vegetation types occur namely: high dryland rainforest on laterite plateaus, high marsh forest on laterite plateaus, mountain savanna forest, mountain savanna moss forest, vegetation on and near rocky creek beds, and high dryland rainforest on slopes. The mountain savanna (moss) forest is less extensive than on the Lely Plateau and has a higher stature. Open vegetation and secondary forest occur near the old airstrip and on places where bauxite exploration has taken place in the past.

The RAP base camp was established at N 4°49'13", W 54°35'20" (UTM N 04.82047, W 054.60572), at an altitude of 514 meters. Vegetation types surveyed in Nassau included primary and secondary high forest, mountain savanna forest, limited patches of palm swamp and some areas cleared for infrastructure such as roads and an overgrown airstrip.

Of the two plateaus surveyed, Nassau had the most widespread human impacts, with a number of unpaved roads, footpaths and a base camp to facilitate mining exploration by BHP-Billiton (BMS) personnel (it also housed the RAP survey teams). A relatively well-maintained unpaved road (connected to the paved road running along the coast) has a number of smaller, more poorly maintained roads and footpaths feeding off it. An airstrip was located near the mining base camp but has not been maintained and was currently unusable at the time of the RAP survey. At higher areas (> 400 m), the forest and streams of the Nassau Mountains are less impacted but many human activities are encroaching fast from the foothills, including shifting cultivation plots, logging, small-scale gold mining, and exploration for construction of a large goldmine (Newmont).

DATES OF THE RAP SURVEYS

The RAP team was divided into two smaller teams to facilitate transportation to these relatively inaccessible areas. Team 1 (consisting of specialists studying birds, fishes, ants and dung beetles) surveyed Lely from October 25 - 31, 2005 while Team 2 (consisting of specialists studying reptiles/amphibians and small mammals/bats/large mammals) surveyed Nassau. From November 2 - 6, 2005, Team 1 surveyed Nassau and Team 2 surveyed Lely.

OVERALL RAP RESULTS

The RAP survey of Lely and Nassau revealed a high diversity of species, at least 27 of which are endemic to the Guayana Shield region. Both sites contain many large mammals and large birds (e.g. parrots, guans), indicating that they still hold significant populations and may serve as a refuge for these larger species. For most taxa-plants (including orchids), mammals, ants, birds, and dung beetles-Lely appears to be more diverse than Nassau. This is likely due to a combination of factors, including the fact that the Lely Plateau is larger and reaches a higher elevation so that the extent of each forest type is greater. Lely also has a seasonal humidity created by rain clouds that touch the forest cover, which provides the appropriate conditions for Guayanan Highland elements to occur. The higher diversity of mammals and dung beetles at Lely may also be influenced by the more pristine condition of its habitats in comparison to Nassau, which has had more human disturbance and higher hunting pressure.

The pattern of higher diversity at Lely does not hold for the fishes of the high altitude streams, for which eight fish species were documented at Lely versus 11 species at Nassau. Nassau also seems to have higher endemism in fishes, the only taxa for which endemism can currently be established with some confidence. *Harttiella crassicauda,* a rare catfish endemic to the Nassau Plateau, was recorded for the first time since 1949, and a new species of *Guyanancistrus* ('big mouth') is also likely endemic.

At least 24 species new to science were recorded from both sites, indicating how little we know of these areas and the Guayana Shield region overall. Many of the new species are amphibians and fishes, which require clean, quality freshwater for their survival.

While still in fairly good condition, both sites are heavily threatened by human activities. Both sites currently show evidence of unregulated hunting activity, which is having a direct impact on larger species (particularly larger mammals and birds) as well as an indirect impact on the larger trophic chain (e.g. dung beetles). The Lely Mountains offer excellent conservation opportunities because of the relatively low human impact, low human population densities and relative lack of access. The Nassau Mountains have been more impacted by human activities, particularly with regards to hunting and habitat fragmentation resulting from access routes created to facilitate small-scale mining activities and exploration activities for large-scale mining. Better resource management, particularly with increased regulation of hunting and improved access control, could help improve ecosystem health.

RAP RESULTS BY TAXONOMIC GROUP

Ants

Thirty-six ant genera and 169 species were collected from 600 m^2 of leaf-litter samples. A total of 136 species (80.5%) were recorded at Lely and 97 species were recorded at Nassau (ca 58% of the total). The difference could be due to the fact that twice as many samples were taken at Lely, but the degree of disturbance seemed to be greater in Nassau than at Lely so that could also be affecting the ant fauna. The ant community of Lely differed somewhat from Nassau in ant species composition. The number of ant species on these plateaus is likely much higher; more sampling is needed.

The subfamily Myrmicinae was represented by 81 species followed by the Ponerinae with 25 species. The most speciose genus was *Pheidole* with 39 species followed by the genera *Hypoponera* (11 species), *Solenopsis* (10 species), *Pyramica* (9 species), and *Gnamptogenys* (8 species), the four genera accounting altogether for 21.9% of the total. With respect to the number of individuals collected, *Solenopsis* ranked first followed by the genera *Pheidole, Hypoponera,* and *Pyramica.*

Up to half of the ant species recorded constitute new records for Suriname; further species identifications are needed to confirm this. Members of the Dacetini tribe are good tools for biodiversity planning since they are relatively well known and are typical of closed forest understory. Four

Dacetine genera are now known from Suriname since the genus *Acanthognathus* was recorded for the first time in Suriname during this study. A possible new species of the genus *Pyramica* was also collected. The range of the recently described genus *Cryptomyrmex* Fernandez (Myrmicinae: Adelomyrmicini) known previously from only two species from Brazil and Paraguay, was extended to Suriname by this survey.

Dung Beetles

A total of 42 dung beetle species was recorded from both sites; 37 species at Lely and 27 species at Nassau. Comparing only standardized dung pitfall transects from primary forest between the two sites, Lely had 33 species and 21.2 individuals/trap, while Nassau had much lower richness and abundance with 24 species and 4.3 individuals/trap. Even though Lely contained more dung beetle species, the dung beetle species composition of primary forest at the two sites was fairly similar. The sites shared 18 species and showed a high Morisita-Horn similarity index of 0.93.

Both sites appeared to have hunting pressures that are likely to have negatively impacted dung beetle species richness and abundance, but Nassau appeared to have the strongest hunting pressure and the lowest beetle species richness and abundance. Dung beetle abundance at Nassau may also have been negatively affected by a large open cesspool near the basecamp. Both sites were characterized by hard, dry and rocky soils that may make it difficult for many dung beetle species to dig burrows for food and nesting, and may also increase larval mortality. This may be one reason why overall dung beetle abundance was much lower at both sites than for almost all other tropical forests previously sampled.

About 20-30% of the species collected may be undescribed. The genera *Anomiopus*, *Ateuchus*, *Canthidium* and *Uroxys* are likely to contain the most undescribed species. A few species appear to have wide geographical ranges and are also found in the southern Amazon, although most species probably have relatively restricted ranges. Much more information on dung beetle diversity is needed from these and nearby sites in order to make an evaluation of range sizes.

Birds

At Lely, 67 species of birds were positively identified by the RAP team. The team also located the remains of either a Harpy Eagle or Crested Eagle killed by local hunters. At Nassau, 79 bird species were positively identified. Thirty-four (34) species occurred at both sites. Hunting seemed to be having some impact on certain species, particularly on guans, curassows, parrots and raptors, the remains of which, along with discharged shotgun shells, were found in both sites. The species richness and diversity are believed to be typical for these habitats.

During a 14-day survey of Lely in 2003, Brian O'Shea recorded 152 bird species in a limited area around the airstrip. Because Lely is situated in a large region of unbroken forest, the mountain's avifauna is estimated to comprise at least 300 species. The avifauna of Lely appears to be representative of the lowland forest that covers the surrounding region, with the addition of several species that are primarily confined to plateaus in the country's interior. Cracids (guans and currassows) and parrots, two groups that are good indicators of human impact in tropical forest, are well represented at Lely. Scarlet Macaw, a CITES I species, was fairly common during the 2003 survey. Curassows were seen regularly as well, suggesting that hunting activity was not especially high at that time of the survey.

Contopus albogularis (White-throated Pewee) was observed at Lely by O'Shea. This species has one of the most restricted geographic ranges of any bird species in the Guayana Shield. *Phaethornis malaris* (Great-billed Hermit) also has a restricted range in the Guianas. Neither of these species has been recorded from adjacent Guyana. Sixteen species of Guayana Shield endemics, or approximately 40% of those occurring in Suriname, were seen during the 2003 study period.

Fishes

A total of 41 fish species were identified from the Lely and Nassau Mountains (4 and 11 sites, respectively). Of these, 26 were collected in a lowland stream in the foothills of the Nassau Mountains (altitude 106 m). The fish fauna of four high-altitude (plateau) streams in the Lely Mountains had 8 species. In four high-altitude streams in the Nassau Mountains we collected 11 fish species, including the endemic catfish *Harttiella crassicauda* known only from the headwaters of the Paramacca Creek in the Nassau Mountains. The small fish fauna of the Nassau Plateau included 6 species that are potentially new to science. The low number of fish species in the high-altitude streams of the Lely and Nassau Mountains was expected, but the high number of potentially new and possibly endemic species in the Nassau Mountains is exceptional. A striking aspect of the fish communities of the high-altitude streams at these sites is the large number of small-sized species, many of which can be considered dwarf species, such as *Lithoxus* spp., *Harttiella crassicauda*, and *Guyanancistrus* 'big mouth'.

The steep slopes bordering the Nassau Plateau apparently act as biogeographic barriers that prevent the dispersal of fishes from one high-altitude stream to the other streams on the plateau. For example, *Harttiella crassicauda* from the central branch of Paramacca Creek ('IJskreek') differed morphologically from *H. crassicauda* collected in the northern branch of Paramacca Creek. A new loricariid species (nicknamed 'big mouth') from the northern branch of Paramacca Creek was not collected in the central branch, notwithstanding extensive collection efforts at the latter site.

Reptiles and Amphibians

We observed a total of 49 species in 12 days of sampling but comparison of our data with other sites in the Guayana Shield indicate that our survey probably only sampled one-quarter to one-third of the total herpetofauna of the two mountains. During the RAP survery we recorded 36 species (19 amphibians, 16 reptiles) at Lely and 29 species (16

amphibians, 15 reptiles) at Nassau. Density of individuals was also higher at Lely.

Species composition differed between the two sites, with only 15/49 (31%) of all species occurring on both mountains. Forty-eight percent of the species at Nassau were unique to Nassau, whereas the percentage was 57% at Lely. Additional surveys by Ouboter et al. (Chapter 11) at Nassau in 2006 revealed 15 additional amphibian species, bringing the total known to 31 species. They also recorded 11 additional reptile species indicating that there are likely many more species to be found at both sites.

The species at the two sites represented a mix of widespread species that occur throughout lowland portions of much of the Amazon Basin, in addition to species known from lowland forest of the Guayana Shield. Five amphibian records are particularly noteworthy since they may represent species new to science (four species of *Eleutherodactylus* and one species of *Adenomera*).

Previous to the RAP survey, five species of *Eleutherodactylus* were known from Suriname; our work on the two mountains has almost doubled the representation of the genus in the country. Forest streams are important habitat for many species encountered during our surveys: about 50% of the species occurring at each site made use of forest streams, and 25% of the species encountered at Lely and about 30% of the species encountered at Nassau were only found in or along forest streams. Because stream-associated amphibians have experienced precipitous population declines in much of the Neotropics, the presence of an apparently intact, stream-associated amphibian fauna on the two mountains is of significant conservation value.

Mammals

Overall, 45 species of mammals from nine orders were recorded from the two study sites in Eastern Suriname: six orders and 28 species at Nassau; and eight orders and 30 species at Lely. Among the small mammals were one species of marsupial, three species of rodents, and 24 species of bats (mostly fruit-eating bats). Seventeen species of medium and large mammals were recorded at the two sites, with more species (13) at Lely than in Nassau (8). The most diverse groups were the primates and the carnivores, each with four species; including large (*Alouatta macconnelli*, *Ateles paniscus*, *Chiropotes chiropotes*) and small (*Saguinus midas*) monkeys, as well as two large (*Panthera onca*, *Puma concolor*) and one small (*Leopardus pardalis*) cat, plus one coati (*Nasua nasua*).

Our results indicate that the Lely Plateau may have higher taxonomic and ecological diversity and suggest that the forest at Nassau is less suitable for small non-volant mammal species, probably because of the alteration of primary forest. For instance, frugivorous bat were predominant at Nassau, as we would expect in secondary growth forest or forest borders. At Lely, we recorded a better representation of Phyllostominae bat species (which are omnivorous or insectivorous), indicating a more complex forest structure than at Nassau. Two bat species, *Lophostoma carrikeri* and *Artibeus obscurus* are listed as threatened (IUCN 2006). Most of the primates and carnivores are also listed as threatened at the global level and several are restricted to the Guiana region, so their global conservation depends largely on the status of these populations. The Brazilian tapir (*Tapirus terrestris*) is listed as Vulnerable because it is affected by hunting everywhere, and we found evidence that the same occurs in this region. The diversity and concentration of medium and large mammals suggest suitable habitats for these species, which usually require large extensions of less disturbed forest. The presence of ungulates may be the reason behind the presence of cougar and jaguar in the area.

RESULTS FROM OTHER BIODIVERSITY SURVEYS OF THE LELY, NASSAU AND BROWNSBERG PLATEAUS

Plants

Six main vegetation types occur on the Lely, Nassau and Brownsberg plateaus: high dryland rainforest on laterite plateaus, high marsh forest on laterite plateaus, mountain savanna forest, mountain savanna moss forest, vegetation on and near rocky creek beds, and high dryland rainforest on slopes. While on the Brownsberg plateau the forest height and vegetation type changes at very short distances forming a 'mosaic' forest, the vegetation types are more pronounced on the Lely Plateau, where large tracts of uniform vegetation types can be found. Open vegetation or open rock such as found on granite outcrops does not seem to occur on these plateaus.

The plot inventories of the bauxite plateaus show a highly diverse forest and form a distinct group within all inventoried plots of the Guianas. The plots found on Lely are currently among those with the highest average diversity for Suriname, which fits well with the general increase in tree alpha-diversity from western Guyana towards French Guiana. Although this difference is small and not significant, the bauxite plateaus and their surrounding forest have very high tree alpha-diversity compared to the other Surinamese forest areas for which data are available. The composition of the Eastern Suriname plots is best comparable with that of French Guiana on similar ferralitic soils. Plots close together are 'more similar' than plots at larger distance and share more species among them (compared to the lowlands) than can be attributed by chance.

The plant collection record for these bauxite plateaus and for Suriname and the Guianas in general is still very small and much more study is needed. In comparison to the Guayana Highlands with their very high endemicity, the vegetation of the lateritic and bauxitic plateaus on basic volcanic rocks is rather uniform and has low endemicity. We did not find proof in the current dataset for endemics specific to the Brownsberg, Lely, and Nassau plateaus.

Orchids

A separate survey of orchids was carried out on the three plateaus. A total of 190 species of orchids have been recorded from the Brownsberg, Nassau and Lely plateaus:

141 from Brownsberg, 70 from Nassau, and 96 from Lely; 16 % are known from all three ranges, and 31 % only from Brownsberg. The lower orchid richness figures for Lely and Nassau can be regarded as artifacts due to low collecting effort. Compared to other sites in the Guayana Shield region, Brownsberg has the second-highest recorded orchid species richness. The available information suggests that a number of orchid species that are very rare in the region occur in these three ranges, e.g. *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) and *Quekettia papillosa* (Nassau).

There were significant differences in the proportion of species assigned to different substrate classes. Lely, with 16% of its orchids growing on the ground or rocks, diverges from the other two plateaus, which each have 4-5% of their orchids on these substrates. A high proportion of highland orchid species (about 30-40 %) may be the characteristic that distinguishes these ranges with elevated plateaus from areas that are true lowlands, and may explain the high species richness. There may be a trend that highland orchids become more important as the height of the range's main plateau increases. Thus, Lely may be the most divergent, unique and species rich of the three ranges for orchids.

Orchid Bees

A total of 34 species of orchid bees was collected at the three plateaus: 13 at Brownsberg, 22 near Lely and 23 at Nassau. The frequency of bees with orchid pollinaria (pollen sacs) differed significantly between Nassau and a lowland location near Lely; at the first location, none of the bees carried pollinaria, at the second 13 %. More sampling needs to be done before a detailed comparison of the bee faunas of the three ranges can be made. The high frequency of orchid bees with pollinaria at Nassau is unusual and may be linked to the habitat in which most sampling took place, the low elevation cloud forest of the submontane plateau.

COMPARISONS BETWEEN THE LELY, NASSAU, AND BROWNSBERG PLATEAUS

Habitat Type and Current Status

Table 1 presents the current status of the three plateaus. All three plateaus contain six major vegetation types (see Chapter 3 and plant summary above). On the Brownsberg plateau, the forest height and vegetation type changes at very short distances forming a 'mosaic' forest, while the vegetation types are more pronounced on the Lely Plateau, where large tracts of uniform vegetation types can be found. Lely differs from Nassau and Brownsberg in the large extent of the mountain savanna forest. The increase in altitude (670 m asl compared to 550 m asl for the other plateaus) appears sufficient for the occurrence of several Guayana Highland elements, such as the Ericaceaous *Cavendishia*. In addition, the very low open forest on the highest slopes has an abundant moss flora (moss forest) with many Orchidaceae.

The natural habitats of the Brownsberg plateau are similar to those described from the interior of French Guiana by De Granville (1994) and also to those of the Nassau and Lely plateaus (De Dijn pers. comm., Chapter 3). The more unique habitats are those associated with the top of the plateaus, such as mountain savanna moss forest and habitats on heavily encrusted soil. These habitats are divergent in terms of soil and climatological conditions and also vegetation composition.

All three areas' ecosystems are relatively intact owing to low human population density, which presents many unique opportunities for conservation over a relatively large landscape area. However, each of these plateaus has had some impact from humans. Lely is in the most pristine shape, owing mainly to its remoteness and inaccessibility. There is some infrastructure at the Lely airstrip and the air strip work crew engages in hunting, with birds being of particular interest, to supplement their diet.

Nassau has a relatively extensive road network that is already fragmenting habitats and facilitating easy access to forest areas, particularly for small-scale gold miners, with subsequent impacts such as hunting. Infrastructure for mining operations at Nassau include a large open cesspool at Nassau and a small camp.

Over 11,600 ha of the Brownsberg plateau has been protected within the Brownsberg Nature Park (BNP) since 1970. However, a substantial part of the BNP has been disturbed by humans and is secondary forest, mainly along the main road across the range and at lower elevations, especially along creeks where miners are active. The lowest level of disturbance generally is found above 250 m, in the northwest corner of the range, and at some locations near Lake Brokopondo. Although it is a protected area, the BNP has also been impacted by tourism and faces challenges from unresolved conflicts over land rights and poverty, particularly with regards to Maroon communities.

All three plateaus face a number of current and potential threats, the greatest of which are hunting/poaching, logging, habitat fragmentation, and small-scale (gold) and large-scale (bauxite and gold) mining. Encroachment by illegal gold miners is the most imminent threat to all three areas. Considerable effects of human activities (e.g. siltation of streams and deforestation) can already be observed in the foothills of the Nassau and Brownsberg plateaus.

Species Richness

It is difficult to directly compare the three plateaus since there is much more information and greater research effort for Brownsberg compared to Lely and Nassau. However, we attempt here to make some general comparisons. Table 2 presents the species richness recorded at the three sites.

Surveys of plant diversity of the three plateau areas and surrounding areas indicate that all three areas have high diversity compared to most lowland forests plots sampled in western Suriname. The forest stature on the slopes of the plateaus is among the highest forest found in the Northern part of Suriname. While surveys showed Lely to have the highest plant diversity per plot of the three and Nassau the lowest, the differences are not great enough to distinguish any real

Table 1. Current status of the Brownsberg, Lely and Nassau Plateaus.

Site	Total Size	Elevation, Habitat type	Degree of habitat degradation	Evidence of Logging	Evidence of Hunting	Evidence of Mining	Taxonomic groups indicating good conditions or richness	Taxonomic groups indicating poor conditions or richness
Brownsberg	(11,800 ha park) [1] 27,500 total[1]	ca. 500 m Six main vegetation types. A mosaic forest of high dryland rainforest, mountain savanna (moss) forest. and liana forest.	5% of park destroyed by illegal gold miners, much secondary forest	moderate but high in northern parts	moderate but high outside of the park	Yes, legal and illegal gold mining	Monkeys, Trumpeters and Curassows, Large rodents, Tapir, Frogs, Tortoises, Rare orchids and other rare plant species (esp. species associated with submontane areas and encrusted soil)	Fruit bats, plant species that colonize large clearings (incl. invasive & pantropical weeds), human avoidance behavior with primates, low predation and dispersal of large seeds
Lely	32,000 ha[2]	640-700 m Six main vegetation types. Mostly high dryland rainforest and extensive mountain savanna (moss) forest with Guayana Highland elements.	low to moderate	low	moderate	Illegal gold mining nearby and at the base	Large mammals, Larger birds, Amphibians Phyllostomine bats, Dung Beetles Ants: *Wasmannia scrobifera, Thaumatomyrmex ferox*	Ant: *Wasmannia auropunctata*
Nassau	20,000 ha[2],[3]	500-550 m Six main vegetation types. Mostly high dryland rainforest and high marsh forest. Less extensive mountain savanna (moss) forest.	moderate	moderate	high	Yes Illegal gold mining, Legal bauxite exploration	Fishes (6 species new to science, endemic catfish), Large mammals, Larger birds	Stenodermatine (fruit eating) bats, Dung beetles, Ant: *Wasmannia auropunctat*a

[1]De Dijn et al. , Chapter 13
[2]Olaf Bánki and Hans ter Steege, pers. comm.
[3]The three major plateaus of Nassau have a total area of about 5000 ha if only the top of the plateaus and not the slopes are considered (Olaf Bánki and Hans ter Steege, pers. comm.).

differences in plant diversity between the three areas. Lely does differ from Nassau and Brownsberg in that it has a large extent of mountain savanna forest. Lely's plateau is at sufficiently higher elevation than the others such that several Guayana Highland elements are found there (see Chapter 3). The lower orchid richness figures for Lely and Nassau compared to Brownsberg are due to lower collecting effort. Compared to other sites in the Guayana Shield region, Brownsberg has the second-highest recorded orchid species richness.

There is no appreciable difference in the avifaunas of the Brownsberg, Lely, and Nassau plateaus. Differences in the quality and quantity of sampling among the three areas are responsible for differences in species lists. There isn't much of a "montane" avifauna in Suriname (Tafelberg being the exception); in fact structurally simplified habitats over ironstone/bauxite caps generally have relatively few bird species, none of which are restricted to those habitats, and slopes also seem to be depauperate. Tall forest on plateau tops, on the other hand, tends to be quite species-rich, but no more so than similar forest at lower elevations. The most important feature of Lely and Nassau from the bird perspective is the presence of good numbers of large birds such as parrots and guans. These birds are heavily hunted and captured for the pet trade, so their large numbers at these two sites is significant. Brownsberg also houses good populations of these birds, and functions as a wildlife refuge for game birds that tend to be much rarer in the surrounding lowlands. Ribot (2006) confirms that some larger birds (trumpeters, curassows and guans) have returned to Brownsberg after a period of heavy hunting during the internal wars.

Only one of the mammal species recorded at Lely and Nassau has not been recorded from Brownsberg (a spiny mouse, *Neacomys guianae*). The mammal fauna of all three areas is typical of Guayana Shield lowland rainforest and is fairly widely distributed across all three areas, which are very similar in origin but now have different degrees of habitat disturbance. Given that Brownsberg is not only a protected area, but also has a longer history of biological studies, it is likely that most of the mammal fauna has a wide distribution, which can help to keep their populations stable. However, Nassau is a more highly impacted area where local reductions or extinctions of some species populations are possible. Any inference about the status of the mammal fauna at both sites is still incomplete and far from accurate; a more extensive survey is required to determine real patterns of the mammalian assemblage. As noted for birds, the most important feature of these three sites may be the presence of good numbers of larger mammals, many of which are globally threatened and under heavy hunting pressure in other areas.

Besides butterflies, insects have not been systematically studied at Brownsberg, thus comparisons between the three areas cannot be made for ants or dung beetles. The species richness of these groups is high at Lely and Nassau and would be expected to also be high at Brownsberg. A number of rare butterflies have been documented at Brownsberg even though much more data are needed.

Table 2. Number of species documented on the Lely, Nassau, and Brownsberg plateaus.

	All RAP sites in this survey	Lely	Nassau	Brownsberg
Plants (including Orchids from botanical collections at Utrecht)	--	487[1]	694[1]	1060[1]
Orchids		96[2]	70[2]	141[2]
Ants	169	136	79	
Dung Beetles	42	37	27	12[3]
Orchid Bees	--	22[4]	32[5]	13[6]
Butterflies	--	--	--	137[7]
Fishes	41 (17)[8]	8[8]	35 (11)[8]	(3)[8]
Amphibians	27	20	16 (31)[9]	64[10]
Reptiles	22	16	13 (26)[9]	80[10]
Birds (RAP)	121	67	79	-
Birds		152		387[11]
Bats	24	14	19	54[12]
Small Mammals	4	3	1	21[12]
Medium and large mammals (including primates)	17	13	8	41[12]

[1]data from ter Steege et. al (Chapter 3 this volume). Lely based on 1097 specimens, Nassau on 1691 specimens, and Brownsberg on 2572 specimens).
[2] listing by Molgo, 11 Oct 2006, based on herbarium material and other reliable sources.
[3] listing by Hielkema, 2006, based on some material in his collection.
[4] no samples available from Lely sensu strictu; based on sample taken near Diitabiki.
[5] based on a modest sample obtained recently at Nassau plateau.
[6] based on museum specimens from Brownsberg present at NZCS in Suriname.
[7] based on listing by Hajo Gernaat, 2005; most unidentified species not included in count.
[8] number of species of high-altitude streams in parentheses (i.e. excluding 26 species from lowland stream in foot hills of Nassau Mountains); Brownsberg data from Jan Mol, unpublished data.
[9] ( ) with additional data from 2006 surveys by Ouboter et. al. (Chapter 11).
[10] based on various sources, 26 doubtful species not included in count.
[11] various sources, compiled by J.H. Ribot (http://www1.nhl.nl/~ribot/english/); some species removed from Ribot's list by O'Shea.
[12] based on Lim et al. 2005, but excluding 10 species not actually observed at Brownsberg.

Endemic Species

Species Endemic to the Lely, Nassau or Brownsberg Plateau

Given the limited biodiversity survey effort for Suriname and throughout the Guayana Shield, it is difficult to say if any of the species documented on the Lely, Nassau and Brownsberg plateaus are endemic to any of the plateaus proper. No species recorded at Brownsberg are known to be endemic to that area. More information is needed on all of the taxa both within and outside of this area to determine if any species are endemic to the plateaus.

The only local endemism possibly documented so far is for a few fish species at Nassau. The streams of the Nassau Plateau revealed six fish species that are new to science and are thus potentially endemic to the Nassau Plateau. No fish species appear to be endemic to the Lely Plateau so far. The reasons for this large difference in endemism are not clear and should be investigated in the future. Some species (e.g. *Harttiella crassicauda* and *Guyanancistrus* 'big mouth') from high-altitude streams of Nassau Mountains are apparently restricted to this small 20x20 km^2 area; but endemism of the other species remains to be established with future collection efforts. The distribution of some fish species could be restricted to a single stream (*H. crassicauda* in Paramacca Creek) or even a tributary of a stream (e.g. *Guyanancistrus*- 'big mouth' and the slender form of *H. crassicauda*). The steep slopes of the Nassau Mountains plateau probably are a biogeographic barrier preventing the dispersal of fishes throughout the mountains/plateau.

In the current plant data set there is no proof for endemics specific for the Brownsberg, Lely, or Nassau plateaus. However, some groups of plants, such as bryophytes, ferns and orchids are thought to show differences in species composition between lowland and mountainous areas. In

Table 3. Animal species recorded at Lely, Nassau and Brownsberg known to be endemic to the Guayana Shield.

Group	Species	Site
Mammals	Guyanan Red Howler, *Alouatta macconnelli*	Lely, Nassau
	Red-backed bearded Saki, *Chiropotes chiropotes*	Lely
	Linnaeus's Mouse opossum, *Marmosa murina*	Nassau
	Red-handed tamarin, *Saguinus midas*	Lely, Nassau
	Red-faced Black Spider monkey, *Ateles paniscus*	Lely, Brownsberg
	Dubost's Neacomys, *Neacomys dubosti*	Lely
	Guiana Neacomys, *Neacomys guianae*	Lely
	Guyenne Spiny Rat, *Proechimys guyannensis*	Lely
	White-faced saki, *Pithecia pithecia*	Brownsberg
	Black-tailed hairy dwarf porcupine, *Coendou melanurus*	Brownsberg
	Spiny mouse, *Neacomys paracou*	Brownsberg
	Auyantepui aboreal rice rat, *Oecomys auyantepui*	Brownsberg
	Red-legged short tailed opossum, *Monodelphis brevicaudata*	Brownsberg
	Warty Round-eared bat, *Lophostoma schulzi*	Brownsberg
Birds	Black Curassow, *Crax alector*	Lely, Nassau
	Marail Guan, *Penelope marail*	Lely, Nassau
	Caica Parrot, *Gypopsitta caica*	Lely
	Black Nunbird, *Monasa atra*	Lely
	Guianan Toucanet, *Selenidera piperivora*	Lely
	Green Aracari, *Pteroglossus viridis*	Lely
	Chestnut-rumped Woodcreeper, *Xiphorhynchus pardalotus*	Lely, Nassau
	Guianan Streaked-Antwren, *Myrmotherula surinamensis*	Lely
	Brown-bellied Antwren, *Myrmotherula gutturalis*	Lely
	Todd's Antwren, *Herpsilochmus stictocephalus*	Lely
	Black-headed Antbird, *Percnostola rufifrons*	Lely, Nassau
	Rufous-throated Antbird, *Gymnopithys rufigula*	Lely, Nassau
	White-throated Pewee, *Contopus albogularis*	Lely, Nassau

Group	Species	Site
	Guianan Cock-of-the-Rock, *Rupicola rupicola*	Lely
	Capuchinbird, *Perissocephalus tricolor*	Lely, Nassau
	White-throated Manakin, *Corapipo gutturalis*	Lely
	White-fronted Manakin, *Lepidothrix serena*	Lely
	Finsch's Euphonia, *Euphonia finschi*	Lely
	Golden-sided Euphonia, *Euphonia cayennensis*	Lely
	Blue-cheeked Parrot, *Amazona dufresniana*	Brownsberg
	Guianan Puffbird, *Notharchus macrorhynchos*	Brownsberg
	Golden-collared Woodpecker, *Veniliornis cassini*	Brownsberg
	McConnell's Spinetail, *Synallaxis macconnelli*	Brownsberg
	Black-throated Antshrike, *Frederickena viridis*	Brownsberg
	Band-tailed Antshrike, *Sakesphorus melanothorax*	Brownsberg
	Rufous-bellied Antwren, *Myrmotherula guttata*	Brownsberg
	Spot-tailed Antwren, *Herpsilochmus sticturus*	Brownsberg
	Dusky Purpletuft, *Iodopleura fusca*	Brownsberg
	Tiny Tyrant-Manakin, *Tyranneutes virescens*	Brownsberg
	Blue-backed Tanager, *Cyanicterus cyanicterus*	Brownsberg
	Red-and-black Grosbeak, *Periporphyrus erythromelas*	Brownsberg
Amphibians	*Colostethus beebei* (toad)	Lely
	Colostethus degranvillei (toad)	Lely, Nassau
	Eleutherodactylus chiastonotus (frog)	Nassau
	Eleutherodactylu zeuctotylu (frog)	Lely
	Chiasmocleis shudikarensis (frog)	Lely, Nassau
	Atelopus hoogmoedi (= *A. spumarius hoogmoedi*; toad)	Brownsberg
	Cochranella oyampiensis (frog)	Brownsberg
	Colostethus granti (frog)	Brownsberg
	Osteocephalus cabrerai (frog)	Brownsberg
	Scinax proboscideus (frog)	Brownsberg
	Eleutherodactylus inguinalis (frog)	Brownsberg
	Leptodactylus longirostris (frog)	Brownsberg
	Leptodactylus meyersi (frog)	Brownsberg
	Pipa aspera (frog)	Brownsberg
	Rhinatrema bivittatum (worm salamander)	Brownsberg
	Microcaecilia unicolor (worm salamander)	Brownsberg
Reptiles	*Gonatodes annularis* (gecko)	Lely
	Neusticurus rudis (lizard)	Lely, Nassau
	Atractus zidoki (snake)	Brownsberg
	Micrurus collaris (snake)	Brownsberg
	Leptotyphlops collaris (snake)	Brownsberg

the mountain savanna forest many yet unidentified Myrtaceae species occur, making it difficult to determine the conservation value of the forest type at this moment.

Species Endemic to Suriname

Three tree species, *Copaifera epunctata* (Fabaceae), *Phoradendron pulleanum* (Santalaceae), and *Sloanea gracilis* (Elaeocarpaceae) that are thought to be endemic to Suriname were collected at Brownsberg and Lely. However, these possible endemics for Suriname could also be the result of low collection efforts in the Guianas and the surrounding countries.

Species Endemic to the Guayana Shield

Eight mammal species recorded in Lely and Nassau are endemic to the Guayana Shield (Table 3). One of these species, *Ateles paniscus* (Red-faced black spider monkey) also occurs at Brownsberg. Brownsberg has an additional six species endemic to the Guayana Shield (Table 3). However, as noted above, further surveys are needed at Lely and Nassau to assess the presence and status of the mammal fauna.

Nineteen species of Guayana Shield bird endemics, or approximately 50% of those occurring in Suriname, were recorded at Lely and Nassau (Table 3). *Contopus albogularis* has one of the most restricted geographic ranges of any bird species in the Guayana Shield and *Phaethornis malaris* (Great-billed Hermit) also has a restricted range in the Guianas. Neither of these species has been recorded from adjacent Guyana. In addition to most of the aforementioned species, twelve additional Guayana Shield bird endemics have been recorded at Brownsberg (Table 3). Overall, the Lely-Nassau-Brownsberg region contains at least 75% of the Guayana Shield endemics that are known to occur in Suriname.

Of the known herpetofauna, six species of amphibians and two species of reptiles documented at Lely and Nassau are endemic to the Guayana Shield. An additional 15 species at Brownsberg are also known to be endemic to this region (Table 3).

In the current plant data set from the three bauxite plateaus, several species such as *Dicranopygium pygmaeum* (Cyclanthaceae), *Elaphoglossum latifolium* (Lomariopsidaceae), *Lonchitis hisuta* (Dennstaedtiaceae), *Thelypteris holodictya* (Thelypteridaceae), and *Thrichomanes membranaceum* (Hymwnophyllaceae) are found that are thought to be strictly endemic, at least in the Guianas, to the mountain savanna forest (moss forest) and rocky creek beds. At Lely some plant

Table 4. Threatened mammal species recorded at Lely, Nassau and Brownsberg.

Group	Species	Site
Bats	Carriker's Round-eared Bat, *Lophostoma carrikeri* (VU)	Lely
	Lophostoma schulzi (VU)	Brownsberg
	Dark Fruit-eating bat, *Artibeus obscurus* (LR/nt)	Lely, Nassau
	Brown Fruit-eating bat, *Koopmania concolor* (LR/nt)	Nassau
	Glyphonycteris daviesi (LR/nt)	Brownsberg
	Glyphonycteris sylvestris (LR/nt)	Brownsberg
	Phyllostomus latifolius (LR/nt)	Brownsberg
	Vampyressa brocki (LR/nt)	Brownsberg
Primates	Red-backed bearded Saki, *Chiropotes chiropotes* (DD)	Lely
	Guyanan Red Howler, *Alouatta macconnelli* (VU)	Nassau, Lely
Larger Mammals	Brazilian Tapir, *Tapirus terrestris* (VU)	Nassau, Lely
	Jaguar, *Panthera onca* (LR/nt)	Lely
	Cougar, *Puma concolor* (LR/nt)	Nassau
	Brocket Deer, *Mazama* sp. (DD)	Nassau, Lely, Brownsberg
	Giant Anteater, *Myrmecophaga tridactyla* (VU)	Lely
	Bush dog, *Speothos venaticus* (VU)	Brownsberg
	Oncilla, *Leopardus tigrinus* (LR/nt)	Brownsberg
	Giant armadillo, *Priodontes maximus* (EN)	Brownsberg
Small and Medium Size Mammals	Dubost's Neacomys, *Neocomys dubosti* (DD)	Lely
	Woolly opossum, *Caluromys philander* (LR/nt)	Brownsberg
	Delicate slender mouse opossum, *Marmosops parvidens* (LR/nt)	Brownsberg
	White-faced tree rat, *Echimys chrysurus* (VU)	Brownsberg

species, e.g. *Cavendishia callista* (Ericaceae) that belong to the Guayanan Highlands were also found in the mountain savanna forest.

Threatened Species

The IUCN Red List categorizes species based on the degree to which they are threatened (IUCN 2006). Categories, from less threatened to most threatened, include: Data Deficient (DD, not enough is known to make an assessment), Lower Risk (LR) which includes Conservation Dependent (cd), Near Threatened (nt), and Least Concern (lc, listed but not threatened), Vulnerable (VU), Endangered (EN), and Critically Endangered (CR) (IUCN 2006).

Ten tree species recorded on the three plateaus are listed by IUCN as threatened; the abundance of each species differs between the three plateaus. These species are: *Vouacapoua americana* (CR), *Apeiba intermedia* (DD), *Virola surinamensi* (EN), *Minquartia guianensis* (LR/nt), *Pouteria rodriguesiana* (LR/nt), *Copaifera epunctata* (VU), *Macrolobium amplexans* (VU), *Couratari guianensis* (VU), *Corythophora labriculata* (VU), and *Bertholletia excelsa* (VU). Five tree species recorded are protected under Surinamese law: *Bertholletia excelsa*, *Manilkara bidentata*, and species of *Dipteryx* and *Copaifera*.

All the mammal species recorded at Lely and Nassau are on the IUCN Red List of Threatened Species, but most are classified as Lower Risk -Least Concern (LR/lc). Eleven species are considered of significant conservation concern. An additional 13 mammal species recorded at Brownsberg are also threatened. Table 4 lists the threatened mammal species recorded at the three areas that are categorized above LR/lc. More information is needed on the mammals at Lely and Nassau to be able to say whether the species known from Brownsberg are also present at these two sites.

A diet based on algae, a low fecundity, sedentary habits and restricted distribution all make the rare catfish, *Harttiella crassicauda,* very vulnerable to increasing human activities on the Nassau Plateau. This species can be considered an endangered species and it should be included in the IUCN red list of endangered species. Efforts are underway to get this species on the IUCN red list.

Four of the bird species recorded at Brownsberg are of conservation concern: Harpy Eagle, *Harpia harpyua*; Olive-sided Flycatcher, *Contopus borealis*; Blue-cheeked Parrot, *Amazona dufresniana* and Scarlet Macaw, *Ara macao*. *Amazona dufresniana* is listed as LR/nt and is of conservation concern in the Guianas due to its value in the wildlife trade. No threatened bird species were recorded at Lely or Nassau, although a talon from a large raptor seen at Lely may be from a Harpy Eagle or Crested Eagle, both of which are threatened (LR/nt). Additional bird surveys of these two plateaus are needed to determine if any of these or other threatened bird species are present.

One frog species (*Atelopus hoogmoedi*) and the Yellow-footed tortoise (*Geochelone denticulata*) known from Brownsberg are listed as VU by IUCN. All of the amphibian and reptile species documented at Lely and Nassau have been evaluated by the IUCN Red List but none are categorized higher than Least Concern (LR/lc).

Species New to Science and Range Extensions

A high number (24) of species that are likely new to science was documented at Lely and Nassau during the RAP survey. These included five amphibian species, four fish species (and one new sub-species), 13 dung beetle species and at least one ant species (more new species are likely as species are analyzed). A new species of *Atelopus* was also found at Nassau in 2006 (see Chapter 11 and photo pages). New species of insects are common, but so many new species of amphibians and fishes indicates that this area has a very high overall diversity and likely harbors many more species yet to discover. No species new to science have been recorded at Brownsberg in recent years, but few studies have been conducted for these taxonomic groups. Thus new species and range extensions in these groups are also likely to be found at Brownsberg.

On the Nassau Plateau a recently new described plant species from French Guiana of Thymelaeaceae (*Daphnopsis granvillei*) was found abundantly at times in the undergrowth. In the Lely Mountains and surrounding area some plants have been found with a known or possible Amazonian distribution. At the base of Lely *Poulsenia armata* (Moraceae) was found in the inventory plots. This species had not been previously collected in Suriname, and has a more Amazonian distribution. Based on collections from the Lely Mountains and from the southern lowlands of Suriname and Northern Brazil, a new Annonaceae, *Guatteria anthracina* was described by Scharf et al. (2006). Plant collections from the Brownsberg Plateau might indicate a new species of *Danaea* (Marattiaceae; Christenhusz pers. comm.) and a new species of *Trigynaea* (Annonaceae; Maas pers. comm.), but further research is needed.

Many species of ants recorded at Lely and Nassau are new records for Suriname. Nine species are definite new records while up to 85 species (half of the 169 species documented) may also be new records for Suriname (pending further study). Two genera were recorded for the first time in Suriname and are represented by three species: *Acanthognathus lentus, Acanthognathus* cf. *ocellatus*, and *Cryptomyrmex* cf. *longinodus.*

CONSERVATION CONCLUSIONS AND RECOMMENDATIONS

(see also each chapter for detailed recommendations for each taxonomic group)

I. ALL THREE PLATEAUS, LELY, NASSAU AND BROWNSBERG, SHOULD RECEIVE INCREASED PROTECTION OF THEIR BIODIVERSITY. Each of these areas contains a high proportion of Suriname's biodiversity including both lowland and higher elevation species, many threatened species, and high numbers of spe-

cies endemic to the Guayana Shield. Worldwide amphibian declines have resulted in the loss of many higher elevation amphibian faunas, so the presence of abundant and diverse amphibian assemblages at Nassau and Lely is of significant global conservation value. The presence of many large mammals and larger birds at all three sites indicates their importance as a refuge for these species, which are heavily hunted in other areas. All three plateaus contain great habitat diversity that includes typical lowland forest habitats as well as more unique habitats at higher elevations (> 400 m) that are not widely found in the region.

1) Each of the three plateaus warrants protection for its own unique features:

a) **Lely** has high habitat and species richness for all taxonomic groups surveyed, as well as good forest conditions. Lely is relatively inaccessible and has not had many human impacts. It thus presents an excellent opportunity to protect a large area of high biodiversity, pristine dryland rainforest, and exceptional mountain savanna forest.

b) **Nassau** has been more heavily impacted, but still contains high biodiversity and good populations of large mammals and birds. Nassau also contains a rare and unique fish fauna. This area is particularly vulnerable to encroachment by illegal gold miners who are already active there. Action, especially to control access roads, must be taken immediately to protect Nassau from this threat.

c) **Brownsberg** contains a Nature Park that already provides some protection to the plateau, but threats still encroach upon the rest of the range and must be addressed. The biodiversity of Brownsberg has been fairly well studied, thus providing excellent opportunities for monitoring and assessment of protection efforts.

2) The mechanism for conservation of these sites should be developed through a collaborative approach between public and private institutions, including local communities, to address and halt the threats currently and potentially facing these sites. Some possible mechanisms include:

a) **Empower and fund the Nature Conservation Division** of the Suriname government to increase monitoring in all three areas, especially for hunting and illegal mining.

b) **Create a Nature Park on the Nassau Plateau** to protect the unique Paramacca Creek watershed. Urgent action is needed at Nassau due to the higher level of human pressures there.

c) **Engage the local people** including the traditional communities in the area, particularly the Paramaka Maroons (Nassau and Lely), Aukaner/Okanisi or Djuka Maroons (Lely), Saramaka Maroons (Brownsberg) and also the non-traditional communities such as the small-scale gold miners.

d) **Integrate the protection of key areas into any development plans for the plateaus (e.g. mining planning).** Key areas include the Paramacca watershed at Nassau, the pristine higher elevation forests of Lely, and the vegetation along creeks at Brownsberg. The Lely and Nassau Plateaus are concessions of the joint venture Suralco (Alcoa) and BHP-Billiton bauxite mining companies. Suralco is also involved in large-scale gold exploration by Newmont in the foothills of the Nassau and Brownsberg Mountains.

e) **Explore potential tourism opportunities in the two areas** as an alternative income for local communities to reduce their dependence on the bushmeat trade, logging, and gold mining.

II. INTEGRATE THE LELY, NASSAU AND BROWNSBERG PLATEAUS INTO A REGIONAL CONSERVATION STRATEGY. All three plateaus are key components of a broad international biodiversity protection plan for the Guayana Shield (Huber and Foster 2003).

1) **Conduct a study of the biological and socio-economic values of the Lely, Nassau and Brownsberg plateaus.** Based on that information, regional land use plans should be developed to guide decision-making on what activities can, or cannot, take place in certain areas. Without this type of planning, the areas will continue to be subject to haphazard and uncoordinated activities, leading to overall poor resource management and degradation of biological resources.

2) **Follow up on the IBAP Recommendations (Chapter 2)** by an inclusive group of stakeholders that includes government, universities, conservation groups, mining companies, and local communities.

III. HUNTING POSES A SIGNIFICANT THREAT TO THE LARGE MAMMALS, LARGER BIRDS AND DUNG BEETLES OF BOTH SITES AND MUST BE CONTROLLED. Hunting pressure is especially strong at Nassau but is also occurring in the Lely area. Healthy mammal and dung beetle communities are especially important for maintaining primary and secondary seed dispersal that may be essential for plant regeneration and forest dynamics. Many large birds (currassows and guans) were seen regularly at Lely in 2003 but the 2005 RAP team found much evidence of hunted birds and shotgun shells.

1) **Prevent access to hunters along roads**. Hunting pressure is particularly high at Nassau where a network of roads has facilitated entry by local hunters. These roads need to be minimized and controlled. A number of footpaths at Lely also apparently facilitate movement of hunters and small-scale gold miners as evinced by the large number of discharged shotgun shells and abandoned camps.

2) **Educate and supplement food for local workers.** Workers at the Lely airstrip engage in hunting to supplement their diet, with birds and primates being of particular interest, and there was evidence of hunting (discharged shotgun shells) around the Nassau exploration base camp, athough it could not be determined who was engaging in the activity. Provision of regular protein sources for the work crews, along with improved education and regulation of their hunting, should be promoted to lessen hunting pressure from local work crews in both sites. Incentives should be given to the workers to minimize hunting, especially of species that they are not killing for food.

3) **Make an alliance against hunting with all who have access to Lely and Nassau**, including airline companies, trucking companies, the Surinamese Airline Authorities, the Nature Conservation Division, and the mining companies (BHP-Billiton, Suralco, Newmont). This would help to control the distribution and sale of bushmeat from Lely and Nassau. The Nature Division of the Surinamese Forestry Service could also control the internal transport of bushmeat from the interior at Zorg en Hoop.

4) **Conduct research to determine** which larger mammal and bird species are targeted and most heavily impacted. The population sizes of key species that are most heavily hunted and most highly threatened in this area can then be determined and used to inform more specific recommendations on conserving key species threatened by hunting.

5) **Enforce hunting regulations, especially at Nassau**. Dung beetle communities at both sites are likely suffering from hunting since their food source, mammal dung, is decreased. The strongest hunting pressures seemed to be at Nassau, where unusually low dung beetle abundance was the observed. Stricter regulations and enforcement of hunting practices could make a big difference to dung beetles as well as mammals. Preventing what appears to be widespread hunting at Nassau should be a top priority.

IV. MAINTAIN THE INTEGRITY OF FOREST STREAMS. Streams in the Lely and Nassau Mountains typically have a sandy, gravel or rocky bottom and oxygen-rich, very clear water. The fishes are adapted to these environmental conditions. The amphibians and fishes found at Lely and Nassau, including the possible new species, depend on clean, quality water for their survival. Plants occurring down stream and their associated fish and invertebrate species are vulnerable to sedimentation. Suspended and deposited sediments can negatively affect fish reproduction and algae-based fish food. Our fish survey shows that the watersheds on the plateau are currently largely intact on both the Lely and Nassau plateaus. Three of the potentially new frog species are known only from forest streams, and two more potentially new species also utilized steam habitat, indicating that forested streams are key reservoirs of biodiversity on both mountains.

1) **Prevent sedimentation and runoff from mining, roads, and clearings**, which all have negative impacts on the water quality in the streams. On both the Lely and Nassau plateaus, human activities, including gold mining, logging, agriculture, hunting, and base camp construction currently threaten the integrity of the aquatic ecosystems. These impacts are particularly high in the foothills. Since we have identified streams as keystone habitat whose importance is disproportionate to their area, we recommend a forest buffer of at least 50 m on both sides of all creeks at the two sites.

2) **Protect upper catchment of Paramacca Creek at Nassau**. Based on our current knowledge, protection of the rare catfish *Harttiella crassicauda* from extinction is only possible by protecting its habitat in this creek. Control and restrict access to the Paramacca Creek catchment, especially with regard to small-scale gold miners, loggers and local people (shifting cultivation plots). Any development at Nassau should restrict water extraction from Paramacca Creek by utilizing rainwater collection facilities. Minimize pollution of Paramacca Creek by creating waste collection/treatment facilities and prohibiting bathing, washing and spilling of chemicals/materials in Paramacca Creek. Water quality, hydrology and catchment integrity should be monitored by government agencies.

   We recommend that an analysis be done of future impacts of the current Nassau mining base camp on the watershed, especially due to sedimentation from runoff and pollution from human habitation of the camp, to determine if there will be any long term impacts of the camp and whether the base camp should be moved further from the river.

3) **Initiate a water-quality monitoring program of the status of several key aquatic taxa** (including fishes, amphibians, plants, and selected invertebrate groups) as well as water quality and sedimentation to create a baseline and identify negative impacts to aquatic resources before they become irreversible. The creek at the Nassau basecamp is a 'keystone habitat', one that is essential to a wide variety of organisms, especially amphibians. Monitoring specific responses to certain indicators is essential. We recommend following standard aquatic monitoring protocols at regular intervals (at least twice a year, see Chapter 10 for more details).

V. MINIMIZE FRAGMENTATION OF THE NATURAL HABITAT AND CONTROL ACCESS ROUTES. This is particularly crucial at Nassau, where a relatively

extensive road network is already fragmenting habitats and facilitating easy access to forest areas. Many small organisms, including dung beetles and ants, are known to be especially sensitive to fragmentation. Even slight perturbations of the forest, such as the loss of plant diversity and changes in soil microclimate, are known to strongly affect these groups. Roads and other access routes provide access not only to humans but also to invasive species.

1) **Minimize the number of access routes.** The road network at Nassau should be blocked, reforested and monitored for illegal access. Footpaths and other access routes in all three areas should be minimized and regulated. Any future development in the three plateau areas must take great care to create a minimal access network, especially roads.

2) **Maintain large areas of forest**. Although deforestation is still not widespread at either site, it is important to keep large areas of primary forest to maintain intact communities of all taxa, especially mammals and dung beetles. Reptiles and amphibians need at least 1500 ha as the 'minimum critical area' necessary to protect a reasonably intact sample of the local fauna. We suggest that forest blocks of at least this size be preserved at Lely and Nassau.

3) **Monitor several key species or groups that depend on intact forest** to ensure healthy populations and to detect changes as early as possible to prevent serious declines. Target groups should include large and small mammals, amphibians, and several insect groups. Since small mammals are highly dependent on forest structure for their survival and constitute a key component of the diet of large animals, monitoring small mammal diversity and abundance is a good way to track the integrity of the forest ecosystem.

4) **Control logging**, which accelerates habitat fragmentation and degradation and has already begun to impact several groups, especially dung beetles, ants, and mammals.

VI. ENHANCE PROTECTION OF BROWNSBERG NATURE PARK AND OTHER PARTS OF THE PLATEAU.

1) **Protect the Brownsberg range** through i) effective law enforcement in and around the Park, ii) formal establishment and southward extension of the buffer zone, iii) a management plan for the larger area that includes the Park and the extended buffer zone, and iv) attempts to restore areas damaged by gold mining.

2) **Expand tourism activities** to i) the central and southern part of the Brownsberg range, ii) the Brokopondo lakeside area, and iii) the village of Brownsweg.

3) **Continue monitoring human activities, biodiversity and the environment**, including i) analyzing the data generated by STINASU in the course of the BNP Monitoring Program from 2002 to 2005, and ii) implementing a modified monitoring program (BMP) based on the results and recommendations of the data analysis.

4) **Make full use of the results of research and monitoring data,** meaning that i) the planning and management of the Park is guided by the results, and ii) the results are used as inputs for a variety of information products, as well as for public awareness and education activities in the Park and in the capital Paramaribo.

5) **Create a super-structure for the Brownsberg-Brownsweg area**, possibly linked to a MUMA (Multiple-Use Management Area), that would at least allow for i) conflict resolution between STINASU, the village of Brownsweg, and local miners and other operators, ii) a dialogue on land use with the stakeholders, and iii) conservation and development projects that benefit the local community.

VII. MONITOR TO DETECT THE PRESENCE OF THE CHYTRID FUNGUS, *BATRACHOCHYTRIUM DENDROBATIDIS* IN ADULT FROGS ALONG FOREST STREAMS

. This fungus has been linked to amphibian declines in many parts of the Neotropics. Global amphibian declines have resulted in the loss of many moderate- to high-elevation anurofaunas, so the presence of abundant, diverse, stream-associated amphibian assemblages at Nassau and Lely is of significant conservation value. The densities we observed at Nassau and Lely are comparable to pre-decline data from forest streams and adjacent forest in Panama, suggesting that the stream-associated fauna of Nassau and Lely have not experienced the dramatic declines that have occurred in other parts of the Neotropics. Although we are not aware of reports of amphibian declines from the Guianas, conditions favorable for the occurrence of *Batrachochytrium dendrobatidis* are predicted to occur in the vicinity of Nassau and Lely Mountains.

1) **Initiate an ongoing detection and monitoring project**. The presence of *B. dendrobatidis* can be detected via analysis of dermal swabs from live animals. We recommend collecting 300 swabs/visit (i.e., one swab per individual from the first 300 individuals encountered). To detect the presence of *B. dendobatidis*, analysis may be conducted on pooled samples of 10 swabs.

2) **Alert amphibian conservation biologists if the fungus is detected**. Individual analysis of all swabs will be necessary to identify infected species. Should *B. dendrobatidis* be detected, the Declining Amphibian Population Task Force (http://www.open.ac.uk/daptf/index.htm) should be contacted for recommended action.

ADDITIONAL RESEARCH PRIORITIES

I. Biodiversity surveys during the rainy season for all taxa are needed to compile a more complete inventory of species. As the RAP surveys were conducted at the height of the dry season, similar surveys in these areas during the rainy season are needed, particularly for groups that may be more active in the wet season, such as amphibians, and for groups that may flower (plants) or breed in the rainy season (birds).

II. Surveys of both lowland streams in the foot hills (especially Paramacca Creek) and high-altitude streams on the plateau of Nassau (and Lely) plateaus are needed to better understand (1) the ecology and evolution of the unique fish communities of the plateau and (2) diversity and endemism of Guayana Shield fish faunas in general.

III. Research on the biodiversity of the Paramacca Creek watershed, including conducting similar surveys during the rainy season.

IV. Research on the rare catfish *Harttiella crassicauda* should be initiated and stimulated by BHP Billiton and Suralco, conservation organizations, and the Surinamese government. Specific actions include:

a. More information about the occurrence of *H. crassicauda* in Paramacca Creek (and its tributary streams) at lower elevations and in two other streams draining Nassau Mountains (Anjumarakreek and an unnamed stream);

b. More information about the (reproductive/feeding) biology of *H. crassicauda* to better understand its ecology.

c. More information about the relationship of *H. crassicauda* with other catfishes of the subfamily Loricariinae (DNA analysis). When properly protected the unique fish *H. crassicauda* could become a symbol for good environmental management practices.

d. Immediate actions should be taken to initiate the process leading to inclusion of *H. crassicauda* on the IUCN/CITES red list of endangered species.

V. Research on the population sizes and viability of key species. Both Lely and Nassau are important for biodiversity conservation since they contain a high diversity of large mammals, as well as several new species of amphibians and dung beetles. Determining the IUCN red list status of the species new to science will depend on estimating the geographic range of these species, so special effort should be made to determine their area of occurrence. We recommended expanded surveys of streams on the two mountains and in adjacent lowlands in order to more accurately quantify abundance and extent of occurrence of stream-associated frogs, particularly new species whose distributions are unknown.

VI. Further plant inventories of Nassau and Lely, in which herbarium specimens are collected as well as live specimens, especially for plants that are associated with rocky creek beds and mountain savanna forest. These should include surveys to assess the presence of rare plant species and the habitats in which they occur, including orchids and plants associated with habitats with encrusted soil.

VII. Further research on the potentially new species for science observed on all three plateaus, especially for frogs and fishes. **Conduct additional inventories** for taxonomic groups for which we have very little information such as dung beetles, bees and ants, especially at Brownsberg. More orchid bee samples need to be obtained form all three ranges, and the relationship between orchids and orchid bees at these ranges should be investigated.

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Rapportage in Vogelvlucht

EEN SNELLE BIOLOGISCHE TAXATIE VAN DE PLATEAUS VAN LELY EN NASSAU, SURINAME

ONDERZOEKSPERIODE
25 oktober – 6 november, 2005

BESCHRIJVING VAN DE ONDERZOEKSGEBIEDEN
Lely Gebergte en Nassau Gebergte zijn twee plateaus in Oost-Suriname die gekarakteriseerd worden door een stevige dikke korst in de bovenste bodemlaag, voornamelijk gevormd door geconsolideerd ferriet (Fe) en bauxiet (Al). Lely Gebergte heeft een serie plateaus met een maximum hoogte van ongeveer 700 meters en Nassau Gebergte bestaat uit vier plateaus, die varieren van 500 – 570 meters. Het RAP onderzoek was gericht op habitats boven 500 m, bij Lely: bergsavannebos, hoogdrooglandbos, palmzwampen, en secundaire groei, en te Nassau: hoogdrooglandbos, wat bergsavannabos, beperkte stukken palmzwampen, secundairbos en vegetatie in gebieden die ontbost waren ten behoeve van de infrastructuur zoals wegen en een begroeide landingsbaan. Deze plateaus bieden vele stroomgebieddiensten voor lokale - en kustgemeenschappen, alsook werkgelegenheid (hoofdzakelijk kleinschalige goudwinning), voedsel, medicijnen en bouwmaterialen voor lokale gemeenschappen.

REDENEN VOOR HET BIODIVERSITEIT SCHATTINGSONDERZOEK
Het Biodiversiteit Schattingsonderzoek van de plateaus van Lely en Nassau is uitgevoerd om de biodiversiteitgegevens voor Oost-Suriname aan te vullen. Uit de “Priority Setting Workshop” van 2002 is naar voren gekomen dat we bepaalde biodiversiteitsgegevens missen die belangrijk zijn voor de planning van natuurbehoud voor deze plateaus in het Guiana Schild. De gegevens die verzameld zijn voor vogels, zoogdieren, vissen, amfibieën, reptielen, mieren, en mestkevers zullen bijdragen tot beter begrip van de fauna en flora van deze twee plateaus. Ook maken deze gegevens een vergelijkingen mogelijk van de biodiversiteit van Nassau en Lely met het plateau van Brownsberg (zie Uitgebreide samenvatting voor vergelijkingen) en met andere gebieden van het Guiana Schild. Ten slotte zullen de gegevens gebruikt worden door BHP-Billiton Maatschappij Suriname en Suralco als deel van hun Mijnbouw Overeenkomst om biodiversiteitsoverwegingen te incorporeren in de vroege stadia van besluitvorming voor elke mijnoperatie die zij in deze gebieden zullen ondernemen. Het is ons streven om informatie te verschaffen zodat mijnbouwondernemingen die in deze gebieden werken het behoud van biodiversiteit in hun projectplanning opnemen.

BELANGRIJKSTE RESULTATEN

Lely en Nassau Plateaus

- Hoge fauna diversiteit (zie tabel hieronder),
- Ten minste 27 soorten endemisch voor het Guiana Schild,
- Ten minste 24 soorten nieuw voor de wetenschap, wat illustreert hoe weinig wij weten van deze gebieden en het geheel Guiana Schild,

- Veel soorten en grote aantallen individuen van grote zoogdieren en grote vogels (e.g. papegaaien, powisi's, marais), wat aantoont dat deze gebieden mogelijk als 'veilige haven' dienen voor grotere soorten,
- Hoewel nog steeds in goede staat, worden beide gebieden zwaar bedreigd door menselijke activiteiten, vooral ongereguleerde jacht wat direct gevolg heeft voor grote zoogdieren en vogels, en ook illegale goudmijnbouwactiviteiten aan de voet van de heuvels hebben gevolgen voor grote zoogdieren en vogels.

Lely Plateau

- Hogere soortenrijkdom van planten, orchideeën, zoogdieren, amfibieën, mieren, vogels, en mestkevers dan Nassau, waarschijnlijk vanwege een combinatie van factoren, inclusief het feit dat het Lely Gebergte groter en hoger is, zodat de uitgestrektheid van elk bostype groter is. Hogere diversiteit van zoogdieren en mestkevers kan ook beinvloed zijn geweest door de meer ongerepte conditie van de habitats in vergelijking met Nassau,
- Het Lely Gebergte biedt uitstekende mogelijkheden voor conservering vanwege relatief weinig menselijke invloeden, kleine bevolkingsdichtheid en haast onmogelijke toegang.

Nassau Plateau

- Hoge soortenrijkdom en endemisme van vissen in hooggelegen beekjes,
- *Hartiella crassicauda*, een zeldzame meerval die endemisch is voor het plateau van Nassau, werd voor het eerst weer gedocumenteerd sinds 1949,
- Het Nassau Gebergte is sterker beinvloed door menselijke activiteiten, vooral met betrekking tot jacht en habitatfragmentatie, als gevolg van toegangswegen die zijn aangelegd om kleinschalige mijnbouwactiviteiten en exploratieactiviteiten voor kleinschalige mijnbouw mogelijk te maken

AANTALLEN GEREGISTREERDE SOORTEN

	Beide Schattings gebieden	Lely	Nassau
Mieren	169	136	79
Mestkevers	42	37	27
Vissen	41	8	35
Amfibieën	27	20	16 (31)**
Reptielen	22	16	13 (26)**
Vogels (RAP)	121	67	79
Vogels (2003) *		(152)	
Vleermuizen	24	14	19
Kleine Zoogdieren	4	3	1
Grote Zoogdieren (inclusief apen)	17	13	8
Totaal	**467**	**314**	**277**

*O'Shea, Hoofdstuk 8

** ( ) – additionele gegevans van Ouboter et al. (Hoofdstuk 11)

NIEUWE SOORTEN VOOR DE WETENSCHAP

Amfibieën *Eelutherodactylus* (4 soorten)
Adenomera (1 soorten)
Atelopus (1 (onder) soort)

Vissen *Guyanancistrus* (1 soort)
Harttiella (1 (onder) soort)
Lithoxus (3 soorten)
Trichomycterus aff. *conradi* (1 soort)

Mieren *Pyramica* (1 soort)

Mestkevers *Anomiopus* (~ 2 soorten)
Ateuchus (~ 2 soorten)
Canthidium (~ 3 soorten)
Eurysternus (~ 3 soorten)
Sylvicanthon sp. nov.
Uroxys (~ 2 soorten)

SOORTEN DIE NIEUW ZIJN VOOR DE FAUNA VAN SURINAME

Mieren: Genera *Acanthognathus: A. lentus* en *A.* cf. *ocellatus*
Cryptomyrmex cf. *longinodus*

Mieren: Soorten *Pyramica auctidens*
Pyramica cincinnata
Pyramica crassicornis
Pyramica halosis
Strumigenys cosmostela
Strumigenys trinidadensis

BEDREIGDE SOORTEN (IUCN 2006 CATEGORIE)

Vleermuizen

Lophostoma carrikeri (Kwetsbaar)
Donkere fruitetende vleermuis, *Artibeus obscurus* (Lager Risico/Bijna Bedreigd
Bruine fruitetende vleermuis, *Koopmania concolor* (Lager Risico/ Bijna Bedreigd)

Apen

Rode Brulaap, *Alouatta macconnelli* (Kwetsbaar)
Roodruggige baardsaki, *Chiropotes chiropotes* (Gegevens afwezig)

Grote zoogdieren

Braziliaaanse Tapir, *Tapirus terrestris* (Kwetsbaar)
Jaguar, *Panthera onca* (Lager Risico/Bijna Bedreigd)
Poema, *Puma concolor* (Lager Risico/Bijna Bedreigd)
Hert, *Mazama* sp. (Gegevens afwezig))
Reuzenmiereneter, *Myrmecophaga tridactyla* (Kwetsbaar)
Dubost's stekelmuis, *Neocomys dubosti* (Gegevens afwezig)

ENDEMISCHE SOORTEN VAN HET GUIANA SCHILD

Zoogdieren:
Guiana Rode Brulaap, *Alouatta macconnelli*
Roodruggige baardsaki, *Chiropotes chiropotes*
Buidelrat, *Marmosa murina*
Roodhand tamarin/ Saguwenke, *Saguinus midas*
Kwata/ Zwarte Spinaap, *Ateles paniscus*
Dubost's stekelmuis, *Neacomys dubosti*
Stekelmuis, *Neacomys guianae*
Guyanese stekelrat/ Maka alata, *Proechimys guyannensis*

Vogels
Powisi, *Crax alector*
Marai, *Penelope marail*
Gypopsitta caica
Roodsnavel/ Redimofo, *Monasa atra*
Stonkuyake, *Selenidera piperivora*
Stonkuyake, *Pteroglossus viridis*
Xiphorhynchus pardalotus
Mirafowru, *Myrmotherula surinamensis*
Mirafowru, *Myrmotherula gutturalis*
Mirafowru, *Herpsilochmus stictocephalus*
Mirafowru, *Percnostola rufifrons*
Mirafowru, *Gymnopithys rufigula*
Tyarman/ Tityari, *Contopus albogularis*
Rotshaan, *Rupicola rupicola*
Busikaw, *Perissocephalus tricolor*
Manakin, *Corapipo gutturalis*
Manakin, *Lepidothrix serena*
Blauwdas/ Kanarie, *Euphonia finschi*
Grangrandir/ Kanarie, *Euphonia cayennensis*

Amfibieën
Colostethus beebei
Colostethus degranvillei
Eleutherodactylus chiastonotus
Eleutherodactylu zeuctotylus
Chiasmocleis shudikarensis

Reptielen
Gonatodes annularis
Neusticurus rudis

Vissen
Harttiella crassicauda (endemisch voor Nassau Plateau)
Guyanancistrus 'grote mond'

NATUURBEHOUD CONSLUSIES VAN HET BIODIVERSITEIT SCHATTINGSONDERZOEK

(zie Uitgebreide Samenvatting voor meer details)

1. Wij bevelen aan dat de plateaus Lely en Nassau (en ook Brownsberg – zie Uitgebreide Samenvatting) **verhoogde niveaus van bescherming van de biodiversiteit krijgen**.

Alle drie gebieden hebben een groot deel van Surinames biodiversiteit en bevatten grote habitatdiversiteit met typische laagland boshabitats, alsook meer unieke habitats op grotere hoogten (>400 m) die niet overal in het Guiana Schild gebied gevonden worden.

Wereldwijde afname van amfibieën heeft geresulteerd in verlies van vele amfibieën op grotere hoogten, dus de aanwezigheid van gezonde, met bergbeken geassocieerde amfibieënpopulaties op Nassau en Lely heeft grotere conserveringswaarde. Deze gebieden bieden bescherming aan vele bedreigde soorten en soorten die endemisch zijn voor het Guiana Schild.

Zowel de plateaus van Lely als Nassau maken conserveringsactiviteiten noodzakelijk om enigszins verschillende redenen:

Lely
- Lely heeft hoge habitat en soortendiversiteit voor alle taxa, alsook ongerepte bossen. Lely heeft iets meer rijkdom binnen de meeste taxa vergeleken met Nassau, en iets meer plantendiversiteit (per plot) dan Brownsberg.
- Er zijn nog steeds grote aantallen grote zoogdieren en grote vogels, wat een indicatie is dat Lely mogelijk een 'veilige haven' is voor deze dieren waarop veel gejaagd wordt.,
- Lely is tamelijk ontoegankelijk met weinig menselijke invloeden, wat dus een uitstekende gelegenheid biedt om een groot gebied van hoge biodiversiteit, ongerept regenbos, en uitzonderlijk bergsavanna(mossen)bos te beschermen.

Nassau
- Nassau is sterker beinvloed door mensen, maar heeft nog steeds een hoge biodiversiteit en goede populaties van grote zoogdieren en grote vogels.
- Nassau heeft vele endemische soorten (die nergens anders gevonden worden), vooral vissen.
- Beschermen van het stroomgebied van de Paramaka kreek (met zijtak IJskreek) is cruciaal voor de overleving van verscheidene zeldzame vissoorten.
- Slechts 31 % van de gedocumenteerde amfibieënsoorten zijn op beide plaatsen gevonden, wat een indicatie is dat zowel Lely als Nassau belangrijk zijn voor de diversiteit van amfibieën, inclusief vele soorten die nieuw zijn voor de wetenschap.
- De grotere menselijke invloeden en bedreigingen te Nassau vragen om onmiddellijke actie.

2. Het mechanisme voor conservering van deze gebieden moet ontwikkeld worden middels samenwerking tussen publieke en private instituten, inclusief lokale gemeenschappen, om een halt toe te roepen aan daadwerkelijke en potentiële bedreigingen in deze gebieden.

Mogelijke mechanismen zijn onder andere:

- Versterken en financieren van de afdeling Natuur Beheer van de Surinaamse overheid, ter verbetering van monitoring in alle drie gebieden, voornamelijk ten aanzien van jacht en illegale mijnbouw.
- Creëren van een Natuur Park op het plateau van Nassau om het unieke stroomgebied van de Paramaka kreek te beschermen. Urgente actie is nodig te Nassau, vanwege de hoge niveaus van menselijke druk daar.
- De lokale gemeenschappen, inclusief de traditionele, betrekken, in het bijzonder de Paramakaners (Nassau en Lely), Aukaners/ Okanisi of n' Djuka (Lely), Saramakaners (Brownsberg) en ook de niet-traditionele gemeenschappen, zoals de kleinschalige mijnbouwers.
- Bescherming van sleutelgebieden integreren in elk ontwikkelingsplan voor de plateaus (e.g. mijnbouwplanning). Sleutelgebieden zijn het Paramaka stroomgebied te Nassau, het maagdelijk, hoger gelegen bos van Lely en de vegetatie langs de kreken van Brownsberg. De plateaus van Lely en Nassau zijn concessies van Suralco (Alcoa). Suralco is ook betrokken bij grootschalige mijnbouw exploratie door Newmont aan de voet van de heuvels van de Nassau en Brownsberg.
- Exploreren van potentiele mogelijkheden voor **toerisme** in de twee gebieden als alternatieve bron van inkomsten voor lokale gemeenschappen om hun afhankelijkheid van de handel van wildvlees, houtkap, en goudmijnbouw te reduceren.

SPECIFIEKE AANBEVELINGEN VOOR CONSERVERING

- Breng de plateaus van Lely, Nassau en Brownsberg samen in een regionale conserveringsstrategie en onderneem actie op basis van IBAP aanbevelingen in hoofdstuk 2,
- Controleer jacht, die een grote bedreiging vormt voor grote zoogdieren, grote vogels en mestkevers van beide gebieden,
- Behoud de integriteit van boskreken
- Minimaliseer fragmentatie van de natuurlijke habitat; controleer toegangswegen en beperk houtkap, die habitatfragmentatie en degradatie versnelt en die al invloed heeft op verscheidene groepen zoals de mestkevers, mieren en zoogdieren.
- Verhoog de bescherming van het Brownsberg Natuur Park en andere delen van de plateaus.
- Monitoor om de aanwezigheid van de chytride schimmel, Batrachochytrium dendrobatidis in volwassen padden langs bosbeken te kunnen ontdekken.

- **Additionele Onderzoeksprioriteiten**
  - Biodiversiteitsonderzoek gedurende het regenseizoen,
  - Onderzoek van laagland beken van Nassau en Lely,
  - Onderzoek van de biodiversiteit van het stroomgebied van de Paramaka kreek, inclusief de zeldzame vis Harttiella crassicauda,
  - Onderzoek van de populatiegrootte en levensvatbaarheid van sleutelsoorten,
  - Verdere planteninventarissen van Nassau en Lely,
  - Verder onderzoek naar potentieel nieuwe soorten voor de wetenschap.

Sjatu Skrifi

WAN ONDROSUKU NA LELY NANGA NASSAU BERGI, SRANAN

Ondrosuku dei

25 oktober – 6 november, 2005

Fa den ondrosuku presi tan

Lely nanga Nassau bergi na tu bergi na ini a sei foe Sranan pe son e opo. A doti habi boksit nanga isri di moksi kon tron tranga doti. Lely habi wan tu bergi di hei 700 m. Nassau habi fo bergi di hei 500 -700 m. A ondrosuku feni presi tapu den bergi di hei moro 500 m, so leki Lely: bergisabanabusi, hei dreigron busi, swampu nanga den difrenti sortoe palmbon nanga jongu busi, tapu Nassau hei dreigron busi, pikinso bergi sabana busi, pikinso palmbon swampu, jongu busi en wiwiri ini presi pe den koti a busi foe meki pasi nanga presi pe opolangi e saka. Den bergi disi habi furu presi pe watra e lon san sma di e tan drape kan dringi, so srefi wrokopresi leki wroko gowtu, njan-njan, dresi nanga udu fu bow oso, den sma kan feni.

Fu san ede wi ondrosoku a presi

A ondrosuku dis na Nassau nanga Lely bergi ben du fu feni sabi di ben mankeri fu a sei dati fu Sranan pe son e opo. A wrokomakandra di wi ben habi na ini a jari 2002, fu poti na tapu papira, den fosi sani di musu psa, a ben kon na krin taki wi ben mankeri prinspari sabi fu den bon, wiwiri, meti, nanga watra fu den bergi disi, di de fanodu fu kibri den.
A sabi di kon na krin fu fowru, meti, fisi, todo, sneki, mira nanga tor, o meki sma sabi den bon nanga meti moro bun, nanga fu kan poti den nanga di fu Brownsbergi, sei – nanga - sei nanga di fu tra kontren na ondrosei fu Sranan, nanga wan tu tra kondre di de krosibei fu Sranan, fu luku a warti san den habi so srefi tu BHP Billiton nanga Suralco di e wroko makandra fu kenki prakseri fruku-fruku abra den bon, wiwiri, nanga meti (= ala sani boiti bon nanga wiwiri), ini den kontren pe den e diki. Wi feni taki wi musu prati a njunsu, meki ala wroko- pè di e go diki a doti suku sani , musu poti den prakseri disi na ini den wroko.

PRINSPARI FENI

Lely nanga Nassau

- Difrenti meti
- 27 sorti de na ondrosei fu Sranan nanga wan tu tra kondre moro di de na sei sei fu Sranan
- 24 njun sortu, san e sori dati wi no sabi den kontren disi so bun ete
- Furu sortu bigi meti nanga bigi fowru (so leki popokai, powisi), e sori taki den presi disi na kibri presi fu den
- Den presi e luku bun, ma libisma e sutu meti nanga fuwru dape. So srefi gowtu man di no habi papira fu wroko gowtu, de na futusei fu a bergi e diki gowtu.

Lely Bergi

- Habi moro sorti bon, orchidee-bromtji, meti, todo, mira, fowru nanga tor leki Nassau. Disi kan kon bikasi Lely bigi moro Nassau. Lely hei tu moro Nassau meki a busi fu en moro bigi moro di fu Nassau. Fu di tungi furu libisma no go dape meki a habi moro meti nanga tor leki Nassau.
- Lely habi moro okasi fu kibri den meti, fu di tungsi furu sma no de dape. Strati no de so meni tu.

Nassau Bergi

- Moro fisi sortu nanga sortu di de dape wawan ini den kriki di de hei,
- *Hartiella crassicauda*, wan kat-fisi di de dape wawan, ben poti na buku ini a jari 1949
- Moro libisma e go tapu Nassau fu e sutu meti, nanga fu meki pasi fu suku gowtu nanga wroko gowtu.

DEN SORTU DI FENI

	Ala tu RAP presi	Lely	Nassau
Mira	169	136	79
Tor	42	37	27
Fisi	41	8	35
Todo	27	20	16 (31)**
Sneki	22	16	13 (26)**
Fowru (RAP)	121	67	79
Fowru (2003) *		(152)	
Fremusu	24	14	19
Pikin Meti	4	3	1
Bigi Meti (Sosrefi Jap-Japi)	17	13	8
Ala nanga ala	**467**	**314**	**277**

*O'Shea, Ede pisi 8 na ini a buku
** ( ) Ede pisi 11 na ini a buku

NJUN SORTU

Todo *Eelutherodactylus* (4 sortu)
Adenomera (1 sortu)
Atelopus (1 sortu)

Fisi *Guyanancistrus* (1 sortu)
Harttiella (1 (ondro) sortu)
Lithoxus (3 sortu)
Trichomycterus aff. *conradi* (1 sortu)

Mira *Pyramica* (1 sortu)

Tor *Anomiopus* (~ 2 sortu)
Ateuchus (~ 2 sortu)
Canthidium (~ 3 sortu)
Eurysternus (~ 3 sortu)
Sylvicanthon sp. nov.
Uroxys (~ 2 sortu)

NJUN SANI SSAN DEN FENI

Mira: Genera *Acanthognathus: A. lentus* and *A.* cf. *ocellatus*
Cryptomyrmex cf. *longinodus*

Mira: Sortu *Pyramica auctidens*
Pyramica cincinnata
Pyramica crassicornis
Pyramica halosis
Strumigenys cosmostela
Strumigenys trinidadensis

SORTU DI HABI PROBLEMA (IUCN 2006 GRUPU)

Fremusu
Lontu jesi fremusu, *Lophostoma carrikeri* (Swaki)
Blaka fremusu, *Artibeus obscurus* (Lagi Risico/Problema de fu kon)
No tungsiblaka fremusu, *Koopmania concolor* (Lagi Risico/ Problema de fu kon)

Jap-Japi
Babun jap - japi, *Alouatta macconnelli* (habi rpoblema)
Redi-baka barba Saki, *Chiropotes chiropotes* (Skrifi no de)

Bigi Meti
Bofru, *Tapirus terrestris* (habi problema)
Tigri, *Panthera onca* (Lower Risk/problema de fu kon)
Puma, *Puma concolor* (lagi risico/problema de fu kon)
Dia, *Mazama* sp. (Skrifi no de)
Mirafroiti, *Myrmecophaga tridactyla* (habi problema)
Djindjamaka, *Neocomys dubosti* (Skrifi no de)

SORTU DI DE SOSO NA ONDROSEI FU SRANAN NANGA ETE WAN TU KONDRE NA SEI SEI FU SRANAN, SAN WI SABI LEKI GUIANA SCHILD.

Meti:
Babun, *Alouatta macconnelli*
Redi-baka barba Saki, *Chiropotes chiropotes*
Awari, *Marmosa murina*
Saguwenke tamarin, *Saguinus midas*
Kwata, *Ateles paniscus*
Dubost's Neacomys, *Neacomys dubosti*
Guiana Neacomys, *Neacomys guianae*
Guyenne Spiny Rat, *Proechimys guyannensis*

Fowru
Powisi, *Crax alector*
Marai, *Penelope marail*
Prakiki, *Gypopsitta caica*
Redi mofo, *Monasa atra*
Stonkuyake, *Selenidera piperivora*
Stonkuyake, *Pteroglossus viridis*
Xiphorhynchus pardalotus
Mirafowru, *Myrmotherula surinamensis*

Mirafowru, *Myrmotherula gutturalis*
Mirafowru, *Herpsilochmus stictocephalus*
Mirafowru, *Percnostola rufifrons*
Mirafowru, *Gymnopithys rufigula*
Tyarman, Tityari, *Contopus albogularis*
Bergi kakafowru, *Rupicola rupicola*
Busikaw, *Perissocephalus tricolor*
Manakin, *Corapipo gutturalis*
Manakin, *Lepidothrix serena*
Blaauwdas/ Kanarie, *Euphonia finschi*
Grangrandir/ Kanarie, *Euphonia cayennensis*

Todo
Colostethus beebei
Colostethus degranvillei
Eleutherodactylus chiastonotus
Eleutherodactylu zeuctotylus
Chiasmocleis shudikarensis

Sneki
Gonatodes annularis
Neusticurus rudis

Fisi
Harttiella crassicauda (Soso Nassau habi en)
Guyanancistrus 'bigi mofo'

SAN KON NA KRIN FU A ONDRUSUKU

(luku a langa pisi skrifi di habi moro sabi)

1. Wi feni taki den difrenti meti, bon nanga so moro fu Lely nanga Nassau bergi (so srefi Brownsbergi tu – luku a langa pisi skrifi), Lanti musu luku wan fasi fu kibri den moro betre. Ala den dri presi habi furu meti, bon, nanga so moro fu Sranan, sosrefi den habi difrenti kontren leki busi di e gro na tapu lagi gron nanga busi di e gro tapu hei gron (> 400 m). Den sortu busi disi no de fu feni alasei ini a birti. Na ini gron tapu, nownow de todo e dede na ini kriki tapu hei gron leki bergi, dati meki a de wan prinspari sani fu kibri den todo di wi feni na Nassau nanga Lely bergi. Den presi disi na kibri presi gi furu furu sortu di libi de na dege- dege, nanga gi sortu di de soso na a ondrosei pisi fu Sranan nanga den kondre na un sei.

Difrenti rede de fu san ede wi musu kibri Lely nanga Nassau:

Lely
- Na Lely difrenti sortu presi, meti, bon sortu de. Sosrefi busi drape di luku leki no wan sma no fasi en. Lely habi pikinso moro bon sortu te ju poti en sei nanga sei nanga Brownsbergi.
- Bigi Fowru nanga bigi meti de ete, meki wi prakseri taki Lely na kibri presi gi den bikasi sma e sutu na den tapu nanga gon.
- Lely no habi furu pasi, furu sma no go drape ete meki a okasi de fu kibri wan bigi pisi nanga busi, meti nanga bergi- sabana- busi.

Nassau
- Nassau habi moro problema, ma a habi furu bigi meti, bigi fowru nanga tra sani ete.
- Nassau habi sortu leki fisi di no de na tra presi.
- Lanti musu kibri Pramacca kriki (nanga Ijskriki) bikasi den na a libi nanga njang presi fu den fisi disi.
- 31 % fu den todo di de na tapu papira de na ala tu presi, san e sori taki Lely nanga Nassau na prinspari presi gi todo, sosrefi furu sortu di njun gi grontapu
- Fu di furu sani e psa na Nassau, a de fanowdu fu du wan sani wanwanten.

2. A wroko fasi fu kibri den presi disi musu de wan, pe difrenti sma nanga Lanti e wroko makandra, sosrefi tu den sma di e tan drape, fu tapu den takru du di e psa drape. Wan tu wroko fasi na:
- Gi Natuur Beheer fu Lanti fu Sranan moni fu den kan luku den presi disi, spesrutu a sutu gon nanga wroko gowtu sondro papira
- Meki wan Natuur Park tapu Nassau bergi fu kibri Pramacca kriki. A de fanowdu fu du den sani disi hesihesi na Nassau, fu di sma de drape e broko a presi.
- Wroko makandra nanga den sma di de drape leki den Pramacca Marron (Nassau nanga Lely), Okanisi noso n'Dyuka Marron (Lely), Saamakka Marron (Brownsbergi) nanga den gowtuman.
- Fu ala sani di Lanti sa du drape a musu skrifi a kibri fu den presi disi ini den papira (so leki diki a doti). Prinspari presi na a Pramacca kriki na Nassau, a hei gron busi fu Lely, nanga den wiwiri na sei kriki na Brownsbergi. Lely nanga Nassau bergi na consessie fu Suralco (Alcoa). Suralco e suku gowtu tu nanga Newmont na a futu fu Nassau nanga Brownsbergi.
- Luku fu tja toerisme ini den two presi fu opo wroko gi den sma drape, san kan meki den tapu fu sutu meti fu seri, noso koti bon, nanga diki gowtu.

SAN MUSU DU

- Poti Lely, Nassau nanga Brownsbergi ini a wroko fasi, fu kibri den presi fu difrenti kontren. Du den sani fu IBAP san knapu ini a hede pisi skrifi 2.
- Luku a sutu gon, di de wan takrusani gi bigi meti, bigi fowru nanga tor na ala tu presi
- Kibri den kriki
- No meki pisi -pisi busi, luku suma nanga san e kon ini a presi nanga skrifi na papira omeni bon sma mag koti, bikansi dati e meki pisi- pisi busi, san e meki son grupu de na dege dege so leki tor, mira nanga meti di e gi bobi.

- Poti busiskowtu fu luku Brownsbergi nanga moro sei fu a bergi moro bun.
- Ondrosuku a presi fu luku efu a sani di e tja siki nanga dede, Batrachochytrium dendrobatidis, gi bigi todo, de drape ini den kriki nanga sei sei fu den kriki.

- **Moro Prispari Ondrosuku di musu du**
  - Ondrosuku ini alen ten,
  - Ondrosuku den kriki di de na a futu fu den bergi (spesrutu Pramacca kriki) sosrefi kriki di de na tapu den bergi fu Nassau nanga Lely
  - Ondrosuku san de na ini Pramacca kriki, sosrefi ondrosuku a katfisi *Hartiella crassicauda,*
  - Ondosuku o bigi den grupu fu den prinspari sortu de,
  - Ondosuku den bon fu Nassau nanga Lely moro fara,
  - Ondrosuku den njun sortu

Uitgebreide Samenvatting

INTRODUCTIE

De Lely en Nassau plateaus zijn gelegen in noordoostelijk Suriname en varieren in hoogten van 500 – 700 m. Ze zijn vooral bedekt met hoogdrooglandbos op de plateaus en hellingen en bergsavannabos op het plateau. Het Brownsberg plateau is een derde belangrijk plateau in dit gebied, het is deels beschermd door het Brownsberg Natuur Park (11.800 ha). De "Guayana Shield Priority Setting Workshop" van 2002, heeft vastgelegd dat deze drie plateaus belangrijk zijn voor de biodiversiteit, maar dat we belangrijke biodiversiteit gegevens missen, vooral voor Lely en Nassau (Huber en Foster, 2003). De plateaus bieden vele stroomgebieddiensten voor lokale en kustgemeenschappen, alsook belangrijke bronnen van werkgelegenheid (voornamelijk kleinschalige goudmijnbouw), voedsel, medicijnen en bouwmateriaal voor lokale gemeenschappen. Lely en Nassau zijn nog steeds relatief in tact vanwege de lage mensenpopulatiedichtheid, wat unieke mogelijkheden biedt voor conservering over een relatief groot landschap. Alle drie plateaus staan echter bloot aan een aantal reële en potentiele bedreigingen, waaronder houtkap, jacht/stroperij, kleinschalige (goud) en grootschalige (bauxiet en goud) mijnbouw.

Conservation International's "Rapid Assessment Program" (RAP)

RAP is een innovatief biologische inventariseringsprogramma, dat ontworpen is om wetenschappelijke informatie te gebruiken om conserveringsactiviteiten te kataliseren. RAP methoden zijn ontworpen om snel de biodiversiteit van gebieden met hoge diversiteit in kaart te brengen en om lokale wetenschappers te trainen in biodiversiteitsonderzoektechnieken. Vanaf 1990 hebben het deskundig team van RAP en wetenschappers van de gastlanden, 56 terrestrische, zoetwater (AquaRAP), en mariene biodiversiteitsonderzoeken verricht en hebben bijgedragen aan capaciteitsopbouw van wetenschappers in zesentwintig landen. Biologische informatie van vorige RAP onderzoeken heeft geresulteerd in de bescherming van miljoenen hectaren tropisch bos, inclusief het instellen van beschermde gebieden in Bolivia, Peru, Ecuador en Brazilie, en het vaststellen van biodiversiteitsprioriteiten in talrijke landen.

Project Initiatie

De mijnmaatschappij Alcoa heeft door haar succesvol partnerschap met CI bij de uitvoering van een RAP onderzoek in Ghana, voorgesteld aan de Suralco/BHPBilliton Joint Venture, dat een soortgelijke aanpak de moeite waard zou zijn in Suriname. In juni 2005 heeft BHP Billiton Maatschappij Suriname (BMS) Conservation International (CI) geconsulteerd om aanbevelingen te presenteren over de manier waarop CI's "Rapid Assessment Programme" (RAP) zou kunnen bijdragen tot beter begrip van de fauna en flora van de Lely, Nassau en Brownsberg plateaus. Suriname Aluminium Company LLC (Suralco) heeft mijnconcessies op deze drie plateaus en heeft een samenwerkingsovereenkomst (Mining Joint Venture) met de BMS. De samenwerking verdeelt het mijnproces tussen de twee bedrijven. BMS verricht eerst de exploratie op de plateaus en als er voldoende bauxiet is gevonden, mijnt BMS. Suralco verwerkt het bauxiet.

CI heeft voorgesteld dat een strategisch partnerschap wordt gevormd met de Mining Joint Venture van BMS en Suralco. Een centraal component van dit partnerschap houdt in het benutten van CI's "Initial Biodiversity Assessment Planning" (IBAP) methodologie, om zowel de kennis van de werking van ecosystemen als de socio-economische dynamiek van deze gebieden te vergroten, als ook aanbevelingen aan te dragen voor het incorporeren van biodiversiteitsoverwegingen in de vroegste stadia van besluitvorming voor Suriname's volgende generatie van mijnen (zie Hoofdstuk 2).

RAP onderzoek van Lely en Nassau Plateaus

Als onderdeel van het IBAP proces, heeft CI's RAP programma een groep van 18 wetenschappers, studenten en logistieke ondersteuning bijeengebracht om snelle biodiversiteit inventarisaties te doen van het Lely Gebergte en Nassau Gebergte. Vóór dit RAP onderzoek, was er weinig biologische data verzameld van de Lely en Nassau plateaus. Vele studies zijn uitgevoerd in het Brownsberg Natuurpark op het Brownsberg plateau waardoor het RAP team de Brownsberg niet heeft opgenomen in hun onderzoek. Echter is de biodiversiteit van Brownsberg samengevat in dit rapport (zie Hoofdstuk 12) en zijn vergelijkingen gemaakt tussen de drie plateaus. De weinige studies die gedaan zijn op de Lely en Nassau plateaus zijn ook opgenomen in dit rapport (zie Hoofdstukken 3, 4, en 8).

Het RAP team heeft onderzoek gedaan op de Nassau en Lely plateaus van 25 oktober – 6 november, 2005, waarbij de nadruk gelegd is op dezelfde studiegebieden van voorgaande vegetatieonderzoeken (Bánki et al.2003, ter Steege et al. 2004, 2005). Het RAP team, dat bestond uit specialisten in zoogdieren, vogels, reptielen en amfibieën, vissen, mieren en mestkevers, verzamelde gegevens van deze taxonomische groepen, ontwikkelde algemene conclusies van de biodiversiteit van de gebieden, en deed aanbevelingen over hoe hun ecosystemen bewaard kunnen blijven.

Algemeen beschouwde criteria om gedurende RAP onderzoeken prioriteitsgebieden te identificeren voor conservering van taxonomische groepen bevatten: soortenrijkdom, soortenendemisme, zeldzame en/of bedreigde soorten, en habitat conditie. Metingen van soortenrijkdom kunnen gebruikt worden om het aantal soorten van gebieden binnen een gegeven regio te vergelijken. Metingen van soortenendemisme geven het aantal endemische soorten aan in een bepaald gebied en geven een indicatie van zowel de uniciteit van het gebied als de soorten die bedreigd zullen worden door verandering van het habitat van dat gebied (of omgekeerd, de soorten die beschermd zouden kunnen worden middels beschermde gebieden). Schatting van zeldzame en/of bedreigde soorten (IUCN 2006) die bekend zijn of te verwachten zijn binnen een gegeven gebied, zijn een indicator voor de belangrijkheid voor behoud van de mondiale biodiversiteit. De bevestigde aan- of afwezigheid van deze soorten, vergemakkelijkt ook de bepaling van de conserveringsstatus. Veel soorten die geplaatst zijn op de Rode Lijst van bedreigde soorten van IUCN vallen onder verhoogde wettelijke bescherming, waardoor beslissingen met betrekking tot conservering groter gewicht en betekenis krijgen. Door specifieke habitats of subhabitattypes binnen een gebied te beschrijven, worden weinig of slecht bekende habitats geidentificeerd die bijdragen aan habitat varieteit en daardoor aan soortendiversiteit binnen een regio.

RAP ONDERZOEKSGEBIEDEN

Het Lely Gebergte en Nassau Gebergte zijn twee geïsoleerde plateau gebieden in oostelijk Suriname langs de grens met Frans-Guyana en ten oosten van het Brokopondo stuwmeer (zie Kaart). Het bepalend kenmerk van deze plateaus is de aanwezigheid van een dikke, harde korst in de bovenste bodemlaag, die bestaat uit voornamelijk geconsolideerde ferriet (Fe) en bauxiet (Al). Alhoewel het RAP onderzoek van beide gebieden uitgevoerd werd in de droge periode, heeft het tijdens het onderzoek op beide plaatsen geregend, op Lely veel meer (soms zwaar) dan op Nassau. Het regende meestal in de late middag of 's avonds.

Lely Gebergte

Het Lely Plateau is gelegen in het stroomgebied van de Marowijnerivier en bevat een serie plateaus met een maximum hoogte van ongeveer 700 meters. Op het Lely Gebergte komen zes belangrijke vegetatietypen voor, namelijk: hoogdrooglandbos op lateriet plateaus, hoogdrasbos op lateriet plateaus, bergsavannabos, bergsavannamossenbos, vegetatie op en dichtbij rotsachtige kreekbedden, en hoogdrooglandbos op hellingen. Op plaatsen waar mensen actief zijn geweest, komen (laag) secundair bos en open vegetatie voor (bijvoorbeeld dichtbij de landingsbaan).

Het RAP basiskamp was gevestigd op N 4º 16' 13", W 54 º 44' 18" (UTM N 04.27043, W 054.73815), op een hoogte van 640 meter.Vegetatie typen die door het RAP team onderzocht zijn, zijn savannabos met kleine gebieden die hoog bos bevatten, palmzwampen en secundaire groei van gebieden die ontbost zijn voor de infrastructuur. Het Lely Gebergte is nog steeds intact, aangezien toegang tot het plateau moeilijk is en in hoofdzaak beperkt is tot kleine vliegtuigen. De infrastructuur die gevonden is op het Lely plateau is aanzienlijk minder ontwikkeld dan die van Nassau, zonder bekende wegen die het gebergte verbinden met andere gebieden van het land.

Tegenwoordig zijn de enige menselijke activiteiten op het Lely Gebergte gerelateerd aan drie tot vijf personeelsleden van de Surinaamse Luchtvaart Dienst op de landingsbaan van het plateau en verscheidene kampen van kleinschalige goudmijnbouwers in de westelijke heuvels aan de voet van het Lely Gebergte. De medewerkers van de Luchtvaart Dienst zijn gestationeerd in enkele hutten dicht bij de landingsbaan en hebben de vegetatie rondom de twee radiotorens, die naast de landingsbaan staan, verwijderd. Een aantal voetpaden komt voor in het onderzoeksgebied.

Nassau Gebergte

Het Nassau Gebergte bestaat uit vier plateaus die varieren van 500 – 570 meter. In het Nassau Gebergte komen zes belangrijke vegetatietypen voor namelijk: hoogdrooglandregenbos op lateriet vlakten, hoogdrasbos op lateriet vlakten, bergsavannabos, bergsavannamossenbos, vegetatie op en dichtbij rotsige kreekbedden, en hoogdrooglandregenbos op hellingen. Het bergsavanna (mossen)bos is minder uitgebreid dan op het Lely Plateau en heeft een grotere hoogte. Open vegetatie en secundair bos komen voor in de omgeving van de oude landingsbaan en op plaatsen waar in het verleden bauxiet exploratie heeft plaatsgevonden.

Het RAP - basiskamp was op N 4º 49'13",W 54º35'20" (UTM N 04.82047,W 054.60572), gevestigd op een hoogte van 514 meter. Vegetatietypen die onderzocht zijn te Nassau waren primair en secundair hoog bos, bergsavannabos, beperkte stukken palmzwampen en enkele gebieden die ontbost zijn voor de infrastructuur, zoals wegen, en een begroeide landingsbaan. Het Nassau Plateau is iets minder hoog (564 m boven zee niveau) dan Lely.

Van de twee onderzochte plateaus had Nassau de meest wijdverspreide menselijke beinvloeding, met een aantal onverharde wegen, voetpaden en een basiskamp voor bauxietexploratie door BHP-Billiton personeel (BMS) (dit kamp heeft ook de RAP onderzoekteams gehuisvest). Een relatief goed onderhouden niet-geasfalteerde weg (die met de geasfalteerde Oost-West verbindingswegweg in verbinding staat) heeft aansluiting met een aantal kleinere, slecht onderhouden wegen en voetpaden. Een landingsbaan werd gelokaliseerd naast het basiskamp, maar deze was niet onderhouden en op het moment van het RAP onderzoek onbruikbaar. Op hogere gebieden (> 400 m), zijn het bos en de beekjes van het Nassau Gebergte minder beinvloed, maar er zijn toenemende menselijke activiteiten aan de voet van de berg, waaronder "shifting cultivation" gronden, houtkap, kleinschalige goudmijnbouw, en exploratie voor constructie van een grote goudmijn (Newmont).

DATUMS VAN HET RAP ONDERZOEK

Het RAP team was verdeeld in twee kleinere groepen om transport naar deze relatief ontoegankelijke gebieden te vergemakkelijken. Groep 1 (bestaande uit specialisten die vogels, vissen, mieren en mestkevers bestuderen) onderzocht Lely van 25 – 31october 2005 terwijl Groep 2 (bestaande uit specialisten die reptielen/amfibieën kleine zoogdieren/vleermuizen/grote zoogdieren bestuderen) Nassau onderzocht. Van 2 – 6 november, 2005, heeft Groep 1 Nassau onderzocht en Groep 2 Lely.

ALGEMENE RAP RESULTATEN

Het RAP onderzoek van Lely en Nassau bracht een hoge soortendiversiteit aan het licht, waaronder tenminste 27 soorten die endemisch zijn voor het Guiana Schild. Beide gebieden hebben veel grote zoogdieren en grote vogels (b.v. papegaaien, boskalkoenen, powisi's), wat een indicatie is dat zij nog steeds aanzienlijke populaties hebben en dienen als 'veilige haven' voor deze grote soorten. Voor de meeste taxa, planten (inclusief orchideeën), zoogdieren, amfibieën, mieren, vogels, en mestkevers, schijnt Lely diverser te zijn dan Nassau. Dit komt waarschijnlijk door een combinatie van factoren, inclusief het feit dat het Lely plateau groter is en hoger reikt, zodat de uitgestrektheid van elk bostype groter is. Lely heeft ook een seizoenmatige humiditeit die gecreëerd wordt door regenwolken die het kronendak van het bos raken, hetgeen zorgt voor geschikte condities voor het ontstaan van Guiana Hooglandelementen. De grote diversiteit van zoogdieren en mestkevers te Lely kan ook te maken hebben met de meer ongerepte condities van habitats in vergelijking met Nassau, waar meer menselijke verstoring en hogere jachtdruk heeft plaats gevonden.

Het patroon van grotere diversiteit te Lely geldt niet voor de vissen van de hooggelegen bergbeekjes, waarvoor acht vissoorten gedocumenteerd zijn te Lely *versus* 11 soorten te Nassau. Nassau schijnt ook een grotere mate van visendemisme te hebben, het enig taxon waarvoor op dit moment endemisme met zekerheid kan worden vastgesteld. *Hartiella crassicauda*, een zeldzame meerval die endemisch is voor het Nassau plateau, werd tijdens de RAP survey voor het eerst gedocumenteerd sinds 1949, en een nieuwe soort *Guyanancistrus* ('grote mond") is waarschijnlijk ook endemisch.

Tenminste 24 soorten die nieuw zijn voor de wetenschap zijn geregistreerd voor beide gebieden, wat aangeeft hoe weinig wij weten van deze gebieden en het Guiana Schild. Vele van de nieuwe soorten zijn amfibieën en vissen, die kwalitatief schoon zoetwater vereisen voor hun overleving.

Hoewel nog steeds in redelijk goede conditie, worden beide gebieden ernstig bedreigd door menselijke activiteiten. Beide gebieden tonen momenteel bewijs van ongereguleerde jachtactiviteiten, die een directe invloed hebben op grote soorten (vooral grote zoogdieren en vogels), alsook een indirecte invloed op de terrestrische voedsel keten (b.v. mestkevers). Het Lely Gebergte biedt uitstekende conserveringsmogelijkheden, vanwege de relatief geringe menselijke invloeden, kleine bevolkingsdichtheid en beperkte toegang. Het Nassau Gebergte is meer beinvloed door menselijke activiteiten, vooral door jacht en habitatfragmentatie, die het resultaat zijn van toegangswegen die gecreëerd zijn om kleinschalige mijnbouw activiteiten en exploratieactiviteiten voor grootschalige mijnbouw te faciliteren. Beter beheer van de hulpbronnen, vooral regulering van jacht en controle op de toegang, kunnen helpen om de staat van het ecosysteem te verbeteren.

RAP RESULTATEN NAAR TAXONOMISCHE GROEPEN

Mieren

Zes-en-dertig mier-geslachten en 169 soorten zijn verzameld in 600 m^2 bladstrooisel monsters. 136 soorten (80.5%) zijn geregistreerd te Lely en 97 soorten te Nassau (ca 58 % van het totaal). Het verschil is mogelijk ontstaan door het feit dat twee keer zoveel monsters te Lely werden genomen, maar ook de grotere mate van verstoring te Nassau kan van invloed kan zijn op mieren. De mierengemeenschap van Lely verschilde enigszins van Nassau in soortensamenstelling. Het aantal mierensoorten op deze plateaus is waarschijnlijk groter; er is meer bemonstering nodig.

De subfamilie Myrmicinae was vertegenwoordigd door 81 soorten, gevolgd door de Ponerinae met 25 soorten. Het geslacht met de meeste soorten was *Pheidole* met 39 soorten gevolgd door de geslachten *Hypoponera* (11 soorten), *Solenopsis* (10 soorten), *Pyramica* (9 soorten), en *Gnamptogenys* (8 soorten), de vier geslachten samen vormen 21,9% van het totaal. Ten aanzien van het aantal verzamelde individuen, is *Solenopsis* op de eerste plaats gevolgd door de geslachten *Pheidole*, *Hypoponera*, en *Pyramica.*

De helft van de geregistreerde mierensoorten zijn tijdens de RAP expeditie voor het eerst in Suriname verzameld; verdere soortenidentificatie is nodig om dit te bevesitigen. Dacetini soorten zijn goede indicator soorten voor biodiversiteitsplanning, aangezien zij relatief goed bekend zijn en typisch zijn voor gesloten bosondergroei. Vier Dacetini geslachten zijn nu bekend van Suriname sinds het geslacht *Acanthognathus* voor het eerst in Suriname werd gevonden. Er werd ook een mogelijk nieuwe soort van het geslacht *Pyramica* verzameld. Het verspreidingsgebied van het recentelijk beschreven geslacht *Cryptomyrmex* Fernandez (Myrmicinae: Adelomyrmicini), eerder bekend van slechts twee soorten uit Brazilie en Paraguay, is uitgebreid tot Suriname.

Mestkevers

Een totaal van 42 mestkeversoorten is gedocumenteerd voor beide gebieden; 37 soorten te Lely en 27 soorten te Nassau. Bij vergelijking van gestandardiseerde potvaltransecten in primair bos tussen de twee gebieden, had Lely 33 soorten en 21.2 individuen/val, terwijl Nassau minder rijkdom was met 24 soorten en 4.3 individuen/val. Ondanks dat Lely meer mestkeversoorten had, was de mestkeversoortensamenstelling van primair bos op beide lokaties vrijwel gelijk. De twee gebieden hadden 18 soorten gemeen en toonden een hoge Morisita – Horn gelijkheidsindex van 0.93.

Beide gebieden schenen onder jachtdruk te lijden, wat waarschijnlijk een negatieve invloed heeft gehad op de soortenrijkdom en populatiedichtheid van mestkevers, maar Nassau scheen onder de grootste jachtdruk te staan en had de laagste soortenrijkdom en aantallen mestkevers. In het Nassau Gebergte zijn de mestkevers mogelijk ook negatief beinvloed door een grote open beerput naast het basiskamp. Beide lokaties worden gekenmerkt door harde, droge en rotsachtige bodems, die het voor veel mestkeversoorten moeilijk maken om gangen te graven om voedsel te zoeken en om nesten te maken, en kunnen de larvale mortaliteit verhogen. Dit kan een reden zijn waarom op beide locaties de aantallen van mestkevers over het algemeen lager zijn dan in bijna alle tropische bossen die eerder bemonsterd zijn.

Mogelijk zijn 20-30% van de verzamelde soorten niet beschreven. De geslachten *Anomiopus*, *Ateuchus*, *Canthidium* en *Uroxys* hebben mogelijk de meeste niet beschreven soorten. Ofschoon vele soorten mogelijk een relatief afgebakende verspreidingdingsgebied hebben, lijken enkele soorten een grote geografische spreiding te hebben en worden ook gevonden in zuidelijk Amazone.

Meer informatie is nodig over de diversiteit van mestkevers van Lely, Nassau en daaraan grenzende gebieden om een evaluatie van de grootte der verspreidingsgebieden te maken.

Vogels

Te Lely zijn 67 vogelsoorten positief geidentificeerd door het RAP team. Het team heeft ook de resten gevonden van een Harpij Arend of een Pakani-aka, die was gedood door lokale jagers. Vierendertig (34) soorten komen voor op beide locaties. Jagen scheen invloed te hebben op bepaalde soorten, vooral op marais/boskalkoenen, powisi's, papegaaien en roofvogels, waarvan de overblijfselen, samen met de lege hulsen van geweerpatronen op beide lokaties zijn aangetroffen. De soortenrijkdom en diversiteit zijn vermoedelijk typisch voor deze habitats.

Gedurende een 14-daags onderzoek van Lely in 2003, heeft Brian O'Shea 152 vogelsoorten geregistreerd in een klein gebied rondom de landingsbaan. Omdat Lely in een groter gebied ligt van ononderbroken bos, wordt het bestand van vogels geschat op tenminste 300 soorten. De vogelfauna van Lely schijnt representatief te zijn voor laaglandbos, dat het omliggend gebied bedekt, met de toevoeging van verscheidene soorten die in hoofdzaak alleen op plateaus voorkomen. Craciden (Marais en Powisi's) en papegaaien, twee groepen die goede indicatoren zijn van menselijke beinvloeding in het tropisch regenwoud, zijn goed vertegenwoordigd te Lely. De roodgele raaf of Bokraaf, een CITES I soort, kwam vrij veel voor gedurende het onderzoek van 2003. Powisi's werden ook regelmatig gezien, wat deed vermoeden dat er niet veel jachtactiviteit was op het tijdstip van het onderzoek.

Contopus albogularis (Tyarman of Tityari) is in het Lely Gebergte gezien door O'Shea. Deze soort heeft een van de meest beperkte geografische verspreidingsgebieden van alle vogelsoorten in het Guiana Schild. *Phaethornis malaris* (Kolibrie / Kownubri of Korke) heeft ook een beperkt verspreidingsgebied in de Guianas. Geen van deze soorten is geregistreerd in het buurland Guyana. Zestien endemen van het Guiana Schild, of ongeveer 40 % van de endemen die in Suriname voorkomen, zijn te Lely gezien in 2003.

Vissen

Een totaal van 41 visssoorten is geidentificeerd van het Lely en Nassau Gebergte (4 en 11 lokaliteiten, respectievelijk). Hiervan, zijn 26 verzameld in een laagland kreek aan de voet van het Nassau gebergte (hoogte 106 m). De visfauna van vier hooggelegen (plateau) beekjes in het Lely Gebergte had 8 soorten. In vier hooggelegen beekjes in het Nassau Gebergte werden 11 soorten verzameld, inclusief de endemische meerval *Hartiella crassicauda*, die alleen bekend is van de bronwateren van de Paramaka Kreek. In de bergbeken van het Nassau Plateau zijn 6 vissoorten aangetroffen die misschien nieuw zijn voor de wetenschap. Het kleine aantal vissoorten in de hooggelegen bergbeekjes van het Lely Gebergte en het Nassau Gebergte was verwachtbaar, maar het grote aantal potentieel nieuwe en mogelijk endemische soorten van het Nassau Gebergte is uitzonderlijk. Een belangrijk aspect van de visgemeenschappen van de hooggelegen beekjes te Lely en Nassau is het grote aantal kleine soorten, waarvan vele tot dwergvissen gerekend kunnen worden, zoals *Lithoxus* spp., *Hartiella crassicauda* en *Guyanancistrus* ('grote mond').

De steile hellingen die grenzen aan het Nassau Plateau fungeren duidelijk als biogeografische barrières, die de verspreiding van vissen van de ene hooggelegen beek naar de andere beek op het plateau voorkomen. Bijvoorbeeld, *Hartiella crassicauda* van de centrale tak van de Paramaka Kreek ('IJskreek') verschilt morfologisch van *H. crassicauda* in een noordelijke tak van Paramaka Kreek. Een nieuwe *Guyanancistrus* soort (bijnaam 'grote mond') van de noordelijke tak van de Paramaka Kreek is niet verzameld in de centrale tak, ondanks veel inspanningen in de IJskreek tak.

Reptielen en Amfibieën

In 12 dagen van bemonstering hebben we totaal 49 soorten gedocumenteerd, maar vergelijking van onze gegevens met andere locaties in het Guiana Schild laten zien dat ons onderzoek waarschijnlijk slechts een kwart tot een derde van de totale herpetofauna van de twee bergen heeft bemonsterd. Onze resultaten doen vermoeden dat Lely de rijkste is van de twee gebergten met 36 soorten (19 amfibieën, 16 reptielen) vergeleken met 29 soorten (16 amfibieën, 15 reptielen) te Nassau. De dichtheid van individuen was ook hoger te Lely.

De soortensamenstelling tussen de twee gebieden verschilde met slechts 15 / 49 (31%) van alle soorten die voorkomen op beide bergen. Vierentachtig procent van de soorten te Nassau waren uniek voor Nassau, terwijl dat percentage 57 % was te Lely. De soorten op de twee locaties representeerden een menging van wijdverspreide soorten die voorkomen in laagland delen van een groot deel van het Amazone Bekken, naast soorten die bekend zijn van laaglandbos van het Guiana Schild. Vijf amfibie vondsten zijn vooral het vermelden waard, aangezien zij waarschijnlijk soorten representeren die nieuw zijn voor de wetenschap (vier soorten van het geslacht *Eleutherodactylus* en een *Adenomera* soort).

Tijdens additioneel onderzoek dat in 2006 door Ouboter et al. (Hoofdstuk 11) gedaan is te Nassau, zijn nog 15 amfibiesoorten gevonden, waardoor het bekende aantal op 31 soorten is gebracht. Ze hebben ook 11 additionele reptielsoorten vastgelegd, wat aangeeft dat er mogelijk veel meer soorten zijn op beide plaatsen. Vóór het RAP onderzoek, waren vijf *Eleutherodactylus* soorten bekend van Suriname; ons werk op de twee gebergten heeft de aanwezigheid van het geslacht in Suriname bijna verdubbeld. Bosbeken zijn belangrijke habitats voor vele soorten die wij zijn tegengekomen gedurende ons onderzoek: ongeveer 50 % van de op beide plaatsen voorkomende soorten, maken gebruik van bosbeekjes, 25% van de soorten die gevonden zijn te Lely en ongeveer 30% van de soorten die te Nassau gevonden zijn, zijn alle in of langs bosbeken gevonden. Aangezien met beken geassocieerde amfibieën populatieafname kennen in het grootste deel van de Neotropen, is de aanwezigheid van een duidelijk intacte, met beken geassocieerde amfibieën fauna in de twee gebergten van bijzondere conserveringswaarde.

Zoogdieren

Voor beide onderzoekgebieden in oostelijk Suriname zijn 45 zoogdiersoorten in negen orden geregistreerd; zes orden met 28 soorten te Nassau; en acht orden met 30 soorten te Lely. Onder de kleine zoogdieren was een buideldiersoort, drie knaagdiersoorten, en 24 vleermuissoorten (meestal vruchtenetende vleermuizen). Zeventien soorten van middelgrote en grote zoogdieren zijn geregistreerd op de twee plaatsen, met meer soorten (13) te Lely dan te Nassau (8). De meest diverse groepen waren de primaten en de carnivoren, elk met vier soorten; inclusief grote (*Alouatta macconnelli*, *Ateles paniscus*, *Chiropotes chiroptes*) en kleine (*Saguinus midas*) apen, alsook twee grote (*Panthera onca*, *Puma concolor*) en een kleine (*Leopardus pardalis*) katachtigen, plus een kwasikwasi/neusbeer (*Nasua nasua*).

Onze resultaten geven aan dat het Lely plateau een hogere taxonomische en ecologische diversiteit heeft en doet vermoeden dat het bos te Nassau minder geschikt is voor kleine niet-vliegende zoogdiersoorten, waarschijnlijk door achteruitgang van het primair bos. Bijvoorbeeld, fruit-etende vleermuizen waren dominant te Nassau, zoals verwachtbaar is voor secundair bos en bosranden. Te Lely hebben we meer Phyllostominae vleermuissoorten geregistreerd (die omnivoren of insekteneters zijn), wat duidt op een meer complexe bosstructuur dan te Nassau. Twee vleermuissoorten, *Lophostoma carrikeri* en *Artibeus obscurus* zijn op de lijst van bedreigde soorten geplaatst (IUCN 2006). De meeste primaten en carnivoren zijn ook op mondiaal niveau op de lijst van bedreigde soorten geplaatst en verscheidene zijn endemisch voor het Guiana Schild, dus hun wereldwijde conservering hangt grotendeels af van de status van deze populaties. De Braziliaanse tapir (*Tapirus terrestris*) is op de lijst geplaatst als Kwetsbaar, omdat de tapir overal door jacht wordt bedreigd en we hebben bewijs gevonden dat hetzelfde gebeurt in Lely en Nassau. De

diversiteit en aantallen van middelgrote en grote zoogdieren wijst op geschikte habitats voor deze soorten, die normaliter uitgebreide, minder verstoorde bossen nodig hebben. De aanwezigheid van hoefdieren kan de aanwezigheid van de poema en de jaguar in het gebied verklaren.

RESULTATEN VAN ANDER BIODIVERISTEITSONDERZOEK VAN DE PLATEAUS VAN LELY, NASSAU EN BROWNSBERG

Planten

Zes belangrijke vegetatietypen komen voor op de plateaus van Lely, Nassau en Brownsberg: hoogdrooglandregenbos op lateriet plateaus, hoogdrasbos op lateriet plateaus, bergsavannabos, bergsavannamossenbos, vegetatie op en dicht bij rotsige kreekbedden, en hoogdrooglandregenbos op hellingen. Terwijl op het Brownsbergplateau de hoogte van het bos en de vegetatietypen op zeer korte afstanden veranderen in een 'mozaiek'bos, zijn de vegetatietypen duidelijker op het Lely plateau, waar grote gebieden met uniforme vegetatietypen gevonden kunnen worden. Open vegetatie of onbedekte rotsen, zoals die gevonden worden op granietbergen, schijnen niet voor te komen op deze plateaus.

Inventaris van de onderzoekplots van de bauxietplateaus wijst op een divers bos wat duidelijk een aparte groep vormt binnen alle geinventariseerde plots van de Guianas. De plots die op Lely gevonden zijn, hebben momenteel de hoogste gemiddelde diversiteit voor Suriname, hetgeen goed past in de algemene toename in alpha-diversiteit bij bomen, van westelijk Guyana naar Frans-Guyana. Alhoewel het verschil klein en niet significant is, hebben de bauxietplateaus en hun omringend bos een hogere alpha-diversiteit voor bomen, vergeleken met andere Surinaamse bosgebieden waarover gegevens beschikbaar zijn. De samenstelling van de plots in oost Surinaamse is beter vergelijkbaar met die van Frans-Guyana op vergelijkbare ijzerhoudende bodems. Plots die geografisch dicht bij elkaar liggen 'komen meer overeen' dan plots die op grotere afstanden liggen, en ze hebben meer soorten met elkaar gemeen (vergeleken met de laaglanden) die door toeval kunnen worden toegevoegd.

De plantenverzamelingen voor de bauxietplateaus en voor Suriname en de Guianas in het algemeen zijn nog steeds erg klein en veel meer onderzoek is nodig. In vergelijking met de Hooglanden van de Guianas met hun hoge endemiciteit, is de vegetatie van de lateriet- en bauxiet plateaus op vulkanische rotsen uniformer en heeft lage endemiciteit. We hebben geen bewijs gevonden voor specifieke endemen voor de plateaus van Brownsberg, Lely, en Nassau.

Orchideeën

Een apart onderzoek van orchideeën werd uitgevoerd op de drie plateaus. Een totaal van 190 soorten orchideeën is geregistreerd voor de plateaus van Brownsberg, Nassau en Lely: 141 van de Brownsberg, 70 van Nassau, en 96 van Lely; 16 % zijn bekend van alle drie verspreidingsgebieden, en 31% alleen van de Brownsberg. De lage orchideeënrijkdom voor Lely en Nassau, kan beschouwd worden als artefact gerelateerd aan een lage verzamelinspanning. Vergeleken met andere gebieden in het Guiana Schild, heeft Brownsberg de tweede hoogste orchideeën soortenrijkdom. De beschikbare informatie doet vermoeden dat een aantal orchideesoorten die erg zeldzaam zijn in het Guiana Schild gebied, voorkomen in deze drie verspreidingsgebieden, bijvoorbeeld *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) en *Quekettia papillosa* (Nassau).

Er waren significante verschillen in de percentages van de soorten verdeeld over verschillende substraatklassen. Lely, met 16% van zijn orchideeën die groeien op de grond of op rotsen, verschilt van de andere twee plateaus met 4-5% van de orchideeënsoorten op deze substraten. Een groot percentage hoogland orchideeënsoorten (ongeveer 30 - 40%) kan het kenmerk zijn dat de gebieden met hoge plateaus onderscheidt van laagland gebieden, en kan de hoge soortenrijkdom van de plateaus verklaren. Er kan een trend zijn dat hoogland orchideeën belangrijker worden, als de hoogte van de belangrijkste plateaus van het verspreidingsgebied toeneemt. Dus Lely is misschien van de drie verspreidingsgebieden voor orchideeën, het meest afwijkend, uniek en soortenrijk.

Orchidee-bijen

Een totaal van 34 soorten orchidee-bijen is verzameld op de drie plateaus: 13 te Brownsberg, 22 dichtbij Lely en 23 te Nassau. De frequentie van bijen met orchidee-stuifmeelzakken (pollenzakken) verschilde duidelijk tussen een laagland locatie dicht bij Lely en Nassau; op de eerste locatie droegen geen van de bijen stuifmeelzakken, op de tweede 13 %. Er moet meer bemonsterd worden voordat een gedetailleerde vergelijking van de bijenfauna van de drie verspreidingsgebieden gemaakt kan worden. De hoge frequentie van orchidee-bijen met stuifmeelzakken te Nassau is ongewoon en kan in verband worden gebracht met de habitat waar de meeste monsters zijn verzameld, het wolkenbos op lage hoogte en het submontane plateau.

VERGELIJKINGEN VAN DE PLATEAUS VAN LELY, NASSAU, EN BROWNSBERG

Habitat Type en Huidige Status

Tabel 1 toont de huidige status van de drie plateaus op dit moment. Alle drie plateaus hebben zes belangrijke vegetatietypen (zie Hoofdstuk 3 en samenvatting van de planten hier boven). Op het Brownsberg plateau veranderen boshoogte en vegetatietype op zeer korte afstanden, wat een 'mozaiek' bos vormt, terwijl de vegetatietypen duidelijker zijn op het Lely plateau, waar grote gebieden met uniforme vegetatietypen gevonden kunnen worden. Lely verschilt van Nassau en Brownsberg in de uitgestrektheid van het bergsavannabos. De toename in hoogte (670 m boven zeeniveau, vergeleken met 550 m boven zeeniveau voor de andere plateaus) schijnt voldoende te zijn voor het voorkomen van verscheidene Guiana Hoogland elementen,

Tabel 1. Huidige status van de plateaus van Brownsberg, Lely en Nassau.

Lokatie	Totale grootte	Hoogte, Habitat type	Graad van habitat degradatie	Bewijs van Houtkap	Bewijs van Jacht	Bewijs van Mijnbouw	Taxonomische groepen die goede conditie of rijkdom aangeven	Taxonomische groepen die slechte conditie of rijkdom aangeven
Brownsberg	(11.800 ha park) [1] 27.500 totaal[1]	ca. 500 m Zes belangrijke vegetatietypen. Mozaiekbos van hoogdroogland regenbos, bergsavanna(mossen)bos en lianenbos.	5% van het park vernietigd door illegale goudmijnbouwers, veel secundair-bos	Matig maar hoog in noordelijke delen	Matig maar hoog buiten het park	Ja, legale en illegale goudmijnbouw	Apen, Kami Kami's en Powisis, Grote knaagdieren, Buffel, Kikkers en Padden, Landschildpadden, Zeldzame orchideeën en andere zeldzame plantensoorten (vooral soorten die voorkomen in sub-bergachtige gebieden en korstige bodem	Fruitetende vleermuizen, plantensoorten die op grote openplekken voorkomen (waaronder vreemde soorten & pantropisch gras), afstandelijk gedrag van apen ten op zichte van mensen, lage predatie en verspreiding van grote zaden
Lely	32.000 ha[2]	640-700 m Zes belangrijke vegetatietypen. Voornamelijk hoogdrooglandregenbos en uitgestrekte bergsavanna(mossen)bos met Guiana Hoogland elementen.	Laag tot matig	laag	matig	Illegale goudmijnbouw dichtbij en aan de voet	Grote zoogdieren, Grote vogels, Amfibieën Phyllostomine vleermuizen, Mestkevers Mieren: *Wasmannia scrobifera, Thaumatomyrmex ferox*	Mier: *Wasmannia auropunctata*
Nassau	20.000 ha[2],[3]	500-550 m Zes belangrijke vegetatietypen. Voornamelijk hoogdrooglandregenbos en hoogzwampbos. Minder uitgestrekte bergsavanna (mossen)bos.	matig	matig	hoog	Ja, illegale goudmijnbouw, Legale bauxiet exploratie	Vissen (6 soorten nieuw voor de wetenschap, endemische meervallen), Grote zoogdieren, Grote vogels	Stenodermatine (fruit etende) vleermuizen, Mestkevers,Mier*: Wasmannia auropunctat*a

[1] De Dijn et al. (Hoofdstuk 13)
[2]Olaf Bánki en Hans ter Steege, persoonlijke communicatie
[3]De drie grootste plateaus van Nassau hebben een totale oppervlakte van ongeveer 5000 ha als slechts de toppen worden meegerekend zonder de hellingen (Olaf Bánki en Hans ter Steege, persoonlijke communicatie)

zoals de Ericacea-achtige *Cavendishia*. Daarnaast, heeft het laag, open bos op de hoogste hellingen een overvloedige mossenflora (mossenbos) met veel Orchidaceae.

De natuurlijke habitats van het Brownsberg plateau zijn gelijk aan die beschreven voor het binnenland van Frans-Guyana door De Granville (1994) en ook voor de Nassau en Lely plateaus (De Dijn persoonlijke communicatie, hoofdstuk 3). De meer unieke habitats zijn geassocieerd met de top van de plateaus, zoals bergsavannamossenbos en habitats op sterk korstige bodems. Deze habitats zijn verschillend in termen van de bodem, klimatologische condities en vegetatiesamenstelling.

Ecosystemen van alle drie gebieden zijn relatief intact vanwege lage mensenpopulatiedichtheden, hetgeen een unieke gelegenheid voor conservering biedt in een relatief groot landschapsgebied. Echter, elk van deze plateaus is enigszins door mensen beinvloed. Lely is in de meest ongerepte staat, wat te danken is aan het verafgelegen zijn en de ontoegangkelijkheid. Er is wat infrastructuur op de Lely landingsbaan en de leden van het werkpersoneel jagen op vogels die voor hun vooral interessant zijn als aanvulling op hun dieet.

Nassau heeft een relatief uitgebreid wegennetwerk dat nu al habitats fragmenteert en gemakkelijk toegang verschaft tot bosgebieden, vooral voor kleinschalige mijnbouwers, met gevolgen zoals jacht. Infrastructuur voor mijnexploratie te Nassau omhelst een grote open beerput en een klein kamp.

Sinds 1970 is meer dan 11.600 ha van het Brownsberg plateau beschermd binnen het Brownsberg Natuur Park (BNP). Echter, een substantieel deel van het BNP is vernietigd door mensen en is secundair bos, voornamelijk langs de belangrijkste weg in het gebied en op lagere hoogten langs kreken waar mijnwerkers actief zijn. De laagste graad van verstoring wordt over het algemeen gevonden boven 250 m, in de noord-westelijke hoek van het natuurpark en op sommige lokaties dicht bij het Brokopondo Stuwmeer. Hoewel het een beschermd gebied is, is BNP ook beinvloed door toerisme en er zijn problemen van onopgeloste conflicten over landenrechten en armoede, vooral met betrekking tot Marron gemeenschappen.

Alle drie plateaus hebben te maken met een aantal werkelijke en potentiele bedreigingen, waarvan de grootste zijn jacht/stroperij, houtkap, habitatfragmentatie, kleinschalige (goud) mijnbouw en grootschalige (bauxiet en goud) mijnbouw. Illegale goudmijnbouwers vormen de grootste bedreiging voor alle drie gebieden. Veel effecten van menselijke activiteiten (b.v. verhoogde sediment aanvoer in kreken en ontbossing) kunnen nu al gezien worden aan de voet van de heuvels van de plateaus van Nassau en Brownsberg.

Soortenrijkdom

Het is moeilijk om de drie plateaus direct te vergelijken aangezien er veel meer informatie is en meer onderzoek gedaan is te Brownsberg in vergelijking met Lely en Nassau. We hebben echter getracht om hier een paar algemene vergelijkingen te maken. Tabel 2 toont de geregistreerde soortenrijkdom op de drie plaatsen.

Onderzoek van plantendiversiteit op de drie plateaus en de omringende gebieden geeft een indicatie dat alle drie gebieden een hoge diversiteit hebben, vergeleken met de meeste laaglandbossen in West- Suriname. Het bos op de hellingen van de plateaus is het hoogste dat is gevonden in het noordelijk deel van Suriname. Hoewel deze onderzoeken aangeven dat Lely, van de drie plateaus, de hoogste plantendiversiteit heeft per plot en Nassau de laagste, zijn de verschillen niet groot genoeg om een echt verschil in de plantendiversiteit tussen de drie gebieden te onderscheiden. Lely verschilt van Nassau en Brownsberg vanwege de grote uitgestrektheid van bergsavannabos. Het plateau van Lely heeft een voldoende grotere hoogte vergeleken met Nassau en Brownsberg dat verschillende Guiana Hoogland elementen hier worden gevonden (zie Hoofdstuk 3). De lage orchideeënrijkdom voor Lely en Nassau, vergeleken met Brownsberg, kan verklaard worden door een lagere verzamelinspanning. Vergeleken met andere plaatsen in het Guiana Schild, heeft Brownsberg de tweede grootste vastgestelde orchideeënrijkdom.

Er is geen aantoonbaar verschil in de avifauna van de Brownsberg, Lely en Nassau plateaus. Verschillen in de kwaliteit en kwantiteit van de bemonstering tussen de drie gebieden is de oorzaak van verschillen in soortenlijsten. Er is niet veel "berg" avifauna in Suriname (Tafelberg is een uitzondering); in feite hebben structureel vereenvoudigde habitats over ijzersteen/bauxiet kappen, over het algemeen relatief weinig vogelsoorten, en geen daarvan is beperkt tot deze habitats; en hellingen schijnen ook arm te zijn. Aan de andere kant schijnen hoge bomen boven op de top van de plateaus, redelijk soortenrijk te zijn, maar niet meer dan vergelijkbaar bos op lagere hoogten. De belangrijkste eigenschap van Lely en Nassau, vanuit het oogpunt van de vogels bekeken, is de aanwezigheid van grote aantallen grote vogels zoals papegaaien, powisi's en marais. Op deze vogels wordt veel gejaagd en ze worden gevangen voor de dierenhandel, dus de grote aantallen in deze twee gebieden zijn wel significant. Brownsberg heeft ook goede populaties van deze vogels en fungeert als een 'veilige haven' voor jaagbare vogels die zeldzamer schijnen te zijn in de omliggende laaglanden. Ribot (2006) bevestigt dat enkele grote vogels (Kamikami's, Powisi's en Marai's) naar Brownsberg teruggekeerd zijn na een periode van intensieve jacht gedurende de binnenlandse oorlog.

Slechts één van de zoogdiersoorten die geregistreerd zijn te Lely en Nassau, is niet te Brownsberg gevonden (een stekelmuis, *Neacomys guianae*). De zoogdierfauna van alle drie gebieden is typisch voor het laaglandregenbos van het Guiana Schild, en is tamelijk wijdverspreid over al de drie gebieden, die zeer sterk op elkaar lijken qua origine, maar die nu verschillende gradaties van habitatverstoring kennen. Gegeven dat Brownsberg niet slechts een beschermd gebied is, maar ook een langere geschiedenis heeft van biologische studies, is het mogelijk dat de meeste zoogdieren een wijd verspreidingsgebied hebben, wat kan helpen om hun populaties stabiel te houden. Nassau is echter een zwaarder beinvloede lokatie, waar lokale achteruitgang

of uitsterving van bepaalde populaties mogelijk is. Elke gevolgtrekking van de status van de zoogdierpopulatie is nog steeds onvolledig en niet accuraat; en uitgebreid onderzoek is nodig om werkelijke patronen te bepalen van de zoogdiersamenstelling. Zoals genoteerd voor de vogels, is de belangrijkste eigenschap van deze drie gebieden misschien, de aanwezigheid van veel grote zoogdieren, vele die mondiaal bedreigd worden en onder zware jachtdruk staan in andere gebieden.

Naast vlinders, zijn insecten niet systematisch bestudeerd op de Brownsberg, dus vergelijkingen tussen de drie gebieden kan niet gemaakt worden voor mieren en mestkevers. De soortenrijkdom van deze groepen is hoog te Lely en Nassau en men zou verwachten dat die ook hoog is op de Brownsberg. Een aantal zeldzame vlinders is gedocumenteerd voor Brownsberg hoewel er veel meer data nodig zijn.

Endemische Soorten

Soorten die endemisch zijn voor de plateaus van Lely, Nassau of Brownsberg

Gegeven de beperkte verzamelinspanning voor Suriname en voor het Guiana Schild, is het moeilijk te zeggen of soorten die bekend zijn van de plateaus van Lely, Nassau en Brownsberg endemisch zijn voor die plateaus. Geen enkele soort die op het Brownsberg plateau gevonden is, is endemisch voor dat gebied. Meer informatie is nodig van alle taxa zowel binnen als buiten dit gebied, om te bepalen of er soorten zijn die endemisch zijn voor de plateaus.

Endemisme is alleen aangetoond voor enkele vissoorten te Nassau. De hooggelegen bergbeken van het Nassau plateau onthulden zes vissoorten die nieuw zijn voor de wetenschap en die potentieel endemisch zijn voor het Nassau plateau. Tot nog toe is geen vissoort endemisch gebleken

Tabel 2. Het aantal soorten dat is gedocumenteerd op de plateaus van Lely, Nassau, en Brownsberg.

	Alle RAP gebieden van dit onderzoek	Lely	Nassau	Brownsberg
Planten (inclusief orchideeën van botanische collecties te Utrecht)	--	487[1]	694[1]	1060[1]
Orchideeën		96[2]	70[2]	141[2]
Mieren	169	136	79	
Mestkevers	42	37	27	12[3]
Orchidee- Bijen	--	22[4]	32[5]	13[6]
Vlinders	--	--	--	137[7]
Vissen	41 (17)[8]	8[8]	35 (11)[8]	(3)[8]
Amfibieën	27	20	16 (31)[9]	64[10]
Reptielen	22	16	13 (26)[9]	80[10]
Vogels (RAP)	121	67	79	-
Vogels		152		387[11]
Vleermuizen	24	14	19	54[12]
Kleine Zoogdieren	4	3	1	21[12]
Medium and grote zoogdieren (inclusief primaten)	17	13	8	41[12]

[1]Data van ter Steege et al. (Hoofdstuk 3; deze editie). Lely gebaseerd op 1097specimens, Nassau op 1691 specimens, en Brownsberg op 2572 specimens).
[2] Genoteerd door Molgo, 11 oct 2006, gebaseerd op herbarium materiaal en andere betrouwbare bronnen.
[3] Genoteerd door Hielkema, 2006, gebaseerd op enig materiaal in zijn collectie.
[4] geen monster beschikbaar van Lely sensu stricto; gebaseerd op monsters verzameld dichtbij Diitabiki.
[5] gebaseerd op een bescheiden monster dat recentelijk genomen is op het plateau van Nassau.
[6] gebaseerd op museum specimens van Brownsberg aanwezig in NZCS in Suriname.
[7] gebaseerd op lijst nota door Hajo Gernaat, 2005; de meeste niet geidentificeerde soorten niet meegeteld
[8]aantal soorten van hooggelegen beken tussen haakjes (d.w.z. met uitzondering van 26 species van laaglandbeken aan de voet van de heuvels van het Nassau Gebergte); Brownsberg data van Jan Mol, niet gepubliceerde data
[9] ( ) additionele gegenvens van Ouboter et al. (Hoofdstuck 11).
[10] gebaseerd op verscheidene bronnen, 26 twijfelgevallen niet opgenomen bij de telling
[11] verscheidene bronnen, gecompileerd door J.H. Ribot (http://www1.nhl.nl/~ribot/english/); enkele species verwijderd van Ribots lijst door O'Shea
[12] gebaseerd op Lim et al. 2005, maar met uitzondering van 10 species die niet echt zijn gezien op de Brownsberg

voor het Lely plateau. De reden voor dit groot verschil in endemisme is niet duidelijk en moet bestudeerd worden in de toekomst. Enkele soorten (v.b. *Hartiella crassicauda* en *Guyanancistrus* 'grote mond') van hooggelegen beken in het Nassau gebergte, zijn duidelijk beperkt tot dit klein gebied van 20 x 20 km^2; maar endemisme van de andere soorten moet vastgesteld worden bij toekomstig onderzoek. De spreiding van bepaalde vissoorten kan beperkt zijn tot een enkele stroom (*H. crassicauda* in Paramaka Kreek) of zelfs tot een zijtak van Paramaka Kreek (v.b. *Guyanancistrus*- 'grote mond' en de slanke vorm van *H. crassicauda*). De steile hellingen van het plateau van het Nassau gebergte, zijn mogelijk een biogeografische barriere, die verspreiding van de vissen over de berg en het plateau verhinderen.

In het huidige plantcollecties is er geen bewijs voor endemisme voor de plateaus van de Brownsberg, Lely of Nassau. Enkele plantengroepen, zoals Bryophyta, varens en orchideeën vertonen echter verschillen, vermoedelijk in soortensamenstelling tussen laagland en bergsavanne gebieden. In het bergsavannebos zijn er veel nog niet-geïdentificeerde Myrtaceae soorten, waardoor het moeilijk wordt de conserveringswaarde van het bostype te bepalen op dit moment.

Endemische soorten voor Suriname

Drie boomsoorten, *Copaifera epunctata* (Fabaceae), *Phoradendron pulleanum* (Santalaceae), en *Sloanea gracilis* (Elaeocarpaceae), waarvan men dacht dat die endemisch waren, zijn verzameld te Brownsberg en Lely. Echter kunnen deze mogelijke endemen voor Suriname ook het resultaat zijn van lage verzamelinspanning in de Guianas en de omringende landen.

Endemische soorten voor het Guiana Schild

Acht zoogdiersoorten die geregistreerd zijn voor Lely en Nassau zijn endemisch voor het Guiana Schild (Tabel 3). Een van deze soorten, *Ateles paniscus* (Kwata aap) komt ook op de Brownsberg voor. Brownsberg heeft additioneel nog zes soorten die endemisch zijn voor het Guiana Schild (Tabel 3). Echter, zoals hier boven is aangegeven, is verder onderzoek nodig te Lely en Nassau om de aanwezigheid en status te bepalen van de zoogdierenfauna.

Negentien soorten van de endemische vogels van het Guiana Schild, of ongeveer 50% van de endemen die in Suriname voorkomen, zijn geregistreerd voor Lely en Nassau (Tabel 3). *Contopus albogularis* heeft een van de meest beperkte geografische verspreidingsgebieden van welke vogelsoort dan ook in het Guiana Schild en *Phaethornis malaris* (Kolibrie, Kownubri of Korke) heeft ook een beperkt verspreidingsgebied in de Guianas. Geen van deze soorten is geregistreerd voor ons buurland Guyana. Naast de eerder genoemde soorten, zijn twaalf endemische vogelsoorten van het Guiana Schild geregistreerd te Brownsberg (Tabel 3). Over het algemeen bevatten de gebieden Lely-Nassau-Brownsberg ten minste 75% van de endemen van het Guiana Schild, waarvan men weet dat die in Suriname voorkomen.

Van de bekende herpetofauna, zijn zes amfibiesoorten en twee reptielsoorten van Brownsberg en Nassau, endemisch voor het Guiana Schild. Nogeens 15 soorten van Brownsberg zijn ook endemisch voor dit gebied (Tabel 3).

In het huidige plantenbestand voor de drie bauxietplateaus, zijn verscheidene soorten zoals *Dycranopygium pygmaeum* (Cyclanthaceae), *Elaphoglossum latifolium* (Lomariopsidaceae), *Longchitis hisuta* (Dennstaedtiaceae), *Thelypteris holodictya* (Thelypteridaceae), *Trichomanes membranaceum* (Hymwnophyllaceae) gevonden, die strict endemisch geacht worden te zijn, ten minste voor de Guianas, in het bergsavannabos (mossenbos) en rotsachtige kreekbedden. Te Lely zijn bepaalde plantensoorten, v.b. *Cavendishia callista* (Ericaceae), die behoort tot de Hooglanden van de Guianas, ook gevonden in het bergsavannebos.

Bedreigde soorten

De rode lijst van IUCN categoriseert soorten die gebaseerd zijn op de mate waarin die bedreigd zijn (IUCN 2006). Categorieën van minder bedreigd tot meest bedreigd, houdt in: Data Onvolledig (DD, er is niet voldoende bekend om een schatting te maken), Laag Risico (LR) wat inhoudt Afhankelijke van conservering (cd), Bijna Bedreigd (nt), en Minder Aandacht (lc, op de lijst geplaatst, maar niet bedreigd), Kwetsbaar (VU), Bedreigd (EN), en Ernstig Bedreigd (CR) (IUCN 2006).

Tien boomsoorten die geregistreerd zijn op de drie plateaus zijn op de IUCN lijst geplaatst als bedreigd: de aantallen van elke soort verschillen tussen de drie plateaus. Deze soorten zijn: *Vouacapoua americana* (CR), *Apeiba intermedia* (DD), *Virola surinamensi* (EN), *Minquartia guianensis* (LR/nt), *Pouteria rodriguesiana* (LR/nt), *Copaifera epunctata* (VU), *Macrolobium amplexans* (VU), *Couratari guianensis* (VU), *Corythophora labriculata* (VU), en *Bertholletia excelsa* (VU). Vijf boomsoorten die geregistreerd zijn, zijn beschermd onder de Surinaamse wet: *Bertholletia excelsa*, *Manilkara bidentata*, en species van *Dipteryx* en *Copaifera*.

Al de geregistreerde zoogdiersoorten te Lely en Nassau zijn op de Rode Lijst van bedreigde soorten van IUCN, maar de meeste zijn geclassificeerd als Lager Risico –Minder Bedreigd (LR/lc). Elf soorten worden als bijzonder belangrijk voor conservering beschouwd. Nogeens 13 zoogdiersoorten die geregistreerd zijn te Brownsberg zijn ook bedreigd. Tabel 4. toont de bedreigde zoogdiersoorten van de drie gebieden, die gecategoriseerd zijn als boven LR/lc. Meer informatie is nodig van de zoogdieren te Lely en Nassau, om te kunnen zeggen of de bekende soorten van de Brownsberg ook aanwezig zijn op deze twee plaatsen.

Een dieet dat is gebaseerd op algen, een lage vruchtbaarheid, grote mate van plaatsgebondenheid en beperkt verspreidingsgebied, maken de zeldzame meerval *Hartiella crassicauda* erg kwetsbaar voor menselijke activiteiten op het plateau van Nasau. Deze soort kan beschouwd worden als een bedreigde soort en moet geplaatst worden op de Rode Lijst van IUCN.

Tabel 3. Diersoorten die geregistreerd zijn te Lely, Nassau en Brownsberg en die bekend zijn als endemen voor het Guiana Schild.

Groep	Species	Locatie
Zoogdieren	Guiana Rode Brulaap, *Alouatta macconnelli*	Lely, Nassau
	Rood ruggige baard saki, *Chiropotes chiropotes*	Lely
	Buidelrat, *Marmosa murina*	Nassau
	Roodhand tamarin/Saguwenke, *Saguinus midas*	Lely, Nassau
	Kwata/ Zwarte Spinaap, *Ateles paniscus*	Lely, Brownsberg
	Dubost's stekel muis, *Neacomys dubosti*	Lely
	Stekel muis, *Neacomys guianae*	Lely
	Guyanese stekelrat/ Maka alata, *Proechimys guyannensis*	Lely
	Witkop saki, *Pithecia pithecia*	Brownsberg
	Gindya maka, *Agidya Coendou melanurus*	Brownsberg
	Stekel muis, *Neacomys paracou*	Brownsberg
	Oecomys auyantepui	Brownsberg
	Monodelphis brevicaudata	Brownsberg
	Lophostoma schulzi	Brownsberg
Vogels	Powisi, *Crax alector*	Lely, Nassau
	Marai, *Penelope marail*	Lely, Nassau
	Gypopsitta caica	Lely
	Roodsnavel/Redimofo, *Monasa atra*	Lely
	Stonkuyake, *Selenidera piperivora*	Lely
	Stonkuyake, *Pteroglossus viridis*	Lely
	Xiphorhynchus pardalotus	Lely, Nassau
	Mirafowru, *Myrmotherula surinamensis*	Lely
	Mirafowru, *Myrmotherula gutturalis*	Lely
	Mirafowru, *Herpsilochmus stictocephalus*	Lely
	Mirafowru, *Percnostola rufifrons*	Lely, Nassau
	Mirafowru, *Gymnopithys rufigula*	Lely, Nassau
	Tyarman/Tityari, *Contopus albogularis*	Lely, Nassau
	Rotshaan, *Rupicola rupicola*	Lely
	Busikaw, *Perissocephalus tricolor*	Lely, Nassau
	Manakin, *Corapipo gutturalis*	Lely
	Manakin, *Lepidothrix serena*	Lely
	Blaauwdas/kanarie, *Euphonia finschi*	Lely
	Grangrandir/kanarie, *Euphonia cayennensis*	Lely
	Mason, *Amazona dufresniana*	Brownsberg
	Notharchus macrorhynchos	Brownsberg
	Timmerman/Timreman, *Veniliornis cassini*	Brownsberg
	Fityo, *Synallaxis macconnelli*	Brownsberg
	Mirafowru, *Frederickena viridis*	Brownsberg

Groep	Species	Locatie
	Mirafowru, *Sakesphorus melanothorax*	Brownsberg
	Mirafowru, *Myrmotherula guttata*	Brownsberg
	Mirafowru, *Herpsilochmus sticturus*	Brownsberg
	Iodopleura fusca	Brownsberg
	Manakin, *Tyranneutes virescens*	Brownsberg
	Cyanicterus cyanicterus	Brownsberg
	Periporphyrus erythromelas	Brownsberg
Amfibieën	*Colostethus beebei* (kikker)	Lely
	Colostethus degranvillei (kikker)	Lely, Nassau
	Eleutherodactylus chiastonotus (pad)	Nassau
	Eleutherodactylu zeuctotylu (pad)	Lely
	Chiasmocleis shudikarensis (pad)	Lely, Nassau
	Atelopus hoogmoedi (= *A. spumarius hoogmoedi*;kikker)	Brownsberg
	Cochranella oyampiensis (pad)	Brownsberg
	Colostethus granti (pad)	Brownsberg
	Osteocephalus cabrerai (pad)	Brownsberg
	Scinax proboscideus (pad)	Brownsberg
	Eleutherodactylus inguinalis (pad)	Brownsberg
	Leptodactylus longirostris (pad)	Brownsberg
	Leptodactylus meyersi (pad)	Brownsberg
	Pipa aspera (pad)	Brownsberg
	Rhinatrema bivittatum (worm salamander)	Brownsberg
	Microcaecilia unicolor (worm salamander)	Brownsberg
Reptielen	*Gonatodes annularis* (gekko)	Lely
	Neusticurus rudis (hagedis)	Lely, Nassau
	Atractus zidoki (slang)	Brownsberg
	Micrurus collaris (slang)	Brownsberg
	Leptotyphlops collaris (slang)	Brownsberg

Vier vogelsoorten die geregistreerd zijn voor de Brownsberg hebben conserveringswaarde: Harpij Arend, *Harpia harpya*; Tyarman of Tityari, *Contopus borealis*; Mason, *Amazona dufresniana* en de Roodgele raaf, *Ara macao*. *Amazona dufresniana* is op de lijst geplaatst als LR/nt en heeft conserveringswaarde in de Guianas vanwege zijn waarde in de handel van in het wild levende dieren. Er zijn geen bedreigde vogelsoorten geregistreerd voor Lely of Nassau, ofschoon een klauw van een grote roofvogel, die gezien is te Lely, van een Harpij Arend of Pakani-aka kan zijn, beide bedreigd (LR/nt). Additionele vogelstudies van deze twee plateaus zijn nodig om te bepalen of enige van deze of andere bedreigde vogelsoorten aanwezig zijn.

Een pad soort (*Atelopus hoogmoedi*) en de geelpoot landschildpad, (*Geochelone denticulata*) bekend van de Brownsberg, zijn op de lijst als VU door IUCN geplaatst.

Alle amfibie- en reptielsoorten, die gedocumenteerd zijn voor Lely en Nassau, zijn geëvalueerd door "IUCN Rode lijst", maar geen daarvan is hoger gecategoriseerd dan Minder Bedreigd (LR/lc).

Soorten die Nieuw zijn voor de Wetenschap en Reikwijdte van Verspreidingsgebied

Een groot aantal (24) soorten, die waarschijnlijk nieuw zijn voor de wetenschap, is gedocumenteerd voor Lely en Nassau, gedurende het RAP onderzoek. Hiertoe behoren vijf amfibiesoorten, vier vissoorten (en een nieuwe ondersoort), 13 mestkeversoorten en ten minste een miersoort (er zullen waarschijnlijk meer nieuwe soorten worden gevonden, naarmate de verzamelde soorten worden gedetermineerd). Een nieuwe soort *Atelopus* pad was ook te Nassau gevonden in 2006 (zie Ouboter et al. Hoofdstuk 11 en fotopagina's).

Tabel 4. Bedreigde zoogdiersoorten vastgelegd voor Lely, Nassau en Brownsberg

Groep	Species	Locatie
Vleermuizen	*Lophostoma carrikeri* (VU)	Lely
	Lophostoma schulzi (VU)	Brownsberg
	Donkere fruitetende vleermuis, Artibeus obscurus (LR/nt)	Lely, Nassau
	Bruine fruit-etende vleermuis, Koopmania concolor (LR/nt)	Nassau
	Glyphonycteris daviesi (LR/nt)	Brownsberg
	Glyphonycteris sylvestris (LR/nt)	Brownsberg
	Phyllostomus latifolius (LR/nt)	Brownsberg
	Vampyressa brocki (LR/nt)	Brownsberg
Primaten	Roodruggige baard Saki*, Chiropotes chiropotes* (DD)	Lely
	Guyanese rode brulaap, *Alouatta macconnelli* (VU)	Nassau, Lely
Grote zoogdieren	Braziliaanse Tapir, *Tapirus terrestris* (VU)	Nassau, Lely
	Jaguar, *Panthera onca* (LR/nt)	Lely
	Poema, *Puma concolor* (LR/nt)	Nassau
	Mazama sp. (DD)	Nassau, Lely, Brownsberg
	Reuzenmiereneter, *Myrmecophaga tridactyla* (VU)	Lely
	boshond, *Speothos venaticus* (VU*)*	Brownsberg
	Tijger, *Leopardus tigrinus* (LR/nt)	Brownsberg
	Reuzen kapasi, *Priodontes maximus* (EN)	Brownsberg
Kleine en middelgrote zoogdieren	*Neocomys dubosti* (DD)	Lely
	Woolly opossum, *Caluromys philander* (LR/nt)	Brownsberg
	Marmosops parvidens (LR/nt)	Brownsberg
	Wit Gezicht boom rat, *Echimys chrysurus* (VU)	Brownsberg

Nieuwe insectensoorten zijn algemeen, maar zoveel nieuwe soorten amfibieën en vissen, doet vermoeden dat dit gebied een zeer hoge diversiteit heeft en waarschijnlijk veel meer soorten huisvest, die nog ontdekt moeten worden. Er zijn recentelijk geen nieuwe soorten voor de wetenschap vastgelegd voor de Brownsberg, maar er zijn weinig studies uitgevoerd van deze taxonomische groepen. Dus nieuwe soorten en uitbreiding van het verspreidingsgebied voor deze groepen kan mogelijkerwijs ook gevonden worden te Brownsberg.

Op het Nassau plateau is een recentelijk beschreven plantensoort voor Frans-Guyana van de familie Thymelaeaceae (*Daphnopsis granvillei*) veelvuldig gevonden, soms in de ondergroei. In het Lely Gebergte en omliggende gebieden zijn enkele planten gevonden met een mogelijk Amazonische verspreiding. Aan de voet van de Lely is *Poulsenia armata* (Moraceae) gevonden; deze soort werd niet eerder in Suriname verzameld en heeft een meer Amazonische verspreiding. Op basis van verzamelingen van het Lely Gebergte en van de zuidelijke laaglanden van Suriname en Noord-Brazilie, is een nieuwe Annonaceae, *Guatteria anthracina* beschreven door Scharf et al. (2006). Plantencollecties van Brownsberg zouden een nieuwe soort van *Danaea* (Marattiaceae; Christenhusz persoonlijke communicatie) en een nieuwe soort van *Trigynaea* (Annonaceae; Maas persoonlijke communicatie) kunnen bevatten, maar verder onderzoek is nodig.

Vele mierensoorten die geregistreerd zijn voor Lely en Nassau zijn nieuwe vondsten voor Suriname. Negen soorten zijn zeker nieuwe soorten, terwijl 85 soorten (de helft van de 169 gedocumenteerde soorten) nieuw voor Suriname kunnen zijn (in afwachting van verder onderzoek). Twee geslachten zijn voor het eerst in Suriname geregistreerd en worden vertegenwoordigd door drie soorten: *Acanthognathus lentus*, *Acanthognathuhs* cf.*ocellatus*, en *Cryptomyrmex* cf.*longinodus.*

CONCLUSIES EN AANBEVELINGEN VOOR CONSERVERING

(zie ook elk Hoofdstuk voor gedetailleerde aanbevelingen voor iedere taxonomische groep)

I. ALLE DRIE PLATEAUS, LELY, NASSAU EN BROWNSBERG, ZOUDEN VERHOOGDE BESCHERMING VAN HUN BIODIVERISTEIT MOETEN KRIJGEN. Elk van deze gebieden heeft een deel van Surinames biodiversiteit, inhoudende zowel laagland als hoger gelegen soorten, vele bedreigde soorten, en grote aantallen van soorten die endemisch zijn voor het Guiana Schild. Wereldwijde afname van amfibieën heeft geresulteerd in verlies van vele amfibie populaties van hoog gelegen gebieden, dus de aanwezigheid van gezonde amfibie populaties in Nassau en Lely heeft grote conserveringswaarde voor de wereld. De aanwezigheid van vele grote zoogdieren en grote vogels in alle drie gebieden geeft de belangrijkheid aan als een 'veilige haven' voor deze soorten, waar veel op gejaagd wordt in andere gebieden. Alle drie plateaus hebben enorme habitatdiversiteit die naast typisch laaglandbos ook meer unieke habitats op grotere hoogten (> 400 m) omvat die niet in de wijde omgeving gevonden worden.

1) Elk van de drie plateaus verdient bescherming van zijn eigen unieke eigenschappen:

a) **Lely** heeft een hoge habitat en soortenrijkdom voor alle onderzochte taxonomische groepen, alsook goede boscondities. Lely is relatief ontoegankelijk en heeft niet veel invloeden van menselijke aard. Het biedt dus een uitstekende gelegenheid om een groot gebied met hoge biodiversiteit, ongerept drooglandregenbos, en uitzonderlijk bergsavannebos te beschermen.

b) **Nassau** is zwaarder beinvloed, maar heeft nog steeds veel biodiversiteit en goede populaties van grote zoogdieren en vogels. Nassau heeft ook een zeldzame en unieke visfauna. Dit gebied is vooral kwetsbaar voor indringende illegale goudmijnbouwers die daar al actief zijn. Actie, vooral om toegangswegen te controleren, moeten direct ondernomen worden om Nassau te beschermen tegen deze bedreiging.

c) **Brownsberg** bevat een Natuur Park dat al bescherming biedt aan de plateaus, maar bedreigingen zijn er nog steeds voor de rest van de keten en moeten aandacht krijgen. De biodiversiteit van de Brownsberg, is tamelijk goed bestudeerd en biedt dus uitstekende mogelijkheden voor monitoring en het bepalen van de bescheming

2) Het mechanisme voor conservering van deze gebieden moet ontwikkeld worden via gezamenlijke aanpak tussen publieke en private instituten, inclusief lokale gemeenschappen, om aandacht te vragen en een halt toe roepen aan de huidige bedreigingen van deze gebieden.

Enkele mogelijke mechanismen zijn, onder andere:

a) Versterken en financieren van de afdeling Natuur Beheer van de Surinaamse Overheid, ter verhoging van monitoring in alle drie gebieden, vooral voor jacht en illegale mijnbouw.

b) Creëren van een Natuur Park op het plateau van Nassau om het unieke stroomgebied van de Paramacca Kreek te beschermen. Urgente actie is nodig te Nassau,vanwege de hoge menselijke druk.

c) De lokale gemeenschappen, inclusief de traditionele, betrekken, in het bijzonder de Paramacaners (Nassau en Lely), Aucaners/ Okanisi of n' Djuka Marrons (Lely), Saramacaners (Brownsberg) en ook de niet-traditionele gemeenschappen, zoals de kleinschalige mijnbouwers.

d) Bescherming van sleutelgebieden integreren in elk ontwikkelingsplan voor de plateaus (b.v.. mijnbouwplanning). Sleutelgebieden zijn het Paramacca stroomgebied te Nassau, het ongerept, hoger gelegen bos van Lely en de vegetatie langs de kreken van de Brownsberg. De plateaus van Lely en Nassau zijn concessies van de "Joint Venture" tussen Suralco (Alcoa) en BHP-Billiton. Suralco is ook betrokken bij grootschalige mijnbouw exploratie door Newmont, aan de voet van Nassau en Brownsberg.

e) Onderzoek naar mogelijkheden voor toerisme in de twee gebieden als alternatieve inkomsten voor lokale gemeenschappen, om hun afhankelijkheid in de handel van wildvlees te reduceren, alsook houtkap, en goudmijnbouw.

II. INTEGREER PLANTEN VAN DE PLATEAUS VAN LELY, NASSAU EN BROWNSBERG IN EEN REGIONALE CONSERVERINGSSTRATEGIE. Alle drie plateaus zijn sleutelcomponenten van een breed internationaal biodiversiteitbeschermings plan voor het Guiana Schild (Huber en Foster 2003).

1) Doe een studie van de biologische en socio-economische waarden van de plateaus van Lely, Nassau en Brownsberg. Op basis van die informatie moeten regionale plannen en plannen voor landgebruik ontwikkeld worden om beleidsmakers te begeleiden met betrekking tot welke activiteiten wel, of niet, kunnen plaatsvinden in bepaalde gebieden. Zonder deze planning zullen de gebieden continu onderworpen zijn aan toevallige en ongecoordineerde activiteiten, die zullen leiden tot, over het algemeen, slecht beheer van de natuurlijke hulpbronnen en degradatie van biologische bronnen.

2) Onderneem acties op basis van de IBAP aanbevelingen (Hoofdstuk 2) door een selecte groep belanghebbenden, waaronder de Overheid, universiteiten, organisaties voor natuurbehoud, mijnbedrijven, en lokale gemeenschappen

III. JACHT VORMT EEN SIGNIFICANTE BEDREIGING VOOR GROTE ZOOGDIEREN, GROTE VOGELS EN MESTKEVERS VAN BEIDE LOKATIES EN MOET GECONTROLEERD WORDEN.
De Jachtdruk is vooral sterk te Nassau maar komt ook voor in het Lely gebied. Gezonde zoogdier- en mestkevergemeenschappen zijn vooral van belang voor het onderhouden van primaire en secundaire zaadverspreiding, die essentieel kan zijn voor plantenregeneratie en bosdynamiek. Vele grote vogels (powisies en boskalkoenen, Marais) zijn regelmatig gezien te Lely in 2003 maar het RAP team van 2005 vond veel bewijs van vogels waarop men jaagt en lege geweerhulsen.

1) **Voorkom toegang voor jagers langs de wegen.** De jachtdruk is vooral hoog te Nassau, waar een netwerk van wegen de toegang voor lokale jagers vergemakkelijkt. Deze wegen moeten geminimaliseerd en gecontroleerd worden. Een aantal voetpaden te Lely vergemakkelijken duidelijk ook de activiteiten van jagers en kleinschalige goudmijnbouwers, zoals aangetoond door het groot aantal afgeworpen geweerhulsen en verlaten kampen.

2) **Geef voorlichting en draag bij aan de voeding van lokale werkers.** Werkers op de landingsbaan van Lely jagen om hun dieet aan te vullen met vogels en primaten die vooral voor hun van belang zijn, en er was bewijs van jacht (afgeworpen geweerhulsen) rondom het exploratiebasiskamp te Nassau, hoewel niet kan worden vastgesteld wie dit gedaan heeft. De werkers regelmatig voorzien van eiwitbronnen, samen met betere voorlichting, educatie en regulering van hun jacht activiteiten moet aangemoedigd worden om de jachtdruk van lokale werkgroepen op beide lokaties te verminderen. Incentieven moeten aan de werkers gegeven worden om jacht te minimaliseren, vooral van soorten die niet als voedsel dienen.

3) **Maak bondgenoten tegen de jacht van allen die toegang hebben tot Lely en Nassau**, inclusief luchtvaartbedrijven, vrachtbedrijven, de Surinaamse Luchtvaart Authoriteiten, Natuur Beheer, en de mijnbedrijven (BHP-Billiton, Suralco, Newmont). Dit zou kunnen helpen om de verspreiding en verkoop van wildvlees van Lely en Nassau te controleren. De afdeling Natuur Beheer van 's Lands Bosbeheer zou ook transport van wildvlees vanuit het binnenland te Zorg en Hoop kunnen controleren.

4) **Doe onderzoek om te bepalen** welke grote zoogdieren en vogelsoorten het mikpunt zijn en zwaar onder druk staan. De populatiegrootte van sleutelsoorten waar het meest op gejaagd wordt en die het meest bedreigd worden in dit gebied kan dan bepaald en gebruikt worden, om meer specifieke aanbevelingen te ontwikkelen voor het conserveren van sleutelsoorten die door jacht bedreigd worden.

5) **Handhaaf de jachtwet, vooral te Nassau.** Mestkever gemeenschappen op beide lokaties hebben waarschijnlijk te lijden van jacht aangezien hun voedselbron, zoogdierfecaliën, is afgenomen. De sterkste jachtdruk schijnt te zijn op Nassau, waar ongewoon lage mestkeverdichtheden zijn waargenomen. Strictere regelgeving en toepassen van jachtpraktijken zouden van grote betekenis kunnen zijn voor mestkevers en zoogdieren. Voorkomen wat wijdverspreide jacht blijkt te zijn te Nassau, moet een top prioriteit zijn.

IV. BEHOUDT DE INTEGRITEIT VAN BOSKREKEN. Kreken in het Lely en Nassau gebergte hebben typisch een zanderige, kiezel of rotsachtige bodem en zuurstofrijk, schoon water. De vissen zijn aangepast aan deze milieuomstandigheden. De amfibieën en vissen die gevonden worden te Lely en Nassau, inclusief de mogelijk nieuwe soorten, zijn afhankelijk van schoon, kwalitatief goed water voor hun overleving. Planten en hun bijbehorende vissen- en invertebratensoorten, die benedenstrooms voorkomen, zijn kwetsbaar voor sedimentatie. Fijne sediment deeltjes, in suspensie en afgezet op bodem en substraat, kunnen de voortplanting van vissen en de als voedsel voor de vissen dienende algen negatief beinvloeden. Onze visstudie laat zien dat de stroomgebieden op de plateaus momenteel grotendeels intact zijn op zowel te Lely als van Nassau. Drie van de potentieel nieuwe kikkersoorten zijn alleen van boskreken bekend en nog twee meer potentieel nieuwe soorten gebruiken ook kreekhabitats wat aantoont dat beboste kreken sleutelreservoirs zijn voor biodiversiteit op beide gebergten.

1) **Voorkom dat fijne sediment deeltjes, afkomstig erosie als gevolg van mijnen, wegen en ontbossingen, in de kreken terecht komen**, vanwege de negatieve gevolgen op de waterkwaliteit en habitatstructuur van de kreken. Op de plateaus van zowel Lely als Nassau, wordt de integriteit van het aquatisch ecosysteem momenteel bedreigd door menselijke activiteiten, waaronder goudmijnbouw, houtkap, landbouw, jacht, en het opzetten van basiskampen. Deze activiteiten zijn vooral waargenomen aan de voet van de bergen. Aangezien we kreken hebben geindentificeerd als sleutelhabitats, waarvan het belang onevenredig groot is voor biodiversiteit in het stroomgebied, bevelen wij een bosbufferzone aan, van tenmminste 50 m aan beide zijden van alle kreken.

2) **Bescherm de bovenstroom van de Paramaka Kreek te Nassau. Op basis van onze huidige kennis**, is bescherming tegen uitsterven van de zeldzame vis *Harttiella crassicauda*, alleen mogelijk door zijn habitat in de Paramaka Kreek te beschermen. Controle en beperkte toegang tot het stroomgebied van de Paramaka Kreek, vooral met betrekking tot kleinschalige goudmijnbouw-

ers, houtkappers en lokale mensen ("shifting cultivation" landbouwgronden). Elke ontwikkeling te Nassau moet restricties leggen op water extractie van de Paramaka Kreek, bijvoorbeeld door gebruik te maken van verzamelfaciliteiten voor regenwater. Minimaliseren van vervuiling van de Paramaka Kreek door het creeren van afvalverzameling/behandeling faciliteiten en het baden, wassen en gooien van chemicalien/materialen in de Paramaka Kreek verbieden. Waterkwaliteit, hydrologie en integriteit van het stroomgebied, moeten gecontroleerd worden door overheidinstanties. Wij bevelen aan dat een analyse wordt gemaakt van toekomstige gevolgen van het Nasau mijnexploratie basiskamp in het Paramaka stroomgebied, vooral vanwege sedimentatie die afkomstig is van wegstromend water en vervuiling vanwege de menselijke bezetting van het kamp, om te bepalen of er enige lange termijn gevolgen van het kamp zullen ontstaan en of het basiskamp verder van de rivier af moet worden verhuisd.

3) **Stel een waterkwaliteitsmonitoring programma in van de status van verscheidene aquatische sleuteltaxa** (waaronder vissen, amfibieën, planten, en geselecteerde invertebrate groepen) alsook waterkwaliteit en sedimentatie om een basislijn te creëren en het identificeren van negatieve gevolgen voor de aquatische bronnen voordat ze onherstelbaar worden. De kreek aan de voet van het Nassau basiskamp is een "sleutelhabitat", een die essentieel is voor een varieteit aan organismen, voornamelijk amfibieën. Het monitoren van specifieke acties op bepaalde indicatoren is essentieel. Wij bevelen de volgende gestandardiseerde aquatische monitoringprotocols aan, op regelmatige basis (ten minste twee keer per jaar, zie Hoofdstuk 10 voor meer details).

V. MINIMALISEER FRAGMENTATIE VAN DE NATUURLIJKE HABITAT EN CONTROLEER TOEGANGSWEGEN. Dit is vooral cruciaal te Nassau, waar een relatief uitgebreid wegennetwerk de habitats reeds aan het fragmenteren is, en de toegang tot bosgebieden vergemakkelijkt. Vele kleine organismen, waaronder mestkevers en mieren, staan erom bekend dat zij vooral gevoelig zijn voor fragmentatie.Het is bekend dat zelfs kleine verstoringen van het bos, zoals verlies van plantendiversiteit en veranderingen in bodemmicroklimaat zeer grote invloeden hebben op deze groepen. Wegen en andere toegangspaden verschaffen niet alleen toegang aan mensen maar ook aan vreemde soorten.

1) **Beperk het aantal toegangswegen**. Het wegennetwerk te Nassau moet geblokkeerd worden, herbebost en gecontrolleerd op illegale toegang. Voetpaden en andere toegangswegen in alle drie gebieden moeten beperkt en gereguleerd worden. Bij elke verdere ontwikkeling op de drie plateaus moet ervoor gezorgd worden dat een minimaal toegangsnetwerk, vooral wegen, wordt aangelegd.

2) **Onderhoudt grote bosgebieden**. Hoewel ontbossing nog niet uitgebreid is op beide gebieden, is het belangrijk om grote gebieden primairbos te behouden, om intacte gemeenschappen van alle taxa te onderhouden, vooral zoogdieren en mestkevers. Reptielen en amfibieën hebben tenminste 1500 ha nodig als het 'minimum kritiek gebied' om een redelijk intacte groep van de lokale fauna te beschermen. We bevelen aan dat stukken bos van tenminste deze grootte beshermd worden te Lely en Nassau.

3) **Monitoor verscheidene sleutelsoorten en groepen die afhankelijk zijn van intact bos** om gezonde populaties te behouden en om veranderingen zo vroeg als mogelijk op te kunnen sporen, om ernstige afname te voorkomen. Onder de doelgroepen moeten kleine zoogdieren, amfibieën, en verscheidene insectengroepen zijn. Aangezien kleine zoogdieren voor hun overleving zeer sterk afhankelijk zijn van structuur van het bos en een sleutelcomponent vormen van het dieet van grote zoogdieren, is monitoren van zoogdierdiversiteit en abundantie een goede manier om de integriteit van het bosecosysteem te volgen.

4) **Controleer houtkap,** die habitatfragmentatie en degradatie versnelt en nu al gevolgen heeft voor verscheidene groepen, vooral mestkevers, mieren en zoogdieren.

VI. VERHOOG DE BESCHERMING VAN HET BROWNSBERG NATUUR PARK EN ANDERE DELEN VAN HET PLATEAU.

1) Bescherm de Brownsbergketen door i) effectieve wetshandhaving in en om het Park, ii) formele installering en zuidwaartse uitbreiding van de bufferzone, iii) een beheerplan voor de grotere gebieden met inbegrip van het Park en de uitgebreide bufferzone, en iv) inzet om gebieden te herstellen die door goudmijnbouw vernietigd zijn.

2) **Breid toerisme activiteiten** uit naar i) het centraal en zuidelijk deel van de Brownsbergketen, ii) het Brokopondo stuwmeer gebied, en iii) het dorp aan de Brownsweg.

3) **Monitoor continue menselijke activiteiten, biodiversiteit en het milieu,** wat inhoudt het analiseren van gegevens die door STINASU verzameld zijn in de loop van het BNP Monitoring Programma 2002 tot 2005, en ii) het implementeren van een gemodificeerd monitoring programma (BMP) dat gebaseerd is op resultaten en aanbevelingen van de data analysen.

4) **Maak goed gebruik van de onderzoeksresultaten en monitoringsgegevens**, wat betekent dat i) de planning en het beheer van het Park worden geleid door de resultaten, en ii) de resultaten worden gebruikt als inputs voor een verscheidenheid aan informatie outputs, alsook

voor publieke bewustwording en educatieactiviteiten in het Park en in de hoofdstad Paramaribo.

5) **Creeer een superstructuur voor het Brownsberg-Brownsweggebied**, mogelijk gelieerd aan een MUMA (Multiple Use Management Area), dat tenminste toegang zal geven tot i) conflictresolutie tussen STINASU, de dorpelingen van Brownsweg, en lokale mijnbouwers en anderen die er actief zijn, ii) een dialoog over landgebruik met de stakeholders, en iii) conservering en ontwikkelingsprojecten die de lokale gemeenschappen ten goede komen.

VII. MONITOOR OM DE AANWEZIGHEID VAN DE CHYTRIDE FUNGUS, *BATRACHOCHYTRIUM DENDROBATIDIS* TE ONTDEKKEN, IN VOLWASSEN KIKKERS LANGS DE BOSKREKEN. Deze schimmel wordt in verband gebracht met de afname van amfibieën in vele delen van de Neotropen. Wereldwijde amfibie afname heeft geresulteerd in verlies van vele matige- tot hooggelegen anurofaunas, dus de aanwezigheid van voldoende, diverse, met kreken geassocieerde amfibiegemeenschappen te Nassau en Lely, is van significante conserveringswaarde. De dichtheden die wij geobserveerd hebben te Nassau en Lely zijn vergelijkbaar met pre-afname data van bosbeken en aangrenzend bos in Panama, wat aantoont dat de met kreekjes-geassocieerde fauna van Nassua en Lely geen dramatische afname hebben ervaren, wat zich wel heeft voorgedaan in andere plaatsen van de Neotropen. Hoewel we geen kennis dragen van rapporten van amfibie afname in de Guianas, kan worden voorspeld dat de condities die gunstig zijn voor het voorkomen van *Batrachochytrium dendrobatidis* aanwezig zijn in de omgeveing van het Nassau en Lely gebergte.

1) **Initieer een doorlopende detectie en monitoring-project**. De aanwezigheid van *B. dendrobatidis* kan gedetecteerd worden via analyse van dermale uitstrijkjes van levende dieren. Wij bevelen aan om 300 uitstrijkjes/bezoek te verzamelen (d.w.z.. een uitstrijkje per individu van de eerste 30 individuen die ontdekt worden). Om de aanwezigheid van *B. dendrobatidis* te onderzoeken, kunnen analyses worden gemaakt van samengevoegde monsters van 10 uitstrijkjes.

2) **Alarmeer amfibieconserveringsbiologen als de schimmel is gevonden.** Individuele analyse van alle uitstrijkjes zal nodig zijn om geinfecteerde species te identificeren. Als *B.dendrobatidis* is gevonden, moet contact gemaakt worden met de "Declining Amphibian Task Force" (http://www.open.ac.uk/daptf/index.htm) voor aanbevelingen.

ADDITIONELE ONDERZOEKSPRIORITEITEN

I. Biodiversiteitsonderzoek gedurende het regenseizoen is nodig voor alle taxa om een completere inventaris van alle soorten te compileren. Aangezien het RAP onderzoek gedaan werd gedurende de piekperiode van de droge tijd, is soortgelijk onderzoek gedurende het regenseizoen nodig, vooral voor groepen die actiever zijn in het regenseizoen, zoals amfibieën, en voor groepen die bloeien (planten) of zich vermenigvuldigen in het regenseizoen (vogels).

II. Onderzoek van zowel laagland kreken aan de voet van de heuvels (vooral Paramacca Kreek) en hooggelegen kreken op het plateau van Nassau (en Lely) is nodig voor een beter begrip van (1) de ecologie en evolutie van de unieke visgemeenschappen van het plateau en (2) de diversiteit en het endemisme van de visfaunas in het algemeen van het Guiana Schild.

III. Onderzoek van de biodiversiteit van het stroomgebied van de Paramacca Kreek, inclusief het doen van hetzelfde onderzoek in het regenseizoen.

IV. Onderzoek van de zeldzame meerval *Hartiella crassicauda* moet geinitieerd en gestimuleerd worden door BHP, natuurbehoudorganisaties, en de Surinaamse Overheid.

Specifieke acties houden in:

a. Meer informatie over het voorkomen van *H. crassicauda* op lage hoogten in de Paramacca Kreek (en zijn zijkreken) en in twee andere kreken die uit het Nassau gebergte stromen (Anjumarakreek en een niet-benoemde kreek);

b. Meer informatie over de (reproductie/voeding) biologie van *H. crassicauda* voor meer kennis over ecologie.

c. Meer informatie over de relatie van *H. crassicauda* met andere meervallen van de subfamilie Loricariinae (DNA analyse). Als het op de juiste manier beschermd wordt, kan de unieke vis *H. crassicauda* een symbool worden voor goede milieubeheerpraktijken

d. Onmiddellijke acties moeten ondernomen worden om het proces, dat leidt naar het opnemen van *H.crassicauda* op de lijst van IUCN/CITES van bedreigde soorten, te initieren.

V. ONDERZOEK NAAR DE POPULATIEGROOTTE EN LEVENSVATBAARHEID VAN SOORTEN. Zowel Lely als Nassau zijn belangrijk voor biodiversiteitbehoud, aangezien zij een hoge diversiteit van grote zoogdieren hebben, alsook verscheidene nieuwe amfibiesoorten en mestkevers. Vaststellen van de status van de rode lijst van IUCN, met betrekking tot soorten die nieuw zijn voor de wetenschap, zal afhankelijk zijn van schatting van het geografisch verspreidingsgebied van deze soorten, dus

moet al het mogelijke worden gedaan om hun gebied van voorkomen te bepalen. Wij hebben uitgebreid onderzoek aanbevolen van de kreken en de twee bergen en in aangrenzende laaglanden, om abundantie en voorkomen van kreek-geassocieerde kikkers adequaat te kunnen kwantificeren, vooral nieuwe soorten met een onbekend verspreidingsgebied.

VI. Verdere planteninventaris van Nassau en Lely, waarbij herbarium specimens, alsook levende specimens, worden verzameld, vooral van planten die geassocieerd zijn met rotsachtige kreekbedden en bergsavannabos. Dit moet een overzicht geven van de aanwezigheid van zeldzame plantensoorten en de habitat waarin zij voorkomen, inclusief orchideeën en planten die geassocieerd zijn met habitats met korstige bodems.

VII. Verder onderzoek van de soorten die op alle drie plateaus zijn waargenomen, naar het voorkomen van soorten die voor de wetenschap nieuw zijn, vooral kikkers en vissen. Opmaken van additionele inventarissen van taxonomische groepen, waarover we erg weinig informatie hebben, zoals mestkevers, bijen en mieren, vooral op de Brownsberg. Er moeten meer bijenmonsters van ochideeën gehaald worden van alle drie bergketens, en de relatie tussen orchideeën en orchidee-bijen op deze ketens moet onderzocht worden.

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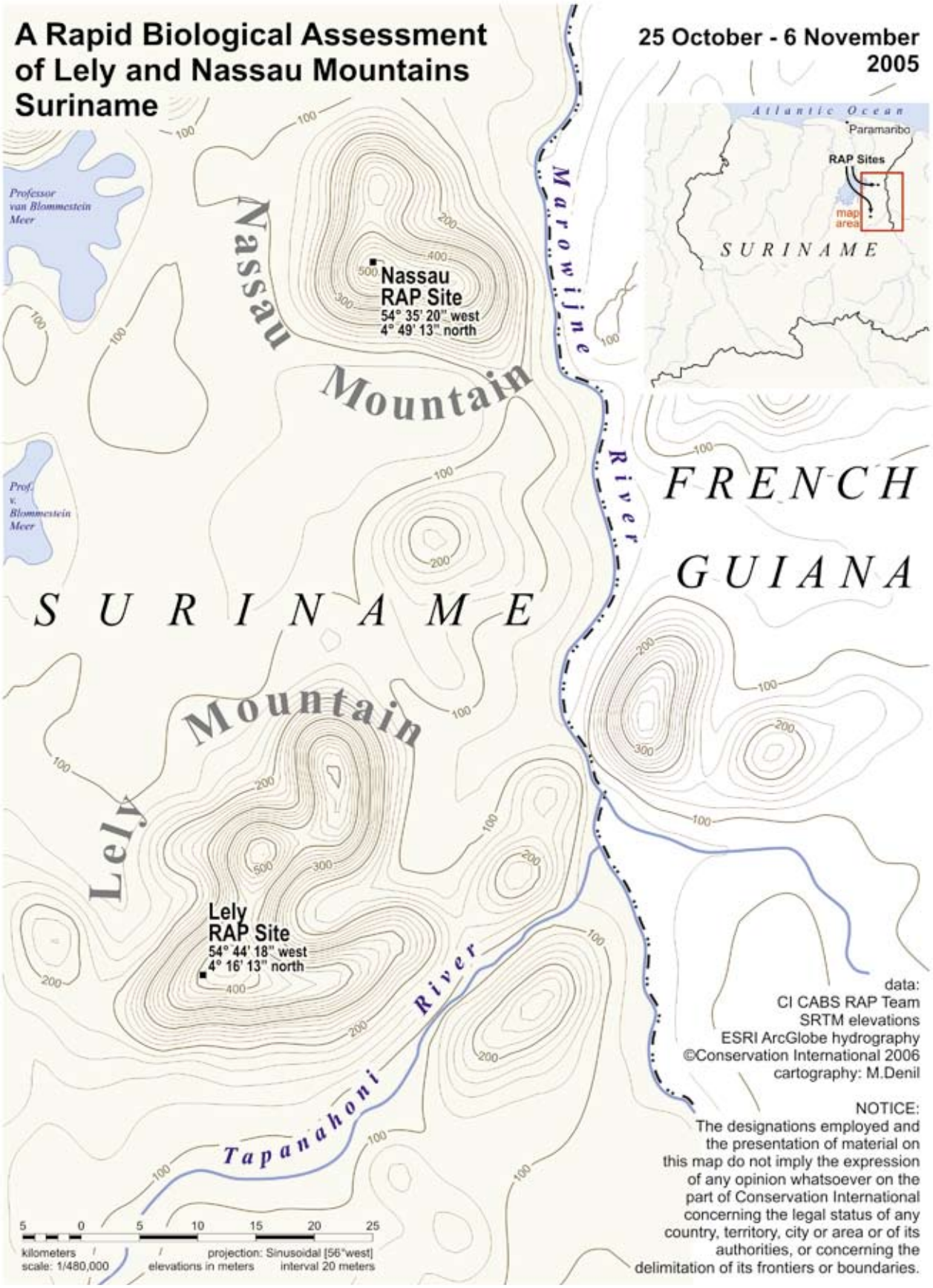


Trond Larsen

Harttiella crassicauda (Boeseman 1953) in its natural environment, headwaters of Paramaka Creek (IJskreek tributary, N1) in the Nassau Mountains at 500 m.amsl altitude.

Jan Wijnp

Headwaters of Paramaka Creek (tributary IJskreek, N1; 460 m.amsl) in the Nassau Mountains, habitat of *Harttiella crassicauda*.

James I. Watling

Adult *Dipsas indica* on the Lely Plateau.

Greg Love

Palm swamp on the Lely Plateau.

Trond Larsen

Canthon triangularis, one of 42 dung beetle species documented during the RAP survey.

Paul Oubotter

A possible new species of *Atelopus* documented during the March 2006 follow-up visit to the Nassau Mountains.

James I. Watling

A male *Epipedobates trivittatus* transports tadpoles on his back on the Nassau Plateau.

James I. Watling

One of the new species of *Eleutherodactylus* being described from the RAP survey in eastern Suriname.

James I. Watling

Eleutherodactylus chiastonotus is endemic to the Guayana Shield.

Jan Wirjosentono

RAP Team 1 studied birds, fishes, ants and dung beetles.

Jan Wirjosentono

View from top of Lely Plateau.

Jeffrey Sosa-Calvo

Odontomachus sp. collected on the Lely Plateau (hand collection).

Jeffrey Sosa-Calvo

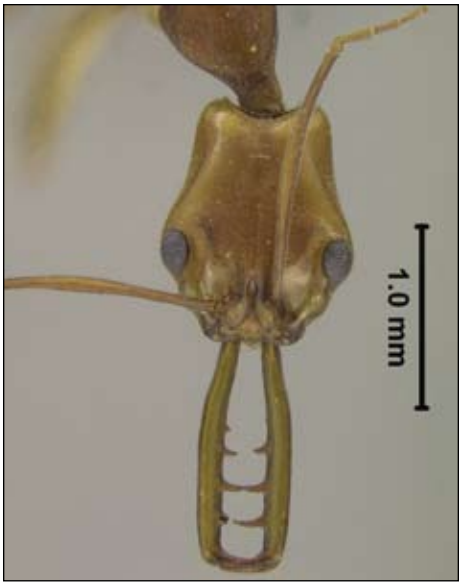
Set of mini-Winkler extractors, Nassau.

Jeffrey Sosa-Calvo

Frontal view of worker of *Carebara* sp. 001 (Automontage®).

Jeffrey Sosa-Calvo

Frontal view of the dacetine ant *Pyramica denticulata* (Automontage®).



Jeffrey Sosa-Calvo

Frontal view of worker of *Anochetus horridus* (Automontage®).

Jeffrey Sosa-Calvo

Frontal view of worker of *Cryptomyrmex longinodus* known previously only from Brazil (Automontage®).

Chapter 1

The conservation context of the Lely, Nassau and Brownsberg Plateaus within Suriname

Greg Love, Eduard Niesten, and Karl Morrison

SUMMARY

The Lely, Nassau and Brownsberg plateaus are located in eastern Suriname in the Guayana Shield, a region noted for its high biodiversity and extensive tracts of intact Neotropical forest. The 2003 Guayana Shield Priority-Setting Workshop determined that, despite many gaps in information, the three plateaus fall into an area designated as one of the highest priority areas for conservation in the entire Guayana Shield. Specific biodiversity data are lacking for Lely and Nassau, but ecological research and monitoring efforts for the 11,600 ha Brownsberg Nature Park (BNP), which encompasses most of the Brownsberg plateaus, have led to relatively better understanding of certain taxonomic groups, notably plants, mammals, birds, reptiles and amphibians, but little on others such as insects and fishes.

Results of surveys of plant diversity in 2003-2005 (see Chapter 3) on the three plateaus showed that all three areas have high plant diversity compared to most lowland forest plots in western Suriname and suggest that they may constitute a unique ecosystem in Suriname (Bánki et al. 2003; ter Steege et al. 2004, 2005). In addition to high biodiversity, the three plateaus provide many watershed services for local and coastal communities, as well as important sources of food, medicine and building materials for Maroon communities. The BNP is also a very popular tourist destination, particularly for residents of Paramaribo and other population centers on the coast.

All three plateaus ecosystems are relatively intact owing to low population density, which presents many unique opportunities for conservation over a relatively large landscape area. However, they face a number of current and potential threats, which include logging, hunting/poaching and small-scale (gold) and large-scale (bauxite and gold) mining. Though a protected area, the BNP has also been impacted by tourism as well. Unresolved conflicts over land rights and poverty, particularly with regards to Maroon communities, complicate the issues of resource use and effective long-term conservation efforts.

THE GUAYANA SHIELD

Suriname is located in the Guayana Shield of northeastern South America, an area of roughly 2.5 million km² (see Map). The Guayana Shield, a 2 billion year old Precambrian geological formation - possibly the oldest on the planet - underlies Guyana, Suriname, and French Guiana as well as parts of northern Brazil, Venezuela, and Colombia. The Guayana Shield is a granitic formation overlaid by the largest expanse of undisturbed tropical rain forest in the world. The region contains high rates of endemism and biological richness, unique tepui formations, and the headwaters of impressive waterfalls.

The population density of the Guayana Shield is the lowest of any tropical rainforest ecosystem (0.6–0.8 people/km) which, coupled with the relative lack of access routes into the interior, contributes to its exceptional degree of intactness, with more than 80% of its ecosystems in pristine or near pristine condition. In addition to its biological richness, the region contains abundant cultural diversity and natural resources. At least 100 Indigenous groups inhabit the

region, as well as groups of Maroons and descendants of African, East Indian, Javanese, Chinese, Portuguese, and other European immigrants. With regards to natural resources, the region has considerable timber, mineral and freshwater resources. All three of these resource sectors, particularly mining and associated small and large-scale extraction, historically have played an important role in the region's economies, and will continue to do so for the foreseeable future. However, national governments in the Guayana Shield lack the institutional capacity to monitor the performance and environmental impacts of these industries, and the lack of environmental monitoring and enforcement facilitates pressure on biological diversity and natural systems. Logging contributes to habitat loss while both large- and small-scale mining threaten water quality within the region's extensive system of rivers, streams, and reservoirs.

SURINAME

Biodiversity

Suriname is situated entirely within the Guayana Shield and supports a rich diversity of flora and fauna (UNDP 1999). Suriname is rich in vertebrate wildlife, including at least 668 species of birds, 185 species of mammals, 152 species of reptiles, 95 species of amphibians, and 790 species of fish. Of the 1,890 known species of vertebrates, at least 65, or 3%, are endemic to Suriname. Over 5,800 species of mosses, ferns and seed plants are found in Suriname, of which an estimated 50% are endemic to the Guayana Shield region. Suriname is also home to such globally threatened and charismatic species as the jaguar, the Harpy Eagle, the blue poison dart frog and the giant river otter, which exist in relatively high numbers in comparison to other similar ecosystems in the Neotropics.

Population

Because of Suriname's low population density, much of the forest within its borders is intact and considered by many to be the most pristine moist tropical forest on Earth. Results from a national population census conducted in 2004 suggest a total population of around 492,000 people, of which approximately 75% lives in urban areas, mostly (70%) in Paramaribo and surrounding areas (GBS 2005). The national average population growth rate is about 1.3% (IADB 2005). The forested interior is the home of Amerindian and Maroon (forest peoples of African descent) peoples, who live in small villages along the major rivers and depend primarily on the forest for their livelihoods. Suriname's population is distributed among 10 administrative districts, with Brownsberg located in the Brokopondo district, and Lely and Nassau in the far eastern part of the vast Sipaliwini district (GBS 2005).

While population density throughout Suriname is very low, the available data offer little insight into actual population pressures in specific areas. The Maroon population of eastern Suriname is comprised mainly of the Ndjuka group, which numbers about 20,000 people living primarily along Tapanahony and Marowijne Rivers, and the Paramaka, numbering about 4,000 living along the Marowijne River. Moreover, one might reasonably expect that the population may be disproportionately concentrated in and around the eastern plateaus, given relative proximity to transportation arteries, such as rivers and roads, and the high level of small-scale mining activity. Regarding trends over time, pressure on natural resources due to population growth may be of relatively little concern due to combined elements of rural-urban migration and emigration; however, the results of a study by Heemskerk (2001b) indicate that in the Sella Creek area south of Lely, the miner population actually increased from 1990 – 1998. The presence of certain natural resources, such as mineral deposits, may therefore result in population increases.

Economy

Suriname has struggled to develop its economy since the cessation of civil war in 1992. In 2001, 64% of the urban population lived under the poverty line. In rural areas and the interior, this percentage is even higher. The government is by far the largest source of employment (more than 60%). In the non-public formal sector, the services industry dominates (a substantial portion of which relates to the mining sector). Logging and related activities account for an estimated 5% of employment. Agriculture accounts for 13% of GDP and is primarily practiced in the coastal plains area and river valleys. Formal sector mining directly accounts for 3.5-4% of employment, but indirectly supports possibly as much as 20% of employment or more (IADB 2005).

Mining

Mining is the predominant economic activity in Suriname. Bauxite alone contributes more than 15% of GDP and 70% of export earnings. However, the informal mining sector is estimated to account for more than 20% of real GDP, and a large portion of this is accounted for by the unregulated small-scale mining industry. While to date, bauxite has been the mainstay of Suriname's mining sector, large-scale gold mining is of increasing importance to Suriname's formal sector economic activity, with the potential to make an enormous economic impact in the short term. The IMF estimates that the Rosebel operation, which commenced in February 2004, contributed 10% of GDP and 12% of total exports that year while employing around 1,100 workers (Fritz-Krockow et al. 2005).

Eastern Suriname bears the brunt of small-scale gold mining in the country. Small-scale or artisanal (and largely illegal) mining grew from relatively little activity in the early 1980s to a 10-15 ton per year industry today, employing 10-20 thousand workers, mostly Maroons and anywhere from 7,500 to 15,000 Brazilian migrant miners. Following the end of the civil war in 1992, the sector boomed to become the second largest employer after the public sector, and now contributes as much as 15% of GDP. As Maroon communities increase their consumption of goods from the coast, in-

cluding canned fish, sugar, salt, and other processed foods, as well as shotguns, plastic ware, and other manufactures, the need for cash increases as well. This results in spurring the small-scale mining sector (usually the only local economic activity that generates appreciable cash revenues), and is also generating a waste-disposal problem.

The literature survey and site visits have confirmed the presence of small-scale mining activity around the Lely, Nassau, and Brownsberg plateaus, athough the precise extent of such activity has not been well documented. One notable exception is the study by Heemskerk (2001b) of small-scale mining activity in the Sella Creek mining area of the Tapanahony region south of the Lely plateau. In the study, Heemskerk noted that until the early 1980s, the number of miners in this area fluctuated, but then began to increase rapidly. The number stagnated from 1986 to 1990, owing probably to the early years of the civil war and subsequent closing off of access routes to the interior. Poor economic performance and options since 1990 led to continous increases in the number of miners in this region until 1998, the last year for which Heemskerk had data on miner population.

Logging

Approximately 2.2 million ha, or 40% of the Suriname's surface area, are under logging concessions. Available maps suggest that the Lely, Nassau and Brownsberg plateaus do not overlap with existing timber concessions. However, due to the paucity of government monitoring and enforcement, illegal logging remains a threat, particularly given the proximity to timber concessions further east and the potential development of infrastructure, such as roads, to facilitate mineral development.

Agriculture

Communities in the interior of Suriname derive the bulk of their food requirements from shifting agriculture. Cassava and rice are the staple foods, complemented by garden-produced maize, sweet potatoes, yams, squashes, taro, arrowroot, peppers, beans, peanuts, bananas, plantains and sugar cane. Under shifting agriculture, cultivated plots typically produce viable yields for one to two years, after which they are left fallow and cultivation moves to a new plot. As human population densities rise, suitable agricultural land becomes scarcer, and people need to travel further to establish plots and fallow periods tend to shorten. The increased pressure on soils undermines both agricultural productivity as well as the ecosystem's ability to support biodiversity. This phenomenon is readily observed near the larger settlements in the interior; additional information needs to be gathered to determine how far the process has progressed in the plateau areas of eastern Suriname.

Hunting and Fishing

Hunting has been identified as one of the major threats to biodiversity in eastern Suriname. Hunted game species include various birds, monkeys, deer, tapir, sloth, peccaries, armadillos, anteaters, rodents and agoutis. Despite low human populations in the interior, hunting is exerting a noticeable impact on game species. Amerindian and Maroon hunters reportedly have to travel further and longer to find bushmeat and the average sizes of the animals they catch are decreasing. In addition to hunting for subsistence and commercial bushmeat sale, national and international markets for exotic pets also are driving increased wildlife exploitation.

Ouboter (2000) cited fishing and the pet trade as two of the major threats to freshwater species (the others being habitat alteration/destruction, pollution and introduction of exotic species). He notes that fishing in freshwater systems in Suriname tends to focus on two species (armored catfish and giant trahiri), both of which appear to be over-fished.

Regional Conservation Priority Areas: The Guayana Shield

The Guayana Shield Conservation Priority Setting Workshop held in 2002 in Paramaribo, Suriname offers the most comprehensive analysis to date of conservation priorities for the region (Huber and Foster 2003). The priorities represent the results of a year-long process which culminated in a five-day workshop with over 100 experts on the biology and socio-economics of the Guayana Shield. Participants overlaid information regarding biological thematic groups including: floristics, plant ecology, invertebrates, fishes and freshwater ecology, reptiles and amphibians, birds, mammals, and physical geography. This information was overlaid with socio-economic information on non-timber forest products (NTFPs), mining, protected areas and indigenous lands, forestry and infrastructure.

The socio-economic and biological information were combined and resulted in the identification of 41 areas totaling approximately 1.2 million km² that fall into current or proposed conservation units. More than half of the priority areas belong either to the highest category of biological importance or the highest category of pressure, with the entire Guayana Shield being cited as both a global priority for tropical biological and cultural diversity. With regards to the area containing Brownsberg, Nassau and Lely plateaus (designated as "Maroni" in the final report), workshop experts determined the region to be one of the highest conservation priority areas within the entire Guayana Shield, citing extensive ecological diversity and endemism in all taxonomic groups (Huber and Foster 2003).

National Conservation Priorities: Suriname

A search of the literature revealed no detailed analysis of conservation priorities within Suriname in general, or specifically for the Brownsberg, Nassau and Lely plateaus. Specific analyses such as BirdLife's Important Bird Area analysis and Conservation International's Key Biodiversity Area (KBA) analysis have yet to be undertaken within Suriname. Despite this, there are several other sources that provide insight into conservation priorities in Suriname, including the following:

Conservation International's High-Biodiversity Wilderness Areas: All three plateaus are located in the Amazonia Wilderness Area designated by Conservation International (CI). High-Biodiversity Wilderness Areas are defined by CI as areas that have "more than 70 percent of original vegetation, have low human population densities and are among the last places where indigenous peoples can maintain traditional lifestyles" (Conservation Internatinal 2005). This area encompasses nine countries (Suriname, Guyana, French Guiana, Brazil, Venezuela, Colombia, Ecuador, Peru and Bolivia) and is the largest tropical forest on Earth, housing over 40,000 plant species alone, along with possibly 30,000 endemics throughout the Wilderness Area.

World Wildlife Fund's Global 200 Ecoregions: World Wildlife Fund (WWF) includes all of Suriname within the Guianan moist forest "ecoregion." With regards to flora, WWF lists 4,500 plant species, including 300 varieties of orchids, 300 types of ferns and 800 tree species that have been inventoried in Suriname. Five hundred of these species are considered rare and 200 endemic to the Ecoregion. WWF also reports for Suriname: 185 mammal species, 668 bird species, 152 species of reptiles, 95 species of amphibians, 338 freshwater fish species, 452 marine fish species and 1,752 invertebrate species to date (Lethier 2002).

IUCN—The World Conservation Union (Red List—Critically Endangered, Endangered, and Vulnerable species): The IUCN has identified a total of 62 Vulnerable, Endangered and Critically Endangered species in Suriname. Forty of these species are terrestrial or freshwater; 22 are marine species (IUCN 2006). Notable species include the following:

- Due to overexploitation, the plant species *Youacapoua americana* is the only terrestrial species listed as Critically Endangered. The baboonwood (*Virola surinamensis*), found in swamp and inundated forest types, is listed as Endangered and twenty four other plant species are listed as Vulnerable.
- The Cara Cara (*Aniba rosaeodora*), giant armadillo (*Pridontes maximus*) and giant Brazilian otter (*Pteronura brasiliensis*) are listed as Endangered and are found in Suriname, along with eight other mammals listed as Vulnerable.
- *Atelopus spumarius* (toad) is listed as Vulnerable because of a projected population decline, estimated to be more than 20% over the next ten years, inferred from declines in other high altitude *Atelopus* species in the same region, probably due to chytridiomycosis.
- The blue poison dart frog (*Dendrobates azureus*) is the only other amphibian listed as Vulnerable as it is known from the vicinity of only one locality and it occurs only in forest fragments that are threatened by forest fires. There is also some illegal collection of the species for the pet trade.
- The yellow spotted river turtle (*Podocnemis unifilis*), the Brazilian giant tortoise (*Geochelone denticulata*) and the American manatee (*Trichechus manatus*) represent the freshwater species listed as Vulnerable by the 2004 Red List.

Protected Areas: Suriname has 15 existing and five proposed protected areas, varying in degree of protection. These areas cover approximately 2.3 million ha, almost 13% of Suriname's total area (WRI 2003). The Central Suriname Nature Reserve is the most extensive of the protected areas within Suriname, totaling approximately 1.6 million ha and granted World Heritage Site status in 1998 (UNEP-WCMC 2005). While no protected areas are located in or around the Lely and Nassau plateaus, the Brownsberg plateau is contains the 11,600 ha BNP. A review of the literature did not reveal any systematic gap analysis to date of the protected area system within Suriname making priority regions for new protected areas impossible to determine at the present time.

National-level Conservation Policies: A reasonably comprehensive national-level guiding framework for environmental policy in Suriname was commissioned by the Inter American Development Bank (IADB 2005). This document lists the following as principal drivers of biodiversity loss in the country: deforestation, mining-related pollution, mercury pollution, sanitation and disposal of solid and liquid wastes, water pollution, excessive use of agricultural chemicals, over-fishing, and coastal-zone degradation. However, the overarching challenge facing biodiversity and the environment in general in Suriname is the lack of legislative, regulatory and institutional provisions and mechanisms for environmental management.

Suriname has yet to adopt a National Biodiversity Action Plan. The principal guiding framework available for environmental policy in the country is the National Environmental Action Plan (NEAP), drafted in 1996, although this framework has not been formally adopted by the Government of Suriname. In 2001 an environmental law was drafted, but this law has yet to be approved by the Minister. Although Suriname has signed several international environmental conventions and treaties, and ratified some of them, these have yet to be integrated into national laws, management structures, and policy-making bodies. To the extent that environmental laws and regulations do exist, adequate monitoring and enforcement is rare due to limited human and material capacity, and low prioritization of environmental considerations by the relevant Ministries (IADB 2005).

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Chapter 2

A Socio-Economic Assessment of Brownsberg, Lely and Nassau plateaus, and the Biodiversity Action Plan Workshop Summary

Greg Love, Eduard Niesten, Karl Morrison, Marielle Canter, and Maureen Silos

INTRODUCTION

In the fall of 2005, Conservation International (CI) joined with the Mining Joint Venture (MJV) of BHP-Billiton Maatschappij Suriname and Suriname Aluminium Company LLC to conduct an Initial Biodiversity Assessment Planning (IBAP) project for the Brownsberg, Lely and Nassau plateaus of eastern Suriname. The IBAP is a science-based approach, which draws on CI's core competencies and expertise in biodiversity science and conservation planning. The methodology assesses an area's biodiversity within the socio-economic context of a region and identifies opportunities on how to conserve the region's ecosystems. The purpose of the IBAP methodology is to assist companies in incorporating biodiversity into their risk analysis and decision-making and planning processes from the earliest stages of project development.

The following chapter summarizes two outputs of the IBAP process, the socio-economic desktop assessment and biodiversity action plan workshop conducted in conjunction with the Rapid Assessment Program (RAP) biodiversity survey.

Socio-Economic Assessment

Chapter 1 of this volume (Love et al. 2007) provides an overview of the human population and economy of Suriname. Here we will focus on those socio-economic aspects that directly affect the Brownsberg, Lely and Nassau plateaus.

The Brownsberg, Nassau and Lely areas have a number of socio-economic variables that pose challenges to effective long-term conservation of biodiversity. All three areas have already been impacted by small-scale mining and associated activities (such as hunting). The Brownsberg National Park (BNP), which encompasses most of the Brownsberg plateau, is a very popular tourist destination, particularly for residents of Paramaribo and other population centers on the coast. Despite its protected status, it has apparently not been spared it from activities that negatively impact biodiversity in other parts of the country, as local residents regularly hunt and log near and occasionally in the BNP, and small-scale gold miners have been mining around and within its boundaries. Tourism is becoming an increasingly valuable source of income for the surrounding communities of the BNP, but even that seemingly benign activity may be negatively impacting the Park, though the precise extent of the damage remains unclear (Fitzgerald et al. 2002).

Small-scale (gold) mining

The literature review suggests that at the present time, small-scale gold mining and associated activities (principally uncontrolled hunting and fishing) are having the most negative impact on the three plateaus' ecosystems, athough more data are needed to assess to what degree. Most small-scale miners exploit alluvial gold deposits using high-pressure hoses to extract soil and then processing soil in sluice boxes and gold pans using mercury. Measurements in many of the rivers that are impacted by gold mining indicate that most are polluted by mercury and have increased turbidity (Ouboter 2000). The sensitivity of freshwater species to these factors indicate that artisanal and large-scale mining could have severe impacts of freshwater species

(including amphibians), ecosystems services and the quality of water available to local populations.

Water pollution resulting from disposal of tailings into waterways is consistently identified by communities in the interior as the principal negative impact from small-scale mining (IADB 2005). Impacts on water flows from silting up of streams and alteration of stream beds contribute to the spread of water-related diseases (especially malaria), and inhabitants have to travel increasing distances to find potable water. The impacts of soil erosion and siltation on fish breeding grounds and habitats reduce species diversity and biomass of food fishes in streams affected by small-scale gold mining. Temporary mining camps also exert impacts on biodiversity through shifting localized intensification of hunting pressure and forest clearing. Thus, efforts to promote 'environmentally friendly' artisanal mining that avoids mercury will not necessarily reduce significant threats to habitat, biodiversity, water-quality and protein sources for people.

A range of negative social impacts also accompanies small-scale mining. The illicit nature of the sector makes it a ready conduit for violent crime, prostitution, the spread of sexually transmitted disease and intra-community conflicts over distribution of minig areas and earnings. Nevertheless, despite various negative environmental and social consequences of small-scale mining, the sector remains one of the few income-generating opportunities available to communities in the interior (Heemskerk 2001a). Although a response to the threats posed by small-scale mining may be among the most urgent conservation priorities in eastern Suriname, such a response will have to address a broad array of socio-economic issues in order to be successful.

Large-scale mining

With regards to large-scale mining, all three plateaus are currently under consideration for bauxite mining, and a large-scale gold mining concession is currently being explored in Nassau. The potential threats posed to biodiversity by the appearance of a large-scale mining in these areas, if not responsibly managed, include:

1. Direct threat from large-scale mining activity on the landscape through extraction and creation of access routes, affecting watersheds, forest cover and habitats;
2. The "magnet effect" – increasing population density as mining activities attract in-migration and increase attendant related pressures (cultivation, hunting, etc.);
3. Displacement of small-scale gold miners, forcing relocation to and impacts on other areas;
4. In the case of large-scale gold mining, a 'gold rush' of small-scale gold miners after mine closure, seeking to find leftover ore in a proven area;
5. "Boom-bust" economic development where after a mine closes, few if any economic opportunities remain for local residents.

Local Communities

Suriname has approximately 200 Maroon villages of 25 to 100 households, and at least 200 additional settlements called camps, or *kampus*. The majority of villages and settlements are found along waterways in the Sipaliwani and Brokopondo districts, including the Suriname, Tapanahoni and Marowijne Rivers and the Brokopondo Reservoir (IADB 2005). These bodies of water are all in close proximity to the three plateaus.

The Ndjuka Maroon group comprises a substantial portion of the population of eastern Suriname. Maroon communities depend on forest and natural resources for their subsistence, through shifting agriculture, fishing, hunting and gathering of forest products. Forests also provide medicine, construction materials, tools, etc. Typically, Maroon settlements lack adequate public services such as electricity, running water, schools, health clinics, waste processing, and the like, intensifying dependence and impacts on forest resources. Site-specific anthropogenic threats to biodiversity depend on localized population density, intensity of natural resource use, and technologies employed in resource utilization. However, more specific data on the size and scope of human activities and their impacts on the ecosystems of the plateaus in question and adjacent areas are lacking.

Ongoing conflicts surrounding land rights with Maroon as well as some Amerindian communities in Suriname undermines prospects for sustainable resource management and complicates the scope for conservation action. In short, Maroon communities maintain that the national Government of Suriname has limited jurisdiction over Maroon territories. In particular, the Maroon position is that they own the rights to sub-surface resources below their traditional territories, implying that the Government has no authority over small-scale mining and that large-scale mining concessions require local Maroon community consent and compensation. The Government takes the position that all sub-surface resources in Suriname are the property of the state, to be disposed of in the public interest as the Government sees fit. Although Government policy statements indicate an interest in working toward recognition and protection of traditional land rights, the issue of rights to sub-surface resources remains highly contentious. Concessionaires in both the mining and logging sectors find themselves squarely in the middle of this controversy, as existing logging concessions impact approximately 60% of Amerindian and Maroon communities, and mining concessions affect nearly 40% of these communities (IADB 2005).

Examples of local community protests relating to land and resource rights abound. In 1990, employees operating in a concession near Klaaskreek in the Brokopondo district were taken hostage by local villagers. Workers in a gold mining concession in the Aluku area in eastern Suriname were withdrawn following threats from local communities around the same time. With respect to eastern Suriname,

forced removal of small-scale gold miners from the Nassau area in 2003 illustrates the potential for friction between the formal and informal mining sectors.

The land and resource rights controversies have several implications of relevance for conservation actions. Insecure land rights fuel unsustainable behavior, since the absence of guaranteed tenure obviates any incentives to conserve or invest in long-term sustainability. Moreover, the controversy over land rights complicates conservation efforts, since such efforts necessarily require working with a broad array of stakeholders including government as well as local communities; conservationists must be careful with respect to strategies that imply – actually or seemingly – partiality to one position or the other on land-rights questions. Seeking a particular land use in areas claimed as traditional lands, whether it is a protected area or a resource concession, risks fueling social conflicts at several levels, with negative consequences for local people, the private sector and biodiversity. Finally, a large influx of investment into the area carries with it a danger of undermining an important part of Suriname's cultural landscape.

Gaps in Information

It is clear from the literature and resource search that while all three plateaus are generally considered by a number of different categorizations to be important areas for biodiversity, there are significant information gaps for both biodiversity and socio-economic issues. This is particularly true for many specific taxonomic groups, ecosystem functions and services, impacts of human activities and the biodiversity value of these areas relative to other areas of Suriname. For Lely and Nassau, it appears that the only substantive understanding is of plant diversity, while little is known about the diversity of other taxonomic groups such as mammals, birds, amphibians, reptiles and insects. In contrast, there has been relatively extensive work done in the BNP for plants, mammals, reptiles and birds (including a monitoring plan), but even in these areas researchers have recommended further studies to better understand the biodiversity in the area.

The issue of small-scale gold mining and its impacts on freshwater ecosystems have also been addressed in a number of studies, such as Mol and Ouboter's study (2004) on the negative impacts to fish diversity and community structure from small-scale mining activities in the Mindrineti River near the BNP. Despite these and similar studies, the cumulative impacts of this and other extractive activities such as large-scale mining, logging and hunting on Suriname's ecosystems are still not well understood. In terms of how the ecosystems of these areas function, the services they provide (such as watershed protection) and their importance relative to other areas of Suriname, too little data exist to make concrete conclusions. Further study on various taxonomic groups, ecosystem functions and services and comparison to other areas of Suriname (and possibly in the larger Guayana Shield) could help fill many of these gaps.

BIODIVERSITY ACTION PLAN WORKSHOP SUMMARY

As part of the IBAP methodology, a workshop was held in Paramaribo on November 8-9, 2005 with the goal of arriving at a realistic assessment of the impacts of human activities on biodiversity and socio-economic conditions in the Nassau, Lely and Brownsberg regions and generating ideas on how to mitigate those impacts and contribute to the region's long-term conservation. Specific workshop objectives were as follows:

1. Improved understanding of the overall socio-economic conditions and biodiversity of the Nassau, Lely and Brownsberg regions;
2. Identification and confirmation of principal stakeholders in the region;
3. Identification, description, and prioritization of threats to biodiversity conservation;
4. Presentation of opportunities for biodiversity conservation; and
5. Completion of a draft Biodiversity Action Plan to support stakeholders in the Lely, Nassau and Brownsberg regions in achieving biodiversity conservation.

RECOMMENDED BIODIVERSITY ACTIONS

Workshop participants initially identified a number of threats in the Lely, Nassau and Brownsberg plateaus, including hunting, trapping, illegal logging, small-scale mining and large-scale mining, lack of regulatory enforcement, waste and trash disposal, and tourism activities. Key actions that could take place to address the threats identified are presented below as a preliminary action plan, with an indication of the time line for each of the identified actions and the suggested stakeholders to be involved in each action.

Brownsberg

Six issues were identified as priorities for biodiversity conservation action in the Brownsberg region: lack of regulatory enforcement, small-scale mining, illegal logging, hunting, waste and trash management, and tourism activities (Tables 2.1-2.5).

Nassau

Six issues were identified as priorities for biodiversity conservation action in the Nassau region: hunting, trapping, illegal logging, waste and trash management, small-scale mining and large-scale mining (Tables 2.6-2.11).

Lely

Three issues were identified as priorities for biodiversity conservation action in the Lely region: hunting, small-scale mining and large-scale mining (Tables 2.12-2.14).

In addition to the aforementioned mentioned issues, the Lely working group came up with additional, general

recommendations for conservation of that area:

1. Use lessons learned from Brownsberg to inform issues in Lely in the short term.
2. Compared to the Brownsberg region, Lely is relatively intact which allows for proactive thinking on how to avoid certain mistakes made in Brownsberg.
3. Get stakeholders to commit to gather more information to decide how resources could be used.

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BROWNSBERG

Table 2.1. Lack of regulatory enforcement at Brownsberg.

Proposed opportunities/actions	Time frame (years)	Stakeholders

• Institutional strengthening of government agencies for effective law enforcement in the following areas:
  • staff development
  • equipment
  • field stations for rangers
  • increase of salaries
  • capacity to draft environmental laws
	0-3	• Ministry of Natural Resources (NH)
		• Ministry of Labor, Technological Development and Environment (ATM)
		• Ministry of Justice and Police (J&P)
		• Department of Geology and Mining (GMD)
		• National Institute for Environment and Development (NIMOS)
		• Suriname Forestry Authority (SBB)
		• Nature Conservancy Division (NB)
		• Donor agencies (i.e. WWF)

• Amendment of existing laws to reflect the new challenges to biodiversity conservation	0-3	
• Establishment of a legal authority for monitoring and enforcing environmental laws	0-3	

Table 2.2. Small-scale mining at Brownsberg.

Proposed actions	Time frame (years)	Stakeholders
• Formation of miners associations • Awareness raising and education • Law enforcement • Introduction of improved mining techniques • Formulate adequate policy on Small-scale mining	All: 0-3	• Small scale miners • Ministry of Natural Resources (NH) • National Institute for Environment and Development (NIMOS) • Ministry of Labor, Technological Development and Environment (ATM) • Ministry of Justice and Police (J&P) • Foundation for Nature Conservation Suriname (STINASU) • Ministry of Finance • District Commissioner of Brokopondo • Resort Council Brownsweg • COGASUR (Association of Brazilian small scale miners)

Table 2.3. Illegal logging at Brownsberg.

Proposed actions	Time frame (years)	Stakeholders
• Adequate law enforcement • Institutional strengthening of government agencies	All: 0-3	• Ministry of Natural Resources (NH) • National Institute for Environment and Development (NIMOS) • Ministry of Spatial Planning and Land Policy (ROGB) • Ministry of Justice and Police (J&P) • District Commissioner of Brokopondo • Resort Council Brownsweg • Suriname Forestry Authority (SBB) • Local communities • Illegal loggers

Table 2.4. Hunting at Brownsberg.

Proposed actions	Time frame (years)	Stakeholders
• Education and awareness raising	0-3	• Nature Conservancy Division (NB) • Ministry of Natural Resources (NH) • Foundation for Nature Conservation Suriname (STINASU) • Local communities • Loggers • Miners • Wildlife rangers
• Adequate enforcement of hunting laws for nature park	3-5	
• Institutional strengthening of government agencies	3-5	

Table 2.5. Waste and trash at Brownsberg.

Proposed actions	Time frame (years)	Stakeholders
• Education and awareness raising	0-3	• Visitors • Ministry of Regional Development • Nature Conservancy Division (NB) • Ministry of Justice and Police (J&P) • Foundation for Nature Conservation Suriname (STINASU) • Local communities • Miners
• Provide waste disposal facilities	0-3	
• Adequate law enforcement	3-5	

NASSAU

Table 2.6. Hunting at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Minimize access • Regulate hunting practices • Adequate law enforcement • Strengthening capacity government agencies • Provide alternative food supply (?)	All: 0-3	• Timber companies • Suriname Forestry Authority (SBB) • Ministry of Justice and Police (J&P)

Table 2.7. Commercial trapping at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Implement education and awareness program • Research	All: 0-3	• WWF • Forestry Service (LBB) • Conservation International • University of Suriname

Table 2.8. Illegal logging at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Enforcement of legal logging	0-3	• Forest Service (LBB)

Table 2.9. Waste/trash at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Education and awareness programs • Waste minimizing plans • Rainwater collection by companies	All: 0-3	• NGOs • Companies

Table 2.10. Small-scale mining at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Minimize impact through implementing best practices	3-5	• Government • NGOs • Business • External funders
• Limit expansion of SSM through regulation (encouraging legal vs. illegal)	3-5	• Government • NGOs
• Technology transfer • Training on mercury	0-3	• NGOs • Companies
• Clean up of old mines (case by case basis)	3-5	• Companies

Table 2.11. Large-scale mining at Nassau.

Proposed actions	Time frame (years)	Stakeholders
• Evaluate impact studies through EIA and other studies	0-3	• Companies
• Applying best practice environmental management (land opening, minimizing area where roads are placed)	0-3	
• Closure and reclamation plan (government and companies	3-5	
• Facilitating exchange and communication between government, NGOs, and companies regarding road closures	0-5	
• Encourage government to maintain high standards of good practice	0-3	
• Review mining legislation (currently being redrafted)	0-3	• Companies • NGOs
• Study dangers SPP to minimize impact	0-3	• Companies • NGOs • University

LELY

Table 2.12. Hunting at Lely.

Proposed actions	Time frame (years)	Stakeholders
• Provide education, food and entertainment for airstrip employees • Wildlife management • Law enforcement • Data collection	All: 0-3	• Garimpeiros • Airstrip employees • Large scale miners

Table 2.13. Small-scale mining at Lely.

Proposed actions	Time frame (years)	Stakeholders
• Training in new technologies	0-3	• Brazilian miners • Large scale companies • Maroons • Geology and Mining Department (GMD) • Law enforcement authorities
• Mercury traps	0-3	
• Law enforcement	0-100	
• Economic opportunities		
• Public information	0-3	

Table 2.14. Large-scale mining at Lely.

Proposed actions	Time frame (years)	Stakeholders
• Baseline study	0-3	• BHP Billiton • Suralco • Grassalco • National Institute for Environment and Development (NIMOS) • Small scale miners • NGOs • CANARC • Government
• Proactive regional land use planning	0-3	
• Resource management plan	3-5	
• NGO ongoing campaign and lobby for better regulation and legislation	0-5	

Chapter 3

Plant diversity of the bauxite plateaus of North East Suriname

Hans ter Steege, Olaf Bánki and Paddy Haripersaud

The laterite-bauxite plateaus in North East Suriname form a large geological formation, locally called the Brokolonko formation, and include, among others, the Nassau, Brownsberg, Winti Wai, Hok-a-Hin, Stonbroekoe, Majordam, and Lely Mountains. These plateaus together cover less than 0.5% of Suriname's land surface (Figure 3.1) and may constitute a rare and endangered landscape type.

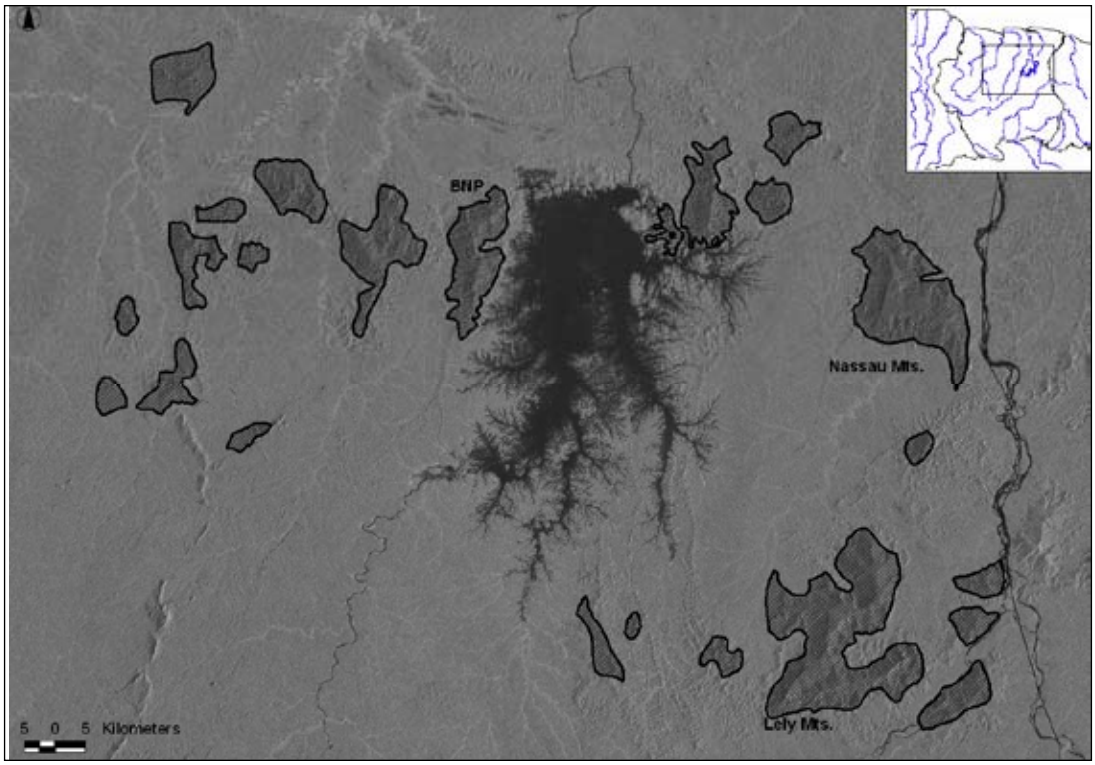

Figure 3.1. Bauxite caps (Brokolonko landscape) of Northeast Suriname as indicated by the 1977 soil map (CBL 1977).

Because most of these formations are laterite-bauxite plateaus (including Nassau, Lely and Brownsberg), they are attractive sites for open pit bauxite mining. Each has been explored for aluminium ore, and several have mining concessions located within their boundaries. Recently mineral exploration has been carried out in the Brownsberg Nature Park (BNP), affecting its status as an undisturbed and protected natural area.

In January and February 2003 the National Herbarium of the Netherlands – Utrecht Branch (NHN-U) and the National Herbarium of Suriname (BBS), with logistical support from SURALCO, carried out a botanical expedition to the Nassau Mountains (Bánki et al. 2003). During this expedition numerical data on tree diversity were obtained by establishing five and a half 1-ha plots, while general plant collecting surveys were conducted to obtain an insight into the flora of the Nassau Mountains.

Subsequent discussions with WWF-Suriname, SURALCO and the Foundation for Nature Conservation in Suriname (STINASU) led to a joint research project to compare three localities of bauxite plateaus (Nassau Mountains, BNP and Lely Mountains).

From a botanical perspective, the bauxite plateaus are relatively unknown and a synthesis of their plant diversity had not been previously carried out. Some of the main botanical expeditions that had surveyed the plateaus in the past include for the Nassau Mountains: Lanjouw and Lindeman 1949, Lindeman and Cowan 1954/55, Maguire 1955 and Jansen Jacobs et al., 2003. For the Lely Mountains, past surveys include: Lindeman et al. 1975 and Jansen-Jacobs et al. 2004. Past surveys of the BNP include: Tjon-Lim-Sang and van de Wiel 1975-77, Mori and Bolten 1976 (including Lely), and van Andel et al. 2003 (see Appendix 1 for collector data used in this study).

At Brownsberg several arboreta have been established in the past. Around 1914-15 Justus Gonggrijp, the head of "Boschwezen" (Forest Department), established an arboretum on top of Brownsberg. Between 1915 and 1931 various collectors have made collections of trees in this arboretum (e.g. Gerling, Gonggrijp, Nijverman, Stahel, van Emden, Zaandam). In 1970 Dr. Joop Schulz, Head of the Nature Conservation Division of the State Forest Service (LBB/NB) and founder and first director of STINASU established an arboretum at the BNP. Trees were identified by John Tawjoeran and Frits van Troon, and collected by, among others, tree climber Leo Roberts (see Teunissen 2005 for details on tree species). ter Steege and Bánki et al. (2003) established five 1-ha plots with labeled trees on the plateau and slopes of the BNP.

METHODS

The main field work took place in three expeditions: Nassau Mountains, January –February 2003; BNP, November – December 2003; and Lely Mountains, November – December 2004. In June and November 2005 two extra fieldtrips were made to Brownsberg for extra plant collecting and the establishment of a 1-ha plot in mountain savanna forest (Bánki et al. unpublished). Each expedition was carried out by two teams: one team focused on general plant collecting (NHN-U, BBS) and the other team focussed on the establishment and inventory of 1-ha tree plots (NHN-U, and CELOS on Lely). Each expedition was comprised of different team members, though H. ter Steege, O. S. Bánki, G. Ramharakh and F. van Troon were present at all three expeditions. Detailed information on the expeditions can be found in Bánki et al. (2003), ter Steege et al. (2004) and ter Steege et al. (2005).

Botanical collections

In preparation for the three expeditions, all known and available plant collections and forest inventories of Nassau Mountains, BNP, and Lely Mountains were gathered and entered into a database in Utrecht. This provided the expedition teams with checklists of known plants for the survey areas.

The collection teams tried to cover all representative vegetation types of the plateaus, or at least those that could be reached by road or trail. Standard botanical collection methods were used. Vouchers from flowering or fruiting

Table 3.1. Plot meta data. Coordinates in UTM (zone 21), Altitude in m ASL, Dimensions in m x m.

Name	Easting	Northing	Altitude	Dimensions	Forest
BB1	545061	697876	c. 500	100 x 100	Plateau forest, few palms
BB2	545455	700277	c. 500	100 x 100	Mixed, high plateau forest
BB3	547039	700849	c. 500	100 x 100	High forest on plateau
BB4	549831	702197	c. 350	100 x 100	High open forest on slope, multiple treefall gaps
BB5	551464	700083	c. 100	100 x 100	Disturbed forest in lowland. Signs of previous logging.
BB6	546585	702175	c. 350	100 x 100	High mixed forest; on slope
BB8	545469	705755	c. 100	500 x 20	Mixed high forest, very open understorey in lowland
BB9	546456	700480	c. 500	100 x 100	Plateau, mountain savanna forest
L1	472256	750297	670	100 x 100	Plateau, high forest, close to edge.
L2	471236	751090	c. 600	100 x 100	Plateau, high forest
L3	472697	751155	670	100 x 100	Plateau, high forest, slightly disturbed
L4	469914	751482	430	100 x 100	Slope, high forest
L5	470396	751497	500	250 x 40	Plateau, mountain savanna forest
L6	472343	746542	135	250 x 40	Lowland, high forest
L7	471978	749208	135	250 x 40	Lowland, high forest
L8	469914	751482	420	250 x 40	Slope, high forest
N1	529275	764217	c. 500	500 x 20	Plateau, high forest
N2	532708	764867	c. 500	250 x 20	Plateau, high forest
N3	532755	765819	c. 500	100 x 100	Plateau, high forest
N4	545419	774643	c. 50	500 x 20	Lowland, high forest
N5	545915	775512	c. 50	500 x 20	Lowland, high forest
N6	534038	764840	c. 500	100 x 100	Plateau, high forest

trees were obtained by using an eight meter long clipper pole and on the Lely Mountains a shotgun was used as well. For safety reasons, no tree climbing took place. When possible, four duplicates were made of each collection: one for the BBS, one for the NHN-U, and two for specialists of that particular family that were not part of the expeditions.

Plot establishment and inventory

In total 21 plots in high forest and two in mountain savanna forest (MSF) were established. Initially on the Nassau Mountains plots were laid out on the plateaus (c. 500 m altitude) and in the surrounding lowlands. On the following two expeditions plots on the slopes were also included. To ensure wide sampling areas, the locations of the plots were relatively well spread out over each plateau, though the selected locations were essentially random with regard to tree composition within the plateau, slope or lowland habitat. Two factors that did influence plot location included: 1) a plot area had to be undisturbed by humans, so plots with old tracks as well as with manmade clearings were avoided; 2) the forest had to have a height of 30-50 meters (not including the plot locations in the mountain savanna forest). Natural gaps were included in the plot inventories. The plots were generally rectangular in shape and measured 100 x 100 m. For either logistical or time constraints, a number of plots were elongated 250 x 40 m or 500 x 20 m (Table 3.1).

At each plot, GPS coordinates were taken, and a line was cut around the plot location, except in the elongated plots, where a center line was cut. Every ten meters, flagging tape was attached to the vegetation or a stick. In this way, subplots of 10 by 10 meter were made (20 x 20 for the elongated plots). All trees with a DBH (Diameter at Breast Height = 130 cm) ≥ 10 cm were pre-identified by Frits van Troon and listed by 10 x 10 m sub-plot. If a tree had buttresses or irregularities at 130 cm, a DBH was measured 10 cm above these and noted in the field notes. Strongly fluted trees were noted and measured at 130 cm. In principal, reference collections were made of each newly encountered species, when trees could not be identified on the spot with certainty or when trees belonged to notoriously difficult plant groups (such as the Myrtaceae, Sapotaceae, etc.) were encountered. This was mostly carried out with a tree-pruner mounted on fibreglass poles (8 m in height). In cases where the pole length was insufficient, lower trees belonging to the same species were sought. At the Lely Mountains twigs with leaves that could not be reached by the pole were shot down with a 12-gauge shotgun. If a tree still could not be sampled, an individual was cut down (excluding Brownsberg). During the expeditions, the identity of many species of the reference collection could be linked to fertile collections of the collection teams. Regular checks were made among the plot teams and botanical teams to exchange potential names and fertile collections. Many of these plants have been identified by Dr. Tinde van Andel and Ms. Marion Jansen-Jacobs.

To link the common names used by Frits van Troon to scientific names, information on 'van Troon names' was gathered before the fieldwork. This information contained data from different documents, including: a list made by Pieter Teunissen, Marga Werkhoven and Frits van Troon present at the BBS; collection data by Lindeman et al. (1980, 1981) from the Kabalebo-area; information from the thesis of van Roosmalen (1985); and information from the expedition to the Nassau Mountains in early 2003 (Bánki et al. 2003), to the BNP at the end of 2003 (ter Steege et al. 2004), and to the Lely Mountains at the end of 2004 (ter Steege et al. 2005). In the field some extra information was added with the help of the Virtual Tree Guide of the Guianas (Haripersaud and ter Steege 2004). Other documents used included: the 'Bomenboek van Suriname' (Lindeman and Mennega 1963); Fruits of the Guianan Flora (van Roosmalen 1985); a list of vernacular names of LBB (Werkhoven 1975); lists from compiled reports by van Troon (1984-1987); the 'tree guide of West Suriname' (Jiménez-Saa 1973); and the index of vernacular plant names of Suriname (van 't Klooster et al. 2003). Identification of the collected plants will further aid in linking the 'van Troon names' to scientific names. The scientific names were updated by using the checklist of the Guianas (Boggan et al. 1997, Hollowell et al. 2001) and classified to families according to APG II (Angiosperm Phylogeny Group II, Stevens 2001 and onwards).

The mostly sterile reference collections were sent to the Utrecht herbarium for identification purposes. Only for the reference collection of the Lely Mountains was a duplicate stored in the National Herbarium of Suriname as a reference to link the van Troon common names to scientific plant names. For administrative reasons the reference collections were given a number in the series of O. S. Bánki (OSB) at a later stage. The identification of the reference collection is still in process and is mostly carried out by O. S. Bánki with the aid of experts at (e.g. Prof. Dr. P. J. M. Maas) or visiting the NHN-U. In the comparison of tree composition between the three plateaus morpho-species were used for the plants that could not be identified to species level. The morpho-species name is constructed by a combination of the family or genus, plot and tree number (e.g. Inga sp. L2_192) or reference collection (e.g. Inga spOSB_400).

Data analysis

Plot data were analysed with Non-linear Multidimensional Scaling (NMS, PC-ORD; MjM Software USA, McCune and Mefford 1999, McCune et al. 2002). Special emphasis was taken to discover altitudinal gradients from the lowland towards the bauxite plateaus and differences between the three plateaus (23 plots).

To test for differences in composition between the lowlands and plateaus and among the plateaus we made use of the Multi-Response Permutation Procedure of PC-ORD (see above). MRRP is a non-parametric procedure that can be used for testing the hypothesis that no difference exists in composition between two or more groups of plots. For distance in composition between the plots we used Relative Sørensen, as it takes both composition (presence-absence of

species) and abundance into account. For weighting option $C_1 = n_1 / \sum n_1$ was used, which is the most widely used and recommended measure. We used 9999 permutations in the test. Two tests were carried out based on two a-priori selections: 1) plots at the base (including the slope) vs. plots on the plateaus vs. mountain savanna forest plots and 2) plots on and in the surrounding of the three mountains as treatment blocks (Lely vs. Nassau vs. BNP).

To test for differences in composition as a function of distance, we carried out a Mantel test (PC-ORD, see above) using two matrices, one with the plot data and one with the plot locations (in UTM). For similarity the Relative Sørensen index was used (see above), while for the distance matrix for plot location, the Euclidean distance was used, calculated from the UTM coordinates (in metres). As test of significance, randomization of the data was used (9999 runs).

RESULTS

Vegetation types

The following main vegetation types were found on the three mountains (based on Bánki et al. 2003, de Granville 1991, Lindeman and Moolenaar 1959, ter Steege et al. 2004, ter Steege et al. 2005, Teunissen 2005):

High dryland forest on laterite plateaus

The forest has a high stature with trees of 30-40 m and emergent trees to 50 m in height. The soil is covered with a relatively thin layer of organic material, and occasionally the laterite/bauxite cap is deep-seated, preventing the soil from drying out quickly during dry seasons. Trees belonging to the plant families of Vochysiaceae (e.g. *Qualea*), Lecythidaceae (e.g. *Couratari, Eschweilera* and *Lecythis)*, and Fabaceae (e.g. *Eperua falcata*, and *Parkia* spp.) can be abundant. Palm trees hardly occur in this type of forest. Typical plant families of the understorey trees include Annonaceae, Violaceae, and Salicaceae (see indicator genera in the plot inventories below). On Lely notable species included *Lacistema* spp. and a cauliflorous 2 m high treelet of *Connarus fasciculatus*. Notable shrubs include species from the Melastomataceae, *Brunfelsia guianensis*, and occasionally *Rhabdodendron amazonicum* (Lely). The herb layer is poor, with the most encountered species including *Olyra latifolia, Mapanea sylvestris*, a few *Piper* species and some ferns. On Nassau a recent newly described species from French Guiana (Thymelaeaceae - *Daphnopsis granvillei*) was found abundantly at times in the undergrowth.

High marsh forest on laterite plateaus

At places where the laterite cap shows depressions, ponds can be formed during the rainy season and persist throughout the dry season. On Nassau this is characterized by dominance of *Symphonia globulifera* and *Pterocarpus officinalis* in some parts. Usually, the high dryland forest is intermingled with elements from the high marsh forest such as *Euterpe oleracea* and Marantaceae species (see also vegetation on and near rocky creek beds).

Mountain savanna forest

The mountain savanna forest is a xerophytic forest and is found where the laterite cap is near the surface (rocky soils) and where there is only a thin layer of topsoil dominated by blackish gravel (iron-stones). At such places, there is a rapid run-off of rainwater and the soil dries out quickly, especially during the dry season. There are several types of mountain savanna forest differing in forest height and species composition. A type mostly seen on the Brownsberg and Nassau Mountains has a stature of 15 to 20 m in height with an open canopy, and is dominated by *Hevea guianensis*, *Micrandra brownsbergensis* and species of Myrtaceae, Nyctaginaceae, Rubiaceae, and Celastraceae (e.g. plot BBS9). A lower type of mountain savanna forest is found especially on the Lely Mountains, and is characterized by a high stem density and very low species diversity, a forest stature of 5 to 10 m in height (e. g. plot LeS5) and very open canopy conditions. For Lely this forest type consists of the following main species: *Croton argyrophylloides* (found on Nassau as well), *Micrandra brownsbergensis*, *Elvasia elvasioides* and a high abundance of Myrtaceae spp (see indicator genera in the plot inventories below). At Brownsberg the low mountain savanna forest type can be found at some places along the trail to the Weti creek. This low type was not observed on the Nassau Mountains, but could be expected there as well. Overall, the undergrowth of the mountain savanna forest is very poor in species, with *Vriesea splendens* and some mosses dominating, and few epiphytes occurring in trees.

Mountain savanna moss forest

The humid types of mountain savanna forest are worthwhile to mention separately as mountain savanna moss forests, because of their typical high coverage of vegetation and soil by mosses and high occurrence of orchids and other epiphytes such as ferns and bromeliads. The mountain savanna moss forest occurs especially on the edge of the plateaus and on the slopes where rain clouds are often coming in contact with the mountains. However, on the Lely Mountains, the mountain savanna moss forest can also be found on top of the plateau itself. On the Lely plateau we found a very low (ca. 4 m in height) forest consisting of e.g. Myrtaceae, *Croton argyrophylloides*, *Micrandra brownsbergensis*, and *Clusia* species completely covered in dark brown mosses. Typical for the Lely Mountains is also the occurrence of *Vriesea pleiosticha*, and some Guyanan Highland elements such as Ericaceae species (e.g. *Cavendishia callista)*.

Vegetation on and near rocky creek beds

The vegetation on and near rocky creek beds was examined by Tjon Lim Sang and Van de Wiel (1980) at Brownsberg (see also Teunissen 2005 for a more detailed description). Close to the waterfalls and in the mist zone of the water many liverworts, mosses, ferns, and herbs (e.g. *Dicranopygium pygmaeum*) occur. On wet rocks Hymenophyllaceae and *Sellaginella* species can be found as well. On the dryer parts species of Acanthaceae, Araceae, Campanulaceae, Cyclantahcaeae, Gesneriaceae and Piperaceae occur. *Thurnia*

sphaerocephala and *Saxofridericia aculeata* were found in and along creeks of gullies at the Nassau Mountains. Close to the creeks tree ferns, e.g. *Cyathea* spp., can be found.

High dryland forest on slopes

Soils on the slopes are deeper than on the plateau, allowing a forest with a very high stature at times reaching a height of 60 m to be found. According to Schulz (in Teunissen 2005) these forests are the best developed high forests in Northern Suriname. On the ridges the soil can be shallower and this is also reflected in the species composition. The composition can be a mix of species occurring more at the plateau and more in the lowlands. Typical tree genera include: *Eschweilera*, *Couratari, Lecythis, Pouteria, Sloanea, Hymenaea, Virola* and *Qualea*. In some parts, where the soil is well-developed, this forest type has an understorey dominated by several palm species, e.g. *Oenocarpus bacaba*, *Astrocaryum sciophilum*, and *Astrocaryum paramaca*. Annonaceae are also very common in the understorey. Several Melastomataceae are also found in the understorey, such as *Henriettea* species.

Disturbed or secondary forests

On each of the mountains man-made disturbances have taken place due to bauxite exploration and other activities, such as clearing areas for airstrips and radio towers. Where bulldozers have opened the forest in the past, secondary forest species can occur including *Cecropia*, *Croton*, *Inga*, *Pourouma*, *Vismia* species and several Melastomataceae and Rubiaceae. In the understorey *Heliconia* species can be abundant. Along the airstrips of Lely and Nassau the only types of really open vegetation occur, allowing for rural plants to flourish (e.g. Asteraceae, Cyperaceae, Poaceae). Along the edges trees of *Clusia* spp., *Byrsonima* spp., *Miconia* spp., *Eugenia* spp., *Isertia coccinea*, *Maprounea guianensis,* Melastomataceae and Solanaceae occur. In the shrub and low tree layer many lianas such as *Dioclea, Moutabea, Pinzona, Doliocarpus, Sabicea, Mikania* and *Rourea* can be found. On Brownsberg, mountain liana forest can be found. The mountain liana forest is the result of large storms ("sibibusi") such as one storm that occurred in 1984 and documented by Van Troon (1984). It is unclear whether the very low mountain savanna forest on the plateaus of the Lely Mountains is also the result of such natural disturbances.

Plot inventories

Most plots had a tree density between 450 and 600 trees (≥ 10 cm DBH). The mountain savanna forest of Lely had a very high density (of small stems) of nearly 1000 stems per ha (Table 3.2). The 23 plots contained a total of 13,241 individuals, of which at present 599 (morpho-) species have been identified. Of these, 292 have actually been identified at the species level. The remaining 307 species have been assigned to morpho-species (173 at the genus level, 121 at the family level and 13 unidentified). A full list of species and numbers of individuals is given in Appendix 2.

The ten most common species on the plots are (in order of abundance): *Lecythis corrugata, Eperua falcata, Micrandra brownsbergensis, Eschweilera sp.* OSB167_263*, Elvasia elvasioides, Croton argyrophylloides, Qualea rosea, Astrocaryum sciophilum, Quararibea duckei,* and *Bocoa prouacensis.* These species account for 23% of all individuals. The number of species that was found with only one individual was 135, with 54 species having two individuals found.

Table 3.2. Primary diversity plot data. N = number of individuals, S = number of species.

Name	N	S	Fisher's alpha
BB1 (Plateau)	639	165	72. 1
BB2 (Plateau)	571	138	57. 8
BB3 (Plateau)	635	136	53. 1
BB4 (Slope)	466	121	53. 1
BB5 (Lowland)	540	126	51. 7
BB6 (Slope)	548	136	57. 9
BB7 (Lowland)	526	124	51. 2
BB8 (Lowland)	562	115	43. 8
BB9 (Plateau; MSF)	623	119	43. 7
L1 (Plateau)	638	150	61. 8
L2 (Plateau)	494	137	62. 8
L3 (Plateau)	602	170	78. 9
L4 (Slope)	524	146	67. 1
L5 (Plateau; MSF)	981	31	6. 1
L6 (Lowland)	477	115	48. 1
L7 (Lowland)	476	107	42. 9
L8 (Slope)	490	112	45. 4
N1 (Plateau)	477	112	46. 1
N2 (Plateau)	257	92	51. 3
N3 (Plateau)	500	132	58. 5
N4 (Lowland)	775	145	52. 6
N5 (Lowland)	832	141	48. 7
N6 (Plateau)	608	137	55. 1

Tree α-diversity

The average Fisher's α (a diversity measure corrected for sample size and widely used to compare plots) over the high forest plots is 55.2. There is a small difference in the diversity of the plots of the plateau (with the exclusion of the mountain savanna plots), slope or lowland (ANOVA, $F_{[2,18]} = 3.98$, $p = 0.037$), with the lowlands having a slightly lower diversity (Fisher's α = 48.4) than the slopes (55.9) and plateau plots (59.7). Table 3.2 shows the number of individuals, the number of species, and the Fisher's α of the 23 plots. The highest Fisher's α is found in plot Lely 3 (78.9), which at present is the plot with the highest tree α-diversity in Suriname. The plot with the lowest diversity for Suriname, however, is located just a kilometre away in the mountain savanna forest (Plot L5). The high forest of the plateaus

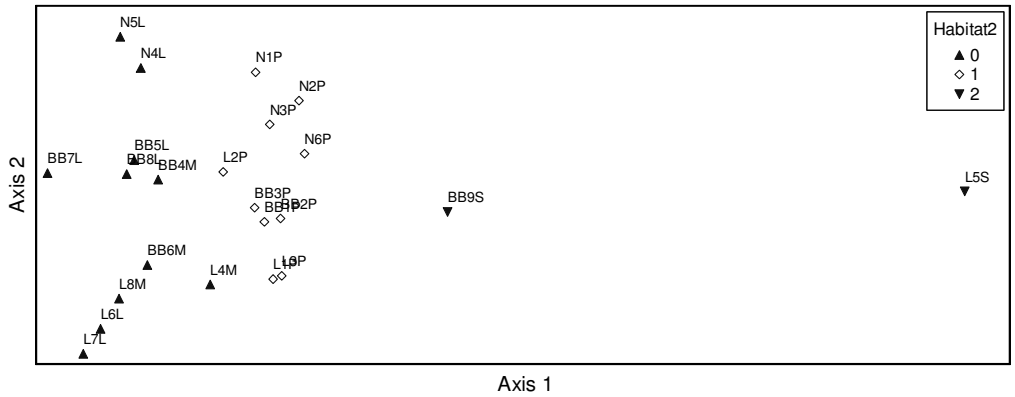

Figure 3.2. Bi-plot of the NMDS Analysis of BNP (BB), Nassau Mts. (N) and Lely Mts. (L) plots. Last letter indicates relative location: L, M (triangle upward) in lowland and (mid-) slope (c. 50-350 m) with deep soils, P (open diamonds) plots on plateau (> 500 m) with relatively shallow soils, and S mountain savanna forest on the plateaus (S, triangle downwards) with very shallow rocky soils. All species included. The data show a clear gradient from lowland to plateau and finally the mountain savanna forest.

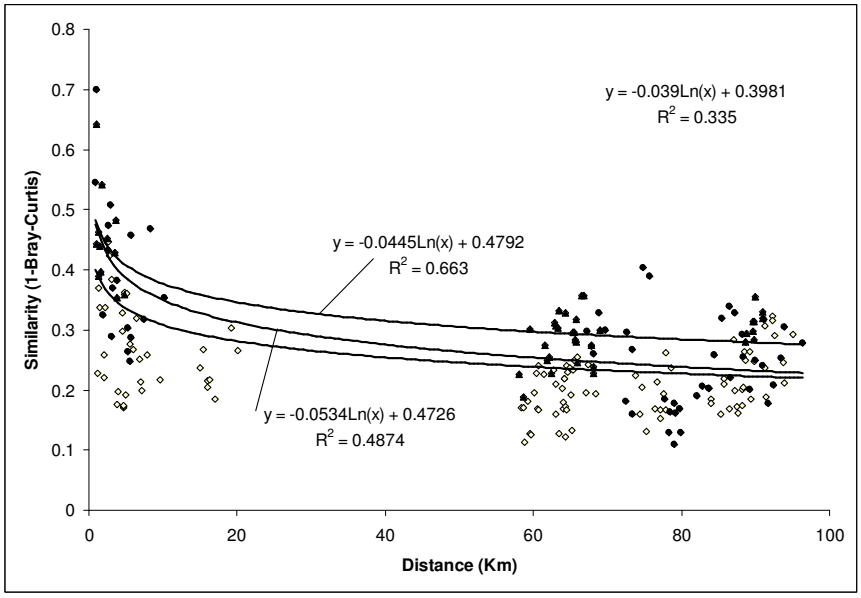

Figure 3.3. Distance has a significant effect on differences in composition of forest plots. Plots very close by typically have an average similarity of 40%. This decreases over distance to 25%. Plots of similar habitat have slightly higher floristic similarity (10% higher). Black diamonds comparison plateau with plateau plots; Black circles lowland with lowland plots; Open diamonds: plateau with lowland plots

and their surroundings have high diversity (Fisher's α, 55.9) compared to most lowland forests plots in western Suriname (c. 30), Mapane (c. 40) and Guyana (c. 20), but lower than the average for French Guiana (c. 90).

A comparison (Figure 3.2) in composition (of all species) between the plots of the three plateaus shows one major gradient dominated by habitat location. Lowland and slope plots are found on the left of this gradient, plateau plots in the middle part and mountain savanna forest plots on the right.

The data in Figure 3.2 show a clear gradient from lowland to plateau and finally to the mountain savanna forest. Geographic location is distributed along the second axis. Plots of Nassau are found in the lower part, while those of Lely are located on the higher part with some overlap with the BNP plots located in the center.

With MRPP the above results can be tested more formally. Differences between habitats (ecological location) (Lowland + Midslope, Plateau, MSF), while significant, are small (MRPP: A = 0.082; P < 0.001). The few species significantly (PC-ORD, Indicator Species Analysis, P <0.05) more abundant or present on the plateaus were *Neea floribunda, Pouteria guianensis,* Nyctaginaceae sp. OSB427*, Sterculia* sp. OSB276_554*, Jacaranda copaia, Henriettea* sp. OSB324*, Pouteria* sp. OSB376*, Protium* sp. OSB337*, Ocotea* sp. OSB268*, Qualea rosea, Cupania scrobiculata, Siparuna decipiens, Inga* sp. OSB130*, Simarouba amara, Abarema jupunba,* and *Pouteria* sp. OSB318_342. Indicator species for the MSF of the plateaus were *Ecclinusa guianensis, Clusia* sp. OSB472, *Inga heterophylla, Micrandra brownsbergensis*, Myrtaceae sp. OSB297, and *Vitex triflora*. Finally, indicator

species for the lowland forest (in this dataset) were *Gustavia hexapetala, Tetragastris panamensis, Licania majuscula, Maquira guianensis, Unonopsis glaucopetala, Couratari stellata*, Chrysobalanaceae sp. OSB421_432, Lecythidaceae sp. OSB428_456, *Sloanea* sp. OSB208_449, *Dicorynia guianensis,* and *Chaetocarpus schomburgkianus*.

The differences in composition between the three geographic localities are also highly significant in statistical sense (MRPP: A = 0.094; P << 0.001). However, as with the differences between habitats, the absolute differences are relatively small.

With Mantel tests the effect of distance was tested more explicitly at the species level. For all trees (omitting the MSF plots BB9S and L5S) distance had a significant effect on the similarity between plots (Standardized Mantel statistic r = 0.46; P < 0.001) (Figure 3.3). Comparison of similarities calculated between plots of similar habitat (plateau vs. plateau and lowland vs. lowland) and between contrasting habitat (plateau vs. lowland) shows that for any distance plateau plots resemble each other much more than lowland plots (ANOVA on residuals from main relation: $F_{[2,207]} = 42.56$ P << 0.001). The similarity in habitat adds roughly 10% in similarity in composition (Figure 3.3).

A comparison (Figure 3.4) in composition (of all genera) between the plots of the three plateaus shows essentially the same major gradient dominated by habitat location. Lowland and slope plots are found on the left of this gradient, plateau plots in the middle part and mountain savanna forest plots on the right. Indicator genera for Lowland are: *Gustavia, Tetragastris, Licania*, Lecythidaceae indet., *Maquirarea, Couratari, Unonopsis*, Sapindaceae indet., Chrysobalanaceae indet., *Chaetocarpus,* and *Oenocarpus*; for Plateau High Forest: *Neea, Ocotea, Pouteria, Qualea, Licaria, Henriettea, Inga*, Sapotaceae indet., *Cupania, Siparuna,* and *Jacaranda*; and Mountain Savanna Forest: *Ecclinusa, Clusia, Micrandra*, Myrtaceae indet. , *Terminalia, Ouratea,* and *Vitex*.

Based on a preliminary analysis of common trees of the 114 one-ha plots situated in the N-Guyana Shield area (ter Steege et al. unpublished data), the plots of eastern Suriname form a relative well separated entity in terms of composition. There is some overlap in composition with lateritic areas in French Guiana (Sabatier et al. unpublished data). In terms of tree alpha diversity the plots on and around the bauxite plateaus are also well positioned in a west to east trend of increasing tree diversity.

Botanical collections

In total 5730 botanical collections were retrieved from our database for the area of the three bauxite plateaus. These collections amounted to 1668 identified species (4873 collections) and a sizable number of (as yet) unknowns (857 collections, 222 taxa). All species encountered can be found in Appendix 3.

Based on our database, the three plateaus have not been collected equally. The BNP has the highest number of collections (2572 collections, 1060 species), most likely due to its better accessibility, followed by the Nassau Mountains (1691 collections, 694 species), and the Lely Mountains (1097 collections, 487 species). A few collections were specifically collected in the lowland areas surrounding the plateaus: Moengo (2), Brownsweg (192), and Marowijne (176). The differences in collecting intensity are the main identifiable cause for the differences in current known species richness recorded among the plateaus (Figure 3.5A). As the Lely Mountains is the largest of the plateaus, it is reasonable to assume that it will have the highest number of species.

When comparing the species collected on the plateaus with the full (but preliminary) collection database of the Guianas (c. 200,000 specimens), there are several problems that cannot be solved easily. Nomenclatural problems are apparent and cannot be sorted at this point in time. We tested whether species found on the plateaus were collected significantly more often on the plateaus than in the rest of the Guia-

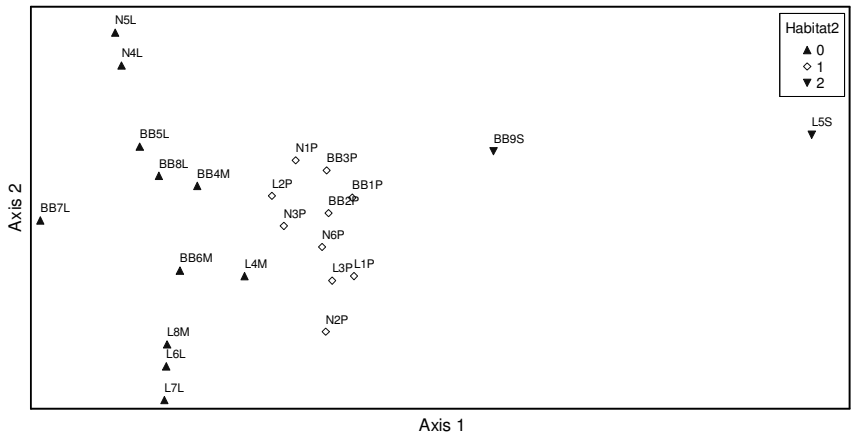

Figure 3.4. Bi-plot of the NMDS Analysis of genera of BNP (BB), Nassau Mts. (N) and Lely Mts. (L) plots. Last letter indicates relative location: L, M (triangle upward) in lowland and (mid-) slope (c. 50-350 m) with deep soils, P (open diamonds) plots on plateau (> 500 m) with relatively shallow soils, and S mountain savanna forest on the plateaus (S, triangle downwards) with very shallow rocky soils. All genera included. The data show a clear gradient from lowland to plateau and finally the mountain savanna forest.

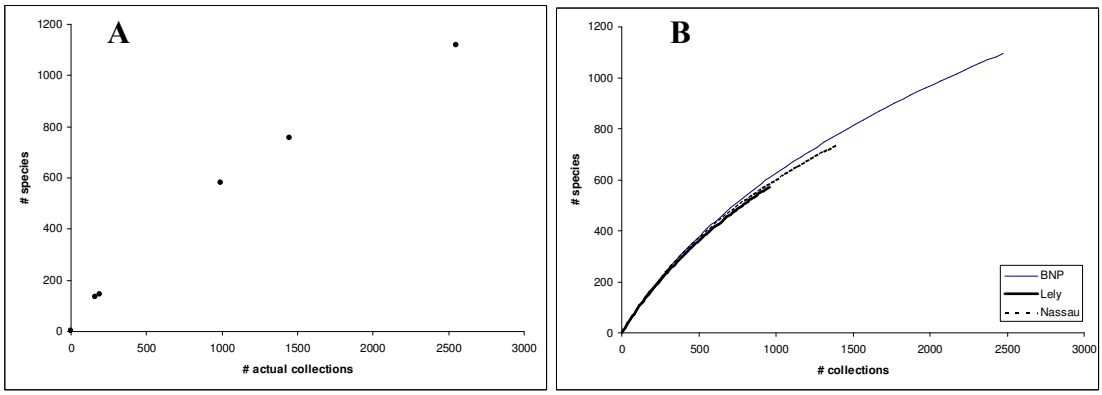

Figure 3.5 A. the number of collections made on the plateaus (and surrounding areas) determines the perceived species richness. **B.** Species accumulation curves for the three plateaus, based on 500 randomisations. There is no difference in the speed at which species richness (# species) increases with increasing (randomised) collecting effort (# collections).

nas (based on the total number of collections on the plateaus and the rest of the Guianas; Chi square test, $P < 0.05$) and found 294 species tested positively. However, as the number of species tested was c. 9000, roughly 450 are expected to show a significant relationship by chance. This is in fact more than the number we found. Hence, we are in no position to make any firm statements on the basis of these data yet.

DISCUSSION

Each of the six main vegetation types occurs on the three mountains. However, while on the plateau of Brownsberg the forest changed at very short distances in height and vegetation type forming a 'mosaic' forest, the vegetation types are more pronounced on the Lely Mountains, where large tracts of uniform vegetation types can be found. Typical for the mountains is that truly open vegetation or open rock such as found on granite outcrops does not seem to occur.

The plot inventories of the bauxite plateaus show a highly diverse forest. The plots found on Lely Mountains are currently among those with the highest average diversity for Suriname (Table 3.2). This high diversity fits well with the general increase in tree alpha-diversity from Western Guyana towards French Guiana. As there were no plot data available from central and southern Suriname, we have no way of comparing the data with the southern part of the country. Data from other sources (ter Steege 2000, ter Steege et al. 2003) may suggest that similar, or even higher, tree diversity may be expected in that area. The plot with the highest tree alpha-diversity for Suriname is now located on the Lely Mountains, and the Lely Mountains support the highest average tree alpha diversity of the three plateaus visited (Nassau Mountains, BNP, and Lely Mountains). However, this difference is small and not significant. It is safe to state, however, that the bauxite plateaus and their surrounding forest have very high tree alpha-diversity compared to the other Surinamese forest areas of which data are available.

In terms of tree composition, the plots of the bauxite plateaus and their surroundings form a distinct group within all inventoried plots of the Guianas. The composition of the Eastern Suriname plots is best comparable with that of French Guiana on similar ferralitic soils. The forests of Western Suriname and Mapane (coastal zone) are more similar to those of Guyana on similar soils of the same Zanderij (Berbice) Formation.

Differences in composition are scale dependent. Whereas within the Guianas the plots in Eastern Suriname are very similar, there are significant changes among them that are also distance dependent. Plots close together are 'more similar' than plots at larger distance. This suggests that the high forest plots on the bauxite plateaus draw most of their species 'relatively randomly' from their surroundings. Still, plateau plots of the three areas investigated share more species among them (compared to the lowlands) than can be attributed by chance. Whereas a distance of c. 90 km results in a change in composition of approximate 20%, the similarity among the plateau plots consistently adds another 10% at any distance.

Lely differs from Nassau and BNP in the large extent of the mountain savanna forest. These forests are dominated by a few species. On Lely notably *Elvasia elvasioides*, *Croton argyrophilloides* and *Micrandra brownsbergensis* have high stem density, coupled with low tree alpha-diversity. Many of the Myrtaceae found in this forest are still unidentified, so apart from their typical physiognomical appearance, it is as yet difficult to indicate their conservation value. Lely is also the highest of the three plateaus inventoried. The increase in altitude (670 m asl compared to 550 m asl for the other plateaus) appears sufficient for the occurrence of several Guayana Highland elements, such as the Ericaceaous *Cavendishia*. In addition, the very low open forest on the highest slopes has an abundant moss flora (moss forest) with many Orchidaceae (Werkhoven and Teunissen unpublished data), which due to the prolonged drought prior to and during our expedition showed very few flowering individuals.

The collection record for the bauxite plateaus, Suriname and the Guianas is still very small. The fact that a species is only once collected on one of the bauxite caps does not truly mean it only occurs there. It could simply not have

been collected elsewhere due to rarity or low collecting effort. Until further collections are carried out, it is possible to use the existing collections to get a second estimate of the diversity of the bauxite plateaus (i.e. the species richness) by using the species – collection curves of the three areas. These curves describe how the number of species increases with randomised collecting effort (for an example in the Guianas see: ter Steege et al. 2000a). The curves for the three bauxite plateaus are very similar at low collecting intensity (Figure 3.5B). This conclusion needs to be confirmed when all Guianan data has been analysed and more robust tests have been developed. In comparison to the Guyana Highlands with their very high endemicity, the vegetation of the lateritic and bauxitic plateaus on basic volcanic rocks is rather uniform and has a low endemicity (see de Granville 1991). However, some groups of plants are thought to show differences in species composition and between lowland and mountainous areas, such as Bryophytes (J. Florschütz-de Waard personal communication), Orchids (Werkhoven 1986) and most likely ferns. According to de Granville (1991) there is a set of species that is strictly endemic, at least in the Guianas, for the submontane cloud forests. In our data we found the following species, which are also mentioned in the list of de Granville: *Dicranopygium pygmaeum* (Cyclanthaceae), *Elaphoglossum latifolium* (Lomariopsidaceae), *Lonchitis hirsute* (Dennstaedtiaceae), *Thelypteris holodictya* (Thelypteridaceae), and *Trichomanes membranaceum* (Hymenophyllaceae). Several of these species occur on and near rocky creek beds (Tjon Lim Sang and van de Wiel 1980). Despite the difference in species between the lowland and mountainous areas, we can not find proof in the current dataset for endemics specific for Brownsberg, Lely Mountains and Nassau Mountains

Our data suggest that the following species might be endemic for Suriname: *Copaifera epunctata* (Fabaceae, five collections for Brownsberg), *Phoradendron pulleanum* (Santalaceae, one collection of Brownsberg and one of Lely), and *Sloanea gracilis* (Elaeocarpaceae, one collection of Brownsberg). However, we feel that these possible endemics for Suriname could also be the result of low collection efforts in the Guianas and surrounding countries. There are ten tree species with a listing on the IUCN red list. Almost all of these species occur to a certain extent on Brownsberg, Lely and Nassau, although the tree species can differ in abundance on the mountains (e.g. the population of *Corytophora labriculata* for Brownsberg; see Teunissen 2005). Approximately five tree species in our dataset are protected under Surinamese law, including: *Bertholletia excelsa*, *Manilkara bidentata*, and species of *Dipteryx* and *Copaifera* (see Appendix 3).

All plateaus are surrounded by gold mining activities. In Nassau this appears to have resulted in very low animal populations, probably due to over-hunting. The relatively undisturbed and protected nature of BNP makes it a safe haven for many rarer mammal species. Lely too, perhaps due to its remote location, still has much wildlife. Among others, evidence of tapir and jaguar was found while, Harpy eagle, macaws, coati mundi and four primate species were observed. However, gold mining and hunting are very close to the plateau. A new gold mining camp was being set up during our fieldwork very close to plot 7 at the base of the mountain and hunting of spider monkeys (and other species) was observed on the plateau and slopes itself.

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Chapter 4

Orchids and Orchid Bees of the Brownsberg, Nassau and Lely ranges

Iwan E. Molgo and Bart P.E. De Dijn

SUMMARY

A total of 190 species of orchids have been recorded from the Brownsberg, Nassau and Lely ranges: 141 from Brownsberg, 70 from Nassau, and 96 from Lely; 16% are known from all three ranges, and 31% only from Brownsberg. The lower orchid richness figures for Lely and Nassau can be regarded as artifacts due to low collecting effort. Compared to other sites in the Guayana Shield region, Brownsberg has the second-highest recorded orchid species richness. The available information suggests that a number of orchid species that are very rare in the region occur at these three ranges, e.g. *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) and *Quekettia papillosa* (Nassau).

There was no significant difference between the three ranges (at $p < 0.05$; based on test of independence) in the proportion of species assigned to different elevation classes, but there were significant differences in the proportion of species assigned to different substrate classes. Lely with 16% ground and epilithic orchids diverges from the other two ranges, which each have 4-5% of such orchids. A high proportion of highland orchid species – ca. 30-40% – may be the characteristic that distinguishes these ranges with elevated plateaus from areas that are true lowlands, and may explain the high species richness. There may be a trend that highland orchids become more important as the height of the range's main plateau increases. This and the greater importance of ground and epilithic orchids at Lely suggests that Lely may be the most divergent, unique and species rich of the three ranges.

A total of 34 species of orchid bees was collected at the three ranges: 13 at Brownsberg, 22 near Lely and 23 at Nassau. The frequency of bees with orchid pollinaria differed significantly between Nassau and a lowland location near Lely. At the first location, none of the bees carried pollinaria, while at the second, the figure was 13% More sampling needs to be done before a detailed comparison of the bee faunas of the three ranges can be made. The high frequency of orchid bees with pollinaria at Nassau is unusual, and may be linked to the habitat in which most sampling took place: the low elevation cloud forest of the submontane plateau.

It is recommended that rapid orchid inventories of Nassau and Lely are undertaken, in which herbarium specimens are collected as well as live specimens. Data resulting from these inventories should be processed together with existing data in relation to the Brownsberg. More orchid bee samples must be obtained form all three ranges, and the relationship between orchids and orchid bees at these ranges should be investigated.

Special protection should be given to the submontane habitats (400 m and higher) at all three ranges, most urgently so at Lely; representative parts of the Nassau and Lely ranges require a degree of protection. The Brownsberg submontane zone where a mining concession is located also requires adequate protection.

INTRODUCTION

The Orchidaceae – the orchid family – is the largest family of flowering plants in the world, with at least 20,000 species worldwide and 7,000 in the Neotropics (see Roubik and Hanson

2004), which amounts to about ten percent of all flowering plant species. For the Guianas (Guyana, Suriname and French Guiana), a total number of 328 orchid species has been recorded, which makes the orchid family the second most species rich vascular plant family of the region (Clarke et al. 2001). More than 300 species of orchids have been recorded for Suriname (Werkhoven 1986). This global, regional and national importance of the orchid family justifies its inclusion in a rapid biological and conservation assessment (RAP) of the Brownsberg, Nassau and Lely ranges in Suriname.

Another reason to include the orchids in surveys is because of their public appeal and economic importance, as obvious from the countless popular publications on orchids, a worldwide network of orchid breeders and enthusiasts, and the global trade in ornamental orchids. In Suriname too, orchids are popular and valuable: there is an orchid association, orchids are traded each week-end in the capital Paramaribo, and orchids feature in the popular flower arrangements and bouquets that are for sale in downtown Paramaribo.

The name orchid bee has its origins in the fact that male Euglossinae are specialized pollinators of a number of orchid species, especially those belonging to the Stanhopeinae and Catasetinae (van der Pijl and Dodson 1966). These orchids provide neither nectar nor pollen to their visitors, but concentrated fragrant chemicals which only male orchid bees seem to be interested in. These male bees may also be the exclusive visitors of the flowers of other orchids, such as *Vanilla, Cyrtopodium*, and *Lycaste*. Euglossinae (male and female) in addition visit the flowers of e.g. *Sobralia* and *Maxillaria* (see van der Pijl and Dodson 1966 and Roubik and Hanson 2004). Based on the above and the orchid species listings by Werkhoven (1986) and Chiron and Bellone (2005), at least 20% of the regional orchid species may be pollinated by Euglossinae, while 10% may strictly depend on pollination by male Euglossinae. The males of virtually all of the Euglossinae in turn depend on the flowers of orchids and a few unrelated plant taxa as a source of fragrant chemicals that they appear to need to establish territoria and/or mate (Roubik and Hanson 2004). The exceptionally strong interdependency between these bees and many of the orchids justifies a joint assessment.

Euglossine bees and orchids may be regarded as indicators of rainforest bee and plant diversity in the Neoptropics because they are archetypical, diverse and abundant Neotropical forest bees that visit, pollinate, and depend on a great variety of plant species (see Roubik and Hanson 2004, who e.g. list 68 plant families visited). They are an ideal group to be used for rapid assessments, since simple techniques exist to quickly get substantial samples of orchid bees: the males can be lured to chemical baits, at which they are easily trapped or captured with nets (Ackerman 1989, Roubik and Hanson 2004).

The Brownsberg, Nassau and Lely ranges are part of a system of ranges with ferro-bauxite encrusted plateaus. Such ranges may cover less than 0.5% of Suriname's land surface and may constitute a rare and endangered landscape type (ter Steege et al. 2005; see also chapter on the Biodiversity of the Brownsberg). The Brownsberg is the only of these ranges that enjoys any kind of protection, but it is being damaged by illegal gold mining, and its main submontane plateau remains a mining exploration concession. Other ranges, like Nassau and Lely, also feature mining exploration concessions and illegal gold mining, currently without the benefit of any protection at all.

During the RAP field work at Lely and Nassau, no sampling of orchids or orchid bees was undertaken. Nevertheless, it will be attempted here to assess the orchid and orchid bee diversity of the Brownsberg, Nassau and Lely ranges, based on the currently available information. A quick scan of the information at hand indicated that it was quite incomplete and unbalanced, so the focus here will necessarily be on a very general characterization of the Orchidaceae and Euglossinae assemblages of these ranges. Obvious differences between the three ranges will be highlighted, and recommendations as to research and conservation will be made.

METHODS

Records of the occurrence of orchid species were obtained from:

- dried herbarium specimens in the National Herbarium of Suriname (BBS);
- the review of Suriname orchids by Werkhoven (1986);
- botanical inventories by Banki et al. (2003), and ter Steege et al. (2004, 2005);
- a Brownsberg orchid inventory by Jan den Held (pers. comm.);
- unpublished observations at Browsberg by the junior author (Molgo);
- live specimens collected at Nassau in 2006, in the care of the junior author.

Live orchids were identified using the reference specimens and the taxonomic literature available to the junior author. All orchid species names were checked and updated using Werkhoven (1986), Boggan et al. (1997), Chiron and Bellone (2005) and the Electronic Plant Information Centre of the Kew Royal Botanical Gardens (see www.kew.org/epic/ accessed July 2006.)

Records of the occurrence of orchid bee species were obtained by processing samples and (re)identifying specimens in the National Zoological Collection of Suriname (NZCS):

- samples / specimens from Brownsberg collected prior to 2006
- samples obtained at the main plateau of Nassau in 2006

- samples obtained along the Tapanahony River near Lely in 2006 (samples were obtained near Diitabiki (Drietabbetje), across the Tapanhony River near Lely, but strictly speaking not at Lely itself; however, the Tapanahony is not assumed to be a barrier for orchid bee dispersal).

At all three ranges, bees were collected with bottle traps placed upright on the forest soil. Bottle traps are white plastic bottles of ca. 1 l with one or several openings cut in the side; the traps are made operational by pouring ca. 5-25 CC of lure chemical in the bottle, as well as at least 100 CC killing / conservation fluid (either a ca. 2% formaldehyde solution in water or pure "coolant" – an ethylene glycol solution). The Brownsberg samples were collected using bottle traps with vanillin and cineole (eucalyptol) as lure chemicals; the Nassau and Tapanahony samples were obtained using vanillin, cineole, eugenol and methyl salicylate. At Tapanahony and Nassau, additional bee specimens were collected at baiting stations by means of an insect net. At each station lure chemicals were poured on toilet paper that was suspended in the vegetation (the four chemicals mentioned above were used, and in addition skatole and p-dimethoxy benzene).

Orchid bees were identified using the taxonomic literature available to the senior author (De Dijn), the images of orchid bees of French Guiana on the Discover Nature (2006) website, reference specimens received from Roubik and Oliveira, and digital images of type material provided by Roubik. Notes were made of bee specimens carrying orchid pollinaria (i.e. typical orchid pollen "containers" which get attached to the body or appendages of orchid flowers visitor pollinators; see Roubik and Hanson 2004).

To characterize the orchid assemblages of Brownsberg, Nassau and Lely, the orchids were classified in function of the elevation range at which they are known to occur elsewhere, and the natural substrate on which they occur. The orchid species recorded were assigned to one of three elevation classes, based on the information contained in Steyermark et al. (1995a, b; info based on observations in the Guayana Shield territories of Venezuela): i) Low – only known from locations below 400 m, ii) High – only known from elevations of at least 400 m, and iii) Low-High – known from locations below 400 m as well as 400 m or more. The species were also assigned to classes in function of substrate (based on Werkhoven (1986), Chiron and Bellone (2005) and Molgo pers. obs.): i) epiphytic orchids – growing mostly on the stems, branches or other above-ground parts of woody plants, and ii) ground and epilithic orchids – growing mostly in soil or on rocky substrates at ground level. Orchid species for which information on elevation or substrate was lacking were not used in statistical analyses.

To investigate eventual differences between the ranges in terms of the proportions of species known from different elevation ranges and different types of substrates, test of independence were performed, based on two-way (R x C) tables and calculation of the G-statistic, as in Sokal and Rohlf (1995: Box 17.8).

RESULTS

A total of 190 species of orchids have been recorded from the three ranges, with 141 species recorded from Brownsberg, 70 from Nassau, and 96 from Lely. A list of all the species and their recorded occurrence can be found in Appendix 4. The most species rich genera are *Pleurothallis* (20 species), *Maxillaria* (20), and *Epidendrum* (15); together they represent 39% of the recorded species.

Figure 4.1 illustrates the overlap in recorded orchid species between the Brownsberg, Nassau and Lely ranges; 16% of the species are known to occur at all three ranges; 31% of the species are only known for the Brownsberg.

Table 4.1 shows the number of recorded species that could be assigned to different elevation classes. Based on this table, a (3 x 3) test of independence was performed, which yielded G = 4.01 (below critical value χ^2 .05[4] = 9.48773), meaning that there was no significant difference between the three ranges (at $p < 0.05$) in the proportion of species assigned to different elevation classes. However, there may be a trend in the data, with the proportion of species assigned to the High elevation class increasing from Brownsberg (29%), over Nassau (33%) to Lely (42%).

Figure 4.2 shows the number of recorded species that could be assigned to different substrate classes. Based on these numbers, a (2 x 3) test of independence was performed, which yielded G = 9.57 (above critical value χ^2 .05[2] = 5.99), meaning that there were significant differences between the three ranges (at $p < 0.05$) in the proportion of species assigned to different substrate classes. Further tests of independence between all possible pairs of ranges (2 x 2 tests; test results not presented here) indicate that the difference in the above proportion is significant only between Lely and Brownsberg and Lely and Nassau, which means that

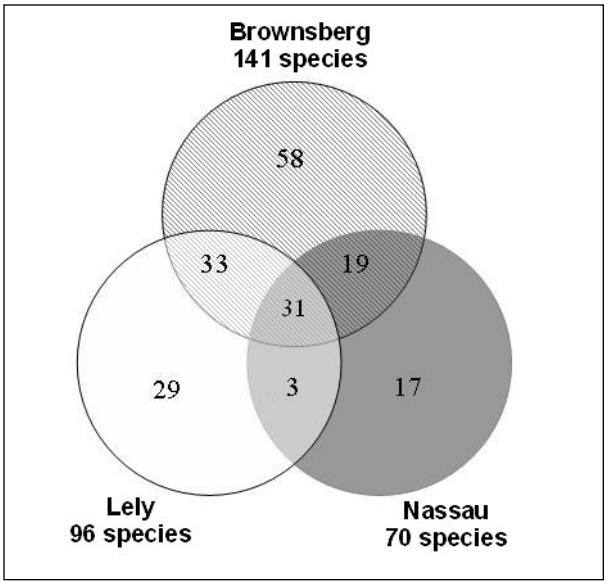

Figure 4.1. Overlap in orchid species composition between three ranges in Suriname.

Lely with 16% ground and epilithic orchids diverges from the other two, which each have 4-5% of such orchids.

Based on the list of recorded orchid species (Appendix 4), and the general information on orchid genera visited by orchid bees (see introduction), it can be concluded that: i) 10 of the orchid species (5%) at Brownsberg, Nassau and Lely are dependent on male orchid bees for pollination, and an additional 25 (13%) are probably pollinated by male and female orchid bees.

A total of 34 species of orchid bees was collected at the three ranges: 13 at Brownsberg, 22 near Lely and 23 at Nassau. The dominant genus was *Euglossa* (mostly small green or blue bees) with 27 species (Appendix 5).

The frequency of bees with orchid pollinaria was calculated on the basis of the bees collected at baiting stations with a net: near Lely 0 of 96 bees had pollinaria, at Nassau 9 of 69 bees. It is obvious that these frequencies are significantly different between the two sites. The bees with pollinaria were: *Euglossa analis* (2), *E. townsendi* (3), and *E. gaianii* (4); these three species represent 9% of the recorded bee species.

Two morphologically very different kinds of pollinaria (belonging to different orchid species; see examples in Roubik and Hanson 2004) were observed on these bees. A number of the bee individuals examined were carrying multiple pollinaria (as could also be observed in flight when the bees were attracted to the chemical baiting stations at Nassau; De Dijn pers. obs.).

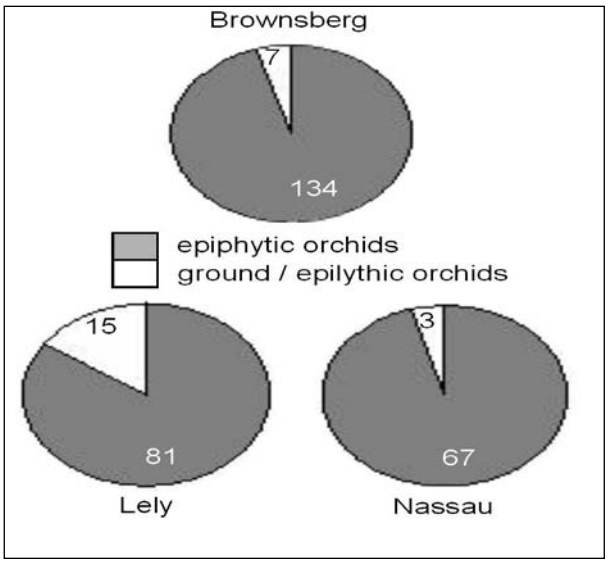

Figure 4.2. Number of orchid species recorded from three ranges in Suriname as a function of the substrate on which they usually grow in nature.

DISCUSSION

The high number of 141 species of orchids recorded at Brownsberg (almost half of the number of species known from Suriname) is no surprise, as this is the most accessible and by far the best investigated of the three ranges (see chapter on the Biodiversity of the Brownsberg). The lower orchid richness figures for Lely and Nassau can be regarded as artifacts of a lower collecting effort (Molgo and De Dijn pers. obs.). The limited overlap in species composition between the three ranges is surprising, given the great similarities in landscape and habitats; it may mean that many species are rare or hard to detect and collect, and that many more species remain to be recorded (at Nassau and Lely for sure, but possibly also at Brownsberg. Indeed, the unpublished Brownsberg orchid survey of den Held is relevant in this respect; when the survey data is transformed into a <randomized> species-effort curve, no obvious asymptote can be detected, suggesting that many more orchid species await discovery even at Brownsberg). When more collecting has been done at Nassau and Lely, the overlap in orchid species composition between the ranges can be investigated in earnest. The currently available information suggests that a number of orchid species that are very rare occur at these ranges, as for example the following species, each of which is only known from one location and from nowhere else in the Guianas: *Beloglottis costaricensis* (Brownsberg), *Cranichis diphylla* (Lely) and *Quekettia papillosa* (Nassau).

Using the Brownsberg orchid species richness result (141 species) as a yardstick, the comparison can be made with other well investigated sites in the region (based on listings in Bongers et al. 2001 and Clarke et al. 2001), such as: Saül (150 species) and Nouragues (68) in French Guyana, Kaieteur Falls (105) and Mabura Hill (109) in Guyana, and Reserva Ducke (79) in the Brazilian state of Amazonas. The Brownsberg is virtually on a par with Saül, these two sites having by far the highest recorded orchid species richness in the region. The low numbers for Reserva Ducke and Nouragues may be due to the fact that these are essentially

Table 4.1. Number orchid species recorded from three ranges in Suriname as a function of the elevation at which they are known to occur elsewhere.

Site (range)	Elevation class			Total no. of species
	Low below 400 m	Low-High below 400 m as well as 400 m or higher	High 400 m or higher	
Brownsberg	14	57	29	100
Nassau	9	23	16	48
Lely	7	28	26	61

lowland locations which lack extensive submontane habitats that seem to be particularly favorable for epiphytes, such as orchids (see also chapter on the Biodiversity of the Brownsberg). It should perhaps not be surprising that Saül and Brownsberg are so comparable in terms of orchid species richness: both areas are well sampled and contain an extensive submontane plateau with ferro-bauxite encrusted soil.

In the chapter on the Biodiversity of the Brownsberg (chapter 13), it is argued that 400 m is a useful cut-off point in the region under consideration, to distinguish between lowland and submontane habitats (in agreement with Steyermark et al. 1995a). Approximately 30-40% of the orchid species at the three ranges may be considered "highland" species, i.e. species that have been recorded in the Venezuelan Guayanas (where much research has been done) at 400 m of higher. Such a high proportion of highland species may be the characteristic that distinguishes these ranges with elevated plateaus from areas that are true lowlands, and may explain the high species richness: lowland and highland (submontane and montane) species coming together at these favorable locations. This would certainly merit further investigation, if alone to explain why the ranges in question may be orchid hot spots. In the Guianas, highland orchid species necessarily have a restricted, fragmented distribution, and may be rare; the submontane plateaus of Brownsberg, Nassau and Lely may be critical for the conservation of these species in the region.

The results on the proportions of ground and epilithic orchids, and of orchid species that are restricted to high elevations, suggest a trend and a quantum leap: i) a trend that the highland orchids become more important with the increase in height of the main plateau of the range, and ii) a much greater importance of ground and epilithic orchids at Lely, compared to the other two ranges. These matters would also merit further investigation, as they suggest that Lely may be the most divergent, unique and species rich of the three ranges. The special status of Lely is recognized by ter Steege and collaborators (2005), who mention the great extent of "moss forest" (low-elevation cloud forest with a high epiphyte load) with many orchids. Nassau should however not be underestimated as an orchid hot spot: in a single survey of less than three days (in 2006 by Molgo and De Dijn; unpublished), 32 species were recorded that were previously not known to occur at Nassau (including three species that were previously unknown from any of the three ranges).

The total number of orchid bees recorded from Brownsberg, Lely and Nassau is comparable to the total of 29 species collected at Bakhuis by means of bottle traps and four chemical lures (De Dijn in prep.). However, the number of species recorded at the different ranges is substantially lower (despite the use of six chemical lures at Nassau and near Lely), and suggests that at each range more sampling needs to be done; very little sampling has taken place at Brownsberg anyway. A detailed comparison of the bee faunas of the three ranges and other areas would not seem possible at this stage. It goes almost without mention that a reliable comparison will require that bee samples be taken at Lely proper, instead of nearby along the Tapanahony River.

The low frequency of orchid bees with pollinaria near Lely is unsurprising, but the high frequency (13 %) at Nassau is unusual, at least given figures of 1% and 5% quoted by Roubik and Hanson (2004). The high numbers of bees with orchid pollinaria at the main plateau of Nassau may be linked to the habitat and the timing of sampling: most of the sampling took place in low elevation cloud forest which is rich in orchids, and the timing of the sampling (April 2006) seemed to coincided with the flowering of a substantial number of orchids (Molgo and De Dijn pers. obs.).

The extent to which orchids and orchid bees actually interdepend at the community level remains a matter of discussion (see Roubik and Hanson 2004), and the data presented here suggests that: i) some 18% of the orchid species of Brownsberg, Nassau and Lely may be pollinated by orchid bees (some 5% exclusively so), and ii) that at least 9% of the orchid bee species may actually pollinate some of these orchids. While the former is in line with expectations (see introduction), the latter is less so (see Roubik and Hanson 2004, who conclude that about half of the species in an Euglossine assemblage carry pollinaria and pollinate orchids), and would seem to be an artifact of much too limited sampling and a total lack of observations of bees visiting orchid flowers at the three ranges under consideration.

RECOMMENDATIONS

It is recommended that rapid orchid inventories of Nassau and Lely are undertaken, in which herbarium specimens are collected as well as live specimens. The latter can be maintained alive in Paramaribo, at least until they produce flowering parts, which are essential to identify the species. Special attention should be given to the investigation of the habitats of highland species and ground and epilithic orchids. The data resulting from these inventories should be processed together with data of den Held in relation to the Brownsberg; collaboration with den Held should be sought to complete analyses. Based on the results, a more detailed comparison between the ranges would be possible, as well as a comparison with other ranges and lowland locations in the region. Based on the additional inventory data and flora comparisons, the status of regionally and nationally rare orchid species must be investigated, especially of those species that are at present only known from the three ranges. Habitats where rare orchids occur should be identified, and measures should be taken to protect them in their native habitats.

The relationship between orchids and orchid bees at these ranges requires further investigation, especially in relation to those orchid and bee species that can be assumed (based on the literature and the data presented above) to be interdependent. More orchid bee samples need to obtained during rapid assessments, at all three ranges (especially at Brownsberg and Lely), and notes should be made on the orchid pollinaria these bees are carrying. The unusually high

frequency of orchid bees with pollinaria recorded at Nassau requires further investigation; there may be an especially significant interaction between orchid bees and orchids at these ranges, at least in special habitats such as low elevation cloud forest. This interaction may only be apparent when sampling or observations are done at specific times of the year, and if so, would require monitoring. Targeted studies of the pollination and seed set with rare orchids at these ranges may be required, e.g. to assess their level of dependency on specific pollinators and their vulnerability to local extinction.

Ahead of the results of proposed further assessment and monitoring studies, special protection should already be given at this stage to the submontane habitats (400 m and higher) at all of these ranges, most urgently so at Lely. Protection is required because: i) the very high orchid species richness of the ranges is no doubt due largely to the presence of highland orchid species in the submontane forest habitats these would seem to require, and ii) each of the ranges appears to be unique in terms of orchid species composition, e.g. at each range occurs at least one orchid species that is known from nowhere else in the Guianas. Lely would merit urgent conservation action because: i) it proves to have high numbers of highland orchid species and ground and epilithic orchids that may be associated with vulnerable submontane habitats, and ii) its submontane habitats are presumably pristine – due to poor accessibility – and characterized by a high degree of functional integrity that may however be negatively affected as soon as the area becomes more accessible, e.g. as a result of renewed mining exploration. Habitats other than submontane ones may also be important for orchids and orchid bees, and it would thus be sensible to work towards the protection of representative parts of the Nassau and Lely ranges, ensuring the protection of a substantial portion of all habitats. At Brownsberg some degree of protection is already in place, but the matter of the SURALCO mining concession that covers most of the submontane zone should be addressed soon, as this zone requires more adequate protection.

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Chapter 5

Ants of the leaf litter of two plateaus in Eastern Suriname

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INTRODUCTION

Due to rapidly declining diversity and disappearing habitats worldwide, systematists and ecologists have created a series of protocols to rapidly explore, understand, and catalogue our planet's extensive living resources. Invertebrates are an important component of the trophic structure of every ecosystem. Among all the invertebrates that live in the forest, ants possess numerous qualities that make them a cornerstone element for conservation planning. Ants are: 1) dominant constituents of most terrestrial environments, 2) easily sampled in sufficiently statistical numbers in short periods of time (Agosti et al 2000), 3) sensitive to environmental change (Kaspari and Majer 2000), and 4) indicators of ecosystem health and of the presence of other organisms, due to their obligate symbioses with plants and animals (Alonso 2000). For these reasons ant taxonomists, ecologists, and behaviorists created the Ants of the Leaf Litter protocol (A.L.L) (Agosti and Alonso 2000). A.L.L is a standardized methodology that can be easily repeated in different habitats at different times of the year (Agosti et al. 2000). Under this protocol different datasets can be combined and analyzed at a larger scale.

The ant fauna of Suriname remains unknown. Borgmeier (1934) reported 36 ant species from a study of the ants in coffee plantations in Paramaribo; Kempf (1961) studied the ant fauna of the soil from collections made by der Drift from April to October of 1959. In his study Kempf found 171 ant species belonging to 59 genera. In that survey, der Drift used pitfall traps, leaf-litter samples using Berlese funnels, and soil samples from primary forest, agricultural fields, and pastures. Previous censuses of the Neotropical ant fauna by Kempf (1972), Brandao (1991), and Fernandez and Sendoya (2004) recognize 290 species for Suriname. The new world tropics is known to contain one of the richest ant faunas in the world, with more than 3000 described species (Fernandez and Sendoya 2004), As sampling becomes more exhaustive, this number continues to increase. The La Selva Biological Station provides an instructive example. As a result of more than ten years of continuous sampling, La Selva accounts for almost 450 species (Longino et al. 2002).

Suriname's position within the Guiana Shield, considered the largest undisturbed region of tropical forest in the world, makes it one of the most important places for tropical forest conservation and sustainable development. The most important and urgent threats faced by Suriname are: 1) large-scale (bauxite and gold) mining, 2) small-scale gold mining, 3) large-scale logging, and 4) hunting. As pointed out by Haden (1999) the principal cause of deforestation and pollution is mining at both large and small scales. The extraction of gold is associated with water poisoning due to the large quantities of mercury or cyanide used. Common techniques to extract gold (i.e., suction-dredge placer and hydraulic) are responsible for erosion, siltation, and water turbidity (Haden 1999). This increasing pressure from mining and other resource-extraction industries threatens the pristine nature not only of Suriname but of the entire Guiana Shield.

I present the results of a rapid assessment program survey of the ant fauna that inhabit the leaf litter, hoping that the information presented here will inform critical conservation decisions by mining companies, governments, and individuals.

MATERIALS AND METHODS

Study sites

The Lely and Nassau plateaus are located in eastern Suriname on the Guiana Shield near the border with French Guiana and east of the man-made Lake Brokopondo, created in 1864 and swamping about 580 square miles of virgin rainforest.

The Lely Mountains comprise a series of plateaus with a maximum altitude of 700 m. A preliminary plant survey of the Lely Mountains (ter Steege et al. 2004) showed two types of forest. The first is a high mesophytic rain forest characterized by relatively well-drained soil and high (25 – 50 m) closed canopy. This type of forest is dominated by tree-species within the genera *Eschweilera, Couratari, Lecythis, Sloanea, Hymenaea, Virola,* and *Qualea*.

The second type of forest, a mountain savannah forest, is characterized by very low tree diversity. The mountain savannah forest was divided into three subcategories by ter Steege et al. (2004): 1) a dry forest dominated by *Croton* sp., *Micrandra brownsbergensis, Vriesea splendes*, and large numbers of species within the family Myrtaceae; 2) a humid type dominated by *Vriesea* spp., mosses, and epiphytes; and 3) a low moss forest with all tree trunks covered by dark brown mosses.

The Nassau Mountains comprise four plateaus ranging from 500 to 570 m. Nassau plateaus include primary and secondary rain forest, 'berg savannah' dominated by *Hevea guianensis, Micrandra* sp., and several Myrtaceae species (Banki et al. 2003), and limited patches of *Euterpe oleracea,* a palm found on the plateau in swamp-like areas. Nassau is also characterized by rocky soils and some cleared areas (roads and an overgrown airstrip).

Data collecting

The sampling method carried out is a modified version of the A.L.L. protocol as described in Agosti et al. (2000). Two hundred-meter linear transects were delimited at each locality (Lely= 2 transects, Nassau= 1 transect). A 1 x 1-m quadrat was set up every 10 m. The leaf-litter, rotten twigs, and first layer of soil present in the quadrat were shaken for about a minute using a wire sieve of 1-cm^2 mesh size. The sifted leaf litter was then placed in a mini-Winkler sack and allowed to run for 48 hours. (For further information and discussion of this technique, see Agosti et al. 2000: p. 133.) The alcohol-preserved samples were sorted to morphospecies in the laboratory using a Leica MZ16 stereomicroscope. Specimens of each morphospecies were mounted and identified to named species whenever allowed by current ant taxonomy.

Data analysis

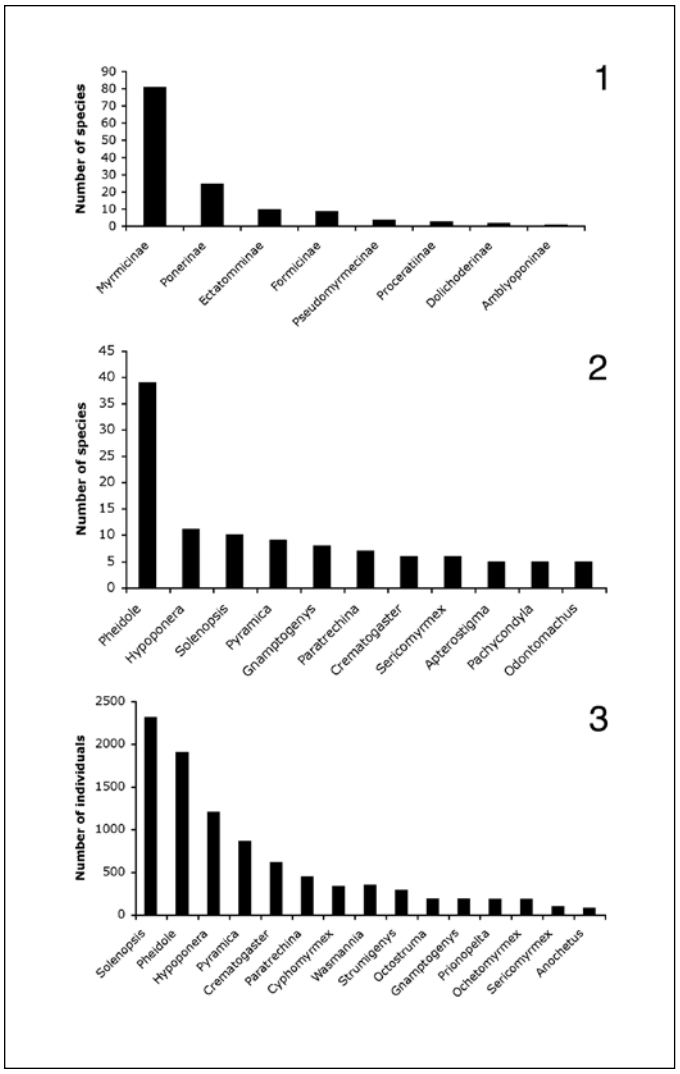
The computer program EstimateS (version 7.5 for Mac) (Colwell 2005) was used to calculate species accumulation curves. Curve-smoothing was accomplished by randomizing sample order 100 times (Toti et al. 2000; Colwell & Coddington 1994). EstimateS was also used to compute the mean of the non-parametric species richness estimator, ICE (incidence-based coverage estimator), which relies on incidence data to quantify rarity (i.e., the number of uniques and duplicates). To compare the taxonomic composition of both sites, two similarity indexes were used. The first was the Sorensen index of similarity:

$$S = 2c/(a+b)$$

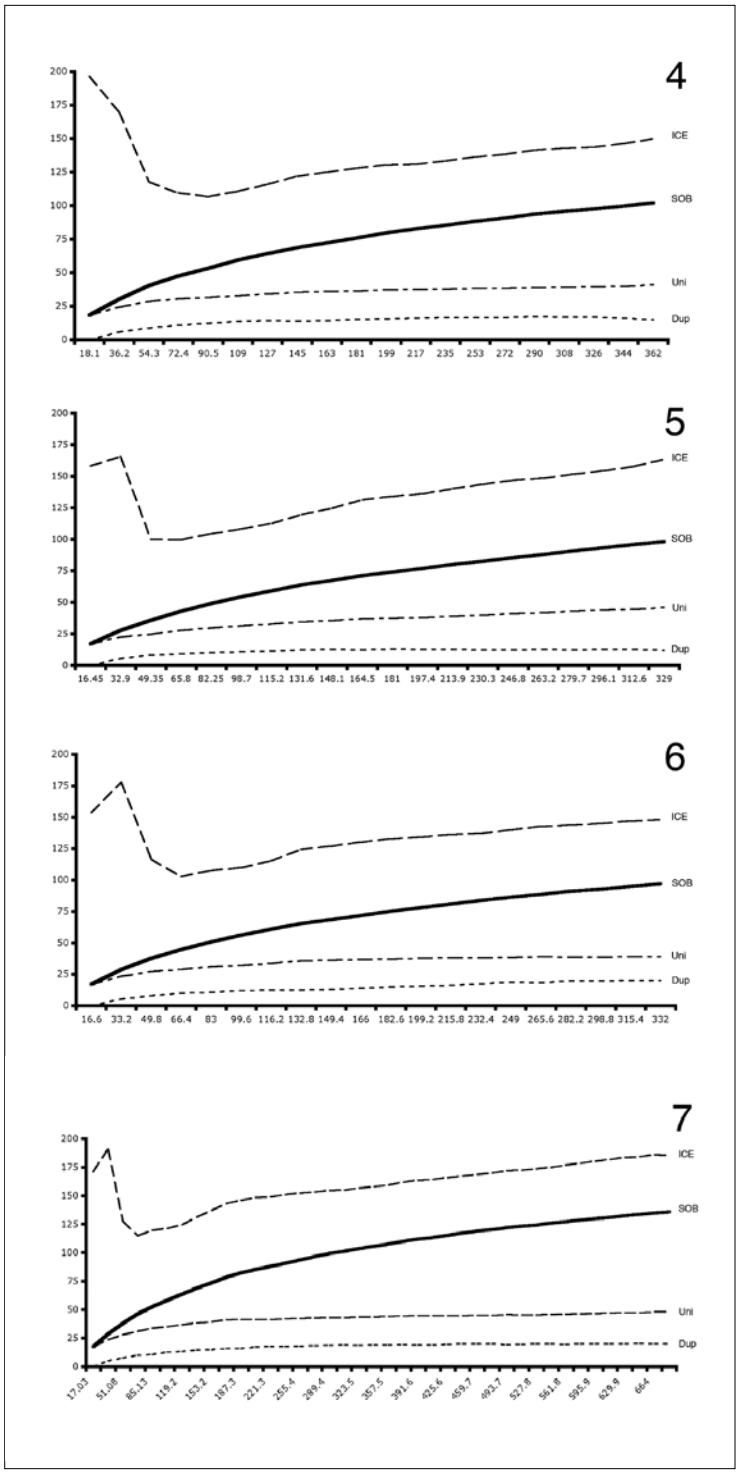
where, a= number of species in site A, b= number of species in site B, and c= number of shared species in sites A and B. This index is considered as one of the most effective presence/absence similarity measures (Magurran 2003). The second index employed was the Jaccard classic index:

$$Sj = c/a+b-c$$

where, a= total number of species in sample A, b= total number of species in sample B, c= number of common species to sample A and B (Wilson and Shmida 1982).



Figures 5.1 – 5.3. Taxonomic composition of the survey: 1) Total number of ant species in the different subfamilies collected at both sites. 2) The eleven most speciose ant genera collected at both sites. 3) The fifteen most individual rich genera collected at both sites.



Figures 5.4 – 5.7. Assessment of the leaf litter ant inventory for each site. 4) Lely transect 1; 5) Lely transect 2; 6) Nassau; 7) Combined Lely transects. The species accumulation curve plots the number of species (Y-axis) and the number of samples (X-axis). Abbreviations: Uni= uniques, Dup= duplicates, SOB= species observed, ICE= incidence-based coverage estimator.

RESULTS

A total of 9838 individual ants was collected. Of those 9838 individuals, 9651 worker specimens, representing 36 genera and 169 species, were collected from 600 m^2 of leaf-litter samples (Appendix 6). Of those 169 species, the combined transects at Lely accounted for 136 species while Nassau accounted for 97 species. The subfamily Myrmicinae (Figure 5.1) was represented by the largest number of species with 81 species, followed by the Ponerinae with 25 species (48% and 15% of the total species, respectively). The most speciose genus (Figure 5.2) was *Pheidole* with 39 species (23% of the total) followed by the genera *Hypoponera* (11 species), *Solenopsis* (10 species), *Pyramica* (9 species), and *Gnamptogenys* (8 species), the four genera together accounting for 21.9% of the total. The ranking of the genera changes with respect to the number of individuals collected (Figure 5.3) with *Solenopsis* ranking first (2316 individuals, 24% of total), followed by the genera *Pheidole, Hypoponera,* and *Pyramica* (1904 [19.7%], 1201 [12.4%], and 862 [8.9%] individuals, respectively). Among species, *Solenopsis* sp. 001 accounted for the largest number of individuals with 797 specimens collected, followed by *Pyramica denticulata* (667 individuals), and *Pheidole* sp. 006 (463 individuals). See photo pages for images of several of the ant species.

Species richness estimates

For none of the three transects (Lely = 2 and Nassau = 1) individually, nor for the combined Lely transects, does the mean, randomized, or observed species accumulation curve reach an asymptote (Figures 5.4 – 5.7). The number of uniques (species detected in only one quadrat) and duplicates (species detected in only two quadrats) for Lely tend to reach a plateau or to slightly decrease. In Nassau, however, the number of uniques has stabilized, while the number of duplicates is increasing. When both Lely transects are combined, the number of uniques and duplicates reaches a plateau. The species estimator, ICE, for the combined Lely transects presents a slightly tendency to decrease and to approach the observed species accumulation curve. However, for each of the individual transects the species estimator continues increasing, suggesting that more sampling is needed. Lely, with 136 species, possessed the richest ant fauna of the survey. In only one transect, 102 species were collected. For Nassau 97 species were recorded from a single transect. Although, this could be an artifact of collection intensity (two entire 200 m transects of leaf litter samples were collected at Lely while a unique entire 200 m transect was carried out at Nassau), previous studies of the diversity of the flora for both sites shown have shown that Lely present a higher diversity while Nassau presented the lowest (including Brownsberg National Park).

Richness estimates and other summary values for each

transect, including the combined Lely leaf-litter sample, are given in Table 5.1. Each richness estimate is represented by the mean of 100 randomized iterations of sample order.

Community structure

Values of the Sorensen similarity index and the Jaccard classic index (Table 5.2) show that the two communities (Lely vs. Nassau) differ slightly in ant species composition. Both transects at Lely share 64 species, while comparisons between transects 1 and 2 with Nassau showed a lower number of species shared (54 each). When both Lely transects are combined and compared with Nassau, the number of shared species shared between Lely and Nassau increases to 66. However, the similarity value of each index shows slightly low complementarity between both sites. Based on the values of the indices none of them approach to 1, with exception of Lely 1 to Lely 2 (Sorensen=0.637; Jaccard= 0.467).

DISCUSSION

According to the censuses of Neotropical ants by Kempf (1972) and Fernandez and Sendoya (2004), Suriname possesses about 290 species. There have been few attempts to study the ant fauna of Suriname. Borgmeier (1934) reported 36 ant species in coffee plantations in Paramaribo, while Kempf (1961) reported the presence of 171 species (54 genera) from primary forest, plantations, and pastures. Most of the ant collections in the interior in Suriname occurred sporadically from 1938 – 1958, mainly by G. Geyskes in Paramaribo and Brownsberg Nature Park. This survey conducted in the eastern part of Suriname recorded 169 ant species and morphospecies from three 200-m leaf litter samples. Species richness estimators (Figures 5.4 – 5.7) suggest a much higher ant diversity for Suriname than suggested by any of the aforementioned studies. More leaf litter samples from different localities within the country are needed to properly estimate Suriname ant diversity and address future conservation strategies. Suriname's central position within the Guyana Shield, an ancient rock massif dating back to the Pre-Cambrian (~ 2.5 billion years ago) (Gibbs and Barron 1993), recommends it for biological resource conservation and sustainable development.

This dataset contains a high number of unnamed morphospecies, making it difficult to quantify the number of species that were not recorded by Kempf (1972) or Fernandez and Sendoya (2004), but perhaps half of the species in this study constitute new records for Suriname. Of all ecological communities, tropical rain forests are thought to have the greatest species diversity. In Costa Rica, for example, Longino et al. (2002) reported about 450 ant species in an area no greater than 1500 ha (La Selva Biological Station). LaPolla et al. (in press) recorded 230 species in eight localities in Guyana and estimated a much higher ant diversity than the 330 species previously known for that country. Other surveys conducted in Borneo (Brühl et al. 1998) and Madagascar (Fisher 1999, 2005), with extensive field sampling over several years, have shown that the number of ant species is usually undersampled. Based on these studies, extensive fieldwork will undoubtedly increase the number of ant species in Suriname.

The absence of some ants that are known to be typical leaf-litter inhabitants, but that were uncommon in this data-

Table 5.1. Richness estimates and other summary values for each locality.

	Lely	Lely 2	Nassau	Lely (combined)
Observed richness	102	98	97	136
Number of samples	20	20	20	40
Number of adult workers	2384	2392	4425	5226
Number of uniques	41	46	39	48
Number of duplicates	15	12	20	20
ICE	149.82	163.14	147.96	185.42
Chao 1	153.25	177.62	132.29	189.71
Chao 2	150.69	173.63	130.52	188.37
Jacknife	140.95	141.7	134.05	182.8
Bootstrap Mean	119.14	116.45	113.93	156.74
MM Mean	130.77	127.16	126.51	159.36

Table 5.2. Number of shared species and values of similarity indices for the two sites (three transects) in Suriname. See text for definition of indices.

	Lely to Lely 2	Lely to Nassau	Lely 2 to Nassau	Lely total to Nassau
Number of shared species	64	54	54	66
Sorensen's similarity index	0.637	0.545	0.554	0.564
Jaccard's similarity index	0.467	0.375	0.383	0.392

set, may be due to an artifact of the sampling method used. For example, at Lely, the genera *Pheidole* and *Camponotus* were found everywhere in high numbers by hand collecting. However, the genus *Camponotus* was not collected in any of the 60 quadrats sampled, perhaps due to their rapid escape response and to the fact that they nest in trees and in rotten logs rather than in the soil or litter. The species *Daceton armigerum* and *Gigantiops destructor* were hand collected in Lely and Nassau, respectively. Again, neither of these was present in the Winkler samples. *Daceton armigerum* is known to be arboreal, so its capture in leaf litter sampling is unlikely. *Gigantiops destructor*, on the other hand, is a typical inhabitant of the leaf litter. Their big eyes give them a highly visual ability, which combined with their quick speed and jumping ability, make their capture in leaf litter quadrats unlikely.

The species *Wasmannia auropunctata* can be abundant in either primary forest or young second growth, although it is perhaps most abundant in disturbed habitats. This species is known to be an important agricultural pest in several regions of the tropics because of its strong sting. The species *Wasmannia scrobifera* while infrequently collected, is known to be more typical of mature lowland rainforest.

The genus *Pheidole* is the most speciose genus at both sites. *Pheidole* represents 23% of total ant species collected in this survey (with 39 species), while the genera *Hypoponera*, *Solenopsis*, *Pyramica*, and *Gnamptogenys* together counted for almost 22% of total species collected (with 11, 10, 9, and 8 species, respectively) (Figure 5.2). The taxonomic dominance of *Pheidole* in most tropical forests is well known (Ward 2000, Wilson 2003). Nonetheless, in terms of the number of individuals collected per genera, *Pheidole* drops to second place with 1904 individuals. The genus *Solenopsis* ranked first with 2316 individuals collected. The genus includes the famous invasive species *S. geminata* and *S. invicta* (fire ants), of great economic importance in the United States. In spite of its widespread distribution, the genus has not been taxonomically revised and the biology of many of its species remain unknown. Another ecologically dominant genus in Neotropical rain forests is *Hypoponera*, a prime candidate for conservation planning and long-term monitoring. However, the number of species recorded here is perhaps underestimated due to the lack of a synoptic revision.

The tribe Dacetini, which was recently revised by Bolton (2000), is represented in Suriname by four genera, *Acanthognathus, Daceton, Pyramica,* and *Strumigenys*. According to Kempf (1972), Bolton (2000), and Fernadez and Sendoya (2004) this represents the first record of the genus *Acanthognathus* for Suriname. Within the genus *Pyramica*, there are five species that are recorded for the first time for Suriname: *P. auctidens* (known previously from French Guiana), *P. beebei* (known from Colombia and Brazil), *P. cincinnata* (known from Brazil), *P. crassicornis* (known from Trinidad and Tobago to Paraguay), and *P. halosis* (known previously from Venezuela). Within the genus *Strumigenys*, two species were recorded for the first time: *S. cosmostela* (known from Mexico to Peru, including Brazil) and *S. trinidadensis* (known previously from Costa Rica to Brazil). A possible new species within the genus *Pyramica* was also collected. Members of the Dacetini tribe are good tools for biodiversity planning. Their biology is relatively well- known, their taxonomy has been recently revised, and their diet is restricted to arthropods that inhabit the soil.

The recently described genus *Cryptomyrmex* Fernandez (Myrmicinae: Adelomyrmicini), known from only two species from Brazil and Paraguay, was collected in Nassau. The species, *Cryptomyrmex longinodus*, was originally described from Brazil from soil samples (see photo pages). Here, the distribution of the species and genus is extended. The biology of this intriguing ant remains unknown. The genus can easily be confused with *Adelomyrmex*, but close examination of the specimen reveals differences in the petiole and eyes, visible under light stereomicroscope, but not visible under Scanning Electron Micrography (SEM) (Fernando Fernandez, personal communication).

Lely contained the most ant species in this survey. The combined transects produced a total of 136 species, while in Nassau 97 species were recorded. This difference could be due to the number of transects and samples collected (2 transects, 40 samples for Lely vs. 1 transect, 20 samples for Nassau). However, the level of disturbance seems to be lower in Lely than Nassau, where open roads, camps, mining, and hunting activities have resulted in a low animal population (ter Steege et al. 2005). The results of this survey with those of ter Steege et al (2004, 2005) and Bánki et al. (2003), which compared the plant diversity of three areas, including Brownsberg Nature Park (BNP), Lely, and Nassau. Those studies concluded that Nassau has the lowest plant diversity of the three, while Lely is the most diverse.

Similarity indices (Jaccard and Sorensen), although low, showed that the two samples within Lely are more similar than either one is to Nassau (Table 5.2). When the combined Lely samples are compared to Nassau, the number of shared species between the two increases to 66, but the indices still suggest a low similarity.

CONSERVATION RECOMMENDATIONS

With most of its landscape still intact, the time for Suriname to take action is now, before deforestation and mining become more widespread. Although the extraction of some natural resources is certain to happen, the rich fauna and flora of Suriname can be preserved with planning and with the creation of protected areas, such as the Central Suriname Nature Reserve. As demonstrated by Agosti et al. (2000), ants of the leaf litter are important tools for conservation planning. The impact of logging, mining, and hunting on the physical environment and on the ant community is severe. Ants are known to respond negatively to the loss of plant diversity and to changes in soil microclimate resulting from deforestation (Underwood and Fisher 2006). Although deforestation is not yet widespread at Lely or Nassau, I recommend the maintenance of large areas of intact primary

forest to serve as reservoirs of keystone species.

As pointed out by ter Steege (2005), the constant pressure from mining activities in the surrounding areas of Nassau has resulted in a very low animal population. Hunting accompanies small-scale mining. As seen in Lely, the pressure of such activity on mammals and birds is shocking. It is imperative that local people be educated to properly use their natural resources. The impact that only a few people can have on the environment was evidenced in Lely, where small mammals, birds, and monkeys, among others, where found dead near the trails used by the local airstrip work crew.

The conservation of these still healthy forests should be a principal goal for the government, the mining companies, and the Surinamese people. One of the largest and richest remnants of pristine forest in the world is still intact within Suriname's borders, but it is largely threatened by uncontrolled logging, hunting, and mining. Thus, the application of high environmental standards to resource extraction companies and strong sanctions on illegal resource exploitation are needed in order to help to preserve the great diversity of the Guiana Shield in Suriname.

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Chapter 6

Dung Beetles of Lely and Nassau plateaus, Eastern Suriname

Trond Larsen

INTRODUCTION

Dung beetles (Insecta: Coleoptera: Scarabaeidae: Scarabaeinae) are frequently used as a focal taxon in biodiversity studies for several reasons (Larsen and Forsyth 2005). Dung beetles are a diverse and abundant group of insects, especially in tropical forests, and their diversity patterns often mirror those of overall biodiversity. Most dung beetle species have small distributional ranges and high Beta-diversity, with relatively few species shared between habitat types (Spector 2002). Dung beetles are very sensitive to many kinds of disturbance. Since they depend primarily on mammal dung for food and reproduction, dung beetles may be a good indicator of mammal biomass and hunting intensity. By burying vertebrate dung, beetles perform several important ecosystem functions, including recycling nutrients for plants, dispersing seeds, and reducing infestation of mammals by parasites (Mittal 1993, Andresen 2002). Finally, dung beetles are a tractable group to study because they can be rapidly and cheaply sampled in a standardized and non-biased way using transects of baited pitfall traps (Larsen and Forsyth 2005). Within just a few days, this trapping method usually captures the majority of Alpha-diversity and also yields good abundance data.

METHODS

I sampled dung beetles at Lely and Nassau plateaus in eastern Suriname using pitfall trap transects. Ten traps baited with human dung were placed approximately 150 m apart at each site and collected every 24 hours for four days (see Larsen and Forsyth 2005 for methodology details). Each trap consisted of 16 oz plastic cups buried in the ground and filled with water and liquid detergent. Bait was suspended above the cups wrapped in nylon tulle and covered with large leaves. Human dung baits were replaced every two days. Since some dung beetle species feed on other resources, additional traps were baited with rotting fungus, rotting fruit, and dead insects. At Nassau, I placed two flight intercept traps consisting of mosquito netting with soapy water beneath. These types of traps often passively catch dung beetle species not attracted to baits.

At Lely, 11 traps were placed from October 27-31, 2005 in primary forest that varied in canopy height and in plant species composition depending on the soil, with small, short trees dominating in more rocky areas. In addition, three traps were placed from October 27-29; one trap was placed in the grassy airstrip, one in secondary forest at the edge of the airstrip, and one in a weed-filled clear-cut area surrounding a radio tower. One trap baited with dead insects and one trap baited with rotting fungus were also placed in primary forest. At Nassau, 10 traps were placed from November 2-6, 2005 in the same general forest type as at Lely, although in many places the forest was taller and showed a wetter forest floor with greater leaf litter decomposition. Two flight intercept traps, one trap baited with dead insects and one trap baited with rotting fruit were also placed in primary forest. Beetles were sorted and identified as they were collected, and vouchers were placed in alcohol for further identification and museum collections.

To determine the completeness of faunal sampling at each site, I compared the observed number of species to the expected number of species based on randomized species accumulation curves computed using EstimateS (Colwell 2003). I used the abundance-based coverage estimator (ACE) because it accounts for species abundance as well as incidence. Similarity indices were calculated using the same software.

RESULTS

I found a total of 42 species from both sites, represented by 1,110 individuals (Appendix 7). Lely had 37 species and 906 individuals, while at Nassau, I captured only 27 species and 204 individuals. Comparing only standardized dung pitfall transects from primary forest between the two sites, Lely had 33 species and 21.2 individuals/trap, while Nassau had 24 species and 4.3 individuals/trap. Species richness estimators (ACE) based on species accumulation curves from dung transects in primary forest predict true species richness of 39 species for Lely and 29 species for Nassau (sampling was about 85% complete for both sites). Both sites appeared to have hunting pressures that are likely to have negatively impacted dung beetle species richness and abundance, but Nassau appeared to have the strongest hunting pressure and the lowest beetle species richness and abundance. Dung beetle abundance at Nassau may also have been negatively affected by a large open cesspool near the basecamp. Even though Lely contained more dung beetle species, the dung beetle species composition of primary forest at the two sites was fairly similar. The sites shared 18 species and showed a high Morisita-Horn similarity index of 0.93.

At Lely, only three individuals of one species, a grassland specialist, occurred on the airstrip. I only found four individuals of one species on the secondary forest edge, and no dung beetles at all in the weedy clearing. Dead insects attracted two species, while no species were attracted to fungus. One species (*Anomiopus* spp.) was only hand-collected on a leaf. A second species of *Anomiopus* was collected in a flight intercept trap at Nassau, as well as six other species. At Nassau, dead insects attracted seven species and fruit attracted none. One species was only hand-collected at felid scat.

Both sites were characterized by hard, dry and rocky soils which may make it difficult for many dung beetle species to dig burrows for food and nesting, and may also increase larval mortality (Sowig 1995). This may be one reason why overall dung beetle abundance was much lower at both sites than for almost all other tropical forests where I have sampled dung beetles.

Interesting Species

While identification to the genus level is relatively simple, the taxonomic status and lack of identification keys for Neotropical dung beetles makes it difficult to place many species names, especially without comparing specimens against multiple museum collections. Nonetheless, I estimate that about 20-30% of the species collected are undescribed. The genera *Anomiopus*, *Ateuchus*, *Canthidium* and *Uroxys* are likely to contain the most undescribed species. A few species appear to have wide geographical ranges and are also found in the southern Amazon, although most species probably have relatively restricted ranges. A paucity of existing dung beetle data from nearby sites makes evaluation of range size difficult.

At Lely, dead insects attracted one individual of *Coprophanaeus lancifer*, the largest species of neotropical dung beetle. This metallic blue species is highly valued for its impressive size and beauty, and the long horns possessed by both sexes. Both species of *Anomiopus* are likely to be undescribed. Species in this genus have never been attracted to baited traps, and their natural history is completely unknown, although their compact morphology suggests an association with ant nests observed for other genera. In most sites I have sampled in the neotropics, I have observed species of *Canthidium* which appear to be Batesian mimics of species in the ball-rolling tribe Canthonini, although to my knowledge nothing has been published about this. Almost all canthonines secrete a foul smelling chemical when handled, while *Canthidium* species, which are tunnellers rather than ball-rollers, do not. At Lely, *Canthidium* sp. 1 possesses the identical yellow and brown coloration pattern, including an unusual pronotal stripe, shown by *Scybalocanthon cyanocephalus*.

THREATS AND RECOMMENDATIONS

The greatest threats to dung beetle communities are logging and hunting, and dung beetles are known to be especially sensitive to fragmentation. Even slight perturbations of the forest are known to strongly affect dung beetles (Davis et al. 2001). At Lely, clear-cut areas and early secondary vegetation contained only two dung beetle species at extremely low abundance. Dung beetle communities at both sites are probably suffering from hunting, although the strongest hunting pressures are likely occurring from gold-miners at Nassau where dung beetle abundance was the lowest I have ever observed. A large open cesspool at Nassau may also be killing many thousands of dung beetles that are continuously attracted and drowned. An underground sewage system would not only spare many dung beetles, but would also make the area more pleasant for people.

Although deforestation is still not widespread at either site, it is important to maintain large areas of intact primary forest in the future in order to maintain intact communities of mammals and dung beetles. I have found that some dung beetle species require more than 85 ha of continuous forest, and that many species will not cross even short distances of clear-cut forest such as to cross roads. I observed indications already at Nassau of a recently created dense network of roads that are fragmenting the forest so severely that the

vegetation is being altered, and the dung beetles will also be strongly affected. I also observed no mammals in these strongly fragmented areas. Hunting is currently the greatest threat to dung beetles at both sites, but especially at Nassau. Stricter regulations and enforcement of hunting practices could make a big difference to dung beetles as well as mammals. Preventing what appears to be widespread hunting within the BHP concession at Nassau should be a first priority. Although fewer people live in the Lely area, hunting pressures are still strong, and incentives should be made for the workers to minimize hunting, especially of species which they are not killing for food. Maintaining healthy mammal and dung beetle communities will be especially important for maintaining primary and secondary seed dispersal which is essential for plant regeneration and forest dynamics (Larsen et al. 2005).

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Chapter 7

A rapid assessment of the birds of the Lely and Nassau plateaus, Suriname

Iwan Derveld and Greg Love

INTRODUCTION

Suriname has over 700 recorded species of birds, making them a rich and diverse taxonomic group for the country. Many of the species found in Suriname, such as the harpy eagle and blue-cheeked parrot, are included in the IUCN Red List as near threatened species. Given the many roles that birds play in tropical ecosystems, serving for example as predators, prey and seed dispersers, it is important to promote their conservation. In addition to their conservation value, a rich and diverse bird population can also provide economic value through the promotion of bird watching tourism. To date, few bird species list exist for the Lely and Nassau Mountains, so CI felt that a rapid assessment of the bird populations would add to a greater understanding of the overall species richness and diversity of the two study areas and facilitate the creation of concrete conservation recommendations.

METHODS AND DESCRIPTION OF STUDY SITES

For both sites, the bird team, which consisted of 2-3 people, spent 7-9 hours a day spotting birds through both visual identification and by birds' songs and calls. The team leader was Iwan Derveld, a Surinamese national with over 30 years experience in bird identification. All team members used binoculars for visual identification. The field guides "Birds of Suriname" (Haverschmidt et al. 1994) and "The Birds of Venezuela" (Hilty 2003) were used to confirm the identification of many of the species not immediately recognized by the team.

In Lely, the team primarily concentrated on two transects which ran parallel to one another from October 25-31, 2005. On the plateau are two radio towers approximately 500 meters apart. The majority (>90%) of all birds were spotted in Lely were in the cleared areas around the radio towers, as well as in the high forest between the towers and the cleared airstrip parallel to the towers. The bird team also spent half a day accompanying the fish team to spot birds along a watershed area (N04º15'08.9",W054º43'54.8") that included high and savanna forests. Another half day was used to spot birds along a 4 km path in the vicinity of the dung beetle survey area, dominated by high forest.

In Nassau, from November 2-6, 2005 the bird team concentrated efforts along concession roads on either side of BHP-Billiton's exploration base camp and the adjacent overgrown airstrip. Daily surveys along 4-5 km of these roads and along the nearby overgrown airstrip produced the majority of bird identifications (>90%). The team also accompanied the fish team for half a day along a westerly 4 km strip of stream bed adjacent to the exploration base camp.

The presence of a fairly extensive network of roads in Nassau allowed the team a greater degree of access and visibility over a larger area than in Lely. Lely did have an airstrip and radio towers, which greatly facilitated bird spotting, but these sites are very localized. All footpaths in the Lely area were relatively small and surrounded by various types of canopy, making bird spotting more difficult than the wider, longer roads in Nassau. This difference in

access may have accounted for the greater number of species identified in Nassau than Lely (see below) but further studies are needed to determine if specific species richness and diversity for both sites.

GENERAL IMPRESSIONS/RESULTS FOR EACH SITE AND OVERALL

For both sites, the bird team positively identified 108 species, 8 identified with some degree of uncertainty and five species spotted but not identified, including four species of hummingbird (Appendix 8).

In Lely the team found the following: 63 species positively identified, three possibly identified, and three species of hummingbird not positively identified. In Nassau the team found: 79 species positively identified; five possibly identified; and two species spotted, but not identified, included one species of hummingbird and a species similar in size and appearance to an oriole, but white instead of yellow and with a black head and stripe across its chest. Twenty-nine (29) species where positively identified in both sites.

Hunting seemed to be having some impact on certain species, particularly on guans, curassows, parrots and raptors, the remains of which, along with discharged shotgun shells, were found in both sites. However, the overall habitats of both sites seem to be largely intact, with some fragmentation from roads (particularly in Nassau) and other infrastructure such as the airstrip and radio towers in Lely. The species richness and diversity are believed to be typical for these habitats (though it was noted that there seemed to be few raptors), but additional consultation with other Suriname bird experts is warranted. Whether the relative lack of raptors was due to the time of year, available prey or hunting pressures (or a combination of these) was not able to be determined.

All of the species positively identified on both plateaus are fairly common for this part of Suriname. None of the species spotted in Lely and Nassau are currently listed as threatened by the IUCN Red List (Appendix 8).

CONSERVATION RECOMMENDATIONS

Both sites surveyed showed evidence of hunting, particularly of larger bird species, with no apparent regulation of the number or types of species killed. It is important to note that the actual extent and impact of hunting on bird species was beyond the scope of this survey. Additional studies on key game bird species are needed to determine the actual impact of hunting on species abundance and diversity in both areas. Banning hunting outright is neither feasible nor probably wise, given reliance of some people on bushmeat as an important dietary source of protein. However, baseline studies and improved regulation can ensure that key game species populations can be maintained at sustainable levels.

In Lely, the local airstrip work crew has to engage in hunting, with birds being a particular interest, to supplement their diet. Provision of regular protein sources for the work crew, with improved education and regulation of their hunting, should be promoted to lessen hunting pressure in the Lely area. In both Lely and Nassau, small-scale gold miners are engaging in hunting of bird and other species as well. Nassau's relatively extensive road networks are facilitating easy access to forest areas and the ability to hunt for local small-scale gold miners. Improved control over road access in Nassau and better regulation and monitoring of key species (both bird and mammal) in both areas should be employed to ensure hunting is maintained at sustainable levels and prevented for IUCN Red List or CITES species.

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Chapter 8

Birds of Lely Gebergte, Suriname

Brian J. O'Shea

INTRODUCTION

Birds are one of the best-known groups of organisms in tropical forest. Because the majority of species are diurnal, and because birds in general are quite conspicuous and easy to identify, they make ideal subjects for rapid biodiversity assessments. Birds are excellent indicators of environmental health in the tropics. Many species are persecuted directly for food or trade, and many more are sensitive to habitat alteration associated with anthropogenic activities. Through their roles as seed dispersers and predators, birds influence the distribution of food resources used by a tremendous variety of animals, and thus play an important role in maintaining ecosystem functions.

The Guayana Shield harbors just over 1000 species of birds (Hollowell and Reynolds 2005), most of which occur in the region's largely intact forests. Although a comprehensive checklist of the birds of Suriname does not exist at this time, approximately 650 species are known from the country (Haverschmidt and Mees 1994; O. Ottema pers. comm.). Roughly 500 species inhabit the forests of Suriname's interior. Because Suriname is quite small and its forest cover is mostly intact, the majority of these species are widespread within the country.

The interior of Suriname is sparsely populated. Most human settlements are situated along rivers; there are few roads, and access to large areas of the interior is limited. The country supports significant populations of bird species that are sensitive to human exploitation and anthropogenic habitat fragmentation. Parrots, guans and curassows, trumpeters, and large raptors are common in Suriname. The country represents a stronghold for these species, many of which have been displaced by large-scale human activities and direct persecution elsewhere.

Suriname contains few true highland areas, with only two mountains exceeding 1000 meters in elevation. The avifauna of plateaus in Suriname typically consists of widespread lowland species, with the addition of a small suite of species that are largely confined to inselbergs and plateaus in the country's interior. Because plateaus are well drained, bird species typical of seasonally inundated forests tend to be absent. Some elements of the Pantepui avifauna reach their eastern limit on the Tafelberg in central Suriname, but are not known to occur below 1000 meters.

The Lely Gebergte is an isolated plateau in east-central Suriname. There is a large airstrip at the summit of the plateau (elev. approx. 670 meters), and a clearing roughly 100 meters in diameter has been made to accommodate a radio tower near the airstrip, but the plateau is otherwise forested. There is no road access to Lely and no human settlements in the immediate vicinity, though local people access the mountain by way of the Tapanahony River.

METHODS

Mist nets were used to sample the avifauna of Lely Gebergte between 2 and 14 June 2003. Six 12-meter nets were opened at first light and closed in the late afternoon every day. Nets were placed in three habitats near the airstrip: 1) mossy "dwarf forest" with many bromeliads and

a canopy height of approximately 6 meters; 2) tall forest on flat to gently sloping terrain; and 3) scrub along the edge of the airstrip. Birds captured in the nets were collected or released. Specimens were preserved as study skins or skeletons. Tissue samples were obtained from all birds collected. Specimens are housed at the Nationale Collectie Zoologische Suriname (NCZS) and the Louisiana State University Museum of Natural Science (LSUMZ); all tissues are housed in the Section of Genetic Resources at the LSUMZ.

Incidental observations of the avifauna were made in the course of checking mist nets and preparing specimens. The approximate number of individuals of each species heard or seen each day was recorded.

RESULTS

Appendix 9 lists all species observed at Lely and their relative abundances. 152 species were observed during the study period. 104 specimens representing 52 species were collected during approximately 700 net-hours of sampling; however, the overall capture rate was far higher because many birds were released from the nets. Capture rates were unusually high, due in part to the placement of nets in an area of fruiting melastomes (Melastomataceae) that attracted large numbers of birds. There were also many juvenile birds in the area – particularly manakins (Pipridae) and *Turdus albicollis* (White-necked Robin) – that contributed greatly to the total number of birds captured.

The avifauna of Lely seemed typical of well-drained forests elsewhere in Suriname. Interesting records include the first interior breeding record of *Tachybaptus dominicus* (Least Grebe) for the country and the first documented specimen for Suriname of *Geotrygon violacea* (Violaceous Quail-Dove; see O'Shea 2005). *Contopus albogularis* (White-throated Pewee) was observed regularly around the Lely airstrip. This species is patchily distributed from the Bakhuis Gebergte in western Suriname into French Guiana, and thus has one of the most restricted geographic ranges of any bird species in the Guiana Shield. *Phaethornis malaris* (Great-billed Hermit) was observed and collected at Lely. The range of this species in the Guianas is also quite restricted and seems to coincide closely with that of *C. albogularis*. Neither of these species has been recorded from adjacent Guyana. Nine species of Guiana Shield endemics, or approximately one-third of those occurring in Suriname, were seen during the study period (Table 8.1).

Table 8.1. Guayana Shield endemics observed on Lely Gebergte.

Scientific name	English name
Pionopsitta caica	Caica Parrot
Selenidera culik	Guianan Toucanet
Pteroglossus viridis	Green Aracari
Myrmotherula gutturalis	Brown-bellied Antwren
Herpsilochmus stictocephalus	Todd's Antwren
Contopus albogularis	White-throated Pewee
Corapipo gutturalis	White-throated Manakin
Lepidothrix serena	White-fronted Manakin
Euphonia finschi	Finsch's Euphonia

The parrot fauna of Lely was diverse. At least nine species were observed on a daily basis, and two species of large macaws (*Ara* spp.) were common during the study period. The total lack of *Amazona* parrots, however, was perplexing. Parrots are known to make seasonal movements in response to changes in food availability, and it is possible that *Amazona* parrots were temporarily absent from the area. Surveying the area at a different time of the year would help to clarify whether the absence of these parrots was a temporary phenomenon, or the result of trapping or hunting pressure.

Trumpeters (Psophiidae) and curassows (Cracidae) are prized for food and are thus good indicators of hunting pressure in tropical forest. *Crax alector* (Black Curassow) and *Psophia crepitans* (Gray-winged Trumpeter) were seen regularly at Lely. Neither species was particularly shy, suggesting that hunting at Lely is limited.

Overall, the avifauna of Lely seemed to be minimally disturbed by human presence in the area, and contained many expected species of well-drained lowland forest in Suriname. Several species typical of higher elevations in Suriname were found at Lely as well. Due to the limited number of observers (one) and the small area covered, the number of species occurring on Lely is undoubtedly higher than this survey indicates.

DISCUSSION

The 14-day survey of Lely Gebergte found 152 species in a limited area around the airstrip. 54 species, or 36% of the total, were captured in approximately 700 net-hours of sampling effort using ground-level mist nets in three distinct habitats within the area. Of these species, only nine were recorded solely as mist-net captures. This emphasizes the importance of supplementing passive census techniques with active observation and tape documentation of a tropical forest avifauna. Because Lely is situated in a large region of unbroken forest, the mountain's avifauna certainly comprises at least 300 species.

The avifauna of Lely appears to be representative of the lowland forest that covers the surrounding region, with the addition of several species that are primarily confined to plateaus in the country's interior. These species include *Phaethornis malaris* (Great-billed Hermit), *Trogon collaris* (Collared Trogon), *Piculus rubiginosus* (Golden-olive Woodpecker), *Contopus albogularis* (White-throated Pewee), and *Lepidothrix serena* (White-fronted Manakin). Within Suriname, these species are also known to occur on the Brownsberg and at higher elevations in the Bakhuis Gebergte (BJO pers. obs.). The global range of *Contopus albogularis* is very small – the species is endemic to portions of Suriname and French Guiana. The other species are more widespread.

Cracids and parrots, two groups that are good indicators of human impact in tropical forest, are well represented at Lely. Curassows were seen regularly during the survey, suggesting that hunting activity is not especially high in the Lely area. With the mysterious exception of the genus *Amazona*, parrots were common in the vicinity of the Lely airstrip. Suriname supports a thriving trade in parrots, and substantial numbers are harvested annually from the country's interior. The proximity of human settlements and access corridors greatly influences trapping pressure on parrots in the Guianas (Hanks 2005). Lely is still quite remote and does not appear to be an important trapping area at this time, but a more focused assessment of the intensity of trapping pressure on parrots around Lely should be undertaken. From a global perspective, Lely is an important stronghold for parrots, curassows, and other species that are sensitive to human disturbance or that require large areas of intact forest for survival. While it does not represent an especially unique area in the Guianas from an ornithological standpoint, the remoteness and pristine condition of Lely relative to Brownsberg and Nassau argue for the expedient implementation of conservation measures. Foremost among these would be a restriction on the building of roads into the area. Road construction would precipitate an influx of hunters and trappers, as has already happened at the nearby Nassau Gebergte. Although the area is used by local people and some hunting undoubtedly occurs, the current level of hunting pressure at Lely seems light, especially in comparison to Nassau and the area surrounding the Brownsberg Nature Park.

The creation of permanent human settlements in the vicinity of Lely should also be discouraged. Settlements would increase hunting and trapping pressure on game birds, parrots, and other wildlife in the area, with deleterious secondary effects on the reproductive ecology of many plant species.

Overall, bird diversity at Lely seems high, and the plateau is a good candidate for protected status, particularly in light of current human pressures on Brownsberg and Nassau. Human activity does not seem to have substantially affected the avifauna of Lely up to the present time, and local people should be granted continued access to the area via the Tapanahony River. However, road construction and large-scale extractive activities should be avoided.

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Chapter 9

Fishes of Lely and Nassau Mountains, Suriname

Jan Mol, Kenneth Wan Tong You, Ingrid Vrede, Adrian Flynn, Paul Ouboter and Frank van der Lugt

ABSTRACT

The fish fauna of Lely Mountains and Nassau Mountains was sampled at 4 and 3 sites, respectively, during a Rapid Assessment Program expedition in November 2005. A total of 36 species were identified. Of these, 26 were collected in a lowland stream in the foot hills of Nassau Mountains (altitude 106 m above mean sea level). The fish fauna of 4 high-altitude (plateau) streams in Lely Mountains had 8 species. In high-altitude reaches of one stream in Nassau Mountains (Paramaka Creek) we collected 6 fish species, including the endemic catfish *Harttiella crassicauda*. A second survey of plateau streams in Nassau Mountains in March/April 2006 increased the number of species to 41; 11 species, including 6 species that are potentially new species to science, were collected from high-altitude streams. The low number of fish species in the high-altitude streams of Lely and Nassau Mountains was expected, but the high number of potentially new (and endemic?) species in Nassau Mountains was exceptional. A diet consisting of filamentous (red) algae, diatoms and fine detritus, low fecundity (3-7 large, mature eggs per female), and sedentary habits make *Harttiella crassicauda* of Nassau Mountains highly vulnerable to human impact on its habitat (e.g. mining-related siltation and sedimentation, and habitat loss). The steep slopes bordering the Nassau Plateau apparently act as biogeographic barriers that prevent the dispersal of fishes from one high-altitude stream to the other streams on the plateau. For example, *Harttiella crassicauda* from the central branch of Paramaka Creek (IJskreek) differed morphologically from *H. crassicauda* collected in a northern branch of Paramaka Creek (the two tributaries joining each other in the foot hills of Nassau Mountains). A new loricariid species (nicknamed 'big mouth') from the northern branch of Paramaka Creek was not collected in the central branch (IJskreek), notwithstanding extensive collection efforts at the latter site. Paramaka Creek with its large catchment on the plateau had most of the unique fish species of Nassau Mountains and should be carefully protected. However, other high-altitude streams of Nassau Mountains were sampled only once (or not at all) and they should be inventoried more thoroughly in the future. The genus *Lithoxus* of high-altitude streams of Nassau Mountains should be studied in detail including analysis of its DNA. Both Nassau and Lely Mountains are concessions of bauxite mining companies. In the foot hills, small- and large-scale gold mining, forestry and shifting cultivation threaten the pristine wilderness character of the forest and streams. Because of its geographical location close to the densely populated coastal plain and its accessibility by road, these threats have a more immediate character in Nassau Mountains as compared to Lely Mountains. The Surinamese government should collaborate with local and international organizations and the concession holder in a comprehensive effort to protect Nassau Mountains and preserve its unique flora and fauna for future generations.

INTRODUCTION

The Neotropics has more species of freshwater fishes than any place else in the world. Most Neotropical freshwater fish species live in lowland streams, and effort to collect fishes of high-

altitude mountain streams has been relatively small compared to collection effort in lowland streams. The Guayana Shield in northern South America has many isolated sandstone table mountains (tepuis) and other mountains with low level of ichthyological understanding. During the 2002 Guayana Shield Priority-Setting workshop, the fish-specialist group identified the Nassau-Lely Mountains as a priority area with high need for biological surveys (Lasso et al. in Huber and Foster 2003), an assessment based mainly on the occurrence of the endemic catfish *Harttiella crassicauda* (Boeseman 1953) in Nassau Mountains and ecological/evolutionary phenomena related to the occurrence of this unique species in Nassau Mountains.

Nassau (~20x20 km^2), Lely (~30x30 km^2), and Brownsberg Mountains are flat-topped, bauxite- or laterite-capped mountains (so-called denudation surfaces; King et al. 1964) in eastern Suriname which escaped erosion during the Tertiary Period because of their protective duricrust (Noordam 1993). In the 2002 Guayana Shield Priority-Setting workshop these mountains were grouped in the Maroni Area (20,600 km^2), an area of the highest biological importance and with great scenic beauty and potential for ecotourism (Huber and Foster 2003). Preliminary results of surveys of plant diversity of the three mountains indicated high diversity of mountain forests compared to lowland forests and suggest that the three mountains may constitute a unique ecosystem in Suriname (Bánki et al. 2003, ter Steege et al. 2004, 2005). Although the foot hills of the mountains and the lowlands separating the mountains are heavily impacted by small (gold) and large (gold, bauxite) mining operations, logging, hunting, fishing and damming (Brokopondo Reservoir), the forests on the mountain plateaus are still largely untouched. Here we present the results of an inventory of the fish fauna of Lely and Nassau Mountains in the period 25 October – 7 November (i.e. dry season; Amatali 1993). Because access to high-altitude streams of Nassau Mountains Plateau was rather limited during the RAP survey, we include results of a second survey of Nassau streams (29 March – 4 April 2006; short rainy season) in the present report. We close with some remarks on potential environmental impacts on the fishes of these mountain streams.

Biogeography

Suriname, up to 1975 known as Dutch Guiana, is a small country (163,820 km^2; population 480,000) in northwestern South America between 2-6ºN and 54-56ºW. To the east is French Guiana, to the west is Guyana, to the south is Brazil, and to the north is the Atlantic Ocean. Suriname covers about 10% of the 2.5 million km^2 Precambrian Guayana Shield, a thinly inhabited area (0.6-0.8 humans/ km^2) in northern South America covered with pristine rain forests, savannas and palm marshes. A characteristic feature of the Guayana Shield are the tepuis or sandstone table-mountains (e.g., Tafelberg Mountain in the upper Coppename basin).

Three major geographical zones can be distinguished in Suriname: the Coastal Plain, the Savanna Belt, and the Interior. Bordering the Atlantic Ocean is the Coastal Plain with Andean/Amazon-derived clays deposited in the Quaternary Period by the Guiana Current (Noordam 1993). Habitats in the Coastal Plain zone include mangrove forests, brackish-water lagoons and river estuaries, fresh- and brackish-water swamps, agriculture lands (rice fields), and marsh forests. This zone is the most accessible, densely populated and disturbed area of Suriname. The fish fauna of the Coastal Plain has many brackish-water species and juveniles of marine species and a small number of freshwater-swamp fishes.

To the south of the Coastal Plain is the Savannah Belt with Pliocene sandy sediments deposited along the northern edge of the Guayana Shield by braided rivers from the Interior. It is characterized by savannas and savanna forests drained by black-water streams (e.g., Cola Creek, Blaka-Watra Creek). The black-water streams have many small fish species that are common aquarium species (e.g., pencil fishes and tetras).

The great majority of Surinamese freshwater fishes live in seven river systems draining the *terra firme* rainforest of the Interior, from west to east: Corantijn River (with tributaries Nanni, Kaboeri, Kabalebo, Lucie, Zuid, Coeroeni, Sipaliwini, and Oronoque), Nickerie River (with tributary Maratakka), Coppename River (with tributaries Coesewijne, Tibiti, Wayombo, Adampada, Rechter Coppename, Midden Coppename, and Linker Coppename), Saramacca River (with tributaries Mindrineti, and Kleine Saramacca), Suriname River (with tributaries Para, Sara, Gran Rio and Pikien Rio, and the hydroelectric reservoir Lake Brokopondo (Lake Van Blommestein; dam completed in 1964)), Commewijne River (with tributaries Cottica, and Mapane), and Marowijne River (with tributaries Lawa, Tapanahoni, Paloemeu, Gonini, Oelemari, and Litani). The border rivers, Corantijn in the west and Marowijne in the east, together drain nearly half of the Surinamese land surface (Amatali 1993). The Interior is hilly with Precambrian Shield rocks (80% of Suriname's land surface), but predominantly low-lying with only few mountains rising above the 250 meter contour. The water of streams in the Interior that drain the old, weathered Precambrian Guayana Shield is mostly clear (Secchi transparency up to 3 m) and poor in sediment (0.001-0.1 g/l) and nutrients. Streams in Nassau (564 m above mean sea level) and Lely (694 m.amsl) Mountains drain to Marowijne River.

History of fish collecting in Nassau and Lely Mountains

A history of freshwater fish collectors in Suriname is given in Mol et al. (2006). Fishes of Nassau Mountains were collected in 1949 by D.C. Geijskens and P.H. Creutzberg (Boeseman 1953; Appendix 10). To our best knowledge, fishes have not been collected in Lely Mountains prior to the present RAP survey of November 2005.

Geijskens and Creutzberg collected 19 fish species in the Nassau mountains (Appendix 10), including 15 specimens of *Harttiella crassicauda*. Boeseman (1953) does not provide altitude of the collection localities of Geijskens and Creutzberg, but from collection dates and known habitat preference of fish species like *Serrasalmus rhombeus*, *Pimelo-*

dus ornatus, *Platydoras costatus*, *Megalechis thoracata*, *Hemigenes marmoratus*, *Rhamdia quelen*, and *Astyanax bimaculatus* (all lowland species) we can infer that all but two species (*Harttiella crassicauda* and 6 specimens of *Trichomycterus guianensis*) were collected in lowland streams in the foot hills of Nassau Mountains. Three new fish species (*H. crassicauda*, *Heptapterus bleekeri* and *Hemibrycon surinamensis*) have been described from the 176 specimens collected in Nassau Mountains by Geijskens and Creutzberg and the small collection also yielded one new record for Suriname (*Chasmocranus brevior*). However, the collection of Geijskens and Creutzberg was not representative for the fish fauna of high-altitude streams of the Nassau Plateau.

METHODS

At seven collection sites in mountain streams in Lely (L1-L4; 25-31 October, 2005) and Nassau (N1-N3; 1-7 November, 2005) Mountains (Figure 9.1, Table 9.1), we measured pH with pH-paper, conductivity and temperature with an YSI-30 meter and transparency with a Secchi disc. Water samples with 2% vol. vol. H_2SO_4 added were analyzed for N, P and C nutrients in FIU-Southeast Environmental Research Center Water Quality laboratory (http://serc.fiu.edu/sercindex/index.htm) following standard Environmental Protection Agency (EPA) methods and American Standard Methods (ASTM). In IJskreek (Nassau Mountains, N1) we also sampled tufts of filamentous algae from boulders and, during a second survey (29 March – 4 April 2006; see Discussion), phytoplankton in 1-liter bottles (5 ml of 4% formalin added); periphyton and phytoplankton samples were analyzed by A. Haripersad-Makhanlal of Hydraulic Research Division (Waterloopkundige Afdeling WLA), Ministry of Public Works, Paramaribo.

During the March/April 2006 survey of Nassau Mountains we measured instream fish habitat of *Harttiella crassicauda* in the headwaters of Paramaka Creek (IJskreek tributary; N1) on the basis of depth, current velocity and substrate type following Gorman and Karr (1978). Point samples of depth, substrate, and current velocity were taken along transects perpendicular to the stream, beginning 10-20 cm from the left bank and then at 1-m intervals across the stream. Repeated sets of measurements were taken across the stream at 5-m intervals moving upstream. At each measurement point, depth was measured with a meter stick, current velocity was measured by recording the time required for a floating object to travel 1 m downstream. Substrate type was classified into one of ten categories (Appendix 14). Depth and current measurements were divided into four and six categories, respectively (Appendix 14), to facilitate computation of a habitat diversity index. Categories were chosen as representative of the habitats in the small mountain streams (e.g., shallow edges, 0-10 cm; riffles11-20 cm; pools, 20-30 cm and deep pools >30 cm). Frequencies of occurrence (p_i) of each habitat category or combination of depth, current, and substrate were used to calculate a Shannon-Wiener index of habitat diversity, $H = -\Sigma\ (p_i)*(\ln p_i)$ (Krebs 1989).

We used 3-m seine (specifications, length = 3 m, height = 2 m, mesh size = 0.5 cm), a 30-m gill net (mesh-size 3 cm), and rotenone to investigate fish communities. During the March/April survey at Nassau Mountains we also used a Smith-Root Model 12B electrofisher (DC output up to 1,100 V) in combination with a seine net set in the current. In shallow mountain streams with weak or moderate

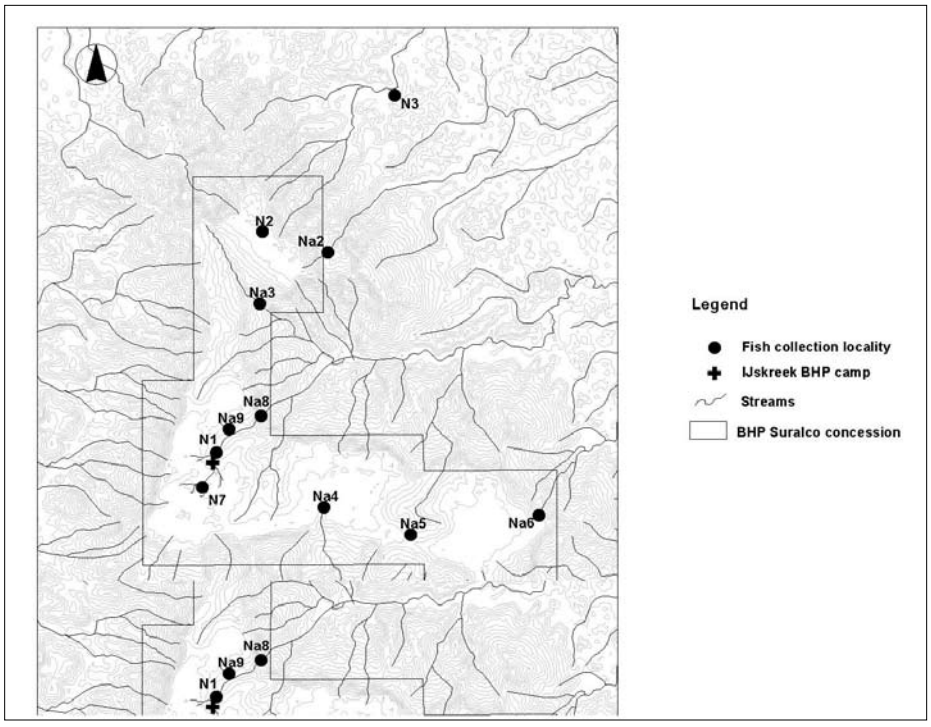

Figure 9.1. Map of Nassau with sampling locations.

current the seine was pulled; in riffles with strong current the seine was set and held in place and upstream rocks were kicked out or fishes were chased from their hiding places with the electrofisher. The gill net was used on one occasion in a medium-sized stream in the foot hills of Nassau (N3). Rotenone was used in four streams with weak current (L2, L3, N1 and N3) to check the completeness of seine samples. When a particular area was chosen we sampled all available habitat types observed, e.g. pools, riffles, root masses, leaf litter, and woody debris.

We sampled in daylight only, although on one occasion we collected the nocturnally-active fishes swamp eel *Synbranchus marmoratus* and armored catfish *Callichthys callichthys* at night. One collection took one to four hours. In total we made 7 collections, 4 in Lely Mountains and 3 in Nassau Mountains. During the March/April 2006 survey of high-altitude streams in Nassau Mountains we made 7 collections in four different streams. Fishes were preserved in 4% formalin and later transferred to 70% ethanol for long term storage at National Zoological Collection of Suriname

Table 9.1. GPS-coordinates of collection sites and water quality of streams in Lely (L1-L4) and Nassau (N1-N3) Mountains, Suriname, 25 October – 7 November 2005. Collection site N2 is a shallow depression (swamp) with standing water. Nutrient concentrations are based on the atomic weight of primary nutrient species (ppm-N, ppm-P, ppm-C), not the molecular weight.

	Lely Mountains				Nassau Mountains		
	L1	L2	L3	L4	N1	N2	**N3**
GPS-coordinates (Deg/Min/Sec)	N04/16/13.5, W54/44/17.2	N04/15/8.9, W54/43/54.8	N04/15/52.7, W54/43/47.2	N04/15/24.1, W54/44/40.9	N04/49/13.7, W54/36/20.6	N04/52/55.8, W54/35/33.5	N04/55/12.5, W54/33/20.6
Altitude (m.amsl)	650	400	?500	550	467	514	106
Date	26 Oct 2005	27 Oct 2005	28 Oct 2005	29 Oct 2005	2 Nov 2005	3 Nov 2005	4 Nov 2005
Time	08.30 AM	10.00 AM	09.00 AM	09.00 AM	07.50 AM	09.45 AM	09.30 AM
Stream width (m)	1	3	2	2	1.5-3	-	4
Water depth (cm)	40	150	50	50	40	20	190
Conductivity (µS/cm)	25.2	23.5	22.6	26.3	27.9	43.6	22.8
Water temperature (°C)	22.2	23.3	22.6	22.5	22.6	23.4	24.8
pH	6.5	7.5	7	7	7	7	7
Secchi transparency (cm)	>40	>150	>50	>50	>40	>20	>100
Color	transparent	transparent	transparent	transparent	Transparent	light brown	transparent
NO_3–N (ppm)	0.030	0.087	0.060	0.074	0.023-0.099	0.017	0.105
NO_2–N (ppm)	0.002	0.002	0.002	0.002	0.002-0.002	0.003	0.002
NH_4-N(ppm)	0.030	0.017	0.029	0.044	0.018-0.042	1.447	0.071
Total inorganic N (ppm)	0.062	0.106	0.091	0.120	0.067-0.120	1.466	0.178
Total organic N (ppm)	0.627	0.479	0.405	0.337	0.307-0.592	0.812	0.993
Total-N (ppm)	0.689	0.585	0.496	0.457	0.393-0.708	2.279	1.170
Dissolved-P (ppm)	0.004	0.002	0.002	0.004	0.001-0.006	0.053	0.002
Total-P (ppm)	0.008	0.170	0.005	0.003	0.002-0.010	?	0.006
Total organic C (ppm)	5.691	4.475	5.386	4.488	2.916-4.972	35.740	4.472
Remarks	weak current	moderate to strong current	weak current	weak current	*Harttiella crassicauda* present	Swamp with standing water	disturbed by gold miners

(NZCS) in Anton de Kom University of Suriname, Paramaribo, Suriname, Field Museum (FMNH), Chicago, and Smithsonian Institution, Washington D.C.

Identifications were made to the lowest taxonomic level possible. Usually this meant to species, but one juvenile specimen could only be identified to genus. Publications used to identify the fishes included regional contributions like 'The Freshwater Fishes of British Guiana' (Eigenmann 1912) and 'Atlas des Poissons d'Eau Douce de Guyane' (Planquette et al. 1996, Keith et al. 2000, Le Bail et al. 2000), general taxonomic treatises like 'Characoids of the World' (Géry 1977), and taxonomic surveys specific to Suriname like 'The Cichlids of Surinam' (Kullander and Nijssen 1989), 'The 'comb-toothed' Loricariinae of Surinam' (Boeseman 1971), and many others.

Identification of *H. crassicauda* was confirmed by Raphael Covain, Museum d'Histoire Naturelle, Geneva, Switzerland, specialist in the subfamily Loricariinae (e.g. Covain et al. 2006). Approximately 50 specimens of *Hartiella crassicauda* were collected in IJskreek (site N1) during the RAP survey in November 2005; 25 specimens were preserved in 4% formalin (and later transferred to 70% ethanol for long-term storage in museums in Suriname, Switzerland and USA), 10 specimens were preserved in 95% ethanol and send to Raphael Covain for analysis of mtDNA, 5 specimens were used for analysis of stomach (intestines) contents, and 10 specimens were kept alive for observation of their behavior in aquarium. We obtained the first photographs of live *H. crassicauda* in its natural habitat (see photo pages). During the second survey in Nassau Mountains (March/April 2006) we collected 40 specimens of *H. crassicauda* and an additional 40 specimens of a second *Harttiella* population in a northern tributary of Paramaka Creek; these specimens were send to the museum of the Universidade de Sao Paulo (MZUSP) and Geneva Museum, or used in (1) stomach (intestines) contents, (2) fecundity analysis, (3) tissue analysis for metals and stable carbon isotopes, and (4) DNA analysis.

RESULTS

We collected 787 specimens in 36 species in 6 streams and 1 palm swamp in Lely and Nassau Mountains (Appendix 11). These 36 species can be divided into 6 orders and 15 families. The largest order is Characiformes (14 species, 39% of the total), followed by Siluriformes (11 species, 31%), Perciformes (5 species, (14%), Gymnotiformes (4 species, 11%), Cyprinodontiformes (2 species, 6%), and finally Synbranchiformes (1 species, 3%). The largest families are Characidae and Loricariidae (each 6 species, 17%), followed by Cichlidae (4 species, 11%), and Erythrinidae, Lebiasinidae (each 3 species, 8%) with other species comprising 39%. Of the 36 species, two (6%) are new to science: *Lithoxus* sp.1 and *Trichomycterus* aff *conradi*. The endemic catfish *Hartiella crassicauda* (Boeseman, 1953) was collected for the first time since its original discovery by Geijskens and Creutzberg in 1949. During the second survey of high-altitude streams in Nassau mountains we collected an additional four species that may prove new to science.

In Lely Mountains we collected 260 specimens in 8 species from 4 high-elevation streams (Table 9.2). In Nassau Mountains we collected 338 specimens in 6 species in one high-elevation stream (N1, IJskreek) and one swampy depression (N2, one species only: *Rivulus* cf. *igneus*), and 189 specimens in 26 species from a lowland stream in the foot hills at altitude 106 m.amsl (N3). The lowland stream had higher species richness than the mountain streams in Lely and Nassau Mountains, but loricariid and trichomycterid catfishes (eight species in total) were collected only in high-altitude streams on the plateau. In Nassau Mountains, only two species (swamp eel *Synbranchus marmoratus* and *Rivulus* cf. *igneus*) were collected in both high-altitude stream and lowland stream in the foot hills.

Shallow headwater streams in Lely (L1, L3 and L4) and Nassau (N1, upstream of temporary BHP-Billiton exploration camp) Mountains had only two or three fish species, i.e. *Rivulus* cf. *igneus*, *R.* cf. *lungi*, swamp eel *S. marmoratus* and armored catfish *C. callichthys*. All these species are capable of moving some distance over land (Ouboter and Mol 1993) and they are also able to use oxygen from the air for breathing (Graham 1997). In addition, *Rivulus* is able to climb vertical rocks in water falls (Eigenmann 1912). These species are thus able to re-colonize ephemeral headwater streams from downstream pools once the headwater streams receive water in the rainy season. More downstream (but still on the plateau), streams of Lely and Nassau Mountains had about 6-8 fish species (L2, N1 downstream of BHP-camp), including the endemic species from Nassau Mountains (see below). The large stream in the foot hills of Nassau Mountains (N3) had most species (26). Abundances of individuals of most species were high. The only species that was collected in low numbers was the predatory swamp eel *S. marmoratus*

Table 9.2. Fishes collected in high-altitude (plateau) streams and one lowland stream (foot hills) of Lely and Nassau Mountains (in number species and number of specimens), 25 October – 7 November 2005.

	Number of species				Number of specimens			
	Lely		Nassau		Lely		Nassau	
	N	%	N	%	N	%	n	%
Plateau	8	100	6	19	260	100	338	64
Foot hills	-		26	81	-		189	36
Total	**8**	**100**	**32**	**100**	**260**	**100**	**527**	**100**

(although this species was present at most collection sites; Appendix 11).

Lely Mountains

Lely Mountains (altitude up to 694 m.amsl) is a very pristine area in the Marowijne River Basin. Access to the plateau is difficult and mostly restricted to small airplanes. At present the only human activities in Lely Mountains are related to three personnel of the Aviation Service (Sur. Luchtvaartdienst) at the airstrip on the plateau and one camp of small-scale gold miners in the western foot hills. We surveyed four high-altitude (i.e. >400 m.amsl) streams that were undisturbed other than by natural processes. The streams had clear water (Secchi transparency >150 cm at L2), with low conductivity (22.6-26.3 µS/cm), relatively low water temperature (22.2- 23.3 °C), pH 6.5-7.5, low inorganic N nutrients (0.062-0.120 ppm), 0.337-0.627 ppm organic N, 0.002-0.004 ppm dissolved P (0.003-0.170 ppm total P), and 4.475-5.691 ppm organic C (Table 9.1).

We made four collections in Lely Mountains: three collections in shallow, low-gradient streams at high altitude (>500 m. amsl) and one collection in a slightly larger stream with higher gradient at altitude 400 m.amsl (L2). In the three high-altitude streams we collected/observed only three fish species: swamp eel *Synbranchus marmoratus* and two *Rivulus* species (killifishes), *Rivulus* cf. *igneus* and *R.* cf. *lungi* (Appendix 11). *Rivulus* were abundant and in good condition, e.g. bright colors, no fish parasites, many large-sized specimens. In the stream at 400 m altitude we collected six fish species: two *Rivulus* species (*R.* cf. *igneus* and *R.* cf. *lungi*) and three loricariid catfishes (*Ancistrus temminckii*, *Guyanancistrus brevispinnis*, and *Lithoxus surinamensis*) and the trichomycterid catfish *Ituglanis* cf *amazonicus* (Appendix 11).

Nassau Mountains

Nassau Mountains has a slightly lower altitude (564 m.amsl) than Lely Mountains. At the high-altitude plateau (> 400 m.amsl), the forest and streams of the Nassau Mountains were mainly intact (e.g. we observed large-sized trees and clear water in IJskreek at 460-535 m.amsl). However, we observed many human activities in the foot hills of Nassau Mountains, e.g. shifting cultivation plots, logging, small-scale gold mining, and exploration for construction of a large goldmine (Newmont). We collected fishes in one high-altitude stream (N1, IJskreek, 460-535 m.amsl; Figure 9.1) and a palm swamp (N2, 560 m.amsl; Figure 9.1) on top of the plateau, and in one low-altitude stream (N3, 106 m.amsl) in the foot hills of the northwestern slope. *Harttiella crassicauda* was collected only in Paramaka Creek (IJskreek tributary, N1). The headwaters of IJskreek had clear water (Secchi transparency> 50 cm) with low conductivity (25.9-31.8 µS/cm), pH 7, low water temperature 22.6 °C, low inorganic N (0.067-0.120 ppm), 0.307-0.592 ppm organic N, 0.03-0.010 ppm total P, and 2.916-4.972 ppm organic C (Table 9.1). At sites where gaps in the closed canopy allowed sunlight to reach the water surface we observed tufts of filamentous red (*Batrachospermum* spp dominant) and green (*Spirogyra* sp) algae attached to boulders; these filamentous algae had large populations of epiphytic diatoms (*Eunotia* spp) attached to their branches (Appendix 12). We observed only one aquatic macrophyte (*Thurnia sphaerocephala*) in a 100-m reach of IJskreek downstream N1 (about 200 m upstream of site Na8; Figure 9.1). Phytoplankton concentrations of IJskreek were low during the March/April 2006 survey (0-5 individuals per liter; Appendix 12). The palm swamp had higher conductivity 43.6 µS/cm, pH of 7, clear-brownish water with temperature of 23.4 °C, high inorganic N nutrients (1.466 ppm, including 1.447 ppm NH_4), 0.053 ppm dissolved P, and high organic C (35.740 ppm) (Table 9.1). Anjumarakreek at 106 m.amsl had conductivity of 22.8 µS/cm, pH 7, high Secchi transparency >100 cm, water temperature of 24.8 °C, 0.178 ppm inorganic N, 0.993 ppm organic N, 0.006 total P, and 4.472 ppm total organic C (Table 9.1).

On the plateau IJskreek (460-535 m.amsl) showed characteristics of a stepped system rather than a continuous gradient. During the November survey (dry season) the headwaters of the stream, a 200-m long, low-gradient reach on top of the plateau (altitude 528-535 m.amsl; N7 in Figure 9.1), were completely dry. At the BHP Billiton exploration camp (528 m.amsl; Figure 9.1), the stream consisted of a 300-m reach of unconnected, shallow pools with standing water, also with low gradient. During the March/April 2006 survey, IJskreek had running water all the way up to its sources 200 m upstream of BHP-Billiton exploration camp (the same March/April situation with flowing water was also observed on 22 July (long rainy season)). Finally, we surveyed a 2500-m-long reach with running water to the edge of the plateau (2.7 km downstream of BHP camp); this reach (N1-Na8 in Figure 9.1) showed alternating high-gradient small falls and low-gradient reaches with riffles-and-pools habitat. In the pools with standing water near BHP camp we collected three fish species: armored catfish *C. callichthys* (Sur. platkop kwikwi), swamp eel *S. marmoratus* and *Rivulus* cf. *igneus*. About 400 m downstream of BHP exploration camp, in running water, we caught the endemic loricariid catfish *Harttiella crassicauda* (see below), together

Table 9.3. Lists of species of high-altitude streams of Nassau Mountains Plateau that are potentially new species to science.

Potentially New Species from Nassau Mountains
Guyanancistrus sp. 'big mouth'
Harttiella cf. *crassicauda (*slender *Harttiella* from northern tributary of IJskreek)
Lithoxus sp. 1
Lithoxus sp. 2 (forked caudal fin)
Lithoxus sp. 3 (with yellow spots on its head)
Trichomycterus aff *conradi*

with swamp eel *S. marmoratus*, *R.* cf. *igneus*, and the catfishes *C. callichthys*, *Lithoxus* sp.1 and *Trichomycterus* aff *conradi*. During the March/April survey and on 22 July 2006 we collected only *C. callichthys* and *Rivulus* cf. *igneus* in IJskreek upstream of BHP camp (i.e. in the 200-m reach N7 that was completely dry in November 2005).

In the high-altitude palm swamp we caught only one fish species (*Rivulus* cf. *igneus*; Appendix 11). In the lowland stream in the foot hills of Nassau Mountains we collected 26 fish species (Appendix 11), but *Harttiella crassicauda* was conspicuously missing in the catch from this lowland site.

During the RAP expedition in November 2005 we had access to only one high-altitude stream on Nassau Plateau (IJskreek, N1). Although we collected only 6 fish species in IJskreek, we were not able to identify two of these species (*Lithoxus* sp. 1 and *Trichomycterus* aff *conradi*; both species are probably new to science), while a third species (*Harttiella crassicauda*) is known to be endemic for Nassau Mountains (e.g. Le Bail et al. 2000). During a second survey of streams draining Nassau Plateau (29 March – 4 April 2006) we had the opportunity to collect fishes in three additional high-altitude streams in Nassau Mountains and two additional tributaries of Paramaka Creek (a northern and a southern tributary) (Figure 9.1; Appendix 13). In a northern tributary of Paramaka Creek we collected a new *Guyanancistrus*-like dwarf catfish (nicknamed 'big mouth') and a slender *Harttiella* (sub)species. We also collected two additional *Lithoxus* species (one species with a forked caudal fin and one species with small, yellow spots on its head) that may prove new to science. Taking into account the results of the second Nassau survey, we have collected 11 fish species from high-altitude (plateau) streams in Nassau Mountains: 3 ubiquitous species with adaptations to colonize high-altitude streams (*S. marmoratus*, *C. callichthys* and *Rivulus* cf. *igneus*), 1 *Ancistrus* species, the endemic catfish (*Harttiella crassicauda*), and 6 (54%) species that are potentially new species to science (Table 9.3).

Interesting species: *Harttiella crassicauda* (Boeseman, 1953)

The loricariid (suckermouth) catfish *Harttiella crassicauda* was collected only once (1949) prior to the present RAP expedition of November 2005. In 1949, D.C. Geijskes collected 15 specimens of *H. crassicauda* in a 'creek in Nassau Mountains' (Boeseman 1953); these 15 specimens were deposited in Naturalis Museum (formerly Rijksmuseum van Natuurlijke Historie - RMNH), Leiden, the Netherlands. In 1953, the new species from Nassau Mountains was described by M. Boeseman as *Harttia crassicauda*. In 1971, Boeseman created a new genus *Harttiella* to accommodate this unique species. At present, *H. crassicauda* is still the only species in the genus *Harttiella* (Ferraris 2003). We took the first photograph of a live specimen of *Harttiella crassicauda* in its natural habitat, IJskreek, Nassau Mountains (see photo pages).

Harttiella crassicauda is the smallest species (maximum length 5 cm SL) of the large subfamily Loricariinae (31 genera, 209 species; Ferraris 2003). The tribe Harttiini (Isbrücker and Nijssen 1978) or 'comb-toothed' Loricariinae, including *H. crassicauda*, is diagnosed as having the dorsal fin approximately opposite the ventral fins, the caudal fin with 12 branched rays, numerous bilobed teeth that form a comb, and usually a strongly depressed body. *Harttiella crassicauda* looks like a dwarf *Harttia* species, but with a body that is only moderately depressed (especially its caudal peduncle), a broad, rounded snout, rounded and indistinct carinae, and a naked belly. In systematic studies, the Harttiini are usually positioned at the base of the Loricariinae tree (e.g. Montoya-Burgos et al. 2003). Isaäc Isbrücker (1980) hypothesized that *H. crassicauda* is ancestral to all species of the subfamily Loricariinae, making it a key species/genus to understanding of the systematics of the family Loricariidae. Preliminary results of analysis of mtDNA of *H. crassicauda* and other Loricariinae (Covain and Mol, unpublished results) confirm the ancestral position of Harttiini at the base of the Loricariinae tree, but show *H. crassicauda* derived from a *Harttia* species (either *H. guianensis* or *H. surinamensis*).

Harttiella crassicauda is probably restricted in its geographical distribution to the Nassau Mountains, where it was collected in a 2500-m reach (IJskreek, altitude 370-530 m; N1-Na8, Figure 9.1, see also photo pages) of a single stream (Paramaka Creek) on the plateau (a second *Harttiella* population with a more slender body was discovered during a survey in March/April 2006 in a northern tributary of Paramaka Creek; Appendix 13). In these high-altitude reaches of Paramaka Creek, *H. crassicauda* was apparently not rare: on four occasions 10-12 specimens were collected in a single seine haul. They were collected both in 'deep' (up to 50 cm) pools on bedrock and boulders and in shallow riffles among gravel substrate (Appendix 14). However, *H. crassicauda* was not collected in Lely Mountains to the south of Nassau Mountains (Appendix 11), in Brownsberg Mountains (J.H. Mol & P.E. Ouboter, pers. observations) and Bakhuis Mountains (Hydrobiology 2006) to the west of Nassau, in lowland streams of the Suriname River Basin (Mol et al. in prep), and in three other high-altitude streams of the Nassau Plateau (Appendix 13). *Harttiella crassicauda* was also not collected to the east of Nassau in French Guiana (Le Bail et al. 2000) and it seems unlikely that it occurs in lowland streams to the north of Nassau (e.g. it was not collected in Anjumarakreek in the northwestern foot hills of Nassau Mountains, at altitude 106 m.amsl; site N3). Thus, to our best knowledge, the geographical distribution of *H. crassicauda* is restricted to one stream in Nassau Mountains (an area of about 20x20 km^2), a distribution unlike that of any other fish species in Suriname (or French Guiana; Planquette et al. 1996, Keith et al. 2000, Le Bail et al. 2000).

Because nothing is known about the biology and ecology of *H. crassicauda* and survival of this species in the near future is threatened by human activities in Nassau Mountains, it seems appropriate to present here some preliminary observations on behavior (aquarium), diet and fecundity of *H. crassicauda* that may help protecting this unique species. *Harttiella crassicauda* is a benthocryptic (see photo pages), dwarf suckermouth catfish that is mainly active at night

(aquarium observations; Appendix 15), although some diurnal activity was also observed both in the aquarium and in its natural habitat (i.e. it was observed grazing on rocks in a deep pool at Na8). In April and July 2006, we did not collect *H. crassicauda* from the headwaters of IJskreek upstream of BHP-Billiton exploration camp (these headwaters were completely dry in November 2005) although the species was collected 400 m downstream of BHP camp both in November 2005 and March/April 2006; these observations indicate that *H. crassicauda* is rather sedentary and does not migrate even short distances in IJskreek. We examined 74 adult specimens and 27 juveniles from high-altitude reaches of Paramaka Creek; the largest specimen measured 49.3 mm TL (41.3 mm SL) and weighed 0.986 g. *H. crassicauda* has the long (4.3-4.6 times SL), coiled intestines and suction-cuplike ventral mouth with comblike rows of teeth of an aufwuchs (periphyton) feeder. Analysis of intestines contents (N=25; 5 adult specimens from November 2005, 20 adult specimens from March/April 2006) showed that in its natural habitat *H. crassicauda* fed mainly on fine detritus, filamentous red algae (*Batrachospermum* spp, *Ballia prieurii*, *Goniotrichum* sp) and epiphytic diatoms (mainly *Eunotia* spp). In the aquarium, *H. crassicauda* did not accept artificial feeds, but only fed on periphyton algae. Among the 5 specimens from November 2005 (dry season), one female (42.4 mm TL, 34.3 mm SL, 0.5800 g) had ripe ovaries, i.e. one ripe ovary with 19 eggs, 7 large, yolky eggs (0.8-2.0 mm diameter) and 12 small-sized developing eggs. In March/April 2006, *Harttiella* were reproducing in Paramaka Creek and we collected 27 juveniles (15.2-26.2 mm TL, 11.9-21.5 mm SL, 0.0187-0.1135 g wet mass) and 17 females with ripe ovaries (in all specimens we found only one ripe ovary per female). Female *Harttiella* had only 3-7 large, yellow, yolk-loaden (1.0-2.5 mm diameter) eggs. Most Loricariidae have spawns consisting of relatively few, large eggs and practice some type of brood care such as cleaning and defense of the spawn (and in virtually all species known to care, it is the male who does so), but the low number of 3-7 mature eggs per female in *H. crassicauda* is extreme even in the family Loricariidae.

A diet based on algae, a low fecundity, sedentary habits and restricted distribution all make *H. crassicauda* very vulnerable to increasing human activities in Nassau Mountains (mining, logging, shifting cultivation). *H. crassicauda* has to be considered an endangered species and it should be included in the IUCN red list of endangered species. Although most catfishes of the subfamily Loricariinae are of little economic interest (e.g. as food fishes) some species are popular with aquarium hobbyists (Evers and Seidel 2005). *Harttiella* is a sensitive species that is easily stressed (and easily dies) both during transportation and in the aquarium when disturbed by tank mates or deprived of shelter (Appendix 15); clearly *Harttiella* can not be recommended for beginner aquarium hobbyists, but even in the case of specialist breeders (e.g. Evers and Seidel, 2005) it is probably wise to restrict collecting this species at Nassau to clearly specified research objectives and under strict conditions (catch quota).

DISCUSSION

We can compare the results of our inventory of the fish fauna of Lely and Nassau Mountains with fish faunas of other mountains in Suriname and Guyana. Data are available for Tafelberg Mountain (Ouboter 2003, P.E. Ouboter pers. communication), Brownsberg Mountain (Mol, personal observations), Bakhuis Mountains (Mol, unpublished results) and, in Guyana, the highlands of the plateau above Kaieteur Falls (Eigenmann 1912). The low number of fish species in the high-altitude streams of Lely and Nassau Mountains reflects the high altitude of the streams. High-altitude streams in Tafelberg (1026 m.amsl) and Brownsberg (514 m.amsl) Mountains also had few fish species, i.e. two species at Tafelberg (*Rivulus amphoreus* and *Erythrinus erythrinus*); and three species at Brownsberg above Koemboe Falls (*Lithoxus surinamensis*, a trichomycterid catfish and an unidentified loricariid catfish; J. Mol and P.E. Ouboter, unpublished results). Small streams in Bakhuis Mountains had more species (about 10-20), but the altitude of the collection sites in Bakhuis Mountains was much lower (<250 m.amsl) than in Lely and Nassau Mountains. In the large Potaro River, Guyana, Eigenmann (1912) recorded 140 fish species below Kaieteur Falls (or 76 species when excluding species of the Essequibo River) and only 23 species on the plateau above the falls (including *C. callichthys*, *Trichomycterus guianensis*, and *Rivulus holmiae*). Eigenmann (1912) collected 5 (22%) new, endemic fish species above Kaieteur Falls, including *Lithogenes villosus*, a peculiar loricariid catfish with its armor reduced to a few ossicles. As expected, the lowland stream in the foot hills of Nassau Mountains had a much larger number of fish species.

It is difficult to estimate how many species occur in the high-altitude streams of Nassau Mountains. Species collected in Nassau Mountains by Geijskens and Creutzberg in 1949 (Appendix 10) and not collected by us during the present RAP expedition are all lowland species (i.e. they were collected at low altitude in the foot hills of Nassau Mountains, not on the plateau). However, our second survey in 2006 added 5 species to the 6 species collected in the high-altitude IJskreek tributary of Paramaka Creek during the RAP survey of November 2005. We think that continued sampling in additional streams and at sites located more downstream from present collection sites would add species to the total. We estimate that at least 15 species occur in the high-altitude streams of Nassau Plateau.

High-altitude streams in both Lely and Nassau Mountains had few species, but the streams of Nassau Plateau had 6 species that are potentially new to science and that potentially have their distribution restricted to the Nassau Plateau (e.g. *H. crassicauda*, *Guyanancistrus* 'big mouth', *Trichomycterus* aff *conradi* and three *Lithoxus* species) while Lely Mountains had none. The reasons for this large difference in endemism are not clear and should be investigated in the future. Some species (e.g. *H. crassicauda* and *Guyanancistrus* 'big mouth') from high-altitude streams of Nassau Mountains are apparently restricted to this small 20x20

km^2 area; with other species endemism has to be established with future collection efforts (*Lithoxus* spp, *Trichomycterus* aff *conradi*). The distribution of some fish species was apparently restricted to high-altitude reaches of a single stream (*H. crassicauda* in Paramaka Creek) or even a tributary of a stream (*Guyanancistrus*-'big mouth' and the slender form of *H. crassicauda* in the northern tributary of Paramaka Creek). The steep slopes of the Nassau Mountains plateau probably are a biogeographic barrier preventing the dispersal of fishes throughout the mountains/plateau.

A striking aspect of the fish communities of the high-altitude streams of Nassau and Lely Mountains is the large number of small-sized species. Although not miniature species according to the criteria of Weitzman and Vari (1988; i.e. species not exceeding 2.6 cm SL), many species of Lely and Nassau Mountains can be considered dwarf species, e.g. *Lithoxus* spp, *H. crassicauda*, *Guyanancistrus* 'big mouth'. Whereas *Harttiella crassicauda* (with 5 cm TL the smallest Loricariinae species) can be considered a derived, dwarf-form of *Harttia*, 'big mouth' can be seen as a dwarf-form of *Guyanancistrus* (the hypothesized relationship of 'big mouth' with *Guyanancistrus* still has to be confirmed by DNA analysis in progress). Both *Harttia* (*H. surinamensis* and *H. guianensis*) and *Guyanancistrus* (*brevispinnis*) are known to occur in the Marowijne and Suriname rivers (Le Bail et al. 2000; Mol et al. in prep). *Lithoxus* are small-sized loricariid catfishes with a restricted geographical distribution endemic to the Guayana Shield (Boeseman 1982, Nijssen and Isbrücker 1990). The occurrence of dwarf species in high-altitude streams may be explained by poor food supply (as indicated by low nutrient concentrations; Table 9.1) or the small size of habitats in these shallow, high-altitude streams. Weitzman and Vari (1988) noted that, with the exception of one pimelodid and some trichomycterid catfish, all 85 miniatures they studied occurred in lentic or slow-flowing, shallow waters, a feature they attributed to the difficulties small fishes have in maintaining position in strong currents. The present collection of several dwarf catfishes from high-altitude streams with strong currents (up to 70 cm/s; Appendix 14) in Nassau Mountains shows that benthocryptic dwarf species actually do occur in fast flowing waters. Although most velocity measurements in IJskreek revealed strong currents, we also detected many spots with counter-currents or still water (e.g. behind boulders) where fishes could 'rest' out of the main current (Appendix 14).

Streams in Lely and Nassau Mountains typically have a sandy, gravel or rocky bottom and oxygen-rich, very clear water (Secchi transparency > 1.5 m; Table 9.1) and the fishes are adapted to these environmental conditions. Mining, which physically disturbs soils and potentially exposes soil to rainfall and thus erosion, has the potential to release fine sediments into streams, increasing the turbidity (suspended sediment concentrations) and depositing a layer of fine sediments (sedimentation) on the streambed and associated structures (rock, woody debris, leaf litter), thus altering the instream habitat of the fishes. Suspended sediment can reduce penetration of sunlight and thus photosynthesis and phytoplankton (algal) growth, while deposited sediment can smother filamentous algae (both diatoms and filamentous algae are major food items in the diet of *H. crassicauda*). Podostemaceae beds in rapids and their associated fish species (and aquatic invertebrates) were also vulnerable to sedimentation (Odinetz Collart et al. 1996). Suspended and deposited sediments can also negatively affect fish reproduction, e.g. by damaging or smothering fish eggs/embryos (Alabaster and Lloyd 1980). Mol and Ouboter (2004) showed that a Surinamese lowland rainforest stream affected by mining-related erosion had low fish species diversity, low proportion of young fishes, high proportion of midchannel surface-feeding fishes (e.g., hatchet fish *Gasteropelecus*) and fishes adapted to low light (e.g., gymnotoids and some catfishes), low proportion of visually-oriented fishes (e.g., cichlids) and fishes that hide in leaf litter and woody debris, and low biomass of food fishes. Many of the fish species of Lely and Nassau Mountains are probably feeding on aufwuchs algae (*H. crassicauda*, *Lithoxus* spp, *G. brevispinnis*, and 'big mouth') and are commonly found over rocks and clean sandy bottoms in clear water. These species would be particularly sensitive to the negative impacts of increased sediment loads.

There is no fishing in the high-altitude streams of Lely and Nassau Mountains; these streams mainly have small-sized species and only 'platkop kwikwi' (*C. callichthys*) of IJskreek can be considered a food fish. Streams in the foot hills of the mountains (e.g. Anjumara Creek, N3) have large-sized fishes (e.g. Anjumara *Hoplias aimara*) and are fished occasionally by Maroons living in the villages of Langatabbetje, Nason and Stoelmanseiland along Marowijne River and small-scale gold miners working in the area. Subsistence and artisanal fishery in lowland tributaries of Marowijne River by Maroons is not a special profession, but rather a part-time activity of vital interest. The Maroons use both traditional methods like hook-and-line, bow-and-arrow, fish traps (Surinamese baskita or maswa), and fish poisons (Surinamese neku, toxic substance is rotenone from the liana *Lonchocarpus* spp.), and modern gill nets. Target food fishes are anjumara (*Hoplias aimara*), patakka (*Hoplias malabaricus*), tukunari (*Cichla ocellaris*), kubi (*Plagioscion* spp.), piren (*Serrasalmus rhombeus* and *S. eigenmanni*), paku/pakusi (*Myleus rubripinnis* and *M. ternetzi*), kumaru (*Myleus rhomboidalis*), moroko (*Brycon falcatus*), sardine (*Triportheus brachipomus*), kwimata (*Prochilodus rubrotaeniatus*), waraku (*Leporinus* spp.), prake or stroomfisi (*Electrophorus electricus*), spikrikati (*Pseudoplatystoma* spp.), plarplari (*Ageneiosus* spp.), kwikwi (*Megalechis thoracata* and *Callichthys callichthys*), krobia (Cichlidae spp.), and other species. The majority of the catch is consumed fresh, but considerable quantities are also salted, dried, and smoked for preservation. Some are transported to Paramaribo.

The lowland streams in the foot hills of Lely and Nassau Mountains have many species that are well-known to ornamental fish hobbyists: pencil fish *Nannostomus bifasciatus*, splashing tetras *Copella carsevennensis* and *Pyrrhulina*

filamentosa, dwarf-cichlid *Nannacara anomala*, leaf fish *Polycentrus schomburgkii*, and *Moenkhausia hemigrammoides*, *Steindachnerina varii*, *Helogenes marmoratus*, (Appendix 11) and *Leporinus* spp, *Hemigrammus unilineatus*, *Hemibrycon surinamensis* (Appendix 10). The high-altitude streams of Lely and Nassau Mountains also have several small-sized fish species of potential interest to ornamental fish hobbyists. These potential 'aquarium species' include two *Rivulus* species, *Ancistrus temminckii*, *Guyanancistrus brevispinnis*, *Lithoxus* spp, *Harttiella crassicauda*, and 'big mouth'. However, because some species of Nassau Mountains have a very restricted distribution (i.e. *H. crassicauda* and 'big mouth' apparently restricted to Nassau Plateau) and the distribution of other species is not well understood (*Lithoxus* spp), collection and export of fishes from high-altitude streams in Nassau Mountains for use as ornamental (aquarium) fishes should be prohibited.

ENVIRONMENTAL ISSUES AND CONSERVATION RECOMMENDATIONS

Lely and Nassau Mountains are concessions of the joint venture Suralco(Alcoa)/BHP-Billiton bauxite mining companies. Suralco is also involved in large-scale gold exploration by Newmont in the foot hills of Nassau Mountains. Both Nassau and Lely Mountains are key components of a larger, international protection plan for the Guayana Shield (Huber and Foster 2003). Our fish survey shows that the watersheds on the plateau are largely intact in both Lely and Nassau Mountains. However, in both Lely and Nassau Mountains, human activities (gold mining, logging, agriculture, hunting) threaten the integrity of the aquatic ecosystems in the foot hills. Considerable effects of human activities (e.g. sedimentation in streams, deforestation) were observed in the northern foot hills of Nassau Mountains.

We encountered no exotic or invasive fish species in the streams of Nassau and Lely Mountains. The current abundance of fishes and excellent condition of the fish fauna in the high-altitude streams in Nassau and Lely Mountains is dependent upon the preservation of the healthy and pristine condition of the watersheds, especially the upper catchment of the head waters on the plateau. Mining of the plateau would potentially expose these head water streams with clear water to sediments re-worked by mining and change the structure of the fish communities (e.g. Mol and Ouboter 2004). For example, the endemic catfish *Harttiella crassicauda* would be affected by (1) food supply (turbidity and sedimentation negatively affect stream algae) and (2) reproduction (smothering and/or abrasion of eggs and larvae).

High-altitude streams in Lely Mountains offer excellent opportunities for conservation because human population densities in the area are low and, consequently, human impact on the aquatic ecosystems is also low. However, fish species diversity and endemism is low. The remoteness of Lely Mountains adds to its importance as a conservation area.

Fish diversity of high-altitude streams in Nassau Mountains is also low, but conservation of these streams is extremely important due to the occurrence of unique species like *Harttiella crassicauda* and *Guyanancistrus* 'big mouth'. The endemic catfish *H. crassicauda* has an extremely restricted geographic distribution: it probably occurs in only one high-altitude stream in the 20x20 km^2 area of Nassau Mountains. At present its occurrence has been proved only for two tributaries of Paramaka Creek at 370-535 m.amsl altitude, notwithstanding considerable collection effort in both Suriname (Ouboter and Mol 1993) and French Guiana (Le Bail et al. 2000). Because most fish species of high-altitude streams of Nassau Mountains are probably not widely distributed and some species may be endemic to Nassau Mountains (e.g. *Harttiella crassicauda*, *Guyanancistrus* 'big mouth') we agree with Sheldon (1988) that conservation efforts should focus on the largest natural drainages as possible (i.e. the entire watershed of the streams draining Nassau Mountains). In other words, ecosystem management as opposed to species management. Activities that cause erosion, turbidity, sedimentation, changes to the natural hydrological cycle of the streams (e.g. deforestation), and/or pollution, have the capacity to diminish forever (1) the pristine character and biological value of streams in Nassau Mountains and (2) opportunities for studies into ecological and evolutionary processes that shaped the unique fish fauna of the mountains. Such activities that lead to degradation of the pristine environmental conditions must be prevented.

Although opportunities for conservation of Nassau Mountains are good, the potential threat of human impact is growing. Threats include not only bauxite and gold mining, but also forestry, tourism, and unregulated hunting. Most of the unique fish species of the plateau of Nassau Mountains were collected in Paramaka Creek and the upper catchment of this stream should be protected carefully (e.g. entrance to the concession should be strictly controlled by the mining companies Suralco/BHP-Billiton or Surinamese Government). Additional surveys of both lowland streams in the foot hills (especially Paramaka Creek) and high-altitude streams on the plateau of Nassau (and Lely) Mountains are needed to better understand (1) the ecology and evolution of the unique fish communities of the plateau and (2) diversity and endemism of Guayana Shield fish faunas in general. Continuing work is also required to confirm the taxonomy of a further six species collected in Nassau Mountains. Actions should be taken to submit *Harttiella crassicauda* for inclusion in IUCN red list of endangered species. A great responsibility is in the hands of the Surinamese government, concession holder Suralco/BHP Billiton and NGOs like Conservation International and WWF.

The flora and fauna of Nassau Mountains is very fragile; we recommend that Nassau Mountains is declared a protected area (nature reserve). In a corridor outside the reserve, forestry and mining should be prohibited and hunting (and fishing) regulated and monitored carefully, involving local people in setting regulations or limits. Hunting and fishing

(including the collection of aquarium fishes) should be prohibited in the reserve. Ecotourism is excellent for developing public awareness and appreciation of Nassau Mountains, but it can also easily have a negative impact because of the fragility of the ecosystems of Nassau Mountains. A tourist camp should be constructed outside the Paramaka Creek watershed and camping should be restricted to this site. A small exhibition building with posters and aquariums should be set up at the tourist camp to inform visitors of the species and ecosystems of Nassau Mountains. Trails should be plotted in the mountains (comparable to Brownsberg Mountains). Bathing in Paramaka Creek should be prohibited. All tourism should be regulated and monitored.

In conclusion, the pristine character of the Nassau and Lely Mountains should be carefully protected, since the unique fish faunas of the mountains evoke questions related to ecological/evolutionary processes that may explain the origin of fish diversity in the Guayana Shield region.

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Chapter 10

A preliminary survey of amphibians and reptiles on the Nassau and Lely plateaus Eastern Suriname

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INTRODUCTION

Amphibians and reptiles are a species-rich and often conspicuous component of many neotropical forests. Three aspects of amphibians and reptile biology make them a valuable focal group for biological surveys: (1) the small body size of many species often results in high population densities, making it possible to collect a large amount of data in a relatively short period of time; (2) they perceive their environment on relatively small scales and many species show strict habitat requirements, making it possible to compare diversity patterns across finely-defined habitats; (3) their intermediate role in food webs ties them to both primary and secondary consumers. Amphibians are of particular interest because their moist, permeable skin makes them more sensitive to changes in their environment (e.g., contamination, climate change) than other vertebrate groups, and the biphasic lifestyle of many species exposes them to changes in both aquatic and terrestrial environments. Widespread reports of enigmatic amphibian declines in seemingly pristine locations are of urgent conservation concern (Lips 1998), and it appears that amphibians as a group are more threatened than other terrestrial vertebrates (Stuart et al. 2004, Beebee and Griffiths 2005). As part of the CI RAP survey in eastern Suriname, we surveyed the herpetofauna of Nassau and Lely mountains for six days each. Here we compare three response metrics (species richness, species composition, and an estimate of density) between the two mountains, and place these preliminary observations in a regional context by making comparisons with other sites in the Guayana Shield and the Amazon Basin. We also describe the distribution of species at a regional scale and among macrohabitats at the two sites, and discuss the conservation implications of our observations.

METHODS

We surveyed amphibians and reptiles for six days each at the Nassau mountain (25 – 30 October 2005) and Lely mountain (1 – 6 November 2005) using a combination of opportunistic surveys and time-constrained Visual Encounter Surveys (VES). Opportunistic surveys require actively searching for animals over large areas (i.e., up to several square kilometers) in order to increase the probability of encountering as many different species as possible. This method is effective for sampling species richness (Donnelly et al. 2004), but because not all individuals encountered are recorded, and cryptic or inactive individuals may be easily overlooked, the method is inappropriate for comparing density. In contrast, VES involve intensive sampling over small areas (i.e., a few hundred square meters) and all individuals encountered are recorded, making it possible to calculate an index of density by comparing the number of individuals encountered per unit time (Crump and Scott 1994). We conducted opportunistic surveys throughout the range of habitats available at each site, walking trails, forest creeks, and searching in natural and anthropogenic clearings both day and night throughout our stay. We conducted ten VES (eight nocturnal and 2 diurnal) at each site, concentrating effort in forest and forest stream habitats (Table 10.1).

Species richness

Because observed species richness is almost always an underestimate of true species richness (Colwell and Coddington 1994, Hellmann and Fowler 1999), we used program EstimateS (Colwell 1997) to calculate extrapolated estimates of amphibian and reptile richness of each site. There is considerable debate as to which of the many species richness estimators provides the most robust results (Hellman and Fowler 1999, Herzog et al. 2002), so we included four of the most commonly used estimators (ACE, ICE, Chao1 and MMMean). We included observations from both VES and opportunistic encounters in our analysis because few reptiles were encountered during VES surveys at Lely, making it impractical to estimate species richness from only that data set. Although not all individuals of all species were recorded during opportunistic surveys, the combined data set accurately reflects observed species abundances (i.e., rare species only occur once or twice in the entire data set, whereas the most commonly encountered species appear frequently), so we assume that the combined data set provides a reasonable basis for comparing species richness between sites.

Species composition

In addition to comparing species richness on the two mountains, we also wanted to describe overlap in species identity. We began simply by comparing the number of species occurring at only one of the sites with the number occurring at both sites. We conducted a formal test of the compositional difference between the two mountains using analysis of similarity (ANOSIM) based on the Bray-Curtis dissimilarity index (Clarke and Warwick 2001), and present these results in a non-metric multidimensional scaling nMDS) graph. Species composition is known to vary with geographic distance (Steinitz et al. 2005), so in addition to establishing that a compositional difference between the two sites exists, we also wanted to determine whether the difference in species composition between Nassau and Lely was more or less than would be expected given the distance between the two mountains. We compiled data on amphibian and reptile surveys from five sites in the Guayana Shield: Nouragues and Arataye, French Guiana (Born and Gaucher 2001); Petit Saut, French Guiana (Duellman 1997), Piste Ste. Elie, French Guiana (Born and Gaucher 2001); and Iwokrama, Guyana (Donnelly et al. 2005). Distance between these sites ranged from 64 – 713 kilometers. Herpetofaunal survey data are available for eight sites separated by a maximum distance of 263 kilometers in the Madre de Dios region of southeastern Peru (Duellman and Thomas 1996, Morales and McDiarmid 1996, Doan and Arriaga 2002), and because distances among sites in Madre de Dios are more similar to those of interest here (straight-line distance between Nassau and Lely is approximately 63 kilometers), we include a comparison with those sites as well. Although some species certainly remain undetected at sites in the Guayana Shield and Peru, those sites are relatively well-sampled compared with Nassau and Lely. For all pairs of sites, we calculated straight-line distance based on coordinates included in the primary literature cited above. We compiled a species by site presence/absence matrix for all sites and calculated dissimilarity among all pairs of sites using the Bray-Curtis dissimilarity index in Program Primer (Clarke and Warwick 2001).

Density

In order to have maximal flexibility and not be constrained to surveying fixed transects that may have resulted in the observation of few individuals, we opted to constrain our VES by time rather than area. At each site we conducted ten VES, eight nocturnal and two diurnal. As an index of density, we calculated the number of individuals encountered per survey minute (# individuals/# minutes surveyed),

Table 10.1. Schedule of herpetofaunal sampling at Nassau and Lely, October-November, 2005.

Nassau			Lely		
25-Oct	AM	Arrive	1-Nov	AM	Arrive
	PM	VES: Forest		PM	Opportunistic survey: Forest & Clearing
26	AM	Trap Preparation			VES: Forest
	PM	VES: Stream & Forest	2	AM	Opportunistic survey: Forest & Stream
27	AM	Opportunistic survey: Forest & Plateau A		PM	VES: Stream
	PM	Opportunistic survey: Stream	3	AM	Prepare specimens
		VES: Stream & Forest		PM	Opportunistic survey: Forest
28	AM	Prepare specimens			VES: Forest
	PM	VES: Stream	4	AM	VES: Forest
		Opportunistic survey: Forest		PM	VES: Stream
29	AM	VES: MSF			VES: Forest
	PM	VES: Swamp Forest	5	AM	Prepare specimens
		VES: Forest		PM	Opportunistic survey: Forest
30	AM	VES: Forest			VES: MSF
	PM	VES: MSF			VES: Forest
		VES: Forest	6	AM	VES: Forest
				PM	VES: Forest

averaged this value across all ten surveys, and multiplied this average by 60 to provide an average number of individuals encountered per hour of survey at each site.

Species-specific data

When individuals of new species were encountered during opportunistic surveys, we noted the habitat in which the observation occurred. Similarly, we noted the habitat where VES occurred. Thus, we are able to assign species occurrences to one or more habitat categories: forest, forest stream, clearing, berg forest (Nassau only), swamp forest (Nassau only), savannah forest (Lely only), or forest clearing (Lely only). Because of the complex interdigitation of savannah forest and high forest around the camp at Lely, we refer to both as 'forest'. We did survey a discreet patch of berg forest east of the main camp at Nassau, and a patch of savannah forest with many bromeliads near the northeastern corner of the airstrip at Lely. We assigned each species to one of two regional distribution patterns: Guayana Shield for those species endemic (or nearly so) to the Guayana Shield, and Widespread for species that also occur beyond the boundaries of the Guayana Shield. Distributional data were taken from Ceñaris and MacCulloch (2005) for amphibians and Ávila Pires (2005) for reptiles. Threat status for each species was established based on IUCN Red List guidelines (www.iucnredlist.org). Data for amphibians were taken from the Global Amphibian Assessment online database (www.globalamphibians.org). Data on the crocodilian were extracted from the IUCN website. For the lizards and snakes (for which no IUCN specialist group currently exists) we used our knowledge of probable distributions and potential threats to assign a threat status based on IUCN criteria. We did not include threat status for unidentified species thought to represent new species for science, because determination of threat status will require more survey work to establish the geographic range of those species.

Table 10.2. Herpetofaunal richness at nine sites in the Guayana Shield, including Nassau and Lely mountains. In each column, data are presented as raw species number/percentage of total herpetofauna.

Site	Amphibians	Reptiles	Total
Iwokrama	37/0.34	71/0.66	108
Nouragues	51/0.47	58/0.53	109
Arataya	62/0.49	65/0.51	127
Piste Ste. Elie	33/0.38	53/0.62	86
Trois Saut	56		
Petit Saut	37/0.28	94/0.72	131
	mean = 46 species	mean = 68 species	mean = 112 species
Brownsberg	64/0.44	80/0.56	144
Nassau	16/0.55	13/0.45	29
Lely	20/0.55	16/0.45	36

RESULTS

We observed a total of 49 species in 12 days of sampling at the two sites (Table 10.2). The data presented herein include only species observed by the two authors; species observed by other members of the RAP team and on a herpetological expedition to Lely in 1979 are included in Appendix 16. Comparison with other well-studied sites in the Guayana Shield indicate that many species remain undetected on the two mountains, and that reptiles were undersampled on the RAP relative to amphibians (because they represent a smaller percentage of the total herpetofauna at RAP sites than at more well-sampled sites, Table 10.2). Despite the fact that many species remain to be detected on both mountains, preliminary observations indicate that Lely appears to be the richer of the two mountains; we observed 36 species there and 29 at Nassau (Figure 10.1). Extrapolated species richness estimates were largely consistent with the notion of higher richness at Lely than Nassau (Table 10.3). However see Chapter 11 for additional data from Nassau.

A simple review of the species list for the two sites indicates that species composition differs between Nassau and Lely, with only 15/49 = 31% of all species occurring on both mountains. Forty-eight percent of the species at Nassau were unique to Nassau, whereas the percentage was 57% at Lely. As expected, the species occurring at the two sites represented a mix of widespread species that occur throughout lowland portions of much of the Amazon Basin, in addition to species known from lowland forest of the Guayana Shield (Appendix 16). Five records are particularly noteworthy because they represent taxa that could not be assigned to any known species. Four of these records were species of the genus *Eleutherodactylus*; one species was encountered at both Lely and Nassau, whereas the other three new species of *Eleutherodactylus* were found at Lely. We also collected what appears to be an undescribed species of *Adenomera* at Lely. Bray-Curtis dissimilarity between Nassau and Lely is 51.7% for reptiles and 44.4% for amphibians, and the two mountains are compositionally distinct (Global R = 0.669, P = 0.002; Figure 10.2). Comparison of the regression

Table 10.3. Observed and estimated species richness for amphibians and reptiles at Nassau and Lely.

Group	No. individuals	Species (observed)	ACE	ICE	Chao 1	MMMeans	Mean (estimates)
Lely frogs	91	19	21.91	22.91	20.2	27.65	23.1675
Lely reptiles	32	16	35.62	52	29.75	43.04	40.1025
Nassau frogs	88	16	18.26	18.68	22	21.37	20.0775
Nassau reptiles	32	15	23.96	25.99	29	25.47	26.105

lines describing the relationship between compositional dissimilarity and geographic distance among sites in the Guayana Shield and Tambopata, Peru reveal that observed dissimilarity between Nassau and Lely is greater than would be expected based on observations from the reference sites (Figure 10.3).

Like richness, herpetofaunal density was higher at Lely (mean = 7.4 individuals/hour) than at Nassau (4.5 individuals/hour). At Nassau, the highest density of individuals occurred in transects running through the IJskreek and forest adjacent to the stream, and lowest in savannah forest. At Lely, density was greatest in forest streams, slightly lower in forest, and lowest in savannah forest.

Habitat use, distribution, and threat status for each species are presented in Appendix 16. We draw particular attention to the observation that forest streams are important habitat for many species encountered during our surveys. Just under half of the species occurring at each site made use of forest streams, and one quarter of the species encountered at Lely and one third of the species encountered at Nassau were only found in or along forest streams. In addition, two of the five new species encountered during our surveys were associated with forest streams. At Lely, density was higher in forest streams than in any other habitat, whereas at Nassau, density was broadly similar between forest and streams, but higher there than in other habitats. Overall, we suggest that forest streams be considered keystone habitat structures (Tews et al. 2004) of paramount biological and conservation value at the two sites because (1) they cover a small proportion of the total habitat at each site, (2) house a substantial fraction of overall herpetofaunal richness at the two sites, (3) are an important habitat for undescribed and probably narrowly endemic taxa recorded during our surveys, and (4) at Lely, have a greater herpetofaunal density than any habitat surveyed.

DISCUSSION

In our short surveys we sampled only a fraction of what is likely a rich herpetofauna on both mountains. Estimated species richness estimates for amphibians and reptiles were not much greater than observed richness (Table 10.3). Our impression is that low estimated richness is a function of seasonal fluctuations in activity (for amphibians) and small sample sizes (for both amphibians and reptiles), rather than being indicative of a depauperate herpetofauna on the two mountains. The rapid accumulation of species during a dry period during which many amphibians and reptiles were likely inactive is suggestive of potentially high richness, as is the geographic proximity to sites in western French Guiana with the highest known richness of amphibians and reptiles in the Guayana Shield (Petit Saut and the Nouragues reserve; Table 10.2). Comparison of our species accumulation curves with those from other sites indicate that species accumulated faster at Lely and Nassau than at individual camps in the Iwokrama reserve in Guyana (Donnelly et al. 2004), and were more similar to species-rich sites in the western Amazon (Duellman and Mendelson 1995, Cadle et al. 2002, Moravec and Aparicio 2005). Although sampling on the two mountains is far from complete, available evidence suggests that Lely is likely to be the richer of the two sites.

Our observation that compositional dissimilarity between the two mountains is greater than expected given their geographic distance suggests that conservation of both areas is not redundant, but necessary in order to conserve a representative regional fauna. Beyond acting as reservoirs of a rich herpetofauna, the two mountains are home to a suite of endemic taxa that is of great regional importance. Particularly striking was the four *Eleutherodactylus* species encountered during our surveys. Previous to our surveys, five species of *Eleutherodactylus* were known from Suriname; our work on the two mountains has almost doubled the representation of the genus in the country.

Two of the new species encountered during our surveys (*Adenomera sp*. and *Eleutherodactylus* sp. 1) utilized both forest and forest stream habitats and were abundant where they occurred. The three other new species (*Eleutherodactylus* sp. 2, *Eleutherodactylus* sp. 3, and *Eleutherodactylus* sp. 4) were found in the forest at Lely and were represented by only one or two individuals each. Although the forest-inhabiting *Eleutherodactylus* appeared to be rare, they likely occur throughout the forest and because they do not require standing water for breeding, their persistence is not as dependent on particular habitat requirements as the other frogs. Therefore, we consider the species associated with forest streams to be the most in need of conservation attention. Amphibians tend to have limited dispersal abilities, often moving less than 500 m (Smith and Green 2005). Because body size of the remaining four new species is small (< 40 mm, implying relatively limited dispersal abilities; Etienne and Olff 2004) and they appear to be reliant on a habitat type that is relatively scarce in the landscape, it may be unlikely that individuals can move to more suitable habitat (i.e., another stream) if they are disturbed. Amphibians tend to be dietary generalists, feeding on a variety of arthropods (Duellman 1978, Parmelee 1999), so it is unlikely that distributions of any of these species are limited by the availability of food resources. Protection of streams where they are known to occur should be considered the best conservation action for these new species, as well as the other species that utilize forest stream habitat on the two mountains.

Streams are a keystone habitat feature of critical importance for amphibians at Nassau and Lely. Almost half of the species encountered during our surveys made at least some use of streamside habitat. Stream-associated amphibians are of paramount conservation significance because many species in this guild have experienced precipitous population declines (Lips et al. 2003). Like virtually all other taxonomic groups, amphibians have been affected by habitat loss and fragmentation, overharvest, and other anthropogenic disturbances. More alarming are population declines, many

to the point of extinction, of amphibians in protected areas where the agent of decline is not so obvious. These enigmatic declines have resulted in the loss of many moderate- to high-elevation anurofaunas (Young et al. 2001), so the presence of abundant, diverse, stream-associated amphibian assemblages at Nassau and Lely is of significant conservation value. The densities we observed at Nassau and Lely are comparable to pre-decline data from forest streams and adjacent forest in Panama (Lips 1999), suggesting that the stream-associated fauna of Nassau and Lely have not experienced the dramatic declines that have occurred in other parts of the Neotropics (Young et al. 2001). This provides an excellent opportunity to protect an intact, upland stream-associated herpetofaunal assemblage.

CONSERVATION RECOMMENDATIONS

Our first and foremost conservation recommendation is to maintain the integrity of forest streams at both Lely and Nassau. Anthropogenic activity at Lely is minimal, so there are no current threats, but every attempt should be made to ensure that future activity at Lely be kept away from stream habitats. The stream at Nassau probably has been impacted and will continue to be impacted by the higher level of human activity. Of most concern is the presence of the camp clearing and a dirt path used by motorized vehicles that crosses the Ijskreek through the clearing. Because of the possibility that human activity may negatively impact stream quality at Nassau, we make the following recommendations:

(1) Because sedimentation and runoff from the clearing and the road have the potential to impact water quality in the stream, we recommend that no further expansion of the existing camp take place, and that vehicular traffic across the stream be reduced to an absolute minimum.

(2) The immediate initiation of a water-quality monitoring project in conjunction with herpetofaunal surveys. We suggest twice yearly surveys of the stream-associated herpetofauna at Nassau using fixed monitoring points established throughout the watershed. Species may be located visually and/or acoustically, but we recommend the utilization of a visual method (i.e., VES) in order to estimate population density as accurately as possible. Because interspecific variation in detection probabilities may compromise results (Mackenzie and Royle 2005), it will be necessary to incorporate methods that will allow for robust density estimation (discussed in Schmidt 2004). Concomittant with the faunal surveys, we recommend the collection of basic water quality data (dissolved oxygen, conductance, temperature, pH, and turbidity) at the beginning of each transect or monitoring point.

(3) An ongoing monitoring project to detect the presence of *Batrachochytrium dendrobatidis* in adult frogs along forest streams. *Batrachochytrium dendrobatidis* is a chytrid fungus that has been linked to amphibian declines in many parts of the Neotropics (Lips et al. 2005), and although we are not aware of reports of amphibian declines from the Guianas, conditions favorable for the occurrence of *B. dendrobatidis* are predicted to occur in the vicinity of Nassau and Lely mountains (Ron 2005). The presence of *B. dendrobatidis* can be detected via analysis of dermal swabs from live animals. We recommend collecting 300 swabs/visit (i.e., one swab per individual from the first 300 individuals encountered). To detect the presence of *B. dendobatidis*, analysis may be conducted on pooled samples of 10 swabs. If the fungus is detected, individual analysis of all swabs will be necessary to identify infected species. Should *B. dendrobatidis* be detected, the Declining Amphibian Population Task Force (http://www.open.ac.uk/daptf/index.htm) may be contacted for recommended action.

(4) We recommended expanded surveys of streams on the two mountains and in adjacent lowlands in order to more accurately quantify abundance and extent of occurrence of stream-associated frogs, particularly new species whose distributions are unknown. Determining the IUCN red list status of these five species will hinge on estimating the geographic range of these species, so a special effort should be made to determine their extent of occurrence.

(5) It is difficult to provide meaningful guidelines for the area required to effectively protect amphibian populations because the availability of breeding habitat is probably more important than area per se (Zimmerman and Bierregaard 1986). Reptiles, on the other hand, probably benefit more from larger areas, though relative to endothermic vertebrates their energetic needs (and therefore area required to sustain populations; Pough 1980) are low. It has been suggested that the 1500 ha of the La Selva reserve in Costa Rica is sufficient to protect the herpetofauna at that site (Guyer 1994), although population declines of both amphibians and reptiles have occurred there (S. Whitfield pers. com.). We therefore regard 1500 ha as the 'minimum critical area' necessary to protect a reasonably intact sample of the local herpetofauna, and suggest that at least this amount be preserved within the concessions at Lely and Nassau. Additionally, because we have identified streams as keystone habitat whose importance is disproportionate to their area, we recommend a forest buffer of at least 50 m (Lee et al. 2004) on both sides of all creeks running through the concessions.

Authors' note: As this chapter was going to press, we became aware of a record of the toad *Atelopus* cf. *spumarius* from the forest near the basecamp at Nassau. *Atelopus spumarius* is a polymorphic taxon, and it is possible that more than one species is included under the name (some authors recognize the Guayana Shield taxon to be a distinct

species, *A. hoogmoedi*). Although *A. spumarius* (as either *A. spumarius* sensu stricto or *A. hoogmoedi*) has a larger geographic range than many species of *Atelopus,* these toads have experienced precipitous population declines in much of Latin America, most likely due to infection by *B. dendrobatidis*, and *A. spumarius* senso lato is classified as vulnerable by the IUCN. A population of *Atelopus* at Nassau would therefore be of significant conservation concern. We recommend that efforts to establish the extent of occurrence of the new taxa encountered during our surveys include *A.* cf. *spumarius*.

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Chapter 11

Additional records of amphibians and reptiles from Nassau Mountain, Suriname

Paul E. Ouboter, Rawien Jairam and Kenneth Wan Tong You

INTRODUCTION

Following the CI RAP survey of October-November 2005, Nassau Mountain was visited again for a fish survey from March 29 - April 4, 2006 (short dry season). During this survey observations of amphibians and reptiles were noted as well. Thereafter a 10-day survey for amphibians and reptiles was carried out from July 15-24, 2005 (long rainy season). These surveys provided so much addition information that it is worthwhile to include these data in the RAP report.

METHODS

During the March-April 2006 fish survey, amphibians and reptiles were only recorded when a species was accidentally encountered. This survey covered part of the plateau and upper slopes of Nassau Mountain, above an altitude of 250 m. During the July survey, line transects were walked during the morning, afternoon and night and every specimen was identified and recorded. If specimens could not be identified on sight, they were collected for later identification. In addition, frog calls were recorded for later identification by comparison with known frog calls. This survey covered only a small part of the plateau of Nassau Mountain, approximately 6 km in diameter around the base camp at the upper IJskreek. These methods provided information on species richness, composition and abundance. Specimens collected are preserved in the National Zoological Collection of Suriname (NZCS).

RESULTS AND DISCUSSION

During the March/April and July 2006 surveys a total of 26 species of amphibians and 19 species of reptiles were recorded (Table 11.1). The amphibians were all frogs, the reptiles included one turtle, one crocodilian, 14 lizards and three snakes.

Of the species recorded, 11 species of amphibians were also reported during the RAP survey (Watling and Ngadino 2007, this volume), 15 species were not. The total number of amphibians now known for the Nassau Mountain (plateau and upper slopes) is 31 species. Of the reptiles, 8 species were also recorded by the RAP team, 11 species were not. This brings the total number of reptiles known from Nassau Mountain to 26 species.

Several species of special interest were collected. The *Atelopus* sp. found was very similar to *A. spumarius hoogmoedi* in shape and pattern, but instead of having yellow rings on a black dorsal and lateral color, it has pink rings (see photo pages). Only one specimen was found in March. Extensive searching for it in July did not produce another specimen, so it seems to be very rare.

The *Epipedobates trivittatus* specimens in this area have orange dorsolateral stripes, instead of green or green-yellow ones, as in specimens from other areas in Suriname. It should therefore be treated as a subspecies of *E. trivittatus*, awaiting formal description. A report by Hoog-

Table 11.1. Amphibians and reptiles recorded during the March/April and July surveys in 2006. Species recorded during the October/November 2005 RAP survey are also included for comparison. Numbers indicate number of specimens collected.

Taxon	March/April survey 2006	July survey 2006	Species recorded during RAP survey
ANURA			
Bufonidae			
Atelopus sp.	1		
Bufo guttatus		2	X
Bufo margaritifer complex		6	X
Bufo marinus		7	X
Centrolenidae			
Cochranella sp.		5	
Dendrobatidae			
Colostethus beebei	1		
Colostethus beobatrachus		6	X?
Colostethus degranvillei	12	26	X
Allobates femoralis	2	2	
Epipedobates trivittatus subsp.	18	11	X
Hylidae			
Phyllomedusa bicolor		15	
Phyllomedusa hypochondrialis		2	
Phyllomedusa tomopterna		3	
Hyla boans	6	5	X
Hyla crepitans	1	21	X
Hyla geographica		2	
Hyla leucophyllata		8	
Hyla marmorata			X
Hyla minuta		18	
Hyla sp. 1		6	
Osteocephalus taurinus		1	X
Leptodactylidae			
Adenomera cf. *andreae*			X
Adenomera sp.		1	
Eleutherodactylus chiastonotus			X
Eleutherodactylus sp. 1		1	X
Leptodactylus bolivianus		1	
Leptodactylus knudseni		7	
Leptodactylus mystaceus		25	X
Leptodactylus pentadactylus			X
Microhylidae			
Chiasmocleis shudikarensis			X
Pipidae			
Pipa aspera		1	
TOTAL NUMBER OF AMPHIBIANS	**26**		**16**
COMBINED TOTAL		**31**	
CHELONIA			
Chelidae			
Platemys platycephala		2	
Emydidae			
Rhinoclemmys punctularia			X
SQUAMATA - SAURIA			
Gekkonidae			
Coleodactylus amazonicus		2	
Gonatodes annularis		1	
Gonatodes humeralis		2	

Taxon	March/April survey 2006	July survey 2006	Species recorded during RAP survey
Polychrotidae			
Anolis fuscoauratus			X
Anolis nitens chrysolepis		4	X
Anolis ortonii	1		
Tropiduridae			
Plica plica		3	
Plica umbra		1	
Uranoscodon superciliosus		1	
Gymnophthalmidae			
Arthrosaura kockii	1	6	X
Cercosaura ocellata		1	X
Iphisa elegans			X
Leposoma guianense		3	
Neusticurus rudis			X
Teidae			
Ameiva ameiva	6	3	X
Kentropyx calcaratus	14	4	X
Scincidae			
Mabuya nigropunctata		1	X
SQUAMATA - SERPENTES			
Colubridae			
Atractus zidoki		1	
Chironius sp.			X
Dipsas catsebyi			X
Dipsas pavonina		1	
Liophis sp.			X
Viperidae			
Bothrops atrox	4	2	X
CROCODILIA			
Alligatoridae			
Paleosuchus trigonatus		2	X ?
TOTAL NUMBER OF REPTILES	**19**		**15**
COMBINED TOTAL	**26**		

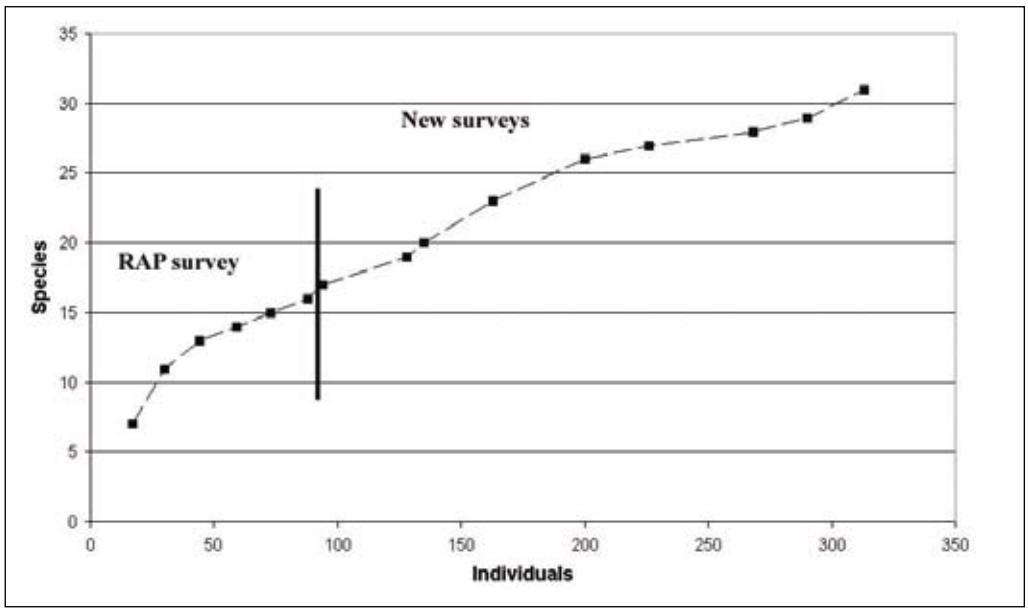

Figure 11.1. Species accumulation curve for amphibians in the Nassau Mountains.

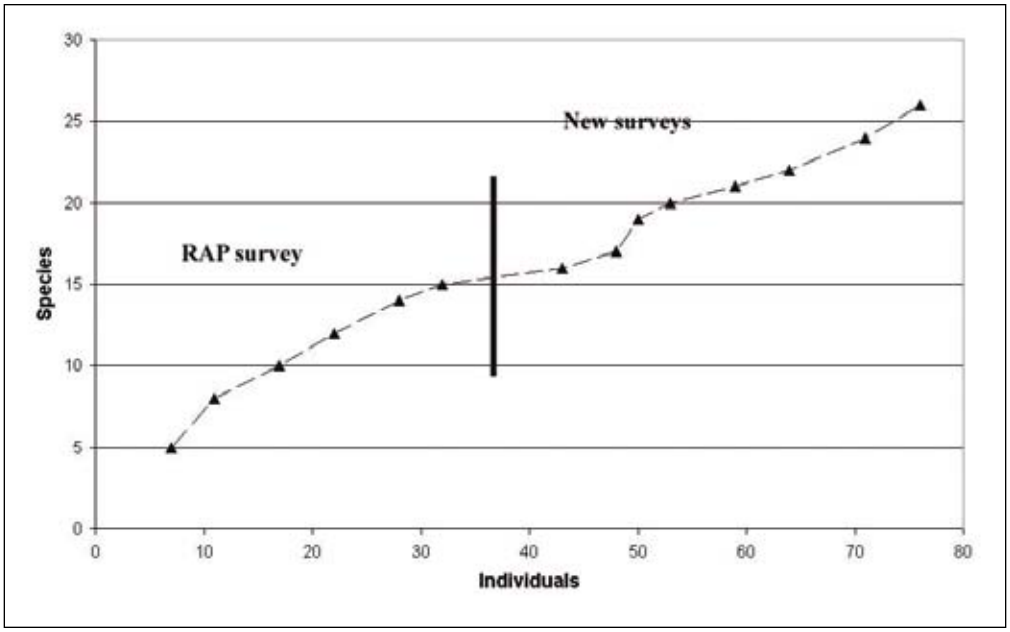

Figure 11.2. Species accumulation curve for reptiles in the Nassau Mountains.

moed (1975) mentions orange-striped *E. trivittatus* from both Lely and Nassau Mountains.

The *Adenomera* sp. found at Nassau, on the basis of photographs seems very similar to the *Adenomera* sp. recorded by the RAP team at Lely Mountain. These specimens could represent a new species to science as was already suggested by Watling and Ngadino (2007, this volume) for the Lely specimen, and should be investigated in more detail.

The *Eleutherodactylus* sp. found by us at Nassau, seems to be the *Eleutherodactylus* sp. 1 listed by Watling and Ngadino as a new species. Cooperation in describing this new species has already been established.

Our results show that it is very difficult to draw conclusions regarding total number of species on the basis of a single survey. The accumulation curve presented for amphibians by Watling and Ngadino seems almost to flatten, indicating that a high percentage of the species present is detected. However, new surveys almost doubled the number of amphibians for the mountain, and including the new data, the accumulation curve continues to increase (Figure 11.1). This shows that accumulation curves are only valid for the community of species active during the period of the survey and therefore only for the season in which the survey is carried out. Also estimates of species richness are decreased by species not active during survey periods. The RAP team's mean estimate for the number of frogs at Nassau, approximately 20, is far exceeded. The mean estimate of species richness for reptiles is approximately 26, which is the present figure of species known for the area. However, on the basis of zoogeography and the species composition of comparable mountain ranges like Brownsberg and Bakhuis, it can be predicted that many reptile species are still to be found on Nassau Mountain. The accumulation curve for reptiles (Figure 11.2) shows a distinct slope, indicating that the inventory of reptiles is far from complete. We anticipate that the number of amphibians might also increase drastically with new surveys, especially when the lower slopes of Nassau Mountain are included. For the Bakhuis Mountains, three surveys with a combined duration of 66 days produced 58 species of amphibians and 47 species of reptiles (Ouboter, pers. obs.).

At present only a part of the herpetofauna of Nassau and Lely Mountains is known: the more common species and a random number of rarer species. An obvious conclusion is that, as long as additional data do not become available for the Nassau and Lely mountains, comparisons between the two mountains and with other areas could easily result in wrong conclusions.

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Chapter 12

A rapid assessment of mammals of the Nassau and Lely plateaus, Eastern Suriname

Sergio Solari and Miguel Pinto

INTRODUCTION

Mammals, along with birds, constitute the most important groups of vertebrates in terms of economic importance for people. They are found everywhere in the World, and recent estimates suggest more than 5400 species (Wilson and Reeder 2005). In the Neotropical region, they are very diverse and some groups are exclusive to this geographic area. Small mammals, such as opossums, bats, and rodents, are particularly diverse and constitute a primary component of the Neotropical rainforests (Eisenberg 1989, Emmons and Feer 1997, Voss and Emmons 1996). Through seed dispersal, pollination, mycorhizal dispersal and control of insect populations and as part of the food chain for carnivorous animals, the small mammals help in the natural functions of ecosystems. A role as indicators of environmental change has also been shown for these groups (Ascorra et al. 1996, Solari et al. 2002), with larger herbivores and carnivores acting as "umbrella species" (Primack 2002) rather than indicator themselves.

The forest of northern South America, and the Guianas specifically, support a number of small mammals in various habitats (Eisenberg 1989, Engstrom and Lim 2002, Husson 1978, Lim and Engstrom 2002; Lim et al. 2005, Simmons and Voss 1998, Tate 1939, Voss and Emmons 1996, Voss et al. 2001); in the Guayana Shield, almost 10% of the 282 mammal species known to occur may be endemic (Huber and Foster 2003). At the Nassau and Lely Mountains (Eastern Suriname), our main goal was to obtain baseline information through an inventory of mammals in most of the several habitats there presents, with emphasis on the factors affecting the sampled communities. The area has great importance because of its biodiversity (see Lim et al. 2005), its geographic location nearby areas well studied in recent times (Lim et al. in press), and also by the chance to study potential effects of mining exploitation on its mammal communities.

The Initial Biodiversity Assessment and Planning (IBAP) program of Conservation International (CI) was carried out in conjunction with BHP-Billiton Maatschappij Suriname (BMS) and the Suriname Aluminum Company LLC (SURALCO) to survey the biological diversity of the Lely and Nassau Mountains of eastern Suriname. Given that these mountains fall into an area with high priority for conservation in the Guayana Shield (Huber and Foster 2003), our aim was to provide a rapid survey of the mammals in the area to increase our understanding of the whole ecosystems and help in future decisions about mining exploitation. With these data, we compare the diversity found in the sampled areas, between them and also between eastern Suriname and others in the Guayana Shield.

MATERIALS AND METHODS

Study Area

We conducted our study from October 25 through November 06, 2005, at the beginning of the dry season. We worked for one week at each sampling site; the first locality was the Nassau Mountains (25-31 October), at 04°49.23' N, 54°36.34' W, 514 masl, and the second locality was Lely Mountains (1-6 November), at 04°16.23 N, 54°44.29" W, 640 masl. Both sites are

located in the District of Sipalawini, being part of a large system of bauxite plateaus in northeastern Suriname that may represent a rare and endangered landscape type, with several potential endemic elements. Both sites included lowland well drained (*terra firme*) tropical forest, with a relatively closed canopy of 20-25 m, along with disturbed primary forest and secondary forest, with lower and open canopy. At Nassau, there was much secondary-growth, which is a consequence of previous mining (bauxite) exploration. There was a road connecting several small camps, and forest clearing was pretty common in the area. A small stream was located near the main camp, as well as a large clearing. At Lely, we sampled around the air strip, which is surrounded by bushes and small trees. We also trapped in the savannah forest located close to the radio antenna, which was characterized by the presence of bromeliads and sparse and small-size trees. Some sampling was done along a stream with irregular topography and dense vegetation. Camera traps were located within two-hour walking distance in a well preserved forest near abundant water bodies.

Collecting methods

We used a combination of several methods to detect and collect mammals (see Wilson et al. 1996a). For non-flying small mammals, rats and opossums, we used a transect design consisting of two trap lines, one with 80 stations and the other with 40 stations. Stations were set 8-10 meters apart of each other, each including a combination of snap (Victor, mouse size) and live (Sherman) traps, or two snap traps. This method allows for sampling several habitats within a given portion of the locality. Traps were set on the ground, near burrows or along potential runways near large trees or in other suitable spots. A variable proportion of traps, between 20-30% of the total, were set on branches or at some height over the ground, intending to capture more arboreal species. Traps were baited with a mix of peanut butter, rolled oats, and vanilla, or sardines in oil, and checked twice a day (morning and evening). Total trapping effort was calculated as the total number of traps set each night.

Mist nets were used to capture bats; we set nets along probable flight ways, like creeks, streams, forest edges, or within forest with both dense and scarce understorey. Our decision to place nets was based on potential abundance of bats in the surrounding habitat either because of presence of food resources or roost sites. Most of the nets, 6-8 each night, 12 m long, were set 2 m above the ground, with a few ones going almost 5 m above the ground. Nets were open from dusk to midnight or so, in just a few nights the nets were open until dawn. Netting effort was calculated as the total number of nets set each night. We tried to keep a standard trapping/netting effort for both localities to make direct comparisons.

For large mammals, we searched for tracks of medium and large species along the roads and trails; for each record we took data on time and relative position in regard to the main camp. Field guides (Emmons and Feer 1997) were used to identify these tracks. In a few cases, we were able to see or hear the animals during our daily excursions from and to camp, and make an identification at that time. We also used 4-6 camera traps operating continuously and located nearby an odor bait (feline urine), or sites that showed some mammal activity. In a few instances, members of other field crews provide information about other records that were identified using field guides. Finally, we interviewed local residents about the species they know for sure were present at the area.

Because it was a rapid inventory, we only compared results between sites, based on our standard trapping/netting. We did not calculate expected species richness based on our data, but compared our list to existing ones for the region (i.e., Brownsberg mammals; Lim et al. in press). Voucher specimens were prepared as whole animals fixed in 10% formalin with final storage in 70% ethanol; individuals were examined for ectoparasites and "wrapped" in cheesecloth for future examination. To verify field identification, skulls were removed from selected specimens. Tissue samples (liver and muscle) were saved in lysis buffer (Longmire et al. 1997). The specimens will be deposited in the Mammal Collection of the Museum of Texas Tech University, USA.

RESULTS AND DISCUSSION

Species Diversity

Overall, 45 species of mammals from nine orders were recorded from the two study sites in Eastern Suriname, as expected the orders Chiroptera (bats) and Rodentia (rodents) were the most diverse (Appendix 17). All small mammal species were represented by specimens. We recorded one species of marsupial, two species of rodents, and 24 species of bats (most of the captured bats were released in the field after positive identification). One pigmy squirrel, *Sciurillus pusillus*, was seen and positively identified in the Lely Mountains camp. An unusual record of medium-size and big mammals was recorded at both places, but it was more evident at Lely Mountains camp. From the first site, Nassau Mountains, we recorded six orders and 28 species; at Lely Mountains, we recorded eight orders and 30 species (Appendix 17).

After ten trapping days, five nights at each locality, our total effort included 900 Victor mouse trap nights and 540 Sherman trap nights. We caught one opossum and five rodents in total, which give us an overall success rate of 0.4%. Abundance data were extremely scarce for non-volant small mammals, but we had a chance to analyze our collecting data on bats for some discussion. The most abundant species was the fruit-eating bat *Artibeus planirostris*, which accounted for almost 40% of total captures at both sites; the second most common species was *Carollia perspicillata*, with almost 20% of captures. In general, fruit-eating bats of the subfamilies Stenodermatinae and Carollinae (Phyllostomidae) dominated the bat faunas at both localities. Only one (*Pteronotus parnelli*) out of 23 species of bats represented a different family, Mormoopidae. Although fruit-eating spe-

cies were the most diverse, with 16 species, the second most diverse trophic guild includes the gleaning insectivores of the subfamily Phyllostominae, with 4 species. The remainder species included one nectar-feeding (*Lionycteris spurrelli*), one insectivore-carnivore (*Trachops cirrhosus*), and one omnivorous (*Phyllostomus discolor*) bat.

Absence of small rodents at Nassau might be explained by either deficient trapping effort, or real lacking of habitats for these species; we cannot draw any definitive conclusions given the short sampling period, but also the small sample size (4 animals) at Lely. We recorded two sympatric species of *Neacomys* at Lely; although based on preliminary identifications needing further comparison and perhaps verification through genetic data, we believe that this remarks how little we know about the geographic limits of these species, which usually are a main component of the local diversity (Lim et al. 2005). As an example, our records of *N. dubosti* and *N. guianae* seem to be the first for northeastern Suriname, based on the data from Lim et al. (in press) and Voss et al. (2001).

We recorded visually, by sound, or by tracks 17 species of medium and large mammals in both localities. There was a large difference in species composition between the two sites, with more species (13) at Lely than in Nassau (8). The most diverse groups were the Primates and the Carnivora, each with four species; the first includes large (*Alouatta macconnelli*, *Ateles paniscus*, *Chiropotes chiropotes*) and small (*Saguinus midas*) monkeys, while the second includes two large (*Panthera onca*, *Puma concolor*) and one small (*Leopardus pardalis*) cat, plus one coati (*Nasua nasua*). Most of these records occurred not too far from the main camp, and in some cases (*S. midas*) included more than one individual. We observed den sites for Brazilian tapir in many places around the camp in Nassau, but not so commonly in Lely. At both study sites, we found tracks of brocket deer (*Mazama*), but without a visual record it was impossible to identify to species (*americana* or *gouazoubira*), as both are known in the area.

There were no pictures of animals on the seven rolls of picture used in the camera traps; four were set off by the sunlight and the camera went through the whole roll. The other three consisted of only a few pictures each that were of either initial set up or of a RAP participant walking through. We believe that our camera trapping design was severely affected by our inexperience and logistic difficulties at the study sites, but the method remains a valid one for record of animals that otherwise went undetected in similar studies (Sanderson and Trolle 2003, Lim et al. 2005).

SPECIES AND GROUPS OF IMPORTANCE

Considering the numbers of species as well as their ecological roles, preliminary results indicate that Lely has higher taxonomic and ecologic diversity. These results suggest that the forest at Nassau is less suitable for small non-volant mammal species, probably because of the alteration of primary forests. For instance, frugivorous bat were predominant at Nassau, as we would expect in secondary growth forests, forest borders, or dynamic habitats (Wilson et al. 1996b), such as those sampled in this site. At Lely, we recorded a better representation of Phyllostominae bat species (which are omnivorous or insectivorous), indicating a more complex forest structure (Wilson et al. 1996b) than in Nassau. Most of the species of bats we recorded at both sites has a wide geographic distribution in the Neotropics (Simmons 2005); the exception was *Ametrida centurio*, which is a small fruit-eating bat restricted to the Guayana Shield and northern Brazil, although usually common through. However, some animals could represent nominated subspecies with a narrower distribution, like *A. planirostris trinitatis* or *P. parnelli rubiginosus*, and their populations deserve further study. It is remarkable that only three bat species are listed as threatened, *Lophostoma carrikeri* (Vulnerable), *Koopmania concolor* (Lower Risk - Near Threatened), and *Artibeus obscurus* (Lower Risk - Near Threatened); we believe that the first two are locally rare species, but their wide geographic range does not suggest any real threat to its survival. However, the case of *A. obscurus* is due to the taxonomic confusion in regard to the large *Artibeus*, which has caused very few confirmed records of this species, which is usually common in well studied areas (Ascorra et al. 1996, Lim and Engstrom 2002)

Among the 17 species of medium and large mammals we recorded, a few deserve some concern because of their conservation status. Most of the Primates and Carnivores are listed by IUCN as endangered at the global level; among the monkeys, *A. macconnelli* is listed as Vulnerable and *Ch. chiropotes* (for distinction of this species, see Groves 2005) as Data Deficient, although as part of *Ch. satanas* it was listed as Endangered, mostly because they are directly affected by local hunting. At the same time, both are restricted to the Guiana region, so their global conservation depends on the status of these populations. Other species, like *S. midas* and *A. paniscus*, both also endemic to the Guiana region, have more stable populations and are therefore listed as Lower Risk - least concern. Among the Carnivores, the larger cats are listed as Lower Risk - near threatened, meaning that their populations are close to become Vulnerable if they are locally affected. Observations in areas within the Guiana region suggest that their populations remain low, although apparently stable (Lim et al. in press, Voss et al. 2001). The smaller ocelot (*L. pardalis*) has equally a larger distribution, but is regarded as Lower Risk - least concern because its more stable populations. It is interesting that many of these records occurred within our range of daily activity, not far from the main camp. Among the ungulates, the Brazilian tapir (*T. terrestris*) is listed as Vulnerable, because this is heavily affected by hunting everywhere, and we found evidence that the same occurs in this region; however, the collared peccary (*P. tajacu*) with less hunting pressure and larger populations is listed as Lower Rosk - least concern. Another species isted as Vulnerable is the giant anteater (*M. tridactyla*), which seems to be locally uncommon (Voss et al. 2001).

At both places, diversity and concentration of medium and large mammals (e.g. almost every day we found feces of Tapir in both places) suggest suitable habitats for these species, which usually require large extensions of not too disturbed forest. The presence of ungulates may be the reason behind the presence of large cats (cougar and jaguar) in the area. Many of the Primate species we identified in the area were based on remains collected near the sampling site at Lely, but groups of *Saguinus midas* and *Alouatta macconnelli* were evident at both places and they seem to have healthy populations, as noted by Voss et al. (2001) for Paracou, French Guiana, suggesting a wider, regional pattern. However, we consider that imminent pressures as habitat loss and hunting could may be threatening large mammals, and their predators, at both places.

We caution that any inference about the status of the mammal fauna in both sites is still incomplete and far from accurate, the short sampling period does not allow for further analyses or comparisons with other better sampled areas in the region. A more extensive survey is required to determine real patterns of the mammalian assemblage.

CONSERVATION RECOMMENDATIONS

We suggest a more rigid control of hunting in both surveyed places and, if possible, allow mining only if high environmental controls are designed. Small mammals are more dependent of forest structure for their survival, reducing clearings to a minimum would preserve this structure and the fauna living there (Granjon et al. 1996). Deforestation in some places has been severe, as evidenced by the high diversity of fruit-eating bats, which favor this kind of dynamic ecosystem (Wilson et al. 1996b).

By regulating the traffic through the road communicating the camps, it could be possible to know the impact of people and/or hunters that access these forests. It was evident from our observations that rural populations around main settlements access the forests with no limits at all, for hunting, fishing, and harvesting non-timber products. Only a strong control could conserve these places that harbor and important and still completely unknown mammal diversity, some elements of which could be endemic to this region (Lim et al. 2005). Because of surrounding gold-mining activities at both places, populations of large animals (e.g., ungulates, monkeys) are usually low because of over-hunting. This is more evident at Nassau, due to more local settlements nearby but also by the more remote location of Lely.

Although some degree of protection has been set for this particular ecosystem, through Brownsberg Nature Reserve (Lim et al. in press), we believe that further studies should be completed before to allow exploitation of the surrounding areas. We lack significant data on the variation of reproductive patterns, microhabitat preferences, morphology and ecology that may be associated with geographic distribution over the mosaic of habitats included in this region. This must go along with an improvement of our sampling techniques. Although time may not be enough to compile such a large dataset, we might focus on the most significant species, from a conservation (e.g., primates), ecological (e.g., bats), or taxonomic (e.g., muroid rodents) point of view to improve the current assessment.

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Chapter 13

The Biodiversity of the Brownsberg

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SUMMARY

The Brownsberg is an elevated forested landscape unit that is both ancient and isolated in the sense of being disconnected from similar units. It is representative of a landscape and habitats that are poorly protected at the national and the Guayana Shield level. At its core is an unbroken ~1,400 ha main plateau at ~500 m elevation; this plateau owes its existence to the protection it has enjoyed against erosion by a ferro-bauxite crust in the soil that goes back to Oligocene.

The Brownsberg is roughly 13.5 km wide at its widest point and is about 34 km long; it is estimated to cover approximately 27,500 ha. It lies about 100 km inland from the coast and Suriname's capital, on the water divide between the Suriname and Saramacca Rivers. The main plateau has a milder, cooler climate than the surrounding lowlands, and is characterized as Af – always wet – but with four distinct seasons. There is significant short-term inter-annual fluctuation in annual rainfall and seasonal pattern. The top of the Brownsberg is often shrouded in clouds and fog, which results in high humidity and a high epiphyte load, hence the qualification of parts of the Brownsberg as "low elevation cloud forest". The Brownsberg lies at the core of a unique cultural-historical landscape. The area is rich in artifacts of the Brownsberg Culture, a Pre-Columbian society. From the late 19th century onwards, it was a focal area for gold mining and balata extraction.

The Brownsberg is characterised by great habitat diversity: i) at least three undisturbed stream habitats types (upper, middle and lower courses of creeks), ii) aquatic habitats of creeks disturbed by mining, iii) undisturbed and old anthropogenic terrestrial habitats that differ in function of elevation and vegetation type, iv) habitats of recently disturbed forest, and v) an old cave made by gold miners. Some of these habitats are scenic, while others may be unique in terms of vegetation composition.

Species diversity is high, and a substantial number of rare species have been recorded; several species endemic to the Guayana Shield are known from the Brownsberg: 7 mammals (incl. 2 monkeys), 30 birds, 5 reptiles, and 13 amphibians. A substantial number of species of considerable conservation concern are also known to occur there: 12 mammals (incl. 5 big cats), 4 birds, 1 tortoise, and 1 toad. The steep slopes and upper plateau of the Brownsberg appear to function as a wildlife refuge, as virtually no hunting and other disturbances occur there.
The interactions between plants and animals are an aspect of biodiversity that is linked to seasonal phenomena. At Brownsberg the "logic" of this seasonality seems to be: i) flowering peak during the long dry season, when weather conditions prevail that favor pollinator activity and reduce pollen loss, but low fruiting and low frugivore activity in this period of water stress, ii) fruit development peak during the subsequent short rainy and dry seasons, when there typically is much less water stress, and iii) peak activity of frugivores that coincides with the peak of ripening and falling of fruits during the short dry season, into the long rainy season, a period when the microclimate favors seedling establishment. Observed levels of seed predation and seed dispersal at Brownsberg are often very high, at least at undisturbed locations for a number of tree species that produce fruits and seeds that are a source of food for large mammals. Long term research has been initiated on the responses of frugivores on seasonal stress and reduction in food supply.

The most serious threat to the Brownsberg is mining, both legal and illegal. Approximately 5% of the Brownsberg Park has recently been devastated by illegal gold miners; the downstream sections of virtually all major creeks in the northern half of the range have been stripped of their natural vegetation. Other threats are forest conversion for agricultural purposes, logging and hunting. A distinct but less serious threat is tourism, or rather the negative impact of recreational activities.

The Brownsberg is isolated from the surrounding forest by the Brokopondo Lake, the village of Brownsweg, and a main dirt road. At the present time, Brownsberg overlaps a bauxite exploration concession, as well as a protected area – the Brownsberg Nature Park, established in 1970. With more than 10,000 annual Park visitors since 2000, the Brownsberg may be the number one nature destination in Suriname. It is an area with a long history of biological research and may be the most thoroughly studied protected area in Suriname. The Brownsberg is readily accessible and offers infrastructure for tourists, researchers and schools. Its fauna and flora can easily be observed, and it is a great location for nature education and conservation awareness building. The main challenge for the conservation of the Brownsberg range is to protect the area from further encroachment by illegal miners; to stop their encroachment, the Park should become more relevant to and more profitable for the local community.

It is recommended that:

- The protection of the Brownsberg range be enhanced by i) effective law enforcement in and around the Park, ii) formal establishment and southward extension of the buffer zone, iii) a management plan for the larger area that includes the Park and the extended buffer zone, and iv) attempts to restore areas damaged by gold mining;
- Tourism activities be expanded to i) the central and southern part of the Brownsberg range, ii) the Brokopondo lakeside area, and iii) the village of Brownsweg;
- Monitoring of human activities, biodiversity and the environment be continued, including i) analyzing the data generated by STINASU in the course of the BNP Monitoring Program from 2002 to 2005, and ii) implementing a modified monitoring program (BMP) based on the results and recommendations of the data analysis;
- Full use be made of the results of research and monitoring, meaning that i) the planning and management of the Park is guided by the results, and ii) the results are used as inputs for a variety of information products, as well as for public awareness and education activities in the Park and in the capital Paramaribo;
- A super-structure be created for the Brownsberg-Brownsweg area, possibly linked to a MUMA (Multiple-Use Management Area), that would at least allow for i) conflict resolution between STINASU, the village of Brownsweg, and local miners and other operators, ii) a dialogue on land use with the stakeholders, and iii) conservation and development projects that benefit the local community.

INTRODUCTION

Relevance

The Brownsberg is an elevated forested landscape unit that is both ancient and isolated in the sense of being disconnected from similar units (see also Geography section below). At its core is an unbroken ~1,400 ha main plateau at ~500 m elevation; around this core are plateau fragments, ridges and steep slopes. The main plateau owes its existence to the protection it has enjoyed against erosion by a ferro-bauxite crust in the soil that goes back to Oligocene (26-38 My ago; GMD 1977). Most of the lands bordering the Brownsberg must have had a less erosion-resistant soil, and hence are now lowlands of less than 150 m elevation. The Brownsberg has a great diversity of natural habitats and native species, including rare and submontane habitats that are not known from the nearby lowlands (see Habitats and Species sections below). There is evidence of idiosyncrasy in the vegetation composition (see ter Steege et al. 2005), similar to those observed by De Granville (1994) in French Guiana. Landscape units similar to the Brownsberg are rare in the Guianas (De Granville 1991); in Suriname they may cover less than 0.5% of the land surface (ter Steege et al. 2005).

The Brownsberg also lies at the core of a unique cultural-historical landscape (see History and Status section below). The area is rich in artefacts of the Brownsberg Culture, a Pre-Columbian society that manufactured stone implements (Versteeg 2003). Anthropogenic vegetation patches, e.g. bamboo thickets (see Habitats section below), may be vestiges of intensive use of the Brownsberg forest by Amerindians in prehistoric times. From the late 19th century onwards, the Brownsberg has been a focal area for gold mining and balata extraction (Reichart 1997). The name of the area dates from that period, and refers to mine concession owner John Brown. At the edge of the main Brownsberg plateau, old digging, blasting and landscaping efforts are still evident, and at least one unique habitat, a small cave, has been the miner's contribution to habitat diversity. Cut-marks in the bark of old balata trees (*Manilkara bidentata*) remain visible, but balata extraction has ceased.

Moreover, the Brownsberg (and a strip of land to the west and south) is an increasingly isolated but protected forested area. By the mid-1970s the Brownsberg got caught between the shores of the then newly created Brokopondo Lake, a major transmigration village and a main dirt road (see Geography and History and Status sections below). Modern Brownsberg features a bauxite exploration concession, as well as a protected area – the Brownsberg Nature Park (Reichart 1997, Fitzgerald et al. 2002, Fitzgerald 2003),

used for recreation, research and education. The former encompasses the main Brownsberg plateau, and will be referred to in this chapter as "the Concession". The latter will be referred to as "the Park", and encompasses mostly slopes, lower plateaus and foothills bordering the Concession. The Concession is entirely surrounded by the Park, and would have been its core if no mining right had been granted there.

Finally, with more than 10,000 Park visitors annually since 2000 (estimate based on STINASU unpublished data), the Brownsberg may not only be the number one nature destination in Suriname, but also the protected area that is most affected by visitors. It is an area with a long history of biological research (see Reichart 1997), and may be the most thoroughly studied protected area in Suriname, as should be obvious from this review.

Geography

Location, size and geomorphological context

The Brownsberg is a unit that has already been defined in geomorphological terms above, the essence being that it is an isolated range of ~500 m elevation with an encrusted ferro-bauxite cap and associated ridges and steep slopes. It is part of an area referred to as the Guiana or Guayana Shield (for different interpretations of this area, see Hammond 2005a; for the purposes of this review, the Guayana Shield concept will be used, in line with Huber and Foster <2003> and Hammond <2005a>. "The Guianas" will refer to the area comprising Guyana, Suriname and French Guiana). The bedrock that underlies the Brownsberg was formed about two billion years ago (Reichart 1997; see also Noordam 2003 and Hammond 2005b); it is metamorphic and often referred to as greenschist or greenstone (rich in quartz with a greenish hue). The greenstone contains high amounts of gold, which explains why the general area is targeted by gold miners.

The Brownsberg can be geographically described as follows (see Figure 13.1):

- located between 04° 45' 46" and 05° 59' 44" N, and 055° 07' 58" and 055° 15' 23" W (deg.° min.' sec."; Zanderij datum);
- land above 100 m elevation and neighboring creek valleys slightly below that level;
- west of the Brokopondo Lake, east of the main course of the upper Mindrineti Creek, and south of the Verjari Creek (a Mindrineti tributary).

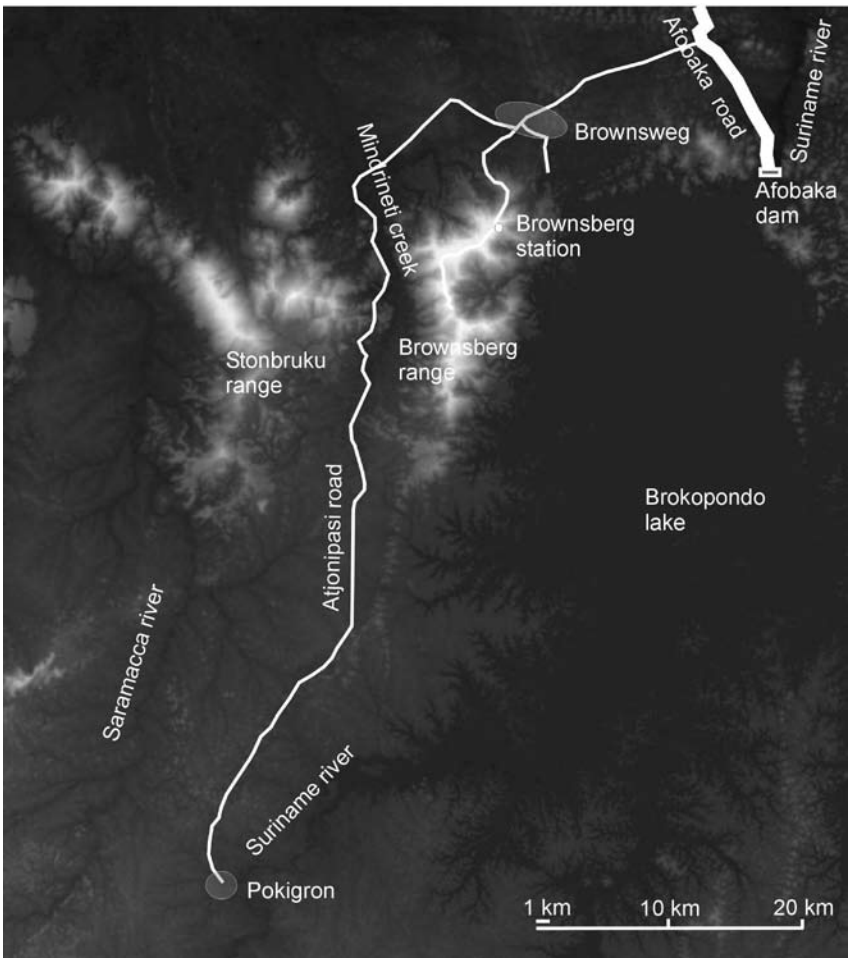

Figure 13.1. Location of the Brownsberg range based on RADAR image, with indication of important villages (uniformly shaded ovals shapes), roads (lines), ranges and water bodies (gradual shading); the gradual shading indicates relief (lighter = higher); thick line = road to Paramaribo; thinner lines = other roads; Brownsberg station = location of STINASU buildings.

The Brownsberg is roughly 13.5 km wide at its widest point and is about 34 km long; it is estimated to cover approximately 27,500 ha. It lies about 100 km inland from the coast and Suriname's capital, on the water divide between the Suriname and Saramacca Rivers.

Several landscape units that are geomorphologically similar to the Brownsberg occur in Suriname and the Guayana Shield region (based on GMD 1977, De Granville 1991, and De Dijn pers. obs.). The Stonbruku range virtually borders the Brownsberg in the west, separated from it by the valley of the Mindrineti Creek. Brownsberg and Stonbruku are at the heart of a belt of approximately ten modest-sized hills with encrusted soil that stretches from the banks of the Saramacca River to the banks of the Suriname River. Towards the east, on the banks of the Marowijne / Maroni River, there are more isolated hills: Nassau and Lely on the Suriname side of the border, and the Francaises and Kotika on the French Guiana side. Other isolated hills and hill complexes also lie scattered throughout much of the northern part of the Guayana Shield from the Venezuela-Guyana border region to Kaw in northeastern French Guiana (these formations are not to be confused with inselbergs, which are isolated outcroppings of granitic basement rock, usually much smaller than the ferro-bauxite encrusted ranges, with different vegetation types associated with them, such as so-called rock savanna, or exposed granite with xeromorphic herb and shrub patches). In the highland zone of Venezuelan Guayana, submontane ferro-bauxite-capped plateaus appear to be located around larger ranges that reach greater heights and are referred to as Tepuis or Mesas (see De Granville 1991).

Climate and weather

The biodiversity of the Brownsberg is difficult to understand without some background knowledge on the local weather and climate. Based on an elevation of approximately 500 m, the temperatures at the Brownsberg main plateau are several degrees lower than those in the surrounding lowlands. Precise historical temperature data are lacking, but Brownsberg weather data were recently captured by means of an automated weather station located at the northeastern margin of the plateau, at the Brownsberg station (Djosetro et al. 2005; see Figure 13.2 for location). Over the course of a 14-month-period (May 2004 – April 2005), a maximum temperature of 30° C and a minimum of 19° C were recorded. This can be compared with data from the Mapane area (approximately 70 km NNE of Brownsberg, located < 100 m elevation) where Schultz (1960) did detailed meteorological observations and recorded a maximum temperature of 36° C and a minimum of 17° C. This leads to the conclusion that, compared to a nearby lowland setting, the Brownsberg main plateau is a thermally less variable environment, with considerably lower maximum temperatures. Assuming that this result can be generalized, this would mean that the Brownsberg main plateau has a milder and cooler climate than the surrounding lowlands, which is also how many human visitors experience it.

As obvious from the luxuriant forest vegetation, the Brownsberg benefits from high levels of precipitation, not unlike most of the interior regions of Suriname (Reichart 1997). Like elsewhere in the region (Hammond 2005b), the climate at Brownsberg is distinctly seasonal, and variably so (see below). Brownsberg lies in a tropical wet climate zone with an annual precipitation of ~2,000 mm, and is classified as Af – Koeppen's "always wet climate", which means that, based on average monthly figures, no month has less than 60 mm rainfall (Scherpenzeel 1977 in Reichart 1997; see also Hammond 2005b). Historical rainfall data for the Brownsberg (taken at the Brownsberg station; Reichart 1997 and Suriname Meteorological Service unpublished data) recorded an average annual rainfall of 1,985 mm, between 1972-85, with a minimum of 1,555 mm in 1983 and a maximum of 2,581 in 1972. These data suggest that the conventional distinction of four seasons in Suriname also applies to the Brownsberg:

- Long rainy season: from late April – May until about mid-August (very reliable);
- Long dry season: from mid-August until November – December (very reliable);
- Short rainy season: December - January (unreliable, occasionally failing);
- Short dry season: February - April (transitional, and often not very distinct).

The Af climate characterization and the conventional subdivision of the year in four seasons are, however, misleading (Schultz 1960). A recent analysis of Suriname weather data (Mol et al. 2000) and a review of regional climate studies (see Hammond 2005b) highlight the often poorly appreciated fact that there is significant short-term inter-annual fluctuation in rainfall, not only in annual rainfall but also in seasonal pattern. The seasonal timing and amount of the rainfall depends very much on the movement and "intensity" of the Inter-Tropical Convergence Belt or Zone (ITCB or ITCZ), which is subject to considerable fluctuation often referred as ENSO (see Hammond 2005b). Recent Brownsberg meteorological data (Djosetro et al. 2005) illustrate this point: a monthly rainfall minimum of 25 mm was recorded in 2004, when rainfall remained below 60 mm / month for three consecutive months (Oct. – Dec.). Such conditions agree with Am – Koeppen's strongly seasonal "monsoon climate". Historical weather records for the Brownsberg (1981-84; Reichart 1997) also illustrate variable seasonality: a prolonged dry period in 1982 and 1983 (3 months below 60 mm / month), but no such period in 1984 (no month below 60 mm). Therefore, at least at the Brownsberg plateau, the climate is relatively non-seasonal in some years, but very distinctly seasonal in others, with a prolonged dry period that may be quite stressful for the flora and fauna.

Longer term climate fluctuations and change (see also Hammond 2005b) cannot be discussed in detail here, but are relevant with respect to the Brownsberg:

- The filling of the Brokopondo Lake in 1964 likely changed the local climate (pers. comm. Becker), as obvious from divergent cloud patterns over the lake area during the long dry season (De Dijn, pers. obs.);
- A gradual increase in temperature over the last ~100 years has been observed in Suriname, which may be accompanied by other climatic changes, e.g. in precipitation (Nurmohamed 2002);
- An analysis (De Dijn unpublished) of weather data from three nearby meteo stations (Lelydorp, Zanderij and Brownsweg) suggests that there may be dry and wet phases, with a 30 to 40 years periodicity and 500 mm amplitude.

Above, we are, in fact, drawing conclusions based on rainfall measurements. However, precipitation also occurs in the form of mist or fog at the Brownsberg. Because of the elevation gradient, the proximity of the coast, and the eastern trade winds (often supplying wet, oceanic air), a distinct "Massenerhebung" effect occurs. This means that cloud formation is promoted at the upper slopes and main plateau of the Brownsberg, and that the top of the range is often shrouded in clouds and fog (De Dijn, pers. obs.). Very often, the morning sky has been clear at the foot of the Brownsberg for hours (e.g. near the village of Brownsweg), while rain or fog still prevails at the main plateau. This phenomenon explains the very wet aspect of much of the Brownsberg, and the great abundance of epiphytes (see below), especially along the eastern margin of the main plateau (areas with so-called "moss forest", see Habitats section below). In fact, because of these peculiar meteorological conditions and the resulting high epiphyte load, the Brownsberg main plateau

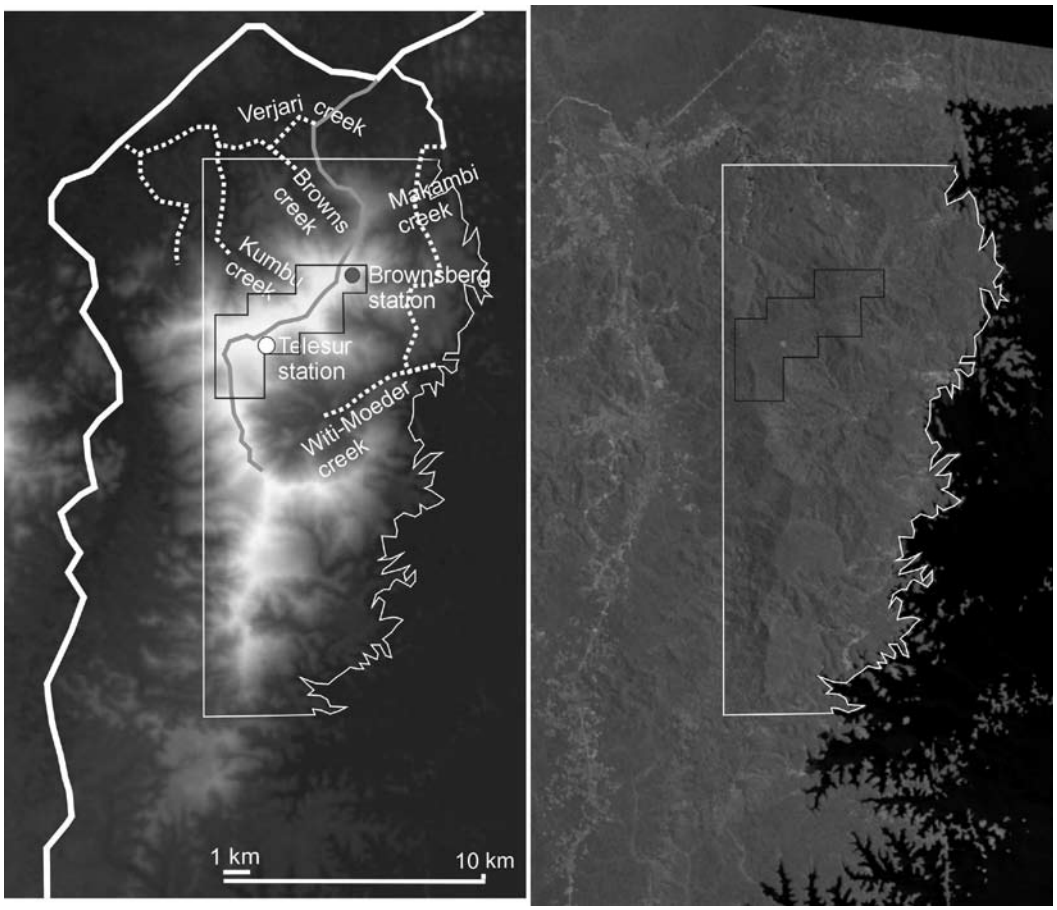

Figure 13.2. RADAR (left) and Landsat composite (right) images of the Brownsberg range, with indication of the borders of the STINASU-managed Park (polygon with white outline) and the SURALCO Concession (polygon with black outline), as well as all-weather dirt roads (full lines; access road up and over the range grey), bulldozer trails used by miners (dotted lines); the gradual shading on the RADAR image indicates relief (lighter = higher); on the Landsat image, the shades of grey reflects living plant biomass (lighter = lower biomass), from closed, high rainforest (dark grey), over sparsely vegetated savanna, agricultural plots or old, abandoned mining areas (medium grey), to exposed soil of roads, active mining areas as well as village and camp sites (light grey); exposed water surfaces are black on the Landsat image, i.e. the Brokopondo lake as well as small water-filled basins created by miners (apparent as black dots in light gray areas).

and upper slopes may very well qualify as "low elevation cloud forest". The moss forest aspect distinguishes submontane habitats of the Brownsberg main plateau and upper slopes from superficially similar habitats at the base of the Brownsberg.

The humidity is persistently high at the Brownsberg main plateau (based on weather data recently recorded by STINASU: Djosetro et al. 2005 and unpublished). When the STINASU weather data for Brownsberg are compared with that recorded by Schultz (1960) from January to June of 1956 in the nearby Mapane area, it is obvious that minimum relative humidity (r.h.) at the Brownsberg main plateau is considerably higher (88% r.h.) than the Mapane minimum (75% r.h.). Thus, the environment of the Brownsberg main plateau may be considerably less stressful than the surrounding lowland environment, at least for organisms that lose water easily via the body surface, such as epiphytic mosses and terrestrial Amphibia.

Landscape, soil and hydrology

As mentioned above, the Brownsberg's defining feature is the encrusted main plateau at about 500 m elevation, located in the northern part of the Brownsberg range, and encompassing no more than one-twentieth of the Brownsberg's surface. The following description is largely based on a survey done by De Dijn and Satyawan for STINASU (unpublished); Figure 13.2 shows some of the features described. Parts of the main plateau form slight depressions that may hold water for a few days to weeks after heavy rainstorms, e.g. in the rainy season. One extensive shallow depression occurs near the Telesur station; smaller ones occur more towards the Brownsberg station. In the southern part of the Brownsberg there are a few smaller submontane plateau fragments, connected with each other and the northern main plateau by a north-south ridge. On this ridge and smaller ridges that fan out from the main plateau, the soil is heavy loam-clay on top of bedrock, with bedrock or ferro-bauxite stones exposed or incorporated. The slopes descending from the submontane plateaus and ridges are mostly steep (an estimated 30-60 degrees) and have a deep clayey soil. Locally, big ferro-bauxite boulders occur on the slopes that have broken off from the crust of the elevated plateau. Immediately below the encrusted margin of the plateau, ferro-bauxite boulders tend to be numerous, and the margin itself is often obvious as a ferro-bauxite escarpment with a vertical drop of a few meters. The steep slopes descend to less than 100 m elevation, except where they encounter one of the eroded foothills (at ca. 100-150 m) or another erosion-resistant plateau. Although there seem to be several smaller encrusted plateaus associated with the Brownsberg at lower elevations, only one seems to be extensive. The latter is known as the Bongrowiri plateau (see Reichart 1997); it occurs at approximately 120 m elevation and appears to be discontinuous. One large Brongrowiri section occurs in the north, where the access road crosses the Park border; the western margin of this section forms a considerable escarpment with a dropdown of up to 10 m.

On the slopes and ridges, the loamy upper soil is well drained, often deep, and, because of the relief, the water flows quickly to the creeks. Water on the main plateau, on the other hand, often stagnates and seems to penetrate the crust very slowly to charge the plateau aquifer. Perennial creeks originate on the main plateau or up to 50 m below it, where depressions or gullies cut into it. These creek origins may look like veritable sources – a small, compact stream of water exiting from below solid crust – or manifest themselves as waterlogged mini-valleys. The perennial creeks follow a pattern that is quite typical of creeks that are associated with submontane encrusted plateaus in the region (see Habitats section below). Seasonal creeks, meaning those that only have noticeable flow after heavy rainstorms or in the (peak) rainy season, are largely limited to the upper parts of slopes; their beds are formed by steep, stony gullies. At the Brownsberg, the upland sections of all creeks are narrow: the creek beds are seldom more than 5 m wide, and only fill up with water in the peak rainy season. The lowland sections of the creeks tend to be much larger; the Witi-Moeder Creek, which drains the much of the eastern portion of the Brownsberg, has a creek bed of up to about 10 m wide (for location, see Figure 13.2).

Because of concern about pollution caused by tourism and gold mining, the Browns-Verjari and Witi-Moeder Creeks were recently investigated in terms of water quality (Ouboter 2005; samples taken at 6 locations in May, Aug. and Oct. 2003 and Jan., Mar. and Jun. 2004). Creek sections upstream from known sources of pollution and disturbance (Browns Creek at ca. 300 – 400 m elevation and Witi Creek at ca. 100 - 150 m elevation) can be characterized as follows:

- Water temperature between 22 and 26° C;
- Clear water (turbidity below 10 NTU - Nephelometric Turbity Unit);
- pH between 6 and 7, but between 7 and 8 for Witi Creek;
- High dissolved oxygen content (6.5 to 9.5 mg/l);
- Low nutrient levels (nitrate < 0.05 mg/l; ortho-phosphate < 0.50 mg/l);
- Low conductivity (< 50 µS), except at Witi kreek (100-170 µS);
- Low hardness ($CaCO_3$ < 10 mg/l), except at Witi kreek (up to 75 mg/l);
- Low alkalinity (Ca/$MgOH_x$ < 100 mg/l), except at Witi Creek (up to 720 mg/l);
- Low level of (dissolved) aluminum (< 0.5 mg/l) and iron (< 1.0 mg/l);
- Often high levels of (dissolved) mercury (< 0.10 µg/l)
- Modest COD (Chemical Oxygen Demand < 20 mg/l)

- Low Coliform bacteria content (< 1,500 per l) but on one occasion (at Browns Creek in Aug.) ca. 5,000 per l

The above can be regarded as the natural baseline for the Brownsberg Creek systems investigated. The data (see above) suggest that the Witi-Moeder Creek system is somewhat different in terms of water quality from the Browns-Verjari Creek system, and from the norm for creeks in the interior of Suriname (Ouboter 2005 and Ouboter pers. comm.). Creek sections at or just downstream of areas recently disturbed by gold miners have very different characteristics (Ouboter 2005; detailed data not presented here): they are very turbid, have periodically high nutrient and COD levels, have high dissolved aluminum and iron levels, and may have very high dissolved mercury levels.

History and status

Pre-Columbian times (10,000 BP – AD 1700)

Archeological finds indicate that the mid-Suriname River/ Brownsberg area was inhabited by Amerindians (Versteeg 2003). Artifacts have been dated to ca. 1000 - 1500 AD, and include pottery (including special pottery products for polishing purposes), roughly prepared raw stones, and finished, polished stones (especially axes), as well as stone fragments for slashing and cutting purposes. There are five known archeological sites at Brownsberg: four sites are settlements associated with the Brownsberg culture, located along the access road, and one site of unknown association is located at Witi Creek.

The life style of the Brownsberg Amerindians may have been similar to the well known traditional life style of the Tareno (Trio) and Wajana (Oayana): engaging in slash-and-burn agriculture, hunting a variety of wildlife species and collecting non-timber forest products, such as nuts, fruits, and medicinal plants (Versteeg 2003). A unique characteristic of the Brownsberg culture people appears to be their stone quarrying activities and associated fashioning of axes. There is evidence that these people exchanged goods with people from other cultures who used to live in the coastal plain; stones were transported to the coast (where they do not occur naturally) to be used there as tools and to be processed further to make ornaments. No Amerdians currently live near the Brownsberg. The Amerindian population may have crashed as a consequence of the arrival of European colonizers in the 17th Century (see Colonial period: 1700-1975 section below).

Colonial period (1700 – 1975)

During the early Colonial period, i.e. the early to mid-17th Century, several Western settlements consisting of a few villages and many plantations, were established along the lower Suriname River (see Dragtenstein 2002 and references therein). By the turn of the 17 - 18th Century, there were some isolated plantations near the middle Suriname River - the most upstream one was no more than 10 km north of the Brownsberg. Around that time, a small military post was also established at Berg-en-Dal (i.e. at the Blauwe Berg, a small riverside hill near the current intersection between the Afobaka road and the road to Brownsweg and Pokigron; see Figure 13.1 for location). Labor at the plantations was provided by African slaves, and many of these Africans ran away from the plantations and initially established themselves in the nearby forests. The African runaways and their descendants are currently referred to as Maroons.

Maroon villages have existed in the mid-Suriname River area ever since the late 17th Century, as obvious from reports of colonial expeditions up the Suriname River to eradicate them (Dragtenstein 2002). By the mid-18th Century, the Maroons had formed several tribes, and those of the Saramaka tribe moved from the Saramacca River to the upper and middle Suriname River. They were well established along the upper Suriname River by 1762, when a definitive peace treaty was signed between them and the Colonial government at Sara Creek (a tributary of the Suriname River). The lifestyle of the Maroons was and, in many places, is still similar to the traditional lifestyle of the Indigenous (Amerindian) people, meaning that it is based on slash-and-burn agriculture, and hunting and collecting in the forest. The eastern Brownsberg foothills was likely the outer limits of areas used for slash-and-burn agriculture (as obvious from an old campsite at Witi-Moeder kreek; De Dijn, pers. obs.), while the Brownsberg range itself was a tribal hunting ground (Teunissen in prep.). The Saramaka people still live along the middle and upstream sections of the Suriname River (along with some Aukaner Maroons at Sara kreek).

By the late 19th Century, new developments had their impact on the area: gold mining and the harvest of balata (exudate from the bark of *Manilkara bidentata*). A veritable gold rush had developed by the turn of the 19-20th Century attracting European and North American adventurers to the Interior of Suriname, as well as laborers from Paramaribo and the Caribbean islands (van Traa 1946). This first gold rush brought miner John Brown to Berg-and-Dal, where he made a cart road to the west, to a nearby range where he owned a gold concession (Bubberman and Jansen 1970). The cart road is now the road to Brownsweg, and the range is now called the Brownsberg. A railroad was built from Paramaribo to the gold fields along the Saramacca and Suriname Rivers, and this reached the Brownsberg area between 1906 and 1908 (based on Van Traa 1946); a station called Brownsweg was established, which is the location of the current Maroon village of Brownsweg. John Brown and succeeding miners (through the late 1920s) used heavy equipment and probably also explosives to mine at the Brownsberg, as obvious from historical accounts (see Bubberman 1977) and remains of machines and considerable earthworks (Molgo pers. comm. and De Dijn pers. obs.). Some of the current attractions of the Brownsberg, such as the Leo and Irene waterfalls, are, at least in part, man-made artifacts resulting from mining activities from a century ago. Old soil pits and water diversion channels in the Witi-Moeder Creek area (De Dijn pers. obs.) indicate that this area too is a historical mining area, and suggest that the habitats

there are not pristine. While this gold rush was continuing, the extraction of balata started to develop in Suriname and peaked in the 1910s (based on figures in van Traa 1946). The "bleeding" of trees was accomplished by making cuts in the bark of balata trees in a fishbone pattern; these cut-marks can still be seen in old trees at Brownsberg. From the 1930s onward, gold mining and balata extractions declined (van Traa 1946). When the Brownsberg Nature Park was established in 1970, these activities had all but ceased (Reichart 1997).

The most dramatic event that changed the geography of the area and catapulted it into the 20th Century was the creation of the Brokopondo Lake, a hydropower reservoir. A dam was created on the Suriname River at Afobaka, and by September 1964 approximately 156,000 ha of forest land were transformed into a shallow lake (Leentvaar 2003). The eastern Brownsberg foothills became a lakeshore, and an estimated 5,000 Saramaka people were displaced (see Hoop 1991), part of whom (approximately 1,000) moved to a "transmigration village" set up at Brownsweg. The hydropower lake and facilities were established with funds from the USA-based ALCOA company, which had established SURALCO as its subsidiary in Suriname. ALCOA was in need of cheap energy to power the alumina factory and aluminum smelter it intended to build in Suriname; when the Brokopondo Lake was finished, it provided power to SURALCO as well as to much of the coastal area. The Brownsberg was one of the target areas for bauxite mining which SURALCO obtained as a mineral concession (see Concession limits in Figure 13.2), and the main plateau area was explored intensively during the late 1960s by SURALCO (Teunissen in prep.). During the exploration, the access road to and across the plateau was created and the first buildings of the Brownsberg station were set up as part of the exploration camp infrastructure. No actual bauxite mining took place though at the Brownsberg, as the deposits were considered of poor quality and not economical to exploit. The current road to Brownsweg was created at the time of the transmigration (i.e. ca. 1964) and the Atjonipasi (a.k.a. Tjongalangapasi), the road between Brownsweg and Pokigron, was created in the mid-1970s (Molgo pers. comm.). Inhabitants from Brownsweg have made "campu" – temporary camps associated with slash-and-burn fields – along the Atjonipasi; many of these campu are currently small permanent settlements. Horticultural fields are currently found within a few km of the road (as seen in Landsat image in Figure 13.2).

In 1970, an area of approximately 7,000 ha that completely surrounds the SURALCO Concession was given in long-term lease to STINASU, a government-linked nature conservation organization established in 1969. This area was named the Brownsberg Nature Park, and represents approximately 60% of the current Park. STINASU was given permission to make use of the Concession and the buildings set up by SURALCO (Reichart 1997).

Post-independence period and current status (1975 – present)
By the late 1970s and early 1980s, STINASU had established a thriving nature tourism resort at the Brownsberg, welcoming thousands of visitors each year (Teunissen in prep.). Dramatic political events, the so-called "Interior" or Civil War, affected the Brownsberg area from the mid-1980s through the early 1990s. There was serious fighting at Brownsweg during the mid-1980s, and STINASU ceased its operations in 1986. Operations were resumed in 1991 after STINASU had rehabilitated some of the Brownsberg station buildings. By the late 1990s, nature tourism activities again achieved their former level and were increasing. In 2002, STINASU obtained much of the southern part of the Brownsberg in concession. Thus, an area of approximately 4,800 ha was added to the Park (the boundaries of the Park indicated in Figure 13.2 reflect the current extent of the Park managed by STINASU, i.e. 7,000 + 4,800 = 11,800 ha).

From 1999 onward, artisanal gold mining made a dramatic resurgence in the Browsberg area, including the Park. Small-scale, artisanal gold mining had never totally ceased since the first gold rush, but it had been reduced to manual digging and panning by the 1980s (Reichart 1997). From the early 1990s onward, a second gold rush developed throughout the Guianas (Hammond 2002b), propelled by an influx of Brazilian miners and mining technology (Healy and Heemskerk 2005). The continuing rise of the international gold price has translated into the use of heavier equipment and larger mining teams. For the Brownsberg area, this has meant that several teams with bulldozers and excavators began to mine their way up the major creeks, such as Browns, Verjari, Kumbu and Witi-Moeder Creeks (De Dijn pers. obs.; see also Figure 13.2). The ongoing artisanal mining is strip, surface mining; it transforms the forested creek valleys into a wasteland with excavator trails, deep basins, unstable sediment, and polluted water. The mining areas currently extend well into the Park, and an old exploration road from Brownsweg to Witi-Moeder Creek was re-opened by miners in 2004. There have been several attempts by STINASU to remove the miners; expelling the Brazilian miners from the Park seems to have worked, but ejecting the local miners (people from Brownsweg) has essentially failed. About 5% of the Park area has been affected by artisanal gold mining during the last decade, and has essentially been devastated (Teunissen in prep.). STINASU has actually proposed to excise approximately 1,000 ha of northwestern corner of the Park and allow miners to work there; this particular area is part of the Browns-Verjari Creeks system and has been heavily mined, historically as well as recently.

The area between the Park's western border and the course of the Minidrineti Creek has been provisionally designated by the Foundation for Forest Management and Control (SBB) as a "buffer zone" that could, in principle, become an extension of the Park. Essentially all other lands surrounding the Park, including the provisional buffer zone, are designated for logging; some areas are timber concessions granted to companies and others are so-called wood-cutting

licenses ("HKV") granted to village chiefs (intended to be used for the benefit of the local communities). Commercial logging operators currently work in most of the areas in the west and north, alongside artisanal gold miners.

Biodiversity

Habitats

Stream habitats have already been characterized in terms of water quality (see above). Many of the creeks of the Brownsberg range dry out during the long dry season, particularly small creeks at higher elevations. Small creeks in Suriname's interior, like the ones at Brownsberg, tend to be heavily shaded, which translates in a low aquatic plant biomass. As a consequence, the aquatic food chain strongly depends on the influx of food from the surrounding forest (see Harripersad-Makhanlal and Ouboter 1993). The creeks associated with submontane plateaus with a ferro-bauxite crust, like the Brownsberg, are different from those associated with other, more common landscapes in the Guianas (generalization based on concise characterization by De Granville 1994 and De Dijn pers. obs.):

- Creek flow starts slowly in near-horizontal gullies on the plateau; parts of these gullies hold alluvial material and may form perennially flooded streambeds;
- Once these creeks pass the margin of the elevated plateau, they become fast-flowing and strongly erosive, descending in steep, cascading beds, and exposing the parent rock; locally, these cascades are considerable and give rise to small waterfalls or strings of rapids, with substantial exposure of bedrock;
- At or below 100 m elevation, these permanent creeks transform abruptly: they become slower-flowing again, but are now much wider and located in yet wider alluvial plains.

These creeks can, thus, be viewed as a linear succession of habitats, following the dramatic elevation and climatic gradient. Unique plant associations and species such as *Dicranopygium pygmaeum* (Cyclanthaceae) and certain fern species (e.g. *Cyathea* – arborescent ferns – and *Diplazium* spp. and other non-woody terrestrial ferns) characterize the creek and creek side habitats at Brownsberg (De Dijn pers. obs.), in full agreement with the general description of streamside habitats that are associated with elevated, ferro-bauxite encrusted plateaus by De Granville (1994).

Creeks affected by on-site gold mining are dramatically different from undisturbed ones (see above) and represent different habitats: the forest cover is largely absent and the creeks are exposed to direct sunlight, as are the basins with standing water that are left behind by the miners. It is obvious (De Dijn pers. obs.) that, at least in the basins, these changes in water quality and exposure to sunlight lead to strong algal blooms that color the water green, which can only mean that the aquatic food chain here is very different, based on a substantial primary production by algae.

The terrestrial habitats of the Brownsberg can best be generally subdivided and described on the basis of the terrestrial vegetation and soil characteristics, in combination with elevation and landscape characteristics. De Granville (1994) and others (e.g. Teunissen in Suriname Planatlas 1988) distinguish between lowland and submontane vegetation types, i.e. those below and above 500 m elevation. This should be interpreted as a distinction between habitat types rather than vegetation types. The 500 m dividing line is somewhat arbitrary and for the Brownsberg it may be more appropriate to set it at 400-450 m, which is the approximate altitude of the lower parts of the main elevated plateau, and is also the altitude above which climatological conditions tend towards those of cloud forest (see above). The basis for the terrestrial vegetation description that follows is the work of De Granville (1994); below, the French terminology is translated and adapted, e.g. to fit the situation as encountered at Brownsberg. The flora and vegetation of the Brownsberg have recently been assessed by ter Steege and collaborators (2005) and De Dijn and Satyawan (for STINASU; unpublished), and the results of these rapid assessments have been incorporated in the following discussion.

The terrestrial habitats at Brownsberg can be classified according to vegetation or forest type (as proposed below) and elevation zone (lowland versus submontane):

- ***"Standard" mesophytic rainforest***: This is a multi-story forest, located mostly on well drained, usually deep soil. Typically, the forest is high to very high, and virtually all plants in the understory are thin-leaved (often big with long drip-tips). At the Brownsberg, this vegetation type is essentially restricted to the lowlands, i.e. the foothills, slopes and ridges, although it may occasionally reach altitudes of approximately 500 m. It may cover 70-80% of the Brownsberg. The specific composition of the vegetation is highly variable, but usually leguminous trees (Mimosoideae, Papilionaceae and Caesalipiniaceae) are dominant, alongside Sapotaceae and other highly diverse tree families (see De Granville 1994). Tree species (with a stem larger than 10 cm diameter), such as *Carapa procera, Gustavia hexapetala* and *Oenocarpus baccaba,* are abundant on the slopes and at the foot of the Brownsberg, and *Tetragastris panamensis, Corypthophora labriculata,* and *Astrocarium sciophylum* are particularly abundant at the foot (generalization based on data in ter Steege et al. 2005). The understory is frequently dominated by *Astrocarium* palms (e.g. the common *A. paramaca*), and is typically open, except near larger streams and where the forest has been disturbed (in natural or man-made clearing). This forest type is usually referred to as "high dryland forest" (but the same term is also used to designate the next type);
- ***Meso-xerophytic forest on partially ferro-bauxite encrusted soil:*** This is also a multi-story vegetation type, but it is restricted to encrusted plateaus and caps, and occurs in submontane and lowland settings at Browns-

berg; typically, many of the plant leaves in the understory are xeromorphic (thick, often small and without distinct drip-tips). This vegetation type has a variable composition, often similar to that of "standard" rainforest, but with higher proportions of e.g. Myrtaceae, Lauraceae, Annonaceae and Burseraceae (see De Granville 1994). Tree species (with a stem larger than 10 cm diameter), such as *Qualea rosea* and *Vouacapoua americana,* are abundant in the high forest of the encrusted plateaus at Brownsberg (regardless of elevation), while *Micrandra brownsbergensis, Coussarea paniculata, Neea ovalifolia* and an unidentified *Myrtaceae* are particularly abundant on the submontane plateau only (generalization based on data in ter Steege et al. 2004). This forest type covers most of the submontane and lower plateaus of the Brownsberg, and is often shorter than "standard" rainforest on nearby slopes with deep soil, and has a denser understory. In Suriname, this forest type is sometimes referred to as "(high) (mountain) savanna forest" (but the term is more often used to designate the next forest type). At high elevations where cloud forest conditions prevail – at Brownsberg along much of the eastern margin of the main plateau – the forest is rich in epiphytes, e.g. mosses, and referred to as "moss forest";

- ***Predominantly xerophytic low forest on heavily ferro-bauxite encrusted soil:*** This is essentially a low, one-story vegetation type that is restricted to areas with an exposed, solid ferro-bauxite crust and little topsoil. It occurs in submontane and lowland settings at Brownsberg. This forest type is dominated by thin-stemmed, xeromorphic trees, many of which are multi-stemmed and gnarled (see De Granville 1994); Myrtaceae are well represented and are striking elements of the vegetation (De Dijn pers. obs.), and epiphytic and epilithic non-woody plants may be very abundant, such as orchids, bromeliads and mosses. At Brownsberg, this vegetation type covers small sections of the submontane plateau, as well as at least two larger slope sections with a heavily encrusted lateritic soil. While parts of the main plateau where this vegetation type occurs are seasonally flooded (for periods of up to a week), flooding has never been observed in lowland areas with a similar vegetation. The vegetation composition in the lowlands (at Brownsberg: on the Bongrowiri plateau) may differ from that in the highland areas (see De Granville 1994), e.g. because of the differences in terms of precipitation and drainage. In Suriname, this forest type is often referred to as "(low) mountain savanna forest";
- ***Bamboo / liana forest:*** This may not be forest *sensu strictu*, as it is often a low thicket, dominated by lianas and bamboo (*Guadua* spp.), with only scattered emergent trees (see De Granville 1994). At the Brownsberg, this vegetation type is restricted to lowland settings; it is regarded as anthropogenic and indicative of locations that have been disturbed for prolonged periods of time (e.g. inhabited by successive generations of people in pre-Columbian times; Versteeg pers. comm.; see also Bubberman 1988). This vegetation type typically occupies relatively small surfaces;
- ***Marshy streamside forest:*** with seasonal flooding tolerant trees (De Granville 1994). This forest type occurs in larger wet depressions, gullies and creek valleys in submontane and lowland settings at Brownsberg. It resembles "standard" rainforest in terms of height and leaf characteristics, but is seasonally flooded or at least waterlogged, and differs in tree composition. Typical tree species associated with this vegetation type are *Eperua* spp. (which can be quite dominant) and the stilt-rooted palm *Socratea exorhizza* (at low densities; De Dijn pers. obs.);
- ***Swamp-marsh forest:*** dominated by the pina palm, *Euterpe oleracea*. At Brownsberg, this forest type is located along creeks in the lowlands, and in submontane and lowland settings in "backswamp" situations (slight depressions that are poorly drained, are permanently flooded or waterlogged, and feed creeks during most of the year; De Dijn pers. obs.).

The natural habitats of the Brownsberg range agree very well with the habitats described as vegetation types of the Interior of French Guiana by De Granville (1994); the correspondence with habitat types found at the Nassau and Lely ranges is striking (De Dijn pers. obs.). The more unique habitats are those associated with the plateaus, e.g. cloud forest habitats and habitats with a heavily encrusted soil. These habitats are divergent in terms of soil and climatological conditions and also vegetation composition (see above). The Brownsberg range, like the other discrete ranges in French Guiana (De Granville 1994) and eastern Suriname (ter Steege et al. 2005), would appear to have idiosyncrasies in terms of tree composition, and possibly also in terms of other plant growth forms and taxa. A case in point is the abundance of *Micrandra brownsbergensis*, which is not endemic to the Brownsberg but is exceptionally abundant there on the main plateau. This can be interpreted as the result of the relatively isolated development of the vegetation of the different ranges. The Brownsberg is, however, part of a wider chain of plateaus (see above) in Suriname, and the nearby Stonbruku range (which has not yet been investigated) may be similar.

The descriptions of terrestrial vegetation (above) apply mainly to "climax" vegetation types, either of pristine or old anthropogenic nature. A substantial part of the Brownsberg is not pristine, but has been recently disturbed by humans. Parts of the Brownsberg forest is in various stages of succession, and may best be referred to as secondary forest. Early secondary forest is typically lower and dominated by fast-growing native tree species (such as *Cecropia* but also *Vismia* and other softwood species). While trees characteristic of secondary forest occur throughout the Brownsberg in natural gaps formed by recent treefalls, these natural gaps tend to be small and isolated. Human disturbance often

leads to the formation of more important gaps that are colonized by secondary forest species. The forest that develops in these man-made gaps will thus typically cover larger areas (more than approximately 0.25 ha), and may represent a distinct habitat type. At Brownsberg, secondary forest occurs along the main road across the Brownsberg range, but also in other disturbed zones. The lowest level of disturbance at the Brownsberg occurs generally above 200-250 m elevation and throughout the southern part of the range. The highest level of disturbance occurs in and near creek valleys below 200 m where miners are active (see Figure 13.2). The level of disturbance is exceptionally high in the northwest (Browns, Verjari, and Kumbu Creek valleys; towards Stonbruku) and at some locations near the Brokopondo Lake (Makambi and Witi-Moeder Creek valleys). A special habitat at the Brownsberg that is also clearly anthropogenic is a small cave at Leo Falls (on Browns Creek), which reportedly dates from the turn of the 19-20th Century (note: it represents a special habitat for bats).

Table 13.1. Mammals collected or observed in the Brownsberg range.

Larger group	No. of spp.	Family	No. of spp.	No. of species		
				Endemic to the Guayana Shield	Listed on CITES Appendix I	Listed by IUCN as CR, EN, VU or NT
Small flying mammals (bats)	54	Emballonuridae	2			
		Molossidae	2			
		Mormoopidae	2			
		Phyllostomidae	43	1		8
		Thyropteridae	1			
		Vespertillionidae	4			
Small non-flying mammals	21	Didelphidae	8	1		2
		Echimyidae	4			1
		Muridae	7	2		
		Sciuridae	2			
Large mammals (incl. primates)	41	Cervidae	3			
		Tayassuidae	2			
		Canidae	2		1	1
		Felidae	6		5	2
		Mustelidae	2			
		Procyonidae	2			
		Dasypodidae	4		1	1
		Tapiridae	1			1
		Bradypodidae	1			
		Cyclopeidae	1			
		Megalonychidae	1			
		Myrmecophagidae	2			1
		Callitrichidae	1			
		Cebidae	7	2		
		Cuniculidae	1			
		Dasyproctidae	2			
		Erethizontidae	2	1		
		Hydrochaeridae	1			
all	**116**			**7**	**7**	**17**

Species

Plants

Plants will not be discussed here much beyond what has already been presented in relation to habitat and vegetation in the above section. A separate chapter in this volume deals with botanical diversity in general, and another one specifically with orchid diversity. It is important to note, though, that a substantial number of rare plants have been recorded at the Brownsberg (see list of "endemic" and "rare" plant species in Mittermeier et al. 1990; see also chapter on orchids and orchid bees). It is worth noting that probably none of the Brownsberg endemics listed in Mittermeier et al. (1990) actually are unique to the area, as they have proven to be more widespread but rare Guayana Shield endemics that at the time were only known from the Brownsberg (De Dijn pers. obs.)

Mammals

A listing of the mammals of the Brownsberg (Appendix 18) has been based on a recent review by Lim et al. (2005); the discussion here is based on this review (including the taxonomy and nomenclature). A summary of the listing features is presented in Table 13.1; nine species mentioned by Lim et al. (2005) have been excluded, as they have not been collected or observed at the Brownsberg range itself (based on our definition of the range).

The 116 mammal species recorded at the Brownsberg range represents almost two-thirds of the total number of mammal species known from Suriname (based on discussion in Lim et al. 2005). With 41 species recorded, the list of large mammals should be complete or nearly so, thanks to the wildlife monitoring efforts of STINASU and numerous volunteers and guest researchers such as Norconk and collaborators (see Plant-Animal Interactions section below). The only large mammal species know from Suriname, but not listed for the Brownsberg, are those occurring in habitats that are not known from the Brownsberg range; many small mammal species have not yet been recorded at Brownsberg, but most probably do occur there and have simply escaped detection (see Lim et al. 2005 for a list).

The mammal fauna of the Brownsberg can be characterized as a typical Guayana Shield lowland rainforest fauna (see Lim et al. 2005), and includes eight species of monkeys (see Norconck et al. 2003 for details), two of which, *Ateles paniscus* (black spider monkey) and *Pithecia pithecia* (white-faced saki), are Guayana Shield endemics. Other Guayana Shield endemics recorded are (based on www.natureserve.org/infonatura accessed July 2006): *Coendou melanurus* (black-tailed hairy dwarf porcupine), *Neacomys paracou* (a spiny mouse), *Oecomys auyantepui* (a rice rat), *Monodelphis brevicaudata* (an opossum) and *Lophostoma schulzi* (a bat).

Table 13.2. Birds recorded from Brownsberg.

Order	No. of spp.	No. of species		
		Endemic to the Guayana Shield	Listed on CITES Appendix I	Listed by IUCN as CR, EN, VU or NT
Apodiformes	30			
Caprimulgiformes	6			
Charadriiformes	4			
Ciconiiformes	5			
Columbiformes	9			
Coraciiformes	5			
Cuculiformes	4			
Falconiformes	31		1	1
Galbuliformes	11	2		
Galliformes	5	2		
Gruiformes	3			
Passeriformes	221	21	1	1
Pelicaniformes	1			
Piciformes	18	3		
Psittaciformes	18	2	2	1
Strigiformes	6			
Tinamiformes	5			
Trogoniformes	5			
Total	**387**	**30**	**4**	**3**

Twenty of the mammal species recorded at Brownsberg are of considerable conservation concern, obvious from their listing on the CITES Appendix I or their listing by IUCN as endangered, vulnerable or near-threatened (based on www.natureserve.org/infonatura accessed July 2006; Appendix 18): *Speothos venaticus* (bush dog), *Herpailurus yagouaroundi* (jaguarundi), *Leopardus pardalis* (ocelot), *L. tigrinus* (oncilla) and *L. wiedii* (margay), *Panthera onca* (jaguar), *Priodontes maximus* (giant armadillo), *Caluromys philander* (woolly opossum), *Marmosops parvidens* (delicate slender mouse opossum), *Tapirus terrestris* (Brazilian tapir), *Myrmecophaga tridactyla* (giant anteater), *Echimys chrysurus* (white-faced tree rat), and eight bat species: *Artibeus concolor* and *A. obscurus*, *Glyphonycteris daviesi* and *G. sylvestris, Lophostoma carrikeri* and *L. schulzi, Phyllostomus latifolius, Vampyressa brocki*.

Table 13.3. Bird species endemic to the Guayana Shield recorded from Brownsberg.

Scientific name	English name
Penelope marail	Marail Guan
Crax alector	Black Curassow
Pionopsitta caica	Caica Parrot
Amazona dufresniana	Blue-cheeked Parrot
Notharchus macrorhynchos	Guianan Puffbird
Monasa atra	Black Nunbird
Pteroglossus viridis	Green Aracari
Selenidera culik	Guianan Toucanet
Veniliornis cassini	Golden-collared Woodpecker
Synallaxis macconnelli	McConnell's Spinetail
Xiphorhynchus pardalotus	Chestnut-rumped Woodcreeper
Frederickena viridis	Black-throated Antshrike
Sakesphorus melanothorax	Band-tailed Antshrike
Myrmotherula surinamensis	Guianan Streaked-Antwren
Myrmotherula guttata	Rufous-bellied Antwren
Myrmotherula gutturalis	Brown-bellied Antwren
Herpsilochmus sticturus	Spot-tailed Antwren
Herpsilochmus stictocephalus	Todd's Antwren
Percnostola rufifrons	Black-headed Antbird
Gymnopithys rufigula	Rufous-throated Antbird
Contopus albogularis	White-throated Pewee
Perissocephalus tricolor	Capuchinbird
Corapipo gutturalis	White-throated Manakin
Lepidothrix serena	White-fronted Manakin
Tyranneutes virescens	Tiny Tyrant-Manakin
Iodopleura fusca	Dusky Purpletuft
Cyanicterus cyanicterus	Blue-backed Tanager
Periporphyrus erythromelas	Red-and-black Grosbeak
Euphonia finschi	Finsch's Euphonia
Euphonia cayennensis	Golden-sided Euphonia

Birds

A listing of the birds of the Brownsberg area is regularly updated on the website of Jan-Hein Ribot (http://www1.nhl.nl/~ribot/english/). These updates are based on inputs from STINASU and various ornithologists that have visited the Brownsberg Nature Park. The summary in 13.2 is based on a Ribot listing (accessed July 2005) that has been modified slightly by one of the specialists co-authoring this review (O'Shea, who removed four species from the list and added one; an additional species was removed based on Ottema pers. comm.).

The 387 bird species recorded at Brownsberg (Appendix 19) represent some 55% of the total number of bird species known from Suriname (Haverschmidt and Mees 1994 and http://www1.nhl.nl/~ribot/english). Knowledge of the Brownsberg avifauna is excellent as a result of a series of monthly inventories done recently by STINASU during one full year (Ottema unpub. data) and because the Brownsberg Park has been visited by numerous experienced ornithologists.

The composition of the avifauna of the Brownsberg is typical of Amazonian lowland rainforest, although almost 8% of the species recorded from Brownsberg are Guayana Shield endemics (Table 13.2, Hilty 2003, Milensky et al. 2005). The majority of the 30 species of endemics found at Brownsberg (Table 13.3) are regional representatives of more widespread species complexes. Nevertheless, they represent distinct taxonomic entities whose global ranges are quite small. Bird diversity at Brownsberg is high, due primarily to the fact that the Park is contiguous with large expanses of undisturbed forest in the region; habitat diversity also accounts for the large number of species recorded from the Park. The tall forest on top of the Brownsberg plateau is the most species-rich habitat.

Four of the bird species recorded at Brownsberg are of considerable conservation concern: *Harpia harpyja* (Harpy Eagle; CITES Appendix I and IUCN Near Threatened), *Ara macao* (Scarlet Macaw; CITES Appendix I), *Amazona dufresniana* (Blue-cheeked Parrot; IUCN Near Threatened and Guayana Shield endemic), and *Contopus cooperi* (Olive-sided Flycatcher; IUCN Near Threatened). Populations of game birds, especially Cracidae (Guans and Curassows) and Psophiidae (Trumpeters), are very healthy. The density of trumpeters, in particular, is higher here than at any other site this author has surveyed in South America. The abundance of game birds supports the impression that the area of Brownsberg remains little affected by human activity and is thus an excellent representation of an undisturbed Guianan lowland forest bird community.

Reptiles and amphibians

To compile a listing of the herpetofauna of the Brownsberg, data from various sources were scrutinized and combined, including: i) data compiled earlier by Reichart (1997), ii) data collected by STINASU staff and volunteers in the

course of the BNP monitoring program (see above), and iii) data from observations of specialists co-authoring this review (Marty, Luger, Ringler, Crothers, and Noonan). Doubtful records and records that may be based on misidentifications were not retained; it was attempted to avoid inflating the species numbers by only counting unidentified species when overlap with identified species was very unlikely. A summary of the listing is presented in Table 13.4 and the list is presented in Appendix 20.

The 80 species of reptiles and 64 species of amphibians (Appendix 20) represent a very rich sample of the Guayana Shield lowland rainforest fauna. The amphibian fauna is quite diverse and includes some rare elements such as Allophrynidae and Centrolenidae and two species of worm salamander (Gymnophiona). The high amphibian species diversity is undoubtedly due to the dramatic relief and the associated high habitat diversity at the Brownsberg. Some Amphibia species appear to be restricted to the foggy and

Table 13.4. Amphibians and reptiles collected or observed at Brownsberg.

Larger group	No. of spp.	Family	No. of spp.	No. of species		
				Endemic to the Guayana Shield	Listed on CITES Appendix I	Listed by IUCN as CR, EN, VU or NT
Amphibia Anura (frogs & toads)	**62**	Allophrynidae	1			
		Bufonidae	7	1		1
		Centrolenidae	2	1		
		Dendrobatidae	6	1		
		Hylidae	23	2		
		Leptodactylidae	21	5		
		Microhylidae	1			
		Pipidae	1	1		
Amphibia Gymnophiona	**2**	Caeciliidae	1	1		
		Rhinatrematidae	1	1		
Reptilia Crocodylia	**1**	Alligatoridae	1			
Reptilia Squamata "lizards"	**28**	Amphisbaenidae	2			
		Gekkonidae	5			
		Gymnophthalmidae	7	2		
		Iguanidae	1			
		Polychrotidae	4			
		Scincidae	1			
		Teiidae	6			
		Tropiduridae	2			
Reptilia Squamata "snakes"	**44**	Aniliidae	1			
		Boidae	4			
		Colubridae	28	1		
		Elapidae	5	1		
		Leptotyphlopidae	2	1		
		Viperidae	4			
Reptilia Testudines	**7**	Chelidae	3			
		Emydidae	1			
		Kinosternidae	1			
		Testudinidae	2			1
all Amphibia	**64**			**13**	**0**	**1**
all Reptilia	**80**			**5**	**0**	**1**

cool submontane parts of the Brownsberg, and may not occur in the surrounding lowlands. A number of the amphibian species remains unidentified or in doubt, and requires further study as to their definitive status. A substantial number of additional frog species may occur at the Brownsberg, especially tree frogs, many of which easily escape detection.

The fauna includes a number of species that are likely to be endemic to the Guayana Shield (based on Avila-Pires 1995, Starace 1998, Lescure and Marty 2000 and www.globalamphibians.org accessed Oct. 2004): *Atelopus hoogmoedi* (= *A. spumarius hoogmoedi*; a terrestrial toad), *Cochranella oyampiensis, Colostethus granti, Osteocephalus cabrerai, Scinax proboscoideus, Eleutherodactylus chiastonotus, E. inguinalis* and *E. zeuctotylus, Leptodactylus longirostris* and *L. meyersi*, *Pipa aspera* (all frogs), *Microcaecilia unicolor, Rhinatrema bivittatum* (both worm salamanders), *Leposoma guianense*, *Neusticurus rudis* (both lizards), and three snakes: *Atractus zidoki, Micrurus collaris*, and *Leptotyphlops collaris*.

Species of significant conservation concern that occur at Brownsberg are *Atelopus hoogmoedi* and *Geochelone denticulata* (yellow-footed tortoise), which are listed as vulnerable by IUCN.

Other animals

As far as other animals are concerned, a listing was obtained of the Brownsberg butterflies (day-active Lepidoptera) from Hajo Gernaat (pers. comm.), and of Scarabeioidea beetles from Meindert Hielkema (pers. comm.); data on these taxa are summarized in Table 13.5. These listings appear to be quite incomplete, as is obvious from the low numbers of species recorded for the very diverse butterfly families Lycaenidae and Riodinidae, and low overall number of species for Scarabeioidea (at least 40-50 species would be expected). Data on orchid bees are presented and discussed elsewhere in this volume.

According to Gernaat (pers. comm.), the Brownsberg has a number of rare butterfly species, most notably *Heraclides garleppi lecerfi* (Papilionidae), *Marpesia crethon, Nessaea batesi magniplaga, Siproeta epaphus gadoui*, and *Telenassa rima* (all Nymphalidae).

Plant-Animal interactions

The interactions between plants and animals represent an aspect of biodiversity that has been receiving special attention at Brownsberg. Its study leads to an understanding of how biodiversity components relate to one another, or, in other words, how the ecosystem functions. Studies on plant-animal interactions have been done at the Brownsberg in undisturbed areas (see below), but also in disturbed ones, to examine how the ecosystem functions, at least in terms of plant-animal interactions, under pressure from human-related activities, e.g. mining, hunting and tourism (see Threats and Conservation section below).

Plant-animal interactions are not static, as is obvious from the monitoring of associated ecological phenomena that are easily observable, such as ecosystem-wide flowering and fruiting, and overall frugivore activity. These ecological phenomena typically follow a seasonal (intra-annual) cycle, which may be subject to inter-annual variability. It is generally assumed that the "motor" behind the intra- and inter-annual variability of these ecological phenomena is the climate. As noted above, the Brownsberg climate is seasonal and variable. The BNP Monitoring Program implemented by STINASU and collaborating volunteers and scientists has been instrumental to assess whether there is a natural seasonal cycle at Brownsberg that also governs the flora and fauna (see Fitzgerald et al. 2002 and Djosetro et al. 2005).

Animal activity, mainly of mammals and some birds and herps, has been monitored intensively at Brownsberg by STINASU from November 2000 until March 2005. Most of the monitoring was done by observing animals when walking transects, and the results primarily reflect the activity of the animals at the time and place of observation. During the first years, monitoring took place in the northern part of the Brownsberg range only (see Fitzgerald 2003); the frequency and quality of monitoring gradually improved, to become fully standardized as of June 2003 when approximately 26 km of trails were walked for monitoring purposes at least twice a month. From July 2004 until March 2005, monitoring was expanded towards the south; during this period approximately 16 km of trails in the northern part of the Brownsberg range and approximately 16 km of trails in the central, less accessible part were walked each month (see Djosetro et al. 2005). The STINASU data remain to be processed further, but some trends can be glanced from the summary graphs presented by Djosetro and collaborators (2005), such as in relation to the annual cycle of monkey activity (monkeys were the most frequently observed animals):

- Low levels of monkey activity from the end of the long wet season until the period when the long dry seasons typically ends (July through Oct.-Nov.);
- Variable monkey activity during the period when there is typically a short wet season (from Oct.-Nov. until about Feb.);
- High levels of monkey activity from the period when there typically is a short dry season through the beginning of the long rainy season (Feb.-Mar. until about May).

Forest phenology was monitored by STINASU in collaboration with Pierre-Michel Forget, by drying and weighing the seeds and flowers that fell to the forest floor (these were intercepted by means of 100 standardized litter traps that were emptied every two weeks; see Bhikhi 2004 and Djosetro et al. 2005). Based on the Jan. 2003 – Feb. 2004 data (STINASU unpublished), the annual cycle was as follows:

- High levels of fruit fall from the short dry season through about the early - middle long rainy season (late Apr. – mid-July), and generally low levels at other times of the year;

- High levels of flower fall from the middle of the long dry season through the onset of the short rainy season (Oct. – Dec.), and generally lower, variable levels at other times of the year.

A similar pattern emerged based on Jan. 2003 – Mar. 2005 opportunistic observations by STINASU of the fruits and flowers that were developing on approximately 200-400 individual trees at Brownsberg that belonged to 100-200 species (the number of trees observed varied; see Bhikhi 2004, Djosetro et al. 2005, and STINASU unpublished). These included:

- A high proportion of trees with (developing) fruits from the short wet season through the short dry season, into the early long rainy season (Dec. – Jan. until Apr. – May), and generally lower proportions at other times of the year;
- A high proportion of trees with flowers from the middle of the long dry season through the onset of the short rainy season (Sep. – Dec.), and generally lower proportions at other times of the year.

Inter-annual variability was also observed: generally poor flowering in 2004 compared to 2005, and generally poor fruiting in 2004-5 compared to 2003-4 (cf. Djosetro et al. 2005).

Based on the above and the Brownsberg climate characteristics (see above), one can infer a logical link between the seasonality of the climate and the annual cycle of fruiting, flowering and frugivore activity:

- Flowering peak during the long dry season, when dry and sunny conditions prevail that ought to favor pollinator activity and reduce pollen losses due to rain, but low fruiting and low frugivore activity in this period of water stress;
- Fruit development peak during the subsequent short rainy and dry seasons, when there typically is much less water stress than during the preceding long dry season;
- peak activity of frugivores that coincides with the peak of ripening and falling of fruits during the short dry season, into the long rainy season, i.e. just ahead of and into a period when the soil-level microclimate ought to be best for seedling establishment.

Table13.5. Butterflies and Scarabeioidea beetles recorded from Brownsberg.

Larger group	No. of species	Family or subfamily	No. of species
Butterflies	**137**	Papilionidae	10
		Pieridae	11
		Lycaenidae	2
		Nymphalidae	67
		Riodinidae	2
		Hesperiidae	45
Scarabeioidea beetles	**18**	Scarabeidae, Coprinae	5
		Scarabeidae, Scarabeinae	7
		Rutelidae	2
		Dynastidae	3

Forget and collaborators (Forget and Jansen, in press; Cuijpers and Forget, in prep.) have focused on seed dispersal (and associated seed predation) by rodents at Brownsberg and in French Guiana. Forget and Jansen (in press) have observed, at the level of individual *Carapa procera* trees (Meliaceae), variable levels of seed dispersal by rodents; overall 83% of the seeds dropped by the trees (seed crop) were dispersed. At some undisturbed locations, the proportion of seeds dispersed increased with the size of seed crop. Cuijpers and Forget (in prep.) investigated rates of secondary dispersal of seeds of *Virola kwatae* trees (Myristicaceae) at Brownsberg: overall, approximately 15% of seeds experimentally placed were dispersed by rodents within 14 days. These data suggest that seed dispersal by rodents at Brownsberg is less important for *V. kwatae* than for *C. procera* (the latter is known to be quite dependent on dispersal by rodents; see e.g. Forget 1996 and Jansen et al. 2004). Pellegrom (2004) studied the predation and removal of *Pouteria guianensis* (Sapotaceae) seeds at Brownsberg. He calculated weekly averages for seed predation by bearded sakis, *Chiropotes satanas* (based on number of fruits dropped, and typical damage to fruits by sakis). He also assessed seed predation and removal by red-rumped agoutis, *Dasyprocta leporina* (based on typical agouti damage to previously intact fruits placed on the ground, as well as on the removal of fruits). At an undisturbed location, average seed predation by sakis was 55 to 88%, and average seed predation and removal by agoutis was 29%. The results from these studies indicate that levels of seed predation and seed dispersal at Brownsberg are often very high, at least at undisturbed locations, for a number of tree species that produce fruits and seeds that are a source of food for large mammals.

Norconk and collaborators (2003 and unpublished) have been focusing on the primate community at Brownsberg, and the plants the primates use as a source of food. Their initial focus has been on the sakis, *Pithecia pithecia* and *Chiropotes satanas*, which at Brownsberg are sympatric (occur in the same general area). These species have very different group sizes (respectively groups of 4-5 and more than 15) and are also distinct in terms of social behavior, locomotion and use of the forest strata, as well as in their food choice (Gregory and Norconk unpublished). Norconk and collaborators (unpublished) have initiated long-term research at Brownsberg on the responses of frugivores (monkeys, other mammals and birds) to seasonal stress and reduction in food supply. They intend to identify plant species that play a disproportionate role in sustaining the local frugivore assemblage.

THREATS AND CONSERVATION

Threats

Although much of the Brownsberg range is protected, it is also threatened. The most serious current threat is mining, both legal and illegal. Other threats are forest conversion for agricultural purposes, logging and hunting; the latter is associated with all of the previously mentioned other threats. A very distinct but less serious threat is tourism, or rather the negative impact of recreational activities at Brownsberg.

The SURALCO mining concession at the heart of the Brownsberg range (see above and Figure 13.2) has been a cause of concern for decades (see Reichart 1997). Surface mining in the concession area would not just physically damage the Brownsberg range and its biodiversity (especially the habitats and species associated with the encrusted plateau), but it would also effectively destroy the image of Brownsberg Nature Park as a protected area. It is, however, becoming increasingly improbable that SURALCO or any other multinational mining company would effectively mine at the heart of the Brownsberg, if alone because of the controversy that would ensue and its potential damage to the company image.

The ongoing gold mining activities in and around the Brownsberg range and Park are another matter altogether. As previously stated above, approximately 5% of the Brownsberg Park has recently been devastated by illegal gold miners. The downstream sections of virtually all major creeks in the northern half of the range have been stripped of their natural vegetation and transformed into a series of basins filled with water or loose sediment, separated by improvised dikes, and connected by a system of dirt roads. At the Brownsberg, undisturbed streamside forest habitats are in danger of disappearing altogether from the lowlands. Also, as mentioned above, dramatic changes in water quality result from the gold mining; one of the changes is the increase in dissolved mercury and other heavy metals in the water. The latter can be expected to lead to increased heavy metal accumulation throughout the aquatic food chain, and beyond, e.g. in raptors and humans that consume substantial amounts of fish. With continued gold mining and mercury use in the area, there is real risk of mercury poisoning and mercury-induced reproductive failure in top predators. Pellegrom (2004) concludes that the disturbance of the forest by mining at Witi-Moeder Creek has led to a reduced predation and dispersal of seeds of *Pouteria guianensis* by bearded sakis and agoutis.

Forest conversion for slash-and-burn (swidden) agriculture is a cause of concern, especially along the northern and western margin of the Brownsberg range, near the Mindrineti Creek and the Atjonipasi road (see above and Figure 13.2). Miners have also created small yards and fields in the mining areas, e.g. at Witi-Moeder Creek. The lowland forest areas near major creeks and access roads of the Brownsberg range are the most impacted (but not the slopes or plateaus).

Although logging has been a problem at Brownsberg, at least occasionally (see Teunissen in prep.), it has been selective logging, and has not resulted in the kind of widespread habitat destruction that is caused by strip mining. The recently established new forest management institute SBB seems to have sufficient grip on the formal logging sector that is active in concessions near the Brownsberg. A worrying development at Brownsberg, however, is opportunistic logging and sawmilling by some of the miners and by local sawmill operators who use the dirt roads created by the miners (Molgo and De Dijn pers. obs.). The small-scale sawmill operators often do not transport wood to the capital and, thus, easily escape detection.

Hunting is a matter of considerable concern relative to the larger fauna. The Brownsberg area is a traditional hunting ground of the Saramaka Maroons; inhabitants of the nearby village of Brownsweg continue to hunt in the lowland areas and foothills of the northern part of the Brownsberg (De Dijn pers. obs.). In and near the areas where gold mining is taking place, the resident miners also hunt. Over the course of the implementation of the Brownsberg monitoring program, STINASU staff and volunteers (unpublished) regularly recorded gunshots that were heard or shotgun shells that were found, mostly in lowlands of the northwest of the Brownsberg or near Witi-Moeder Creek, which are both heavily used mining areas. Forget and Jansen (in press) conclude that hunting negatively affects seed dispersal of *Carapa procera*, as evident in areas where hunting pressure was high from large numbers ("piles") of undispersed seeds remaining under trees that had produced a large seed crop.

Tourism may also negatively affect biodiversity, but there is little evidence that this is the case at Brownsberg. The creation of new lodges and panoramic views on the northwestern rim of the Browsberg main plateau has resulted in some unnecessary clearcutting of moss forest habitat, but the damage is very localized and, for instance, not evident on Landsat images (contrary to the mining damage; see Figure 13.2). The issue of the impact of tourism on the water quality at Brownsberg has been addressed by Ouboter (2005), and his conclusion is that there is only a slight impact at some of the most heavily visited areas. The Brownsberg monitoring program implemented by STINASU has not yielded evidence that tourism has a negative impact on the wildlife: based on Djosetro et al. (2005), all of the forty wildlife species that have been observed near the trails that are never used by tourists (including the central part of the Brownsberg range) have also been observed on trails used by tourists (including the most heavily used trails), with the exception of the two-toed sloth, *Choloepus didactylus*.

A threat that is specific to Amphibia is fungal infection leading to chitridomycosis, a lethal disease (Daszak et al. 1999). This disease has led to species extinctions in much of South America. Specimens of the toad *Atelopus hoogmoedi* from Brownsberg have tested negative on infection by the lethal fungus *Batrachochytridium dendrobatidis* (Luger unpublished). The fungus seems to preferentially attack species in cooler highland areas, and the Brownsberg would thus potentially be at risk.

Conservation

Brownsberg Nature Park came into existence almost accidentally as a by-product of the bauxite exploration of the area by SURALCO. The company engineers were undoubtedly impressed by the scenery, wildlife, mild climate and tranquility of the Brownsberg range. Others were surely intrigued by the pre-Columbian artifacts, as well as earthworks and machines from Suriname's first gold rush. The establishment of the Park in 1970s marks the beginning of heritage conservation in the Brownsberg area, and coincided with the development of commercial nature tourism activities by STINASU.

When the Park was established, the Brokopondo Lake and the village of Brownsweg had already separated the Brownsberg range from the forests to the north and east. By the mid-1970s, the Brownberg range and a narrow strip of forest land west and south of it were separated from the surrounding forests by the Atjonipasi road. Thus, an isolated strip of forest land of approximately 60,000 ha came into existence between Brownsweg and Pokigron, including the approximately 27,500 ha of the Brownsberg range and the 11,800 ha of the current Park. The data presented above do not suggest that this isolation has dramatically affected the biodiversity of the Brownsberg range: the area still has a very rich, typical lowland Guayana Shield rainforest fauna. Steep slopes and the upper plateau of the Brownsberg appear to function as a wildlife refuge, as virtually no hunting or other disturbances occur in these areas.

Recent gold mining activities are, however, reducing the natural and cultural value of the Brownsberg range. The modern gold miners have already destroyed a substantial part of the creek habitats and historical sites associated with the first gold rush. They increasingly open up the area with excavators and other heavy machinery and allow others, e.g. logging crews and hunters, to enter and cause additional damage. The illegal mining continues to encroach upon the Park and has proven to be a veritable Pandora's Box, not just leading to collateral and cumulative damage, but also leading to accusations of corruption and damage to the image of STINASU (De Dijn pers. obs.).

The importance of the Brownsberg range for conservation can be summarized as follows:

- It is representative of landscape and habitat types that are poorly protected at the national and the Guayana Shield level (see above; encrusted plateaus rich in bauxite or gold tend to be mining concessions or candidates to become such, not protected areas);
- It is of great archaeological and historical importance (see above);
- It has a great diversity of habitats, some of which are scenic and may be unique in terms of vegetation composition (see above);
- It has substantial numbers of rare plant and animal species (see above);
- It functions as a wildlife refuge with a rich Guayana Shield lowland rainforest fauna (see above); many of the animal species are Guayana Shield endemics or species of considerable conservation concern (see above: species listed on CITES Appendix I or listed by IUCN as Endangered, Vulnerable, Threatened or Near-Threatened);
- It is easily accessible for visitors, and there is on-site infrastructure, such as buildings and trails, for tourists and researchers as well as schools;
- Its fauna and flora can easily be observed and are well documented;
- It is arguably the most popular nature tourism destination in Surinamers and is, thus, a great location for purposes of nature education and conservation awareness building (STINASU refers to the Park as a "Rainforest School").

The main challenge for the conservation of the Brownsberg range appears to be to protect the area from further encroachment by illegal miners. This will not be easy since the illegal gold mining activities are driven by international gold prices, which continue to rise (Hammond 2005c and De Dijn, pers. obs.). The Government of Suriname (GoS) should actually be removing illegal miners from the Park, ensuring that they do not return, but this is simply not happening. So part of the challenge will be to motivate the GoS to act and restore law and order in the larger Brownsberg-Brownsweg area. The multinational mining companies seem to pose less of a threat, but it will require considerable skill to arrive at a "non-mining agreement" in relation to the Brownsberg, e.g. with SURALCO (see also Teunissen in prep.).

Another strategy to stop the encroachment by miners is to make the Park more relevant and more profitable for the local community, i.e. the community of Brownsweg. This may, in fact, represent the most relevant challenge: to link conservation and nature tourism with the development of the community. In the Brownsberg-Brownsweg area, this challenge may be more formidable than elsewhere in Suriname: not only is the local community large (several thousand persons), but it is also in a difficult transition (having been dislodged and forced into modernity), and, for a large part, engaged in gold mining, which in the short-term would seem more profitable and less demanding (in terms of education and dedication) than jobs in, for instance, the ecotourism sector.

RECOMMENDATIONS

Based on this review it is recommended that the protection of the Brownsberg range be enhanced by: i) effective law enforcement in and around the Park, ii) formal establishment and extension of the buffer zone towards the south,

so that it includes the entire approximately 60,000 ha area between the Brokopondo Lake and the Atjonipasi road, iii) the development of a management plan for the larger area that includes the Park and the extended buffer zone, and iv) the restoration of areas damaged by gold mining. To enable law enforcement, the borders of the Park should be unambiguous, meaning that they must be well demarcated in the field; currently, only the northern Park border has been demarcated. It should be noted that subsistence and economic activities in the buffer zone need not be excluded, but must be regulated and monitored to avoid excessive damage (e.g. to habitats and fauna) and prevent their expansion into the Park. This recommendation is in line with that of Teunissen (in prep.), but differs in the sense that a much larger buffer zone is proposed that may serve more varied purposes.

As far as tourism operations are concerned, these could be expanded to: i) the central and southern part of the Brownsberg range (outside the SURALCO concession), ii) the Brokopondo lakeside area, and iii) the village of Brownsweg. The aim would be to spread the visitors over a larger area, to make the Brownsberg a more attractive location to visit and to increase community involvement (see also below). A move into to central and southern parts of Park and the lakeside area is important for STINASU to ensure that buildings are established on terrain that is within its legal lease or concession, e.g. to make use of this property as collateral (which is currently not possible due to the location of the existing buildings). The tourism operations are of critical important to ensure that income is generated for the daily management of the Park; the use of buildings as collateral is crucial to obtain private, unrestricted development capital. When tourism activities are expanded, it would be wise to make as much use as possible of already disturbed areas for infrastructure development, and combine this type of development with landscape restoration. Care must, of course, be taken to avoid damage to pristine habitats and to wildlife. Based on the results of ecological monitoring at Brownsberg by STINASU (see section above), an expansion of tourism activities should not be assumed to have a negative effect on wildlife.

To assess the impact of the measures proposed above, it is important to monitor human activities, biodiversity and the environment at Brownsberg, in line with the research and monitoring program developed by Fitzgerald and collaborators (2002) and the modifications thereof, as well as the additions to the program (see STINASU unpublished project proposal and quarterly reports to WWF Guianas; see also results in Djosetro et al. 2005, Vreedzaam et. al. 2005 and Ouboter 2005). In agreement with Teunissen (in prep.), it is recommend that the data generated by STINASU during the course of the BNP Monitoring Program from 2002 to 2005 be processed further, and that the results thereof be reviewed and published. Based on these results, a modified Brownberg Monitoring Program (BMP) should be initiated that covers the Park as well as the buffer zone. Staff and volunteers involved in the BMP and guest researchers should be housed in a new station that may be set up at the center of the Brownsberg range (on the main plateau). Serious consideration should be given to setting up an additional research station at the Brokopondo lakeside (to be used to investigate the Brownsberg lowlands, as well as the aquatic and island habitats of the Brokopondo Lake). Vigilance and some preventive measures may need to be associated with continued research and monitoring to prevent chitridiomycosis with Amphibia at Brownsberg. To prevent transmission of the disease, it is recommended that researchers (especially visiting herpetologists) disinfect their equipment, maybe even their clothing (see La Marca et al. 2005).

It is also recommended, in line with Fitzgerald et al. 2002 and Fitzgerald 2003, that full and proper use be made of the results of the past and future research and monitoring at Brownsberg. This means that the strategic planning and the daily management of at least the Park should be guided by the results of research and monitoring. It also means that these same results should be used as inputs for a variety of information products on the Brownsberg (for tourist, volunteers and guest researchers), as well as for public awareness and education activities in the Park and in the capital Paramaribo. To achieve this, changes will have to be made in the institutional and human resource domain, not just at the level of the unit responsible for research and monitoring at Brownsberg, but also in terms of the interface between this unit and other units that are responsible for education and public relations, as well as in terms of the entire approach to the management of the Park.

It is further recommend that a super-structure be created for the Brownsberg-Brownsweg area that would at least allow for: i) conflict resolution between STINASU, the village of Brownsweg, and local miners and other operators, ii) a dialogue on land-use with the stakeholders that will lead to land-use planning for the area, and iii) the development and initiation of conservation and development projects that benefit the local community. This structure should also facilitate the dialogue between the strictly local stakeholders and the multinational mining companies that are active in the region, as well as the most important actor, the Government of Suriname. Given ongoing developments and the complex tenure situation in the area, a Multiple-Use Management Area (MUMA) may be an appropriate basis for such a structure. The stakes are high and there is a need for effective action. A Consultation Commission for the Park (and buffer zone; a proposal of Reichart 1997, reiterated by Teunissen in prep.) may not be sufficient to effectively address the issues and solve conflicts. A MUMA could include the Park, the buffer zone, lands traditionally used by the Brownsweg village, including HKVs (see above) and small mining concessions owned or used by members of the Brownsberg community.

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Appendix 1

Plant collection data used in the current study.

Hans ter Steege, Olaf Bánki and Paddy Haripersaud

Data include the collectors included in the study, amount of collections per location (BB = Brownsberg; BW = Brownsweg; Le = Lely; Ma = Marowijne; Mo = Moengo; Na = Nassau), and indication of the year of collection.

Collector(s)	BB	BW	Le	Ma	Mo	Na	Grand Total	Year of collection
Andel, T.R. van *et al.*	445						445	2003
Budelman, A.		1					1	1974
Christenhusz, M.J.M. & Bollendorff, S.M.	4						4	2003
Cowan, R.S. & Lindeman, J.C.						198	198	1954-55
Cremers, G. & Crozier, F.	1						1	1997
Determann, R.O.	44						44	1978-79
Donselaar, J. van & Helstone, E.M.C.	3	56					59	1965-66
Emden, W.C. van	13						13	1931
Evans, R.J. & McDonnell, K.	1						1	1999
Gerling, A.H.	13						13	1917-1922
Gonggrijp, J.W.	9	1					10	1910, 1915, 1917, 1924
Gonggrijp, L.	7						7	1924
Görts-van Rijn, A.R.A.	3						3	1999
Heyde, N.M.	7						7	1976-77
Hoffman, B. & Troon, F. van	2						2	1998
Jansen-Jacobs, M.J. *et al.*			441			408	849	2003-4
Jenman, G.S.	2						2	1918, 1924
Kanhai, E.D.	97						97	1971
Kastelein, W.J.	22						22	1977
Kock, C.	2						2	1972
Koster	17						17	1971-73
Kramer, K.U. & Hekking, W.H.A.		41					41	1961
Lanjouw, J.	18	18					36	1933
Lanjouw, J. & Lindeman, J.C.	2			176		801	979	1949
Lindeman, J.C.	69						69	e.g. 1967
Lindeman, J.C. & Cowan, R.S.						146	146	1954-55
Lindeman, J.C. & Mennega, E.A.	40						40	1977
Lindeman, J.C. & Roon, A.C. de	8						8	1981
Lindeman, J.C. & Stoffers, A.L. *et al.*			532				532	1975
Maas, P.J.M. et al.	52						52	1974
Maguire, B. & Maguire, C.K.					2	138	140	1955
Mori, S.A. & Bolten, A.	42		124				166	1976
Narain, T.R.	1						1	1975

Collector(s)	BB	BW	Le	Ma	Mo	Na	Grand Total	Year of collection
Nijverman, J.	28						28	1910, 1916-17
Picorni, J.L.	1						1	1920
Reeder, D.	1						1	1970
Roberts, L.	17						17	e.g. 1974-78
Roberts, L. & Schulz, J.P.	1						1	1975
Roberts, L. & Troon, F. van	14						14	1977
Scharf, U.	8	1					9	2001
Schulz, J.P.	2	1					3	1973
Stahel, G.	38						38	e.g. 1915-16, 1924
Stahel, G. & Gonggrijp, J.W.	65						65	e.g. 1915, 1923-25
Stahel, G. & Gonggrijp, L.	29						29	e.g. 1915, 1923-25
Tawjoeran, J.A.	49						49	1969, 1970, 1972
Teunissen, P.A.	3						3	1970, 1972, 1973, 1975
Teunissen, P.A. & Werkhoven, M.C.M.	6						6	1970, 1973, 1975
Tjon-Lim-Sang, R.J.M. & Wiel, I.H.M. van de	194						194	1975-77, 1981
Troon, F. van	2						2	1975, 1977, 1980
Troon, F. van & Roberts, L.	2						2	1977
Various Collectors	848	11					859	
Vreden, C.C.J.	32						32	1973-74
Vreden, C.C.J. & Werkhoven, M.C.M.	34						34	1973-74
Webster, G.L.	26						26	1979
Webster, G.L. & Armbruster, W.S.	2						2	1979
Werkhoven, M.C.M.	4						4	1972-73
Werkhoven, M.C.M. & Vreden C.C.J.	35						35	1972-73
Wessels Boer, J.G.	2	61					63	1963
Zaandam, C.J.	205	1					206	1921-26
Grand Total	**2572**	**192**	**1097**	**176**	**2**	**1691**	**5730**	

Appendix 2

List of tree species and number of individuals/species recorded in 23 plots in the Nassau, Brownsberg, and Lely Mountains.

Hans ter Steege, Olaf Bánki and Paddy Haripersaud

Genus	Species	total	% trees
Abarema	*jupunba*	29	0.22
Abarema	sp.BB4_48	1	0.01
Abarema	sp.Na6_442	1	0.01
Agonandra	*silvatica*	13	0.1
Alchorneopsis	*floribunda*	10	0.08
Allophylus	*punctatus*	1	0.01
Amaioua	*corymbosa*	42	0.32
Amaioua	*guianensis*	21	0.16
Ambelania	*acida*	8	0.06
Ampelocera	*edentula*	15	0.11
Anacardium	sp.1_BBLe	6	0.05
Anacardium	sp.OSB450	3	0.02
Anaxagorea	*dolichocarpa*	3	0.02
Andira	*surinamensis*	16	0.12
Aniba	*panurensis*	18	0.14
Annona	*foetida*	2	0.02
Annona	*sericea*	2	0.02
Antonia	*ovata*	6	0.05
Aparisthmium	*cordatum*	9	0.07
Apeiba	*albiflora*	3	0.02
Apeiba	*glabra*	26	0.2
Apeiba	*petoumo*	22	0.17
Apocynaceae	sp.OSB169	33	0.25
Apocynaceae	sp.OSB374	2	0.02
Apocynaceae	sp.OSB548	3	0.02
Aspidosperma	*cruentum*	29	0.22
Aspidosperma	*marcgravianum*	52	0.39
Aspidosperma	*sandwithianum*	3	0.02
Aspidosperma	sp.BBNa	7	0.05
Aspidosperma	*vargassii*	16	0.12
Astrocaryum	*paramaca*	1	0.01

Genus	Species	total	% trees
Astrocaryum	*sciophilum*	194	1.47
Attalea	*maripa*	12	0.09
Bagassa	*guianensis*	3	0.02
Balizia	*pedicellaris*	13	0.1
Bauhinia	*eilertsii*	17	0.13
Bellucia	*grossularioides*	6	0.05
Bocoa	*prouacensis*	170	1.28
Bocoa	*viridiflora*	32	0.24
Bombacopsis	*nervosa*	16	0.12
Brosimum	*acutifolium*	7	0.05
Brosimum	*guianense*	7	0.05
Brosimum	*parinarioides*	4	0.03
Brosimum	*rubescens*	20	0.15
Byrsonima	*crassifolia*	5	0.04
Byrsonima	sp.L1_376	1	0.01
Byrsonima	sp.Na4_353	1	0.01
Byrsonima	sp.OSB290	1	0.01
Byrsonima	sp.OSB388	6	0.05
Byrsonima	sp.TvA4673	2	0.02
Byrsonima	*stipulacea*	2	0.02
Calophyllum	*brasiliense*	1	0.01
Calyptranthes	*speciosa*	1	0.01
Campomanesia	*aromatica*	7	0.05
Capirona	*decorticans*	2	0.02
Capparis	sp.OSB158_445	44	0.33
Capparis	sp.OSB504	9	0.07
Caraipa	sp.OSB209	9	0.07
Carapa	*guianensis*	5	0.04
Carapa	*procera*	46	0.35
Caryocar	*glabrum*	5	0.04
Casearia	*arborescens*	24	0.18
Casearia	*javitensis*	15	0.11
Cassipourea	*guianensis*	34	0.26
Catostemma	*fragrans*	52	0.39
Cecropia	*obtusa*	18	0.14
Cecropia	*sciadophylla*	8	0.06
Cecropia	sp.L1_263	1	0.01
Cedrela	*odorata*	5	0.04
Cedrelinga	*cateniformis*	3	0.02
Ceiba	*pentandra*	1	0.01
Chaetocarpus	*schomburgkianus*	47	0.35
Chaunochiton	*kappleri*	1	0.01

Genus	Species	total	% trees
Cheiloclinium	*cognatum*	13	0.1
Chimarrhis	*microcarpa*	3	0.02
Chimarrhis	*turbinata*	45	0.34
Chrysobalanaceae	sp.1Na	19	0.14
Chrysobalanaceae	sp.2Na	5	0.04
Chrysobalanaceae	sp.Na3_294	1	0.01
Chrysobalanaceae	sp.OSB398	19	0.14
Chrysobalanaceae	sp.OSB421_432	49	0.37
Chrysobalanaceae	sp.OSB436	2	0.02
Chrysobalanaceae	sp.OSB494_510	3	0.02
Chrysophyllum	*argenteum*	14	0.11
Chrysophyllum	*cuneifolium*	2	0.02
Clathrotropis	*brachypetala*	4	0.03
Clusia	sp.OSB472	5	0.04
Coccoloba	sp.NaBB	6	0.05
Conceveiba	*guianensis*	22	0.17
Copaifera	*epunctata*	6	0.05
Copaifera	*guyanensis*	4	0.03
Cordia	*alliodora*	1	0.01
Cordia	*laevifrons*	72	0.54
Cordia	*nodosa*	1	0.01
Cordia	sp.BB6_491	1	0.01
Cordia	sp.L7_20	1	0.01
Cordia	sp.MJ6758	5	0.04
Cordia	sp.OSB442	2	0.02
Corythophora	*labriculata*	82	0.62
Couepia	sp.OSB406	2	0.02
Couepia	sp.OSB446_553	27	0.2
Couma	*guianensis*	13	0.1
Couratari	*fagifolia*	2	0.02
Couratari	*gloriosa*	3	0.02
Couratari	*stellata*	137	1.03
Couratari	*surinamensis*	4	0.03
Croton	*argyrophylloides*	219	1.65
Croton	*hostmannii*	1	0.01
Croton	*matourensis*	3	0.02
Croton	sp.OSB341	7	0.05
Crudia	*aromatica*	89	0.67
Crudia	*glaberrima*	56	0.42
Cupania	*hirsuta*	1	0.01
Cupania	*scrobiculata*	27	0.2
Dendrobangia	*boliviana*	26	0.2

Genus	Species	total	% trees
Dichapetalaceae	sp.OSB453	4	0.03
Dicorynia	*guianensis*	84	0.63
Diospyros	*guianensis*	17	0.13
Diospyros	sp.OSB306_558	14	0.11
Diospyros	sp.OSB320	1	0.01
Diospyros	*tetandra*	37	0.28
Diplotropis	*purpurea*	15	0.11
Dipteryx	*odorata*	11	0.08
Discophora	*guianensis*	3	0.02
Drypetes	*variabilis*	61	0.46
Duguetia	*calycina*	4	0.03
Duguetia	sp.OSB295_390	41	0.31
Duroia	*aquatica*	13	0.1
Duroia	*eriopila*	1	0.01
Ecclinusa	*guianensis*	66	0.5
Elizabetha	*princeps*	135	1.02
Elvasia	*elvasioides*	232	1.75
Enterolobium	*schomburgkii*	13	0.1
Eperua	*falcata*	482	3.64
Eriotheca	*globosa*	41	0.31
Erisma	*uncinatum*	3	0.02
Erythroxylum	sp.OSB157	1	0.01
Erythroxylum	sp.OSB358	1	0.01
Erythroxylum	sp.OSB989	1	0.01
Eschweilera	*coriacea*	144	1.09
Eschweilera	*pedicellata*	120	0.91
Eschweilera	sp.OSB167_263	262	1.98
Eschweilera	sp.OSB375	2	0.02
Eschweilera	sp.OSB443	2	0.02
Eugenia	*patrisii*	61	0.46
Euterpe	*oleracea*	23	0.17
Fabaceae	sp.L6_270	1	0.01
Fabaceae	sp.OSB503	11	0.08
Fabaceae	sp.OSB979_988	10	0.08
Ferdinandusa	*rudgeoides*	14	0.11
Ficus	sp.BB2_540	1	0.01
Ficus	sp.L6	1	0.01
Ficus	sp.L6_7	2	0.02
Ficus	sp.OSB492	1	0.01
Fusaea	*longifolia*	31	0.23
Geissospermum	*sericeum*	7	0.05
Genipa	*americana*	2	0.02

Genus	Species	total	% trees
Goupia	*glabra*	11	0.08
Guarea	*grandifolia*	17	0.13
Guarea	*guidonia*	1	0.01
Guarea	*pubescens*	16	0.12
Guarea	sp.BB1_474	1	0.01
Guarea	sp.OSB501	41	0.31
Guatteria	*schomburgkiana*	11	0.08
Guatteria	sp.OSB531	1	0.01
Guettarda	*acreana*	138	1.04
Gustavia	*augusta*	10	0.08
Gustavia	*hexapetala*	116	0.88
Hebepetalum	*humiriifolium*	4	0.03
Heisteria	*cauliflora*	18	0.14
Heisteria	*ovata*	7	0.05
Henriettea	sp.OSB324	25	0.19
Hevea	*guianensis*	7	0.05
Hieronyma	*alchorneoides*	1	0.01
Himatanthus	*articulatus*	15	0.11
Hydrochorea	*corymbosa*	5	0.04
Hymenaea	*courbaril*	9	0.07
Hymenolobium	*flavum*	3	0.02
Ilex	*martiniana*	1	0.01
Ilex	sp.OSB344	1	0.01
Ilex	sp.OSB356	1	0.01
Inga	*alba*	69	0.52
Inga	*capitata*	22	0.17
Inga	*edulis*	3	0.02
Inga	*heterophylla*	9	0.07
Inga	*leiocalycina*	8	0.06
Inga	*rubiginosa*	58	0.44
Inga	sp.L2_192	1	0.01
Inga	sp.L3_323	1	0.01
Inga	sp.L3_411	1	0.01
Inga	sp.L4_77	1	0.01
Inga	sp.L6_281	1	0.01
Inga	sp.L6_446	1	0.01
Inga	sp.L8_439	2	0.02
Inga	sp.OSB_400	1	0.01
Inga	sp.OSB130	68	0.51
Inga	sp.OSB143_410	3	0.02
Inga	sp.OSB186_372	67	0.51
Inga	sp.OSB315	3	0.02

Genus	Species	total	% trees
Inga	sp.OSB317_357_382	7	0.05
Inga	sp.OSB330	2	0.02
Inga	sp.OSB338_340_347	4	0.03
Inga	sp.OSB360	1	0.01
Inga	sp.OSB399_560_539	11	0.08
Inga	sp.OSB419	1	0.01
Inga	sp.OSB424	1	0.01
Inga	sp.OSB434	1	0.01
Inga	sp.OSB497_515_519	14	0.11
Inga	sp.OSB512	1	0.01
Inga	sp.OSB527	1	0.01
Inga	sp.OSB542	2	0.02
Inga	sp.OSB997	2	0.02
Inga	*stipularis*	5	0.04
Inga	*thibaudiana*	34	0.26
Iryanthera	*sagotiana*	52	0.39
Iryanthera	sp.OSB280	1	0.01
Isertia	*coccinea*	7	0.05
Jacaranda	*copaia*	82	0.62
Jacaranda	*obtusifolia*	3	0.02
Jessenia	*bataua*	14	0.11
Lacistema	*sp.OSB294*	10	0.08
Lacmellea	*aculeata*	14	0.11
Lacunaria	*crenata*	11	0.08
Laetia	*procera*	12	0.09
Lauraceae	sp.BB	2	0.02
Lauraceae	sp.BB1_14	1	0.01
Lauraceae	sp.BB6_131	1	0.01
Lauraceae	sp.BBLeNa	54	0.41
Lauraceae	sp.Na6_166	1	0.01
Lauraceae	sp.OSB150	1	0.01
Lauraceae	sp.OSB270	18	0.14
Lauraceae	sp.OSB282	118	0.89
Lecythidaceae	sp.BB2_268	1	0.01
Lecythidaceae	sp.L6	4	0.03
Lecythidaceae	sp.OSB346_435	26	0.2
Lecythidaceae	sp.OSB428_456	35	0.26
Lecythidaceae	sp.OSB506	2	0.02
Lecythidaceae	sp.TvA4605	15	0.11
Lecythis	*chartacea*	11	0.08
Lecythis	*corrugata*	617	4.66
Lecythis	*zabucajo*	21	0.16

Genus	Species	total	% trees
Licania	*divaricata*	18	0.14
Licania	*heteromorpha*	13	0.1
Licania	*incana*	4	0.03
Licania	*macrophylla*	12	0.09
Licania	*majuscula*	38	0.29
Licania	*ovalifolia*	3	0.02
Licania	*robusta*	3	0.02
Licania	sp.2Na	8	0.06
Licania	sp.BB3_372	1	0.01
Licania	sp.BB4_358	1	0.01
Licania	sp.BBNa	8	0.06
Licania	sp.L4_186	1	0.01
Licania	sp.Na	9	0.07
Licania	sp.OSB394	23	0.17
Licania	sp.OSB402_405	2	0.02
Licania	sp.OSB407	3	0.02
Licania	sp.OSB423	1	0.01
Licania	sp.OSB529	60	0.45
Licania	sp.OSB565_552	18	0.14
Licaria	*cannella*	19	0.14
Licaria	sp.OSB283	5	0.04
Licaria	sp.OSB441	76	0.57
Lonchocarpus	*heptaphyllus*	5	0.04
Lonchocarpus	sp.BB	6	0.05
Loxopterygium	*sagotii*	8	0.06
Lueheopsis	*rosea*	11	0.08
Mabea	*piriri*	157	1.19
Macoubea	*guianensis*	1	0.01
Malvaceae	sp.L4_297	1	0.01
Malvaceae	sp.L7_1	2	0.02
Malvaceae	sp.Le	2	0.02
Manilkara	*bidentata*	36	0.27
Manilkara	*huberi*	3	0.02
Maprounea	*guianensis*	1	0.01
Maquira	*guianensis*	91	0.69
Martiodendron	*parviflorum*	16	0.12
Maytenus	sp.L5_108	1	0.01
Maytenus	sp.L6_7	3	0.02
Maytenus	sp.MJ6410	34	0.26
Maytenus	sp.OSB339	4	0.03
Maytenus	sp.OSB385	5	0.04
Maytenus	sp.OSB391	3	0.02

Genus	Species	total	% trees
Maytenus	sp.OSB505	8	0.06
Maytenus	sp.OSB986_1008	7	0.05
Melastomataceae	sp.1_Na	3	0.02
Melastomataceae	sp.BB3_78	1	0.01
Melastomataceae	sp.BB3_79	1	0.01
Melastomataceae	sp.BB6_28	1	0.01
Melastomataceae	sp.Le	16	0.12
Melastomataceae	sp.Na6-184	1	0.01
Melastomataceae	sp.OSB204_987	5	0.04
Melastomataceae	sp.OSB205	2	0.02
Melastomataceae	sp.OSB408	13	0.1
Melastomataceae	sp.OSB991	2	0.02
Miconia	sp.OSB359_992	7	0.05
Micrandra	*brownsbergensis*	453	3.42
Micropholis	*guyanensis*	19	0.14
Minquartia	*guianensis*	46	0.35
Moracea	sp._BBLe	10	0.08
Moracea	sp.BB1_179	4	0.03
Moracea	sp.OSB526	1	0.01
Mouriri	*crassifolia*	30	0.23
Mouriri	*grandiflora*	1	0.01
Mouriri	sp.2_Na	5	0.04
Mouriri	sp.OSB417	2	0.02
Mouriri	sp.OSB438_463	4	0.03
Myrtaceae	sp.2_BB	7	0.05
Myrtaceae	sp.468	1	0.01
Myrtaceae	sp.5_BB	6	0.05
Myrtaceae	sp.5_Na	58	0.44
Myrtaceae	sp.6_Na	3	0.02
Myrtaceae	sp.8_BB	1	0.01
Myrtaceae	sp.BB1_51	1	0.01
Myrtaceae	sp.BB3_451	2	0.02
Myrtaceae	sp.BBLe	4	0.03
Myrtaceae	sp.L1_201	1	0.01
Myrtaceae	sp.L2_22	1	0.01
Myrtaceae	sp.L6_337	1	0.01
Myrtaceae	sp.L7_25	1	0.01
Myrtaceae	sp.Na3_200	2	0.02
Myrtaceae	sp.OSB1001	10	0.08
Myrtaceae	sp.OSB1004	1	0.01
Myrtaceae	sp.OSB131	10	0.08
Myrtaceae	sp.OSB137	1	0.01

Genus	Species	total	% trees
Myrtaceae	sp.OSB175	1	0.01
Myrtaceae	sp.OSB192	35	0.26
Myrtaceae	sp.OSB197	9	0.07
Myrtaceae	sp.OSB200	1	0.01
Myrtaceae	sp.OSB271	21	0.16
Myrtaceae	sp.OSB273	79	0.6
Myrtaceae	sp.OSB297	71	0.54
Myrtaceae	sp.OSB314	27	0.2
Myrtaceae	sp.OSB322	53	0.4
Myrtaceae	sp.OSB332	5	0.04
Myrtaceae	sp.OSB409	1	0.01
Myrtaceae	sp.OSB411	1	0.01
Myrtaceae	sp.OSB465	134	1.01
Myrtaceae	sp.OSB479	2	0.02
Myrtaceae	sp.OSB481	5	0.04
Myrtaceae	sp.OSB486	4	0.03
Myrtaceae	sp.OSB543	2	0.02
Myrtaceae	sp.OSB971	14	0.11
Myrtaceae	sp.OSB974	13	0.1
Myrtaceae	sp.OSB977	3	0.02
Neea	*floribunda*	93	0.7
Nyctaginaceae	sp.Na	5	0.04
Nyctaginaceae	sp.OSB170_325_326	2	0.02
Nyctaginaceae	sp.OSB173_269	3	0.02
Nyctaginaceae	sp.OSB267	18	0.14
Nyctaginaceae	sp.OSB427	111	0.84
Nyctaginaceae	sp.OSB478	17	0.13
Nyctaginaceae	sp.OSB973	20	0.15
Ocotea	*guianensis*	1	0.01
Ocotea	*puberula*	30	0.23
Ocotea	*schomburgkiana*	4	0.03
Ocotea	sp.BBLe	2	0.02
Ocotea	sp.OSB268	43	0.32
Ocotea	sp.OSB336	18	0.14
Oenocarpus	*bacaba*	79	0.6
Ormosia	*coccinea*	5	0.04
Ormosia	*costulata*	17	0.13
Ormosia	*coutinhoi*	2	0.02
Ouratea	sp.BB5_323	1	0.01
Ouratea	sp.BB6_337	1	0.01
Ouratea	sp.OSB188	3	0.02
Ouratea	sp.OSB482	1	0.01

Genus	Species	total	% trees
Oxandra	*asbeckii*	141	1.06
Pachira	*aquatica*	6	0.05
Pachira	*flaviflora*	1	0.01
Pachira	*insignis*	4	0.03
Palicourea	*guianensis*	16	0.12
Panopsis	*sessilifolia*	5	0.04
Parahancornia	*fasciculata*	16	0.12
Parinari	*campestris*	9	0.07
Parkia	*nitida*	14	0.11
Parkia	*pendula*	10	0.08
Parkia	*ulei*	7	0.05
Pausandra	*martinii*	6	0.05
Paypayrola	*guianensis*	38	0.29
Paypayrola	*longifolia*	1	0.01
Peltogyne	*paniculata*	13	0.1
Peltogyne	*venosa*	4	0.03
Pera	*bicolor*	4	0.03
Pithecellobium	sp.OSB513	2	0.02
Platymiscium	*ulei*	7	0.05
Pogonophora	*schomburgkiana*	25	0.19
Poulsenia	*armata*	16	0.12
Pourouma	*guianensis*	29	0.22
Pourouma	*minor*	9	0.07
Pourouma	*mollis*	1	0.01
Pourouma	sp.1_Na	10	0.08
Pourouma	sp.BB6_438	1	0.01
Pourouma	sp.BB7_209	1	0.01
Pourouma	sp.BB7_445	1	0.01
Pourouma	sp.BBLe	3	0.02
Pourouma	sp.L3_312	1	0.01
Pourouma	sp.OSB313	1	0.01
Pourouma	*tomentosa*	11	0.08
Pouteria	*cladantha*	5	0.04
Pouteria	*guianensis*	75	0.57
Pouteria	*melanpoda*	77	0.58
Pouteria	*sagotiana*	2	0.02
Pouteria	sp.BB	7	0.05
Pouteria	sp.BB3_210	1	0.01
Pouteria	sp.Na1_197	2	0.02
Pouteria	sp.Na5_749	1	0.01
Pouteria	sp.OSB266_328	44	0.33
Pouteria	sp.OSB284	9	0.07

Genus	Species	total	% trees
Pouteria	sp.OSB312	44	0.33
Pouteria	sp.OSB318_342	107	0.81
Pouteria	sp.OSB376	72	0.54
Pouteria	sp.OSB397_420	8	0.06
Pouteria	sp.OSB536	19	0.14
Pouteria	sp.OSB541	18	0.14
Pouteria	*speciosa*	18	0.14
Pradosia	*ptychandra*	62	0.47
Pradosia	sp.1_Na	3	0.02
Protium	*heptaphyllum*	5	0.04
Protium	*polybotrium*	89	0.67
Protium	sp.BB5_238	1	0.01
Protium	sp.BBLe	59	0.45
Protium	sp.BBLeNa	10	0.08
Protium	sp.BBNa	7	0.05
Protium	sp.L1_52_62	2	0.02
Protium	sp.Na4_55	1	0.01
Protium	sp.OSB281_308	19	0.14
Protium	sp.OSB337	51	0.39
Protium	sp.OSB439	2	0.02
Protium	sp.OSB525	22	0.17
Prunus	*myrtifolia*	5	0.04
Pseudolmedia	*laevis*	18	0.14
Pseudopiptadenia	*suaveolens*	23	0.17
Pterocarpus	*officinalis*	8	0.06
Pterocarpus	*rohrii*	10	0.08
Qualea	*coerulea*	19	0.14
Qualea	*dinizii*	1	0.01
Qualea	*rosea*	198	1.5
Quararibea	*duckei*	192	1.45
Quiinaceae	sp.BBLeNa	9	0.07
Quiinaceae	sp.BBNa	3	0.02
Quiinaceae	sp.OSB201	8	0.06
Quiinaceae	sp.OSB532	2	0.02
Quiinaceae	sp.OSB970	1	0.01
Rhabdodendron	*amazonicum*	7	0.05
Rheedia	*benthamiana*	31	0.23
Rhodostemonodaphne	*praeclara*	28	0.21
Rinorea	sp._Na	9	0.07
Rollinia	*elliptica*	15	0.11
Roupala	*montana*	7	0.05
Rubiaceae	sp.1_BB	24	0.18

Genus	Species	total	% trees
Rubiaceae	sp.1_Na	3	0.02
Rubiaceae	sp.Na6_449	1	0.01
Rubiaceae	sp.OSB165	101	0.76
Rubiaceae	sp.OSB214	6	0.05
Rubiaceae	sp.OSB474	3	0.02
Ruizterania	*albiflora*	50	0.38
Ryania	sp.1_Na	2	0.02
Sacoglottis	*cydonioides*	16	0.12
Sacoglottis	*guianensis*	8	0.06
Sagotia	*racemosa*	5	0.04
Salicaceae	sp.3_Na	4	0.03
Salicaceae	sp.BB2_161	1	0.01
Salicaceae	sp.L2_406	1	0.01
Salicaceae	sp.Na1_204	1	0.01
Salicaceae	sp.Na6_262	1	0.01
Salicaceae	sp.Na6_471	1	0.01
Salicaceae	sp.OSB202	6	0.05
Salicaceae	sp.OSB370	1	0.01
Salicaceae	sp.OSB414	2	0.02
Salicaceae	sp.OSB546	7	0.05
Salicaceae	sp.TvA4708	10	0.08
Sapindaceae	sp._BBLeNa	22	0.17
Sapindaceae	sp.OSB274	10	0.08
Sapindaceae	sp.OSB304	118	0.89
Sapindaceae	sp.OSB334	38	0.29
Sapindaceae	sp.OSB452	1	0.01
Sapium	*ciliatum*	2	0.02
Sapium	*glandulosum*	19	0.14
Sapotaceae	sp.BBLeNa	34	0.26
Sapotaceae	sp.BBNa	8	0.06
Sapotaceae	sp.OSB213	1	0.01
Sapotaceae	sp.OSB262	42	0.32
Sarcaulus	*brasiliensis*	24	0.18
Schefflera	*decaphylla*	2	0.02
Schefflera	*morototoni*	2	0.02
Sclerolobium	*guianense*	30	0.23
Sclerolobium	*melinonii*	80	0.6
Sextonia	*rubra*	3	0.02
Simaba	*cedron*	3	0.02
Simarouba	*amara*	20	0.15
Siparuna	*cuspidata*	6	0.05
Siparuna	*decipiens*	40	0.3

Genus	Species	total	% trees
Sloanea	*grandifolia*	1	0.01
Sloanea	sp.BB6	2	0.02
Sloanea	sp.L4_340	2	0.02
Sloanea	sp.Na5_634	1	0.01
Sloanea	sp.OSB151	19	0.14
Sloanea	sp.OSB152_166	5	0.04
Sloanea	sp.OSB161	5	0.04
Sloanea	sp.OSB162_354	11	0.08
Sloanea	sp.OSB208_449	37	0.28
Sloanea	sp.OSB310	5	0.04
Sloanea	sp.OSB350_444	10	0.08
Sloanea	sp.OSB447	2	0.02
Sloanea	sp.OSB455	19	0.14
Sloanea	sp.OSB544	2	0.02
Sloanea	sp.OSB561	1	0.01
Socratea	*exorrhiza*	8	0.06
Sterculia	*pruriens*	41	0.31
Sterculia	sp.OSB276_554	55	0.42
Swartzia	*arborescens*	12	0.09
Swartzia	*benthamiana*	37	0.28
Swartzia	*benthamiana*	5	0.04
Swartzia	*panacoco*	9	0.07
Swartzia	*remiger*	50	0.38
Swartzia	*schomburgkii*	11	0.08
Swartzia	sp.1_BBLeNa	60	0.45
Swartzia	sp.1_BBNa	16	0.12
Swartzia	sp.1_LeNa	3	0.02
Symphonia	*globulifera*	18	0.14
Tabebuia	*capitata*	20	0.15
Tabebuia	*inisgnis*	2	0.02
Tabebuia	*serratifolia*	25	0.19
Tabernaemontana	sp.OSB430	2	0.02
Tachigali	*albiflora*	2	0.02
Tachigali	*paniculata*	7	0.05
Tachigali	sp.OSB275	9	0.07
Talisia	*megaphylla*	5	0.04
Talisia	sp.BB1_27	1	0.01
Talissia	sp.OSB351	1	0.01
Tapirira	*guianense*	42	0.32
Tapura	*amazonica*	85	0.64
Tapura	*guianensis*	21	0.16
Terminalia	*guyanensis*	59	0.45

Genus	Species	total	% trees
Terminalia	sp.L5	52	0.39
Terminalia	sp.OSB404_996	17	0.13
Tetragastris	*altissima*	142	1.07
Tetragastris	*panamensis*	50	0.38
Thyrsodium	*guianense*	14	0.11
Thyrsodium	*puberulum*	3	0.02
Toulicia	*pulvinata*	77	0.58
Touroulia	*guianensis*	3	0.02
Tovomita	*choisyana*	16	0.12
Tovomita	sp.1_Na	3	0.02
Tovomita	sp.OSB155	36	0.27
Tovomita	sp.OSB345	6	0.05
Trattinnickia	*burserifolia*	24	0.18
Trichilia	sp.OSB211_300	33	0.25
Trichilia	sp.OSB302	1	0.01
Trichilia	sp.OSB335	15	0.11
Trichilia	sp.OSB364	22	0.17
Trichilia	sp.OSB511_528	2	0.02
Trigynaea	sp.	32	0.24
Trymatococcus	*oligandrus*	29	0.22
Unidentified	sp.6_Na	1	0.01
Unidentified	sp.BB9_74	1	0.01
Unidentified	sp.L6_302	1	0.01
Unidentified	sp.L8_473	1	0.01
Unidentified	sp.Na3_456	1	0.01
Unidentified	sp.Na3_82	1	0.01
Unidentified	sp.OSB168	1	0.01
Unidentified	sp.OSB207	1	0.01
Unidentified	sp.OSB348	1	0.01
Unidentified	sp.OSB377	1	0.01
Unidentified	sp.OSB392	1	0.01
Unidentified	sp.OSB550	1	0.01
Unidentified	sp.OSB557	1	0.01
Unonopsis	*glaucopetala*	109	0.82
Vatairea	*guianensis*	13	0.1
Vataireopsis	*speciosa*	6	0.05
Vataireopsis	*surinamensis*	1	0.01
Violaceae	sp.MJ6444	1	0.01
Violaceae	sp.OSB171	13	0.1
Violaceae	sp.OSB193	66	0.5
Violaceae	sp.OSB499	50	0.38
Virola	*calophylla*	5	0.04

Genus	Species	total	% trees
Virola	*kwatae*	20	0.15
Virola	*michelii*	71	0.54
Virola	*sebifera*	9	0.07
Virola	*surinamensis*	35	0.26
Vismia	*cayennensis*	1	0.01
Vismia	*guianensis*	8	0.06
Vismia	*japurensis*	21	0.16
Vismia	*macrophylla*	1	0.01
Vismia	*sessilifolia*	2	0.02
Vitex	*triflora*	8	0.06
Vochysia	*densiflora*	1	0.01
Vochysia	*guianensis*	9	0.07
Vochysia	*tetraphylla*	3	0.02
Vochysia	*tomentosa*	35	0.26
Vouacapoua	*americana*	67	0.51
Ximenia	*americana*	1	0.01
Xylopia	*nitida*	30	0.23
Xylopia	sp.BB	8	0.06
Xylosma	*benthamii*	1	0.01
Zanthoxylum	*rhoifolium*	1	0.01
Zygia	*racemosa*	47	0.35
Zygia	*tetragona*	6	0.05

Appendix 3

Plant species collected on the three bauxite plateaus, Brownsberg, Nassau and Lely.

Hans ter Steege, Olaf Bánki and Paddy Haripersaud

Sum number of collections per species; IUCN: status according to IUCN red list; Prot: protected according to Surinamese law (source Pieter Teunissen); End: endemic status (E = possibly endemic for Suriname); BB: Brownsberg; BW: Brownsweg; Le: Lely Mts.; Ma: Marowijne (base of Nassau); Mo: Moengo; Na: Nassau Mts.

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Acanthaceae	*Anisacanthus secundus*	5				4					1
Acanthaceae	*Aphelandra scabra*	1				1					
Acanthaceae	*Blechum pyramidatum*	1				1					
Acanthaceae	*Justicia calycina*	7				5		1			1
Acanthaceae	*Justicia cayennensis*	4				4					
Acanthaceae	*Lepidagathis alopecuroidea*	2				2					
Acanthaceae	*Mendoncia aspera*	2							2		
Acanthaceae	*Mendoncia hoffmannseggiana*	6				2		2			2
Acanthaceae	*Pulchranthus surinamensis*	4						4			
Acanthaceae	*Pulchranthus variegatus*	1				1					
Acanthaceae	*Ruellia longifolia*	3				1					2
Acanthaceae	*Ruellia rubra*	4				2		1	1		
Achariaceae	*Carpotroche surinamensis*	10				7	1	2			
Achariaceae	*Lindackeria* sp.	1				1					
Adiantaceae	*Adiantopsis radiata*	2						2			
Adiantaceae	*Adiantum cajennense*	3				1			1		1
Adiantaceae	*Adiantum decoratum*	1						1			
Adiantaceae	*Adiantum fuliginosum*	1				1					
Adiantaceae	*Adiantum glaucescens*	4				1		1			2
Adiantaceae	*Adiantum latifolium*	3				2					1
Adiantaceae	*Adiantum leprieurii*	2				1					1
Adiantaceae	*Adiantum macrophyllum*	1				1					
Adiantaceae	*Adiantum obliquum*	2				1		1			
Adiantaceae	*Adiantum paraense*	1						1			
Adiantaceae	*Adiantum phyllitidis*	1				1					
Adiantaceae	*Adiantum pulverulentum*	2				2					
Adiantaceae	*Adiantum terminatum*	5				1		1			3
Adiantaceae	*Adiantum tetraphyllum*	1									1
Adiantaceae	*Pityrogramma calomelanos*	2							2		
Algae	Indet.	3							1		2
Amaranthaceae	*Cyathula prostrata*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Amaranthaceae	*Pfaffia glomerata*	2							2		
Anacardiaceae	*Anacardium spruceanum*	1				1					
Anacardiaceae	*Loxopterygium sagotii*	6				5					1
Anacardiaceae	*Tapirira guianensis*	15				12		3			
Anacardiaceae	*Thyrsodium guianense*	3				1					2
Anacardiaceae	*Thyrsodium* sp.	1									1
Anacardiaceae	*Thyrsodium spruceanum*	1				1					
Annonaceae	*Anaxagorea acuminata*	4						4			
Annonaceae	*Anaxagorea dolichocarpa*	13				4		6			3
Annonaceae	*Anaxagorea prinoides*	2						2			
Annonaceae	*Annona densicoma*	1				1					
Annonaceae	*Annona* sp.	1				1					
Annonaceae	*Cardiopetalum surinamense*	5				2	1	2			
Annonaceae	*Cymbopetalum brasiliense*	10				8		1			1
Annonaceae	*Cymbopetalum sp.*	1				1					
Annonaceae	*Duguetia calycina*	8				5	2	1			
Annonaceae	*Duguetia eximia*	7									7
Annonaceae	*Duguetia inconspicua*	7				1	2	1			3
Annonaceae	*Duguetia pycnastera*	17				8		6			3
Annonaceae	*Duguetia* sp.	1									1
Annonaceae	*Duguetia surinamensis*	10				7		1			2
Annonaceae	*Fusaea longifolia*	13				8			1		4
Annonaceae	*Guatteria anthracina*	2						2			
Annonaceae	*Guatteria intermedia*	1				1					
Annonaceae	*Guatteria pteropus*	1				1					
Annonaceae	*Guatteria punctata*	12				6		6			
Annonaceae	*Guatteria scandens*	1				1					
Annonaceae	*Guatteria schomburgkiana*	5				5					
Annonaceae	*Oxandra asbecki*	4				1			1		2
Annonaceae	*Rollinia elliptica*	1				1					
Annonaceae	*Rollinia exsucca*	3							1		2
Annonaceae	*Trigynaea duckei*	1				1					
Annonaceae	*Trigynaea* sp. nov?	1				1					
Annonaceae	*Unonopsis rufescens*	14				11		2			1
Annonaceae	*Unonopsis stipitata*	4				1	1				2
Annonaceae	*Xylopia aromatica*	2									2
Annonaceae	*Xylopia cayennensis*	1									1
Annonaceae	*Xylopia frutescens*	3				2	1				
Annonaceae	*Xylopia sericea*	1				1					
Apocynaceae	*Allamanda cathartica*	2				1	1				
Apocynaceae	*Ambelania acida*	8				6					2
Apocynaceae	*Aspidosperma album*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Apocynaceae	*Aspidosperma cruentum*	8				3					5
Apocynaceae	*Aspidosperma marcgravianum*	2				1					1
Apocynaceae	*Aspidosperma oblongum*	4				2					2
Apocynaceae	*Aspidosperma spruceanum*	1									1
Apocynaceae	*Aspidosperma vargasii*	2				2					
Apocynaceae	*Blepharodon nitidus*	6				3		2			1
Apocynaceae	*Blepharodon* sp.	1				1					
Apocynaceae	*Forsteronia acouci*	4				2		2			
Apocynaceae	*Forsteronia gracilis*	2				1		1			
Apocynaceae	*Forsteronia guyanensis*	3				3					
Apocynaceae	*Geissospermum argenteum*	1				1					
Apocynaceae	*Geissospermum laeve*	3				3					
Apocynaceae	*Geissospermum sericeum*	1				1					
Apocynaceae	*Gonolobus* sp.	2						2			
Apocynaceae	*Himatanthus articulatus*	2				2					
Apocynaceae	*Himatanthus bracteatus*	2				2					
Apocynaceae	Indet.	3						3			
Apocynaceae	*Lacmellea aculeata*	5				2		2			1
Apocynaceae	*Macoubea guianensis*	5				5					
Apocynaceae	*Mandevilla hirsuta*	2									2
Apocynaceae	*Mandevilla rugellosa*	3						1			2
Apocynaceae	*Mandevilla scabra*	1				1					
Apocynaceae	*Mandevilla* sp.	1									1
Apocynaceae	*Matelea denticulata*	1							1		
Apocynaceae	*Matelea* sp.	1				1					
Apocynaceae	*Mesechites trifida*	1							1		
Apocynaceae	*Odontadenia geminata*	1				1					
Apocynaceae	*Odontadenia macrantha*	1							1		
Apocynaceae	*Odontadenia nitida*	2				2					
Apocynaceae	*Odontadenia perrottetii*	3				2		1			
Apocynaceae	*Odontadenia puncticulosa*	1						1			
Apocynaceae	*Parahancornia fasciculata*	4				4					
Apocynaceae	*Rauvolfia ligustrina*	2				2					
Apocynaceae	*Rauvolfia paraensis*	2				1					1
Apocynaceae	*Tabernaemontana albiflora*	1				1					
Apocynaceae	*Tabernaemontana disticha*	10						6			4
Apocynaceae	*Tabernaemontana heterophylla*	4				2		1			1
Apocynaceae	*Tabernaemontana undulata*	20				12		4			4
Apocynaceae	*Tassadia guianensis*	1							1		
Apocynaceae	*Tassadia propinqua*	1					1				
Apocynaceae	*Tassadia* sp.	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Aquifoliaceae	*Ilex jenmanii*	1									1
Araceae	*Anthurium bonplandii*	1									1
Araceae	*Anthurium digitatum*	1						1			
Araceae	*Anthurium eminens*	1						1			
Araceae	*Anthurium gracile*	9				3	1	2			3
Araceae	*Anthurium jenmanii*	1									1
Araceae	*Anthurium pentaphyllum*	3				2					1
Araceae	*Anthurium rubrinervium*	9				7					2
Araceae	*Anthurium sinuatum*	2						2			
Araceae	*Anthurium* sp.	2						2			
Araceae	*Anthurium trinerve*	5				1		2			2
Araceae	*Caladium bicolor*	1				1					
Araceae	*Dieffenbachia seguine*	2				2					
Araceae	*Dieffenbachia sp.*	1									1
Araceae	*Dracontium asperum*	1				1					
Araceae	*Dracontium polyphyllum*	1				1					
Araceae	*Heteropsis flexuosa*	4				2					2
Araceae	*Heteropsis jenmanii*	1				1					
Araceae	*Heteropsis spruceana*	1				1					
Araceae	*Heteropsis tenuispadix*	1						1			
Araceae	Indet.	6				4		2			
Araceae	*Monstera adansonii*	4				4					
Araceae	*Monstera obliqua*	5				5					
Araceae	*Monstera spruceana*	2				2					
Araceae	*Philodendron deflexum*	1				1					
Araceae	*Philodendron duckei*	2				1					1
Araceae	*Philodendron fragrantissimum*	3						1			2
Araceae	*Philodendron guianense*	1				1					
Araceae	*Philodendron guttiferum*	9				9					
Araceae	*Philodendron insigne*	2				1	1				
Araceae	*Philodendron linnaei*	4				2					2
Araceae	*Philodendron pedatum*	6				3		2			1
Araceae	*Philodendron rudgeanum*	1				1					
Araceae	*Philodendron scandens*	5				2		2			1
Araceae	*Philodendron* sp.	6				1		4			1
Araceae	*Philodendron splitgerberi*	1				1					
Araceae	*Philodendron squamiferum*	1				1					
Araceae	*Philodendron surinamense*	5				4	1				
Araceae	*Rhodospatha obliqua*	2				2					
Araceae	*Syngonium podophyllum*	3				2					1
Araceae	*Syngonium* sp.	1				1					
Araceae	*Xanthosoma sagittifolium*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Araceae	*Xanthosoma undipes*	1				1					
Arecaceae	*Bactris acanthocarpoides*	1					1				
Arecaceae	*Bactris campestris*	1				1					
Arecaceae	*Bactris gastoniana*	4				4					
Arecaceae	*Bactris maraja*	2					1				1
Arecaceae	*Bactris simplicifrons*	9				2	3				4
Arecaceae	*Desmoncus polyacanthos*	2						2			
Arecaceae	*Geonoma baculifera*	1				1					
Arecaceae	*Geonoma macrostachys*	1									1
Arecaceae	*Geonoma maxima*	3				1		2			
Arecaceae	*Geonoma* sp.	2						2			
Arecaceae	*Geonoma stricta*	7				4					3
Arecaceae	Indet.	4						2	2		
Arecaceae	*Mauritia flexuosa*	6					6				
Arecaceae	*Oenocarpus bacaba*	1				1					
Arecaceae	*Socratea exorrhiza*	2				2					
Aristolochiaceae	*Aristolochia guianensis*	2				1		1			
Aristolochiaceae	*Aristolochia sp.*	1						1			
Aristolochiaceae	*Aristolochia stahelii*	3				2		1			
Aristolochiaceae	Indet.	1									1
Aspleniaceae	*Asplenium abscissum*	1				1					
Aspleniaceae	*Asplenium angustum*	1							1		
Aspleniaceae	*Asplenium auritum*	1						1			
Aspleniaceae	*Asplenium juglandifolium*	3									3
Aspleniaceae	*Asplenium laetum*	1									1
Aspleniaceae	*Asplenium pedicularifolium*	1									1
Aspleniaceae	*Asplenium rutaceum*	1									1
Aspleniaceae	*Asplenium salicifolium*	2						1			1
Aspleniaceae	*Asplenium serratum*	2						1			1
Asteraceae	*Bidens cynapiifolia*	1				1					
Asteraceae	*Chromolaena odorata*	3				1		1			1
Asteraceae	*Conyza bonariensis*	1							1		
Asteraceae	*Cyanthillium cinereum*	1				1					
Asteraceae	*Emilia sonchifolia*	2				1			1		
Asteraceae	*Erechtites hieracifolia*	2				1		1			
Asteraceae	*Hebeclinium macrophyllum*	1				1					
Asteraceae	Indet.	3						3			
Asteraceae	*Mikania*	2				1		1			
Asteraceae	*Mikania banisteriae*	1						1			
Asteraceae	*Mikania congesta*	1							1		
Asteraceae	*Mikania gleasonii*	4				1					3
Asteraceae	*Mikania guaco*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Asteraceae	*Mikania lindleyana*	1				1					
Asteraceae	*Mikania micrantha*	3							1		2
Asteraceae	*Mikania parviflora*	2						2			
Asteraceae	*Mikania psilostachya*	1				1					
Asteraceae	*Mikania vitifolia*	1				1					
Asteraceae	*Neurolaena lobata*	3				2					1
Asteraceae	*Piptocarpha triflora*	4							1		3
Asteraceae	*Rolandra fruticosa*	2				2					
Asteraceae	*Wedelia* sp.	1						1			
Asteraceae	*Wulffia baccata*	2				1		1			
Balanophoraceae	*Helosis cayennensis*	6						1			5
Begoniaceae	*Begonia glabra*	3				2		1			
Begoniaceae	*Begonia humilis*	1									1
Bignoniaceae	*Anemopaegma brevipes*	1						1			
Bignoniaceae	*Arrabidaea fanshawei*	1				1					
Bignoniaceae	*Arrabidaea florida*	3				3					
Bignoniaceae	*Arrabidaea inaequalis*	1					1				
Bignoniaceae	*Arrabidaea mollis*	1					1				
Bignoniaceae	*Callichlamys latifolia*	1						1			
Bignoniaceae	*Cydista aequinoctialis*	1						1			
Bignoniaceae	*Distictella elongata*	1				1					
Bignoniaceae	*Distictella magnoliifolia*	2				1		1			
Bignoniaceae	*Distictis granulosa*	4						4			
Bignoniaceae	*Jacaranda copaia*	8				7		1			
Bignoniaceae	*Jacaranda obtusifolia*	6				5		1			
Bignoniaceae	*Lundia erionema*	3				1	2				
Bignoniaceae	*Macfadyena unguis-cati*	1				1					
Bignoniaceae	*Mansoa kerere*	1						1			
Bignoniaceae	*Martinella obovata*	3				2		1			
Bignoniaceae	*Memora flavida*	1						1			
Bignoniaceae	*Memora flaviflora*	1				1					
Bignoniaceae	*Memora moringifolia*	1						1			
Bignoniaceae	*Memora racemosa*	2						2			
Bignoniaceae	*Memora schomburgkii*	1							1		
Bignoniaceae	*Pithecoctenium crucigerum*	1				1					
Bignoniaceae	*Schlegelia violacea*	3				1					2
Bignoniaceae	*Stizophyllum inaequilaterum*	2				2					
Bignoniaceae	*Stizophyllum riparium*	1				1					
Bignoniaceae	*Tabebuia capitata*	2						1			1
Bignoniaceae	*Tabebuia impetiginosa*	1				1					
Bignoniaceae	*Tabebuia serratifolia*	5				5					
Bignoniaceae	*Tabebuia* sp.	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Boraginaceae	*Cordia alliodora*	1				1					
Boraginaceae	*Cordia bicolor*	1						1			
Boraginaceae	*Cordia laevifrons*	3						2	1		
Boraginaceae	*Cordia lomatoloba*	2				2					
Boraginaceae	*Cordia nodosa*	15				11		2			2
Boraginaceae	*Cordia panicularis*	4				1		1			2
Boraginaceae	*Cordia sagotii*	2				2					
Boraginaceae	*Cordia schomburgkii*	5				3		1	1		
Boraginaceae	*Cordia tetrandra*	1				1					
Boraginaceae	*Heliotropium indicum*	1				1					
Boraginaceae	*Hydrolea spinosa*	1					1				
Boraginaceae	*Tournefortia bicolor*	6				6					
Boraginaceae	*Tournefortia cuspidata*	2				2					
Boraginaceae	*Tournefortia maculata*	1				1					
Boraginaceae	*Tournefortia ulei*	6				3		1			2
Bromeliaceae	*Aechmea bromeliifolia*	2				1		1			
Bromeliaceae	*Aechmea melinonii*	2						2			
Bromeliaceae	*Aechmea mertensii*	3				1			1		1
Bromeliaceae	*Araeococcus micranthus*	4				2		1			1
Bromeliaceae	*Araeococcus* sp.	1						1			
Bromeliaceae	*Billbergia violacea*	4				2		1			1
Bromeliaceae	*Catopsis berteroniana*	1				1					
Bromeliaceae	*Catopsis sp.*	1						1			
Bromeliaceae	*Guzmania lingulata*	2				1		1			
Bromeliaceae	Indet.	5						5			
Bromeliaceae	*Tillandsia anceps*	2				1					1
Bromeliaceae	*Tillandsia monadelpha*	4						2			2
Bromeliaceae	*Tillandsia* sp.	2						2			
Bromeliaceae	*Tillandsia spiculosa*	2				1		1			
Bromeliaceae	*Vriesea heliconioides*	1					1				
Bromeliaceae	*Vriesea pleiosticha*	1						1			
Bromeliaceae	*Vriesea splendens*	6						1			5
Bryophyte	Indet.	129						7	9		113
Burmanniaceae	*Burmannia bicolor*	1					1				
Burmanniaceae	*Dictyostega orobanchoides*	1									1
Burmanniaceae	*Dictyostega* sp.	1				1					
Burmanniaceae	*Gymnosiphon cymosus*	1									1
Burmanniaceae	*Gymnosiphon divaricatus*	1						1			
Burmanniaceae	Indet.	1				1					
Burseraceae	Indet.	2						2			
Burseraceae	*Protium altsonii*	2									2
Burseraceae	*Protium apiculatum*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Burseraceae	*Protium aracouchini*	1						1			
Burseraceae	*Protium giganteum*	1									1
Burseraceae	*Protium guianense*	1				1					
Burseraceae	*Protium plagiocarpium*	1				1					
Burseraceae	*Protium polybotryum*	2				2					
Burseraceae	*Protium tenuifolium*	2				1		1			
Burseraceae	*Tetragastris altissima*	1						1			
Burseraceae	*Tetragastris panamensis*	10				8					2
Burseraceae	*Trattinnickia burserifolia*	1				1					
Burseraceae	*Trattinnickia demerarae*	1						1			
Burseraceae	*Trattinnickia lawrancei*	1				1					
Burseraceae	*Trattinnickia rhoifolia*	5				5					
Cactaceae	*Epiphyllum phyllanthus*	1						1			
Campanulaceae	*Centropogon cornutus*	7						2			5
Cannabaceae	*Celtis iguanaea*	1				1					
Cannabaceae	*Trema micrantha*	1						1			
Capparaceae	*Capparis flexuosa*	2						1			1
Capparaceae	*Capparis maroniensis*	6				5					1
Cardiopteridaceae	*Dendrobangia boliviana*	2				1					1
Caricaceae	*Jacaratia spinosa*	2				2					
Caryocaraceae	*Caryocar glabrum*	2									2
Caryophyllaceae	*Drymaria cordata*	1				1					
Cecropiaceae	*Cecropia obtusa*	4				1		3			
Cecropiaceae	*Cecropia sciadophylla*	3				1		1			1
Cecropiaceae	*Coussapoa angustifolia*	2				2					
Cecropiaceae	*Coussapoa asperifolia*	1						1			
Cecropiaceae	*Coussapoa latifolia*	7				3		4			
Cecropiaceae	*Pourouma bicolor*	1				1					
Cecropiaceae	*Pourouma guianensis*	3				1		1	1		
Cecropiaceae	*Pourouma minor*	1							1		
Cecropiaceae	*Pourouma mollis*	3					2		1		
Cecropiaceae	*Pourouma tomentosa*	1						1			
Cecropiaceae	*Pourouma villosa*	9				6	1	2			
Celastraceae	*Cheiloclinium cognatum*	11				5		2			4
Celastraceae	*Cheiloclinium hippocrateoides*	1				1					
Celastraceae	*Hippocratea volubilis*	1									1
Celastraceae	*Maytenus ficiformis*	1				1					
Celastraceae	*Maytenus guyanensis*	1				1					
Celastraceae	*Maytenus kanukuensis*	1				1					
Celastraceae	*Maytenus myrsinoides*	4									4
Celastraceae	*Maytenus oblongata*	1				1					
Celastraceae	*Maytenus pruinosa*	5				4					1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Celastraceae	*Peritassa laevigata*	4				4					
Celastraceae	*Peritassa pruinosa*	1						1			
Celastraceae	*Prionostemma aspera*	1				1					
Celastraceae	*Pristimera nervosa*	1				1					
Celastraceae	*Salacia cordata*	1				1					
Celastraceae	*Salacia duckei*	1									1
Celastraceae	*Salacia multiflora*	2				1					1
Celastraceae	*Tontelea coriacea*	1				1					
Chrysobalanaceae	*Couepia guianensis*	7				5		2			
Chrysobalanaceae	*Couepia parillo*	4				1		3			
Chrysobalanaceae	*Exellodendron barbatum*	1				1					
Chrysobalanaceae	*Hirtella hispidula*	4						3			1
Chrysobalanaceae	*Hirtella margae*	1				1					
Chrysobalanaceae	*Hirtella mucronata*	2						2			
Chrysobalanaceae	*Hirtella paniculata*	4				4					
Chrysobalanaceae	*Hirtella racemosa*	5				3		1			1
Chrysobalanaceae	*Hirtella silicea*	3						1			2
Chrysobalanaceae	*Hirtella triandra*	2				2					
Chrysobalanaceae	*Licania apetala*	1				1					
Chrysobalanaceae	*Licania canescens*	2						2			
Chrysobalanaceae	*Licania glabriflora*	2				1		1			
Chrysobalanaceae	*Licania heteromorpha*	3				2	1				
Chrysobalanaceae	*Licania hypoleuca*	7				5		2			
Chrysobalanaceae	*Licania incana*	2					1				1
Chrysobalanaceae	*Licania laxiflora*	3									3
Chrysobalanaceae	*Licania licaniiflora*	6				3					3
Chrysobalanaceae	*Licania majuscula*	11				10		1			
Chrysobalanaceae	*Licania ovalifolia*	2				2					
Chrysobalanaceae	*Licania robusta*	1				1					
Chrysobalanaceae	*Licania* sp.	3				1					2
Chrysobalanaceae	*Parinari campestris*	4				4					
Chrysobalanaceae	*Parinari excelsa*	3				3					
Clusiaceae	*Calophyllum brasiliense*	1				1					
Clusiaceae	*Caraipa punctulata*	17				15					2
Clusiaceae	*Clusia fockeana*	1				1					
Clusiaceae	*Clusia grandiflora*	10				1		4			5
Clusiaceae	*Clusia nemorosa*	8				3	1	4			
Clusiaceae	*Clusia palmicida*	1									1
Clusiaceae	*Clusia panapanari*	12				4		4			4
Clusiaceae	*Clusia platystigma*	2				1					1
Clusiaceae	*Clusia scrobiculata*	3				1					2
Clusiaceae	*Platonia insignis*	2				2					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Clusiaceae	*Rheedia acuminata*	1				1					
Clusiaceae	*Rheedia benthamiana*	6				2		2			2
Clusiaceae	*Rheedia macrophylla*	1				1					
Clusiaceae	*Rheedia madruno*	4				4					
Clusiaceae	*Symphonia globulifera*	8				7					1
Clusiaceae	*Tovomita brevistaminea*	3				2					1
Clusiaceae	*Tovomita calodictyos*	2							1		1
Clusiaceae	*Tovomita carinata*	1				1					
Clusiaceae	*Tovomita choisyana*	11				6		1			4
Clusiaceae	*Tovomita schomburgkii*	3				3					
Clusiaceae	*Tovomita secunda*	4				2		1			1
Clusiaceae	*Tovomita* sp.	1									1
Clusiaceae	*Tovomita umbellata*	3				3					
Collemataceae	*Leptogium* sp.	1									1
Combretaceae	*Buchenavia parvifolia*	1				1					
Combretaceae	*Combretum laxum*	2				1		1			
Combretaceae	*Combretum pyramidatum*	1							1		
Combretaceae	*Combretum rotundifolium*	1							1		
Combretaceae	*Terminalia amazonia*	3				2		1			
Combretaceae	*Terminalia guyanensis*	2						1			1
Combretaceae	*Terminalia* sp.	2				1		1			
Commelinaceae	*Commelina rufipes*	1									1
Connaraceae	*Cnestidium guianense*	2				1		1			
Connaraceae	*Connarus coriaceus*	1						1			
Connaraceae	*Connarus fasciculatus*	6						2			4
Connaraceae	*Connarus perrottetii*	3						1	1		1
Connaraceae	*Rourea pubescens*	1				1					
Connaraceae	*Rourea surinamensis*	3				2		1			
Convolvulaceae	*Bonamia maripoides*	1				1					
Convolvulaceae	*Dicranostyles guianensis*	2				2					
Convolvulaceae	*Dicranostyles* sp.	1						1			
Convolvulaceae	*Dicranostyles villosus*	1									1
Convolvulaceae	*Ipomoea batatoides*	2						2			
Convolvulaceae	*Ipomoea imperati*	1				1					
Convolvulaceae	*Ipomoea phillomega*	2							1		1
Convolvulaceae	*Ipomoea tiliacea*	1							1		
Convolvulaceae	*Lysiostyles scandens*	1						1			
Convolvulaceae	*Maripa glabra*	4				1	1				2
Convolvulaceae	*Maripa scandens*	5				3		1			1
Convolvulaceae	*Maripa* sp.	1				1					
Convolvulaceae	*Maripa violacea*	7				7					
Convolvulaceae	*Merremia macrocalyx*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Costaceae	*Costus arabicus*	1							1		
Costaceae	*Costus claviger*	8				4		2			2
Costaceae	*Costus congestiflorus*	2				1					1
Costaceae	*Costus scaber*	3				1		1			1
Cucurbitaceae	*Anguria* sp.	1				1					
Cucurbitaceae	*Gurania bignoniacea*	2					1				1
Cucurbitaceae	*Gurania lobata*	4				1	1		1		1
Cucurbitaceae	*Gurania robusta*	1				1					
Cucurbitaceae	*Gurania spinulosa*	1				1					
Cucurbitaceae	*Gurania subumbellata*	3				1	1				1
Cucurbitaceae	*Helmontia leptantha*	5				1		1			3
Cucurbitaceae	*Melothria pendula*	1				1					
Cucurbitaceae	*Psiguria triphylla*	3				2		1			
Cucurbitaceae	*Selysia prunifera*	11				2		9			
Cyatheaceae	*Cnemidaria cruciata*	1									1
Cyatheaceae	*Cnemidaria spectabilis*	1				1					
Cyatheaceae	*Cyathea andina*	1				1					
Cyatheaceae	*Cyathea cyatheoides*	1				1					
Cyatheaceae	*Cyathea pungens*	2				1					1
Cyatheaceae	*Cyathea* sp.	1				1					
Cyatheaceae	*Cyathea surinamensis*	3				1					2
Cyatheaceae	Indet.	2						1			1
Cyclanthaceae	*Asplundia brachyphylla*	1									1
Cyclanthaceae	*Asplundia fanshawei*	1						1			
Cyclanthaceae	*Asplundia glandulosa*	1				1					
Cyclanthaceae	*Asplundia heteranthera*	9						2			7
Cyclanthaceae	*Asplundia maguirei*	4				4					
Cyclanthaceae	*Cyclanthus bipartitus*	1						1			
Cyclanthaceae	*Dicranopygium pygmaeum*	9				5		1			3
Cyclanthaceae	*Evodianthus funifer*	4						1			3
Cyclanthaceae	*Ludovia lancifolia*	1				1					
Cyclanthaceae	*Stelestylis surinamensis*	1				1					
Cyclanthaceae	*Thoracocarpus bissectus*	2				2					
Cyperaceae	*Becquerelia cymosa*	4				3	1				
Cyperaceae	*Bisboeckelera longifolia*	4				2					2
Cyperaceae	*Bulbostylis lanata*	2				1	1				
Cyperaceae	*Calyptrocarya glomerulata*	9				4			1		4
Cyperaceae	*Calyptrocarya* sp.	1						1			
Cyperaceae	*Cyperus laxus*	1							1		
Cyperaceae	*Cyperus ligularis*	1							1		
Cyperaceae	*Cyperus luzulae*	2						1			1
Cyperaceae	*Cyperus simplex*	2				2					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Cyperaceae	*Cyperus* sp.	1					1				
Cyperaceae	*Diplacrum guianense*	1					1				
Cyperaceae	*Diplasia karatifolia*	10				5	1	1			3
Cyperaceae	*Diplasia* sp.	1						1			
Cyperaceae	*Eleocharis filiculmis*	1					1				
Cyperaceae	*Fimbristylis annua*	1					1				
Cyperaceae	*Fuirena umbellata*	1					1				
Cyperaceae	*Hypolytrum jenmanii*	6				2					4
Cyperaceae	*Hypolytrum longifolium*	1									1
Cyperaceae	*Hypolytrum pulchrum*	2				1	1				
Cyperaceae	Indet.	6				1		5			
Cyperaceae	*Lagenocarpus rigidus*	1				1					
Cyperaceae	*Mapania* sp.	1						1			
Cyperaceae	*Mapania sylvatica*	8				2		3			3
Cyperaceae	*Rhynchospora barbata*	4				1	3				
Cyperaceae	*Rhynchospora cephalotes*	6				1		2			3
Cyperaceae	*Rhynchospora curvula*	1				1					
Cyperaceae	*Rhynchospora filiformis*	1					1				
Cyperaceae	*Rhynchospora globosa*	3				1	2				
Cyperaceae	*Rhynchospora holoschoenoides*	6				3	1	1			1
Cyperaceae	*Rhynchospora marisculus*	1						1			
Cyperaceae	*Rhynchospora montana*	1				1					
Cyperaceae	*Rhynchospora pubera*	2					1				1
Cyperaceae	*Rhynchospora rugosa*	2				1	1				
Cyperaceae	*Scleria cyperina*	1				1					
Cyperaceae	*Scleria hirtella*	1					1				
Cyperaceae	*Scleria latifolia*	2						1			1
Cyperaceae	*Scleria melaleuca*	2				1					1
Cyperaceae	*Scleria secans*	1						1			
Cyperaceae	*Scleria* sp.	1						1			
Cyperaceae	*Scleria stipularis*	2				1					1
Dennstaedtiaceae	*Lindsaea dubia*	2				1					1
Dennstaedtiaceae	*Lindsaea lancea*	3				1		1			1
Dennstaedtiaceae	*Lindsaea pallida*	1						1			
Dennstaedtiaceae	*Lindsaea portoricensis*	2						1			1
Dennstaedtiaceae	*Lindsaea quadrangularis*	1				1					
Dennstaedtiaceae	*Lindsaea reniformis*	1				1					
Dennstaedtiaceae	*Lindsaea sagittata*	1				1					
Dennstaedtiaceae	*Lindsaea surinamensis*	1				1					
Dennstaedtiaceae	*Lonchitis hirsuta*	1				1					
Dennstaedtiaceae	*Saccoloma inaequale*	1									1
Dichapetalaceae	*Dichapetalum pedunculatum*	3				2		1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Dichapetalaceae	*Dichapetalum rugosum*	2				2					
Dichapetalaceae	*Tapura amazonica*	2						1			1
Dichapetalaceae	*Tapura capitulifera*	11				11					
Dichapetalaceae	*Tapura guianensis*	22				12		2	1		7
Dilleniaceae	*Davilla kunthii*	3				1					2
Dilleniaceae	*Davilla rugosa*	1									1
Dilleniaceae	*Doliocarpus brevipedicellatus*	3				1		2			
Dilleniaceae	*Doliocarpus dentatus*	2						2			
Dilleniaceae	*Doliocarpus guianensis*	1				1					
Dilleniaceae	*Doliocarpus macrocarpus*	2				2					
Dilleniaceae	*Doliocarpus major*	2							2		
Dilleniaceae	*Doliocarpus paraensis*	2									2
Dilleniaceae	*Doliocarpus* sp.	1									1
Dilleniaceae	*Doliocarpus spraguei*	1									1
Dilleniaceae	*Pinzona coriacea*	1						1			
Dioscoreaceae	*Dioscorea megacarpa*	1				1					
Dioscoreaceae	*Dioscorea pilosiuscula*	1									1
Dioscoreaceae	*Dioscorea* sp.	4				2		1			1
Droseraceae	*Drosera cayennensis*	1					1				
Dryopteridaceae	*Cyclodium guianense*	1				1					
Dryopteridaceae	*Cyclodium inerme*	9				1		3			5
Dryopteridaceae	*Cyclodium meniscioides*	3						1			2
Dryopteridaceae	*Didymochlaena truncatula*	1									1
Dryopteridaceae	*Dryopteris* sp.	2									2
Dryopteridaceae	*Olfersia cervina*	2				1					1
Dryopteridaceae	*Polybotrya fractiserialis*	1				1					
Dryopteridaceae	*Stigmatopteris rotundata*	1				1					
Dryopteridaceae	*Stigmatopteris* sp.	1									1
Ebenaceae	*Diospyros martinii*	1									1
Ebenaceae	*Diospyros ropourea*	1						1			
Ebenaceae	*Diospyros* sp.	4									4
Ebenaceae	*Diospyros tetrandra*	1				1					
Ebenaceae	Indet.	1						1			
Elaeocarpaceae	*Sloanea eichleri*	1									1
Elaeocarpaceae	*Sloanea floribunda*	1									1
Elaeocarpaceae	*Sloanea garckeana*	4				2					2
Elaeocarpaceae	*Sloanea gracilis*	1			E	1					
Elaeocarpaceae	*Sloanea grandiflora*	8				5					3
Elaeocarpaceae	*Sloanea guianensis*	5				4					1
Elaeocarpaceae	*Sloanea laxiflora*	8				6		2			
Elaeocarpaceae	*Sloanea pubescens*	1				1					
Elaeocarpaceae	*Sloanea robusta*	3				1		1			1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Elaeocarpaceae	*Sloanea rufa*	1				1					
Elaeocarpaceae	*Sloanea* sp.	3				2		1			
Elaeocarpaceae	*Sloanea synandra*	1						1			
Ericaceae	*Cavendishia callista*	3						3			
Ericaceae	*Sphyrospermum*	1						1			
Ericaceae	*Sphyrospermum cordifolium*	1						1			
Eriocaulaceae	*Tonina fluviatilis*	2				1					1
Erythroxylaceae	*Erythroxylum amazonicum*	3				1	2				
Erythroxylaceae	*Erythroxylum citrifolium*	3					1				2
Erythroxylaceae	*Erythroxylum kapplerianum*	10						4			6
Erythroxylaceae	*Erythroxylum macrophyllum*	5				1		1			3
Erythroxylaceae	*Erythroxylum mucronatum*	2									2
Erythroxylaceae	*Erythroxylum* sp.	4						4			
Erythroxylaceae	*Erythroxylum squamatum*	3									3
Euphorbiaceae	*Acalypha diversifolia*	6				6					
Euphorbiaceae	*Acalypha sp.*	2						2			
Euphorbiaceae	*Alchornea triplinervia*	1						1			
Euphorbiaceae	*Alchorneopsis floribunda*	1						1			
Euphorbiaceae	*Aparisthmium* sp.	1						1			
Euphorbiaceae	*Chaetocarpus schomburgkianus*	3				2					1
Euphorbiaceae	*Chamaesyce hyssopifolia*	1				1					
Euphorbiaceae	*Conceveiba guianensis*	4				2			1		1
Euphorbiaceae	*Croton draconoides*	1						1			
Euphorbiaceae	*Croton guianensis*	1						1			
Euphorbiaceae	*Croton longiradiatus*	1				1					
Euphorbiaceae	*Croton matourensis*	7				4					3
Euphorbiaceae	*Croton schiedeanus*	2				2					
Euphorbiaceae	*Croton* sp.	5						5			
Euphorbiaceae	*Croton trinitatis*	2				2					
Euphorbiaceae	*Dalechampia attenuistylus*	1						1			
Euphorbiaceae	*Dalechampia brownsbergensis*	1				1					
Euphorbiaceae	*Dalechampia cissifolia*	1				1					
Euphorbiaceae	*Dalechampia fragrans*	1				1					
Euphorbiaceae	*Dalechampia heterobractea*	1				1					
Euphorbiaceae	*Dalechampia triphylla*	2				1		1			
Euphorbiaceae	*Hevea guianensis*	1									1
Euphorbiaceae	*Hyeronima alchorneoides*	1				1					
Euphorbiaceae	*Hyeronima oblonga*	1				1					
Euphorbiaceae	Indet.	6						5			1
Euphorbiaceae	*Mabea piriri*	7				4		1			2
Euphorbiaceae	*Mabea* sp.	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Euphorbiaceae	*Mabea speciosa*	14				12	1				1
Euphorbiaceae	*Maprounea guianensis*	3				2		1			
Euphorbiaceae	*Maprounea* sp.	1						1			
Euphorbiaceae	*Margaritaria nobilis*	1									1
Euphorbiaceae	*Micrandra brownsbergensis*	25				14		7			4
Euphorbiaceae	*Micrandra* sp.	1						1			
Euphorbiaceae	*Pausandra martinii*	18				10		1			7
Euphorbiaceae	*Pera bicolor*	1				1					
Euphorbiaceae	*Pera* sp.	1						1			
Euphorbiaceae	*Pogonophora schomburgkiana*	2						1			1
Euphorbiaceae	*Sagotia racemosa*	3									3
Euphorbiaceae	*Sapium paucinervium*	3				1		1			1
Euphorbiaceae	*Tragia lessertiana*	3				2					1
Fabaceae	*Abarema jupunba*	9				7	1				1
Fabaceae	*Abarema mataybifolia*	1				1					
Fabaceae	*Abarema* sp.	1						1			
Fabaceae	*Acacia articulata*	1				1					
Fabaceae	*Acacia tenuifolia*	3				2					1
Fabaceae	*Alexa wachenheimii*	3				2					1
Fabaceae	*Andira coriacea*	1				1					
Fabaceae	*Andira surinamensis*	1				1					
Fabaceae	*Balizia pedicellaris*	8				8					
Fabaceae	*Bauhinia eilertsii*	5				5					
Fabaceae	*Bauhinia guianensis*	9				2		3	1		3
Fabaceae	*Bauhinia siqueiraei*	2				2					
Fabaceae	*Bauhinia smilacina*	1							1		
Fabaceae	*Bauhinia* sp.	1						1			
Fabaceae	*Bauhinia surinamensis*	3				3					
Fabaceae	*Bocoa prouacensis*	4				2			1		1
Fabaceae	*Bocoa viridiflora*	1					1				
Fabaceae	*Calliandra coriacea*	1				1					
Fabaceae	*Calliandra hymenaeodes*	1									1
Fabaceae	*Calopogonium mucunoides*	1					1				
Fabaceae	*Cassia* sp.	1						1			
Fabaceae	*Cedrelinga catenaeformis*	1				1					
Fabaceae	*Chamaecrista apoucouita*	1									1
Fabaceae	*Clathrotropis brachypetala*	7				7					
Fabaceae	*Clitoria javitensis*	1				1					
Fabaceae	*Clitoria pendens*	1				1					
Fabaceae	*Clitoria sagotii*	1				1					
Fabaceae	*Copaifera epunctata*	5	VU		E	5					
Fabaceae	*Copaifera guyanensis*	3		PR		2					1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Fabaceae	*Copaifera reticulata*	1				1					
Fabaceae	*Crudia aromatica*	10				10					
Fabaceae	*Dalbergia foliosa*	1							1		
Fabaceae	*Dalbergia monetaria*	1				1					
Fabaceae	*Desmodium adscendens*	2				1		1			
Fabaceae	*Desmodium axillare*	3				2					1
Fabaceae	*Desmodium barbatum*	1					1				
Fabaceae	*Desmodium wydlerianum*	2				2					
Fabaceae	*Dialium guianense*	3				3					
Fabaceae	*Dicorynia guianensis*	2				1					1
Fabaceae	*Dioclea macrocarpa*	4				3		1			
Fabaceae	*Dioclea* sp.	1						1			
Fabaceae	*Diplotropis purpurea*	5				5					
Fabaceae	*Dipteryx odorata*	2		PR		2					
Fabaceae	*Dipteryx punctata*	1		PR		1					
Fabaceae	*Dipteryx* sp.	1		PR		1					
Fabaceae	*Elizabetha princeps*	6						1			5
Fabaceae	*Enterolobium schomburgkii*	4				4					
Fabaceae	*Eperua falcata*	14				11		3			
Fabaceae	*Eperua* sp.	1				1					
Fabaceae	*Hymenaea courbaril*	1									1
Fabaceae	*Hymenolobium* sp.	2				2					
Fabaceae	Indet.	8						3	2		3
Fabaceae	*Inga acrocephala*	1				1					
Fabaceae	*Inga alba*	5				3		1			1
Fabaceae	*Inga bourgoni*	1				1					
Fabaceae	*Inga capitata*	2				1					1
Fabaceae	*Inga disticha*	1							1		
Fabaceae	*Inga huberi*	2				1					1
Fabaceae	*Inga lateriflora*	1				1					
Fabaceae	*Inga marginata*	3				1					2
Fabaceae	*Inga nobilis*	1							1		
Fabaceae	*Inga paraensis*	1						1			
Fabaceae	*Inga pezizifera*	6				4		1			1
Fabaceae	*Inga pilosula*	4				1		2			1
Fabaceae	*Inga rhynchocalyx*	3						3			
Fabaceae	*Inga rubiginosa*	8				6					2
Fabaceae	*Inga sertulifera*	1							1		
Fabaceae	*Inga* sp.	9				6		3			
Fabaceae	*Inga stipularis*	5				3		1	1		
Fabaceae	*Inga thibaudiana*	9				6		2			1
Fabaceae	*Inga virgultosa*	2				1					1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Fabaceae	*Lonchocarpus negrensis*	1				1					
Fabaceae	*Machaerium altiscandens*	1				1					
Fabaceae	*Machaerium ferox*	1						1			
Fabaceae	*Machaerium floribundum*	2				2					
Fabaceae	*Machaerium kegelii*	1									1
Fabaceae	*Machaerium macrophyllum*	2				1					1
Fabaceae	*Machaerium madeirense*	1						1			
Fabaceae	*Machaerium quinatum*	1									1
Fabaceae	*Macrolobium acaciifolium*	1							1		
Fabaceae	*Macrolobium amplexans*	2	VU								2
Fabaceae	*Macroptilium lathyroides*	1				1					
Fabaceae	*Macroptilium longepedunculatum*	1							1		
Fabaceae	*Martiodendron parviflorum*	3				2					1
Fabaceae	*Mimosa* sp.	1						1			
Fabaceae	*Ormosia cinerea*	1									1
Fabaceae	*Ormosia coccinea*	1				1					
Fabaceae	*Ormosia flava*	1				1					
Fabaceae	*Ormosia paraensis*	2				1		1			
Fabaceae	*Parkia nitida*	4				3					1
Fabaceae	*Parkia pendula*	3				2			1		
Fabaceae	*Parkia* sp.	2						2			
Fabaceae	*Parkia ulei*	3				3					
Fabaceae	*Peltogyne paniculata*	2				2					
Fabaceae	*Peltogyne* sp.	1				1					
Fabaceae	*Peltogyne venosa*	1									1
Fabaceae	*Piptadenia floribunda*	2				1		1			
Fabaceae	*Pithecellobium* sp.	1						1			
Fabaceae	*Platymiscium pinnatum*	1				1					
Fabaceae	*Poecilanthe effusa*	1				1					
Fabaceae	*Poecilanthe hostmannii*	1									1
Fabaceae	*Pseudopiptadenia psilostachya*	2				1					1
Fabaceae	*Pseudopiptadenia suaveolens*	2				1					1
Fabaceae	*Pterocarpus officinalis*	1				1					
Fabaceae	*Pterocarpus rohrii*	1				1					
Fabaceae	*Sclerolobium guianense*	2					1	1			
Fabaceae	*Sclerolobium melinonii*	6				4			1		1
Fabaceae	*Sclerolobium micropetalum*	2				2					
Fabaceae	*Sclerolobium* sp.	1				1					
Fabaceae	*Senna latifolia*	4					1	2			1
Fabaceae	*Senna multijuga*	4				1					3
Fabaceae	*Senna quinquangulata*	6				2					4

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Fabaceae	*Stryphnodendron polystachyum*	3				2					1
Fabaceae	*Stylosanthes angustifolia*	1					1				
Fabaceae	*Swartzia amshoffiana*	11				7		2			2
Fabaceae	*Swartzia arborescens*	2				1					1
Fabaceae	*Swartzia benthamiana*	15				15					
Fabaceae	*Swartzia grandifolia*	1							1		
Fabaceae	*Swartzia guianensis*	1									1
Fabaceae	*Swartzia latifolia*	2									2
Fabaceae	*Swartzia longicarpa*	4				4					
Fabaceae	*Swartzia panacoco*	5				3	1	1			
Fabaceae	*Swartzia polyphylla*	1						1			
Fabaceae	*Swartzia remiger*	5				3					2
Fabaceae	*Swartzia* sp.	3				2		1			
Fabaceae	*Tachigali albiflora*	5				3					2
Fabaceae	*Tachigali paniculata*	1				1					
Fabaceae	*Vatairea paraensis*	1				1					
Fabaceae	*Vataireopsis speciosa*	1				1					
Fabaceae	*Vataireopsis surinamensis*	2				2					
Fabaceae	*Vouacapoua americana*	6	CR			4		1			1
Fabaceae	*Zollernia paraënsis*	1				1					
Fabaceae	*Zollernia surinamensis*	1				1					
Fabaceae	*Zornia latifolia*	1					1				
Fabaceae	*Zygia cataractae*	2							1		1
Fabaceae	*Zygia racemosa*	3				1		1			1
Fabaceae	*Zygia tetragona*	1									1
Fungus	Indet.	1									1
Gentianaceae	*Chelonanthus alatus*	1									1
Gentianaceae	*Chelonanthus purpurascens*	4					2				2
Gentianaceae	*Coutoubea ramosa*	1					1				
Gentianaceae	*Coutoubea spicata*	1					1				
Gentianaceae	Indet.	3							1		2
Gentianaceae	*Voyria aphylla*	4					1				3
Gentianaceae	*Voyria aurantiaca*	1				1					
Gentianaceae	*Voyria caerulea*	5				3					2
Gentianaceae	*Voyria clavata*	1									1
Gentianaceae	*Voyria corymbosa*	4									4
Gentianaceae	*Voyria rosea*	3							1		2
Gentianaceae	*Voyria* sp.	5				3		1			1
Gentianaceae	*Voyria tenella*	4									4
Gentianaceae	*Voyria tenuiflora*	5									5
Gentianaceae	*Voyriella parviflora*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Gesneriaceae	*Besleria flavovirens*	1									1
Gesneriaceae	*Besleria laxiflora*	6				6					
Gesneriaceae	*Besleria patrisii*	1				1					
Gesneriaceae	*Codonanthe calcarata*	5				3	1				1
Gesneriaceae	*Codonanthe crassifolia*	1				1					
Gesneriaceae	*Codonanthe* sp.	1						1			
Gesneriaceae	*Columnea calotricha*	8				6					2
Gesneriaceae	*Drymonia coccinea*	9				6				1	2
Gesneriaceae	*Drymonia serrulata*	1						1			
Gesneriaceae	*Drymonia* sp.	2						1			1
Gesneriaceae	Indet.	9				3		2	2		2
Gesneriaceae	*Lembocarpus amoenus*	5									5
Gesneriaceae	*Napeanthus macrostoma*	1									1
Gesneriaceae	*Nautilocalyx pictus*	5									5
Gesneriaceae	*Paradrymonia campostyla*	2				2					
Gleicheniaceae	*Sticherus remota*	1				1					
Gloeophyllaceae	*Gloeophyllum striatum*	2									2
Gnetaceae	*Gnetum urens*	1				1					
Goupiaceae	*Goupia glabra*	4				2	2				
Grammitidaceae	*Cochlidium furcatum*	1									1
Grammitidaceae	*Cochlidium linearifolium*	3				1					2
Grammitidaceae	*Cochlidium serrulatum*	4						1			3
Grammitidaceae	*Grammitis blanchetii*	2									2
Grammitidaceae	*Grammitis mollissima*	1									1
Grammitidaceae	*Grammitis suspensa*	2									2
Grammitidaceae	*Grammitis taxifolia*	1									1
Grammitidaceae	*Lellingeria suspensa*	1						1			
Gyalectaceae	*Coenogonium* sp.	1									1
Haemodoraceae	*Xiphidium caeruleum*	5						1	1		3
Heliconiaceae	*Heliconia acuminata*	7				5					2
Heliconiaceae	*Heliconia bihai*	2				1					1
Heliconiaceae	*Heliconia hirsuta*	2				2					
Heliconiaceae	*Heliconia psittacorum*	4						1			3
Heliconiaceae	*Heliconia richardiana*	1									1
Heliconiaceae	*Heliconia* sp.	2						2			
Heliconiaceae	*Heliconia spathocircinata*	1				1					
Helotiaceae	*Ascotremella* sp.	1									1
Hepaticeae	Indet.	28							5		23
Hernandiaceae	*Sparattanthelium uncigerum*	1				1					
Hernandiaceae	*Sparattanthelium wonotoboense*	1				1					
Hookeriaceae	*Lepidopilum scabrisetum*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Humiriaceae	*Humiria balsamifera*	3				3					
Humiriaceae	*Sacoglottis cydonioides*	3				2					1
Humiriaceae	*Sacoglottis guianensis*	3				1		1			1
Hymenochaetaceae	*Hymenochaete damicornis*	1									1
Hymenophyllaceae	*Hymenophyllum decurrens*	1				1					
Hymenophyllaceae	*Hymenophyllum hirsutum*	4				1					3
Hymenophyllaceae	*Hymenophyllum polyanthos*	5									5
Hymenophyllaceae	Indet.	3									3
Hymenophyllaceae	*Trichomanes botryoides*	1				1					
Hymenophyllaceae	*Trichomanes crispum*	1									1
Hymenophyllaceae	*Trichomanes cristatum*	2									2
Hymenophyllaceae	*Trichomanes diversifrons*	3				1					2
Hymenophyllaceae	*Trichomanes elegans*	1									1
Hymenophyllaceae	*Trichomanes kapplerianum*	3									3
Hymenophyllaceae	*Trichomanes martiusii*	1									1
Hymenophyllaceae	*Trichomanes membranaceum*	2									2
Hymenophyllaceae	*Trichomanes pedicellatum*	5				1					4
Hymenophyllaceae	*Trichomanes pinnatinervium*	1									1
Hymenophyllaceae	*Trichomanes pinnatum*	4				1		1			2
Hymenophyllaceae	*Trichomanes punctatum*	1									1
Hymenophyllaceae	*Trichomanes radicans*	1						1			
Hymenophyllaceae	*Trichomanes rigidum*	2				1					1
Hymenophyllaceae	*Trichomanes* sp.	1									1
Hymenophyllaceae	*Trichomanes trollii*	2				1					1
Hypericaceae	*Vismia cayennensis*	5				1		2			2
Hypericaceae	*Vismia guianensis*	7				5		1			1
Hypericaceae	*Vismia guianensis*	1									1
Hypericaceae	*Vismia latifolia*	9				6		2	1		
Hypericaceae	*Vismia ramuliflora*	6				6					
Hypericaceae	*Vismia sessilifolia*	1				1					
Hypericaceae	*Vismia* sp.	1						1			
Icacinaceae	*Leretia cordata*	2				1		1			
Icacinaceae	*Poraqueiba guianensis*	1									1
Indet.		1						1			
Indet.	Indet.	1				1					
Indet.	Indet.	100							2		98
Lacistemataceae	*Lacistema aggregatum*	6				2	2	1	1		
Lacistemataceae	*Lacistema grandifolium*	15				8	2	3			2
Lacistemataceae	*Lacistema polystachyum*	2				1		1			
Lacistemataceae	*Lacistema* sp.	5						5			
Lamiaceae	*Hyptis atrorubens*	1				1					
Lamiaceae	*Hyptis brevipes*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Lamiaceae	*Hyptis lanceolata*	2				1			1		
Lamiaceae	*Hyptis lantanifolia*	3					1				2
Lauraceae	*Aniba citrifolia*	3				1					2
Lauraceae	*Aniba hostmanniana*	1							1		
Lauraceae	*Aniba jenmanii*	4				3					1
Lauraceae	*Aniba kappleri*	3				3					
Lauraceae	*Aniba panurensis*	5				4					1
Lauraceae	*Aniba riparia*	1				1					
Lauraceae	*Endlicheria canescens*	5				5					
Lauraceae	*Endlicheria multiflora*	5					5				
Lauraceae	*Endlicheria pyriformis*	6				1					5
Lauraceae	*Endlicheria* sp.	1				1					
Lauraceae	Indet.	10				3		5			2
Lauraceae	*Licaria aurea*	1									1
Lauraceae	*Licaria cannella*	1				1					
Lauraceae	*Licaria debilis*	4				3		1			
Lauraceae	*Licaria martiniana*	6				6					
Lauraceae	*Licaria subbullata*	2						2			
Lauraceae	*Licaria vernicosa*	1									1
Lauraceae	*Nectandra cissiflora*	2				1					1
Lauraceae	*Nectandra cuspidata*	1				1					
Lauraceae	*Nectandra globosa*	5				5					
Lauraceae	*Nectandra reticulata*	3				3					
Lauraceae	*Ocotea aciphylla*	1									1
Lauraceae	*Ocotea canaliculata*	7				5		1			1
Lauraceae	*Ocotea caudata*	1				1					
Lauraceae	*Ocotea cernua*	1									1
Lauraceae	*Ocotea cujumary*	1				1					
Lauraceae	*Ocotea endlicheriopsis*	1				1					
Lauraceae	*Ocotea floribunda*	2				1		1			
Lauraceae	*Ocotea guianensis*	1				1					
Lauraceae	*Ocotea indirectinervia*	1				1					
Lauraceae	*Ocotea percurrens*	6				4		1			1
Lauraceae	*Ocotea petalanthera*	1				1					
Lauraceae	*Ocotea schomburgkiana*	1				1					
Lauraceae	*Ocotea* sp.	1				1					
Lauraceae	*Ocotea splendens*	6				4					2
Lauraceae	*Rhodostemonodaphne praeclara*	3				3					
Lauraceae	*Rhodostemonodaphne rufovirgata*	1									1
Lauraceae	*Sextonia rubra*	2				2					
Lecythidaceae	*Bertholletia excelsa*	1	VU	PR							1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Lecythidaceae	*Corythophora labriculata*	8	VU			7		1			
Lecythidaceae	*Couratari gloriosa*	1				1					
Lecythidaceae	*Couratari guianensis*	6	VU			3		3			
Lecythidaceae	*Couratari multiflora*	2				1					1
Lecythidaceae	*Couratari stellata*	8				5		1			2
Lecythidaceae	*Eschweilera collina*	7				5		1			1
Lecythidaceae	*Eschweilera congestiflora*	4				3					1
Lecythidaceae	*Eschweilera coriacea*	16				11		4			1
Lecythidaceae	*Eschweilera decolorans*	2						1			1
Lecythidaceae	*Eschweilera micrantha*	3				3					
Lecythidaceae	*Eschweilera pedicellata*	13				7		5	1		
Lecythidaceae	*Eschweilera simiorum*	3				2					1
Lecythidaceae	*Eschweilera* sp.	2						2			
Lecythidaceae	*Eschweilera subglandulosa*	1						1			
Lecythidaceae	*Eschweilera wachenheimii*	2									2
Lecythidaceae	*Gustavia augusta*	5				4					1
Lecythidaceae	*Gustavia hexapetala*	9				8					1
Lecythidaceae	*Lecythis chartacea*	3				3					
Lecythidaceae	*Lecythis confertiflora*	3						3			
Lecythidaceae	*Lecythis holcogyne*	1				1					
Lecythidaceae	*Lecythis idatimon*	17				16					1
Lecythidaceae	*Lecythis poiteaui*	1									1
Lecythidaceae	*Lecythis zabucajo*	10				5		4			1
Lentibulariaceae	*Utricularia adpressa*	1				1					
Lentibulariaceae	*Utricularia hispida*	3				1	2				
Lentibulariaceae	*Utricularia hydrocarpa*	1						1			
Lentibulariaceae	*Utricularia juncea*	2					2				
Lentibulariaceae	*Utricularia subulata*	1					1				
Leucobryaceae	*Leucobryum crispum*	1									1
Lichen	Indet.	3						2			1
Liliaceae	*Curculigo scorzonerifolia*	1					1				
Linaceae	Indet.	1						1			
Lobariaceae	*Sticta* sp.	1									1
Loganiaceae	*Antonia ovata*	3				2	1				
Loganiaceae	*Spigelia anthelmia*	1									1
Loganiaceae	*Spigelia hamelioides*	9						3			6
Loganiaceae	*Spigelia* sp.	1						1			
Loganiaceae	*Strychnos cogens*	2						2			
Loganiaceae	*Strychnos erichsonii*	2				1					1
Loganiaceae	*Strychnos medeola*	2									2
Loganiaceae	*Strychnos melinoniana*	6				2		1			3
Loganiaceae	*Strychnos peckii*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Loganiaceae	*Strychnos* sp.	2				1		1			
Loganiaceae	*Strychnos toxifera*	1									1
Lomariopsidaceae	*Bolbitis semipinnatifida*	4				1					3
Lomariopsidaceae	*Elaphoglossum glabellum*	1									1
Lomariopsidaceae	*Elaphoglossum herminieri*	1									1
Lomariopsidaceae	*Elaphoglossum latifolium*	1				1					
Lomariopsidaceae	*Elaphoglossum luridum*	2				1					1
Lomariopsidaceae	*Elaphoglossum macrophyllum*	2									2
Lomariopsidaceae	*Elaphoglossum strictum*	1						1			
Lomariopsidaceae	*Lomariopsis japurensis*	1				1					
Loranthaceae	Indet.	5						5			
Loranthaceae	*Oryctanthus alveolatus*	1						1			
Loranthaceae	*Oryctanthus florulentus*	2				2					
Loranthaceae	*Phthirusa pyrifolia*	1				1					
Loranthaceae	*Phthirusa rufa*	2				1	1				
Loranthaceae	*Phthirusa stelis*	3				2					1
Loranthaceae	*Struthanthus syringifolius*	1				1					
Lycopodiaceae	*Huperzia dichotoma*	1									1
Lycopodiaceae	*Huperzia taxifolia*	2									2
Lycopodiaceae	Indet.	1						1			
Malpighiaceae	*Banisteriopsis lucida*	1				1					
Malpighiaceae	*Byrsonima aerugo*	11				9		1			1
Malpighiaceae	*Byrsonima crassifolia*	1				1					
Malpighiaceae	*Byrsonima densa*	8				5	1	1			1
Malpighiaceae	*Byrsonima laevigata*	2				1					1
Malpighiaceae	*Byrsonima* sp.	6						3			3
Malpighiaceae	*Byrsonima spicata*	4				1		2			1
Malpighiaceae	*Byrsonima stipulacea*	2				1					1
Malpighiaceae	*Byrsonima surinamensis*	9				5		2			2
Malpighiaceae	*Excentradenia propinqua*	1				1					
Malpighiaceae	*Heteropterys macradena*	1							1		
Malpighiaceae	*Heteropterys nervosa*	1				1					
Malpighiaceae	*Heteropterys* sp.	1						1			
Malpighiaceae	*Hiraea faginea*	1							1		
Malpighiaceae	*Hiraea gaudichaudiana*	1				1					
Malpighiaceae	Indet.	3				1		1			1
Malpighiaceae	*Jubelina rosea*	4				3		1			
Malpighiaceae	*Lophopterys* sp.	1				1					
Malpighiaceae	*Mascagnia guianensis*	2				2					
Malpighiaceae	*Mascagnia sepium*	1				1					
Malpighiaceae	*Mascagnia surinamensis*	2				2					
Malpighiaceae	*Spachea* sp.	3						3			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Malpighiaceae	*Stigmaphyllon convolvulifolium*	1							1		
Malpighiaceae	*Stigmaphyllon sinuatum*	6				4		2			
Malpighiaceae	*Stigmaphyllon* sp.	1						1			
Malpighiaceae	*Tetrapterys crispa*	2				2					
Malpighiaceae	*Tetrapterys discolor*	1				1					
Malpighiaceae	*Tetrapterys fimbripetala*	1				1					
Malpighiaceae	*Tetrapterys mucronata*	2				1		1			
Malpighiaceae	*Tetrapterys styloptera*	2				1	1				
Malvaceae	*Apeiba glabra*	2				1		1			
Malvaceae	*Apeiba intermedia*	4	DD			4					
Malvaceae	*Apeiba petoumo*	13				12		1			
Malvaceae	*Apeiba* sp.	1				1					
Malvaceae	*Bombacopsis nervosa*	2									2
Malvaceae	*Ceiba pentandra*	1				1					
Malvaceae	*Eriotheca crassa*	2				2					
Malvaceae	*Eriotheca globosa*	1				1					
Malvaceae	*Eriotheca surinamensis*	2				2					
Malvaceae	*Guazuma ulmifolia*	1				1					
Malvaceae	*Herrania kanukuensis*	1									1
Malvaceae	Indet.	1				1					
Malvaceae	*Lueheopsis rosea*	5				4					1
Malvaceae	*Melochia spicata*	1					1				
Malvaceae	*Pachira insignis*	1									1
Malvaceae	*Pavonia fruticosa*	1				1					
Malvaceae	*Pavonia schiedeana*	2				2					
Malvaceae	*Quararibea duckei*	2				2					
Malvaceae	*Quararibea guianensis*	2				1			1		
Malvaceae	*Quararibea* sp.	1						1			
Malvaceae	*Sida glomerata*	3									3
Malvaceae	*Sida setosa*	2						2			
Malvaceae	*Sterculia excelsa*	1				1					
Malvaceae	*Sterculia pruriens*	11				7		1			3
Malvaceae	*Sterculia* sp.	1						1			
Malvaceae	*Sterculia villifera*	1				1					
Malvaceae	*Wissadula patens*	1				1					
Marantaceae	*Calathea cyclophora*	1							1		
Marantaceae	*Calathea elliptica*	3				1			1		1
Marantaceae	*Calathea maasiorum*	7						1			6
Marantaceae	*Calathea propinqua*	1						1			
Marantaceae	*Calathea* sp.	3									3
Marantaceae	*Hylaeanthe hexantha*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Marantaceae	Indet.	1						1			
Marantaceae	*Ischnosiphon arouma*	4				1	1	1			1
Marantaceae	*Ischnosiphon gracilis*	1						1			
Marantaceae	*Ischnosiphon obliquus*	3				2					1
Marantaceae	*Ischnosiphon petiolatus*	1				1					
Marantaceae	*Ischnosiphon puberulus*	3				2		1			
Marantaceae	*Ischnosiphon* sp.	2						1			1
Marantaceae	*Maranta humilis*	1				1					
Marantaceae	*Maranta rupicola*	1				1					
Marantaceae	*Maranta* sp.	2						2			
Marantaceae	*Monotagma plurispicatum*	3					1				2
Marantaceae	*Monotagma spicatum*	5				2	1				2
Marantaceae	*Stromanthe tonckat*	3						2			1
Marattiaceae	*Danaea elliptica*	1				1					
Marattiaceae	*Danaea leprieurii*	2				1					1
Marattiaceae	*Danaea nodosa*	1				1					
Marattiaceae	*Danaea sp. nov.*	1				1					
Marattiaceae	*Danaea trifoliata*	1				1					
Marcgraviaceae	Indet.	1						1			
Marcgraviaceae	*Marcgravia coriacea*	1				1					
Marcgraviaceae	*Marcgravia pedunculosa*	6				1					5
Marcgraviaceae	*Marcgravia* sp.	6				2		3			1
Marcgraviaceae	*Marcgraviastrum* sp.	1									1
Marcgraviaceae	*Norantea guianensis*	4				1	1	2			
Marcgraviaceae	*Souroubea guianensis*	7				4		2			1
Marcgraviaceae	*Souroubea* sp.	1						1			
Mayacaceae	*Mayaca fluviatilis*	1				1					
Mayacaceae	*Mayaca longipes*	2						1			1
Melastomataceae	*Aciotis ornata*	2				1	1				
Melastomataceae	*Aciotis purpurascens*	15				7	1	3			4
Melastomataceae	*Aciotis* sp.	1						1			
Melastomataceae	*Adelobotrys adscendens*	3				2					1
Melastomataceae	*Adelobotrys ciliata*	4				4					
Melastomataceae	*Adelobotrys* sp.	1									1
Melastomataceae	*Adelobotrys spruceana*	1				1					
Melastomataceae	*Bellucia grossularioides*	5				1		2			2
Melastomataceae	*Clidemia conglomerata*	11				3	2	1			5
Melastomataceae	*Clidemia hirta*	5				3					2
Melastomataceae	*Clidemia laevifolia*	1						1			
Melastomataceae	*Clidemia minutiflora*	2									2
Melastomataceae	*Clidemia* sp.	1						1			
Melastomataceae	*Clidemia venosa*	5				1					4

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Melastomataceae	*Comolia villosa*	1					1				
Melastomataceae	*Henriettea succosa*	2					1				1
Melastomataceae	*Henriettella caudata*	7				6					1
Melastomataceae	*Henriettella flavescens*	5						1			4
Melastomataceae	*Henriettella* sp.	4						3			1
Melastomataceae	Indet.	3						2			1
Melastomataceae	*Leandra divaricata*	2						2			
Melastomataceae	*Leandra micropetala*	3				2		1			
Melastomataceae	*Leandra rufescens*	3				2		1			
Melastomataceae	*Leandra* sp.	1				1					
Melastomataceae	*Loreya mespiloides*	3				2		1			
Melastomataceae	*Macrocentrum cristatum*	2									2
Melastomataceae	*Macrocentrum fasciculatum*	8						2			6
Melastomataceae	*Macrocentrum* sp.	2						2			
Melastomataceae	*Maieta guianensis*	3							1		2
Melastomataceae	*Miconia acinodendron*	2							1		1
Melastomataceae	*Miconia acuminata*	4				2					2
Melastomataceae	*Miconia affinis*	4				4					
Melastomataceae	*Miconia alata*	1				1					
Melastomataceae	*Miconia albicans*	1									1
Melastomataceae	*Miconia argyrophylla*	2				1					1
Melastomataceae	*Miconia bracteata*	5									5
Melastomataceae	*Miconia bubalina*	1						1			
Melastomataceae	*Miconia cacatin*	2				1		1			
Melastomataceae	*Miconia ceramicarpa*	15				4		2			9
Melastomataceae	*Miconia chrysophylla*	6				2		1			3
Melastomataceae	*Miconia ciliata*	3					1	2			
Melastomataceae	*Miconia fallax*	1					1				
Melastomataceae	*Miconia gratissima*	1					1				
Melastomataceae	*Miconia holosericea*	3				2					1
Melastomataceae	*Miconia hypoleuca*	1				1					
Melastomataceae	*Miconia kappleri*	2				2					
Melastomataceae	*Miconia lateriflora*	2				2					
Melastomataceae	*Miconia lepidota*	1									1
Melastomataceae	*Miconia minutiflora*	3				1					2
Melastomataceae	*Miconia mirabilis*	26				17	1	3			5
Melastomataceae	*Miconia nervosa*	2				2					
Melastomataceae	*Miconia phaeophylla*	1				1					
Melastomataceae	*Miconia plukenetii*	2									2
Melastomataceae	*Miconia poeppigii*	1				1					
Melastomataceae	*Miconia prasina*	15				9		1			5
Melastomataceae	*Miconia pyrifolia*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Melastomataceae	*Miconia racemosa*	1									1
Melastomataceae	*Miconia ruficalyx*	1									1
Melastomataceae	*Miconia serrulata*	1							1		
Melastomataceae	*Miconia* sp.	9						9			
Melastomataceae	*Miconia splendens*	1				1					
Melastomataceae	*Miconia tomentosa*	1						1			
Melastomataceae	*Miconia tschudyoides*	9				9					
Melastomataceae	*Myriaspora egensis*	1							1		
Melastomataceae	*Nepsera aquatica*	2				1	1				
Melastomataceae	*Pterolepis glomerata*	4				2	1				1
Melastomataceae	*Rhynchanthera grandiflora*	1					1				
Melastomataceae	*Sarmentaria decora*	1				1					
Melastomataceae	*Tibouchina aspera*	2					2				
Melastomataceae	*Topobea parasitica*	2				2					
Meliaceae	*Carapa procera*	3				3					
Meliaceae	*Guarea costata*	6				1		3			2
Meliaceae	*Guarea glabra*	3				3					
Meliaceae	*Guarea grandifolia*	4				3					1
Meliaceae	*Guarea guidonia*	1							1		
Meliaceae	*Guarea kunthiana*	1				1					
Meliaceae	*Guarea macrophylla*	1				1					
Meliaceae	*Guarea pubescens*	3									3
Meliaceae	Indet.	8				2		6			
Meliaceae	*Trichilia lecointei*	1						1			
Meliaceae	*Trichilia micrantha*	8				6					2
Meliaceae	*Trichilia pallida*	1				1					
Meliaceae	*Trichilia quadrijuga*	1				1					
Meliaceae	*Trichilia schomburgkii*	4				2					2
Meliaceae	*Trichilia septentrionalis*	6				5					1
Meliaceae	*Trichilia* sp.	2						1			1
Meliaceae	*Trichilia surinamensis*	2						1			1
Memecylaceae	*Mouriri acutiflora*	1				1					
Memecylaceae	*Mouriri collocarpa*	7				6		1			
Memecylaceae	*Mouriri duckeana*	1						1			
Memecylaceae	*Mouriri grandiflora*	1							1		
Memecylaceae	*Mouriri nigra*	1						1			
Memecylaceae	*Mouriri sagotiana*	1						1			
Memecylaceae	*Mouriri sideroxylon*	1						1			
Memecylaceae	*Mouriri vernicosa*	1						1			
Menispermaceae	*Abuta barbata*	1				1					
Menispermaceae	*Abuta candollei*	1				1					
Menispermaceae	*Abuta grandifolia*	1							1		

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Menispermaceae	*Abuta imene*	1									1
Menispermaceae	*Abuta rufescens*	1				1					
Menispermaceae	*Cissampelos andromorpha*	3				2					1
Menispermaceae	*Cissampelos fasciculata*	1									1
Menispermaceae	*Cissampelos pareira*	2				2					
Menispermaceae	*Cissampelos* sp.	1				1					
Menispermaceae	*Curarea candicans*	2									2
Menispermaceae	*Disciphania* sp.	1				1					
Menispermaceae	Indet.	1						1			
Menispermaceae	*Orthomene schomburgkii*	3				2			1		
Menispermaceae	*Sciadotenia cayennensis*	2									2
Metaxyaceae	*Metaxya rostrata*	7				2		1			4
Monimiaceae	*Mollinedia grazielae*	6				4					2
Moraceae	*Artocarpus altilis*	1						1			
Moraceae	*Bagassa guianensis*	2						1			1
Moraceae	*Brosimum acutifolium*	2				1					1
Moraceae	*Brosimum guianense*	5				3	1				1
Moraceae	*Brosimum parinarioides*	5				3	1				1
Moraceae	*Brosimum rubescens*	3				1		1			1
Moraceae	*Clarisia ilicifolia*	2				1	1				
Moraceae	*Ficus albert-smithii*	2				1		1			
Moraceae	*Ficus broadwayi*	2				1		1			
Moraceae	*Ficus donnell-smithii*	1				1					
Moraceae	*Ficus gomelleira*	2						2			
Moraceae	*Ficus guianensis*	1						1			
Moraceae	*Ficus insipida*	3				3					
Moraceae	*Ficus nymphaeifolia*	2						2			
Moraceae	*Ficus pakkensis*	1				1					
Moraceae	*Ficus* sp.	1						1			
Moraceae	*Ficus trigona*	1						1			
Moraceae	*Helicostylis pedunculata*	3					3				
Moraceae	*Helicostylis tomentosa*	4					4				
Moraceae	Indet.	1							1		
Moraceae	*Maquira guianensis*	8					3	1			4
Moraceae	*Naucleopsis guianensis*	4				3					1
Moraceae	*Perebea rubra*	3				3					
Moraceae	*Trymatococcus amazonicus*	2				1					1
Moraceae	*Trymatococcus oligandrus*	5				2		2			1
Myristicaceae	*Compsoneura ulei*	1									1
Myristicaceae	*Iryanthera sagotiana*	11				9		1			1
Myristicaceae	*Virola michelii*	8				6		1			1
Myristicaceae	*Virola sebifera*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Myristicaceae	*Virola surinamensis*	1	EN					1			
Myrsinaceae	*Cybianthus fulvopulverulentus*	2				1					1
Myrsinaceae	*Cybianthus guyanensis*	4									4
Myrsinaceae	*Cybianthus leprieurii*	1				1					
Myrsinaceae	*Cybianthus microbotrys*	12				4		2			6
Myrsinaceae	*Cybianthus prieurii*	2				1		1			
Myrsinaceae	*Cybianthus* sp.	4						1			3
Myrsinaceae	*Cybianthus surinamensis*	6				2					4
Myrsinaceae	Indet.	1									1
Myrsinaceae	*Myrsine guianensis*	2				1					1
Myrsinaceae	*Stylogyne* sp.	1				1					
Myrtaceae	*Calycolpus revolutus*	1				1					
Myrtaceae	*Calycorectes*	2									2
Myrtaceae	*Calycorectes bergii*	13				11					2
Myrtaceae	*Calycorectes grandifolius*	3				1	1				1
Myrtaceae	*Calyptranthes amshoffae*	11									11
Myrtaceae	*Calyptranthes* sp.	4				1		1			2
Myrtaceae	*Calyptranthes speciosa*	5				4					1
Myrtaceae	*Campomanesia aromatica*	4				2		1			1
Myrtaceae	*Eucalyptus torreliana*	1				1					
Myrtaceae	*Eugenia albicans*	8				4					4
Myrtaceae	*Eugenia anastomosans*	4						2			2
Myrtaceae	*Eugenia brownsbergii*	4				4					
Myrtaceae	*Eugenia chrysophyllum*	1									1
Myrtaceae	*Eugenia coffeifolia*	14				10			1		3
Myrtaceae	*Eugenia cowanii*	10				5		3			2
Myrtaceae	*Eugenia cucullata*	1									1
Myrtaceae	*Eugenia cupulata*	6				5					1
Myrtaceae	*Eugenia egensis*	3				3					
Myrtaceae	*Eugenia exaltata*	1									1
Myrtaceae	*Eugenia excelsa*	2						2			
Myrtaceae	*Eugenia feijoi*	2									2
Myrtaceae	*Eugenia florida*	2				1			1		
Myrtaceae	*Eugenia ligustrina*	3				3					
Myrtaceae	*Eugenia macrocalyx*	7				2		2			3
Myrtaceae	*Eugenia omissa*	3						1	1		1
Myrtaceae	*Eugenia patrisii*	5				5					
Myrtaceae	*Eugenia pseudopsidium*	2						1			1
Myrtaceae	*Eugenia ramiflora*	2				1					1
Myrtaceae	*Eugenia* sp.	9				4		3			2
Myrtaceae	*Eugenia tafelbergica*	5									5
Myrtaceae	*Eugenia tapacumensis*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Myrtaceae	*Eugenia tetramera*	2									2
Myrtaceae	Indet.	19				2		13			4
Myrtaceae	*Marlierea ferruginea*	3						3			
Myrtaceae	*Marlierea montana*	1				1					
Myrtaceae	*Myrcia albidotomentosa*	2									2
Myrtaceae	*Myrcia amazonica*	11				11					
Myrtaceae	*Myrcia bracteata*	2							1		1
Myrtaceae	*Myrcia coumeta*	3							2		1
Myrtaceae	*Myrcia decorticans*	5				2		3			
Myrtaceae	*Myrcia deflexa*	1			R						1
Myrtaceae	*Myrcia fallax*	3				2					1
Myrtaceae	*Myrcia guianensis*	2				1		1			
Myrtaceae	*Myrcia magnoliifolia*	5				4					1
Myrtaceae	*Myrcia paivae*	1									1
Myrtaceae	*Myrcia platyclada*	5				1		3			1
Myrtaceae	*Myrcia pyrifolia*	4									4
Myrtaceae	*Myrcia* sp.	1				1					
Myrtaceae	*Myrcia sylvatica*	2									2
Myrtaceae	*Myrcia tomentosa*	1				1					
Myrtaceae	*Myrcianthes prodigiosa*	1						1			
Myrtaceae	*Myrciaria floribunda*	2				1					1
Myrtaceae	*Plinia costata*	1						1			
Myrtaceae	*Psidium guineense*	2				1			1		
Nyctaginaceae	*Guapira eggersiana*	6				3					3
Nyctaginaceae	*Guapira salicifolia*	1				1					
Nyctaginaceae	*Guapira* sp.	1						1			
Nyctaginaceae	Indet.	1						1			
Nyctaginaceae	*Neea constricta*	2				1					1
Nyctaginaceae	*Neea floribunda*	6				4					2
Nyctaginaceae	*Neea ovalifolia*	4				1		3			
Nyctaginaceae	*Neea spruceana*	3						1			2
Ochnaceae	*Elvasia elvasioides*	2				1					1
Ochnaceae	Indet.	1							1		
Ochnaceae	*Ouratea gigantophylla*	1									1
Ochnaceae	*Ouratea guianensis*	3									3
Ochnaceae	*Ouratea leblondii*	1									1
Ochnaceae	*Ouratea pendula*	3									3
Ochnaceae	*Ouratea* sp.	6						6			
Ochnaceae	*Sauvagesia erecta*	2							1		1
Olacaceae	*Chaunochiton kappleri*	2				1					1
Olacaceae	*Heisteria cauliflora*	21				10	1	1	2		7
Olacaceae	*Heisteria densifrons*	3				2					1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Olacaceae	*Heisteria ovata*	3				2		1			
Olacaceae	*Heisteria scandens*	1									1
Olacaceae	*Heisteria* sp.	2						1			1
Olacaceae	Indet.	1						1			
Olacaceae	*Minquartia guianensis*	2	LR					1			1
Olacaceae	*Ptychopetalum olacoides*	1				1					
Olacaceae	*Ximenia americana*	1						1			
Oleandraceae	*Nephrolepis biserrata*	1				1					
Oleandraceae	*Nephrolepis exaltata*	1									1
Oleandraceae	*Nephrolepis rivularis*	1						1			
Oleandraceae	*Oleandra articulata*	1				1					
Onagraceae	*Ludwigia erecta*	1							1		
Onagraceae	*Ludwigia hyssopifolia*	2						2			
Onagraceae	*Ludwigia octovalvis*	1				1					
Opegraphaceae	*Chiodecton* sp.	1									1
Opiliaceae	*Agonandra silvatica*	1									1
Orchidaceae	*Aganisia pulchella*	2						1			1
Orchidaceae	*Aspidogyne foliosa*	1						1			
Orchidaceae	*Batemannia colleyi*	1				1					
Orchidaceae	*Beloglottis costaricensis*	1				1					
Orchidaceae	*Bollea violacea*	1						1			
Orchidaceae	*Caluera surinamensis*	1				1					
Orchidaceae	*Campylocentrum fasciola*	1						1			
Orchidaceae	*Campylocentrum micranthum*	1				1					
Orchidaceae	*Catasetum deltoideum*	1				1					
Orchidaceae	*Catasetum discolor*	1					1				
Orchidaceae	*Chaubardiella tigrina*	1				1					
Orchidaceae	*Cheiradenia cuspidata*	7				1					6
Orchidaceae	*Cheiradenia* sp.	5									5
Orchidaceae	*Cryptarrhena kegelii*	1				1					
Orchidaceae	*Cyclopogon elatus*	1				1					
Orchidaceae	*Dichaea hookeri*	1									1
Orchidaceae	*Dichaea muricata*	1				1					
Orchidaceae	*Dichaea* sp.	2									2
Orchidaceae	*Elleanthus caravata*	3				1					2
Orchidaceae	*Elleanthus cephalotus*	1				1					
Orchidaceae	*Elleanthus graminifolius*	3				1					2
Orchidaceae	*Elleanthus linifolius*	2				1		1			
Orchidaceae	*Elleanthus* sp.	4				2					2
Orchidaceae	*Encyclia calamara*	1				1					
Orchidaceae	*Encyclia diurna*	1				1					
Orchidaceae	*Encyclia granitica*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Orchidaceae	*Epidendrum anceps*	1				1					
Orchidaceae	*Epidendrum densiflorum*	1									1
Orchidaceae	*Epidendrum difforme*	2				1					1
Orchidaceae	*Epidendrum nocturnum*	4							1		3
Orchidaceae	*Epidendrum purpurascens*	3				1		1			1
Orchidaceae	*Epidendrum ramosum*	1				1					
Orchidaceae	*Epidendrum secundum*	2				2					
Orchidaceae	*Epidendrum* sp.	2									2
Orchidaceae	*Epidendrum unguiculatum*	1				1					
Orchidaceae	*Erycina pusilla*	2				2					
Orchidaceae	*Erycina* sp.	2						1			1
Orchidaceae	*Erythrodes* sp.	5				3		1			1
Orchidaceae	*Gongora histrionica*	1				1					
Orchidaceae	*Gongora* sp.	1									1
Orchidaceae	Indet.	10				2					8
Orchidaceae	*Jacquiniella globosa*	1						1			
Orchidaceae	*Kefersteinia lafontainei*	1				1					
Orchidaceae	*Kegeliella houtteana*	1				1					
Orchidaceae	*Koellensteinia hyacinthoides*	1									1
Orchidaceae	*Koellensteinia* sp.	6									6
Orchidaceae	*Lepanthes helicocephala*	2				2					
Orchidaceae	*Lepanthes ruscifolia*	1				1					
Orchidaceae	*Lepanthes* sp.	2				2					
Orchidaceae	*Liparis nervosa*	1									1
Orchidaceae	*Lockhartia imbricata*	2				1					1
Orchidaceae	*Lyroglossa grisebachii*	1				1					
Orchidaceae	*Macradenia lutescens*	1				1					
Orchidaceae	*Masdevallia cuprea*	1				1					
Orchidaceae	*Masdevallia infracta*	1									1
Orchidaceae	*Masdevallia norae*	1				1					
Orchidaceae	*Masdevallia* sp.	1						1			
Orchidaceae	*Maxillaria alba*	1									1
Orchidaceae	*Maxillaria camaridii*	3				1			1		1
Orchidaceae	*Maxillaria desvauxiana*	1				1					
Orchidaceae	*Maxillaria discolor*	2				1					1
Orchidaceae	*Maxillaria jenischiana*	1				1					
Orchidaceae	*Maxillaria porrecta*	1				1					
Orchidaceae	*Maxillaria reichenheimiana*	1				1					
Orchidaceae	*Maxillaria rufescens*	1				1					
Orchidaceae	*Maxillaria* sp.	9						2			7
Orchidaceae	*Maxillaria splendens*	1				1					
Orchidaceae	*Maxillaria stenophylla*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Orchidaceae	*Maxillaria superflua*	2									2
Orchidaceae	*Maxillaria uncata*	1				1					
Orchidaceae	*Notylia sagittifera*	1				1					
Orchidaceae	*Notylia* sp.	1				1					
Orchidaceae	*Octomeria brevifolia*	1				1					
Orchidaceae	*Octomeria grandiflora*	1				1					
Orchidaceae	*Octomeria scirpoidea*	1						1			
Orchidaceae	*Octomeria* sp.	3									3
Orchidaceae	*Oncidium baueri*	1				1					
Orchidaceae	*Ornithocephalus*	1						1			
Orchidaceae	*Ornithocephalus gladiatus*	1				1					
Orchidaceae	*Paphinia cristata*	1				1					
Orchidaceae	*Pelexia callifera*	2				1		1			
Orchidaceae	*Peristeria pendula*	1									1
Orchidaceae	*Platystele ovalifolia*	2				2					
Orchidaceae	*Platystele stenostachya*	1									1
Orchidaceae	*Pleurothallis aristata*	2				1		1			
Orchidaceae	*Pleurothallis barbulata*	1				1					
Orchidaceae	*Pleurothallis ciliolata*	1				1					
Orchidaceae	*Pleurothallis consimilis*	1				1					
Orchidaceae	*Pleurothallis discoidea*	3				1		1			1
Orchidaceae	*Pleurothallis grobyi*	2									2
Orchidaceae	*Pleurothallis polygonoides*	1				1					
Orchidaceae	*Pleurothallis pruinosa*	1				1					
Orchidaceae	*Pleurothallis ruscifolia*	3				1					2
Orchidaceae	*Pleurothallis semperflorens*	2									2
Orchidaceae	*Pleurothallis seriata*	1				1					
Orchidaceae	*Pleurothallis* sp.	14				2		5			7
Orchidaceae	*Pleurothallis spiculifera*	1									1
Orchidaceae	*Pleurothallis suspensa*	1				1					
Orchidaceae	*Pleurothallis uniflora*	1				1					
Orchidaceae	*Pleurothallis yauaperyensis*	1				1					
Orchidaceae	*Polystachya* sp.	1						1			
Orchidaceae	*Prosthechea aemula*	1				1					
Orchidaceae	*Prosthechea aemula*	1							1		
Orchidaceae	*Prosthechea pygmaea*	1				1					
Orchidaceae	*Quekettia papillosa*	1									1
Orchidaceae	*Quekettia* sp.	2				2					
Orchidaceae	*Quekettia vermeuleniana*	1				1					
Orchidaceae	*Reichenbachanthus reflexus*	1						1			
Orchidaceae	*Rodriguezia flavida*	1									1
Orchidaceae	*Rodriguezia lanceolata*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Orchidaceae	*Scaphyglottis dunstervillei*	1				1					
Orchidaceae	*Scaphyglottis lindeniana*	1				1					
Orchidaceae	*Scaphyglottis modesta*	1				1					
Orchidaceae	*Scaphyglottis prolifera*	1				1					
Orchidaceae	*Scaphyglottis* sp.	1						1			
Orchidaceae	*Scaphyglottis violacea*	1				1					
Orchidaceae	*Sobralia crocea*	1									1
Orchidaceae	*Sobralia macrophylla*	1				1					
Orchidaceae	*Sobralia suaveolens*	1				1					
Orchidaceae	*Stelis aprica*	1				1					
Orchidaceae	*Stelis argentata*	1						1			
Orchidaceae	*Stelis* sp.	3				2					1
Orchidaceae	*Trichocentrum fuscum*	1									1
Orchidaceae	*Trichosalpinx dura*	2				2					
Orchidaceae	*Trichosalpinx foliata*	1				1					
Orchidaceae	*Trichosalpinx memor*	2				1		1			
Orchidaceae	*Trichosalpinx orbicularis*	2				1		1			
Orchidaceae	*Trigonidium acuminatum*	2				2					
Orchidaceae	*Trisetella triglochin*	1				1					
Orchidaceae	*Vanilla* sp.	2						1	1		
Orchidaceae	*Xylobium foveatum*	1				1					
Oxalidaceae	*Ruptiliocarpon caracolita*	2									2
Parmeliaceae	*Parmotrema latissima*	1									1
Passifloraceae	*Passiflora cirrhiflora*	2									2
Passifloraceae	*Passiflora coccinea*	7				2		4			1
Passifloraceae	*Passiflora fuchsiiflora*	2									2
Passifloraceae	*Passiflora garckei*	4				1		3			
Passifloraceae	*Passiflora glandulosa*	8				3		3			2
Passifloraceae	*Passiflora laurifolia*	3				1					2
Passifloraceae	*Passiflora* sp.	8				2		1			5
Passifloraceae	*Passiflora vespertilio*	5				3		1	1		
Phyllanthaceae	*Phyllanthus hyssopifolioides*	1				1					
Phyllanthaceae	*Phyllanthus* sp.	1							1		
Phyllanthaceae	*Phyllanthus stipulatus*	1						1			
Phyllanthaceae	*Phyllanthus urinaria*	1				1					
Phytolaccaceae	*Phytolacca rivinoides*	4				1	1	1			1
Picramniaceae	*Picramnia guianensis*	5				3		1			1
Picramniaceae	*Picramnia latifolia*	2				2					
Picramniaceae	*Picramnia* sp.	2						2			
Piperaceae	*Peperomia alata*	8						5		1	2
Piperaceae	*Peperomia glabella*	3				2					1
Piperaceae	*Peperomia haematolepis*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Piperaceae	*Peperomia macrostachya*	4				1		3			
Piperaceae	*Peperomia maguirei*	12				3		8			1
Piperaceae	*Peperomia obtusifolia*	1				1					
Piperaceae	*Peperomia ouabianae*	3				1		1			1
Piperaceae	*Peperomia pellucida*	1							1		
Piperaceae	*Peperomia rotundifolia*	5				1					4
Piperaceae	*Peperomia serpens*	4				3					1
Piperaceae	*Peperomia* sp.	15				1		14			
Piperaceae	*Peperomia tenella*	1									1
Piperaceae	*Piper adenandrum*	2						1			1
Piperaceae	*Piper aequale*	8				6					2
Piperaceae	*Piper anonifolium*	3				1					2
Piperaceae	*Piper arboreum*	13				11		1			1
Piperaceae	*Piper avellanum*	2				1					1
Piperaceae	*Piper bartlingianum*	5				3					2
Piperaceae	*Piper brownsbergense*	5				2		1			2
Piperaceae	*Piper consanguineum*	4				2		1			1
Piperaceae	*Piper cyrtopodon*	1							1		
Piperaceae	*Piper demeraranum*	1				1					
Piperaceae	*Piper dilatatum*	1				1					
Piperaceae	*Piper divaricatum*	1									1
Piperaceae	*Piper foveolatum*	1									1
Piperaceae	*Piper fuligineum*	1				1					
Piperaceae	*Piper hispidum*	9				9					
Piperaceae	*Piper hostmannianum*	4				1		3			
Piperaceae	*Piper humistratum*	1				1					
Piperaceae	*Piper nematanthera*	3				2					1
Piperaceae	*Piper obliquum*	1				1					
Piperaceae	*Piper paramaribense*	1				1					
Piperaceae	*Piper reticulatum*	1				1					
Piperaceae	*Piper* sp.	12						12			
Piperaceae	*Piper trichoneuron*	2									2
Piperaceae	*Piper wachenheimii*	1				1					
Plantaginaceae	*Achetaria ocimoides*	3				2	1				
Plantaginaceae	*Lindernia crustacea*	3						3			
Poaceae	*Andropogon leucostachyus*	1					1				
Poaceae	*Aristida torta*	1					1				
Poaceae	*Dichanthelium pycnoclados*	1						1			
Poaceae	*Echinolaena inflexa*	2					2				
Poaceae	*Eleusine indica*	1						1			
Poaceae	*Homolepis aturensis*	1									1
Poaceae	*Ichnanthus leiocarpus*	1						1			

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Poaceae	*Ichnanthus nemoralis*	8				2		5			1
Poaceae	*Ichnanthus pallens*	14				5		4	1		4
Poaceae	*Ichnanthus panicoides*	5				3		1	1		
Poaceae	*Ichnanthus tenuis*	1				1					
Poaceae	Indet.	7						7			
Poaceae	*Lasiacis ligulata*	3				2			1		
Poaceae	*Lasiacis sorghoidea*	2						2			
Poaceae	*Olyra ecaudata*	1					1				
Poaceae	*Olyra latifolia*	3				3					
Poaceae	*Olyra obliquifolia*	14				5		2			7
Poaceae	*Olyra* sp.	2						2			
Poaceae	*Oplismenus hirtellus*	1				1					
Poaceae	*Orthoclada laxa*	3				2			1		
Poaceae	*Panicum micranthum*	1					1				
Poaceae	*Panicum nervosum*	2					2				
Poaceae	*Panicum pilosum*	5				1		2			2
Poaceae	*Panicum* sp.	1						1			
Poaceae	*Panicum stoloniferum*	4					1				3
Poaceae	*Pariana campestris*	2							2		
Poaceae	*Parodiolyra micrantha*	11				9					2
Poaceae	*Paspalum conjugatum*	2						2			
Poaceae	*Paspalum decumbens*	1				1					
Poaceae	*Paspalum multicaule*	1				1					
Poaceae	*Pharus lappulaceus*	1				1					
Poaceae	*Pharus latifolius*	1				1					
Poaceae	*Pharus parvifolius*	2				2					
Poaceae	*Piresia goeldii*	2						2			
Poaceae	*Streptogyna americana*	1				1					
Podostemaceae	*Apinagia flexuosa*	1							1		
Podostemaceae	*Apinagia longifolia*	1							1		
Polygalaceae	*Barnhartia floribunda*	2				2					
Polygalaceae	*Moutabea guianensis*	2				1		1			
Polygalaceae	*Moutabea* sp.	3						3			
Polygalaceae	*Polygala adenophora*	1					1				
Polygalaceae	*Polygala echinosperma*	4				1					3
Polygalaceae	*Polygala galioides*	1					1				
Polygalaceae	*Polygala longicaulis*	3					3				
Polygalaceae	*Polygala membranacea*	4							1		3
Polygalaceae	*Polygala* sp.	1									1
Polygalaceae	*Polygala trichosperma*	2					2				
Polygalaceae	*Polygala variabilis*	1				1					
Polygalaceae	*Polygala violacea*	1					1				

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Polygalaceae	*Securidaca diversifolia*	1				1					
Polygalaceae	*Securidaca pubescens*	2				2					
Polygalaceae	*Securidaca uniflora*	1				1					
Polygonaceae	*Coccoloba ascendens*	8				7		1			
Polygonaceae	*Coccoloba conduplicata*	1						1			
Polygonaceae	*Coccoloba excelsa*	2				1		1			
Polygonaceae	*Coccoloba gymnorrhachis*	4				3					1
Polygonaceae	*Coccoloba lucidula*	1						1			
Polygonaceae	*Coccoloba marginata*	3				2	1				
Polygonaceae	*Coccoloba parimensis*	1				1					
Polygonaceae	*Coccoloba* sp.	2						2			
Polygonaceae	*Ruprechtia brachysepala*	3							3		
Polypodiaceae	*Campyloneurum phyllitidis*	4				1		2			1
Polypodiaceae	*Dicranoglossum desvauxii*	5						1	1		3
Polypodiaceae	*Microgramma fuscopunctata*	3				1					2
Polypodiaceae	*Microgramma lycopodioides*	5				1		2			2
Polypodiaceae	*Microgramma reptans*	1						1			
Polypodiaceae	*Microgramma tecta*	1									1
Polypodiaceae	*Pecluma pectinata*	1						1			
Polypodiaceae	*Pleopeltis percussa*	1						1			
Polypodiaceae	*Polypodium dissimile*	1				1					
Polypodiaceae	*Polypodium dulce*	1				1					
Polypodiaceae	*Polypodium polypodioides*	2				1		1			
Polypodiaceae	*Polypodium triseriale*	1									1
Polyporaceae	*Earliella scabrosa*	1									1
Polyporaceae	*Microporellus obovatus*	1									1
Proteaceae	*Euplassa pinnata*	2									2
Proteaceae	*Panopsis rubescens*	2						1			1
Proteaceae	*Roupala montana*	3				1	1	1			
Pteridaceae	Indet.	3				3					
Pteridaceae	*Pteris biaurita*	1				1					
Putranjivaceae	*Drypetes variabilis*	3				2					1
Quiinaceae	*Lacunaria crenata*	11				6		4			1
Quiinaceae	*Lacunaria jenmanii*	2				2					
Quiinaceae	*Quiina cruegeriana*	1									1
Quiinaceae	*Quiina integrifolia*	2				1					1
Quiinaceae	*Quiina obovata*	1									1
Quiinaceae	*Quiina parvifolia*	1				1					
Quiinaceae	*Quiina wurdackii*	1						1			
Quiinaceae	*Touroulia guianensis*	1							1		
Rapateaceae	*Saxofridericia aculeata*	4									4
Rapateaceae	*Spathanthus unilateralis*	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Rhabdodendraceae	*Rhabdodendron amazonicum*	4						4			
Rhamnaceae	*Ampelozizyphus amazonicus*	1						1			
Rhamnaceae	*Gouania blanchetiana*	7				4	1		1		1
Rhizophoraceae	*Cassipourea guianensis*	7				1		1			5
Rosaceae	*Prunus myrtifolia*	4				3		1			
Rubiaceae	*Amaioua corymbosa*	1									1
Rubiaceae	*Amaioua guianensis*	13				9		1			3
Rubiaceae	*Bertiera guianensis*	2									2
Rubiaceae	*Borreria assurgens*	1				1					
Rubiaceae	*Borreria capitata*	3				2		1			
Rubiaceae	*Borreria latifolia*	4				2	1				1
Rubiaceae	*Borreria prostrata*	2						2			
Rubiaceae	*Capirona decorticans*	4				4					
Rubiaceae	*Chimarrhis turbinata*	2				1					1
Rubiaceae	*Cordiera myrciifolia*	4				2	2				
Rubiaceae	*Cosmibuena grandiflora*	2						2			
Rubiaceae	*Coussarea micrococca*	4				4					
Rubiaceae	*Coussarea paniculata*	5				5					
Rubiaceae	*Coussarea racemosa*	17				15	1	1			
Rubiaceae	*Coussarea* sp.	3				3					
Rubiaceae	*Coussarea surinamensis*	1				1					
Rubiaceae	*Diodia ocymifolia*	1							1		
Rubiaceae	*Diodia ocymifolia*	1				1					
Rubiaceae	*Diodia* sp.	2						2			
Rubiaceae	*Diodia spicata*	1									1
Rubiaceae	*Duroia aquatica*	6				6					
Rubiaceae	*Duroia eriopila*	1									1
Rubiaceae	*Duroia longiflora*	1									1
Rubiaceae	*Duroia longiflora*	2				2					
Rubiaceae	*Duroia micrantha*	1				1					
Rubiaceae	*Duroia* sp.	1						1			
Rubiaceae	*Emmeorhiza umbellata*	1						1			
Rubiaceae	*Faramea guianensis*	7						4			3
Rubiaceae	*Faramea irwinii*	2				2					
Rubiaceae	*Faramea multiflora*	6				5			1		
Rubiaceae	*Faramea paniculata*	1									1
Rubiaceae	*Faramea quadricostata*	5						3			2
Rubiaceae	*Faramea sessiliflora*	2						2			
Rubiaceae	*Faramea sessilifolia*	1									1
Rubiaceae	*Faramea* sp.	4						2			2
Rubiaceae	*Ferdinandusa goudotiana*	1									1
Rubiaceae	*Ferdinandusa paraensis*	12				9		1			2

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Rubiaceae	*Ferdinandusa rudgeoides*	1				1					
Rubiaceae	*Geophila cordifolia*	6				1		4			1
Rubiaceae	*Geophila tenuis*	1									1
Rubiaceae	*Gonzalagunia dicocca*	9				9					
Rubiaceae	*Guettarda argentea*	1				1					
Rubiaceae	*Hillia illustris*	1				1					
Rubiaceae	*Ibetralia surinamensis*	5									5
Rubiaceae	Indet.	15						14			1
Rubiaceae	*Isertia coccinea*	6						1	1		4
Rubiaceae	*Isertia parviflora*	1					1				
Rubiaceae	*Isertia spiciformis*	1					1				
Rubiaceae	*Ixora aluminicola*	8									8
Rubiaceae	*Ixora graciliflora*	8				6					2
Rubiaceae	*Ixora piresii*	3									3
Rubiaceae	*Malanea macrophylla*	2				2					
Rubiaceae	*Manettia alba*	1						1			
Rubiaceae	*Morinda surinamensis*	1					1				
Rubiaceae	*Notopleura uliginosa*	1				1					
Rubiaceae	*Pagamea guianensis*	6				3	3				
Rubiaceae	*Palicourea calophylla*	1					1				
Rubiaceae	*Palicourea crocea*	4				3					1
Rubiaceae	*Palicourea guianensis*	17				11	1	2			3
Rubiaceae	*Palicourea longiflora*	10					1	3	1		5
Rubiaceae	*Palicourea riparia*	1									1
Rubiaceae	*Palicourea* sp.	7				1		5			1
Rubiaceae	*Perama hirsuta*	2				1	1				
Rubiaceae	*Posoqueria latifolia*	8				4					4
Rubiaceae	*Posoqueria* sp.	1						1			
Rubiaceae	*Psychotria acuminata*	1				1					
Rubiaceae	*Psychotria anceps*	1									1
Rubiaceae	*Psychotria apoda*	3				2					1
Rubiaceae	*Psychotria bahiensis*	1									1
Rubiaceae	*Psychotria barbiflora*	1				1					
Rubiaceae	*Psychotria callithrix*	3				1		1			1
Rubiaceae	*Psychotria capitata*	2				1					1
Rubiaceae	*Psychotria cardiomorpha*	1					1				
Rubiaceae	*Psychotria carthagenensis*	1						1			
Rubiaceae	*Psychotria colorata*	2						1			1
Rubiaceae	*Psychotria ctenophora*	1					1				
Rubiaceae	*Psychotria cupularis*	9						1			8
Rubiaceae	*Psychotria deflexa*	3				2		1			
Rubiaceae	*Psychotria erecta*	3				1					2

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Rubiaceae	*Psychotria gracilenta*	1									1
Rubiaceae	*Psychotria hoffmannseggiana*	3				1		1			1
Rubiaceae	*Psychotria humboldtiana*	1						1			
Rubiaceae	*Psychotria iodotricha*	6				3		2			1
Rubiaceae	*Psychotria kapplerii*	1				1					
Rubiaceae	*Psychotria ligularis*	1						1			
Rubiaceae	*Psychotria mapourioides*	9				3					6
Rubiaceae	*Psychotria moroidea*	9				3		3			3
Rubiaceae	*Psychotria muscosa*	5				5					
Rubiaceae	*Psychotria officinalis*	3					1	2			
Rubiaceae	*Psychotria paniculata*	1							1		
Rubiaceae	*Psychotria poeppigiana*	2				1	1				
Rubiaceae	*Psychotria racemosa*	2				2					
Rubiaceae	*Psychotria* sp.	22						14	1		7
Rubiaceae	*Psychotria subundulata*	1						1			
Rubiaceae	*Psychotria trichophoroides*	2				2					
Rubiaceae	*Psychotria uliginosa*	1									1
Rubiaceae	*Psychotria ulviformis*	2						1			1
Rubiaceae	*Psychotria variegata*	2									2
Rubiaceae	*Randia armata*	5				1		2			2
Rubiaceae	*Randia* sp.	1				1					
Rubiaceae	*Retiniphyllum schomburgkii*	2				1	1				
Rubiaceae	*Ronabea latifolia*	11				10	1				
Rubiaceae	*Rudgea klugii*	4						4			
Rubiaceae	*Rudgea* sp.	2									2
Rubiaceae	*Sabicea aspera*	6				1		1			4
Rubiaceae	*Sabicea* sp.	1						1			
Rubiaceae	*Sabicea velutina*	1							1		
Rubiaceae	*Sipanea biflora*	1				1					
Rubiaceae	*Sipanea pratensis*	4				2	2				
Rubiaceae	*Sipanea stahelii*	1				1					
Rubiaceae	*Spermacoce ocymifolia*	1									1
Rutaceae	*Conchocarpus longifolius*	4						4			
Rutaceae	*Esenbeckia grandiflora*	2				1		1			
Rutaceae	*Esenbeckia pilocarpoides*	3									3
Rutaceae	*Monnieria trifolia*	1									1
Rutaceae	*Pilocarpus microphyllus*	1						1			
Rutaceae	*Ticorea foetida*	9				8		1			
Rutaceae	*Zanthoxylum acuminatum*	2				2					
Rutaceae	*Zanthoxylum ekmanii*	3				3					
Rutaceae	*Zanthoxylum pentandrum*	1				1					
Rutaceae	*Zanthoxylum* sp.	1									1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Salicaceae	*Banara guianensis*	4				1			1		2
Salicaceae	*Casearia acuminata*	4						4			
Salicaceae	*Casearia arborea*	4				2		2			
Salicaceae	*Casearia combaymensis*	4				1		1			2
Salicaceae	*Casearia commersoniana*	7						4			3
Salicaceae	*Casearia grandiflora*	2				1					1
Salicaceae	*Casearia guianensis*	1				1					
Salicaceae	*Casearia javitensis*	7				7					
Salicaceae	*Casearia negrensis*	7				2		2			3
Salicaceae	*Casearia pitumba*	9				2		1	1		5
Salicaceae	*Casearia rusbyana*	1									1
Salicaceae	*Casearia singularis*	3				1					2
Salicaceae	*Casearia* sp.	2						2			
Salicaceae	*Casearia sylvestris*	5				1	1	3			
Salicaceae	*Casearia ulmifolia*	1				1					
Salicaceae	*Casearia zizyphoides*	1									1
Salicaceae	*Homalium guianense*	1							1		
Salicaceae	*Homalium racemosum*	2							2		
Salicaceae	*Laetia procera*	1				1					
Salicaceae	*Neoptychocarpus apodanthus*	2									2
Salicaceae	*Ryania speciosa*	3									3
Santalaceae	*Phoradendron crassifolium*	3				2					1
Santalaceae	*Phoradendron perrottetii*	1				1					
Santalaceae	*Phoradendron piperoides*	4				2					2
Santalaceae	*Phoradendron pulleanum*	2			E	1		1			
Santalaceae	*Phoradendron* sp.	1						1			
Santalaceae	*Phoradendron undulatum*	1									1
Sapindaceae	*Allophylus punctatus*	3									3
Sapindaceae	*Allophylus* sp.	1									1
Sapindaceae	*Cupania americana*	2							1		1
Sapindaceae	*Cupania diphylla*	1									1
Sapindaceae	*Cupania hirsuta*	2				1					1
Sapindaceae	*Cupania scrobiculata*	5				4					1
Sapindaceae	Indet.	8				1		3			4
Sapindaceae	*Matayba arborescens*	6				2		2	1		1
Sapindaceae	*Melicoccus pedicellaris*	3				2	1				
Sapindaceae	*Melicoccus* sp.	2									2
Sapindaceae	*Paullinia latifolia*	2				2					
Sapindaceae	*Paullinia rufescens*	1				1					
Sapindaceae	*Paullinia* sp.	3				3					
Sapindaceae	*Paullinia venosa*	1							1		
Sapindaceae	*Serjania oblongifolia*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Sapindaceae	*Serjania paucidentata*	6				5					1
Sapindaceae	*Serjania* sp.	3				1					2
Sapindaceae	*Talisia eximia*	2				2					
Sapindaceae	*Talisia furfuracea*	1				1					
Sapindaceae	*Talisia guianensis*	1									1
Sapindaceae	*Talisia hemidasya*	4				4					
Sapindaceae	*Talisia longifolia*	1				1					
Sapindaceae	*Talisia microphylla*	2				2					
Sapindaceae	*Talisia praealta*	6				2					4
Sapindaceae	*Talisia* sp.	5				4					1
Sapindaceae	*Talisia sylvatica*	2						2			
Sapindaceae	*Toulicia pulvinata*	1				1					
Sapindaceae	*Toulicia* sp.	1									1
Sapindaceae	*Urvillea ulmacea*	2				1			1		
Sapindaceae	*Vouarana guianensis*	5				4		1			
Sapotaceae	*Chrysophyllum argenteum*	4				1					3
Sapotaceae	*Chrysophyllum cuneifolium*	4				4					
Sapotaceae	*Chrysophyllum pomiferum*	5						1			4
Sapotaceae	*Chrysophyllum* sp.	1									1
Sapotaceae	*Diploön cuspidatum*	1									1
Sapotaceae	*Ecclinusa guianensis*	6				4		1			1
Sapotaceae	*Ecclinusa lanceolata*	1									1
Sapotaceae	*Ecclinusa psilophylla*	1						1			
Sapotaceae	*Ecclinusa ramiflora*	1									1
Sapotaceae	Indet.	5						2	1		2
Sapotaceae	*Manilkara bidentata*	3		PR		3					
Sapotaceae	*Micropholis egensis*	3				1					2
Sapotaceae	*Micropholis guyanensis*	5				4					1
Sapotaceae	*Micropholis longipedicellata*	3									3
Sapotaceae	*Micropholis mensalis*	5				1		1			3
Sapotaceae	*Micropholis venulosa*	9				4			1		4
Sapotaceae	*Pouteria bangii*	15				9		2			4
Sapotaceae	*Pouteria cladantha*	2						2			
Sapotaceae	*Pouteria coriacea*	3									3
Sapotaceae	*Pouteria cuspidata*	4				4					
Sapotaceae	*Pouteria egregia*	4				3		1			
Sapotaceae	*Pouteria engleri*	1									1
Sapotaceae	*Pouteria filipes*	3				3					
Sapotaceae	*Pouteria gonggrijpii*	4						1			3
Sapotaceae	*Pouteria grandis*	1				1					
Sapotaceae	*Pouteria guianensis*	3				2					1
Sapotaceae	*Pouteria jariensis*	1				1					

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Sapotaceae	*Pouteria melanopoda*	3				1					2
Sapotaceae	*Pouteria reticulata*	2				1		1			
Sapotaceae	*Pouteria retinervis*	1				1					
Sapotaceae	*Pouteria rodriguesiana*	1	LR					1			
Sapotaceae	*Pouteria sagotiana*	4							1		3
Sapotaceae	*Pouteria* sp.	8				2		1			5
Sapotaceae	*Pouteria speciosa*	1						1			
Sapotaceae	*Pouteria trigonosperma*	2				1			1		
Sapotaceae	*Pouteria venosa*	2						2			
Sapotaceae	*Pradosia ptychandra*	2				2					
Sapotaceae	*Pradosia surinamensis*	2				2					
Sapotaceae	*Sarcaulus brasiliensis*	1				1					
Schizaeaceae	*Lygodium volubile*	1							1		
Selaginellaceae	*Selaginella conduplicata*	1									1
Selaginellaceae	*Selaginella dendricola*	1									1
Selaginellaceae	*Selaginella flagellata*	2									2
Selaginellaceae	*Selaginella parkeri*	3									3
Selaginellaceae	*Selaginella producta*	2									2
Selaginellaceae	*Selaginella radiata*	1							1		
Sematophyllaceae	*Acroporium pungens*	1									1
Sematophyllaceae	Indet.	1									1
Sematophyllaceae	*Taxithelium concavum*	1									1
Sematophyllaceae	*Trichosteleum papillosum*	1									1
Simaroubaceae	*Quassia amara*	1				1					
Simaroubaceae	*Simaba guianensis*	9				4		2			3
Simaroubaceae	*Simaba multiflora*	2							2		
Simaroubaceae	*Simarouba amara*	5				4		1			
Siparunaceae	*Siparuna cuspidata*	1				1					
Siparunaceae	*Siparuna decipiens*	17				15		2			
Siparunaceae	*Siparuna guianensis*	12				8			1		3
Siparunaceae	*Siparuna poeppigii*	1									1
Siparunaceae	*Siparuna* sp.	2						2			
Smilacaceae	*Smilax megalophylla*	2				1		1			
Smilacaceae	*Smilax schomburgkiana*	3				3					
Smilacaceae	*Smilax* sp.	1						1			
Smilacaceae	*Smilax syphilitica*	7				5		2			
Solanaceae	*Brunfelsia guianensis*	16				7		3	1		5
Solanaceae	*Cyphomandra hartwegii*	2				2					
Solanaceae	*Cyphomandra oblongifolia*	1						1			
Solanaceae	*Cyphomandra tegore*	3						3			
Solanaceae	*Lycianthes pauciflora*	10				6		1			3
Solanaceae	*Markea coccinea*	4				1		2			1

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Solanaceae	*Markea longiflora*	3				3					
Solanaceae	*Markea sessiliflora*	1									1
Solanaceae	*Markea* sp.	1						1			
Solanaceae	*Physalis angulata*	1							1		
Solanaceae	*Schwenckia grandiflora*	1							1		
Solanaceae	*Solanum anceps*	6				6					
Solanaceae	*Solanum asperum*	2									2
Solanaceae	*Solanum coriaceum*	4				2		2			
Solanaceae	*Solanum costatum*	3									3
Solanaceae	*Solanum crinitum*	2						2			
Solanaceae	*Solanum lanceifolium*	1							1		
Solanaceae	*Solanum leucocarpon*	10				6			1		3
Solanaceae	*Solanum morii*	1									1
Solanaceae	*Solanum paludosum*	2				1		1			
Solanaceae	*Solanum pensile*	2						1			1
Solanaceae	*Solanum rubiginosum*	2						2			
Solanaceae	*Solanum rugosum*	3				1	1				1
Solanaceae	*Solanum schlechtendalianum*	7				2		4			1
Solanaceae	*Solanum* sp.	6				1		4			1
Solanaceae	*Solanum stramoniifolium*	2					1				1
Solanaceae	*Solanum subinerme*	4				3			1		
Solanaceae	*Solanum velutinum*	2				1					1
Stemonuraceae	*Discophora guianensis*	1									1
Stereophyllaceae	*Pilosium chlorophyllum*	1									1
Styracaceae	*Styrax fanshawei*	1				1					
Symplocaceae	*Symplocos guianensis*	1					1				
Tectariaceae	*Tectaria incisa*	1				1					
Tectariaceae	*Tectaria plantaginea*	3				2					1
Tectariaceae	*Tectaria trifoliata*	2				2					
Tectariaceae	*Triplophyllum dicksonioides*	1				1					
Tectariaceae	*Triplophyllum funestum*	5				1		3	1		
Theaceae	*Gordonia fruticosa*	1				1					
Thelypteridaceae	*Thelypteris abrupta*	1				1					
Thelypteridaceae	*Thelypteris glandulosa*	2				1		1			
Thelypteridaceae	*Thelypteris hispidula*	2				1		1			
Thelypteridaceae	*Thelypteris holodictya*	2				1		1			
Thelypteridaceae	*Thelypteris leprieurii*	1				1					
Thelypteridaceae	*Thelypteris pennata*	1				1					
Thelypteridaceae	*Thelypteris* sp.	1				1					
Theophrastaceae	*Clavija lancifolia*	4				4					
Thurniaceae	*Thurnia sphaerocephala*	3									3
Thymelaeaceae	*Daphnopsis granvillei*	2									2

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Trigoniaceae	*Trigonia laevis*	7				5		1			1
Trigoniaceae	*Trigonia villosa*	1						1			
Triuridaceae	*Sciaphila albescens*	11				6					5
Triuridaceae	*Sciaphila* sp.	3				1					2
Triuridaceae	*Soridium spruceanum*	5				1	1				3
Turneraceae	*Turnera glaziovii*	3						1			2
Turneraceae	*Turnera rupestris*	2				2					
Urticaceae	*Laportea aestuans*	1				1					
Urticaceae	*Pilea imparifolia*	2				2					
Urticaceae	*Pilea pubescens*	1				1					
Urticaceae	*Urera caracasana*	1				1					
Verbenaceae	*Aegiphila membranacea*	3						2	1		
Verbenaceae	*Aegiphila racemosa*	1									1
Verbenaceae	*Amasonia campestris*	2					2				
Verbenaceae	*Citharexylum macrophyllum*	1				1					
Verbenaceae	*Citharexylum* sp.	1									1
Verbenaceae	*Lantana camara*	1				1					
Verbenaceae	*Petrea bracteata*	4				2	2				
Verbenaceae	*Petrea volubilis*	1				1					
Verbenaceae	*Stachytarpheta cayennensis*	1				1					
Verbenaceae	*Vitex compressa*	3				2					1
Verbenaceae	*Vitex stahelii*	3				3					
Verbenaceae	*Vitex triflora*	5				1		4			
Violaceae	*Amphirrhox longifolia*	8				8					
Violaceae	*Amphirrhox surinamensis*	2				2					
Violaceae	*Corynostylis arborea*	2							1		1
Violaceae	Indet.	1							1		
Violaceae	*Noisettia orchidiflora*	2									2
Violaceae	*Paypayrola guianensis*	3				2					1
Violaceae	*Paypayrola hulkiana*	1						1			
Violaceae	*Paypayrola longifolia*	1				1					
Violaceae	*Rinorea amapensis*	1									1
Violaceae	*Rinorea brevipes*	1						1			
Violaceae	*Rinorea falcata*	1				1					
Violaceae	*Rinorea flavescens*	1									1
Violaceae	*Rinorea pubiflora*	3				2		1			
Violaceae	*Rinorea riana*	27				8		10			9
Violaceae	*Rinorea* sp.	1									1
Vitaceae	*Cissus* sp.	2				2					
Vitaceae	*Cissus verticillata*	2				1			1		
Vittariaceae	*Antrophyum guayanense*	1				1					
Vittariaceae	*Hecistopteris pumila*	3				1			2		

Family	Species	Sum	IUCN	Prot	End	BB	BW	Le	Ma	Mo	Na
Vittariaceae	*Vittaria lineata*	1						1			
Vochysiaceae	*Erisma uncinatum*	1				1					
Vochysiaceae	*Qualea coerulea*	4				4					
Vochysiaceae	*Qualea dinizii*	3				1		2			
Vochysiaceae	*Qualea rosea*	10				7					3
Vochysiaceae	*Ruizterania albiflora*	3				1					2
Vochysiaceae	*Vochysia costata*	4				4					
Vochysiaceae	*Vochysia densiflora*	1									1
Vochysiaceae	*Vochysia guianensis*	1						1			
Vochysiaceae	*Vochysia surinamensis*	6				5					1
Woodsiaceae	*Diplazium cristatum*	1				1					
Woodsiaceae	*Hemidictyum marginatum*	1				1					
Xylariaceae	*Kretzschmaria deusta*	1									1
Xyridaceae	*Xyris jupicai*	1									1
Zingiberaceae	*Renealmia floribunda*	1						1			
Zingiberaceae	*Renealmia guianensis*	5				1		2			2
Zingiberaceae	*Renealmia monosperma*	1									1
Zingiberaceae	*Renealmia orinocensis*	2									2
Grand Total		**5730**				**2572**	**192**	**1097**	**176**	**2**	**1691**

Appendix 4

Preliminary checklist of the orchids (Orchidaceae) of the Brownsberg, Nassau, and Lely ranges in Suriname.

Iwan E. Molgo and Bart P.E. De Dijn

The recorded occurrence of species at each range is indicated by highlighting in black in the Range column below the corresponding range identifier (B = Brownsberg, N = Nassau, and L = Lely). Ground & epilithic orchids are marked "G" and highlighted in black in the Substrate column; all others (not highlighted in this column) are epiphytic orchids (marked "E"). Orchids recorded below 400 m elevation in Venezuelan Guayana (see Steyermark et al. 1995b) are highlighted in black and marked "L" (for Lowland) in the Elevation column; those recorded at 400 m or higher are also highlighted but marked "H" (for Highland); if no species-specific data from Venezuelan Guayana was available, the Elevation column is not highlighted, and the elevation at which the species may occur is indicated between brackets (based on data of congeners in Steyermark et al. 1995b and / or notes on the occurrence of the species in French Guiana (Chiron and Bellone 2005) or Suriname (Werkhoven 1986)).

Orchid genera that are considered to produce fragrant chemicals only (no nectar) as a reward for pollinating male orchid bees (Euglossinae) are highlighted dark grey and underlined in the Genus column; orchid genera considered to produce nectar and visited by potentially pollinating male as well as female orchid bees are highlighted light grey.

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Acianthera	*fockei*				E	L	
Aganisia	*pulchella*				E		H
Aspidogyne	*foliosa*				G	(L)	(H)
Batemania	*colleyi*				E	L	
Beloglottis	*costaricensis*				G		(H)
Bollea	*violacea*				E	(L)	(H)
Brassia	*caudate*				E	L	H
Brassia	sp.				E	(L)	(H)
Bulbophyllum	*bracteolatum*				E	(L)	
Caluera	*surinamensis*				E	(L)	
Campylocentrum	*micranthum*				E	L	H
Catasetum	*cristatum*				E	L	H
Catasetum	*deltoideum*				E	(L)	(H)
Chaubardiella	*tigrina*				E		H
Cheiradenia	*cuspidata*				E	L	H
Cochleanthes	*guianensis*				E		H
Cranichis	*diphylla*				G		H

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Cryptarrhena	*guatemalensis*	■			E	(L)	(H)
Cryptarrhena	*kegelii*	■			E		**H**
Cyclopogon	*elatus*	■		■	**G**		**H**
Dichaea	*histrio*			■	E		(H)
Dichaea	*hookeri*	■	■	■	E	**L**	**H**
Dichaea	*muricata*	■		■	E		**H**
Dichaea	*picta*	■	■		E	**L**	**H**
Dichaea	*pumila*		■		E	(L)	(H)
Dichaea	*rendlei*			■	E	(L)	(H)
Dichaea	*trulla*	■	■	■	E	**L**	**H**
Dimerandra	*elegans*	■			E	**L**	
Dipteranthus	sp.	■			E		(H)
Elleanthus	*capitatus*	■		■	E	(L)	(H)
Elleanthus	*caravata*	■	■	■	E	**L**	**H**
Elleanthus	*graminifolius*	■	■	■	E		**H**
Encyclia	*ceratistes*	■		■	E	(L)	
Encyclia	*diurna*	■		■	E	**L**	
Encyclia	*granitica*			■	E	**L**	
Encyclia	*guianensis*	■			E	**L**	**H**
Epidendrum	*anceps*	■			E	**L**	**H**
Epidendrum	*desiflorum*	■			E		**H**
Epidendrum	*difforme*		■		E	(L)	
Epidendrum	*microphyllum*	■			E	(L)	
Epidendrum	*nocturnum*	■	■	■	E	**L**	**H**
Epidendrum	*paniculatum*		■		E	(L)	(H)
Epidendrum	*purpurascens*	■	■	■	E	(L)	(H)
Epidendrum	*ramosum*	■	■	■	E		**H**
Epidendrum	*rigidum*	■			E	**L**	**H**
Epidendrum	*secundum*	■			E	**L**	
Epidendrum	sp. 1	■			E	(L)	(H)
Epidendrum	sp. 2	■			E	(L)	(H)
Epidendrum	*strobiliferum*	■			E	**L**	**H**
Epidendrum	*strobiloides*	■	■	■	E	**L**	**H**
Epidendrum	*unguiculatum*	■		■	E	**L**	**H**
Eriopsis	*biloba*	■		■	E	**L**	**H**
Erycina	*pusilla*	■	■	■	E	**L**	**H**
Erythrodes	sp.	■		■	**G**		(H)
Gongora	*histrionica*	■			E	(L)	(H)
Gongora	*pleiochroma*		■		E	**L**	

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Habenaria	*alterosula*				**G**	(H)	(H)
Ionopsis	*satyrioides*				E	**L**	**H**
Ionopsis	*utricularioides*				E	**L**	**H**
Isochilus	*linearis*				E		**H**
Jacquiniella	*globosa*				E		**H**
Jacquiniella	*teretifolia*				E		**H**
Kefersteinia	*lafontainei*				E	(L)	(H)
Kegeliella	*houtteana*				E	(L)	(H)
Koellensteinia	*carraoensis*				**G**		**H**
Koellensteinia	*hyacinthoides*				E	**L**	
Koellensteinia	*kellneriana*				E		(H)
Lepanthes	*helicocephala*				E	**L**	
Lepanthes	*ruscifolia*				E		(H)
Lepanthes	*wageneri*				E		(H)
Ligeophila	*stigmatoptera*				**G**		**H**
Ligeophila	cf. *umbraticola*				**G**		(H)
Liparis	*nervosa*				**G**	**L**	
Lockhartia	*imbricata*				E	**L**	**H**
Lophiaris	*lanceana*				E	(L)	
Lycaste	*macrophylla*				E		**H**
Lyroglossa	*grisebachii*				**G**	(L)	(H)
Macradenia	*lutescens*				E	**L**	**H**
Macroclinium	*wullschlaegelianum*				E	**L**	**H**
Malaxis	*excavata*				**G**		**H**
Masdevallia	*cuprea*				E	(L)	(H)
Masdevallia	*infracta*				E	(L)	(H)
Masdevallia	*minuta*				E	(L)	
Masdevallia	*norae*				E	**L**	**H**
Maxillaria	*alba*				E		**H**
Maxillaria	cf. *auyantepuiensis*				E		**H**
Maxillaria	*brunnea*				E		**H**
Maxillaria	*caespitifica*				E	(L)	(H)
Maxillaria	*camaridii*				E	**L**	
Maxillaria	*christobalensis*				E		(H)
Maxillaria	*crassifolia*				E	(L)	
Maxillaria	*desvauxiana*				E	**L**	**H**
Maxillaria	*discolor*				E	**L**	**H**
Maxillaria	*jenischiana*				E		(H)
Maxillaria	*ochroleuca*				E		**H**

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Maxillaria	*parkeri*			**L**	E	**L**	**H**
Maxillaria	*ponerantha*		**N**	**L**	E	(L)	(H)
Maxillaria	*reichenheimiana*	**B**	**N**	**L**	E		**H**
Maxillaria	*rufescens*	**B**	**N**	**L**	E	**L**	**H**
Maxillaria	*splendens*	**B**		**L**	E		**H**
Maxillaria	*stenophylla*	**B**		**L**	E		**H**
Maxillaria	*superflua*		**N**		E	**L**	
Maxillaria	*uncata*	**B**	**N**		E	**L**	**H**
Maxillaria	*violaceopunctata*	**B**			E	**L**	**H**
Mesadenella	*cuspidata*	**B**	**N**	**L**	**G**		(H)
Neolehmannia	sp.	**B**			E	(L)	(H)
Notylia	cf. *incurva*			**L**	E	(L)	(H)
Notylia	*sagittifera*	**B**			E		(H)
Notylia	sp 1	**B**			E	(L)	(H)
Notylia	sp. 2	**B**			E	(L)	(H)
Octomeria	*brevifolia*	**B**		**L**	E	(L)	(H)
Octomeria	*deltoglossa*			**L**	E	(L)	
Octomeria	*minor*			**L**	E	**L**	**H**
Octomeria	sp		**N**		E	(L)	(H)
Octomeria	*surinamenis*	**B**			E	**L**	**H**
Oncidium	*baueri*	**B**			E	**L**	
Ornithidium	*parviflorum*	**B**	**N**	**L**	E	**L**	**H**
Ornithocephalus	*cf. bicornis*	**B**			E	**L**	
Ornithocephalus	*gladiatus*	**B**			E	**L**	
Paphinia	*cristata*	**B**	**N**		E	**L**	**H**
Pelexia	*callifera*	**B**		**L**	**G**	**L**	**H**
Peristeria	*guttata*	**B**	**N**	**L**	E		**H**
Peristeria	*pendula*			**L**	E	**L**	**H**
Physurus	sp.			**L**	**G**		(H)
Platystele	*ovalifolia*	**B**		**L**	E	**L**	**H**
Platystele	*stenostachya*	**B**	**N**	**L**	E	(L)	(H)
Platythelys	*maculata*	**B**			**G**		(H)
Plectrophora	*iridifolia*	**B**			E	**L**	**H**
Pleurothallis	*archidiaconi*			**L**	E		**H**
Pleurothallis	*aristata*	**B**	**N**	**L**	E	**L**	**H**
Pleurothallis	*barbulata*	**B**		**L**	E	**L**	**H**
Pleurothallis	*ciliolate*	**B**			E	**L**	**H**
Pleurothallis	*determannii*	**B**			E	(L)	(H)
Pleurothallis	*discoidea*	**B**	**N**	**L**	E		(H)

Genus	Species	Range			Substrate	Elevation	
		B	N	L			
Pleurothallis	*glandulosa*	■		■	E	**L**	
Pleurothallis	*grobyi*	■	■		E	**L**	**H**
Pleurothallis	*lanceana*			■	E	**L**	
Pleurothallis	*monocardia*			■	E		(H)
Pleurothallis	*picta*	■			E	**L**	**H**
Pleurothallis	*polygonoides*	■			E	(L)	
Pleurothallis	*pruinosa*	■			E	**L**	**H**
Pleurothallis	*pubescens*			■	E		(H)
Pleurothallis	*ruscifolia*		■		E		**H**
Pleurothallis	*semperflorens*		■		E	(L)	
Pleurothallis	*seriata*	■			E		**H**
Pleurothallis	*spiculifera*	■	■	■	E	**L**	**H**
Pleurothallis	*suspensa*	■	■	■	E		**H**
Pleurothallis	*yauaperyensis*	■			E	**L**	**H**
Polystachya	*concreta*	■	■		E	**L**	**H**
Polystachya	sp.			■	E	(L)	(H)
Prescottia	*stachyodes*			■	**G**		**H**
Prosthechea	*aemula*	■	■	■	E	**L**	
Prosthechea	*calamaria*	■			E		**H**
Prosthechea	*pygmaea*	■		■	E		**H**
Prosthechea	*vespa*	■			E	**L**	**H**
Quekettia	*papillosa*		■		E	(L)	(H)
Quekettia	*vermeuleniana*	■		■	E	(L)	(H)
Reichenbachanthus	*reflexus*	■	■	■	E		**H**
Rodriguezia	*flavida*		■		E	(L)	
Rodriguezia	*lanceolata*	■	■		E	**L**	**H**
Sarcoglottis	*acaulis*			■	**G**	**L**	**H**
Sarcoglottis	*amazonica*			■	**G**	(L)	
Scaphyglottis	*dunstervillei*	■			E		**H**
Scaphyglottis	*fusiformis*	■		■	E	**L**	**H**
Scaphyglottis	*graminifolia*	■	■	■	E	**L**	**H**
Scaphyglottis	*lindeniana*	■		■	E		(H)
Scaphyglottis	*modesta*	■	■		E		**H**
Scaphyglottis	*prolifera*	■	■		E		**H**
Scuticaria	*steelii*	■			E	**L**	**H**
Sigmatostalix	*amazonica*	■	■		E	**L**	
Sobralia	*crocea*		■		E	(L)	(H)
Sobralia	*fimbriata*			■	E		**H**

Genus	Species	Range			Substrate	Elevation	
		B	**N**	**L**			
Sobralia	*fragrans*	■			E	**L**	**H**
Sobralia	*macrophylla*	■			E	**L**	**H**
Sobralia	*suaveolens*	■			E	**L**	**H**
Stanhopea	*grandiflora*	■			E	**L**	**H**
Stelis	*aprica*	■			E	**L**	**H**
Stelis	*argentata*	■	■	■	E	(L)	(H)
Trichocentrum	*fuscum*	■	■		E	**L**	**H**
Trichosalpinx	*foliata*	■			E		(H)
Trichosalpinx	*memor*	■		■	E		**H**
Trichosalpinx	*orbicularis*	■	■	■	E	**L**	**H**
Trigonidium	*acuminatum*	■		■	E	**L**	**H**
Trisetella	*triglochin*	■			E	**L**	**H**
Vanilla	cf. *odorata*	■	■		E	**L**	**H**
Vanilla	sp.			■	E	(L)	(H)
Wullschlaegelia	sp.			■	E	(L)	(H)
Xylobium	*foveatum*	■		■	E	(L)	(H)
Xylobium	*pallidiflorum*	■			E		**H**
Xylobium	*variegatum*	■			E		(H)

Appendix 5

Preliminary checklist of the orchid bees (Euglossinae) of the Brownsberg, Lely and Nassau ranges in Suriname.

Iwan E. Molgo and Bart P.E. De Dijn

Genus	Species	Brownsberg	near Lely[1]	Nassau
Eufriesea	*pulchra*		X	
Eufriesea	sp. 1	X		
Euglossa	*amazonica*		X	X
Euglossa	*analis*		X	X
Euglossa	*augaspis*		X	X
Euglossa	*chalybeata*	X	X	X
Euglossa	*chlorina*			X
Euglossa	*cognata*		X	X
Euglossa	*cordata*			X
Euglossa	*crassipunctata*	X		
Euglossa	cf. *deceptrix*		X	X
Euglossa	cf. *despecta*	X	X	
Euglossa	*gaianii*		X	X
Euglossa	*ignita*		X	X
Euglossa	*imperialis*	X	X	X
Euglossa	*intersecta*		X	X
Euglossa	*ioprosopa*			X
Euglossa	*iopyrrha*		X	
Euglossa	*magnipes*			X
Euglossa	*modestior*	X	X	X
Euglossa	*mourei*		X	
Euglossa	*orellana*			X
Euglossa	*piliventris*		X	X
Euglossa	cf. *prasina*			X
Euglossa	*retroviridis*		X	X
Euglossa	sp. 1	X		
Euglossa	*stilbonota*	X		X
Euglossa	*townsendi*	X	X	X
Euglossa	*tridentata*	X		
Eulaema	*meriana*	X	X	X
Eulaema	*mocsaryi*		X	

Genus	Species	Brownsberg	near Lely[1]	Nassau
Eulaema	*pseudocingulata*	X		
Exaerete	*frontalis*		X	X
Exaerete	*smaragdina*	X	X	
Total Number of species		**13**	**22**	**23**

[1]Samples were obtained near Diitabiki (Drietabbetje), across the Tapanhony river near Lely, but strictly speaking not at Lely itself; however, the Tapanahony is not assumed to be a barrier for orchid bee dispersal.

Appendix 6

List of ant species and number of individuals collected on three transects during the RAP survey.

Jeffrey Sosa-Calvo

Species	Lely transect 1	Lely transect 2	Nassau
Acanthognathus lentus	2		
Acanthognathus ocellatus	4		
Acromyrmex sp. 001	1	1	
Acromyrmex sp. 002	8		
Acropyga guianensis			14
Anochetus horridus	4	1	7
Anochetus inermis	20	33	
Anochetus mayri	2		1
Anochetus targionii	11		
Apterostigma pilosum sp. 001		7	
Apterostigma pilosum sp. 002	4		
Apterostigma pilosum sp. 003			1
Apterostigma pilosum sp. 004	24		1
Apterostigma pilosum sp. 005			3
Brachymyrmex sp. 001	7	5	24
Brachymyrmex sp. 002		1	
Brachymyrmex sp. 003	2		
Carebara sp. 001	1		
Carebara sp. 002	3		5
Carebara reticulata	20		2
Carebara urichi	6		18
Crematogaster sp. 001		52	207
Crematogaster sp. 002	28		
Crematogaster sp. 003	99	4	1
Crematogaster limata	18	5	
Crematogaster sotobosque	54	83	61
Crematogaster tenuicula		3	
Cryptomyrmex longinodus			4
Cyphomyrmex cf. *peltatus*	25	21	66

Species	Lely transect 1	Lely transect 2	Nassau
Cyphomyrmex rimosus	48	124	49
Discothyrea denticulata	5		3
Discothyrea sexarticulata		1	
Discothyrea sp. 001			3
Dolichoderus imitator	3		
Dolichoderus sp. 001			51
Ectatomma lugens			1
Ectatomma tuberculatum	1		
Gnamptogenys horni	13	6	13
Gnamptogenys interrupta	1	4	
Gnamptogenys moelleri	1	5	9
Gnamptogenys pleurodon	59	1	17
Gnamptogenys relicta			45
Gnamptogenys sulcata	15		
Gnamptogenys tortulosa	1		
Gnamptogenys sp. 001	1		
Hylomyrma sp. 001	1	13	
Hylomyrma sp. 002			20
Hylomyrma sp. 003			19
Hypoponera nitidula	92		58
Hypoponera sp. 001	121	1	33
Hypoponera sp. 002	25		23
Hypoponera sp. 003	3		2
Hypoponera sp. 004	44	64	3
Hypoponera sp. 005	29	4	1
Hypoponera sp. 006	37	28	143
Hypoponera sp. 007	33		
Hypoponera sp. 008	21	4	52
Hypoponera sp. 009	97	108	174
Hypoponera sp. 010	1		
Leptogenys sp. 001	1		
Megalomyrmex sp. 001	3		5
Megalomyrmex sp. 002			1
Myrmelachista cf. *mexicana*			1
Ochetomyrmex sp. 001	93	39	52
Octostruma balzani	35	61	72
Octostruma iheringi	6		
Octostruma sp. 001		8	1
Octostruma sp. 002	1	7	
Odontomachus brunneus	2	3	17
Odontomachus hastatus			1

Species	Lely transect 1	Lely transect 2	Nassau
Odontomachus laticeps			1
Odontomachus scalptus			1
Odontomachus sp. 001	3	1	
Pachycondyla constricta	1	1	6
Pachycondyla harpax	6	9	
Pachycondyla pergandei	4		
Pachycondyla stigma		1	
Pachycondyla unidentata			9
Paratrechina sp. 001			10
Paratrechina sp. 002			70
Paratrechina sp. 003	27	98	137
Paratrechina sp. 004	7		
Paratrechina sp. 005	20		76
Paratrechina sp. 006			4
Paratrechina sp. 007	1	1	
Pheidole sp. 001	11	8	19
Pheidole sp. 002		5	
Pheidole sp. 003		1	
Pheidole sp. 004		2	
Pheidole sp. 005	133	81	178
Pheidole sp. 006	29	173	261
Pheidole sp. 007		5	
Pheidole sp. 008		4	1
Pheidole sp. 009		2	
Pheidole sp. 010		2	
Pheidole sp. 011		3	
Pheidole sp. 012	12	8	
Pheidole sp. 013	16		2
Pheidole sp. 014	16	5	
Pheidole sp. 015	3	10	
Pheidole sp. 016		9	26
Pheidole sp. 017	74	19	
Pheidole sp. 018	2	12	
Pheidole sp. 019		5	
Pheidole sp. 020	27	6	2
Pheidole sp. 021	97	136	215
Pheidole sp. 022		24	
Pheidole sp. 023	22	6	94
Pheidole sp. 024		18	
Pheidole sp. 025	11	3	
Pheidole sp. 026			5

Species	Lely transect 1	Lely transect 2	Nassau
Pheidole sp. 027	1	1	
Pheidole sp. 028	1		
Pheidole sp. 029	16	2	
Pheidole sp. 030		1	14
Pheidole sp. 031	1	1	5
Pheidole sp. 032		2	15
Pheidole sp. 033	5	11	21
Pheidole sp. 034	1		
Pheidole sp. 035			1
Pheidole sp. 036		1	
Pheidole sp. 037			1
Pheidole sp. 038	1		
Pheidole sp. 039			1
Prionopelta amabilis	81	1	103
Pseudomyrmex sp. 001			3
Pseudomyrmex sp. 002			2
Pseudomyrmex sp. 003		1	
Pseudomyrmex sp. 004		1	
Pyramica auctidens	1	18	16
Pyramica beebei		10	
Pyramica cincinnata		11	
Pyramica crassicornis		1	
Pyramica denticulata	189	98	480
Pyramica halosis		3	5
Pyramica subedentata			22
Pyramica sp. 001	1	6	
Pyramica sp. 002		1	
Rogeria blanda			2
Rogeria curvipubens			11
Rogeria innotabilis	1		
Rogeria micromma		1	1
Sericomyrmex beniensis	4	7	
Sericomyrmex harekulli arawakensis	3		
Sericomyrmex impexus		10	1
Sericomyrmex myersi	7	1	
Sericomyrmex zacapanus	1	52	7
Sericomyrmex sp. 001			1
Solenopsis sp. 001	229	198	370
Solenopsis sp. 002	49	171	3
Solenopsis sp. 003	14	60	388
Solenopsis sp. 004	172	27	98

Species	Lely transect 1	Lely transect 2	Nassau
Solenopsis sp. 005	17	88	244
Solenopsis sp. 006		47	23
Solenopsis sp. 007	17	24	15
Solenopsis sp. 008	31	27	
Solenopsis sp. 009	3		
Solenopsis sp. 010		1	
Strumigenys cosmostela		4	
Strumigenys elongata	18	17	18
Strumigenys perparva	114	61	49
Strumigenys trinidadensis	1	1	2
Thaumatomyrmex ferox	4		
Trachymyrmex cf. *bugnioni*			17
Trachymyrmex sp. 001	3		
Tranopelta gilva			1
Wasmannia auropunctata	189	59	83
Wasmannia rochai			3
Wasmannia scrobifera	1	11	
Total Number of Species	**103**	**98**	**97**

Appendix 7

Species list and abundance of dung beetles from the Nassau and Lely plateaus.

Trond Larsen

	Abundance at each site	
	Nassau	Lely
Anisocanthon cf. *sericinus* Harold	9	19
Anomiopus sp. 1	0	1
Anomiopus sp. 2	1	0
Ateuchus sp. 1	1	1
Ateuchus sp. 2	1	13
Canthidium cf. *bicolor* Boucomont	0	1
Canthidium sp. 1	0	6
Canthidium sp. 2	0	4
Canthidium sp. 3	0	3
Canthidium sp. 4	2	20
Canthon bicolor Laporte	2	46
Canthon mutabilis Lucas	0	3
Canthon quadriguttatus Olivier	1	7
Canthon triangularis Drury	13	14
Coprophanaeus cf. *dardanus* MacLeay	0	3
Coprophanaeus cf. *parvulus* Olsoufieff	0	1
Coprophanaeus lancifer Linne	0	1
Deltochilum carinatum Westwood	2	2
Deltochilum icarus Olivier	1	3
Deltochilum sp. 1	8	0
Deltochilum sp. 2	4	0
Deltochilum sp. 3	3	1
Dichotomius mamillatus Felsche	0	1
Dichotomius sp. 1	1	0
Dichotomius sp. aff. *podalirius* Felsche	4	7
Eurysternus caribaeus Herbst	5	16
Eurysternus cf. *hirtellus* Dalman	0	1
Eurysternus sp. 1	0	3
Eurysternus sp. 2	1	0

Eurysternus sp. aff. *caribaeus* Herbst	4	17
Eurysternus velutinus Bates	1	1
Hansreia affinis Fabricius	88	569
Onthophagus cf. *haematopus* Harold	1	11
Onthophagus sp. 1	34	52
Oxysternon aeneum Olsoufieff	0	2
Oxysternon cf. *durantoni* Arnaud	0	24
Phanaeus chalcomelas Perty	2	7
Scybalocanthon cyanocephalus Harold	1	10
Sylvicanthon sp. nov.	0	4
Uroxys sp. 1	4	2
Uroxys sp. 2	4	1
Uroxys sp. 3	6	29
Total abundance	**204**	**906**
Number of species	**27**	**37**

Appendix 8

Bird species recorded on the Lely and Nassau plateaus during the RAP survey.

Iwan Derveld and Greg Love

Scientific Name	Common Name (English)	IUCN Red List Status	Lely (Date seen)	Nassau (Date seen)
Amazona amazonica	ORANGE-WINGED PARROT	LC		11/2/05
Amazona ochrocephala	YELLOW-CROWNED PARROT	LC		11/3/05
Anthracothorax nigricollis	BLACK-THROATED MANGO	LC		11/3/05
Ara chloropterus	RED-AND-GREEN MACAW	LC	10/26/05	
Ara macao	SCARLET MACAW	LC		11/5/05 (?)
Ara manilata	RED-BELLIED MACAW	LC		11/5/05 (?)
Brotogeris chrysopterus	GOLDEN-WINGED PARAKEET	LC	10/25/05	
Campephilus rubricollis	RED-NECKED WOODPECKER	LC	10/30/05	11/5/05 (?)
Capito niger	BLACK-SPOTTED BARBET	LC	10/26/05	11/2/05
Caprimulgus nigrescens	BLACKISH NIGHTJAR	LC	10/26/05	11/2/05
Cathartes melambrotus	GREATER YELLOW-HEADED VULTURE	LC	10/29/05	11/3/05
Celeus elegans	CHESTNUT WOODPECKER	LC		11/2/05
Celeus undatus	WAVED WOODPECKER	LC		11/4/05
Chaetura chapmani (C. spinicaudus?)	CHAPMAN'S SWIFT	LC	10/26/05	
Chaetura spinicaudus	BAND-RUMPED SWIFT	LC		11/4/05
Chlorophanes spiza	GREEN HONEYCREEPER	LC	10/30/05	11/2/05
Chlorostilbon mellisugus	BLUE-TAILED EMERALD	LC		11/2/05
Coereba flaveola	BANANAQUIT	LC		11/5/05
Colonia colonus	LONG-TAILED TYRANT	LC		11/2/05
Columba subvinacea	RUDDY PIGEON	LC	10/26/05	
Conopias parva	YELLOW-THROATED FLYCATCHER	LC	10/29/05	11/2/05
Contopus albogularis	WHITE-THROATED PEWEE	LC		11/3/05
Coragyps atratus	BLACK VULTURE	LC		11/2/05
Corapipo gutturalis	WHITE-THROATED MANAKIN	LC	10/26/05	
Crax alector	BLACK CURASSOW	LC	10/26/05 (feathers)	11/4/05
Crypturellus soui	LITTLE TINAMOU	LC		11/4/05
Cyanerpes caeruleus	PURPLE HONEYCREEPER	LC	10/28/05	11/2/05
Cyanerpes cyaneus	RED-LEGGED HONEYCREEPER	LC	10/28/05	11/2/05
Cyanocompsa cyanoides	BLUE-BLACK GROSBEAK	LC	10/26/05	

Scientific Name	Common Name (English)	IUCN Red List Status	Lely (Date seen)	Nassau (Date seen)
Cymbilaimus lineatus	FASCIATED ANTSHRIKE	LC	10/31/05	11/4/05
Dacnis cayana	BLUE DACNIS	LC	10/30/05	11/2/05
Elanoides forficatus	SWALLOW-TAILED KITE	LC	10/26/05	11/2/05
Euphonia cayennensis	GOLDEN-SIDED EUPHONIA	LC	10/28/05	
Euphonia minuta	WHITE-VENTED EUPHONIA	LC		11/3/05
Euphonia musica	ANTILLEAN EUPHONIA	LC	10/29/05	
Falco peregrinus	PEREGRINE FALCON	LC		11/5/05
Formicarius analis	BLACK-FACED ANTTHRUSH	LC		11/6/05
Galbula dea	PARADISE JACAMAR	LC	10/30/05	
Glyphorynchus spirurus	WEDGE-BILLED WOODCREEPER	LC	10/27/05	11/2/05
Gymnopithys rufigula	RUFOUS-THROATED ANTBIRD	LC		11/6/05
Haematoderus militaris	CRIMSON FRUITCROW	LC	10/27/05	
Harpagus bidentatus	DOUBLE-TOOTHED KITE	LC		11/6/05
Heliothryx aurita	BLACK-EARED FAIRY	LC		11/4/05
Hylocharis sapphirina	RUFOUS-THROATED SAPPHIRE	LC	10/28/05 (?)	
Hypocnemoides melanopogon	BLACK-CHINNED ANTBIRD	LC		11/3/05
Ibycter americanus	RED-THROATED CARACARA	LC	10/26/05	11/2/05
Jacamerops aureus	GREAT JACAMAR	LC		11/4/05
Lanio fulvus	FULVOUS SHRIKE-TANAGER	LC		11/4/05
Legatus leucophaius	PIRATIC FLYCATCHER	LC	10/26/05	
Lepidothrix serena	WHITE-FRONTED MANAKIN	LC		11/4/05
Leptotila verreauxi	WHITE-TIPPED DOVE	LC	10/26/05	11/3/05
Lipaugus vociferans	SCREAMING PIHA	LC	10/26/05	11/2/05
Lophornis ornatus	TUFTED COQUETTE	LC	10/29/05 (?)	
Manacus manacus	WHITE-BEARDED MANAKIN	LC	10/26/05	11/2/05
Micrastur mirandollei	SLATY-BACKED FOREST-FALCON	LC	10/30/05 (?)	
Microcerculus bambla	WING-BANDED WREN	LC	10/30/05	
Mionectes oleagineus	OCHRE-BELLIED FLYCATCHER	LC		11/4/05
Myiodynastes maculatus	STREAKED FLYCATCHER	LC		11/4/05
Myiophobus fasciatus	BRAN-COLOURED FLYCATCHER	LC		11/6/05
Myiozetetes cayanensis	RUSTY-MARGINED FLYCATCHER	LC	10/26/05	
Myrmeciza ferruginea	FERRUGINOUS-BACKED ANTBIRD	LC		11/4/05
Myrmotherula brachyura	PYGMY ANTWREN	LC		11/2/05
Myrmotherula surinamensis	STREAKED ANTWREN	LC	10/26/05	
Nemosia pileata	HOODED TANAGER	LC	10/29/05	
Nyctidromus albicollis	COMMON PAURAQUE	LC		11/5/05
Odontophorus gujanensis	MARBLED WOOD-QUAIL	LC		11/2/05
Ortalis motmot	LITTLE CHACHALACA	LC	10/28/05	11/2/05
Penelope marail	MARAIL GUAN	LC	10/26/05	11/3/05
Percnostola leucostigma	SPOT-WINGED ANTBIRD	LC	10/26/05	

Scientific Name	Common Name (English)	IUCN Red List Status	Lely (Date seen)	Nassau (Date seen)
Percnostola rufifrons	BLACK-HEADED ANTBIRD	LC		11/6/05
Perissocephalus tricolor	CAPUCHINBIRD	LC	10/26/05	11/3/05
Phaeothlypis rivularis	NEOTROPICAL RIVER WARBLER	LC		11/5/05
Phaethornis bourcieri	STRAIGHT-BILLED HERMIT	LC		11/3/05
Phaethornis superciliosus	LONG-TAILED HERMIT	LC		11/2/05
Philydor ruficaudatus	RUFOUS-TAILED FOLIAGE-GLEANER	LC		11/3/05
Piculus chrysochloros	GOLDEN-GREEN WOODPECKER	LC		11/3/05
Piculus flavigula	YELLOW-THROATED WOODPECKER	LC		11/3/05 (?)
Piculus rubiginosus	GOLDEN-OLIVE WOODPECKER	LC	10/28/05	
Pionopsitta caica	CAICA PARROT	LC		11/5/05
Pionus fuscus	DUSKY PARROT	LC	10/26/05	11/3/05
Pionus menstruus	BLUE-HEADED PARROT	LC	10/28/05	11/2/05
Pipra erythrocephala	GOLDEN-HEADED MANAKIN	LC	10/27/05	11/2/05
Polioptila plumbea	TROPICAL GNATCATCHER	LC		11/3/05
Procnias alba	WHITE BELLBIRD	LC		11/2/05
Progne tapera	BROWN-CHESTED MARTIN	LC	10/26/05	
Psarocolius viridis	GREEN OROPENDOLA	LC		11/2/05
Psophia crepitans	GREY-WINGED TRUMPETER	LC	10/25/05	11/5/05
Pyrrhura picta	PAINTED PARAKEET	LC	10/30/05	11/6/05
Querula purpurata	PURPLE-THROATED FRUITCROW	LC	10/28/05	
Ramphastos tucanus	RED-BILLED TOUCAN	LC		11/3/05
Ramphastos vitellinus	CHANNEL-BILLED TOUCAN	LC	10/26/05	11/3/05
Ramphocelus carbo	SILVER-BEAKED TANAGER	LC		11/6/05
Rhytipterna simplex	GREYISH MOURNER	LC	10/26/05	
Sarcoramphus papa	KING VULTURE	LC	10/31/05	11/2/05
Selenidera culik	GUIANAN TOUCANET	LC	10/26/05	11/4/05
Tachybaptus dominicus	LEAST GREBE	LC	8/31/05 (Pre-RAP trip)	
Tachyphonus cristatus	FLAME-CRESTED TANAGER	LC		11/3/05 (?)
Tachyphonus luctuosus	WHITE-SHOULDERED TANAGER	LC	10/29/05	
Tachyphonus surinamus	FULVOUS-CRESTED TANAGER	LC	10/30/05	11/2/05
Tangara chilensis	PARADISE TANAGER	LC	10/26/05	11/4/05
Tangara gyrola	BAY-HEADED TANAGER	LC	10/26/05	
Tangara punctata	SPOTTED TANAGER	LC	10/26/05	
Tangara velia	OPAL-RUMPED TANAGER	LC	10/29/05	
Thalurania furcata	FORK-TAILED WOODNYMPH	LC		11/5/05
Thamnophilus murinus	MOUSE-COLOURED ANTSHRIKE	LC	10/26/05	11/2/05
Thryothorus coraya	CORAYA WREN	LC		11/5/05
Tityra cayana	BLACK-TAILED TITYRA	LC	10/29/05	
Trogon collaris	COLLARED TROGON	LC		11/2/05

Scientific Name	Common Name (English)	IUCN Red List Status	Lely (Date seen)	Nassau (Date seen)
Trogon rufus	BLACK-THROATED TROGON	LC		11/3/05
Trogon violaceus	VIOLACEOUS TROGON	LC	10/29/05	
Turdus albicollis	WHITE-NECKED THRUSH	LC	10/29/05	11/2/05
Tyrannus melancholicus	TROPICAL KINGBIRD	LC	10/26/05	
Vireolanius leucotis	SLATY-CAPPED SHRIKE-VIREO	LC	10/26/05	
Xipholena punicea	POMPADOUR COTINGA	LC	10/26/05	11/5/05
Xiphorhynchus pardalotus	CHESTNUT-RUMPED WOODCREEPER	LC		11/3/05
Xiphorhynchus guttatus	BUFF-THROATED WOODCREEPER	LC	10/27/05	11/3/05
Total Number of Species			**67**	**86**

? – Species not definitively identified by field team

Appendix 9

List of bird species observed on Lely Mountain, 1-15 June 2003.

Brian O'Shea

Key to abundance codes:
A: abundant; more than 20 individuals/groups observed daily
C: common; 5-20 daily
F: fairly common; 1-4 daily
U: uncommon; average fewer than 1 per day, or same individuals seen repeatedly

Scientific name	English name	Abundance	Specimen collected
ORTALIS MOTMOT	Variable Chachalaca	F	
Crax alector	Black Curassow	F	
Tachybaptus dominicus	Least Grebe	U	
Cathartes melambrotus	Greater Yellow-headed Vulture	F	
Coragyps atratus	Black Vulture	U	
Sarcoramphus papa	King Vulture	U	
Elanoides forficatus	Swallow-tailed Kite	F	
Ictinia plumbea	Plumbeous Kite	F	
Leucopternis melanops	Black-faced Hawk	U	X
Buteogallus urubitinga	Great Black-Hawk	U	
Spizastur melanoleucos	Black-and-white Hawk-Eagle	U	
Daptrius ater	Black Caracara	U	
Ibycter americanus	Red-throated Caracara	F	
Psophia crepitans	Gray-winged Trumpeter	F	
Aramides cajanea	Gray-necked Wood-Rail	U	
Patagioenas plumbea	Plumbeous Pigeon	C	
Leptotila rufaxilla	Gray-fronted Dove	C	X
Geotrygon violacea	Violaceous Quail-Dove	U	X
Geotrygon montana	Ruddy Quail-Dove	C	X
Ara macao	Scarlet Macaw	C	
Ara chloropterus	Red-and-green Macaw	C	
Aratinga leucophthalma	White-eyed Parakeet	F	
Pyrrhura picta	Painted Parakeet	C	
Brotogeris chrysoptera	Golden-winged Parakeet	C	
Touit batavica	Lilac-tailed Parrotlet	F	
Pionites melanocephalus	Black-headed Parrot	F	
Pionopsitta caica	Caica Parrot	U	
Pionus menstruus	Blue-headed Parrot	C	

Scientific name	English name	Abundance	Specimen collected
Pionus fuscus	Dusky Parrot	F	
Piaya melanogaster	Black-bellied Cuckoo	F	
Pulsatrix perspicillata	Spectacled Owl	U	
Glaucidium hardyi	Amazonian Pygmy-Owl	U	
Caprimulgus nigrescens	Blackish Nightjar	C	X
Chaetura spinicaudus	Band-rumped Swift	C	
Chaetura chapmani	Chapman's Swift	F	
Phaethornis ruber	Reddish Hermit	F	
Phaethornis bourcieri	Straight-billed Hermit	F	X
Phaethornis superciliosus	Eastern Long-tailed Hermit	C	X
Phaethornis malaris	Great-billed Hermit	C	X
Campylopterus largipennis	Gray-breasted Sabrewing	F	X
Thalurania furcata	Fork-tailed Woodnymph	F	X
Heliothryx auritus	Black-eared Fairy	U	
Trogon viridis	White-tailed Trogon	C	
Trogon collaris	Collared Trogon	F	
Trogon melanurus	Black-tailed Trogon	F	
Chloroceryle inda	Green-and-rufous Kingfisher	U	X
Galbula dea	Paradise Jacamar	F	
Malacoptila fusca	White-chested Puffbird	U	X
Monasa atra	Black Nunbird	C	
Capito niger	Black-spotted Barbet	C	
Ramphastos tucanus	Red-billed Toucan	F	
Ramphastos vitellinus	Channel-billed Toucan	F	
Selenidera culik	Guianan Toucanet	F	
Pteroglossus viridis	Green Aracari	F	X
Piculus rubiginosus	Golden-olive Woodpecker	C	X
Celeus undatus	Waved Woodpecker	F	
Celeus elegans	Chestnut Woodpecker	U	
Campephilus rubricollis	Red-necked Woodpecker	F	
Dendrocincla fuliginosa	Plain-brown Woodcreeper	F	X
Glyphorhynchus spirurus	Wedge-billed Woodcreeper	C	X
Xiphorhynchus pardalotus	Chestnut-rumped Woodcreeper	F	
Lepidocolaptes albolineatus	Lineated Woodcreeper	U	
Synallaxis rutilans	Ruddy Spinetail	U	X
Philydor erythrocercum	Rufous-rumped Foliage-gleaner	F	
Sclerurus rufigularis	Short-billed Leaftosser	U	X
Xenops minutus	Plain Xenops	F	X
Cymbilaimus lineatus	Fasciated Antshrike	U	
Thamnophilus murinus	Mouse-colored Antshrike	F	
Thamnophilus punctatus	Northern Slaty-Antshrike	C	X
Thamnomanes ardesiacus	Dusky-throated Antshrike	F	

Scientific name	English name	Abundance	Specimen collected
Thamnomanes caesius	Cinereous Antshrike	F	X
Myrmotherula gutturalis	Brown-bellied Antwren	F	
Myrmotherula axillaris	White-flanked Antwren	C	X
Myrmotherula longipennis	Long-winged Antwren	F	X
Myrmotherula menetriesii	Gray Antwren	F	X
Herpsilochmus stictocephalus	Todd's Antwren	F	
Terenura spodioptila	Ash-winged Antwren	U	
Cercomacra cinerascens	Gray Antbird	F	
Myrmoborus leucophrys	White-browed Antbird	F	X
Hypocnemis cantator	Warbling Antbird	C	X
Percnostola rufifrons	Black-headed Antbird	C	X
Myrmeciza ferruginea	Ferruginous-backed Antbird	U	
Myrmeciza atrothorax	Black-throated Antbird	U	X
Hylophylax naevius	Spot-backed Antbird	U	
Hylophylax poecilinotus	Scale-backed Antbird	F	X
Myrmornis torquata	Wing-banded Antbird	U	
Grallaria varia	Variegated Antpitta	U	
Myrmothera campanisona	Thrush-like Antpitta	F	
Tyrannulus elatus	Yellow-crowned Tyrannulet	C	X
Myiopagis gaimardii	Forest Elaenia	F	X
Ornithion inerme	White-lored Tyrannulet	F	
Zimmerius gracilipes	Slender-footed Tyrannulet	C	X
Corythopis torquatus	Ringed Antpipit	F	X
Mionectes macconnelli	McConnell's Flycatcher	F	X
Leptopogon amaurocephalus	Sepia-capped Flycatcher	U	
Lophotriccus galeatus	Helmeted Pygmy-Tyrant	C	X
Tolmomyias assimilis	Yellow-margined Flycatcher	U	
Tolmomyias poliocephalus	Gray-crowned Flycatcher	U	
Platyrinchus saturatus	Cinnamon-crested Spadebill	U	X
Terenotriccus erythrurus	Ruddy-tailed Flycatcher	F	X
Contopus albogularis	White-throated Pewee	F	
Legatus leucophaius	Piratic Flycatcher	F	
Myiozetetes cayanensis	Rusty-margined Flycatcher	C	
Conopias albovittatus	White-ringed Flycatcher	F	
Myiodynastes maculatus	Streaked Flycatcher	F	
Megarynchus pitangua	Boat-billed Flycatcher	F	
Empidonomus varius	Variegated Flycatcher	F	
Tyrannus melancholicus	Tropical Kingbird	C	
Attila spadiceus	Bright-rumped Attila	F	X
Schiffornis turdina	Thrush-like Schiffornis	F	X
Pachyramphus marginatus	Black-capped Becard	U	

Scientific name	English name	Abundance	Specimen collected
Pachyramphus minor	Pink-throated Becard	U	
Oxyruncus cristatus	Sharpbill	U	
Rupicola rupicola	Guianan Cock-of-the-rock	U	
Cotinga cayana	Spangled Cotinga	F	
Lipaugus vociferans	Screaming Piha	C	
Xipholena punicea	Pompadour Cotinga	C	
Perissocephalus tricolor	Capuchinbird	U	
Corapipo gutturalis	White-throated Manakin	C	X
Lepidothrix serena	White-fronted Manakin	A	X
Manacus manacus	White-bearded Manakin	C	X
Pipra pipra	White-crowned Manakin	C	X
Pipra erythrocephala	Golden-headed Manakin	A	X
Vireo olivaceus	Red-eyed Vireo	F	
Hylophilus muscicapinus	Buff-cheeked Greenlet	U	
Hylophilus ochraceiceps	Tawny-crowned Greenlet	U	
Progne chalybea	Gray-breasted Martin	A	
Cyphorhinus arada	Musician Wren	U	
Ramphocaenus melanurus	Long-billed Gnatwren	U	
Turdus albicollis	White-throated Robin	A	X
Coereba flaveola	Bananaquit	F	
Lamprospiza melanoleuca	Red-billed Pied Tanager	C	
Tachyphonus cristatus	Flame-crested Tanager	F	
Tachyphonus surinamus	Fulvous-crested Tanager	C	X
Tachyphonus phoeniceus	Red-shouldered Tanager	F	X
Tangara chilensis	Paradise Tanager	C	
Tangara punctata	Spotted Tanager	C	X
Tangara gyrola	Bay-headed Tanager	C	X
Tangara velia	Opal-rumped Tanager	F	
Dacnis lineata	Black-faced Dacnis	F	
Dacnis cayana	Blue Dacnis	C	
Cyanerpes caeruleus	Purple Honeycreeper	C	
Cyanerpes cyaneus	Red-legged Honeycreeper	F	
Chlorophanes spiza	Green Honeycreeper	C	
Sporophila lineola	Lined Seedeater	F	X
Arremon taciturnus	Pectoral Sparrow	U	
Saltator maximus	Buff-throated Saltator	C	X
Cyanocompsa cyanoides	Blue-black Grosbeak	U	X
Psarocolius viridis	Green Oropendola	U	
Euphonia finschi	Finsch's Euphonia	U	
Euphonia cyanocephala	Golden-rumped Euphonia	U	
Euphonia cayennensis	Golden-sided Euphonia	F	

Appendix 10

Fishes collected in Nassau Mountains in 1949 by D.C. Geijskens and P.H. Creutzberg (Boeseman 1953).

Jan H. Mol, Kenneth Wan Tong You, Ingrid Vrede, Adrian Flynn, Paul Ouboter and Frank van der Lugt

Taxa	Number of specimens	Remarks
Characiformes		
Anostomidae		
Leporinus granti Eigenmann 1912	6	lowland streams
Leporinus fasciatus (Bloch 1795)	1	lowland streams & rivers
Characidae		
Astyanax bimaculatus (L. 1758)	4	lowland streams
Hemibrycon surinamensis Gery 1962	8	mountain streams? (Géry 1962)
Hemigrammus unilineatus Gill 1858	4	lowland streams
Jupiaba abramoides (Eigenmann 1909)	4	lowland streams
Erythrinidae		
Erythrinus erythrinus (Bloch & Schneider 1801)	4	lowland streams
Lebiasinidae		
Pyrrhulina filamentosa Val. 1846	60	lowland streams
Prochilodontidae		
Prochilodus rubrotaeniatus Jardine & Schomburgk 1841	1	lowland rivers
Serrasalmidae		
Serrasalmus rhombeus L. 1766	3	lowland streams & rivers
Siluriformes		
Callichthyidae		
Megalechis thoracata (Val. 1840)	11	lowland streams
Cetopsidae		
Helogenes marmoratus Günther 1863	7	lowland streams
Doradidae		
Platydoras costatus (L. 1758)	2	lowland streams & rivers
Heptapteridae		
Chasmocranus brevior Eigenmann 1912	3	known only from Nassau & Potaro River, Guyana (Mees 1974)
Heptapterus bleekeri Boeseman 1953	9	known also from Suriname River & Amapa, Brazil (Mees 1974)
Rhamdia quelen (Quoy & Gaimard 1824)	7	lowland streams

Taxa	Number of specimens	Remarks
Loricariidae		
Harttiella crassicauda (Boeseman 1953)	15	endemic to Nassau Mountains
Pimelodidae		
Pimelodus ornatus Kner 1858	1	lowland streams & rivers
Trichomycteridae		
Trichomycterus guianensis (Eigenmann 1909)	26	identification correct?
Total = 19 species	**176**	

Appendix 11

Fishes collected during the November 2005 RAP expedition to the Lely and Nassau plateaus, Suriname.

Jan H. Mol, Kenneth Wan Tong You, and Ingrid Vrede

Collections were made in four mountain streams in the Lely Mountains (L1-L4) and one mountain stream (N1), one lowland stream (N3) and one high-altitude-depression palm swamp (N2) in the Nassau Mountains.

Taxa	Lely Mountains				Nassau Mountains			Number of Specimens
	L1	L2	L3	L4	N1	N2	N3	
CHARACIFORMES								
Characidae								
Acestrorhynchus sp. (juvenile)							●	1
Bryconops affinis							●	1
Hemigrammus cf *rodwayi*							●	10
Jupiaba abramoides							●	1
Moenkhausia chrysargyrea							●	25
Moenkhausia hemigrammoides							●	7
Crenuchidae								
Microcharacidium eleotrioides							●	2
Curimatidae								
Steindachnerina varii							●	2
Erythrinidae								
Erythrinus erythrinus							●	2
Hoplias aimara							●	3
Hoplias malabaricus							●	5
Lebiasinidae								
Copella carsevennensis							●	2
Nannostomus bifasciatus							●	17
Pyrrhulina filamentosa							●	11
SILURIFORMES								
Callichthyidae								
Callichthys callichthys					●			10
Megalechis thoracata [1]							●	1
Cetopsidae								
Helogenes marmoratus							●	5

Taxa	Lely Mountains				Nassau Mountains			Number of Specimens
	L1	L2	L3	L4	N1	N2	N3	
Loricariidae								
Ancistrus temminckii		●						2
Ancistrus cf *temminckii*		●						28
Guyanancistrus brevispinnis		●						13
Harttiella crassicauda					●			50
Lithoxus sp.1					●			7
Lithoxus surinamensis		●						14
Trichomycteridae								
Ituglanis cf *amazonicus*		●						39
Trichomycterus aff *conradi*					●			45
GYMNOTIFORMES								
Gymnotidae								
Gymnotus carapo							●	1
Gymnotus coropinae							●	24
Hypopomidae								
Hypopygus lepturus							●	5
CYPRINODONTIFORMES								
Rivulidae								
Rivulus cf. *igneus*	●	●	●		●	●	●	286
Rivulus cf. *lungi*	●	●		●				98
SYNBRANCHIFORMES								
Synbranchidae								
Synbranchus marmoratus	●		●		●		●	10
PERCIFORMES								
Cichlidae								
Crenicichla saxatilis							●	1
Guianacara owroewefi							●	4
Krobia guianensis							●	21
Nannacara anomala							●	7
Nandidae								
Polycentrus schomburgkii							●	27
Total = 36 species	**3**	**7**	**2**	**1**	**6**	**1**	**26**	**787**

[1] see Reis et al. 2005

Appendix 12

Phytoplankton and periphyton of Paramaka Creek headwaters (IJskreek; altitude 300-530 m.amsl).

Jan H. Mol and Asha Haripersad-Makhanlal

Periphyton (5 samples of tufts of filamentous algae attached to boulders) were collected on November 5, 2005. Phytoplankton (5 samples of 1 L) were collected from March 30 – April 3, 2006; three out of 5 samples had no algae. Analyses were done by Asha Haripersad-Makhanlal, Hydraulic Research Division (WLA), Ministry of Public Works, Paramaribo.

Taxa	Periphyton Abundance	Phytoplankton Abundance (individuals/L)
Filamentous Rhodophyta (red algae)		
Batrachospermum cf. *cayenense*	Dominant	
Batrachospermum sp.	Abundant	
?Hildenbrandia sp.	Rare	
Rhodophyta sp.	Rare	
Filamentous Chlorophyta (green algae)		
Chaetophora cf *attennuata*	Rare	
Spirogyra sp.	Locally abundant	0-5
Diatomae		
Eunotia spp.	Abundant (on branches of *Batrachospermum*)	0-5
Navicula sp.	5 specimens	0-5
Desmidiaceae		
Cosmarium sp.	1 specimen	
Closterium sp.		0-5
Miscellaneous		
Bacteria	In one sample	
Rhizopoda	Rare	
Rotifera (*Lecane* sp.)	1 specimen	

Appendix 13

Fishes collected in high-altitude (plateau) streams of the Nassau Mountains from March 29 – April 4, 2006.

Jan Mol, Kenneth Wan Tong You, and Ingrid Vrede

Paramaka Creek was sampled in the central branch (IJskreek) up- and downstream (N1) of the BHP camp, and in a northern and southern tributary (tributaries joined the central branch in the foot hills).

Taxa	Paramaka Creek				Other streams on the plateau			Number of specimens
	central tributary upstream BHP camp	central tributary downstream BHP camp	northern tributary Na3	southern tributary Na5	unnamedsouthern stream Na6	unnamedsouthern stream Na4	unnamednorthern stream Na2	
SILURIFORMES								
Callichthyidae								
Callichthys callichthys	•							3
Loricariidae								
Ancistrus sp.							•	1
Guyanancistrus sp. 'big mouth'			•					15
Harttiella crassicauda		•						40
Harttiella cf. *crassicauda*			•					40
Lithoxus sp.1		•				•	•	7
Lithoxus sp.2 (forked caudal)		•						1+
Lithoxus sp.3 (light spots)				•				1+
Trichomycteridae								
Trichomycterus aff *conradi*		•		•	•	•	•	20
CYPRINODONTIFORMES								
Rivulidae								
Rivulus cf. *igneus*	•	•		•		•		47
SYNBRANCHIFORMES								
Synbranchidae								
Synbranchus marmoratus			•		•		•	3
Total = 11 species	**2**	**5**	**3**	**3**	**2**	**3**	**4**	**178**

Appendix 14

Habitat structure of a high-altitude reach of Paramaka Creek (IJskreek, 460 m.amsl; site N1), Nassau Mountains, where *Harttiella crassicauda* was collected.

Jan H. Mol, Kenneth Wan Tong You, and Ingrid Vrede

N = 40 point samples. Date of measurements was March 31, 2006. Habitat diversity (Gorman and Karr 1978) was calculated for each dimension alone and then for the combination of depth, current, and substrate type with the Shannon-Wiener index (H). $H = - \Sigma (pi * \ln (pi))$, where pi is the proportion of point samples in the ith category.

Variable/category	Proportion (pi)	Diversity (H)
Water depth (cm)		1.275
0-10	0.150	
11-20	0.450	
21-30	0.250	
>30	0.150	
Current (cm/second)		1.767
0-10	0.175	
11-20	0.125	
21-30	0.200	
31-40	0.150	
41-50	0.225	
51-70	0.125	
Substrate type		1.527
Silt (diameter <0.05 mm)	0	
Sand (0.05-2 mm)	0	
Gravel (2-10 mm)	0.375	
Pebbles (10-30 mm)	0.125	
Boulder (>30 mm)	0.200	
Bedrock	0.235	
Leaf litter	0.025	
Woody debris	0	
Tree roots	0.050	
Aquatic macrophytes	0	
Water depth x current x substrate		3.295

Appendix 15

Observations on the behavior of *Harttiella crassicauda* and *Guyanancistrus* n.sp. ('big mouth') of Nassau Mountains in the aquarium.

Kenneth Wan Tong You

Transportation of *Harttiella crassicauda* from Nassau Mountains to Paramaribo proved difficult: in November 2005 only two out of ten specimens survived the 7-hour drive over roads that were in bad condition and partially unpaved. With special precautions (battery-powered air pumps, low density of fishes, transport containers with thermal isolation against over heating) survival during transportation was much better after the survey of March/April 2006 (estimated survival 80%).

The two *Harttiella* specimens (including a 5.5-cm Total Length male with enlarged pectoral spines) from the November-survey were transferred to a large (90x40x40 (height) cm) aquarium with gravelly substrate, dense vegetation of submersed aquatic macrophytes (Vallisneria, Cryptocoryne, Echinodorus, Cabomba) and woody debris from IJskreek for shelter. Other fishes in the tank included *Apistogramma steindachneri*, *Lithoxus* cf *bovalli*, *Chasmocranus longior*, *Parotocinclus britskii*, and some small-sized poeciliids. Tank water was filtered by two 3-5 W air pumps. Light was provided by a 20 W neon lamp. The two *Harttiella* specimens were only active during the night, possibly related to activity of other fishes in the aquarium (see below). *Harttiella* was not very active in the aquarium, staying at one spot for long times. The male was territorial, defending its shelter against intruders (e.g. *Lithoxus*). Otherwise, *Harttiella* is a peaceful fish not bothering other fishes (conspecifics or other species). At night they spend most time grazing periphyton algae on the aquarium panes, macrophytes leaves and woody debris.

In the period November 2005 – March 2006, the male increased about 0.5 cm in length. In April, I obtained four additional *Harttiella* specimens from Nassau Mountains (second population from the northern tributary of Paramaka Creek) together with four specimens of a new loricariid catfish *Guyanancistrus* 'big mouth'. These eight fishes were transferred to a small aquarium (37x23x22 (height) cm) with a battery-powered air pump, fine sandy substrate, no aquatic macrophytes, some rock (shelter) and no other fishes in the tank. The aquarium received indirect sun light to stimulate algal growth. At one occasion I observed that *Harttiella* specimens buried themselves in the sand (note that the northern tributary of Paramaka Creek had sand substrate at some sites, contrary to the central branch of Paramaka Creek (IJskreek) with substrate that consisted of gravel, pebbles and boulders). I also observed that *Harttiella* were active during the day in this tank. At times they moved to the water surface near the outlet of the air pump (in the water current) where they lifted their head partially out of the water to graze on algae.

In conclusion, I find *Harttiella* a sensitive species that does not accept artificial aquarium feeds (e.g. flakes and tablet feeds), but feeds exclusively on algae. Therefore it is important to stimulate growth of algae in the aquarium. They are easily disturbed by other tank mates with the result that they retreat in shelter during the day. They are also easily stressed when deprived of shelter. *Harttiella* seems to prefer fresh, clear water with neutral pH and high dissolved oxygen concentration, and possibly a low water temperature (20-24 ºC) like observed in its natural habitat, the high-altitude IJskreek (500 m.amsl).

Guyanancistrus 'big mouth' of the northern branch of Paramaka Creek was active both during the day and at night. This species did not retreat in shelter (including one specimen that was transferred to the large aquarium with numerous other fishes). 'Big mouth' was not territorial, tolerating the presence of conspecifics and other species. 'Big mouth' preferred to stay in the water flow near the outlet of the air pump where they were observed feeding on algae and flakes with their head partially lifted out of the water. They did not spend much time on the bottom, but were mainly observed grazing algae on the aquarium panes, macrophytes, woody debris and rock. After a short acclimation time 'Big mouth' accepted vegetarian flakes.

Appendix 16

List of Reptiles and Amphibians recorded on the Nassau and Lely plateaus.

James I. Watling and Lucille F. Ngadino

Data include habitat use, Distribution (W=Widespread Amazonian, GS=Guayana Shield), and IUCN Threat Status (LC = least concern, NE = not evaluated). 'X' indicates presence of species not observed by the authors.

	Site		Distribution	IUCN Threat Status
Taxon	**Nassau**	**Lely**		
ANURA				
Bufonidae				
Bufo guttatus	Clearing		W	LC
B. margaritifer	Forest Stream, Forest	Forest, Forest Stream	W	LC
B. marinus	Forest, Clearing	Clearing, Savannah Forest	W	LC
Dendrobatidae				
Colostethus beebei		Forest, Forest Stream	GS	LC
C. degranvillei	Forest Stream, Forest, Swamp	Forest Stream, Forest	GS	LC
Colostethus cf. *brunneus*	Forest Stream, Swamp		W	LC
*Allobates femoralis***		X	W	LC
Epipedobates trivittatus	Forest, Savannah Forest	X	W	LC
HYLIDAE				
Hypsiboas boans	Forest Stream, Forest		W	LC
Hypsiboas crepitans	Forest Stream			
Dendropsophus marmorata	Clearing		W	LC
Dendropsophus minuta		Forest	W	LC
Osteocephalus taurinus	Forest	Forest	W	LC
*Phyllomedusa hypochondrialis***		X	W	LC
*Scinax proboscideus **		X	GS	LC
LEPTODACTYLIDAE				
Adenomera cf. *andreae*	Forest Stream, Forest	Forest		
Adenomera sp.		Forest Clearing, Forest, Forest Stream		
Eleutherodactylus chiastonotus	Forest Stream, Forest		GS	LC
Eleutherodactylus cf *inguinalis*		Forest Stream		
*Eleutherodactylus marmoratus***		X	GS	LC
Eleutherodactylus zeuctotylus		Forest Stream	GS	LC

	Site		Distribution	IUCN Threat Status
Taxon	**Nassau**	**Lely**		
Eleutherodactylus sp. 1	Forest Stream	Forest, Forest Stream		
Eleutherodactylus sp. 2		Forest		
Eleutherodactylus sp. 3		Forest		
Eleutherodactylus sp. 4		Forest		
Leptodactylus knudseni		Clearing	W	LC
Leptodactylus leptodactyloides		Forest Stream, Forest Clearing	W	LC
Leptodactylus longirostris		Clearing	W	LC
Leptodactylus mystaceus	Forest	Forest, Forest Clearing	W	LC
Leptodactylus pentadactylus	Swamp Forest, Forest Stream, Clearing	Forest Stream, Forest	W	LC
*Leptodactylus stenodema***		X	W	LC
MICROHYLIDAE				
Chiasmocleis shudikarensis	Forest	Forest	GS	LC
SQUAMATA—SAURIA				
Gekkonidae				
Gonatodes annularis		Forest	GS	LC
Gonatodes humeralis		Clearing	W	LC
GYMNOPHTHALMIDAE				
Arthrosaura kockii	Forest, Forest Stream		W	LC
Iphisa elegans	Forest, Savannah Forest		W	LC
Lepsoma guianense		Forest Stream, Forest	GS	LC
Neusticurus rudis	Forest Stream, Swamp Forest	Forest Stream	GS	LC
Cecrosaura cf. *ocellata*	Forest Stream		W	LC
POLYCHROTIDAE				
Noprops chrysolepis	Forest	Forest, Forest Stream		LC
Noprops fuscoauratus	Clearing		W	LC
Scincidae				
Mabuya nigropunctata	Forest	Clearing	W	LC
TEIIDAE				
Ameiva ameiva	Clearing	Clearing	W	LC
Kentropyx calcarata	Clearing	Clearing, Forest Stream, Forest	W	LC
Tupinambis teguixin		Clearing	W	LC
TROPIDURIDAE				
Tropidurus plica		Forest, Forest Stream	W	LC
Squamata--Sepentes				
COLUBRIDAE				
Chironius sp.	Forest			
Dipsas catsebyi	Forest	Forest	W	LC
Dipsas indica		Forest Stream	W	LC
Imantodes sp. *		X		

	Site		Distribution	IUCN Threat Status
Taxon	**Nassau**	**Lely**		
Liophis sp.	Forest			
Oxyrhopus formosus		Forest	W	LC
VIPERIDAE				
Bothrops atrox	Forest	Forest	W	LC
Bothriopsis bilineatus		Forest	W	LC
CROCODYLIA				
Alligatoridae				
Paleosuchus cf. *trigonatus*	?	Forest Stream	W	LC
CHELONIA				
Bataguridae				
*Rhinoclemys punctularia**	X		W	NE
CHELIDAE				
*Platemys platycephalus**		X	W	NE
Total # species	**32**	**45**		
Total recorded by RAP herpetology team	**29**	**37**		
# amphibians/reptiles recorded by RAP herpetology team	**16/13**	**21/16**		

* species recorded by other members of RAP team
** species recorded from Lely by C. Myers, August 1975

Appendix 17

Mammal species recorded on the Nassau and Lely plateaus during the RAP survey.

Sergio Solari and Miguel Pinto

IUCN Red List Categories of threatened species (IUCN 2006): Data Deficient (DD, not enough is known to make an assessment), Near Threatened (NT), Least Concern (LC, listed but not threatened), and Vulnerable (VU).

CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see http://www.cites.org/eng/app/index.shtml).

Order	Family	Genus	Species	English common name	IUCN Red List Category	CITES Appendix	Endemism	Nassau	Lely
Chiroptera	Mormoopidae	*Pteronotus*	*parnelli*	Common Mustached bat	LC				x
Chiroptera	Phyllostomidae	*Lophostoma*	*carrikeri*	Carriker's Round-eared Bat	VU				x
Chiroptera	Phyllostomidae	*Lophostoma*	*silvicolum*	White-throated Round-eared bat	LC				x
Chiroptera	Phyllostomidae	*Micronycteris*	*minuta*	Tiny Big-eared bat	LC				x
Chiroptera	Phyllostomidae	*Phyllostomus*	*discolor*	Pale Spear-nosed bat	LC			x	
Chiroptera	Phyllostomidae	*Tonatia*	*saurophila*	Stripe-headed Round-eared bat	LC			x	x
Chiroptera	Phyllostomidae	*Trachops*	*cirrhosus*	Fringe-lipped bat	LC			x	x
Chiroptera	Phyllostomidae	*Lionycteris*	*spurrelli*	Chestnut long-tongued bat	LC			x	
Chiroptera	Phyllostomidae	*Carollia*	*brevicauda*	Silky Short-tailed bat	LC			x	x
Chiroptera	Phyllostomidae	*Carollia*	*perspicillata*	Seba's Short-tailed bat	LC			x	x
Chiroptera	Phyllostomidae	*Rhinophylla*	*pumilio*	Dwarf Little Fruit bat	LC			x	x
Chiroptera	Phyllostomidae	*Ametrida*	*centurio*	Little White-shouldered bat	LC			x	
Chiroptera	Phyllostomidae	*Artibeus*	*lituratus*	Great Fruit-eating bat	LC			x	
Chiroptera	Phyllostomidae	*Artibeus*	*obscurus*	Dark Fruit-eating bat	NT			x	x
Chiroptera	Phyllostomidae	*Artibeus*	*planirostris*	Flat-faced Fruit-eating bat	LC			x	x
Chiroptera	Phyllostomidae	*Chiroderma*	*trinitatum*	Little Big-eyed bat	LC			x	
Chiroptera	Phyllostomidae	*Chiroderma*	*villosum*	Hairy Big-eyed bat	LC			x	x
Chiroptera	Phyllostomidae	*Dermanura*	*gnoma*	Dwarf Fruit-eating bat	LC				x
Chiroptera	Phyllostomidae	*Koopmania*	*concolor*	Brown Fruit-eating bat	NT			x	
Chiroptera	Phyllostomidae	*Platyrrhinus*	*helleri*	Heller's Broad-nosed bat	LC			x	
Chiroptera	Phyllostomidae	*Sturnira*	*lilium*	Little Yellow-shouldered bat	LC			x	
Chiroptera	Phyllostomidae	*Sturnira*	*tildae*	Tilda's Yellow-shouldered bat	LC			x	x
Chiroptera	Phyllostomidae	*Uroderma*	*bilobatum*	Common Tent-making bat	LC			x	
Chiroptera	Phyllostomidae	*Vampyrodes*	*caraccioli*	Great Stripe-faced bat	LC			x	

Order	Family	Genus	Species	English common name	IUCN Red List Category	CITES Appendix	Endemism	Nassau	Lely
Didelphimorphia	Didelphidae	*Marmosa*	*murina*	Linnaeus's Mouse opossum	LC		Guiana region	x	
Primates	Cebidae	*Saguinus*	*midas*	Red-Handed tamarin	LC	II	Guiana region	x	x
Primates	Atelidae	*Alouatta*	*macconnelli*	Guyanan Red Howler	VU	II	Guiana region	x	x
Primates	Atelidae	*Ateles*	*paniscus*	Red-faced Spider monkey	LC	II	Guiana region		x
Primates	Pitheciidae	*Chiropotes*	*chiropotes*	Red-backed Bearded Saki	DD	II	Guiana region		x
Carnivora	Felidae	*Pantera*	*onca*	Jaguar	NT	I			x
Carnivora	Procyonidae	*Nasua*	*nasua*	South American coati	LC				x
Carnivora	Felidae	*Leopardus*	*pardalis*	Ocelot	LC	I		x	
Carnivora	Felidae	*Puma*	*concolor*	Cougar	NT	II		x	
Perissodactyla	Tapiridaee	*Tapirus*	*terrestris*	South American tapir	VU	II		x	x
Artiodactyla	Cervidae	*Mazama*	sp.	Brocket deer	DD			x	x
Artiodactyla	Tayassuidae	*Pecari*	*tajacu*	Collared peccary	LC	II		x	
Cingulata	Dasypodidae	*Dasypus*	*novemcinctus*	Nine-banded armadillo	LC				x
Pilosa	Myrmecophagidae	*Myrmecophaga*	*tridactyla*	Giant anteater	VU	II			x
Rodentia	Dasyproctidae	*Dasyprocta*	*leporina*	Red-rumped Agouti	LC			x	
Rodentia	Sciuridae	*Sciurillus*	*pusillus*	Neotropical Pygmy squirrel	LC				x
Rodentia	Cricetidae	*Neacomys*	*dubosti*	Dubost's Neacomys	DD		Guiana region		x
Rodentia	Cricetidae	*Neacomys*	*guianae*	Guiana Neacomys	LC		Guiana region		x
Rodentia	Erethizonidae	*Coendou*	*prehensilis*	Brazilian Porcupine	LC				x
Rodentia	Dasyproctidae	*Myoprocta*	*acouchy*	Red acouchi	LC				x
Rodentia	Echimyidae	*Proechimys*	*guyannensis*	Guyenne Spiny Rat	LC		Guiana region		x
Total number of species	**45**							**28**	**30**

Appendix 18

Mammals recorded from Brownsberg.

Iwan E. Molgo, Kelly Fitzgerald, Sutrisno Mitro, Marilyn A. Norconk, L. Tremaine Gregory, Arioene Vreedzaam, and Dharma Satyawan

IUCN Red List Categories of threatened species (IUCN 2006): Data Deficient (DD, not enough is known to make an assessment), Near Threatened (NT), Least Concern (LC, listed but not threatened), and Vulnerable (VU).
CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see http://www.cites.org/eng/app/index.shtml).

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Mammalia	Artiodactyla	Cervidae	*Mazama*	*americana*	# 1	Red Brocket, Redi dia	DD		
Mammalia	Artiodactyla	Cervidae	*Mazama*	*gouazoubira*	# 1	Brown Brocket, Kuriaku	DD		
Mammalia	Artiodactyla	Cervidae	*Odocoileus*	*virginianus*	# 2	White-tailed deer			
Mammalia	Artiodactyla	Tayassuidae	*Tayassu*	*pecari*	# 1	White-lipped peccary, Pingo		II	
Mammalia	Artiodactyla	Tayassuidae	*Tayassu*	*tajacu*	# 1	Collared peccary, Pakira		II	
Mammalia	Carnivora	Canidae	*Cerdocyon*	*thous*	# 2	Crab-eating fox		II	
Mammalia	Carnivora	Canidae	*Speothos*	*venaticus*	# 1	Bush dog, Busi dagu	VU	I	
Mammalia	Carnivora	Felidae	*Herpailurus*	*yagouaroundi*	# 1	Eyra cat, Blaka Tigri-kati	LC	I	
Mammalia	Carnivora	Felidae	*Leopardus*	*pardalis*	# 1	Ocelot		I	
Mammalia	Carnivora	Felidae	*Leopardus*	*tigrinus*	# 1	Oncilla	NT	I	
Mammalia	Carnivora	Felidae	*Leopardus*	*wiedii*	# 1	Margay	LC	I	
Mammalia	Carnivora	Felidae	*Panthera*	*onca*	# 1	Jaguar	NT	I	
Mammalia	Carnivora	Felidae	*Puma*	*concolor*	# 1	Puma		II	
Mammalia	Carnivora	Mustelidae	*Eira*	*barbara*	# 1	Tayra, Aira		III	
Mammalia	Carnivora	Mustelidae	*Galictis*	*vittata*	# 1	Greater grison		III	
Mammalia	Carnivora	Procyonidae	*Nasua*	*nasua*	# 1	South American coati, Kwasikwasi			
Mammalia	Carnivora	Procyonidae	*Potos*	*flavus*	# 1	Kinkajou, Neti keskesi		III	
Mammalia	Chiroptera	Emballonuridae	*Saccopteryx*	*bilineata*	# 1	Black 2-lined Sac-winged bat			
Mammalia	Chiroptera	Emballonuridae	*Saccopteryx*	*leptura*	# 1	Brown 2-lined Sac-winged bat			
Mammalia	Chiroptera	Molossidae	*Molossus*	*molossus*	# 1	Common Free-tailed bat			
Mammalia	Chiroptera	Molossidae	*Molossus*	*rufus*	# 1	Black Mastiff bat			
Mammalia	Chiroptera	Mormoopidae	*Pteronotus*	*gymnonotus*	# 1	Naked-back Leaf-chinned bat			
Mammalia	Chiroptera	Mormoopidae	*Pteronotus*	*parnellii*	# 1	Common Leaf-chinned bat	LC		
Mammalia	Chiroptera	Phyllostomidae	*Ametrida*	*centurio*	# 1	Little White-shouldered bat			
Mammalia	Chiroptera	Phyllostomidae	*Anoura*	*caudifer*	# 1	Tailless Long-nosed bat			
Mammalia	Chiroptera	Phyllostomidae	*Anoura*	*geoffroyi*	# 1	Geoffroy's Tailless bat			
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*bogotensis*	# 1				
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*concolor*	# 1	Brown Fruit-eating bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*gnomus*	# 1	Dwarf Fruit-eating bat			
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*lituratus*	# 1	Greater Fruit-eating bat			

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*obscurus*	# 1	Sooty Fruit-eating bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Artibeus*	*planirostris*	# 1	Larger fruit-eating bat			
Mammalia	Chiroptera	Phyllostomidae	*Carollia*	*brevicauda*	# 1	Silky Short-tailed fruit bat			
Mammalia	Chiroptera	Phyllostomidae	*Carollia*	*perspicillata*	# 1	Seba's Short-tailed fruit bat			
Mammalia	Chiroptera	Phyllostomidae	*Chiroderma*	*trinitatum*	# 1	Small Big-eyed bat			
Mammalia	Chiroptera	Phyllostomidae	*Chiroderma*	*villosum*	# 1	Greater Big-eyed bat			
Mammalia	Chiroptera	Phyllostomidae	*Choeroniscus*	*minor*	# 1	Long-nosed Nectar-feeding bat			
Mammalia	Chiroptera	Phyllostomidae	*Chrotopterus*	*auritus*	# 1	Wooly False vampire bat			
Mammalia	Chiroptera	Phyllostomidae	*Glossophaga*	*soricina*	# 1	Common Nectar-feeding bat			
Mammalia	Chiroptera	Phyllostomidae	*Glyphonycteris*	*daviesi*	# 1	Davies' Big-eared bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Glyphonycteris*	*sylvestris*	# 1	Tri-colored Big-eared bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Lionycteris*	*spurrelli*	# 1	Spurrell's Nectar-feeding bat			
Mammalia	Chiroptera	Phyllostomidae	*Lonchophylla*	*thomasi*	# 1	Thomas' Nectar-feeding bat			
Mammalia	Chiroptera	Phyllostomidae	*Lophostoma*	*brasiliense*	# 1	Pygmy Round-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Lophostoma*	*carrikeri*	# 1	White-bellied Round-eared bat	VU		
Mammalia	Chiroptera	Phyllostomidae	*Lophostoma*	*schulzi*	# 1	Warty Round-eared bat	VU		Guayana Shield
Mammalia	Chiroptera	Phyllostomidae	*Lophostoma*	*silvicolum*	# 1	White-throated Round-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Micronycteris*	*hirsuta*	# 1	Hairy Big-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Micronycteris*	*megalotis*	# 1	Little Big-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Micronycteris*	*minuta*	# 1	White-bellied Big-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Mimon*	*crenulatum*	# 1	Hairy-nosed bat			
Mammalia	Chiroptera	Phyllostomidae	*Phylloderma*	*stenops*	# 1	Pale-faced bat			
Mammalia	Chiroptera	Phyllostomidae	*Phyllostomus*	*discolor*	# 1	Flower-eating bat			
Mammalia	Chiroptera	Phyllostomidae	*Phyllostomus*	*elongatus*	# 1	Brown spear-nosed bat			
Mammalia	Chiroptera	Phyllostomidae	*Phyllostomus*	*hastatus*	# 1	Greater-spear-nosed bat			
Mammalia	Chiroptera	Phyllostomidae	*Phyllostomus*	*latifolius*	# 1	Red Spear-nosed bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Platyrrhinus*	*helleri*	# 1	Heller's Broad-nosed OR White-lined bat			
Mammalia	Chiroptera	Phyllostomidae	*Rhinophylla*	*pumilio*	# 1	Little Fruit bat			
Mammalia	Chiroptera	Phyllostomidae	*Sturnira*	*lilium*	# 1	Small Yellow-shouldered bat			
Mammalia	Chiroptera	Phyllostomidae	*Sturnira*	*tildae*	# 1	Greater Yellow-shouldered bat			
Mammalia	Chiroptera	Phyllostomidae	*Tonatia*	*saurophila*	# 1	Striped Round-eared bat			
Mammalia	Chiroptera	Phyllostomidae	*Trachops*	*cirrhosus*	# 1	Frog-eating bat			
Mammalia	Chiroptera	Phyllostomidae	*Trinycteris*	*nicefori*	# 1	Nicefori's Big-eared bat			

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Mammalia	Chiroptera	Phyllostomidae	*Uroderma*	*bilobatum*	# 1	Common Tent-making bat			
Mammalia	Chiroptera	Phyllostomidae	*Vampyressa*	*brocki*	# 1	Brock's Yellow-eared bat	NT		
Mammalia	Chiroptera	Phyllostomidae	*Vampyressa*	*caraccioli*	# 1	Greater White-lined bat			
Mammalia	Chiroptera	Thyropteridae	*Thyroptera*	*tricolor*	# 1	Disc-winged bat			
Mammalia	Chiroptera	Vespertilionidae	*Eptesicus*	*brasiliensis*	# 1	Brazilian Brown bat			
Mammalia	Chiroptera	Vespertilionidae	*Eptesicus*	*chiriquinus*	# 1	Big Black bat			
Mammalia	Chiroptera	Vespertilionidae	*Eptesicus*	*furinalis*	# 1	Big Brown bat			
Mammalia	Chiroptera	Vespertilionidae	*Myotis*	*riparius*	# 1	Red myotis			
Mammalia	Cingulata	Dasypodidae	*Cabassous*	*unicinctus*	# 1	Southern Naked-tailed armadillo			
Mammalia	Cingulata	Dasypodidae	*Dasypus*	*kappleri*	# 1	Greater Long-nosed armadillo, Maka kapasi			
Mammalia	Cingulata	Dasypodidae	*Dasypus*	*novemcinctus*	# 1	Common Long-nosed armadillo, Dikidiki	LC		
Mammalia	Cingulata	Dasypodidae	*Priodontes*	*maximus*	# 1	Giant armadillo, Granman kapasi	VU	I	
Mammalia	Didelphimorphia	Didelphidae	*Caluromys*	*philander*	# 1	Woolly opossum	NT		
Mammalia	Didelphimorphia	Didelphidae	*Didelphis*	*marsupialis*	# 1	Common opossum, Dagu awari			
Mammalia	Didelphimorphia	Didelphidae	*Marmosa*	*murina*	# 1	Murine mouse opossum, Busmoismoisi			
Mammalia	Didelphimorphia	Didelphidae	*Marmosops*	*parvidens*	# 1	Delicate slender mouse opossum	NT		
Mammalia	Didelphimorphia	Didelphidae	*Marmosops*	*pinheiroi*	# 1	Slender mouse opossum			
Mammalia	Didelphimorphia	Didelphidae	*Metachirus*	*nudicaudatus*	# 1	Brown Four-eyed opossum, Froktu awari			
Mammalia	Didelphimorphia	Didelphidae	*Monodelphis*	*brevicaudata*	# 1	Red-legged Short-tailed opossum			Guayana Shield
Mammalia	Didelphimorphia	Didelphidae	*Philander*	*opossum*	# 1	Gray Four-eyed opossum, Fo ai awari			
Mammalia	Perissodactyla	Tapiridae	*Tapirus*	*terrestris*	# 1	Tapir	NT	II	
Mammalia	Pilosa	Bradypodidae	*Bradypus*	*tridactylus*	# 1	Pale-throated sloth, Sonlori			
Mammalia	Pilosa	Cyclopeidae	*Cyclopes*	*didactylus*	# 1	Pygmy anteater, Likanu			
Mammalia	Pilosa	Megalonychidae	*Choloepus*	*didactylus*	# 1	Linné's Two-toed sloth, Skapulori	DD		
Mammalia	Pilosa	Myrmecophagidae	*Myrmecophaga*	*tridactyla*	# 1	Giant Anteater	VU	II	
Mammalia	Pilosa	Myrmecophagidae	*Tamandua*	*tetradactyla*	# 1	Collared anteater, Mira froiti		III	

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Mammalia	Primates	Callitrichidae	*Saguinus*	*midas*	# 1	Golden-handed tamarin, Saguwenke		II	
Mammalia	Primates	Cebidae	*Alouatta*	*macconnelli*	# 1	Guyanan Red Howler, Babun		II	
Mammalia	Primates	Cebidae	*Ateles*	*paniscus*	# 1	Black Spider monkey, Kwata		II	E. Lowlands of Guayana Shield
Mammalia	Primates	Cebidae	*Cebus*	*apella*	# 1	Brown capuchin, Keskesi		II	
Mammalia	Primates	Cebidae	*Cebus*	*olivaceus*	# 1	Wedge-capped capuchin, Bergi Keskesi		II	
Mammalia	Primates	Cebidae	*Chiropotes*	*satanas*	# 1	Bearded saki, Baard saki		II	
Mammalia	Primates	Cebidae	*Pithecia*	*pithecia*	# 1	Golden-faced saki, Wanaku		II	Guayana Shield
Mammalia	Primates	Cebidae	*Saimiri*	*sciureus*	# 1	Common Squirrel monkey, Monki monki		II	
Mammalia	Rodentia	Cuniculidae	*Cuniculus*	*paca*	# 1	Paca, Hei		III	
Mammalia	Rodentia	Dasyproctidae	*Dasyprocta*	*leporina*	# 1	Brazilian agouti, Konkoni			
Mammalia	Rodentia	Dasyproctidae	*Myoprocta*	*acouchy*	# 1	Green acouchi, Mambula			
Mammalia	Rodentia	Echimyidae	*Echimys*	*chrysurus*	# 1	White-faced Tree Rat	VU		
Mammalia	Rodentia	Echimyidae	*Mesomys*	*hispidus*	# 1	Spiny Tree rat			
Mammalia	Rodentia	Echimyidae	*Proechimys*	*cuvieri*	# 1	Cuvier's Spiny rat			
Mammalia	Rodentia	Echimyidae	*Proechimys*	*guyannensis*	# 1	Guiana Spiny rat, Maka alata			
Mammalia	Rodentia	Erethizontidae	*Coendou*	*melanurus*	# 1	Black-tailed Hairy Dwarf porcupine			Guayana Shield
Mammalia	Rodentia	Erethizontidae	*Coendou*	*prehensilis*	# 1	Brazilian porcupine, Gindyamaka			
Mammalia	Rodentia	Hydrochaeridae	*Hydrochaeris*	*hydrochaeris*	# 1	Cabybara, Kapuwa			
Mammalia	Rodentia	Muridae	*Neacomys*	*paracou*	# 1	Spiny mouse			Guayana Shield
Mammalia	Rodentia	Muridae	*Oecomys*	*auyantepui*	# 1	Auyantepui aboreal rice rat			Guayana Shield
Mammalia	Rodentia	Muridae	*Oecomys*	*bicolor*	# 1	Bicolored arboreal rice rat			
Mammalia	Rodentia	Muridae	*Oryzomys*	*macconnelli*	# 1	Macconnelli's terrestrial rice rat			
Mammalia	Rodentia	Muridae	*Oryzomys*	*megacephalus*	# 1	Common rice rat			
Mammalia	Rodentia	Muridae	*Oryzomys*	*yunganus*	# 1	Yungas rice rat			
Mammalia	Rodentia	Muridae	*Rhipidomys*	*nitella*	# 1	Climbing rat			
Mammalia	Rodentia	Sciuridae	*Sciurillus*	*pusillus*	# 1	Neotropical pygmy squirrel			
Mammalia	Rodentia	Sciuridae	*Sciurus*	*aestunas*	# 1	Guianan squirrel, Bonboni			

Taxonomic Reference(1) Lim B.K. et al. 2005. Results of the Alcoa Foundation-Suriname Expeditions. XIV. Mammals of Brownsberg Nature Park, Suriname. Annals of Carnegie Museum, 74: 225-274.

Taxonomic Reference(2) InfoNatura: Birds, mammals, and amphibians of Latin America [web application]. 2004. Version 4.1. Arlington, Virginia (USA): NatureServe. Available: http://www.natureserve.org/infonatura. (Accessed: July 1, 2006).

Appendix 19

Birds recorded from Brownsberg.

Brian O'Shea (based on Brownsberg bird list at webserv.nhl/~ribot)

IUCN Red List Categories of threatened species (IUCN 2006): Data Deficient (DD, not enough is known to make an assessment), Near Threatened (NT), Least Concern (LC, listed but not threatened), and Vulnerable (VU).

CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see http://www.cites.org/eng/app/index.shtml).

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Apodiformes	Apodidae	*Chaetura*	*brachyura*	# 1	Short-tailed Swift	LC		
Aves	Apodiformes	Apodidae	*Chaetura*	*chapmani*	# 1	Chapman's Swift	LC		
Aves	Apodiformes	Apodidae	*Chaetura*	*spinicauda*	# 1	Band-rumped Swift	LC		
Aves	Apodiformes	Apodidae	*Panyptila*	*cayennensis*	# 1	Lesser Swallow-tailed Swift	LC		
Aves	Apodiformes	Apodidae	*Tachornis*	*squamata*	# 1	Fork-tailed Palm-Swift	LC		
Aves	Apodiformes	Trochilidae	*Amazilia*	*fimbriata*	# 1	Glittering-throated Emerald	LC	II	
Aves	Apodiformes	Trochilidae	*Amazilia*	*leucogaster*	# 1	Plain-bellied Hummingbird	LC	II	
Aves	Apodiformes	Trochilidae	*Anthracothorax*	*nigricollis*	# 1	Black-throated Mango	LC	II	
Aves	Apodiformes	Trochilidae	*Anthracothorax*	*viridigula*	# 1	Green-throated Mango	LC	II	
Aves	Apodiformes	Trochilidae	*Calliphlox*	*amethystina*	# 1	Amethyst Woodstar	LC	II	
Aves	Apodiformes	Trochilidae	*Campylopterus*	*largipennis*	# 1	Grey-breasted Sabrewing	LC	II	
Aves	Apodiformes	Trochilidae	*Chlorestes*	*notatus*	# 1	Blue-chinned Sapphire	LC	II	
Aves	Apodiformes	Trochilidae	*Chrysolampis*	*mosquitus*	# 1	Ruby-topaz Hummingbird	LC	II	
Aves	Apodiformes	Trochilidae	*Colibri*	*delphinae*	# 1	Brown Violetear	LC	II	
Aves	Apodiformes	Trochilidae	*Discosura*	*longicauda*	# 1	Racket-tailed Coquette	LC	II	
Aves	Apodiformes	Trochilidae	*Florisuga*	*mellivora*	# 1	White-necked Jacobin	LC	II	
Aves	Apodiformes	Trochilidae	*Glaucis*	*hirsuta*	# 1	Rufous-breasted Hermit	LC	II	
Aves	Apodiformes	Trochilidae	*Heliothryx*	*aurita*	# 4	Black-eared Fairy	LC	II	
Aves	Apodiformes	Trochilidae	*Hylocharis*	*cyanus*	# 1	White-chinned Sapphire	LC	II	
Aves	Apodiformes	Trochilidae	*Hylocharis*	*sapphirina*	# 1	Rufous-throated Sapphire	LC	II	
Aves	Apodiformes	Trochilidae	*Lophornis*	*ornata*	# 1	Tufted Coquette	LC	II	
Aves	Apodiformes	Trochilidae	*Phaethornis*	*bourcieri*	# 1	Straight-billed Hermit	LC	II	
Aves	Apodiformes	Trochilidae	*Phaethornis*	*longuemareus*	# 1	Little Hermit	LC	II	
Aves	Apodiformes	Trochilidae	*Phaethornis*	*malaris*	# 1	Great-billed Hermit	LC	II	
Aves	Apodiformes	Trochilidae	*Phaethornis*	*ruber*	# 1	Reddish Hermit	LC	II	
Aves	Apodiformes	Trochilidae	*Phaethornis*	*superciliosus*	# 1	Long-tailed Hermit		II	
Aves	Apodiformes	Trochilidae	*Polytmus*	*theresiae*	# 1	Green-tailed Goldenthroat	LC	II	
Aves	Apodiformes	Trochilidae	*Thalurania*	*furcata*	# 1	Fork-tailed Woodnymph	LC	II	
Aves	Apodiformes	Trochilidae	*Threnetes*	*niger*	# 4	Pale-breasted Barbthroat	LC	II	
Aves	Apodiformes	Trochilidae	*Topaza*	*pella*	# 1	Crimson Topaz	LC	II	
Aves	Caprimulgiformes	Caprimulgidae	*Caprimulgus*	*nigrescens*	# 1	Blackish Nightjar	LC		
Aves	Caprimulgiformes	Caprimulgidae	*Chordeiles*	*acutipennis*	# 1	Lesser Nighthawk	LC		

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Caprimulgiformes	Caprimulgidae	*Lurocalis*	*semitorquatus*	# 1	Semicollared Nightjar	LC		
Aves	Caprimulgiformes	Caprimulgidae	*Nyctidromus*	*albicollis*	# 1	Pauraque	LC		
Aves	Caprimulgiformes	Nyctibiidae	*Nyctibius*	*aethereus*	# 4	Long-tailed Potoo			
Aves	Caprimulgiformes	Nyctibiidae	*Nyctibius*	*griseus*	# 1	Common Potoo	LC		
Aves	Charadriiformes	Charadriidae	*Charadrius*	*collaris*	# 1	Collared Plover	LC		
Aves	Charadriiformes	Jacanidae	*Jacana*	*jacana*	# 1	Wattled Jacana	LC		
Aves	Charadriiformes	Scolopacidae	*Actitis*	*macularia*	# 1, 4	Spotted Sandpiper			
Aves	Charadriiformes	Scolopacidae	*Tringa*	*solitaria*	# 1	Solitary Sandpiper	LC		
Aves	Ciconiiformes	Ardeidae	*Ardea*	*alba*	# 1	Great Egret	LC		
Aves	Ciconiiformes	Ardeidae	*Ardea*	*cocoi*	# 1	Cocoi Heron			
Aves	Ciconiiformes	Ardeidae	*Butorides*	*striatus*	# 1	Striated Heron	LC		
Aves	Ciconiiformes	Ardeidae	*Tigrisoma*	*lineatum*	# 1	Rufescent tiger-Heron	LC		
Aves	Ciconiiformes	Ciconiidae	*Mycteria*	*americana*	# 1	Wood Stork	LC		
Aves	Columbiformes	Columbidae	*Columbina*	*passerina*	# 1	Common ground-Dove	LC		
Aves	Columbiformes	Columbidae	*Geotrygon*	*montana*	# 1	Ruddy Quail-Dove	LC		
Aves	Columbiformes	Columbidae	*Geotrygon*	*violacea*	# 1	Violaceous Quail-Dove	LC		
Aves	Columbiformes	Columbidae	*Leptotila*	*rufaxilla*	# 1	Grey-fronted Dove	LC		
Aves	Columbiformes	Columbidae	*Leptotila*	*verreauxi*	# 1	White-tipped Dove	LC		
Aves	Columbiformes	Columbidae	*Patagioenas*	*cayennensis*	# 3	Pale-vented Pigeon	LC		
Aves	Columbiformes	Columbidae	*Patagioenas*	*plumbea*	# 3	Plumbeous Pigeon	LC		
Aves	Columbiformes	Columbidae	*Patagioenas*	*speciosa*	# 3	Scaled Pigeon	LC		
Aves	Columbiformes	Columbidae	*Patagioenas*	*subvinacea*	# 3	Ruddy Pigeon	LC		
Aves	Coraciiformes	Alcedinidae	*Ceryle*	*torquata*	# 1	Ringed Kingfisher	LC		
Aves	Coraciiformes	Alcedinidae	*Chloroceryle*	*aenea*	# 1	Pygmy Kingfisher	LC		
Aves	Coraciiformes	Alcedinidae	*Chloroceryle*	*amazona*	# 1	Amazon Kingfisher	LC		
Aves	Coraciiformes	Alcedinidae	*Chloroceryle*	*americana*	# 1	Green Kingfisher	LC		
Aves	Coraciiformes	Momotidae	*Momotus*	*momota*	# 1	Blue-crowned Motmot	LC		
Aves	Cuculiformes	Cuculidae	*Crotophaga*	*ani*	# 1	Smooth-billed Ani	LC		
Aves	Cuculiformes	Cuculidae	*Piaya*	*cayana*	# 1	Squirrel Cuckoo	LC		
Aves	Cuculiformes	Cuculidae	*Piaya*	*melanogaster*	# 1	Black-bellied Cuckoo	LC		
Aves	Cuculiformes	Cuculidae	*Piaya*	*minuta*	# 1	Little Cuckoo	LC		
Aves	Falconiformes	Accipitridae	*Accipiter*	*bicolor*	# 1	Bicoloured Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Accipiter*	*poliogaster*	# 1	Grey-bellied Hawk		II	
Aves	Falconiformes	Accipitridae	*Asturina*	*nitida*	# 1	Grey Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Buteo*	*albicaudatus*	# 1	White-tailed Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Buteo*	*brachyurus*	# 1	Short-tailed Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Buteo*	*magnirostris*	# 1	Roadside Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Buteo*	*platypterus*	# 4	Broad-winged Hawk	LC	II	

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Falconiformes	Accipitridae	*Buteogallus*	*urubitinga*	# 1	Great black Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Elanoides*	*forficatus*	# 1	Swallow-tailed Kite	LC	II	
Aves	Falconiformes	Accipitridae	*Harpagus*	*bidentatus*	# 1	Double-toothed Kite	LC	II	
Aves	Falconiformes	Accipitridae	*Harpia*	*harpyja*	# 1	Harpy Eagle	NT	I	
Aves	Falconiformes	Accipitridae	*Ictinia*	*plumbea*	# 1	Plumbeous Kite	LC	II	
Aves	Falconiformes	Accipitridae	*Leptodon*	*cayanensis*	# 1	Grey-headed Kite	LC	II	
Aves	Falconiformes	Accipitridae	*Leucopternis*	*albicollis*	# 1	White Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Leucopternis*	*melanops*	# 1	Black-faced Hawk	LC	II	
Aves	Falconiformes	Accipitridae	*Pandion*	*haliaetus*	# 1	Osprey	LC	II	
Aves	Falconiformes	Accipitridae	*Spizaetus*	*ornatus*	# 1	Ornate Hawk-Eagle	LC	II	
Aves	Falconiformes	Accipitridae	*Spizaetus*	*tyrannus*	# 1	Black Hawk-Eagle	LC	II	
Aves	Falconiformes	Accipitridae	*Spizastur*	*melanoleucus*	# 1	Black-and-white Hawk-Eagle	LC	II	
Aves	Falconiformes	Cathartidae	*Cathartes*	*aura*	# 1	Turkey Vulture	LC		
Aves	Falconiformes	Cathartidae	*Cathartes*	*melambrotus*	# 1	Greater yellow-headed Vulture	LC		
Aves	Falconiformes	Cathartidae	*Sarcoramphus*	*papa*	# 1	King Vulture	LC	III	
Aves	Falconiformes	Falconidae	*Daptrius*	*americanus*	# 1	Red-throated Caracara	LC	II	
Aves	Falconiformes	Falconidae	*Daptrius*	*ater*	# 1	Black Caracara	LC	II	
Aves	Falconiformes	Falconidae	*Falco*	*rufigularis*	# 1	Bat Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Herpetotheres*	*cachinnans*	# 1	Laughing Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Micrastur*	*gilvicollis*	# 1	Lined forest-Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Micrastur*	*mirandollei*	# 1	Slaty-backed forest-Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Micrastur*	*ruficollis*	# 1	Barred forest-Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Micrastur*	*semitorquatus*	# 1	Collared forest-Falcon	LC	II	
Aves	Falconiformes	Falconidae	*Milvago*	*chimachima*	# 1	Yellow-headed Caracara	LC	II	
Aves	Galbuliformes	Bucconidae	*Bucco*	*capensis*	# 1	Collared Puffbird	LC		
Aves	Galbuliformes	Bucconidae	*Bucco*	*tamatia*	# 1	Spotted Puffbird	LC		
Aves	Galbuliformes	Bucconidae	*Chelidoptera*	*tenebrosa*	# 1	Swallow-Wing	LC		
Aves	Galbuliformes	Bucconidae	*Malacoptila*	*fusca*	# 1	White-chested Puffbird	LC		
Aves	Galbuliformes	Bucconidae	*Monasa*	*atra*	# 1	Black Nunbird	LC		Guayana Shield
Aves	Galbuliformes	Bucconidae	*Notharchus*	*macrorhynchos*	# 1	Guianan Puffbird			Guayana Shield
Aves	Galbuliformes	Bucconidae	*Notharchus*	*tectus*	# 1	Pied Puffbird	LC		
Aves	Galbuliformes	Galbulidae	*Galbula*	*albirostris*	# 1	Yellow-billed Jacamar	LC		
Aves	Galbuliformes	Galbulidae	*Galbula*	*dea*	# 1	Paradise Jacamar	LC		
Aves	Galbuliformes	Galbulidae	*Galbula*	*leucogastra*	# 1	Bronzy Jacamar	LC		
Aves	Galbuliformes	Galbulidae	*Jacamerops*	*aurea*	# 1	Great Jacamar	LC		

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Aves	Galliformes	Cracidae	*Crax*	*alector*	# 1	Black Curassow	LC		Guayana Shield
Aves	Galliformes	Cracidae	*Ortalis*	*motmot*	# 1	Little Chachalaca	LC		
Aves	Galliformes	Cracidae	*Penelope*	*jacquacu*	# 1	Spix's Guan			
Aves	Galliformes	Cracidae	*Penelope*	*marail*	# 1	Marail Guan	LC		Guayana Shield
Aves	Galliformes	Odontophoridae	*Odontophorus*	*gujanensis*	# 1	Marbled Woodquail			
Aves	Gruiformes	Psophiidae	*Psophia*	*crepitans*	# 1	Grey-winged Trumpeter	LC		
Aves	Gruiformes	Rallidae	*Anurolimnas*	*viridis*	# 2	Russet-crowned Crake	LC		
Aves	Gruiformes	Rallidae	*Aramides*	*cajanea*	# 1	Grey-necked Woodrail	LC		
Aves	Passeriformes	Cardinalidae	*Caryothraustes*	*canadensis*	# 2	Yellow-green Grosbeak	LC		
Aves	Passeriformes	Cardinalidae	*Cyanocompsa*	*cyanoides*	# 2	Blue-black Grosbeak	LC		
Aves	Passeriformes	Cardinalidae	*Paroaria*	*gularis*	# 1	Red-capped C ardinal	LC		
Aves	Passeriformes	Cardinalidae	*Periporphyrus*	*erythromelas*	# 2	Red-and-black Grosbeak	LC		Guayana Shield
Aves	Passeriformes	Cardinalidae	*Saltator*	*grossus*	# 3	Slate-colored Grosbeak			
Aves	Passeriformes	Cardinalidae	*Saltator*	*maximus*	# 2	Buff-throated Saltator	LC		
Aves	Passeriformes	Conopophagidae	*Conopophaga*	*aurita*	# 1	Chestnut-belted Gnateater	LC		
Aves	Passeriformes	Corvidae	*Cyanocorax*	*cayanus*	# 1	Cayenne Jay	LC		
Aves	Passeriformes	Cotingidae	*Cotinga*	*cayana*	# 1	Spangled Cotinga	LC		
Aves	Passeriformes	Cotingidae	*Cotinga*	*cotinga*	# 1	Purple-breasted Cotinga	LC		
Aves	Passeriformes	Cotingidae	*Haematoderus*	*militaris*	# 1	Crimson Fruitcrow	LC		
Aves	Passeriformes	Cotingidae	*Iodopleura*	*fusca*	# 1	Dusky Purpletuft	LC		
Aves	Passeriformes	Cotingidae	*Lipaugus*	*vociferans*	# 1	Screaming Piha	LC		
Aves	Passeriformes	Cotingidae	*Pachyramphus*	*marginatus*	# 1	Black-capped Becard	LC		
Aves	Passeriformes	Cotingidae	*Pachyramphus*	*minor*	# 1	Pink-throated Becard	LC		
Aves	Passeriformes	Cotingidae	*Pachyramphus*	*surinamus*	# 1	Glossy-backed Becard	LC		
Aves	Passeriformes	Cotingidae	*Perissocephalus*	*tricolor*	# 1	Capuchinbird	LC		Guayana Shield
Aves	Passeriformes	Cotingidae	*Phoenicircus*	*carnifex*	# 1	Guianan Red-Cotinga	LC		
Aves	Passeriformes	Cotingidae	*Procnias*	*alba*	# 1	White Bellbird	LC		
Aves	Passeriformes	Cotingidae	*Querula*	*purpurata*	# 1	Purple-throated Fruitcrow	LC		
Aves	Passeriformes	Cotingidae	*Tityra*	*cayana*	# 1	Black-tailed Tityra	LC		
Aves	Passeriformes	Cotingidae	*Xipholena*	*punicea*	# 1	Pompadour Cotinga	LC		
Aves	Passeriformes	Dendrocolaptidae	*Campylorhamphus*	*procurvoides*	# 1	Curve-billed Scythebill	LC		
Aves	Passeriformes	Dendrocolaptidae	*Deconychura*	*longicauda*	# 1	Long-tailed Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Dendrexetastes*	*rufigula*	# 1	Cinnamon-throated Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Dendrocincla*	*fuliginosa*	# 1	Plain-brown Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Dendrocolaptes*	*certhia*	# 1	Barred Woodcreeper	LC		

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Aves	Passeriformes	Dendrocolaptidae	*Dendrocolaptes*	*picumnus*	# 1	Black-banded Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Glyphorynchus*	*spirurus*	# 1	Wedge-billed Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Hylexetastes*	*perrotii*	# 1	Red-billed Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Lepidocolaptes*	*albolineatus*	# 1	Lineated Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Xiphorhynchus*	*guttatus*	# 1	Buff-throated Woodcreeper	LC		
Aves	Passeriformes	Dendrocolaptidae	*Xiphorhynchus*	*pardalotus*	# 1	Chestnut-rumped Woodcreeper	LC		Guayana Shield
Aves	Passeriformes	Emberizidae	*Arremon*	*taciturnus*	# 1	Pectoral sparrow	LC		
Aves	Passeriformes	Emberizidae	*Sporophila*	*americana*	# 1	Variable Seedeater	LC		
Aves	Passeriformes	Emberizidae	*Sporophila*	*castaneiventris*	# 1	Chestnut-bellied Seedeater	LC		
Aves	Passeriformes	Emberizidae	*Sporophila*	*lineola*	# 1	Lined Seedeater	LC		
Aves	Passeriformes	Emberizidae	*Sporophila*	*schistacea*	# 1	Slate-colored Seedeater	LC		
Aves	Passeriformes	Formicariidae	*Formicarius*	*analis*	# 1	Black-faced Antthrush	LC		
Aves	Passeriformes	Formicariidae	*Formicarius*	*colma*	# 1	Rufous-capped Antthrush	LC		
Aves	Passeriformes	Formicariidae	*Grallaria*	*varia*	# 1	Variegated Antpitta	LC		
Aves	Passeriformes	Formicariidae	*Hylopezus*	*macularius*	# 1	Spotted Antpitta	LC		
Aves	Passeriformes	Formicariidae	*Myrmothera*	*campanisona*	# 1	Thrush-like Antpitta	LC		
Aves	Passeriformes	Fringillidae	*Euphonia*	*cayennensis*	# 1	Golden-sided Euphonia	LC		Guayana Shield
Aves	Passeriformes	Fringillidae	*Euphonia*	*chlorotica*	# 1	Purple-throated Euphonia	LC		
Aves	Passeriformes	Fringillidae	*Euphonia*	*chrysopasta*	# 1	Golden-bellied Euphonia	LC		
Aves	Passeriformes	Fringillidae	*Euphonia*	*cyanocephala*	# 4	Golden-rumped Euphonia	LC		
Aves	Passeriformes	Fringillidae	*Euphonia*	*finschi*	# 1	Finsch's Euphonia	LC		Guayana Shield
Aves	Passeriformes	Fringillidae	*Euphonia*	*minuta*	# 1	White-vented Euphonia	LC		
Aves	Passeriformes	Fringillidae	*Euphonia*	*violacea*	# 1	Violaceous Euphonia	LC		
Aves	Passeriformes	Furnariidae	*Automolus*	*infuscatus*	# 1	Olive-backed Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Automolus*	*ochrolaemus*	# 1	Buff-throated Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Automolus*	*rubiginosus*	# 1	Ruddy Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Automolus*	*rufipileatus*	# 1	Chestnut-crowned Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Philydor*	*erythrocercus*	# 1	Rufous-rumped Foliage-gleaner	LC		
Aves	Passeriformes	Furnariidae	*Philydor*	*pyrrhodes*	# 1	Cinnamon-rumped Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Philydor*	*ruficaudatus*	# 1	Rufous-tailed Foliage-Gleaner	LC		
Aves	Passeriformes	Furnariidae	*Sclerurus*	*caudacutus*	# 1	Black-tailed Leafstosser	LC		
Aves	Passeriformes	Furnariidae	*Sclerurus*	*rufigularis*	# 3	Short-billed Leaftosser			
Aves	Passeriformes	Furnariidae	*Sclerurus*	*mexicanus*	# 1	Tawny-throated Leaftosser	LC		
Aves	Passeriformes	Furnariidae	*Synallaxis*	*albescens*	# 1	Pale-breasted Spinetail	LC		

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Aves	Passeriformes	Furnariidae	*Synallaxis*	*macconnelli*	# 1	McConnell's Spinetail	LC		Guayana Shield
Aves	Passeriformes	Furnariidae	*Synallaxis*	*rutilans*	# 1	Ruddy Spinetail	LC		
Aves	Passeriformes	Furnariidae	*Xenops*	*milleri*	# 1	Rufous-tailed Xenops	LC		
Aves	Passeriformes	Furnariidae	*Xenops*	*minutus*	# 1	Plain Xenops	LC		
Aves	Passeriformes	Furnariidae	*Xenops*	*tenuirostris*	# 1	Slender-billed Xenops	LC		
Aves	Passeriformes	Hirundinidae	*Hirundo*	*rustica*	# 1	Barn Swallow	LC		
Aves	Passeriformes	Hirundinidae	*Progne*	*chalybea*	# 1	Grey-breasted Martin	LC		
Aves	Passeriformes	Hirundinidae	*Progne*	*tapera*	# 1	Brown-chested Martin	LC		
Aves	Passeriformes	Hirundinidae	*Tachycineta*	*albiventer*	# 1	White-winged Swallow	LC		
Aves	Passeriformes	Icteridae	*Cacicus*	*cela*	# 1	Yellow-rumped Cacique	LC		
Aves	Passeriformes	Icteridae	*Cacicus*	*haemorrhous*	# 1	Red-rumped Cacique	LC		
Aves	Passeriformes	Icteridae	*Psarocolius*	*decumanus*	# 1	Crested Oropendola	LC		
Aves	Passeriformes	Icteridae	*Psarocolius*	*viridis*	# 1	Green Oropendola	LC		
Aves	Passeriformes	Icteridae	*Scaphidura*	*oryzovora*	# 1	Giant Cowbird			
Aves	Passeriformes	Mimidae	*Donacobius*	*atricapillus*	# 1, 3	Black-capped Donacobius			
Aves	Passeriformes	Mimidae	*Mimus*	*gilvus*	# 1	Tropical Mockingbird	LC		
Aves	Passeriformes	Oxyruncidae	*Oxyruncus*	*cristatus*	# 1	Sharpbill			
Aves	Passeriformes	Parulidae	*Basileuterus*	*rivularis*	# 1	River Warbler	LC		
Aves	Passeriformes	Parulidae	*Conirostrum*	*speciosum*	# 1	Chestnut-vented Conebill			
Aves	Passeriformes	Parulidae	*Granatellus*	*pelzelni*	# 1	Rose-breasted chat	LC		
Aves	Passeriformes	Parulidae	*Parula*	*pitiayumi*	# 1	Tropical Parula	LC		
Aves	Passeriformes	Parulidae	*Setophaga*	*ruticilla*	# 1	American Redstart	LC		
Aves	Passeriformes	Pipridae	*Corapipo*	*gutturalis*	# 1	White-throated Manakin	LC		Guayana Shield
Aves	Passeriformes	Pipridae	*Lepidothrix*	*serena*	# 1	White-fronted Manakin	LC		Guayana Shield
Aves	Passeriformes	Pipridae	*Manacus*	*manacus*	# 1	White-bearded Manakin	LC		
Aves	Passeriformes	Pipridae	*Neopelma*	*chrysocephalum*	# 1	Saffron-crested Tyrant-Manakin	LC		
Aves	Passeriformes	Pipridae	*Pipra*	*erythrocephala*	# 1	Golden-headed Manakin	LC		
Aves	Passeriformes	Pipridae	*Pipra*	*pipra*	# 1	White-crowned Manakin	LC		
Aves	Passeriformes	Pipridae	*Piprites*	*chloris*	# 1	Wing-barred Manakin	LC		
Aves	Passeriformes	Pipridae	*Schiffornis*	*turdinus*	# 1	Thrush-like Manakin	LC		
Aves	Passeriformes	Pipridae	*Tyranneutes*	*virescens*	# 1	Tiny Tyrant-Manakin	LC		Guayana Shield
Aves	Passeriformes	Pipridae	*Xenopipo*	*atronitens*	# 1	Black Manakin	LC		
Aves	Passeriformes	Polioptilidae	*Microbates*	*collaris*	# 1	Collared Gnatwren			
Aves	Passeriformes	Polioptilidae	*Polioptila*	*plumbea*	# 1	Tropical Gnatcatcher			
Aves	Passeriformes	Polioptilidae	*Ramphocaenus*	*melanurus*	# 1	Long-billed Gnatwren			
Aves	Passeriformes	Thamnophilidae	*Cercomacra*	*cinerascens*	# 1	Grey Antbird	LC		

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Aves	Passeriformes	Thamnophilidae	*Cercomacra*	*nigrescens*	# 1	Blackish Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Cercomacra*	*tyrannina*	# 1	Dusky Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Cymbilaimus*	*lineatus*	# 1	Fasciated Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Frederickena*	*viridis*	# 1	Black-throated Antshrike	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Gymnopithys*	*rufigula*	# 1	Rufous-throated Antbird	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Herpsilochmus*	*stictocephalus*	# 1	Todd's Antwren	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Herpsilochmus*	*sticturus*	# 1	Spot-tailed Antwren	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Hylophylax*	*naevia*	# 1	Spot-backed Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Hylophylax*	*poecilonota*	# 1	Scale-backed Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Hypocnemis*	*cantator*	# 1	Warbling Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Hypocnemoides*	*melanopogon*	# 1	Black-chinned Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmeciza*	*atrothorax*	# 1	Black-throated Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmeciza*	*ferruginea*	# 1	Ferrugineous-backed Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmoborus*	*leucophrys*	# 1	White-browed Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmornis*	*torquata*	# 1	Wing-banded Antpitta	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*axillaris*	# 1	White-flanked Antwren	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*brachyura*	# 1	Pygmy Antwren	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*guttata*	# 1	Rufous-bellied Antwren	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*gutturalis*	# 1	Brown-bellied Antwren	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*longipennis*	# 1	Long-winged Antwren	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*menetriesii*	# 1	Grey Antwren	LC		
Aves	Passeriformes	Thamnophilidae	*Myrmotherula*	*surinamensis*	# 1	Guianan Streaked-Antwren			Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Percnostola*	*leucostigma*	# 1	Spot-winged Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Percnostola*	*rufifrons*	# 1	Black-headed Antbird	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Pithys*	*albifrons*	# 1	White-plumed Antbird	LC		
Aves	Passeriformes	Thamnophilidae	*Pygiptila*	*stellaris*	# 1	Spot-winged Antshrike			
Aves	Passeriformes	Thamnophilidae	*Sakesphorus*	*canadensis*	# 1	Black-crested Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Sakesphorus*	*melanothorax*	# 1	Band-tailed Antshrike	LC		Guayana Shield
Aves	Passeriformes	Thamnophilidae	*Taraba*	*major*	# 1	Great Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Terenura*	*spodioptila*	# 1	Ash-winged Antwren			
Aves	Passeriformes	Thamnophilidae	*Thamnomanes*	*ardesiacus*	# 1	Dusky-throated Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Thamnomanes*	*caesius*	# 1	Cinereous Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Thamnophilus*	*amazonicus*	# 1	Amazonian Antshrike	LC		

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Aves	Passeriformes	Thamnophilidae	*Thamnophilus*	*murinus*	# 1	Mouse-colored Antshrike	LC		
Aves	Passeriformes	Thamnophilidae	*Thamnophilus*	*punctatus*	# 1	Slaty Antshrike	LC		
Aves	Passeriformes	Thraupidae	*Chlorophanes*	*spiza*	# 1	Green Honeycreeper			
Aves	Passeriformes	Thraupidae	*Coereba*	*flaveola*	# 2, 3	Bananaquit	LC		
Aves	Passeriformes	Thraupidae	*Cyanerpes*	*caeruleus*	# 1	Purple Honeycreeper	LC		
Aves	Passeriformes	Thraupidae	*Cyanerpes*	*cyaneus*	# 1	Red-legged Honeycreeper	LC		
Aves	Passeriformes	Thraupidae	*Cyanerpes*	*nitidus*	# 4	Short-billed Honeycreeper			
Aves	Passeriformes	Thraupidae	*Cyanicterus*	*cyanicterus*	# 1	Blue-backed Tanager	LC		Guayana Shield
Aves	Passeriformes	Thraupidae	*Dacnis*	*cayana*	# 1	Blue Dacnis	LC		
Aves	Passeriformes	Thraupidae	*Dacnis*	*lineata*	# 1	Black-faced Dacnis	LC		
Aves	Passeriformes	Thraupidae	*Hemithraupis*	*flavicollis*	# 1	Yellow-backed tanager	LC		
Aves	Passeriformes	Thraupidae	*Lamprospiza*	*melanoleuca*	# 1	Red-billed Pied Tanager	LC		
Aves	Passeriformes	Thraupidae	*Lanio*	*fulvus*	# 1	Fulvous shrike-Tanager	LC		
Aves	Passeriformes	Thraupidae	*Piranga*	*lutea*	# 1, 4	Highland Hepatic-Tanager			
Aves	Passeriformes	Thraupidae	*Ramphocelus*	*carbo*	# 1	Silver-beaked Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tachyphonus*	*cristatus*	# 1	Flame-crested tanager			
Aves	Passeriformes	Thraupidae	*Tachyphonus*	*luctuosus*	# 1	White-shouldered Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tachyphonus*	*surinamus*	# 1	Fulvous-crested Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*chilensis*	# 1	Paradise Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*gyrola*	# 1	Bay-headed Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*mexicana*	# 1	Turquoise Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*punctata*	# 1	Spotted Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*varia*	# 1	Dotted Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tangara*	*velia*	# 1	Opal-rumped Tanager	LC		
Aves	Passeriformes	Thraupidae	*Tersina*	*viridis*	# 1	Swallow-Tanager	LC		
Aves	Passeriformes	Thraupidae	*Thraupis*	*episcopus*	# 1	Blue-grey Tanager	LC		
Aves	Passeriformes	Thraupidae	*Thraupis*	*palmarum*	# 1	Palm Tanager	LC		
Aves	Passeriformes	Troglodytidae	*Cyphorhinus*	*arada*	# 1	Musician Wren	LC		
Aves	Passeriformes	Troglodytidae	*Henicorhina*	*leucosticta*	# 1	White-breasted Woodwren	LC		
Aves	Passeriformes	Troglodytidae	*Microcerculus*	*bambla*	# 1	Wing-banded Wren	LC		
Aves	Passeriformes	Troglodytidae	*Thryothorus*	*coraya*	# 1	Coraya Wren	LC		
Aves	Passeriformes	Troglodytidae	*Thryothorus*	*leucotis*	# 1	Buff-breasted Wren	LC		
Aves	Passeriformes	Troglodytidae	*Troglodytes*	*aedon*	# 1	House Wren	LC		
Aves	Passeriformes	Turdidae	*Catharus*	*minimus*	# 4	Grey-cheeked Thrush	LC		
Aves	Passeriformes	Turdidae	*Turdus*	*albicollis*	# 1	White-necked Robin	LC		
Aves	Passeriformes	Turdidae	*Turdus*	*fumigatus*	# 1	Cocoa Thrush	LC		
Aves	Passeriformes	Turdidae	*Turdus*	*leucomelas*	# 1	Pale-breasted Thrush	LC		
Aves	Passeriformes	Turdidae	*Turdus*	*nudigenis*	# 1	Bare-eyed Robin	LC		

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Passeriformes	Tyrannidae	*Attila*	*spadiceus*	# 1	Bright-rumped Attila	LC		
Aves	Passeriformes	Tyrannidae	*Camptostoma*	*obsoletum*	# 1	Southern beardless Tyrannulet	LC		
Aves	Passeriformes	Tyrannidae	*Colonia*	*colonus*	# 1	Long-tailed Tyrant	LC		
Aves	Passeriformes	Tyrannidae	*Conopias*	*parva*	# 1	White-ringed Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Contopus*	*albogularis*	# 1	White-throated Pewee	LC		Guayana Shield
Aves	Passeriformes	Tyrannidae	*Contopus*	*cooperi*	# 1	Olive-sided Flycatcher	NT		
Aves	Passeriformes	Tyrannidae	*Corythopis*	*torquatus*	# 1	Ringed Antpipit	LC		
Aves	Passeriformes	Tyrannidae	*Elaenia*	*flavogaster*	# 1	Yellow-bellied Elaenia	LC		
Aves	Passeriformes	Tyrannidae	*Elaenia*	*parvirostris*	# 1	Small-billed Elaenia	LC		
Aves	Passeriformes	Tyrannidae	*Empidonomus*	*varius*	# 1	Variegated Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Hemitriccus*	*zosterops*	# 1	White-eyed Tody-tyrant	LC		
Aves	Passeriformes	Tyrannidae	*Laniocera*	*hypopyrrha*	# 1	Cinereous Mourner			
Aves	Passeriformes	Tyrannidae	*Lathrotriccus*	*euleri*	# 3	Euler's Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Legatus*	*leucophaius*	# 1	Piratic Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Leptopogon*	*amaurocephalus*	# 1	Sepia-capped Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Lophotriccus*	*galeatus*	# 1	Helmeted Pygmy-Tyrant	LC		
Aves	Passeriformes	Tyrannidae	*Lophotriccus*	*vitiosus*	# 1	Double-banded Pygmy-Tyrant	LC		
Aves	Passeriformes	Tyrannidae	*Megarynchus*	*pitangua*	# 1	Boat-billed Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Mionectes*	*macconnelli*	# 1	McConnell's Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Mionectes*	*oleagineus*	# 1	Ochre-bellied Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Myiarchus*	*ferox*	# 1	Short-crested Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Myiarchus*	*tuberculifer*	# 1	Dusky-capped Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Myiobius*	*barbatus*	# 1	Sulphur-rumped Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Myiopagis*	*flavivertex*	# 1	Yellow-crowned Elaenia	LC		
Aves	Passeriformes	Tyrannidae	*Myiopagis*	*gaimardii*	# 1	Forest Elaenia	LC		
Aves	Passeriformes	Tyrannidae	*Myiornis*	*ecaudatus*	# 1	Short-tailed Pygmy-Tyrant	LC		
Aves	Passeriformes	Tyrannidae	*Myiozetetes*	*cayanensis*	# 1	Rusty-margined Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Myiozetetes*	*luteiventris*	# 1	Dusky-chested Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Onychorhynchus*	*coronatus*	# 1	Royal Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Ornithion*	*inerme*	# 1	White-lored Tyrannulet	LC		
Aves	Passeriformes	Tyrannidae	*Phaeomyias*	*murina*	# 1	Mouse-coloured Tyrannulet			
Aves	Passeriformes	Tyrannidae	*Phyllomyias*	*griseiceps*	# 4	Sooty-headed Tyrannulet			
Aves	Passeriformes	Tyrannidae	*Pitangus*	*lictor*	# 1	Lesser Kiskadee	LC		
Aves	Passeriformes	Tyrannidae	*Pitangus*	*sulphuratus*	# 1	Great Kiskadee	LC		
Aves	Passeriformes	Tyrannidae	*Platyrinchus*	*coronatus*	# 1	Golden-crowned Spadebill	LC		
Aves	Passeriformes	Tyrannidae	*Platyrinchus*	*platyrhynchos*	# 1	White-crested Spadebill	LC		
Aves	Passeriformes	Tyrannidae	*Platyrinchus*	*saturatus*	# 1	Cinnamon-crested Spadebill	LC		

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Passeriformes	Tyrannidae	*Rhynchocyclus*	*olivaceus*	# 1	Olivaceous Flatbill	LC		
Aves	Passeriformes	Tyrannidae	*Rhytipterna*	*simplex*	# 1	Greyish Mourner	LC		
Aves	Passeriformes	Tyrannidae	*Sirystes*	*sibilator*	# 1	Sirystes	LC		
Aves	Passeriformes	Tyrannidae	*Terenotriccus*	*erythrurus*	# 1	Ruddy-tailed Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Todirostrum*	*cinereum*	# 1	Common Tody-flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Tolmomyias*	*assimilis*	# 4	Zimmer's Flatbill	LC		
Aves	Passeriformes	Tyrannidae	*Tolmomyias*	*poliocephalus*	# 1	Grey-crowned Flycatcher	LC		
Aves	Passeriformes	Tyrannidae	*Tyrannulus*	*elatus*	# 1	Yellow-crowned Tyrannulet	LC		
Aves	Passeriformes	Tyrannidae	*Tyrannus*	*melancholicus*	# 1	Tropical Kingbird	LC		
Aves	Passeriformes	Tyrannidae	*Zimmerius*	*gracilipes*	# 1	Slender-footed Tyrannulet	LC		
Aves	Passeriformes	Vireonidae	*Cyclarhis*	*gujanensis*	# 1	Rufous-browed Peppershrike			
Aves	Passeriformes	Vireonidae	*Hylophilus*	*muscicapinus*	# 1	Buff-cheeked Greenlet			
Aves	Passeriformes	Vireonidae	*Hylophilus*	*ochraceiceps*	# 1	Tawny-crowned Greenlet			
Aves	Passeriformes	Vireonidae	*Hylophilus*	*thoracicus*	# 1	Lemon-chested Greenlet			
Aves	Passeriformes	Vireonidae	*Vireo*	*olivaceus*	# 1	Red-eyed Vireo	LC		
Aves	Passeriformes	Vireonidae	*Vireolanius*	*leucotis*	# 1	Slaty-capped Shrike-Vireo	LC		
Aves	Pelecaniformes	Anhingidae	*Anhinga*	*anhinga*	# 1	Anhinga	LC		
Aves	Piciformes	Capitonidae	*Capito*	*niger*	# 1	Black-spotted Barbet	LC		
Aves	Piciformes	Picidae	*Campephilus*	*melanoleucos*	# 1	Crimson-crested Woodpecker	LC		
Aves	Piciformes	Picidae	*Campephilus*	*rubricollis*	# 1	Red-necked Woodpecker	LC		
Aves	Piciformes	Picidae	*Celeus*	*elegans*	# 1	Chestnut Woodpecker	LC		
Aves	Piciformes	Picidae	*Celeus*	*torquatus*	# 1	Ringed Woodpecker	LC		
Aves	Piciformes	Picidae	*Celeus*	*undatus*	# 1	Waved Woodpecker	LC		
Aves	Piciformes	Picidae	*Dryocopus*	*lineatus*	# 1	Lineated Woodpecker	LC		
Aves	Piciformes	Picidae	*Melanerpes*	*cruentatus*	# 1	Yellow-tufted Woodpecker	LC		
Aves	Piciformes	Picidae	*Piculus*	*chrysochloros*	# 1	Golden-green Woodpecker	LC		
Aves	Piciformes	Picidae	*Piculus*	*flavigula*	# 1	Yellow-throated Woodpecker	LC		
Aves	Piciformes	Picidae	*Piculus*	*rubiginosus*	# 1	Golden-olive Woodpecker	LC		
Aves	Piciformes	Picidae	*Picumnus*	*exilis*	# 1	Golden-spangled Piculet	LC		
Aves	Piciformes	Picidae	*Veniliornis*	*cassini*	# 1	Golden-collared Woodpecker	LC		Guayana Shield
Aves	Piciformes	Ramphastidae	*Pteroglossus*	*aracari*	# 1	Black-necked Aracari	LC	II	
Aves	Piciformes	Ramphastidae	*Pteroglossus*	*viridis*	# 1	Green Aracari	LC	II	Guayana Shield
Aves	Piciformes	Ramphastidae	*Ramphastos*	*tucanus*	# 1	White-throated Toucan	LC	II	
Aves	Piciformes	Ramphastidae	*Ramphastos*	*vitellinus*	# 1	Channel-billed Toucan	LC	II	
Aves	Piciformes	Ramphastidae	*Selenidera*	*culik*	# 1	Guianan Toucanet	LC		Guayana Shield
Aves	Psittaciformes	Psittacidae	*Amazona*	*amazonica*	# 1	Orange-winged Parrot	LC	II	

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Aves	Psittaciformes	Psittacidae	*Amazona*	*dufresniana*	# 1	Blue-cheeked Parrot	NT	II	Guayana Shield
Aves	Psittaciformes	Psittacidae	*Amazona*	*farinosa*	# 1	Mealy Amazon	LC	II	
Aves	Psittaciformes	Psittacidae	*Amazona*	*ochrocephala*	# 1	Yellow-crowned Parrot	LC	II	
Aves	Psittaciformes	Psittacidae	*Ara*	*ararauna*	# 1	Blue-and-yellow Macaw	LC	II	
Aves	Psittaciformes	Psittacidae	*Ara*	*chloroptera*	# 1	Red-and-green Macaw	LC	II	
Aves	Psittaciformes	Psittacidae	*Ara*	*macao*	# 1	Scarlet Macaw	LC	I	
Aves	Psittaciformes	Psittacidae	*Orthopsittaca*	*manilata*	# 1	Red-bellied Macaw	LC	II	
Aves	Psittaciformes	Psittacidae	*Aratinga*	*leucophtalmus*	# 1	White-eyed Parakeet	LC	II	
Aves	Psittaciformes	Psittacidae	*Brotogeris*	*chrysopterus*	# 1	Golden-winged Parakeet	LC	II	
Aves	Psittaciformes	Psittacidae	*Deroptyus*	*accipitrinus*	# 1	Red fan Parrot	LC	II	
Aves	Psittaciformes	Psittacidae	*Pionites*	*melanocephala*	# 1	Black-headed Parrot	LC	II	
Aves	Psittaciformes	Psittacidae	*Pionopsitta*	*caica*	# 1	Caica Parrot	LC	II	Guayana Shield
Aves	Psittaciformes	Psittacidae	*Pionus*	*fuscus*	# 1	Dusky Parrot	LC	II	
Aves	Psittaciformes	Psittacidae	*Pionus*	*menstruus*	# 1	Blue-headed Parrot	LC	II	
Aves	Psittaciformes	Psittacidae	*Pyrrhura*	*picta*	# 1	Painted Parakeet	LC	II	
Aves	Psittaciformes	Psittacidae	*Touit*	*batavicus*	# 1	Lilac-tailed Parrotlet	LC	II	
Aves	Psittaciformes	Psittacidae	*Touit*	*purpurata*	# 1	Sapphire-rumped Parrotlet	LC	II	
Aves	Strigiformes	Strigidae	*Ciccaba*	*huhula*	# 1	Black-banded Owl	LC	II	
Aves	Strigiformes	Strigidae	*Ciccaba*	*virgata*	# 1	Mottled Owl	LC	II	
Aves	Strigiformes	Strigidae	*Lophostrix*	*cristata*	# 1	Crested Owl	LC	II	
Aves	Strigiformes	Strigidae	*Megascops*	*choliba*	# 3	Tropical screech-Owl	LC	II	
Aves	Strigiformes	Strigidae	*Megascops*	*watsonii*	# 3	Tawny-bellied screech-Owl	LC	II	
Aves	Strigiformes	Strigidae	*Pulsatrix*	*perspicillata*	# 1	Spectacled Owl	LC	II	
Aves	Tinamiformes	Tinamidae	*Crypturellus*	*cinereus*	# 1	Cinereous Tinamou	LC		
Aves	Tinamiformes	Tinamidae	*Crypturellus*	*erythropus*	# 1	Red-legged Tinamou	LC		
Aves	Tinamiformes	Tinamidae	*Crypturellus*	*soui*	# 1	Little Tinamou	LC		
Aves	Tinamiformes	Tinamidae	*Crypturellus*	*variegatus*	# 1	Variegated Tinamou	LC		
Aves	Tinamiformes	Tinamidae	*Tinamus*	*major*	# 1	Great Tinamou	LC		
Aves	Trogoniformes	Trogonidae	*Trogon*	*collaris*	# 1	Collared Trogon	LC		
Aves	Trogoniformes	Trogonidae	*Trogon*	*melanurus*	# 1	Black-tailed Trogon	LC		
Aves	Trogoniformes	Trogonidae	*Trogon*	*rufus*	# 1	Black-throated Trogon	LC		
Aves	Trogoniformes	Trogonidae	*Trogon*	*violaceus*	# 1	Violaceous Trogon	LC		
Aves	Trogoniformes	Trogonidae	*Trogon*	*viridis*	# 1	White-tailed Trogon	LC		

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Taxonomic Reference (2) InfoNatura: Birds, mammals, and amphibians of Latin America [web application]. 2004. Version 4.1. Arlington, Virginia (USA): NatureServe. Available: http://www.natureserve.org/infonatura. (Accessed: July 1, 2006)

Taxonomic Reference (3) http://www.museum.lsu.edu/~Remsen/SACCBaseline.html

Taxonomic Reference (4) Hilty, S.L. 2003. Birds of Venezuela, second edition. Princeton University Press, Princeton, NJ.

Appendix 20

Reptiles and Amphibians recorded from Brownsberg.

Bart P.E. De Dijn, Iwan E. Molgo, Christian Marty, Martina Luger, Max Ringler, Samuel Crothers IV, Brice Noonan, Kelly Fitzgerald

IUCN Red List Categories of threatened species (IUCN 2006): Data Deficient (DD, not enough is known to make an assessment), Near Threatened (NT), Least Concern (LC, listed but not threatened), and Vulnerable (VU).
CITES Appendices I, II and III list species afforded different levels or types of protection from over-exploitation (see http://www.cites.org/eng/app/index.shtml).

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Amphibia	Anura	Allophrynidae	*Allophryne*	*ruthveni*	# 2		LC		
Amphibia	Anura	Bufonidae	*Atelopus*	*hoogmoedi*	# 1, 2		VU		Guayana Shield
Amphibia	Anura	Bufonidae	*Bufo*	*granulosus*	# 2		LC		
Amphibia	Anura	Bufonidae	*Bufo*	*guttatus*	# 2		LC		
Amphibia	Anura	Bufonidae	*Bufo*	*margaritifer*	# 2		LC		
Amphibia	Anura	Bufonidae	*Bufo*	*marinus*	# 2	Giant toad, Papi Todo	LC		
Amphibia	Anura	Bufonidae	*Bufo*	sp. *typhonius* group	# 1		LC		
Amphibia	Anura	Bufonidae	*Dendrophryniscus*	*minutus*	# 2		LC		
Amphibia	Anura	Centrolenidae	*Cochranella*	*oyampiensis*	# 2		LC		East and Central Guayana Shield
Amphibia	Anura	Centrolenidae	*Cochranella*	sp.					
Amphibia	Anura	Centrolenidae	*Hyalinobatrachium*	sp.					
Amphibia	Anura	Dendrobatidae	*Allobates*	*femoralis*	# 2		LC		
Amphibia	Anura	Dendrobatidae	*Colostethus*	cf. *baeobatrachus*	# 2		DD		
Amphibia	Anura	Dendrobatidae	*Colostethus*	*degranvillei*	# 2		LC		
Amphibia	Anura	Dendrobatidae	*Colostethus*	*granti*	# 2		LC		Guayana Shield
Amphibia	Anura	Dendrobatidae	*Colostethus*	*sp.*					
Amphibia	Anura	Dendrobatidae	*Epipedobates*	*trivittatus*	# 2	Okopipi	LC	II	
Amphibia	Anura	Hylidae	*Hyla*	*boans*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*brevifrons*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*crepitans*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*geographica*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*leucophyllata*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*marmorata*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*minuscula*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*minuta*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	*punctata*	# 2		LC		
Amphibia	Anura	Hylidae	*Hyla*	sp.					
Amphibia	Anura	Hylidae	*Hyla*	sp. 1	# 1				East Guayana Shield?
Amphibia	Anura	Hylidae	*Osteocephalus*	*buckleyi*	# 2		LC		

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Amphibia	Anura	Hylidae	*Osteocephalus*	*cabrerai*					
Amphibia	Anura	Hylidae	*Osteocephalus*	*oophagus*	# 2		LC		
Amphibia	Anura	Hylidae	*Osteocephalus*	*taurinus*	# 1		LC		
Amphibia	Anura	Hylidae	*Phrynohyas*	*coriacea*			LC		
Amphibia	Anura	Hylidae	*Phrynohyas*	*hadroceps*	# 2		LC		
Amphibia	Anura	Hylidae	*Phyllomedusa*	*bicolor*	# 2		LC		
Amphibia	Anura	Hylidae	*Phyllomedusa*	*hypochondrialis*	# 2		LC		
Amphibia	Anura	Hylidae	*Phyllomedusa*	*tomopterna*	# 2		LC		
Amphibia	Anura	Hylidae	*Phyllomedusa*	*vaillantii*	# 2		LC		
Amphibia	Anura	Hylidae	*Scinax*	*boesemani*	# 2		LC		
Amphibia	Anura	Hylidae	*Scinax*	*proboscideus*	# 2		LC		Guayana Shield
Amphibia	Anura	Hylidae	*Scinax*	*ruber*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Adenomera*	*andreae*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Adenomera*	cf. *hylaedactyla*					
Amphibia	Anura	Leptodactylidae	*Adenomera*	*hylaedactyla*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Adenomera*	sp.					
Amphibia	Anura	Leptodactylidae	*Adenomera*	*heyeri*			LC		
Amphibia	Anura	Leptodactylidae	*Ceratophrys*	*cornuta*	# 2	Amazonian Horned Frog	LC		
Amphibia	Anura	Leptodactylidae	*Eleutherodactylus*	*chiastonotus*	# 2		LC		East Guayana Shield
Amphibia	Anura	Leptodactylidae	*Eleutherodactylus*	*gutturalis*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Eleutherodactylus*	*inguinalis*	# 2		LC		East Guayana Shield
Amphibia	Anura	Leptodactylidae	*Eleutherodactylus*	sp.					
Amphibia	Anura	Leptodactylidae	*Eleutherodactylus*	*zeuctotylus*	# 2		LC		North Guayana Shield
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*bolivianus*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*knudseni*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*leptodactyloides*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*longirostris*	# 2		LC		Guayana Shield
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*myersi*	# 2		LC		Guayana Shield
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*mystaceus*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*pentadactylus*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*petersii*	# 2				
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*rhodomystax*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Leptodactylus*	*stenodema*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Physalaemus*	*ephippifer*	# 2		LC		

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Amphibia	Anura	Leptodactylidae	*Physalaemus*	*petersi*	# 2		LC		
Amphibia	Anura	Leptodactylidae	*Physalaemus*	sp.					
Amphibia	Anura	Microhylidae	*Chiasmocleis*	*shudikarensis*	# 2		LC		
Amphibia	Anura	Microhylidae	*Chiasmocleis*	sp.					
Amphibia	Anura	Pipidae	*Pipa*	*aspera*	# 2		LC		Guayana Shield
Amphibia	Gymnophiona	Caeciliidae	*Microcaecilia*	*unicolor*	# 2	Worm salamander	LC		North French Guiana
Amphibia	Gymnophiona	Rhinatrematidae	*Rhinatrema*	*bivittatum*	# 2	Worm salamander	LC		North Guayana Shield
Reptilia	Crocodylia	Alligatoridae	*Paleosuchus*	*trigonatus*	# 3	Smooth-fronted cayman, Wigkopkaaiman			
Reptilia	Squamata	Amphisbaenidae	*Amphisbaena*	*alba*	# 3	Toe ede sneki			
Reptilia	Squamata	Amphisbaenidae	*Amphisbaena*	*fuliginosa*	# 3	Toe ede sneki			
Reptilia	Squamata	Aniliidae	*Anilius*	*scytale*	# 3	Krarasneki			
Reptilia	Squamata	Boïdae	*Boa*	*constrictor*	# 3	Dagoewe sneki			
Reptilia	Squamata	Boïdae	*Corallus*	*caninus*	# 3	Bigi Popokay sneki			
Reptilia	Squamata	Boïdae	*Epicrates*	*cenchria*	# 3	Egron Aboma			
Reptilia	Squamata	Boïdae	*Eunectes*	*murinus*	# 3	Aboma			
Reptilia	Squamata	Colubridae	*Atractus*	*badius*	# 3	Faja sneki			
Reptilia	Squamata	Colubridae	*Atractus*	*zidoki*	# 3				Guayana Shield
Reptilia	Squamata	Colubridae	*Chironius*	*carinatus*	# 3	Reditere			
Reptilia	Squamata	Colubridae	*Chironius*	*fuscus*	# 3	Ingibangi			
Reptilia	Squamata	Colubridae	*Chironius*	*multiventris*	# 3				
Reptilia	Squamata	Colubridae	*Chironius*	*scurrulus*	# 3				
Reptilia	Squamata	Colubridae	*Chironius*	sp.	# 3				
Reptilia	Squamata	Colubridae	*Dipsas*	*catesbyi*	# 3				
Reptilia	Squamata	Colubridae	*Dipsas*	*indica*	# 3				
Reptilia	Squamata	Colubridae	*Erythrolampus*	*aesculapii*	# 3	Krara sneki			
Reptilia	Squamata	Colubridae	*Helicops*	*angulatus*	# 3	Watra sneki			
Reptilia	Squamata	Colubridae	*Imantodes*	*cenchoa*	# 3				
Reptilia	Squamata	Colubridae	*Leptophis*	*ahaetulla*	# 3				
Reptilia	Squamata	Colubridae	*Liophis*	*reginae*	# 3	Popkai sneki			
Reptilia	Squamata	Colubridae	*Liophis*	*typhlus*	# 3	Popkai sneki			
Reptilia	Squamata	Colubridae	*Mastigodryas*	*boddaerti*	# 3	Alata sneki, Alataman			
Reptilia	Squamata	Colubridae	*Oxybelis*	*aeneus*	# 3	Busi swipi, Tite sneki			
Reptilia	Squamata	Colubridae	*Oxybelis*	*argenteus*	# 3	Busi swipi, Tite sneki			

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Reptilia	Squamata	Colubridae	*Oxybelis*	*fulgidus*	# 3				
Reptilia	Squamata	Colubridae	*Oxyrhopus*	*aff. melanogenys*	# 3				
Reptilia	Squamata	Colubridae	*Oxyrhopus*	*formosus*	# 3				
Reptilia	Squamata	Colubridae	*Philodryas*	*olfersii*	# 3				
Reptilia	Squamata	Colubridae	*Pseustes*	*poecilonotus*	# 3	Brokobaka, Trangabaka			
Reptilia	Squamata	Colubridae	*Pseustes*	*sulphureus*	# 3	Brokobaka, Trangabaka			
Reptilia	Squamata	Colubridae	*Siphlophis*	*cervinus*	# 3				
Reptilia	Squamata	Colubridae	*Tantilla*	*melanocephala*	# 3				
Reptilia	Squamata	Colubridae	*Xenodon*	*rhabdocephalus*	# 3	Todo sneki			
Reptilia	Squamata	Colubridae	*Xenopholis*	*scalaris*	# 3				
Reptilia	Squamata	Elapidae	*Micrurus*	*collaris*	# 3	Krara sneki			Guayana Shield
Reptilia	Squamata	Elapidae	*Micrurus*	*hemprichii*	# 3	Krara sneki			
Reptilia	Squamata	Elapidae	*Micrurus*	*diutus*	# 3	Krara sneki			
Reptilia	Squamata	Elapidae	*Micrurus*	*lemniscatus*	# 3	Krara sneki			
Reptilia	Squamata	Elapidae	*Micrurus*	*psyches*	# 3	Coral snake; Blaka Krara sneki			
Reptilia	Squamata	Gekkonidae	*Coleodactylus*	*amazonicus*	# 4				
Reptilia	Squamata	Gekkonidae	*Gonatodes*	*annularis*	# 4				
Reptilia	Squamata	Gekkonidae	*Gonatodes*	*humeralis*	# 4				
Reptilia	Squamata	Gekkonidae	*Hemidactylus*	*mabouia*	# 4				
Reptilia	Squamata	Gekkonidae	*Thecadactylus*	*rapicauda*	# 4				
Reptilia	Squamata	Gymnophthalmidae	*Alopoglossus*	*angulatus*	# 4				
Reptilia	Squamata	Gymnophthalmidae	*Arthrosaura*	*kockii*	# 4				
Reptilia	Squamata	Gymnophthalmidae	*Iphisa*	*elegans*	# 4				
Reptilia	Squamata	Gymnophthalmidae	*Leposoma*	*guianense*	# 4				Guayana Shield
Reptilia	Squamata	Gymnophthalmidae	*Leposoma*	sp.					
Reptilia	Squamata	Gymnophthalmidae	*Neusticurus*	*bicarinatus*	# 4				
Reptilia	Squamata	Gymnophthalmidae	*Neusticurus*	*rudis*	# 4				Guayana Shield
Reptilia	Squamata	Gymnophthalmidae	*Tretioscincus*	*agilis*	# 4				
Reptilia	Squamata	Iguanidae	*Iguana*	*iguana*	# 4	Iguana			
Reptilia	Squamata	Leptotyphlopidae	*Leptotyphlops*	*tenella*	# 3				
Reptilia	Squamata	Leptotyphlopidae	*Leptotyphlops*	*collaris*	# 3				Guayana Shield
Reptilia	Squamata	Polychrotidae	*Anolis*	*fuscoauratus*	# 4				
Reptilia	Squamata	Polychrotidae	*Anolis*	*nitens chrysolepis*					
Reptilia	Squamata	Polychrotidae	*Anolis*	*punctatus*	# 4				

Class	Order	Family	Genus	Species	Taxonomic Reference	Common Name(s)	IUCN	CITES	Endemism
Reptilia	Squamata	Polychrotidae	*Polychrus*	*marmoratus*	# 4				
Reptilia	Squamata	Scincidae	*Mabuya*	*nigropunctatus*	# 4				
Reptilia	Squamata	Teiidae	*Ameiva*	*ameiva*	# 4				
Reptilia	Squamata	Teiidae	*Cercosaura*	*ocellata*	# 5				
Reptilia	Squamata	Teiidae	*Cnemidophorus*	*lemniscatus*	# 4				
Reptilia	Squamata	Teiidae	*Gymnophthalmus*	*underwoodi*	# 5				
Reptilia	Squamata	Teiidae	*Kentropyx*	*calcarata*	# 4				
Reptilia	Squamata	Teiidae	*Tupinambis*	*teguixin*	# 4	Sapakara			
Reptilia	Squamata	Tropiduridae	*Plica*	*plica*	# 4				
Reptilia	Squamata	Tropiduridae	*Plica*	*umbra*	# 4				
Reptilia	Squamata	Tropiduridae	*Uracentron*	*azureum*	# 4				
Reptilia	Squamata	Typhlypidae	*Typhlops*	*reticulates*	# 3				
Reptilia	Squamata	Viperidae	*Bothrops*	*atrox*	# 3	Labaria, Owrukuku			
Reptilia	Squamata	Viperidae	*Bothrops*	*bilineatus*	# 3	Popkai sneki			
Reptilia	Squamata	Viperidae	*Bothrops*	*brazili*	# 3	Busi Owrukuku			
Reptilia	Squamata	Viperidae	*Lachesis*	*muta*	# 3	Maka sneki, Bushmaster			
Reptilia	Testudines	Chelidae	*Phrynops*	*nasutus*	# 6	Common Toad-headed turtle			
Reptilia	Testudines	Chelidae	*Phrynops*	*gibbus*	# 6	South American Keel-backed Side-necked turtle			
Reptilia	Testudines	Chelidae	*Platemys*	*platycephala*	# 6	Flat-headed Flat-shelled turtle			
Reptilia	Testudines	Emydidae	*Rhinoclemmys*	*punctularia*	# 6	Guiana Wood turtle, Arakaka			
Reptilia	Testudines	Kinosternidae	*Kinosternon*	*scorpioides*	# 6	Scorpion mud turtle			
Reptilia	Testudines	Testudinidae	*Geochelone*	*carbonaria*	# 6	Sabana sekrepatu		II	
Reptilia	Testudines	Testudinidae	*Geochelone*	*denticulata*	# 6	Busi sekrepatu	VU	II	

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