Executive Summary

Source: A Rapid Biological Assessment of the Upper Palumeu River Watershed (Grensgebergte and Kasikasima) of Southeastern Suriname: 38

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Executive Summary

INTRODUCTION

Suriname is one of the last places on Earth where an opportunity still exists to conserve huge tracts of pristine diverse tropical forests. Suriname is less than 6% deforested, exhibits the lowest population density of any moist tropical region on Earth (0.2 people/ha), has few roads in the forested part of the country (which can be accessed only by small boat, small plane, or on foot), and virtually all of the lands are public and under the control of national government or indigenous and Maroon communities.

However, the isolation that has protected Suriname's ecosystems, natural resources, and indigenous cultures is disappearing at an increasing rate, and the opportunity to act to preserve these remarkable resources will soon be gone. Record high commodity prices have encouraged the spread of illegal gold miners from Brazil across the region, spurred potential major hydropower and mining investments, and provided the incentive to press ahead with road and dam projects.

Southeastern Suriname is possibly the most remote and pristine region of Suriname. The region extends from the Sipaliwini Nature Reserve in the west, across the mountain ranges of the Grensgebergte, Toemoekhoemak gebergte, and Orangebergte, to the border with French Guiana. It is bordered to the north by the Tapanahony River, which becomes part of the Marowijne River watershed. Southern Suriname has a rich biodiversity, making it a high priority region for protection. This region was highlighted in the Guiana Shield Priority Setting Workshop held by CI, IUCN and UNDP in April 2002 (Huber and Foster 2003) as one of the highest ranked areas for biodiversity conservation. One of the first steps in the process of protecting Southern Suriname is to collect baseline biological and socio-economic data for the region, particularly in areas where no scientific data exist.

Conservation International-Suriname and CI's RAP program began this process by collecting biodiversity data in August 2010 in Southwestern Suriname near the Amerindian village of Kwamalasamutu (see results in O'Shea et al. 2011). The 2012 RAP survey of Southeastern Suriname was the next step in establishing a baseline of data for Southern Suriname. Together, these RAP surveys provide data to guide conservation and development activities in Southern Suriname and to provide scientific justification for protection of this diverse and important ecosystem.

The Grensgebergte and Kasikasima Mountains and Palumeu River

The RAP survey provided scientists with the rare opportunity to explore a totally unstudied and unique mountain range, as well as the Upper Palumeu River. To our knowledge, the mountains of the Grensgebergte (Border Mountains) and Upper Palumeu River have never been studied or even explored by scientists. The local Amerindians occasionally travel up the Palumeu River and walk over the border to Brazil but few ever enter the Grensgebergte Mountains. The elevation and forest types within the Southeastern Suriname mountains range from lowland floodplain forest to isolated mountain peaks at over 780 m elevation. The Palumeu River flows in a wide floodplain within the Grensgebergte but the river is shallow and difficult to navigate by boat. Thus the only way to enter the mountains is to cut a new trail and enter on foot, or to enter by air. The first step for this RAP survey was to identify rocky outcrops in the mountains from satellite imagery where a helicopter could possibly land. The Kasikasima Mountain is a unique granitic mountain formation that rises over 700 m above the rainforest. It has over twelve peaks of steep granite outcroppings. While the METS tourism company takes adventurous tourists to the rock, there have not been many studies of the biodiversity of the area. The mountain has a trail that allows access up to about 500 m within the forested side of the mountain.

The RAP Team

The RAP scientific team of 16 people included scientists from the Anton de Kom University of Suriname, CELOS, Conservation International, Global Wildlife Conservation, the Museum of Comparative Zoology at Harvard University, the North Carolina Museum of Natural Sciences, the Biodiversity Institute at the University of Kansas, the Royal Ontario Museum, and the National Herbarium of the Netherlands—Naturalis Biodiversity Centre. The RAP team

collected data on water quality, plants, and the following groups of animals: aquatic beetles, dung beetles, ants, katydids, fishes, reptiles and amphibians, birds, and small and large mammals. The RAP team was accompanied by many local AmerIndian guides and field assistants, a film crew from Media Vision, a writer and a photographer sponsored by the National Geographic Society, two game wardens from the Nature Conservation Division, two medics, and staff from Conservation International-Suriname.

CI'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 over 80 terrestrial, freshwater aquatic and marine rapid biodiversity surveys and have contributed to building local scientific capacity for scientists in over 30 countries (Alonso et al. 2011). Biological information from RAP surveys has resulted in the protection of thousands of hectares of tropical forest, including the declaration of protected areas and the identification of biodiversity priorities in numerous countries.

The Grensgebergte and Kasikasima RAP Adventure

The Grensgebergte and Kasikasima RAP survey took place from March 8–29, 2012. Prior to these dates, an advance team of 21 men from the Amerindian villages of Apetina (Wayana) and Palumeu (Trio and Wayana) led a reconnaissance mission to locate and set up the first RAP base camp (RAP Site 1) from February 26–March 7, 2012. They were accompanied by Krisna Gajapersad (RAP coordinator from CI-Suriname), three CI field workers (Andre Semmie, Hermando Banda, and Jeffrey Krimbo), along with Ted Jantz and Rafael Jantz from MediaVision, who filmed the adventure. The team traversed and carried six heavy boats around many treacherous rapids to get far up the Palumeu River. The water level was very high, which made the trip all the more dangerous and lengthy. They reached Juuru camp on March 6, a site where the Trio and Wayana occasionally camp on their way to Brazil. From this site, a trail to the border with Brazil commences. The men from Apetina quickly got to work to clear a 30 m × 30 m site within the forest within which a small helicopter could land. They chose the site of a former small agricultural plot so cutting was a bit easier. They also set up a very large base camp consisting of two large tents (tarps over poles) for hanging hammocks in which to sleep, a kitchen tent, an eating tent, and a laboratory tent for the soon to be arriving scientific team. They also built several smaller tents to sleep in themselves. The camp was at the bottom of a steep hill, right along the Palumeu River, which at this point was a fairly small creek.

The RAP scientific team of 16 scientists, accompanied by a journalist and a photographer from National Geographic Magazine, two game wardens from Nature Conservation Division, and a medic flew from Paramaribo to Palumeu Village on March 8. They brought along with them about 2000 kilos in food and scientific equipment! Some of this was stored by METS in Palumeu while most went to the base camp with them. The RAP team spent one night in Palumeu at the METS camp. On March 9, a helicopter from HiJet arrived in Palumeu around 10 am (to the delight and wonder of the people of Palumeu!). The RAP team and gear were transported from Palumeu Village to the RAP base camp (RAP Site 1) over the following three days. Each flight to base camp took approximately one hour round trip. On one trip, the helicopter had mechanical difficulties while at the base camp and was almost stuck there overnight. However, the helicopter mechanic was fortunately along on the ride and was able to fix the problem well enough for the helicopter to return to Palumeu. However, a problem with the rotor motor was found and a part had to be ordered from Miami. In the meantime, HiJet sent a replacement helicopter to assist the RAP team. The rest of the RAP team and equipment finally arrived at RAP base camp on March 11 in the new helicopter.

From this base camp, the RAP team sampled in the lowland forest nearby and in the Upper Palumeu River (RAP Site 1) and also flew by helicopter to a mountain top in the Grensgebergte Mountains (RAP Site 2) with an open rocky outcrop and a flat area upon which the helicopter was able to land. The RAP team visited this mountain top in small numbers (2–6 people per day) with some people staying overnight or a few nights on the mountain. Fortunately, the weather was clear enough for helicopter flying and landing on the mountain most days. Only on March 17 was the weather too cloudy for the helicopter to land in the morning, but it was able to pick up stranded RAP team members in the late afternoon. There must have been a lot of rain in the upper reaches of the Palumeu River that day (and the previous day) for the river started to rise and by 6 pm on March 17 had flooded most of the base camp. The trail that once connected the base camp with the helipad was now completely underwater and had to be traversed by boat (see page 20). This area was known to flood by the local Amerindians, but the RAP team was hoping that it would not flood during the week that the team spent there! However, it did and the water continued to rise during the night.

Thus on March 18, the RAP team evacuated the first base camp and set off toward the next camp at Kasikasima on the Middle Palumeu river. The botany, water quality, and fish teams, along with all the Amerindians and most of the support crew headed out in boats. They were able to sample a third site (RAP Site 3) at the confluence of the Palumeu River with the Makrutu Creek en route. Eleven of the RAP scientists along with the National Geographic team departed by helicopter and landed at Kampu, a small village across the river from the Kasikasima Mountain. The scientists spent one night there. The next day, Krisna Gajapersad (who had left the field on March 9 for a week in Paramaribo) arrived at the village by boat with Priscilla Miranda from CI-Suriname

and nine men from Palumeu. The men immediately set to constructing a base camp (RAP Site 4) for the RAP team along the river on the side of the Kasikasima Mountain. They constructed two large tents for sleeping, a kitchen tent, and a laboratory tent. The RAP team was able to move in the next day. The rest of the RAP team arrived the next day after a challenging three-day voyage by boat. From this camp, the team was able to reach the Kasikasima mountain by a three hour hike along well established trail system set up by METS for tourists that they bring out to this area. The METS camp was located about one hour hike along the river from the RAP camp.

While the team was now closer to Palumeu, they still had to get around several dangerous rapids on the Palumeu River to get back. The now 29 men from Apetina and Palumeu bravely spent several days carrying and dragging the large dugout boats along the trail 3 km through the forest from the RAP camp to the METS camp to get around the largest of the rapids. They also carried food and gear this distance. The RAP team was amazed at their strength and very grateful for their support.

The RAP team departed the Kasikasima base camp in two stages so that boats could be used to transport people and gear to Palumeu and then return for more. Ten people departed on March 26 and the rest departed on March 28. Both teams were able to get to Palumeu Village after about one hour walk (around two rapids) and a four-hour boat ride.

The RAP team then spent one night in Palumeu Village to present their preliminary findings and tell their adventures to the Captain and people of Palumeu. They returned to Paramaribo on March 29 to prepare the preliminary report and to present their findings to partners and supporters in Paramaribo on March 30.

Description of RAP survey sites

Olaf Bánki

The RAP team surveyed around four main sites along the Upper and Middle Palumeu River: Juuru Camp, Grensgebergte Rock, Makrutu Creek, and Kasikasima Camp. Only the coordinates of the four base camps are given here; most sampling was done within 5–10 kilometers of these camps. Certain groups sampled in other areas as well (e.g., along rivers between camps). Please refer to individual chapters for sampling protocols and localities.

Site 1. Juuru Camp (Upper Palumeu River)
N 2.47700, W 55.62941
Elevation 277 m asl.
9–18 March 2012

The first camp was situated on the west bank of the Upper Palumeu River. This place is known as the boat landing or 'Tiyaring' (Trio) for the trail to Brazil and is used by the Amerindians of Palumeu and Apetina as a temporary campsite (Juuru Camp). The camp was situated in 'tall seasonally flooded forest', which was unmistakingly proven when the camp flooded on the 17th and 18th of March. During our stay in this camp it rained almost every day and part of days.

The Upper Palumeu River is a meandering river similar to the Kutari River and Wioemi Creek in the vicinity of Kwamalasamutu where the 2010 RAP survey took place. The Upper Palumeu River is situated in a hilly landscape in which the valleys have been filled with erosion material (loamy and sandy substrate). The river has cut its way through the eroded sediment. In the valleys of the hilly landscape 'seasonally flooded palm swamp forest' can occur, and in the river bends downstream of Juuru Camp 'tall herbaceous swamp vegetation and swamp wood' can be found. Most aquatic sampling was done in the Upper Palumeu River, up and downstream of Juuru Camp and in its tributary creeks.

On top of the hills 'tall dryland tropical forest on laterite/granite hills' did occur which was intersected with large granite boulders. Rocky places with species typically found in open rock vegetation were also found in the forest. Most terrestrial collecting was done along a trail that went up from the camp to a hill of 417 meters above sea level, and along the trail to Brazil. Our sampling trail to Brazil passed through 'tall seasonally flooded forest', 'secondary forest', 'tall dryland tropical rain forest', 'tall swamp forest', 'bamboo forest', and ended at a large waterfall. The secondary forest patch, which was an abandoned agricultural field, was cut open to serve as a helipad.

Site 2. Grensgebergte Rock
N 2.46554, W 55.77034
Elevation 790–820 m asl.
12–18 March 2012

The second camp was a small satellite camp based on top of a granite mountain within the Grensgebergte at an elevation of 790 to 820 meters above sea level. This mountain peak was one of the highest points of the Grensgebergte observed. It could only be reached by helicopter, and was approximately 16.5 km from the helipad of base camp 1. The mountain was pre-selected by using a landscape classification based on Landsat imagery and by flying over the area in a small Cessna airplane a few months in advance of the RAP. The helicopter landed on the rock on a quite open spot with low shrubs.

The Grensgebergte is a mountain range of rolling mountains with steep granite rock faces. The name Grensgebergte literally means 'border mountains.' The mountains are covered with forest and only a few mountain peaks have places with open rocks. On the mountain a mosaic of vegetation types could be found. At the slopes we observed bare rocks with seeping water with carnivorous water plants forming ideal habitats for water beetles. The occurrence of carnivorous plants indicates the low nutrient status that some of these micro-habitats have for plants. Patches of cyper grasses and bromeliads with orchids and gesneriads could be found on the slopes as well. We observed a tortoise of 30–40 cm

long in wet patches surrounded by cyper grasses and small herbs on the mountain plateau. On top of the mountain peak some areas were covered with low shrub vegetation. All these herb and shrub vegetation is generally referred to as 'open rock (Inselberg) vegetation'. We also observed 'short savannah forest on granite rock' with mosses, potentially formed by moisture from low hanging clouds. Most of the mountain peak was covered by a mixture of 'savannah forest on granite rock' and medium sized 'dryland tropical forest on granite hills'. A small flowing creek was spotted between two large ridges on lower elevation. Due to logistical constraints both the forest and the creek could not be properly assessed in terms of species composition.

Site 3. Makrutu Creek
N2.793311, W 55.367445
Elevation 240–260 m asl.
18–21 March 2012

The third camp was situated at the junction of the Upper Palumeu River and the Makrutu Creek. Only the fish, plant, and water quality RAP teams visited this camp by boat from the first camp. The first stretch of the journey the Upper Palumeu River was frequently meandering with many trees growing in the river bends. Almost the entire river was associated with 'tall seasonally flooded forest' accompanied by overhanging tree branches above the water. From the point onwards where the Tapaje Creek was flowing into the Palumeu River the meandering got less and the river banks of the Palumeu River became steeper. The steep banks were covered with 'high dryland tropical rain forest'. On less steep spots we observed 'tall swamp forest', and 'tall herbaceous swamp vegetation and swamp wood'.

Rapids occurred close to the junction with the Makrutu Creek. The camp was situated on rocks within the rapids just downstream of the junction of the Palumeu River and the Makrutu Creek. On top of these rocks a mixture could be found of 'open rock vegetation' dominated by bromeliads, 'short savannah forest on granite rock' and secondary forest. The meandering Makrutu Creek is accompanied by 'tall herbaceous swamp and swamp wood', and 'tall seasonally flooded forest'. Most collecting took place upstream of the Palumeu River from the Makrutu camp, along the Tapaje Creek, and along the Makrutu Creek.

Site 4. Kasikasima camp
N2.97731, W 55.38500
Elevation 201 m asl.
18–28 March 2012

Part of the team that did not join RAP Camp 3 were transferred from the first camp by helicopter to a small settlement called Kampu along the Palumeu River on the opposite of the river from the Kasikasima Mountains. On the 20th of March the RAP teams moved into the camp that was built on the opposite side of the Palumeu River from the settlement of Kampu. The fish, plant, and water quality RAP teams joined the group at this camp on the 21st of March.

On the journey from the Makrutu camp to the Kasikasima camp we crossed two major rapids where the boats had to be unloaded and pulled. Within these rapids large forested rocks occurred. The forest on top of these rocks can be classified as 'short savannah forest on granite rock', with some species very typical for open rock places. The rapids contain 'open rock vegetation' with seeping water and some carnivorous plants similar to the vegetation that was found on the granite mountain (site 2) on much higher elevation. Steep banks also occurred along the Palumeu River.

The camp was situated along the river where large rock formations were found in the forest and into the river creating a large relatively shallow rapid. 'Short savannah forests on granite rock' occurred along the river and on top of the hills where the parent rock reached the surface of the soil. From the river bank a landscape of undulating granite hills started instantly. These granite hills were covered with 'tall dryland tropical forest on laterite/granite hills'. Creeks, with palm swamps and some creek vegetation and forests could be found in the sharp gullies between the mountains. Large trees occurred on the slopes. Closer to the Kasikasima Mountains, the amount of large boulders in the landscape increased. 'Short (dry) savannah forest on granite rock' with palms intersected now and then by a creek, could be found on the Kasikasima Mountain. The 'short savannah forest' on top of the Kasikasima Mountain (ca. 510–790 m asl.) was dominated by mosses, bromeliads, and ferns, which indicates frequent moist conditions due to low hanging clouds. The open rock vegetation on this mountain was similar to that of the Grensgebergte, dominated with bromeliads, orchids, and gesneriads.

OVERALL RESULTS

Results from all of the taxonomic groups surveyed during the RAP survey reveal that Southeastern Suriname contains very high biodiversity with many unusual and endemic species. We found over fifty species that are probably new to science, including eleven fishes, six frogs, one snake, and many insects. Our survey also indicated that ecosystems of this region are extremely healthy, with good water quality and virtually no human impact. High abundance of large birds such as cracids and parrots and records of large cats and other mammals including primates, coupled with high dung beetle abundance and biomass, indicate that hunting pressure is low or non-existent. The occurrence of a high diversity of all taxa, including large and medium-sized mammals, indicates a pristine and productive ecosystem.

For all of the taxonomic groups except the large mammals, the RAP data indicate that Southeastern Suriname is unique from other areas of the Guiana Shield, containing many species not found elsewhere. Plant species composition differs from the flora of Northern Suriname and several bird species occur that are not found in the northern parts of the country. The flora and fauna of Southeastern Suriname is also

distinct from nearby Southwestern Suriname. For example, about half of water beetle and katydid species documented in Southeastern Suriname were different from those recorded in Southwestern Suriname (Short and Kadosoe 2011). Dung beetle communities were also distinct from Southwestern Suriname. This is especially remarkable given the short distance between these two areas, as well as the fact that the lowland forests of Southern Suriname are often considered fairly homogenous. Diversity, standardized by sampling effort was also generally higher in Southeastern Suriname.

A high degree of heterogeneity was found between the three RAP survey sites within Southeastern Suriname. As may be expected, the higher elevation sites on Grensgebergte (Site 2) and Kasikasima Mountain (Site 4) have a distinct flora and fauna compared to the surrounding lowlands. Four of the 15 new plant records were found in the transition between short savanna forest on granite rock and open rock vegetation at the Grensgebergte. Five of the 15 new plant records including one new plant genus for Suriname were recorded in the hilly landscapes surrounding the Grensgebergte and the Kasikasima Mountains. The surroundings contain several dominant vegetation types that are floristically distinct for the central and southern parts of Suriname. The bird fauna of the Grensgebergte contained several species with ranges restricted to higher elevations. Similarly, the small mammal fauna was distinct from that of the lowlands with more and different species of non-volant mammals on the mountaintop. Three families of water beetles new for Suriname were recorded on the Grensgebergte. Two snakes not recorded from the lowlands were also recorded on the mountaintop.

In addition, the two lowland sites, the Juuru Camp (Upper Palumeu River, Site 1) and Kasikasima (Site 4) both had high levels of biodiversity but showed some differences in species composition. Only 50% of the water beetle fauna was similar between the two sites. Many species of small mammals (especially bats), reptiles and amphibians, and birds were recorded from only one of these two lowland sites. Fish species composition differed between these sites due to habitat differences- smaller creeks and thus smaller fishes were documented in the Upper Palumeu while larger fishes were collected in the main channel of the Palumeu River at Kasikasima and in Makrutu Creek (Site 3). A 50 m waterfall in the Upper Palumeu region contained several fish species new to science and to Suriname.

TAXONOMIC SUMMARIES

Water Quality

Fourteen sites on the Palumeu River, Tapaje Creek and Makrutu Creek revealed typical water quality conditions for undisturbed aquatic ecosystems in Suriname's interior, except for mercury. Although analysis of rainwater samples taken on the Grensgebergte did not have any mercury, levels above international norms were occasionally found in sediment and fish tissue samples. This indicates that there might be an external mercury source. Further monitoring is needed to confirm this. This aspect is very important and needs immediate action because these headwaters provide drinking water and food for many local communities downstream.

Plants

Out of 609 plant specimens collected, 354 species, 152 genera and 93 families have so far been determined. At site 1, along the upper Palumeu River, we collected 188 plant specimens. At the Grensgebergte (site 2) we collected 69 plant specimens and 75 at the Makrutu camp (site 3). We also collected 11 plant specimens at the Palumeu village and 27 specimens at the rapids of the Palumeu River. We found 15 new plant species records for Suriname and two new genera. Two of these belong to lianas, four to shrubs and herbs and ten to trees. The surroundings of the Grensgebergte and the Kasikasima Mountains contain several vegetation types that are dominant and floristically distinct for the central and southern parts of Suriname. These vegetation types include tall dryland tropical forest on laterite/granite hills, short savannah (moss) forest and open rock vegetation, including rocky outcrops around rapids, and tall seasonally flooded forest. Within these vegetation types, we recorded nearly all of the 15 new plant species records and the two new genus records for Suriname. We also recorded several rare species with only a few known occurrences in Suriname and/or in the Guianas. The noteworthy species include several rare orchids that are listed in Appendices I & II of CITES, some carnivorous plants, and three tree species that are listed on the IUCN Red List, including one tree species listed as Critically Endangered. Plot surveys (0.1 ha) also indicated that the forests of South Suriname are floristically distinct from those of North Suriname, but do not significantly differ in tree alpha diversity. The forests on the Guiana Shield basement complex are not uniform as stated by some. Our findings indicate the pristine status of the forests and vegetation types in Southeastern Suriname, and the fact that these forests are still poorly explored.

Water Beetles

More than 2500 specimens of water beetles were collected representing 157 species in 70 genera. Twenty-six species and 8 genera are confirmed as new to science, with an additional 10–15 species likely to be undescribed. Surprisingly, more species were recorded here than during the Kwamalasamutu Region RAP in Southwestern Suriname despite less collecting effort. Additionally, there was a high species turnover between these RAP sites: 40% of the species recorded here were not found in the Kwamalasamutu Region. The families Lutrochidae, Hydroscaphidae, and Torridincolidae are recorded from Suriname for the first time. While a broad range of habitats contributed to the high species and lineage diversity, hygropetric habitats on granite outcrops in particular provided a wealth of new and interesting taxa.

Dung Beetles

Dung beetles are among the most cost-effective of all animal taxa for assessing biodiversity patterns, yet RAP's recent surveys are among the few that are expanding our knowledge of Suriname's little known dung beetle fauna. In addition to cost-effective sampling using standardized pitfall traps, dung beetles depend upon large mammals for food and consequently can be used to rapidly assess the health of the overall mammal community and hunting impacts in a fraction of the time it would take to survey the mammals themselves. I sampled dung beetles using baited pitfall traps and flight intercept traps in the Grensgebergte and Kasikasima regions of Southeastern Suriname. I collected 4,483 individuals represented by 107 species. This ranks among the most diverse places on the planet for dung beetles, and exceeds the extraordinarily high species richness observed in nearby southwestern Suriname (94 species, Larsen 2011). Ten species are most likely new to science, while an additional 10–20 species may be undescribed pending further taxonomic revisions.

Dung beetle species richness, abundance and biomass were higher around Upper Palumeu than at Kasikasima, probably due to the extensive intact forest and lack of hunting pressure in this remote headwater region where no one currently lives. Dung beetle diversity and abundance at Kasikasima were still relatively high, indicating only mild to moderate hunting of large mammals and birds in the region. All sites, including the Grensgebergte Mountains, supported high endemism, including several rare species, demonstrating the exceptional biodiversity value of the region. Surprisingly, dung beetle species composition varied strongly among sites within this survey, as well as among sites sampled on previous surveys, including nearby southwestern Suriname. This high Beta diversity shows that the forests of Suriname and the Guiana Shield are not nearly as homogenous as is often assumed, and consequently protecting this varied biodiversity requires conserving many different forest areas.

The high abundance of several large-bodied dung beetle species in the region is indicative of the intact wilderness that remains. These species support healthy ecosystems through seed dispersal, parasite regulation and other processes. Maintaining continuous primary forest and regulating hunting (such as through hunting-restricted reserves) in the region will be essential for conserving dung beetle communities and the ecological processes they sustain. These results indicate that the intact headwater region of the Upper Palumeu watershed merits the highest conservation priority.

Katydids

Fifty-two species of katydids were collected, representing 35 genera in 4 subfamilies. At least 6 species are new to science and 26 species were recorded for the first time from Suriname; one of the new species recorded during the survey represents the first example in the Neotropical region of the loss of the ability to produce sound in male katydids. The katydid fauna of this country exhibits a remarkably high turnover—50% of species recorded during the current survey had not been collected during the 2010 survey in the Kwamalasamutu region, and all represent records new to Suriname. This may indicate a potentially high degree of uniqueness of the Grensgebergte mountains and warrants their protection.

Ants

A total of 149 ant species from 35 genera have been identified from the RAP collections. Additional work is ongoing to process and identify the remaining samples, which will undoubtedly raise the total number of species, possibly to over 200 species. The results indicate a healthy and diverse ant fauna reflective of pristine rainforest. Ants play important roles as predators, scavengers, and seed-dispersers in tropical forests. The ant data from Southeastern Suriname will add to a growing dataset on the ant fauna of the Guiana Shield, which is still poorly documented, to help identify areas of high diversity and endemism that are important to conserve within the region. Data on ants and other invertebrates are important since these groups may be able to illustrate differences between habitats within the Guiana Shield that larger animals with wide geographical ranges do not discern.

Fishes

A total of 94 species of fishes were recorded which, in combination with a collection of fishes from Lower Palumeu River by Covain et al. (2008), makes a total of 128 species now known to occur in Palumeu River. This diversity is high compared to the rest of the world, but is typical for a medium-sized river of the Guiana Shield. Eleven species of fishes are potentially new to science, including a *Bryconops* species, a small *Parotocinclus* catfish, and a tetra (*Hemigrammus* aff. *ocellifer*). Two species are new records for Suriname: *Hyphessobrycon heterorhabdus* and *Laimosemion geayi*; a third and fourth species, *Ituglanis nebulosus* and *Pimelodella megalops*, may also represent new species for Suriname if their identity is confirmed. We did not find the same species at each site; sites 3 and 4 included large-sized fishes from the main channel of the Middle Palumeu River, while site 1 had many small-sized species of creek habitat. Overall, large top level predators were still common in Palumeu River.

Reptiles and Amphibians

A total of 47 species of amphibians and 42 species of reptiles were recorded during the RAP survey. These numbers are relatively high when compared with other sites sampled over the same time period (e.g., recent RAP surveys in other parts of Suriname). Seven (six frogs and one snake) of the total 89 species encountered could not be assigned to any nominal species. These unidentified taxa may represent novel species yet require validating genetic and morphological data before formal diagnoses can be made. A number of records represent range expansions for taxa within the Guiana Shield (e.g., *Rhinatrema bivitattum*, *Alopoglossus buckleyi*).

Additionally, a teiid lizard (*Cercosaura argulus*) was recorded for just the second time in Suriname. Encountering >80 total species (including 19 snake species) is evidence of a healthy, diverse and seemingly pristine forest ecosystem.

Birds

A total of 313 bird species were seen or heard at the three RAP survey sites, the village of Palumeu, and during excursions along the Palumeu River. We recorded fourteen species listed as Vulnerable or Near-Threatened on the IUCN Red List, and consider another seven species as likely to occur in the region. Our records of several species represent range extensions within Suriname and the Guiana Shield. Whereas the lowland forest avifauna was broadly similar at the different localities, 32% of species were only observed at one of the four survey sites. The abundance of parrots and cracids was particularly noteworthy, especially compared to the more populated Kwamalasamutu region that we surveyed in Southwestern Suriname in 2010. The high-elevation savanna forest harbored several species not known to occur in the adjacent lowlands, and therefore had the most unique species assemblage of any site. Our results indicate that the lowland forest of SE Suriname probably contains the vast majority of bird species known to occur in the country's interior, including many species of high conservation value, arguing strongly for protection of the region's forests. We recommend further surveys of high-elevation sites in the Grensgebergte and other mountain ranges in southern Suriname, to better determine the range limits of species restricted to high-elevation forests.

Small Mammals

A total of 39 species of small mammals (<1 kg) were documented during the RAP survey. Taxonomic composition included 28 species of bats, 8 species of rats, and 3 species of opossums. Of the 3 sites sampled, the lowland sites were most similar, with Upper Palumeu having the highest diversity of bats and Kasikasima having the highest abundance for bats. The highland site of Grensgebergte had the highest diversity and abundance for small non-volant mammals but the lowest for bats. The species composition was heterogeneous with no opossums shared among sites, whereas 25% of rats and just over 50% of bats were shared among sites. The most noteworthy records were the documentation of the poorly known water rat (*Nectomys rattus*) near the open granite outcrop of Grensgebergte. This region of Southeastern Suriname has a mix of primary rainforest in a mosaic of lowland and highland habitats that supports diverse and different faunal communities of small mammals.

Large Ground Dwelling Mammals

During the survey of large and medium-sized ground dwelling mammals of the Kasikasima and Upper Palumeu river region, we recorded 18 species. Camera traps were the most important tools for the survey, but direct observations were made and tracks, scat and scratch marks were also recorded. We observed important species, including endangered and vulnerable species, such as Jaguar, Tapir and Giant River Otter. All these species fulfil important roles in the ecosystem such as by dispersing seeds or regulating populations of other species. The occurrence of a high diversity of large and medium-sized mammals in the surveyed area indicates that the ecosystem is healthy and relatively pristine. Southeastern Suriname is very important for large mammal species, especially wide-ranging species, because the area encompasses vast tracts of pristine forest and rivers.

Primates

Six of the eight primate species known from Suriname were recorded during the RAP survey. These included the black spider monkey (*Ateles paniscus*), red howler monkey (*Alouatta maconnelli*), bearded saki (*Chiropotes sagulatus*), brown capuchin (*Cebus paella*), squirrel monkey (*Saimiri scuireus*), and golden handed tamarin (*Saguinus midas*). The large-bodied species (black spider monkey, red howler monkey) were fairly abundant, indicating sustainable hunting practices by local communities. Although we did not record the white faced saki or wedge capped capuchin, they may occur in the area. These species are quite difficult to observe due to rarity and elusiveness. Primates play keystone ecological roles in maintaining healthy ecosystems, and also are important for local people. The high diversity and abundance of primates in the area make it a high conservation priority.

CONSERVATION RECOMMENDATIONS

(see also Chapter 1 for a discussion of the conservation importance of Southeastern Suriname)

We strongly recommend protection of Southeastern Suriname to preserve its unique and diverse species, as well as its forest and freshwater resources. Protection of Southeastern Suriname will:

- Protect unique biodiversity that is found nowhere else,
- Conserve critical natural resources for the well-being of Suriname and the world,
- Guarantee perpetuity of Suriname´s freshwater resources—a prerequisite for economic activities (agriculture, energy, mining, oil) and human health (consumption, sanitation, transportation)—by protecting and conserving the headwaters of one third of Suriname's Rivers,
- Mitigate global climate change through the conservation of large tracts of carbon rich tropical forest,
- Ensure sustainable flow of forest resources (e.g., food, medicines, building materials) and freshwater for the indigenous and Maroon communities in the interior of Suriname, and
- Maintain large-scale ecological processes and protect wide-ranging species and species vulnerable to climate change through establishment of a vast network of international conservation areas.

Protect the freshwater resources of Southeastern Suriname

Water quality and flows

Water quality of Southeastern Suriname is currently very high and typical for undisturbed aquatic ecosystems in Suriname's interior. This region contains the headwaters of several of Suriname's largest rivers, including the Marowijne, supplying much of the water used downstream for drinking, agriculture, energy, mining, sanitation, transportation, etc. Thus, maintaining high quality freshwater for the people and natural ecosystems of Suriname is essential for long-term sustainability. While the area may not be directly affected by mercury pollution from downstream sites, the RAP results show that it does receive atmospheric mercury deposition probably from trans-boundary sources. Protecting the headwaters of Southeastern Suriname and minimizing mercury pollution from neighboring countries will be important for safeguarding this source of clean freshwater and protecting human health.

Our findings also show that Southeastern Suriname will be disproportionately important for future water resources for the country. Watersheds in Southeastern Suriname are predicted to be more resilient to climate change than other parts of Suriname, where water scarcity could become a problem (see Chapter 1 this volume).

Fishes

The fishes of Southeastern Suriname are a major food source for the local indigenous and Maroon communities. The primary threat to the fishes of the region is the Tapajai Project, which proposes to build one or more dams in the Tapanahony River in order to divert its water via Jai Creek to Brokopondo Reservoir and thus increase power generation by the hydroelectric station at Afobaka. The dam(s) would not only directly affect migratory fishes, fishes of running water and creek habitats and fishes downstream of the dam(s), but also effectively mix the fish faunas of the Marowijne River System and the Suriname River System, each with its own endemic species, likely leading to species extinctions. Local communities along the Tapanahony River should be extensively informed about the potential impacts of the Tapajai Project on their immediate environment so they can make rational, well-informed choices about their future with or without the Tapajai Project.

Conserving the forested headwaters and middle reaches of the Palumeu River will be important for maintaining food for people for many years to come. Large stretches of seasonally flooded forest and swamps predominantly occur in southern Suriname. These habitat types, as well as mountain headwaters, appear to provide important spawning grounds for a variety of fish species, including large migratory species which are one of the most important food sources for people throughout Suriname.The fishes of Palumeu River can also be of interest to the aquarium hobby and sport fishers and thus generate income for local people if catches are regulated.

Actions that should be taken to protect the fisheries:

1. Assess which fish species from the Palumeu River are used for food, determine the amount caught and eaten, and study their life histories to determine how fast they reproduce and grow
2. Determine the amount of fish that can be sustainably harvested, both for food fishes and aquarium fishes
3. Conduct more research to understand migratory fish behavior in Southeastern Suriname
4. Set catch limits and/or seasons if necessary to avoid overfishing
5. Create picture guides of fishes, especially colorful species and fun-to-catch fish species
6. Promote sustainable catch and export of aquarium fishes to generate local income and conservation incentives

Protect the unique habitats and biodiversity of Southeastern Suriname

Flora

Vegetation plot studies revealed that species composition of the forests in the South of Suriname is different from the North, and a small set of significant indicator species and genera were found for the South of Suriname. The RAP results indicate that forests on the Guiana Shield basement complex are not one uniform forest type as has been suggested. Some forest types like the tall dryland forests on laterite/granite hills are more dominant in the South of Suriname, and are floristically distinct.

The flora of southern Suriname is surprisingly varied, and contains at least sixteen distinct habitat types (see Chapter 1 this volume). The surroundings of the Grensgebergte and the Kasikasima Mountains contain several vegetation types that are dominant within southern Suriname and floristically distinct for this region. Within these vegetation types, we recorded nearly all of the fifteen new plant species and two new genera for Suriname we found during this study. Nine plant records including one genus new for Suriname were found in the hilly landscape and at higher elevations. The other six new plant records including one plant genus new for Suriname were found in seasonally flooded forest and swamp forest along the Palumeu River. We also recorded several species with a restricted distribution in Suriname and/or in the Guianas, orchids listed on Appendices I & II of CITES, some carnivorous plants and three tree species that are listed on the IUCN Red List. Amongst these is a unique palm species, *Syagrus stratincola,* that is only know from ten localities in the Guianas, and is listed as Vulnerable on the IUCN Red List. We also found the tree species *Vouacapoua americana* that is listed as Critically Endangered on the IUCN Red List. As plant collections from several plant families still await identification, we expect to find more new records or noteworthy species for Suriname. These findings indicate the pristine status of the forests and vegetation types in Southeastern Suriname, and the fact that these forests are still poorly explored.

Fauna

As with plants, the differences in species composition for most animal taxa between this expedition and the 2010 Kwamalasamutu RAP survey, combined with the high turnover between camps within Southeastern Suriname, suggest very high Beta diversity and species turnover within southern Suriname. Many species appear to be very localized or patchily distributed, which leads to high overall diversity over relatively small areas. Forests of southern Suriname and of the Guianas in general are often considered relatively homogenous, but our findings contradict this pattern. Because of this high heterogeneity, conserving a wide range of species requires conserving numerous large areas of forest that only superficially appear to be the same.

The findings of dozens of species new to science on both RAP surveys, while not unexpected given the paucity of collecting in the region, reinforces how much further we have to go before we have an understanding of the biological diversity of southern Suriname. The collection of eleven potentially new fish species in the Upper and Middle Palumeu River under unfavorable (high-water) conditions during the present study and the absence of many fish species from the rapids in the present collection both indicate a richer fish fauna in Palumeu River than the fish fauna that is currently known (128 species). In order to arrive at a more complete list of the fish fauna of Palumeu River the following actions are recommended:

- Additional scientific surveys are necessary to document the fish biodiversity at different times of the year, but especially when river levels are lower; and collection efforts should be aimed mainly at the major rapid complexes and the main river channel and tributaries in middle reaches of the Palumeu River
- The 1966-collections of King Leopold III of Belgium and J.P Gosse from the Palumeu River (Table 8.2) should be studied

Hunting

The Grensgebergte area is quite pristine, and is visited only occasionally by the local people while they travel from the villages in southern Suriname to villages in Brazil. Hunting does not seem to pose a threat for the large and medium-sized mammals in the Grensgebergte area, because the area is so remote and very inaccessible. We found no signs of hunting or any other human disturbance. The large bodied primates (black spider monkey and red howler monkey) are present in relatively high abundance. They were either spotted or heard on a regular basis at both sites. Since these two species are the most hunted by local communities, this indicates sustainable hunting practices by these communities. Southeastern Suriname provides a refuge for many species that are heavily hunted in other parts of the Guiana Shield, as well as a source of food as these animals reproduce and disperse into hunted areas.

In the Kasikasima area there are more human activities than in the Grensgebergte area, such as ecotourism and some hunting by a small number (10–20) of people that live in Kampu. Kampu is a small settlement along the Middle Palumeu River a few kilometers downstream of the Papadron rapids. Currently the greatest potential threat for large and medium-sized mammals at Kasikasima would be hunting, but the results from the RAP survey show that hunting pressure is currently low. Nevertheless, the presence of species sensitive to hunting and disturbance such as Jaguar, Puma, Tapir, curassows and large primates also suggests that hunting pressure is low, and that the important ecological processes maintained by these species, such as seed dispersal and population regulation, remain intact. Dung beetles, which are often used as a rapid indicator of hunting pressure, also suggest low levels of hunting, since they were diverse and abundant during the survey. However, dung beetle species richness and abundance were still lower around Kasikasima than around Grensgebergte, reflecting these differences in hunting pressures.

Hunting is probably limited by reduced river access to some areas in the dry season, and more generally by distance from Palumeu and other villages. The absence of a market and the concentration of the indigenous people in Palumeu both reduce hunting pressure on large vertebrates in the region as a whole. The extensive surrounding forest acts as a source to offset local population depletion due to hunting. Nevertheless, the most significant current threat to medium- and large-bodied mammals in the area is hunting from Palumeu village. This could change if plans to build a road from northern to southern Suriname move ahead. A road would make the area accessible and hunting and habitat destruction would become important threats for large terrestrial vertebrates. Further plans to increase hydro energy capacity of the existing hydro lake in Brokopondo by diverting water from the Tapanahony River to the Jai Creek could be a threat if the project would take place, because a part of the area in South Suriname will be flooded. Aquatic mammals, such as giant otters, may be particularly vulnerable. More data on large mammal populations will be necessary to manage these possible future threats. Recommended studies include more camera trapping and a sustainability evaluation of wild bushmeat hunting to have better baseline data.

The value of extensive wilderness and ecosystem services

Southeastern Suriname is very important for wide-ranging species, such as large mammals, birds and fish because the area encompasses vast tracts of pristine forest and rivers. In fact, there are few places left on earth that are as pristine as Southeastern Suriname. Many large mammal and bird species have broad home ranges and can move freely across Southeastern Suriname in the absence of disturbance. Large migratory fish species move long distances to spawn. The area is also connected to protected areas in Brazil to the south and to a national park in French Guiana to the east. This makes Southeastern Suriname part of a large wilderness area, which is important to sustain genetic diversity within large mammal species, as well as other taxa such as reptiles

and amphibians. The RAP sites are most likely acting as a corridor for gene flow through this region of the Guiana Shield. The presence of species that are rarely seen or were previously unrecorded in Suriname helps to substantiate that there is (or was) an historical connection between this and surrounding areas. Maintaining the pristineness of this corridor should be a priority for healthy ecosystem function and to maintain natural gene flow throughout the Guiana Shield.

This contiguous network of protected areas, with Southeastern Suriname at its center, also allows species to persist in the face of climate change by providing corridors for redistribution. This is especially important as many species are being forced to move upslope from the lowlands into the mountains as climate warms. In addition to helping species adapt to climate change, the extensive, intact and carbon-rich forests of Southeastern Suriname also help to regulate regional climate and mitigate global climate change.

Furthermore the area is important for the production of ecosystem services directly used by humans, such as water, food, medicines, recreation and lands of indigenous people (see Chapter 1 this volume). Since a large part of the rivers in Suriname originate in this area, protecting Southeastern Suriname guarantees flows of fresh water which is used for economic activities downstream such as transportation, hydro energy, agriculture and mining. The area also has a high potential for ecotourism, because of the beautiful pristine landscape and rich biodiversity, particularly of charismatic birds and mammals.

As one of the last remaining wilderness areas and a key provider of ecosystem services, we believe it is essential to protect Southeastern Suriname and the numerous benefits the region provides to people throughout Suriname and the world, avoiding threats from large-scale projects such as roads, mining and hydropower in this part of the country.

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