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WWF

WETLANDS OF GUYANA

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Wetlands of GUYANA

AN INSIGHT INTO THE ECOLOGY OF SELECTED WETLANDS WITH RECOMMENDATIONS FROM WWF-GUIANAS

A PUBLICATION OF WWF-GUIANAS
2012

Koninkrijk der Nederlanden

FFEM

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The drivers for the field research team.

WWF-GUIANAS
WWF has been active in the Guianas since the 1960s, starting with conservation work on marine turtles. The Guianas office opened in 1998. WWF-Guianas' mission is to conserve distinct natural communities, ecological phenomena, and maintain viable populations of species of the Guianas in order to sustain important ecological processes and services that maintain biodiversity, while supporting the region's socio-economic development.

WWF
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FOREWORD

With a population of fewer than 800,000 people, Guyana has one of the lowest population densities in one of the most ecologically diverse countries of the Amazon, biome, which is one of the most biodiverse terrestrial natural areas in the world. Guyana's 18.5 million hectares of forests cover over 85% of the country and contain over 5 gigatons of CO^2 in above-ground biomass. The country has one of the world's lowest deforestation rates, estimated at a rate lower than 0.1% per annum. Guyana, an indigenous name which means "land of many waters", is especially rich in aquatic biodiversity, hence the importance of this publication, *Wetlands of Guyana*. The Amazon is mainly known for its tropical rainforest, but its freshwater ecosystems are at least as important, and represent the "'veins'" which keep the "Amazon body" ecologically functioning.

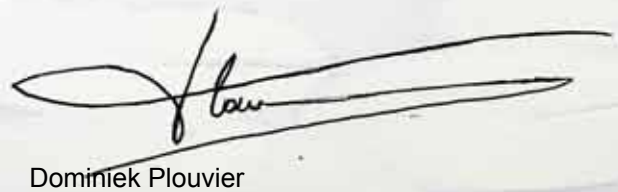
Guyana has been a leader in the push for REDD+ as one of the High Forest Cover Low Deforestation Rate (HFLD) countries, which also include Suriname, Gabon, Papua New Guinea (PNG) and others – all of huge global importance. Guyana is also remarkable as one of the first countries in the world to have embarked on a nation-wide low carbon development strategy, making it an early laboratory for a green economy. In 2007, former President Bharrat Jagdeo spearheaded negotiations for payments for REDD+ as a vehicle for *Transforming Guyana's Economy While Combating Climate Change*. An important five-year, US$250 million agreement was signed with the government of Norway in October 2009 to initiate this strategy.

Despite its efforts to create a low-carbon economy, Guyana lagged behind in its commitment under the Convention on Biological Diversity (CBD) to create a national system of protected areas. With the promulgation of the Protected Areas Act (2011), the designation of two new protected areas (Kanuku Mountains and Shell Beach) in 2011, then the establishment of the Protected Areas Commission in 2012, substantial progress has been made since 2011. However, Guyana still has a long way to go to meet the CBD's global biodiversity target of having 17% of the country's ecologically representative terrestrial and inland freshwater ecosystems conserved in well-connected and effective protected areas systems, and with the participation of local communities, by 2020.

For more than a decade, WWF-Guianas and the WWF Living Amazon Initiative have supported the Guyana government in its quest for sustainable development, including the creation of new protected areas and the management of existing ones, such as the iconic Kaieteur National Park.

With the publication of *Wetlands of Guyana*, WWF hopes to contribute further to the discussion on biodiversity conservation, and more specifically, on the role of wetlands as an important habitat for birds, fish, mammals and other wildlife, as well as the ecosystem function these provide to Guyana's economy and to the world.

WWF was at the forefront of establishing the Convention on Wetlands of International Importance, known as the Ramsar Convention, in 1971. At the end of 2012, Guyana was the only country in South America not yet a party to the Ramsar Convention. Through this publication and other forms of support, WWF will continue to promote Guyana internationally in its quest for sustainable development through the implementation of its Low Carbon Development Strategy, while establishing an ecologically representative and sustainable National Protected Areas System, which includes all of the country's fantastic diversity of ecosystems and habitats.



Dominiek Plouvier
Regional Representative
WWF-Guianas

Cláudio C. Maretti
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Living Amazon Initiative (LAI)

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BACKGROUND ON PUBLICATION

Rationale and Objectives of the Publication

Guyana, as is the case in the entire Guiana Shield, is defined by its abundance of water resources and wetlands, including rivers, streams, lakes, marshes and swamps. The country's wetlands are one of the most biologically diverse ecosystems, and are important centres for socio-economic and cultural activities, and for ecological processes. However this very ecosystem richness and the varying facets of wetlands tend to attract threats and increase pressures, therefore requiring effective management interventions, at a national, regional and international level. Guyana's decision-makers are posed with challenges in being able to implement well-guided and comprehensive approaches to the conservation and management of the country's wetlands.

One such challenge for instance in both coping with the threats to wetlands and protecting their richness, while at the same time supporting development and enhancing local peoples' livelihoods, is limited capacity and inadequate and undocumented information on the nation's water resources and wetlands. Pertinent information on a country's natural resources quite obviously will facilitate enhanced management decisions on conservation and management. However, any existing information in Guyana on wetlands or water resources, in general, is very much fragmented and spread out across various national agencies, non-governmental organizations, and researchers. A comprehensive, nationwide assessment of wetlands has not been conducted in Guyana; all of the previous studies and publications, though invaluable, have been concentrated on particular geographical locations, specific services or a particular group of species. Most of the information on wetlands in Guyana exists primarily on the North Rupununi wetlands, largely facilitated through a focus on the Iwokrama Forest Reserve and the wider North Rupununi area and communities. Community-based initiatives, research and management work by Iwokrama, other projects and publications, such as the Darwin Initiative-funded project, "Sustainable Management of the Rupununi: linking people, wildlife and environment", and the Watkins and Oxford 2010 book, *Rupununi: Rediscovering a Lost World*, provide data and descriptions focused on the North Rupununi. There have been some isolated wetland or wetland-related studies and publications on other locations, including the South Rupununi, coastal areas of Guyana and major river systems. Much of the information from all of these research and/or conservation initiatives, however, is neither consistently documented nor chronologically stored. More comprehensive, nationwide research has the potential to provide good baseline data for monitoring and assessing changes in character and functions of the wetlands. This is of particular importance since population growth and infrastructure development in and around these areas are increasing the threats to them. While it is recognized that this publication only explores the wetlands limitedly, and only particular aspects, it is felt that this study will serve to arouse interest among scientists and scholars, to the extent that they will be encouraged to undertake follow-up studies to fill the gaps that still exist.

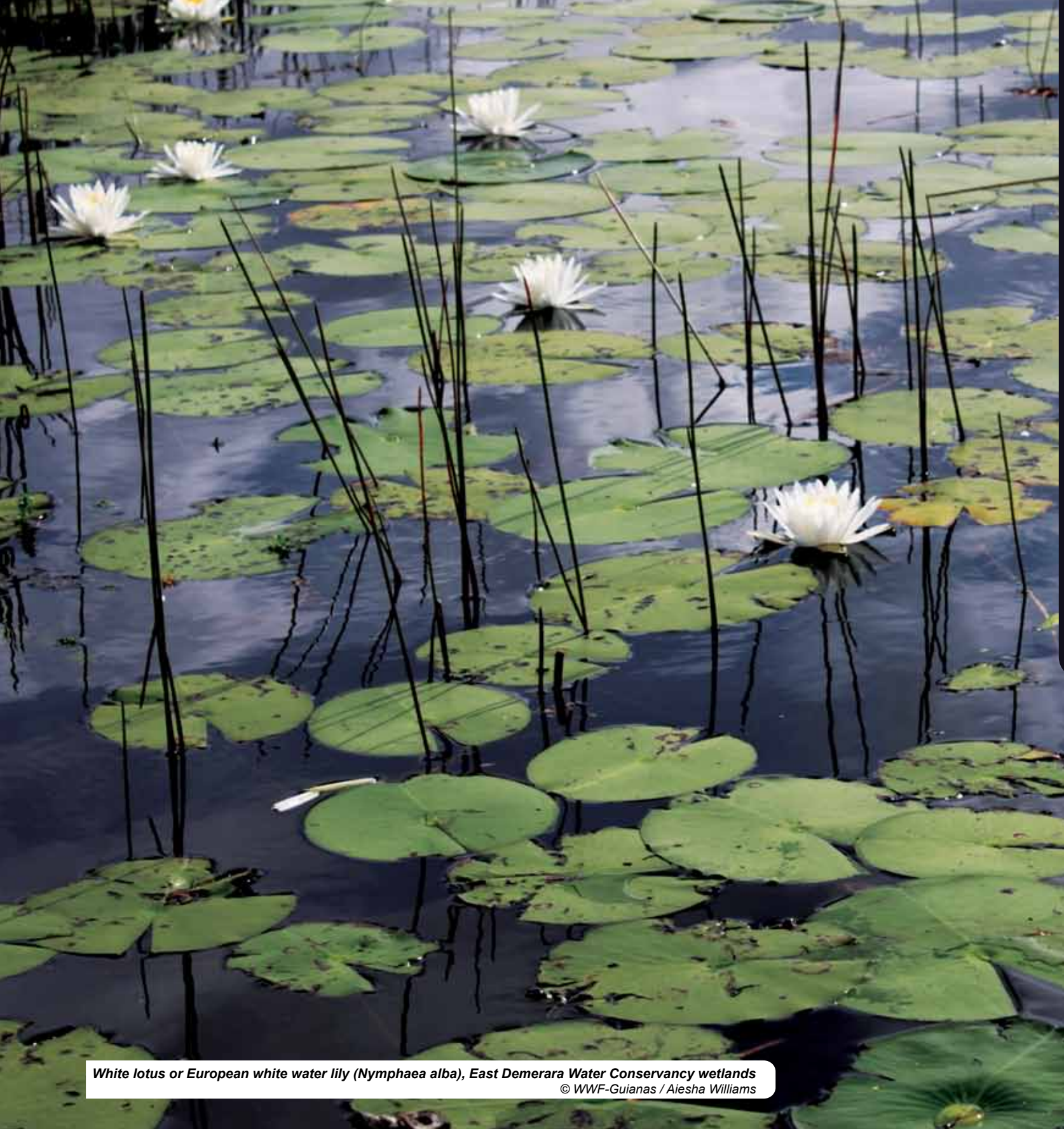
WWF field vehicle crossing a section of the Rupununi River en route to Sand Creek Village during the field surveys *© WWF Guianas / Aiesha Williams*

Guyana's focus on conservation and management initiatives is mainly on terrestrial ecosystems, and more specifically, on forest resources and species (or groups of species). However there should also be a concentrated effort on water resources, especially wetlands. In Guyana, the significance of wetlands and wetlands protection to the socio-economic, environmental and cultural landscape has not yet been fully understood and appreciated by the population at large and by decision-makers. As a result, wetlands and their protection have been generally under-valued, and key decisions relating to their conservation and management remain inadequate. Guyana's Low Carbon Development Strategy (LCDS), REDD+ Initiative and Norway Deal, the Forest Act and other policies and legal instruments give the duly required focus on protection and management of forests. However, Guyana does not yet have a National Water Policy (NWP), which incorporates an integrated water resources management approach, as defined by the National Water and Sewage Act 2002 (Laws of Guyana, Cap. 30:01) and other international agreements. In addition, Guyana was by 2012 the only country in South America, and among six other countries of the Americas (South, North and Central America and the Caribbean) not yet signatory to the Ramsar Convention on Wetlands. However, there have been steps to develop and finalize the IWRM Policy for Guyana along with the Global Water Partnership–Caribbean. There has also been some level of site-specific wetland or water conservation and management interventions, especially within the North Rupununi and the various water conservancies. The latter however has been focused on water management for irrigation purposes, and not specifically on conservation of wetlands as an ecosystem. With the new Protected Areas Act 2011 (Guyana Act No. 14 of 2011) also, there is potential for a national approach to the protection and management of wetlands as an ecosystem. The four existing protected areas, Kaieteur National Park, Iwokrama Rain Forest, and the recently declared Shell Beach and Kanukus Protected Areas, are largely "terrestrial in nature". However the protected areas, especially with an integrated approach to management, can benefit water resources and wetland ecosystems nearby, and more so downstream from the managed area. However, it is essential that designation of new protected areas must also examine, more closely, the aspect of water and wetland ecosystems protection. It is hoped that this publication will serve as a tool to educate and increase awareness among different stakeholders generally and decision-makers in particular, thereby stimulating decisive actions on these very important environmental issues and fulfilling Guyana's commitment to the International Convention on Biodiversity (CDB) and other international environmental agreements.

It is widely felt among scientists that the current framework used to pursue protected areas and wetlands management are fragmented and out-dated and in need of over-haul to bring it in line with more progressive countries in the region such as Brazil and Colombia. In this regard, this publication will provide the opportunity for a pitch to be made for a review and possibly revision of the system of protected areas in Guyana, incorporating wetlands as part of the system. Therefore, this publication is also intended to put the issue of protected areas and wetlands on the national agenda in Guyana.

This publication therefore, presents the results of a preliminary nationwide assessment of Guyana's Wetlands, as an attempt to enhance and encourage focus on wetland ecosystem management and protection. It attempts to bring to the attention of stakeholders in Guyana, decision-makers, conservationists, NGOs, academics and local communities, the urgency of keeping wetland conservation on the agenda in Guyana and to move towards decisive action to ensure their incorporation into the country's overall system of protected areas. It provides valuable scientific data on the key wetlands investigated, including their ecological characteristics (flora, fauna, water quality, soils and geomorphology), uses, anthropogenic influences, a range of management issues impacting on the current status of wetlands, and suggests broad interventions for future improved conservation and management.

The primary objectives of this publication are in summary three-fold. First it sets out to provide some basic information about the ecological characteristics, management and utilization of the resources in selected major wetlands in Guyana to generate awareness among stakeholders about the functions of such ecosystems and the threats that confront them. Secondly, the publication seeks to add to existing research that has been undertaken on wetlands in Guyana with a view to broadening the knowledge base of the phenomena and filling gaps. Thirdly, the study attempts to stimulate national debate and elevate the issue of protected areas and wetlands management, initially through the ratification of the Ramsar Convention on Wetlands.



White lotus or European white water lily (Nymphaea alba), East Demerara Water Conservancy wetlands
© WWF-Guianas / Aiesha Williams

CHAPTER 1

INTRODUCTION

1.1. Historical and global/ regional perspectives of wetlands management

Over the past five decades WWF and its partners, in particular the International Union for Conservation of Nature (IUCN), have played a pivotal role in setting the global agenda on the conservation and management of wetlands. The advent of WWF's involvement in wetland conservation dates back to the 1960s when the organization recognized the ecological importance and threats to one of Europe's wetlands, Spain's Coto Doñana. In an attempt to protect the area, WWF became the owner of a significant part of it and promoted the creation of the National Park, which was the first of a series that have made the area one of the most prized reserves in Europe.

The Coto Doñana is a delta located at the junction of the Atlantic Ocean and the Guadalquivir River in the southwest of Spain and is regarded as one of the most valuable wetlands in Europe covering an area of about 280,000 hectares. It is a sanctuary for almost 6 million migratory birds, and endangered species such as the imperial eagle and Iberian lynx. Over time, a combination of anthropogenic and natural factors have forged a diverse landscape comprising marshlands, natural beaches, dune systems and a variety of forests and bush lands. However, activities such as mining, farming, tourism and infrastructure development have

also posed severe threats to the environment.

As a follow-up to WWF's work in southwest Spain and in collaboration with the IUCN, a broader global initiative was unfolding to address the issues impacting on other major wetlands around the world. This led to the Convention on Wetlands of International Importance which was signed in Ramsar, Iran, on 3 February 1971, and which came into force on 21 December 1975. This Convention provided a framework for national action and international cooperation for the conservation and wise use of wetlands, mainly for the protection of habitats for water birds, especially migratory species. Later the scope of the Convention was expanded to all aspects of wetland conservation and wise use, reflecting an appreciation of wetlands as ecosystems with the capacity to address the issues of biodiversity conservation and human well-being.

Current estimates are that wetlands equate to about 9% of earth's land surface, and play a major role in the global economy with respect to water supply, fisheries, agriculture, forestry and tourism. It is noteworthy, therefore, given the socio-economic and ecological importance of wetlands, that the Ramsar Convention is the only environmental treaty focusing on a particular ecosystem. By 2012 the convention had been ratified by 165 parties; listed were 2,109 wetlands of international importance, with the total surface area of the designated sites amounting to 205,203,794 hectares (2,052.037.9km^2.) Agreement was also reached among the Parties to the Convention that at least one site in each of the signing parties' territories which met Ramsar criteria would be designated a Ramsar site, and a number of management principles would be put in place to support the implementation of the Convention.

The operating procedures of the contracting parties of the Ramsar Convention are organized around a meeting every three years to assess progress made in implementing the Convention and wetland conservation, as well as to share knowledge and experience on technical issues, and plan for the next triennium. In addition to the Conference of the Parties (COP), the Convention's work is supported by a Standing Committee, a Scientific and Technical Review Panel, and the Ramsar Bureau, which carries out the functions of a Secretariat.

As far back as the 1960s, WWF's global freshwater programme has been focusing on the protection of ecosystems and the improvement of water access, efficiency, and allocation for people and the environment. This includes water stewardship, water security and climate change adaptation. Work to protect wetlands is particularly focused on habitat protection. Since 1999 about 75% of new sites included in the Ramsar List of Wetlands of International Importance are the result of WWF's work at different levels. These include working with national governments, international river basin organizations and other institutions in supporting the implementation of international agreements and treaties on biodiversity and wetlands, promoting payments for environmental services (PES) for financing freshwater ecosystem services, assessing and increasing the representativeness of freshwater habitats in protected area networks, establishing freshwater conservation networks and restoring critical freshwater habitats.

In a regional context, within the wider Amazon, WWF has also been engaged in focusing on freshwater conservation. In the Guianas, for instance, there are large areas of pristine freshwater landscapes such as the Kaw in French Guiana, the Coroni Swamps in Suriname and the North Rupununi in Guyana that are now facing severe threats as the region seeks to meet the demands of its impoverished and growing population for energy, food, leisure and other environmental services. While recognizing the immense value of these ecological landscapes, it is clear to WWF-Guianas, however, that enough is still not known about the essential ecological characteristics of these wetlands, thereby restricting the capabilities of the stakeholders in the region to meaningfully participate in their management.

There is no doubt that wetland protection and management represent a significant aspect of the environmental portfolio of many national governments and conservation organizations around the world, including the three countries of the Guianas. The seminal work of WWF and the IUCN in the marshlands of southwest Spain almost 50 years ago undoubtedly pointed to the pitfall of anaemic wetland conservation and management policies, and to a more positive approach on how the problems of wetlands management around the world could be addressed. This WWF/IUCN initiative played an important role in helping to fashion the Ramsar Convention.

At the local level, in Guyana, the Environmental Protection Agency (EPA) in 2002 sponsored a workshop and identified two areas as potential Ramsar sites. These were the wider Shell Beach and the North Rupununi. The workshop participants observed that these two areas should be the first Ramsar wetlands of international importance to Guyana. However, by 2012, unlike the country's eastern neighbour Suriname, there had been no declaration of such sites in Guyana, despite increased threats to these areas from oil exploration, infrastructure development and other investment, and Guyana was the only country within South America which had not yet signed and ratified the Ramsar Convention on Wetlands.

1.2. General overview of wetlands

1.2.1 Definitions of wetlands

Trying to imagine what constitutes wetlands might seem an effortless and obvious exercise. However, the variations in definitions of wetlands may be as broad as including all areas influenced by water, including cultivated fields, or as narrow as specifically focusing on temporal and spatial variations and life form adaptations. The definitions utilized in each case often reflect the management needs and goals, the need for conservation or preservation, the particular audience or user or discipline. Though attempts have been made to derive an acceptable definition, no final agreement has been achieved on the specific definition of wetlands. Dodds (2002) contends that the problem is making a distinction between wetland and terrestrial habitats, often with the types of plants and the soil characteristics helping in making that distinction. However interminable the disagreement in defining wetlands, it is implicit that wetlands are areas of land in which water is the principal influence on the environment.

Some definitions indicate that Wetlands occur where the soil is inundated or saturated with water and where water determines the types of plants, animals and other life forms that inhabit the surface and subsurface. For example, Winning (2001) noted that in Australia, the New South Wales (NSW) Wetlands Management Policy defined wetlands as “areas that are wet for a long enough period such that the plants and animals living in them are adapted to, and often dependent on, living in wet conditions for at least part of their life cycle”. Another useful definition of wetland was provided by Keddy (2012) who posited that a wetland “is an ecosystem that arises when inundation by water produces soils dominated by anaerobic processes, which, in turn, forces the biota, particularly rooted plants, to adapt to flooding.” Shine and de Klemm (1999), in an IUCN publication also support the notion that wetlands are characterized by the presence of plants and also animals dependent on water, in an area of land saturated with water. The United States Environmental Protection Agency for regulatory purposes under the Clean Air Act describes wetlands as “those areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas”. The US Fish and Wildlife Service, in its delineation and identification of wetlands, contends that wetlands are a transition between terrestrial and aquatic systems, with the water table close or just above the land surface, and include one or more of these characteristics – periodically the land supports predominantly hydrophytes (plants adapted to live in wetlands); the substrate is predominantly undrained hydric (wetland) soil; and/or the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin, Carter, Golet, and La Roe, 1979).

Wetlands International identifies wetlands as “water bodies but also include land. They are freshwater, brackish or saline, inland or coastal, seasonal or permanent, natural or man-made. Wetlands include mangroves, (peat) swamps and marshes, rivers, lakes, floodplains and flooded forests, rice-fields, and even coral reefs.” (www.wetlands.org.)

The Ramsar Convention on Wetlands (Ramsar, Iran, 1971) gives an internationally agreed, all-encompassing definition of wetlands as “… areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres” (Article 1.1), and “may incorporate riparian and coastal zones adjacent to the wetlands, and islands or bodies of marine water deeper than six metres at low tide lying within the wetlands.” (Article 2.1. Ramsar Convention Secretariat, 2006.) Though this definition has also been seen as flawed and inadequate, it is an internationally agreed definition (Shine and de Klemm, 1999), and is thus utilized as the definition of wetlands within this book.

1.2.2
Functions of wetlands

Water is vital for life and all aspects of life and is the primary component of wetland ecosystems. Further, the hydrology coupled with the geology, topography and the climate influence the vegetation and other species, ultimately determining the ecological functions of a particular wetland (California Coastal Commission, 1996).

Wetland ecosystems have and **support a high level of biological diversity**, in comparison to other ecosystems and landscapes (Denny, 1994). Both aquatic and terrestrial species exist in or depend on the aquatic habitat, producing this distinguishing high-biodiversity feature of wetlands (United Nations Environment Programme, 2006). Wetlands provide a place of refuge, migration routes and feeding grounds for many species which are critical for their ecological functions, or are endangered, migratory or native species. More importantly, wetlands also contribute to and maintain the variety of habitats and micro-habitats which globally support the existence of many species and increase the richness of many important areas around the world. The diverse food chain support in wetlands for both aquatic and terrestrial species contributes to the biodiversity and rich ecological functions of such areas. By virtue of the type of wetland, geographical location, hydrology and other physical attributes, the level of species diversity and general biological diversity varies (IWRB , 1991). The capacity for wetlands to maintain and house such great biological diversity enables the natural cycling of nutrients. This in turn is especially enabled by the nutrient uptake, retention or recycling actions of many aquatic plants and the interrelations of animal species (Ramsar Convention Secretariat, 2010). The species diversity of these ecosystems enables a number of nutrient processes which in turn increase the productivity of wetlands.

Various species spend at least one part or their entire life cycle and existence within wetlands, for breeding, feeding, shelter and/ or as their primary habitat. Fish, aquatic reptiles, waterfowl and amphibians utilize wetlands as their nursery and breeding grounds. During the early periods of advocacy for the conservation of wetlands, ornithologists were the first to voice their concerns, since such ecosystems were vital habitats for the migratory waterfowl and for their species diversity. Migratory species, especially waterfowl such as plovers, sandpipers, gulls, terns, some tyrant-flycatchers and swallows in one part of the world depend on the wetland habitats in other parts of the world, thereby ensuring their survival and global biodiversity. Wetland ecosystems, especially with a mosaic of vegetation,

Assakata Village Landing *© WWF-Guianas / Aiesha Williams*

Ité palm fruits *© WWF-Guianas / Aiesha Williams*

can include stands of various species of palms which play an important role for bird species such as parrots, also known as psittacines (Bonadie and Bacon, 2000). Macaws, parrots and toucans are normally found nesting in dead trees and palm trunks within wetland sites. Their diet consists principally of the fruits, seeds, flowers and berries produced by plants such as palms, which grow in the swamps, marshes and grassy areas of the wetlands. This feature renders psittacines important seed dispersers. Outside of the fruiting season or the fragmentation of fruiting vegetation within wetland sites, psittacines are known to feed in non-wetland areas such as tropical forest, or even raid cultivated lands (Bonadie and Bacon, 2000). Consequently, wetlands with patches of palms and other fruiting trees can be seen as an important barrier and protection for cultivated lands and farmers' and farming communities' livelihoods.

The plant diversity of permanent and seasonal wetlands and the surrounding areas linked to these wetlands are relatively high when compared to more dry and upland areas. This may be due to an interdependent effect, where a range of animal species are supported by the wetlands, and in turn support a variety of plants and the micro-habitats these form, for instance through aiding seed dispersal by various means. The combination of the diversity of plants species, animal species, microhabitats and interactions occurring in wetland ecosystems make such a system the highly biologically diverse area wetlands are known to be.

Wetland ecosystems largely influence **hydrological functions** including hydrological cycle regulation, groundwater protection and regulation, and water storage. Wetlands act as sponges, **absorbing and storing water**, especially resulting from high levels of rainfall and the run-offs from upland areas. This feature is especially evident in peatlands and wet grasslands where water is not merely absorbed into an open "basin" but absorption is facilitated by peat and the soil material. The resulting **flood control and mitigation**, an all so important function of wetland ecosystems, is especially evident in areas of low elevation and along coast lines. Wetlands intercept or slow the run-off of water into rivers, canals, residential areas and cultivated lands in periods of heavy and frequent rainfalls. Coastal wetlands such as mangrove swamps, estuaries, salt marshes and lagoons act as a wall and basin preventing flooding and improving sea defences for many coastal communities. The hydrological cycle is also supported by the water retaining and releasing function of wetlands. Also linked to wetlands are underground reservoirs or aquifers, depending on the soil type, which also holds and releases enormous amounts of water.

The attributes of wetlands for water storage and slowing of water run-off as well as their tempering effect on high tide currents also function in reducing or altogether **preventing erosion, as well as stabilizing river banks and shorelines**. For coastal communities, wetlands such as mangrove swamps and coral reefs act as sea defences, absorbing the imminent damage from storms and high tide currents. By virtue of the vegetation in these coastal and riparian wetlands, the coastlines and flood plains are reinforced, which offer further protection for adjacent communities and ecosystems. Vegetation within wetlands also increases physical barriers and maximizes the protective value of wetlands. These natural defences are far more inexpensive and decrease the vulnerability of many third world countries and poor communities (Ramsar Convention Secretariat, 2010).

Wetlands **facilitate decomposition and storage, and enables geochemical and biochemical cycles**; most notable are carbon, nitrogen, phosphorous, and sulphur (Walternade, 2000). These chemicals are introduced into the atmosphere and waterways through natural or human activities, including by various levels of destruction and degradation of wetlands. Whatever the source, pollutants, nutrients and other chemicals are decomposed or retained within wetlands ecosystems by microbial and chemical processes.

Wetlands therefore have a dual role, acting as carbon sinks as well as a source of carbon and other elements, which in turn influence climatic conditions and ecological processes. For instance, methane, a green-house gas, is naturally released from wetlands; when released into the atmosphere it contributes to extreme changes in climatic conditions, and with the resulting increased global temperatures, methane production in turn also increases. Acting as sinks for nitrogen, wetlands concurrently enable its removal from the environment by facilitating nitrification and denitrification through the action of bacteria and plants found within wetlands. Nitrogen in its pollutant form is retained and broken down in wetlands, decreasing its release downstream (Haidary and Nakane, 2009). Phosphorus is also retained in sediments within wetlands and decomposed by wetland plants and micro-organisms, thereby minimizing release into the environment. Some aquatic plants and micro-organisms absorb heavy metals in their various states and chemical pollutants, thus reducing such elements within the aquatic systems and ultimately reducing water pollution. Wetlands act as sinks for these chemicals; many if released can have ripple effects on the environment and human livelihoods. The spin-offs from chemical processes and decomposition and storage occurring in wetlands are wide reaching, having both ecological and socio-economic benefits. Chemical decomposition especially preserves biological diversity within these ecosystems themselves, by preventing excess growth of certain organisms such as algae. Destruction through draining or filling of wetland ecosystems which have these functions eliminates these chemical and microbial processes, thereby releasing the various gases and contributing to change in climatic conditions.

With their chemical decomposition and retention properties, wetlands **purify the water** stored and flowing through these ecosystems. Not only do wetlands remove chemicals, but they also filter suspended solids and other types of waste materials from water. Wetlands, as a source of filtered and “clean” water are also invaluable to the development of various aquatic species.

The day’s catch being prepared for sale *© WWF-Guianas / Aiesha Williams*

In addition, the water purifying properties of wetlands mean that such areas are sources of improved water quality, thereby making the industrial and domestic water supply less expensive. The water storage capacity of wetlands is further utilized in the agricultural industries, especially for irrigation of cultivated lands. Many of the plant and animal species found in and dependent upon wetlands are utilized as food and are the basis for fisheries, and for the plant, live pet and bush meat trade of f local communities and even for some of the country's economy.

Neither should the **aesthetic and socio-economic** value of wetlands be overlooked; wetlands sites are important areas for recreation. Their main natural characteristics, especially the variety of wildlife inhabiting these areas, make wetlands attractive and exciting not only to residents of the land, but are a draw to visitors, boosting and diversifying any country's tourism sector.

Their mere "naturalness" lures eco-tourists to wetlands. With some visitors remaining days or weeks in such areas, there is a consequent increase in income to local communities, and to countries as a whole. The cultures of many indigenous peoples and local communities are linked to water and wetland areas.

1.2.3 Classifications of wetlands

Conservation and management, identification and demarcation of wetlands are vital. However the very diversity of wetlands makes it necessary to follow a system of classification in order to ensure efforts are successfully focused. According to Birkett et al. (1996), the difficulty of identifying and classifying wetlands globally has also made determining the spatial extent of wetlands uncertain. In addition, this problem of determining the areal extent of wetlands is compounded by the fact that land use changes continually alter or modify such areas. Matthews and Fung (1987) and Mitchell (1990) have estimated the global areal extent of wetlands as 5.3x1012 and 8.6x1012 million square miles respectively, while in 1999, the Ramsar Secretariat estimated a minimum of between 748 and 778 million hectares (not including all types of wetlands). UNEP-WCMC estimates put wetlands at 570 million hectares (5.7 million km^2), about 6% of the Earth's land surface. These varying calculations of the extent of wetlands may be owing to the fact that various classification systems are utilized.

There is no single classification system adopted globally; that of the Ramsar Convention however is the only internationally agreed system, yet all signatories to the Convention do not strictly adhere to the system. There however seem to be some

A passenger motorboat along the Moruca River *© WWF-Guianas / Aiesha Williams*

Aerial view of Kaieteur Falls and the Gorge as part of the Potaro River with Kaieteur National Park
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commonalities among the more utilized systems of classification, in that they are based on hydrological, geomorphological and vegetation characteristics. Invariantly such commonalities for each classification system establish a common language for wetlands and wetland managers globally. According to Brinson (2011), generally speaking, systems of classification are categorized based on three broad topics: the function (what wetlands do), structure (what wetlands look like), or utility (how wetlands are managed).

The Canadian Wetland Classification System identifies wetlands on the basis of genetic origin, morphology, surface pattern, water type, and morphology of underlying mineral soil and vegetation physiognomy; i.e. soil, water and vegetation (National Wetlands Working Group, 1997). With this basis, wetlands are subdivided into three levels of “wetlands class”, which is further subdivided into “wetlands form”, which is also further subdivided into “wetlands type”. Some constructed wetlands (e.g. for waste water treatment) are not included in the classification system; those however which eventually function as a natural wetlands system are incorporated into this system of classification.

The U.S. Fish and Wildlife Service (USFWS) classification system, also known as the Cowardin System, has defined its wetlands in a hierarchical manner on the basis of hydrology, soils and vegetation, basically grouped broadly as coastal or inland wetlands. This gave rise to five “systems” of wetlands, three of which are grouped as tidal wetlands, and the other two non-tidal and open wetlands. Each of the five systems is subdivided into subsystems, on the basis of the “substrate material and flooding regime, or on vegetative life form”. (Cowardin, Carter, Golet, and LaRoe, 1979).

A bit more complicated system is the National Wetland Classification System for South Africa which takes a hydrogeomorphic (i.e. hydrological and geomorphological) approach to its classification scheme, which is linked to how the wetland ecosystem functions. This system also categorizes wetlands in a hierarchical manner, within six primary levels of classification. From Level 1 through to 4 the various types of wetlands are distinguished by a set of “primary discriminators”. The highest Level is distinguished by the level of connectivity to the ocean- namely marine vs. estuarine vs. inland; then subsequently by regional setting. Level 3 however subdivides marine systems by their periodicity of connection, and inland systems by their varying topographic position. Level 4 categorizations are based on landform, hydrology and hydrodynamics. Level 5 is classed according to the “secondary discriminators” of tidal or hydrological

regime. The final level of classification is based on the wetland characteristics including geology; natural vs. artificial; vegetation cover type; substratum; salinity; and acidity/alkalinity.

The Ramsar Classification system for wetland type was utilized to identify and categorize the Guyana sites under study. This system of classification, a modification of the Cowardin System, was applied since it is an internationally agreed system available to effect broad classification of wetlands. With the Ramsar System, wetlands are classified into three broad groups. These are marine and coastal, inland, and human-made; which are further sub-categorized into forty-two types based on setting, water permanence, soils, substrate and vegetation. As indicated in the Ramsar guidance notes on the application of the system of classification, , where “codes are based upon the Ramsar Classification System for Wetland Type as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties”, a site can be categorized by a range of wetland types. Below are the summarized tables of classification for the three broad groups.

Fiery sky as the sun sets over Moruca, North West wetlands *© WWF-Guianas / Aiesha Williams*

Table 1: Tabulations of wetland type characteristics

(Extracted from www.ramsar.org)

Marine / Coastal Wetlands:

Saline water	Permanent	< 6 m deep	A
		Underwater vegetation	B
		Coral reefs	C
	Shores	Rocky	D
		Sand, shingle or pebble	E
Saline or brackish water	Intertidal	Flats (mud, sand or salt)	G
		Marshes	H
		Forested	I
	Lagoons		J
	Estuarine waters		F
Saline, brackish or fresh water	Subterranean		Zk(a)
Fresh water	Lagoons		K

Inland Wetlands:

Fresh water	Flowing water	Permanent	Rivers, streams, creeks	M
			Deltas	L
			Springs, oases	Y
		Seasonal/ intermittent	Rivers, streams, creeks	N
	Lakes and pools	Permanent	> 8 ha	O
			> 8 ha	Tp
		Seasonal/ intermittent	> 8 ha	P
			> 8 ha	Ts
	Marshes on inorganic soils	Permanent	Herb-dominated	Tp
		Permanent/ Seasonal/ intermittent	Shrub-dominated	W
			Tree-dominated	Xf
		Seasonal/ intermittent	Herb-dominated	Ts
	Marshes on peat soils	Permanent	Non-forested	U
			Forested	Xp
	Marshes on inorganic or peat soils	High altitude (alpine)		Va
		Tundra		Vt
Saline, brackish or alkaline water	Lakes	Permanent		Q
		Seasonal/intermittent		R
	Marshes & pools	Permanent		Sp
		Seasonal/ intermittent		Ss
Fresh, saline, brackish or alkaline water	Geothermal			Zg
	Subterranean			Zk(b)

Human-made Wetlands:

Name & Characteristics	Codes
Aquaculture (e.g., fish/shrimp) **ponds**	1
Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).	2
Irrigated land; includes irrigation channels and rice fields.	3
Seasonally flooded agricultural land (including intensively managed or grazed wet meadow or pasture)	4
Salt exploitation sites; salt pans, salines, etc	5
Water storage areas; reservoirs/barrages/dams/impoundments (generally over 8 ha)	6
Excavations; gravel/brick/clay pits; borrow pits, mining pools	7
Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc	8
Canals and drainage channels, ditches	9
Karst and other subterranean hydrological systems, human-made	Zk(c)

Boys travelling in their canoe along the Moruka River, North West wetlands *© WWF-Guianas*

CHAPTER 2

SCOPE AND METHODOLOGICAL APPROACH TO THE STUDY

2.1 Background to scope and methodological approach

In order to prepare this publication, a study was designed to identify and characterize wetland types in Guyana, and executed from April 2010 to October 2011. The characterization of the major sites was based on their ecological, geomorphological and socio-economic attributes. This study focused specifically on representative wetland types described under the Ramsar Convention on Wetlands (Article 1.1.) as fresh and brackish water, since including all riparian areas and deeper coastal waters would have increased the scope of the assessment beyond the timeline and resource availability. Specific focus was given only to the wetland categories of human-made; naturally formed permanent; and naturally formed, seasonally flooded (i.e. for more than seven months of the calendar year).

The results of the study, however, only provided baseline information and preliminary insight into the characteristics of the specific study sites and did not definitively state the absence of a particular species or attribute from the wetlands or wetland types. The ability to generalize the findings of the field studies for all wetlands with similar characterization is very limited. Field survey data also did not give insight into the overall

Large flock of great egrets (Ardea alba) within the MMA Conservancy and wetlands
© WWF-Guianas / Waldyke Prince

status or health of the wetlands under study; further detailed and long-term research would enable this. The disparity in information available per site makes the descriptions of some sites more robust than others.

2.2 Selection of sites and sample points

A preliminary Global Information System (GIS) analysis was conducted to identify the presence of major wetland sites and subsequently to select sample points.

The methodology for constructing such a Guyana wetlands basemap utilized a process of classification satellite imagery supplemented by inputs from historic records (topographic sheets) and ground truthing.

The available image tiles (33 in number) from the satellites Landsat 5 and 7 were identified and ranked for their suitability of use, based on the extent of cloud cover, geographic area cover and time range. The images provided coverage of the entire geographical extent under study during both wet and dry periods. Cloud cover was determined the major factor for suitability, as the optical bands utilized recorded both the clouds and their ground shadows. The analysis created coarse land cover classes. These land cover classes highlighted the various areas of open water-bodies, the permanently flooded vegetated lands, and the seasonally flooded lands. Within these broad areas, preliminary data on the hydrology, elevation, landscape and vegetation types were analysed, and from these results, six major wetland study sites were selected based on their geographic location, as representative of the various categories of the country's wetlands. Within these six major sites, twenty-five (25) sample points were identified for further detailed field data collection in order to define the wetland categories; twenty-three (23) were used in the final analysis.

The criteria for selection of the wetland sample points were as follows:

1. The site should provide opportunity for collection of maximum and most representative information about the biological and physical features of the specific category of wetland, based on a list generated. The list included the species groups, physical, and hydrological parameters needed to be collected. (See Appendix 1.)
2. The presence of a permanent body of water (excluding main channel of river/ canal) at the time of the study to enable sampling of all parameters.
3. Geographically linked to or located within the specified category of wetland basin.
4. Relative ease of access to ensure all the representative sites could be visited and surveyed within the timeframe of the study.

Wetland sample sites visited between April 2010 – Sept 2011:

1. Lake Mainstay, Essequibo Coast
2. Lake Tapakuma, Essequibo Coast
3. Lake Capoey, Essequibo Coast
4. Lake Mashabo, Essequibo Coast
5. Surama Pond, North Rupununi
6. Airstrip Pond, North Rupununi
7. Oma Pond, North Rupununi
8. Devil Pond, North Rupununi
9. Grass Pond, North Rupununi
10. Shulinab, South-central Rupununi
11. Sandcreek, South-central Rupununi
12. Moruca Swamp, Moruca Sub-district
13. Assakata Lake and wetlands, North West District
14. Baramani Lake, North West District
15. Almond Beach, North West District
16. George, North West District
17. Arnold Ponds, North West District
18. East Demerara Water Conservancy, ECD
19. Mahaica-Mahaicony-Abary Conservancy, ECD
20. Manarabissi Swamp, Corentyne
21. Sandaca Swamp, Corentyne
22. Guysuco Conservancy, Corentyne
23. Halcrow Conservancy Corentyne

The steps taken for the Remote Sensing and Geographic Information System Analysis are offered below:

STEP 1. Identification of suitable images:
The 33 available Landsat 5 and 7 image tiles were identified and ranked for suitability. Of this number, 15 were selected for use. These provided coverage of 95% of the national geographical area of Guyana during wet and dry periods.

STEP 2. Mosaic:
This involved a two-step process. The images were positioned to ensure that there were no gaps, overlaps or duplications. The 15 individual images were then stitched together creating a single image used for analysis.

Step 3.
Unsupervised classification:
An 'Iso Cluster' method of unsupervised classification was conducted to define the initial base land cover classes. This looked at the graph of the data values in the single image created in the last step. Clusters of significant data groupings were determined. Individual data cells of similar values were then grouped and assigned to the nearest data cluster. Each cluster then represented a single land cover class.

To give further insight, a 'K-means' unsupervised classification was then conducted, which showed more variation than the Iso cluster. This data mining cluster analysis method partitioned observations of each pixel into clusters of land cover allocations. The number of clusters was determined after observing the graph of data values in the image. The K-means and Iso Cluster were then compared with a principle components analysis of the same mosaic to further verify that a suitable number of clusters were used, and to gain a better idea of the distribution of these clusters via visual identification. The Iso Cluster, K-means and Principle Components analysis outputs were used in a repeating process to improve accuracy of the training sites utilized in the next step.

Step 4.
'NeuralNet' neural network analysis:
Training sites were created for the network based on the output from the iso cluster analysis after the K-Means and Principle Components results were considered. These training sites were important as they affected the accuracy of the Neural Network Analysis. Additionally, training samples were also used by the module to verify the class allocation results of the training process. The RMS (root mean square) error was then calculated to assess the accuracy of the end result, continuing the process until an acceptable result with minimal error was achieved. At the end of the neural network analysis, a TCA (typical components analysis) was conducted as an additional measure to validate the accuracy of the classes generated.

Thus, the initial land cover maps were produced based on the outputs of the iso cluster, K-means, principle components, and neural network analysis procedures. Here the identified base land cover types generated by the coarser 'iso cluster' and K-means functions were utilized to inform the description of the results of the neural network analysis.

Step 5.
Historic data:
1:50,000 topographic sheets, forest type and soil type maps were used to obtain historical data on the location of land cover types. A normalized difference vegetation index (NDVI) was conducted on the mosaiced image to give further insight into the present distribution of land cover, and was compared to the historic spatial distribution.

Flock of vultures over Tapakuma Lake, Essequibo Coast wetlands *© WWF-Guianas / Sopheia Edghill*

Step 6.
New training sites:
New training sites were created for the supervised classification of land cover types based on the comparison of the historic data with the output of the neural network analysis, reinforced by the NDVI.

Step 7.
Maximum likelihood classification:
The 'maximum likelihood classification' method was determined to be the most suitable method of defining and finalizing the necessary land cover types. Here each data point (pixel) was assigned to the most likely land cover type as determined by comparing it to the class training sites created in the above step. The data point was then automatically assigned to the land cover type represented by the training site(s) it most closely resembled. This method provided the opportunity to use prior knowledge gained from the iso cluster, neural network analyses and the reference to the 1:50,000 topographic map sheets, in defining the training sites for each land use class.

Step 8.
Boolean identifiers:
The outputs of the supervised maximum likelihood classification process were converted to 'Boolean identifiers' for each individual class. The Boolean transformation simply converted the results into absolute values, identifying each pixel as either containing or being devoid of the particular land cover type, thus providing a simpler visual presentation and manipulation of the outputs.

Step 9.
Majority filter:
A 'Majority Filter' operation was conducted in an eight-pixel moving window to remove unwanted data values. A second 'majority filter' operation was then run on each land cover data set. This filter technique compared each pixel of the image with the eight closest to it. If the majority (five minimum) of those did not match the identified pixel, it was removed from the selection. While this allowed for a smoother, more uniform presentation, it also potentially removed small clusters of useful data scattered about the image- it was later determined that the process had deleted several small lakes.

Step 10.
Draft maps:
The outputs of each created land cover class were layered, one on top of another, to produce a draft land cover map.

Step 11.
Ground truthing:
Ground truthing was then used to determine the accuracy of the initial map and to refine the number and location of training sites used in successive iterations of this second phase of analysis. The geographic coordinates of sample locations were recorded on field visits, along with notes on the land cover of each. These were then compared with the predicted land cover type on the draft land cover maps. If there were differences, the training sites were then adjusted to reflect the observed land cover type at that location and analysis was redone from Step 7.

Aerial view of a section of the North West wetlands along the Atlantic Ocean *© WWF-Guianas*

Step 12.
SPOT data:
SPOT data was made available from WWF-Guianas and was then added to the mosaic to increase spatial resolution. Cloud cover still remained an issue as the process underwent another iteration, with the training sites further improved by the ongoing ground truthing field exercises at the time.

Step 13.
ALOS PALSAR data:
Data from the ALOS PALSAR satellite was made available by Conservation International and added to the analysis. The PALSAR instrument on this satellite uses different technology to the Landsat or SPOT satellites and allows for land observations unaffected by clouds. This data was first used in conjunction with the existing land cover classes to increase spatial resolution. While a favourable result was gained, this did leave the analysis product with areas of varying spatial resolution.

The identified land cover classes derived from the Landsat/SPOT analysis were then compared with the ALOS PALSAR data and found to have very similar spatial (ground) distribution and number of classes. Most variations were determined to be due to differences in the smallest area the satellite could see (spatial resolution) and some sensor differences (what the satellite looked for). The land cover classes derived from Landsat/SPOT analysis were then correlated with the existing but undetermined/unnamed class breakdown of the ALOS PALSAR data in order to derive the final land cover classification product, of superior spatial resolution but comparable accuracy.

2.3 Data collection procedures for sample points

Research information was gathered through a combination of primary and secondary data sources. The primary sources included field sampling and one-on-one informal interviews. The secondary sources included satellite image and shape files, topographic maps, existing datasets, institutional records, and published materials. The data collected (see Appendix 1) were utilized to:

- Generate species lists -f*ish and aquatic macro invertebrates, amphibians, reptiles, mammals and birds*
- Analyse species richness (diversity)
- Describe the habitat types and identify micro-habitats
- Assess the water quality
- Identify the threats and pressures to the wetland and associated river basin
- Identify the socio-economic and cultural value.

Drag-netting at Airstrip Pond near Karanambu, Rupununi *© WWF-Guianas / Waldyke Prince*

2.4
Primary data collection

A one-day field sampling was conducted to observe and record the vegetation, wildlife species, water quality and hydro-geomorphology evident at each study site. Field sampling was conducted in both dry and wet seasons. Dry season observations were conducted at all of the wetland sample sites, while wet season sampling was only conducted at a few of the sites due to the unfavourable and unusual weather patterns for the duration of the project. The specific sample methods for taxa and the physical parameters are summarized below.

Vertebrates - mammals, birds, amphibians and reptiles

At each sample site, transects were utilized to observe vertebrates including aquatic mammals, birds, amphibians (frogs) and reptiles. Transects are a good way to determine species presence and distribution, and to measure the relative abundance or density of a variety of species. These transects were approximately 2km in length, measured with the use of GPS Units. The Visual Encounter Surveys (VES) were conducted along these transects either by foot and/or by boat, utilizing various vantage points to give the maximum observation. Surveys were done three times per day commencing at 06:00hrs, 16:00hrs and 19:00hrs, to ensure observation of species with varying daily activity patterns. The observers moved along transects slowly and identified and recorded all vertebrates seen within each wetland sample site. Indirect observations such as scats, tracks and vocalizations were also utilized to record vertebrates along these transects.

Records of the weather conditions, disturbances and behaviour of species at the time of the surveys were also recorded. The surveys were conducted with the aid of binoculars, especially in daylight, and with torchlights (Maglites) at nights. For nocturnal surveys most vertebrates such as caimans and frogs could be easily seen via the reflections from their eyes in the torchlight. Incidental encounters of targeted aquatic wildlife outside of stipulated transects and sampling periods were also recorded. Records were also made of non-aquatic species. Visual Encounter Surveys tend to be biased towards detecting large terrestrial species and very 'vocal' species, whereas many small, cryptic or arboreal species are under-sampled or not detected.

Fish and other aquatic macro-invertebrates

Field surveys of fish and macro-invertebrates including all aquatic molluscs and crustaceans utilized a number of observation or collection methods. Hoop, gill and cast-netting together with drag-seining and hook

Giant otter (Pteronura brasiliensis) *© WWF-Canon / Michel Gunther*

and line were employed to survey each water body at the sample sites. Except where the sample site was too small, sampling plots were approximately 200m. Specimens of fish and macro-invertebrates were collected and preserved in 10% formalin for later identification. Select specimens were photographed in a photographic aquarium before preservation. Records were also made of specimens of taxa other than fish, aquatic molluscs and crustaceans which were caught.

Gill nets of three different eye sizes (1.25”, 2.5” and 4.5” - stretched) were used to enable capture of a wide range of fish species. Placement of the nets was dependent on the specific characteristics of the sample sites. However, nets were placed at a number of locations to enable sampling of all micro-habitats or types of vegetation. Gill-netting sites were separated from other more active sampling areas by approximately 50m to reduce disturbances. Whenever possible nets were set to span the width of the water body; otherwise, in wider sites, placement ensured the full span of the net was maintained. Nets with larger eyes were placed upstream from nets with smaller eyes. The nets were monitored at dawn and during the day until late evening as frequently as possible, but not exceeding one-hour intervals.

Hoop-netting was used without standardization at convenient times, during the morning and late afternoon to evening. Fish hoop nets were used to sweep through free-flowing water and amongst aquatic vegetation. Drag-seining was conducted within sample sites which were relatively shallow and allowed for researchers to wade a reasonable distance. This entailed two persons entering the water and dragging the seine for approximately 10m along the bank. Three drags were conducted in the morning and three in the afternoon. Sampling with hook and line and with cast nets were utilized whenever possible within the sample sites.

Insects

A combination of field collection methods and subsequent specimen sorting and identification in the lab was employed for the field survey of insects. Sampling was conducted at three general locations or subplots within each sample site, including bank, water’s edge and within the open water body (aquatic sampling), in order to observe the insect assemblages. Sampling from the bank and water’s edge were randomly conducted using sweep nets, which are suitable for catching flying insects and those sitting on vegetation. A sweep consisted of a forward and backward stroke with the insect net. The aquatic sampling involved the use of dip nets, drag seines and cast nets, with subsequent sorting of the water samples and vegetation collected. Both the sweep net and the aquatic samples were placed in a plastic zipper bag for further sorting.

Subsequent to field collection, insect specimens were killed via freezing or through the use of other killing agents (alcohol), and sorted and stored in alcohol for preservation. During sorting, specimens were identified to the taxonomic level of order, family and genus. Lower taxonomic identifications were attempted; however many insects are known to be new to science.

Ecosystem assessment

The ecosystem assessment at each sample site included field and desktop map observations to assess ecology, hydrology and geomorphology. Observations of a detailed map to give an indication of water intakes and outputs were initially conducted, followed by validation on the ground. The visual observation of the sample site was done to assess aspects of geomorphology and micro-habitat, including bank and water body vegetation types, substrates, bank material, bank slopes, erosion and accretion. Aquatic plant specimen collections were conducted at each site. Sampling was conducted within each water body traversed within the sample site using a boat. Two vouchers of all plants species were collected. Subsequent to field collection of aquatic plants, specimens were photographed in an aquarium or on a flat surface. One of each of the species was preserved in 70% alcohol for further identification.

Measurements of water chemistry and other physical parameters were carried out using boats to access between two (2) to twenty (20) metres out from the bank, or otherwise at the centre of the water body. Parameters measured within the water body of the sample site included turbidity, salinity, dissolved oxygen, conductivity, pH and temperature. The Hach Brand Multi-parameter IntelliCAL and Turbidimeter portable water quality field testing kits were used to measure these parameters.

Interviews on resource use and extraction

At each study site one-on-one informal interviews were conducted with local community representatives and community leaders to gather additional information on the sites. The discussions were centred on the harvesting of the resources of the wetland site and environs. Generally, the interviews gathered information on what were the target resources, how and when the resource was harvested, and the scale and purpose of the target resource. The informal interviews also were geared towards garnering insights into any socio-cultural beliefs and activities linked to the study sites and their environs.

2.5 Secondary data collection

Throughout the period of the project a literature review was conducted. A number of reports, research documents, scientific journals and datasets were gathered and examined for information related to sample sites. Institutions including the Environmental Protection Agency, the Hydrometeorological Service of the Ministry of Agriculture, the National Drainage and Irrigation Authority, the North Rupununi District Development Board, the Guyana Sugar Company (GUYSUCO), and the Guyana Water Inc housed databases and scientific reports on water quality, wildlife and resources use.

Corkwood (Pterocarpus officinalis) along Moruka River, North West wetlands
© WWF-Guianas Aiesha Williams

CHAPTER 3

SITE PROFILES OF GUYANA'S WETLANDS

Sunset in the Rupununi *© WWF-Guianas / Waldyke Prince*

Table 2: Details of extractive activities and uses of major wetlands and environs

Uses	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi
Fishing- subsistence/ commercial	Subsistence- most popular is Peacock Bass fish etc.	Subsistence esp. by Amerindian community and a few residents of the coast	Mainly for subsistence by residents of the Corentyne Coast, especially from No. 63 - Molson area	Mainly for subsistence by residents of the Amerindian villages but also others of the outlying townships and villages. Occasional sale also.	Both subsistence and commercial - largest scale commercial is off the sea-coast	Both subsistence and now lesser commercial. arawana, lukanani, piranha, hassar, some catfishes. Aquarium fishing has been done in the past.
Ranching	Cattle, smaller herds of sheep and goat within environs		Commercial cattle ranching is practiced by a substantial amount of private owners, with grazing pastures within (during dry season) and on the environs of the wetland	limited - cattle		Cattle ranching, commercially; other smaller operations of pigs, chickens
Farming- cash crops	Within the environs	Within the environs	Fairly large farmlands for sale and subsistence (bananas, plantains, pumpkins, bora, coconut and watermelons etc.)	Domestic use and sale by Amerindian residents- of cassava, bananas, plantains, pumpkins, bora and peppers, fruits. Pineapple-growing- main economic activity	Mainly for subsistence livelihood, though for some small-scale sale to miners. At Mabaruma cassava, yam, banana, plantain, pineapple, pepper, eddoes, a few garden vegetables are grown	Not widespread, mainly for home and village use, and small commercial locally

Uses	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi
Large Scale Cultivation	Rice	Rice, sugar cane	Sugar cane - owned by GUYSUCO and private suppliers to GUYSUCO. Rice to a lesser extent over the years.	Rice		Rice cultivation attempted
Hunting	Minimally by residents: ducks, labba, tapir	Minimally by residents: ducks, labba, tapir	For domestic use but also for sale within the local markets and to local restaurants- duck, some large mammals and turtles	Ducks, paca, deer, tapir, mainly for domestic usage and also sale on the coastal markets	For local bush meat trade, and subsistence	Domestic use, but also some commercial: tapir, peccaries, deer, a few birds.
Trapping	Esp. of finches for local songbird trade; but also psittacidae	Within the environs; esp. finches for the local songbird trade	For local songbird trade and for live pet trade- has lessened over the years		For live pet trade- international and local	Songbirds for local market; and some larger bird, mammal and Herpetofauna species for the international live pet trade - more so decades ago
Logging- small scale/ commercial	Within the environs such Moraikobai Village	For village use; within the seasonally flooded forest area and environs	To some extent		At commercial (not widespread or to a very large scale) and at local use level	Both commercial and local use

Table 2: Details of extractive activities and uses of major wetlands and environs

Uses	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi
Harvesting non-traditional forest plants	Especially from palms and vines of the surrounding area	Residents of St Cuthbert's Village; palm fronds collected for housing material			Commercial and home use: mainly palm heart, fronds of palms and lianas for building materials and making craft and household utensils	For local use primarily as building materials, craft, utensils and tools, oils, food and drinks etc.; also commercial esp. for tourism- cotton, crabwood seed vines, fronds and other plant parts, honey
Tourism and recreation	Seasonally: bird watching, sport fishing- peacock bass; hunting- ducks	Prohibited		Nature-based tourism, including water sports; recreation esp. at Lakes Mainstay, Capoey. Mainstay Regatta an annual attraction	Mainly at Shell Beach- for sea turtles and Moruca- Santa Rosa (annual Moruca Day activities)	Mainly nature-based and community-based tourism; one of the main Guyana destinations
Transportation		Mainly by St Cuthbert's Village Amerindian residents	Esp. constructed canals used to transport harvested sugar cane stems to the sugar factories	With motorised boats, especially for access for commerce along the Essequibo Township and villages- mainly at Mashabo, Capoey	With motorized boats and paddle boats and dugout canoes. Motorized boats on a commercial basis, also for the mining sector	Waterways not a primary mode of transport, but for some villages; during the wet season this mode becomes more important
Water storage/ source for domestic use	Few residents in the immediate environs- for washing and cleaning etc.	Potable water supply for Georgetown residents and businesses		Especially Amerindian residents of the 4 villages- for domestic use but not for consumption	Important source of water for many residents for domestic use, not so much for drinking in certain areas	Domestic use but often not for drinking. Villages use the deeper water bodies-lakes, ponds and rivers.
Water storage/ source for commercial/ industrial/ irrigation use	Irrigation of agri. lands of rice, cash crops and ranching along West Coast Berbice	Water for manufacturing sector, irrigation of agricultural lands	Mainly for irrigation purposes - sugar, rice, cash crops	Irrigation of Reg. 2 cultivated lands esp. rice; also cash crops and livestock	Mainly for mining	Limited
Flood Control	To some extent, esp. in very extreme rains	Potentially caused by run-off from the southern intermediate savannahs and rain, especially in extreme wet season, beneficial for entire city and parts of East Coast Demerara and East Bank Demerara.	Prevents water run-off from upland areas to the residential and cultivated coast land		To some extent; however because the area is one which floods extensively, this affects people's livelihoods	Most of the area is like a basin; holds flood waters away from homes and far areas
Scientific research	Caiman surveys previously done	Caiman and fish pop. surveys previously done		Limited	A number of studies done on turtles, plants, non-timber forest products, and resource use	Several research projects are conducted and research institutions operate
Biodiversity conservation		A restricted area; there are rules which prohibit certain exploitation to protect the area			Mainly sea turtle; but also community-based efforts.	Much: species specific, area specific, community-based.
Mining - minerals					Mainly in the northern sections	Isolated, however with potential to expand

HUMAN-MADE/ SEMI-NATURAL WETLANDS

3.1

SITE 1- EAST DEMERARA WATER CONSERVANCY (EDWC) WETLANDS

Ecological Profile

3.1.1 Location

The EDWC is located in Administrative Region 4, Demerara-Mahaica[1], extending between the Mahaica and Demerara Rivers. It lies inland from the Atlantic Coast, approximately 24km (15 miles) south.

1 Between 57° 55' 57.263" W 6° 37' 32. 116" N (north-eastern end) and 58° 9' 56.536" W 6°38'51.71" N (western end)

Landscape of the EDWC *© WWF-Guianas*

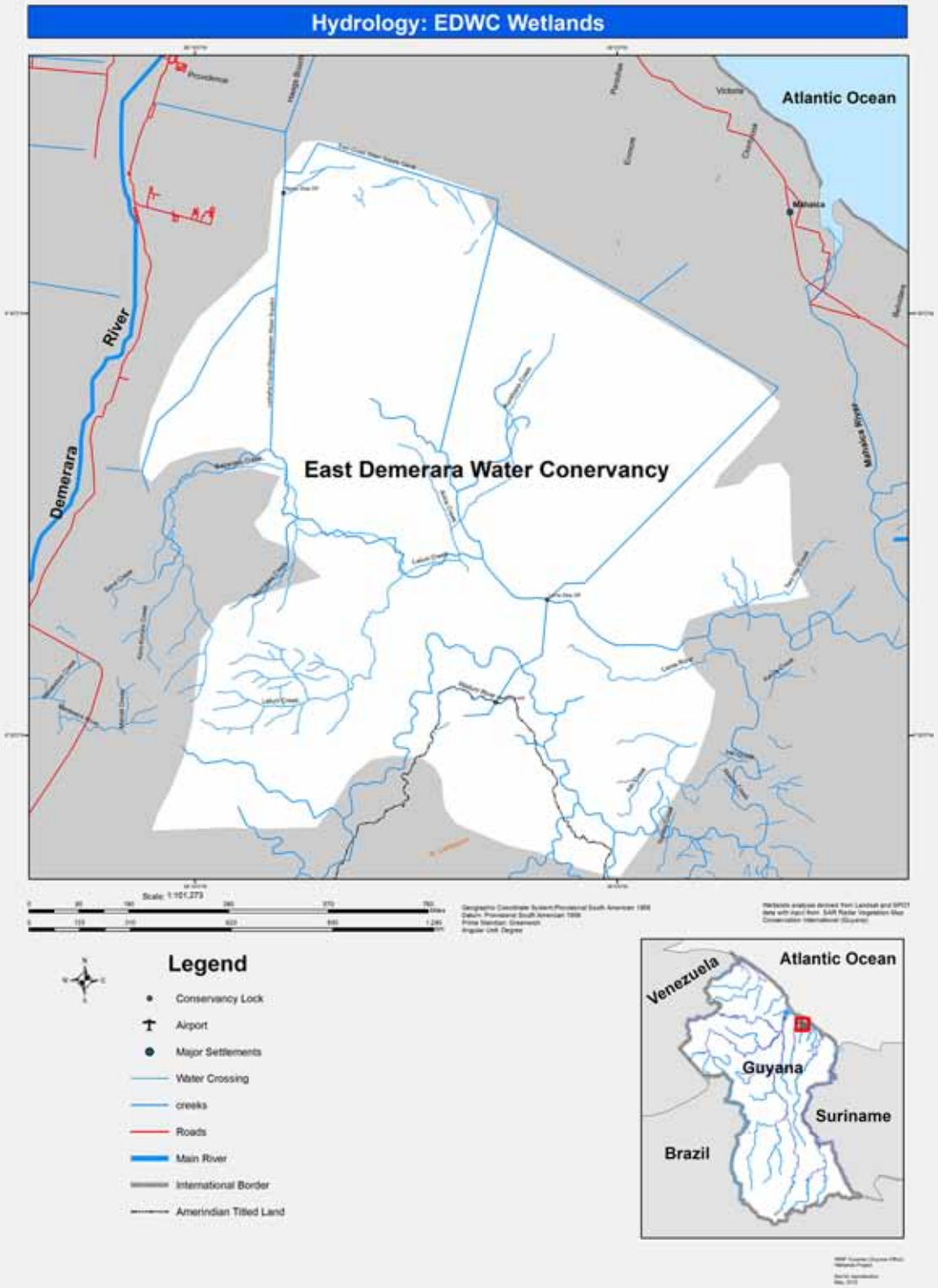


Fig. 1: Map showing location and hydrology of the East Demerara Water Conservancy

3.1.2 Wetland type

The East Demerara Water Conservancy is a wetland classed as Ramsar Type U (non-forested peatland).

This semi-natural peatland sits on the impervious clay of the Demerara formation, characteristic of much of the coast of Guyana. Conservancy construction started in 1877 and was completed in 1878 (Source: EDWC), by damming the flows of the Lama and Maduni Rivers and their tributaries on the southern side, and the establishment of a northern earthen dam to protect the low coastal lands. These constructions have amalgamated smaller conservancies and water courses into this single large flooded area, the EDWC. The vegetation, which may have originated from smaller flooded areas along the natural water courses prior to dam construction, provided the starting material for the peatland ecosystem now existing and which over these years has come to be fairly balanced.

3.1.3 Hydrogeomorphology[2]

The northern dam which runs parallel to the Atlantic Coast is approximately 72 kilometres in length. The catchment covers an area of approximately 518km^2, with a water surface area of approximately 337km^2. It has the capacity to hold 336.7 square kilometres (130 square miles) equivalent to 100 billion gallons of water with maximum storage at a level of 17.53 metres or 57.50ft, relative to Georgetown Datum (GD).

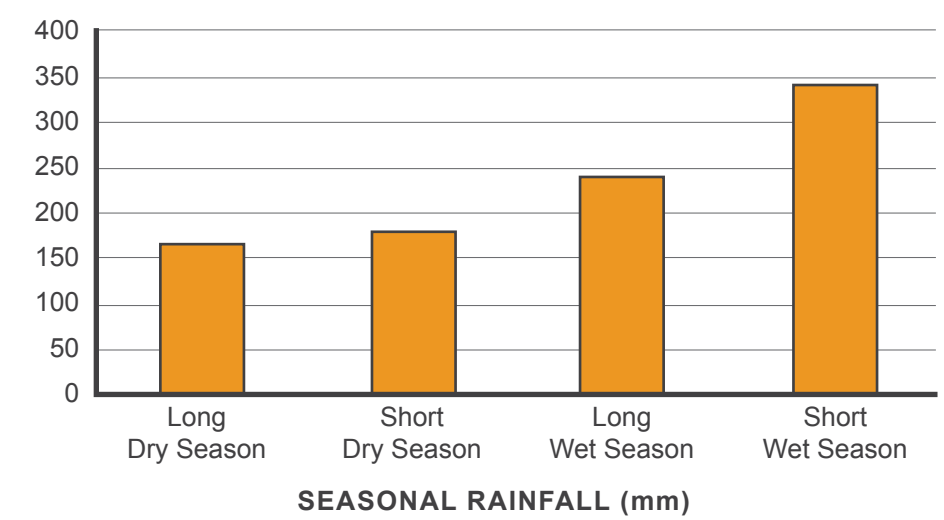


Fig. 2: Bar-Chart showing the seasonal rainfall pattern[3] for the EDWC

2 The physical characteristics of the shape, the boundaries and the content of a water body.
3 Calculations based on field measurements by Hydromet 2007 – 2010 dataset, converted to seasonal/ quarterly rainfall averages at various locations within the vicinity of the sample sites. A spline operation was carried out to interpolate each set of seasonal data via a minimum curvature technique providing national coverage. Isohyets for each season were created and mapped.

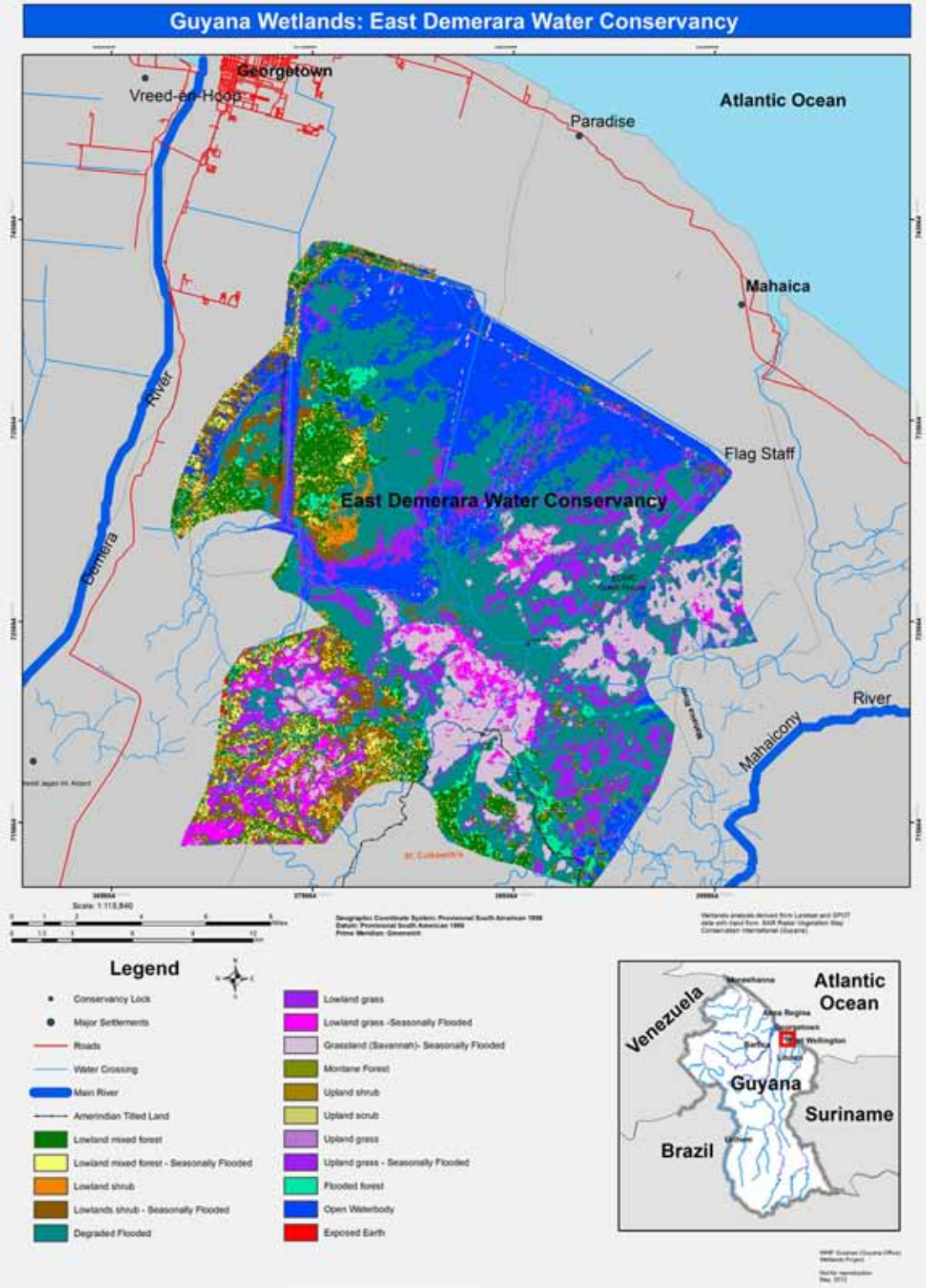


Fig. 3: Map of Vegetation and land cover types of the East Demerara Water Conservancy

The conservancy feeds an extensive network of drainage canals which generally lead to agricultural lands between the north bank of the conservancy and the coastline. Hydrological input to the system is mainly from direct precipitation, underground flow, surface run-off (see Fig. 1) and inflows from the natural water courses through 27 intake structures. The main outputs are human-controlled water-level regulation systems managed via sluices and canals leading eventually north to the Atlantic: at Kofi, Cunha and Land-of-Canaan which lead west to the Demerara River; and the Lama and Maduni Rivers leading east to the Mahaica River (see Fig. 1).

Table 3:
Water Chemistry Measurements taken at sample point within the EDWC

Parameters	Values
Electrical conductivity (µS)	1.06
pH	5.17
Temperature from pH meter (°C)	28.3
Dissolved oxygen (%)	1.56
Turbidity (NTU)	1.57
Total dissolved solids – TDS (mg/L)	0.43
Visibility depth (cm)	-
Salinity (o/oo)	0.00

The conservancy holds “blackwater” which is characteristically acidic (pH 5.17). Its low velocity of flow lends itself to low levels of turbidity, dissolved oxygen, dissolved solids and electrical conductivity (see Table 3). The low levels of dissolved solids are likely organics, as salinity is 0% and electrical conductivity is much lower than would be expected for the blackwaters of the Neotropics.

The bottom substrate is earthen and predominantly deep organic peats (pegasse) accumulated over the years of inundation of the catchment area. The constructed dams are soft clay and silty clay.

Section of the vegetation in the EDWC *© WWF-Guianas / Aiesha Williams*

3.1.4
Vegetation cover

The nature of this water body means that the only shorelines directly observable are the earthen northern and eastern dams of the conservancy, along which one of the main canals runs. A large percentage of the EDWC has floating mats of decaying organic matter, so thick in certain areas that they support small shrubs. In other areas, water levels appear to be quite shallow and some small trees are evident. It was difficult to ascertain if these areas are dry for any significant period of the year, but indications are that they are not.

Vegetation along the dam consists mainly of introduced trees in small sparsely distributed clumps – a bamboo species, jamoon/jamun (*Syzigium cumini*) and a few other unidentified species. Grasses and succulents are also common on the dam but these appear to be controlled by the managers of the conservancy.

The floating organic quasi-banks supported a surprising array of species including ferns (*Blechnum*), club mosses (*Lycopodiella*), grasses (Poaceae, *Xyris* sp.), sedges (*Cyperus* sp.), and succulent shrubs (*Montrichardia arborescens, Heliconia acuminata, Sagittaria* sp.) and vines (Araceae, *Mikania* sp.).

Among the strictly aquatic species found in the shallow areas, there are patches as well as individual, sparsely distributed stands of Ité Palm (*Mauritia*

Canje pheasant/ hoatzin (Opisthocomus hoazin) © WWF-Guianas / Waldyke Prince

flexuosa), with a number of other small trees including some Annonaceae species.

The fully aquatic vegetation is also very diverse. The large masses are irregularly subdivided into patches of three dominant groups; the most visibly dominant is the emergent spikerush, *Eleocharis* sp. with cylindrical stalks emerging more than 12 inches above the water surface. These patches stretch for hundreds of metres in some areas. In relatively still enclosures, the floating-leaved water snowflakes (*Nymphoides indica*), fragrant water lily (*Nymphaea odorata*) and another *Nymphaea* species form smaller patches. The lilies are also seen lining the canals in patches. In addition to these abundant species, bladderworts (*Utricularia* sp.), *Cabomba* sp. and submerged club mosses are also fairly common in the conservancy.

Altogether, a total of 24 plant species were identified during the field study; however some of the grasses and sedges are yet to be identified. Only the Ité Palm (*Mauritia flexuosa*) is of known commercial or cultural value and is a protected species because of its multiple value to indigenous communities for food and shelter. It is an important source of food and nesting for several species, such as macaws, parrots, tapir (*Tapirus terrestris*), paca (*Cuniculus paca*), red-rumped agouti (*Dasyprocta leporina*), and a number of fish. The patches of spikerushes, lilies and water snowflakes, as well as the *Cabomba* sp. and submerged parts of aquatic and semi-aquatic species, provide critical cover for fish and invertebrates, and food for primary consumers.

3.1.5 Faunal Species

3.1.5.1 Fish

This wetland shows substantial fish species diversity, including fish groups such as medium-sized carnivores (*Cichla*), small carnivores (*Polycentrus*), benthivores (*Satanoperca*) and omnivores (*Doras*). None of the species identified are of any critical conservation status. Many are valuable, however, as human food; the peacock bass or lukanani (*Cichla ocellaris*). In other locations in the country where it is allowed, this fish is considered important for sports fishing.

3.1.5.2 Birds

Some of the aquatic birds which are most frequently observed within the EDWC are the 10 species of herons, four kingfishers, two species of ducks, wattled jacanas, swallows and the ever common flycatchers. Such a diversity of herons is indicative of a large and diverse population of fish, amphibians and invertebrates. In a complementary manner, the herons have an important ecological role in population control of

several species of fish, invertebrates and some species of amphibians.

The most unique species recorded within the EDWC wetlands is the hoatzin (*Opisthocomus hoazin*), locally known as the Canje pheasant. This bird, like a cow, has a unique crop to ferment/digest food, especially leaves, with the aid of bacteria. The young have functional claws on their wingtips, which some have posited may be a relic from the dinosaur age, but which are lost as they become adults. The Canje pheasant, which has a manure-like odour, is also found throughout most coastal wetlands and river systems east of the Demerara River. It is depicted on the country's Coat of Arms as Guyana's national bird and is therefore of immense cultural significance. As a folivore, it feeds only on leaves; its ecological importance hinges on its ability to trim a range of vegetation within the wetlands ecosystem.

The EDWC is also inhabited by the maguari stork (*Ciconia maguari*), which feeds on frogs, crustaceans, small reptiles such as caiman hatchlings and small-size fish. These storks feed in shallow water and in temporary pools as the water diminishes during the dry season. They are therefore important in 'cleaning up' these small pools of increased accumulation of fish and other smaller species.

Other bird species associated with the conservancy which are not waterfowls include psittacines -parrots, parakeets, macaws, toucans, and some seed finches, flycatchers and raptors. These are generally associated with the wetland, especially for roosting, nesting and/or feeding, because of the various species of palms, weeds, grasses and tree trunks within the wetland. The fruits, seeds, flowers and berries produced by these plants serve as a source of food, while the birds are in turn important seed dispersers.

More strictly terrestrial than wetland species observed within the vicinity of the EDWC include other raptors, cuckoos, woodcreepers and woodpeckers.

3.1.5.3 Other vertebrates *(mammals, amphibians and reptiles)*

Giant river and Neotropical river otters (*Pteronura brasiliensis* and *Lontra longicaudis*, respectively), West Indian manatees (*Trichechus manatus*) and capybaras (*Hydrochaeris hydrochaeris*) are the aquatic mammals known to inhabit the EDWC. They are however rarely seen possibly due to the size and vegetation cover of the area. The capybara and manatee are herbivorous, contributing to the biological control of vegetation of the conservancy. In addition, their faeces become fertilizer, providing nutrients for plants within the wetlands ecosystem, which in turn provide shelters and food for herbivores. The keystone aquatic mammals, the giant river and the Neotropical river otters are carnivorous, feeding mainly on fish, and to a lesser extent, small reptiles such as baby spectacled caimans.

The most frequently observed amphibian species were Neotropical tree-frogs, (*Hyla minuta* and *Scinax ruber*), with the latter more associated with aquatic habitats. The tree frog, though arboreal, usually descends to lower shrubs and grasses near shallow water during the breeding season.

Caimans and aquatic turtles are the most frequently observed reptiles of this wetland. The spectacled caiman (*Caiman crocodilus*), the most common caiman species, is

Red howler monkey (Alouatta seniculus) *© WWF-Guianas / Waldyke Prince*

carnivorous and hence pivotal in keeping a balanced and healthy aquatic ecosystem in the EDWC. The spectacled caiman is a species specifically targeted in the international wildlife trade.

Some primates, rodents and ungulates are terrestrial groups reportedly sighted by interviewees within the EDWC and its environs. Red howler monkeys (*Alouatta seniculus*), one such species, are important to this wetland ecosystem because of their herbivorous diet. They feed on the fruits of trees within and bordering the wetlands, thus contributing to dispersal of their seeds. Other mammals reportedly associated with the EDWC and environs include paca (*Cuniculus paca*) locally known as labba, red-rumped agouti (*Dasyprocta leporina*), red brocket deer (*Mazama americana*), tapir (*Tapirus terrestris*), collared and white-lipped peccary (*Pecari tajacu* and *Tayassu pecari*) and the jaguar (*Panthera onca*). Green iguanas (*Iguana iguana*), and snakes including bushmasters (*Lachesis muta*), boa constrictors, emerald boas (*Corallus caninus*), rattle snakes, labaria (*Bothrops atrox*), and yellow-tailed snakes) are some of the terrestrial species of reptiles known to be in this area.

Water scorpions with long breathing tubes at the base of the abdomen © WWF-Guianas / Elroy Charles

3.1.5.4 Macro-invertebrates

The most common insect families observed were the Hemiptera (true bugs), Diptera (true flies), Odonata (damselflies and dragonflies) and Coleoptera (beetles). These included aquatic and semi-aquatic specimens from the hemipteran order such as the water stick insect, giant water bug, water strider, backswimmer and water boatman; from the dipteran were seen the lake fly, shore fly, mosquito, black fly and hoverfly; from the Odonata- naiads of the numerous species of damsel and dragonfly; from the coleopteran- the diving water beetle, other aquatic beetle larvae, and the mayfly and stonefly.

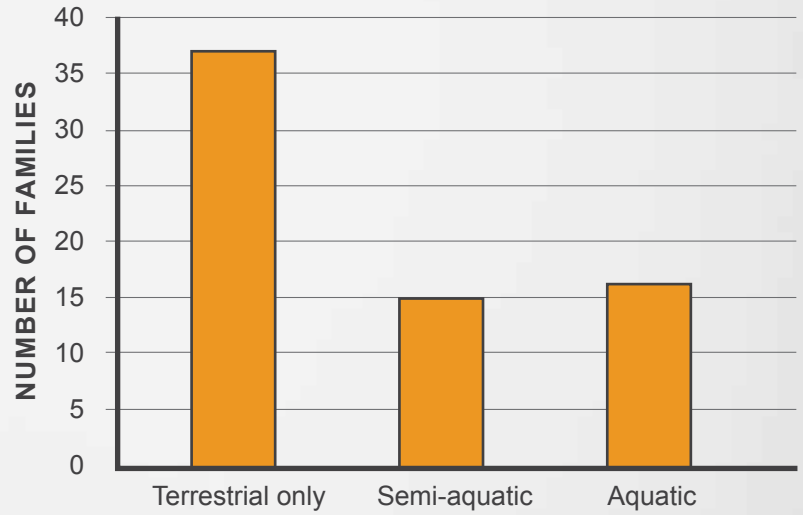


Fig. 4: Families of insects collected and categorized by life history association

Most of the aquatic and semi-aquatic groups were carnivores (see Fig. 5) feeding on other aquatic organisms, thus limiting such populations. Others were herbivores feeding on aquatic weeds, while the remainder were filter feeders removing sediments or nutrients such as nitrogen that promote algal growth, which in turn have the effect of reducing the dissolved oxygen in water. Finally, there were those species, such as the water boatman, which act as decomposers, eating decaying vegetable matter and other animals.

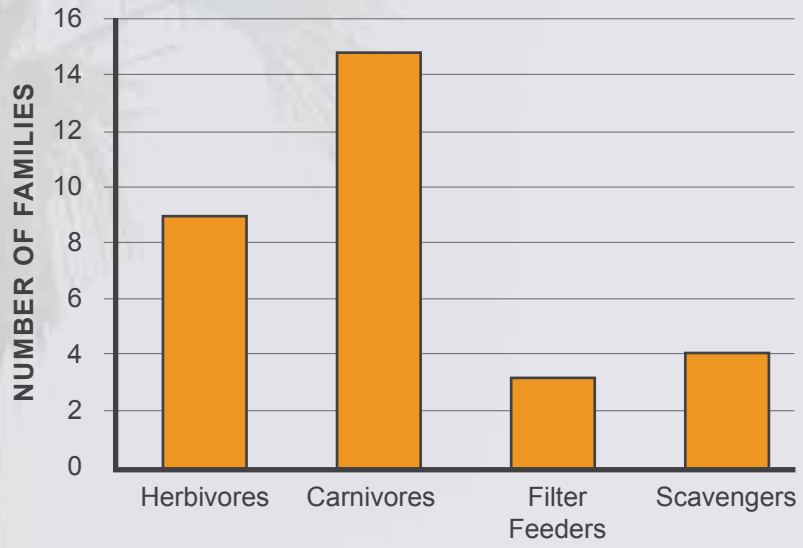


Fig. 5: Aquatic and semi-aquatic insect families classified according to their ecological functions

The non-insect macro-invertebrate sampling at this site only yielded snails of the genera *Pomacea* (species unidentified; family: Ampullariidae), and species of freshwater shrimp of the family Palaemonidae (Crustacea: Decapoda).

The *Pomacea* sp. is the singular food source for the snail kite (*Rostrhamus sociabilis*), with its bill uniquely adapted to tweeze the soft tissue of the snail out of its hard protective shell. The shrimp are important in the food chain as they feed on decomposing material and are themselves food sources for birds and fish.

Of the dataset of these wetland insects which were analysed, 54% of the total insect families have members which are solely terrestrial. Of these terrestrial insect families the most common ones are in the orders Hymenoptera, Hemiptera, Lepidoptera, Coleoptera and Diptera. Within these groups, herbivores dominate these habitats, followed by decomposers, carnivores and pollinators. The larger proportion of herbivores are those with sucking/ piercing mouthparts that withdraw sap from the plant phloem (e.g., planthoppers) and xylem tissues (e.g. leafhoppers). The other major types of leaf-chewing herbivores come from a cross-section of families which include Coleoptera (beetles), Orthoptera (grasshoppers) and Lepidoptera (Nymphalidae caterpillars). Insects that play different roles such as the decomposers Blattodea (e.g. cockroaches), population reducers (parasitic wasps, ladybugs) and pollinators (wasps and bees) are important for the maintenance and health of the ecosystem.

A section of the EDWC and wetlands with an até palm plant (Mauritia flexuosa) *© WWF-Guianas / Aiesha Williams*

3.1.6
Land ownership, management and conservation

The Conservancy, as state property, is administered through the East Demerara Water Conservancy Act, 1953, Cap. 55:03 of the Laws of Guyana, which nominally ensures the management of the area as a water conservancy and irrigation system. A Board of Commissioners comprising ten members also constitute the legal and institutional framework within which the Conservancy is governed and managed. Though not managed for its ecological functions and resources, hunting, fishing, water pollution and construction within the EDWC are by and large prohibited and visitors are required to seek official permission for entering and for the above activities.

Several communities of the East Coast and East Bank Demerara and the city of Georgetown are located proximate to the perimeters of the Conservancy. These communities are privately-owned, freeholder and state lands which are dependent on the EDWC for water supply for a variety of uses. St Cuthbert's Mission, the only titled Amerindian Village in this area, is located on the south-eastern edge of the conservancy, at the Upper Mahaica River.

3.1.7
Wetland community conservation initiatives

There are no known formal community conservation initiatives undertaken within the EDWC. However, residents of neighbouring communities participate, through representation on the conservancy management authority, in water distribution and irrigation of agricultural lands. Six of the members are elected from among proprietors of cultivated lands who are beneficiaries of irrigation water.

3.1.8
Anthropogenic influences and uses

Construction of dams, irrigation structures and regular rehabilitation affect the biodiversity in the immediate vicinity of these activities, and over time contribute to removing certain species and hence their eco-functions. It should be noted however that it was this very construction of dams which led to the biodiversity of the area. The flooding of the 518km^2 catchment area from the dam construction of decades ago has enabled the formation of unique wetland, unlike any other within Guyana. Being human-made, this area is less subject to seasonal variations than natural ones would be. This has led to an amassing of organic matter, and thereby a number of species and functions typical of marshes have accumulated.

Despite the fact that the EDWC was intended to serve as a water-storage facility to supply water for domestic, industrial and agricultural purposes, the controlled withdrawal of water affects the natural functioning of the ecosystem of EDWC, especially in extreme weather periods.

Rehabilitation within the EDWC *© WWF-Guianas / Aiesha Williams*

The northern and western environs of this site constitute the most densely populated area of coastal Guyana, including the burgeoning capital city, Georgetown. In support of this population, residential, agricultural, industrial and commercial infrastructures have been developed over the years. The immediate environs of the EDWC are therefore of immense importance to the economic and social well-being of the nation. However, no economic or industrial activities are being conducted within the wetland.

Much of the wetland value directly provided by the water conservancy is maintained naturally, but also by virtue of the measures, albeit limited, implemented by the conservancy management body. The main wetland values directly harnessed from the EDWC, especially by the people of the Administrative Region 4, include flood control, especially since the coastal plain is below sea level, and water supply for domestic, industrial and agricultural purposes. The stored water in the conservancy is used primarily to irrigate agricultural lands which produce a number of crops including sugar cane, rice, vegetables, coconuts and orchard produce, while 42% of the potable water supply intended mainly for the City of Georgetown is provided by the reservoir of the EDWC.

Some other invaluable benefits of the EDWC wetlands, though less utilized by residents, include biodiversity research and conservation, as well as fishing, hunting, transport and gathering of non-timber forest products especially for residents' sustenance. Specifically, the EDWC was one of the pilot sites used for the purpose of determining caiman conservation status and for development of species management plans, in an effort to manage the live pet trade of Caimans (Gorzula and Pilgrim, 1992; EPA 2002). Fish surveys have also been conducted within the conservancy, as a means of documenting the diversity of this rich area. The potential exists for the conduct of other studies such as carbon-stock assessment, and research related to organic matter/ peat in wetlands.

Negative impact of the wetlands

In the 2000s, more dramatically so in January 2005, there was overtopping of the conservancy dam due in part to the increased volume of rains, and, reportedly, the collapse of sections of the conservancy dam. The resultant flooding of adjoining residential areas and agricultural lands caused economic and social distress for large numbers of residents, in addition to the spread of infectious diseases throughout the coastal settlements.

These catastrophes caused the Government to start the construction of additional relief canals leading from the conservancy.

Organic matter (pegasse) accumulated over decades *© WWF-Guianas / Aiesha Williams*

3.2

SITE 2 – MAHAICONY – ABARY (MMA) CONSERVANCY AND WETLANDS

Ecological Profile

3.2.1
Location

The MMA Conservancy and wetlands which were surveyed are coastally located at about 30km inland, spanning from the Mahaicony River to the Berbice River (including the flood plain) in Region 5,[4] with the actual conservancy construction located between the Abary and Berbice Rivers (see Fig. 6).

[4] 420,743.374 645,329.720 metres (57° 42' 57.244" W 5° 50' 16.001" N)- Berbice River. 411,429.387 678,860.071 metres (57° 48' 1.683" W 6° 8' 27.448" N) - Mahaica River.

A section of the MMA wetlands *© WWF-Guianas / Waldyke Prince*

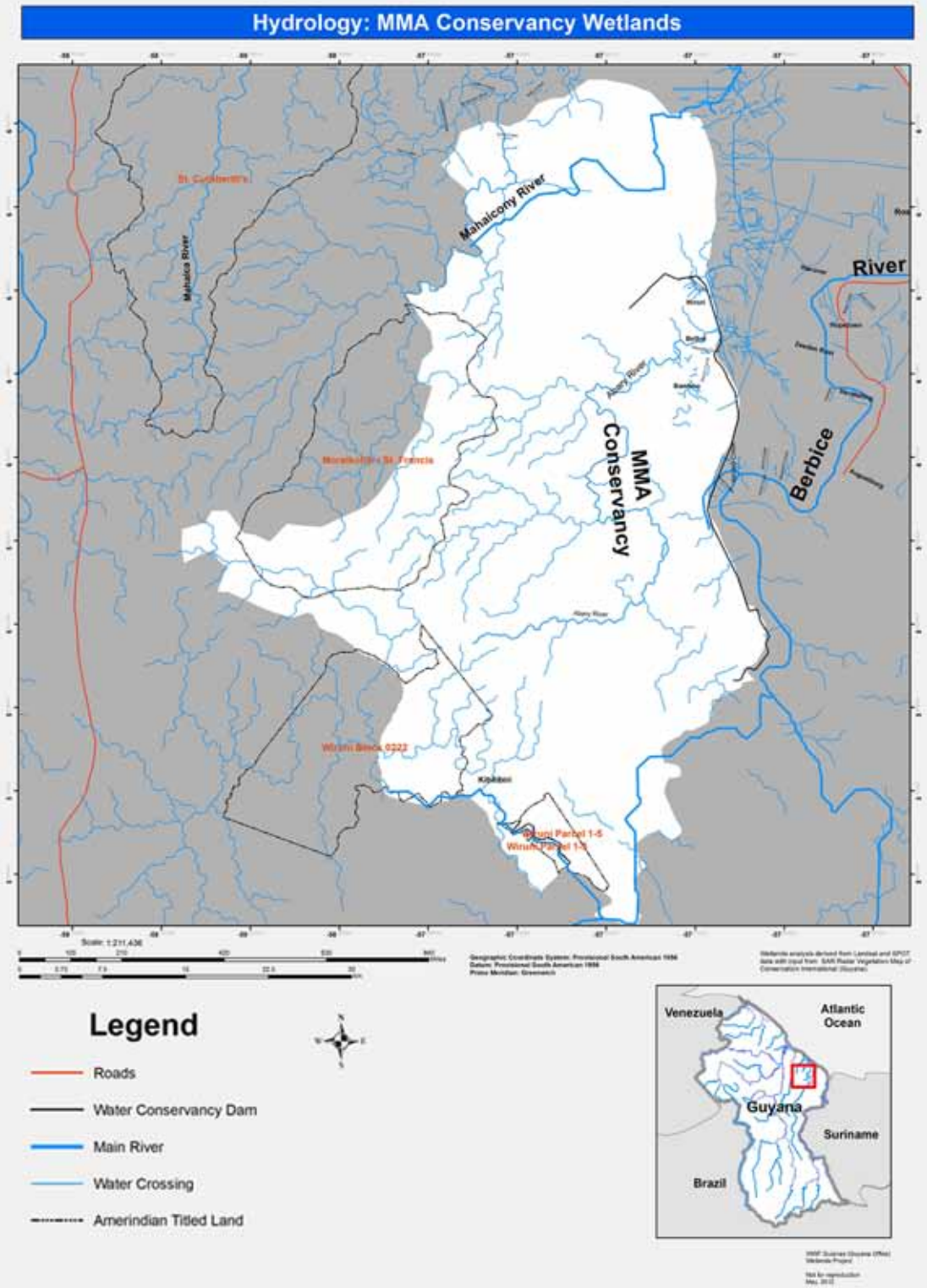


Fig. 6: Map showing location and hydrology of the Mahaica-Mahaicony-Abary Conservancy and wetlands

3.2.2 Wetland type

The MMA Conservancy is a Ramsar Type 6 human-made wetland / water-storage area.

The wetlands ecosystem that has been established here is much like one that would be expected from a dammed river, but on a much smaller scale. The previously higher lands appear as vegetated islands and shallow pools, which are seasonally flooded with various types of aquatic vegetation. Lower ground and the old river channel are deep, raging waters. Unlike the EDWC, there are large areas of open water here with no vegetation, much like the Essequibo coast lakes, and this allows for the generation of waves during the passage of winds over the surface of the water as the land heats up.

3.2.3 Hydrogeomorphology

The MMA conservancy construction began in the early 1980s, by the damming of the Abary River,[5] with a sluice gate mechanism and establishment of a dam partially around the catchment area. The 56.33km-long (35 miles long) dam is elevated above the surrounding lands. This area is approximately 808km^2 with 362km^2 of water surface (Singhroy 1998). The storage capacity of this conservancy is approximately 609 million cubic metres.

The soil on the banks and on the floor of the reservoir consists largely of clay soils with some organic material. The floor of the reservoir is covered, in some areas, by organic matter (pegasse), silt, clay and white sand.

[5] Phase 1 of a three-phased construction project; only the first phase was completed.

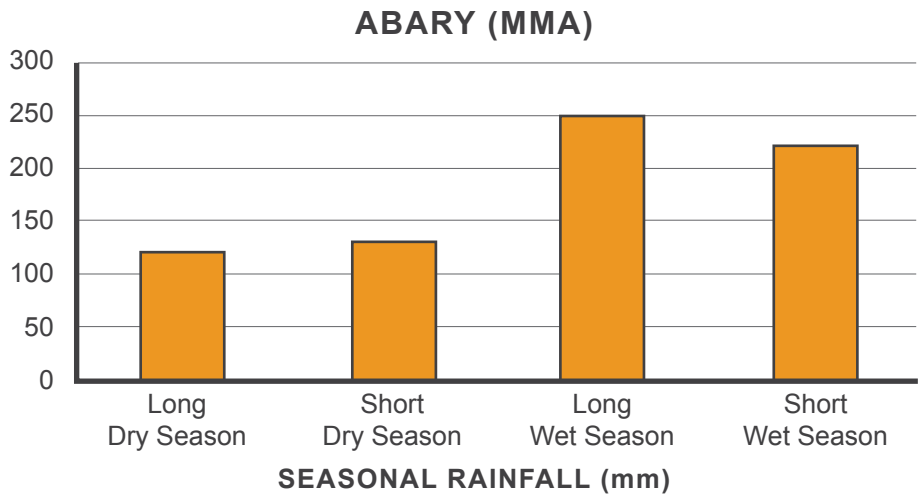


Fig. 7: Bar chart showing the seasonal rainfall pattern for the Mahaica-Mahaicony-Abary Water Conservancy and wetlands

The MMA is a “black” water conservancy, fed directly from precipitation and the flow from the Abary River, and to a lesser extent, indirectly from the Berbice and Mahaicony Rivers (see Fig. 6 and Fig. 7). Outflow is controlled to the agricultural lands on the West Coast Berbice via an extensive main canal, approximately 320km long and by an eight-gate sluice. A seven-gate sluice to the original river channel provides a relief spillway for volume control.

The water of this wetland is fairly acidic, with low salinity. Clay soils of the MMA are the likely influence of the slightly higher turbidity (see Table 4).

Table 4: Water chemistry measurements taken at a sample point within the MMA Conservancy

Categories	MMA Conservancy
Electrical conductivity (µS)	18.36
pH (pH)	5.43
Temperature from pH meter (°C)	33
Dissolved Oxygen (%)	5.71
Turbidity (NTU)	6.55
Total Dissolved Solids – TDS (mg/L)	8.55
Visibility depth (cm)	76
Salinity (o/o)	0.01

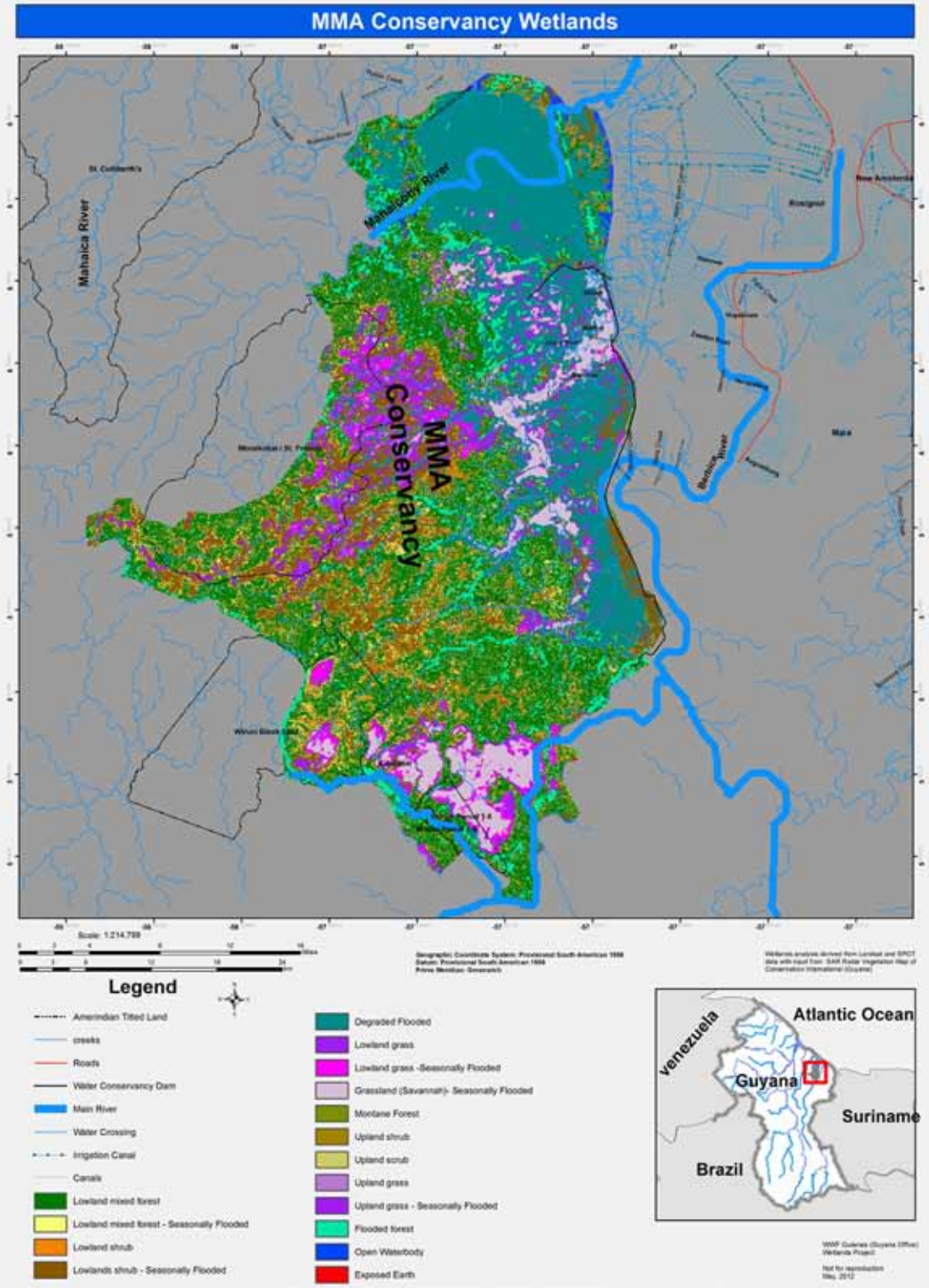


Fig. 8: Map of vegetation and land cover types of the Mahaica-Mahaicony-Abary Conservancy and wetland

3.2.4
Vegetation cover

In general the vegetation cover of the MMA Conservancy and catchment area comprises seasonally flooded savannahs with a mixture of grassland and shrubs, with patches of mixed forest. A large area of the MMA is void of vegetation due to the inundation from the dam construction.

The aquatic fauna shows significant diversity in form and species. “Moco-moco” (*Montrichardia arborescens*) is found in large clumps of islands and in shallow waters. Ité palms are restricted to clumps in primarily the western area, providing feeding places for psittacids and roosting places for mainly herons and ducks. Other smaller species include emergent plants such as sedges (Cyperaceae), aquatic grasses (Poaceae) and succulent shrubs found at the edge of bush islands. Floating vegetation covers significant areas; these include water lilies (*Nymphaea* sp.), water snowflakes (*Nymphoides* sp.), water ferns (*Salvinia auriculata*), bladderworts (*Utricularia* sp.) and water hyacinths (*Eichhornia crassipes*). In addition submerged species such as *Cabomba* sp. and algal species were observed.

Moco moco (Montrichardia arborescens) *© WWF-Guianas*

The vegetation on the constructed earthen banks (dam) of the conservancy consists principally of early succession species of small trees, shrubs, grasses and ferns. Prominent species include the congo pump (*Cecropia* sp.) glamma cherry (*Cordia oblique*), *Lantana* sp., *Blechnum* sp., *Bactris* sp. There are some islands of vegetation within the reservoir with similar species. Also present are the introduced Jamoon/ jamun (*Syzigium cumini*) and the Araceae vine (*Philodendron* sp.) which is commonly found on many of the trees and shrubs.

Almost all of the species mentioned above have some cultural value but little economic value. *Cecropia* is commonly used in traditional medicine for treatment of a variety of conditions including diabetes, diarrhoea, fever, kidney and liver disorders etc. The jamoon is an introduced species whose fruits are consumed by many and used to make local alcoholic beverages (jamoon wine). The fruit is sold in local markets at the peak fruiting season. Philodendrons are often used as decorative plants growing on the sides of houses or over specially designed frames.

Various vegetation types at the MMA (floating, emergent, submerged) *© WWF-Guianas*

3.2.5
Faunal Species

3.2.5.1
Fish

The most common group among fish observed during WWF field surveys are the Characiformes, characteristic of tropical waters, including the piranha. Piranhas were observed as the most abundant, and often cause great damage to fish nets. The Cichlids - lukanani/peacock bass (*C. ocellaris*) are fairly common in this location, and are the target species for sport fishing. Almost 50% of the fish species observed are carnivores (mainly fish feeders) (*Hoplias, Cichla, Serrasalmus*). Three are omnivores (*Heros, Pygopristis* and *Catoprion*), two are planktivores (*Anchoviella* and *Curimatopsis*) and one a bentivore (*Satanoperca*).

With the exception of the anchovy species, all fish observed are food fish. However *Cichla*, *Serrasalmus* (piranha), and *Hoplias* (huri) are preferred species. *Cichla* in particular is sought after by sport fishermen who either have vacation houses on the banks of the reservoir or make day or weekend expeditions.

Common pleco /smoke hassar (Hypostomus plecostomus) *© WWF-Guianas / Calvin Bernard*

3.2.5.2
Birds

Aquatic birds easily observed within this conservancy include species such as ducks, herons, kingfishers, storks, flycatchers and jacanas, and to a lesser extent the Neotropical cormorant, anhinga and osprey (*Pandion haliaetus*).

Seven species of the heron family were observed within the MMA wetlands, including the globally distributed black-crowned night heron and the unique-looking boat-billed heron. The herons have an important role in population control for several species of fish, invertebrates and some species of amphibians. Four of the five species of kingfishers found in Guyana were also sighted here. This diversity of herons and kingfishers at the MMA Conservancy is indicative of a diverse and healthy population of fish which sustains these fish-eating birds. The herons help to balance the frog population within the wetlands, and along with the kingfishers, the fish population as well.

Osprey, a migratory fish specialist, found both within marine and freshwater habitats, inhabit the MMA wetlands. While ospreys are opportunistic in their feeding behaviour, fish are their primary food. Any negative impact on fish population or water quality within their habitat can prove to be detrimental to their presence within the area and to their

Black-bellied whistling duck (Dendrocygna autumnalis) *© WWF-Guianas / Sopheia Edghill*

general geographical distribution. The presence of ospreys within the MMA may be indicative not only of this wetland's abundant fish population diversity, but also of its water quality, despite the location being an artificially created reservoir.

The Muscovy duck (*Cairina moschata*) and the black-bellied whistling duck (*Dendrocygna autumnalis*) are frequently observed in this wetland. Both species are hunted for their meat; they are also captured for domestication. These ducks exploit both aquatic and terrestrial resources. Thus, their short beak facilitates feeding on terrestrial grasses, aquatic weeds, invertebrates and small fish. Their webbed feet, seemingly an impediment to quick locomotion on land, are however advantageous for swimming.

AAs in the case of the EDWC wetland, the unique hoatzin (*Opisthocomus hoazin*) is also found within the MMA conservancy, possibly due to the proximity of the Berbice River.

The non-aquatic species closely associated with the wetland include hundreds of red-bellied macaws (*Orthopsittaca manilata*), as is also normally observed within the other coastal wetlands. Other species present include seedeaters, other psittacids and flycatchers. They are found in the seasonally flooded forest, grass and shrubs islands of the wetlands, mainly feeding, roosting and nesting.

Large-billed tern (Phaetusa simplex) *© WWF-Guianas*

3.2.5.3
Other vertebrates
(mammals, amphibians and reptiles)

Neotropical river otters (*Lontra longicaudis*), giant river otters (*Pteronura brasiliensis*), the West Indian manatee (*Trichechus manatus*), and capybaras (*Hydrochaeris hydrochaeris*) are the main aquatic mammals sighted fairly frequently by residents of the MMA wetlands.

The Neotropical river otter is a major fish predator, though they may feed on juvenile caimans. While, by the nature of their diet, otters help to regulate the fish population, they are also an important indicator species, especially of the ecological health of habitats where they are found. This is due to the nature of the otter's strict carnivorous diet, which renders it susceptible to any accumulation of contaminants which may occur in the environment. The West Indian manatee (*Trichechus manatus*) on the other hand is herbivorous, eating a variety of plants– submerged (rooted plants with most of their mass below the water surface), emergent (rooted plants that emerge above the water surface), and floating (plants not attached to the bottom). Manatees play a key role as 'gardeners' of the wetlands, trimming the vegetation and aiding in the clearing of waterways. Manatees are often used as an effective biological control for weeds on many waterways.

Some of the terrestrial mammals found within the MMA Conservancy and its immediate environs include peccaries, anteaters, tapirs, deer, sloths and primates such as the red howler monkey, the capuchin and squirrel monkey, and apex predators such as the jaguar and puma. The primates, peccaries and tapirs are herbivores which include fruits, leaves and seeds in their diet, while the sloths and tapirs are mainly folivores, feeding mainly on leaves. The folivorous species help in weed control, while the frugivores, feeding mainly on fruit, aid primarily in seed dispersal and vegetation re-growth within the wetlands and environs. With this variety of prey animals, the reported presence of top predators including jaguar and puma within the conservancy indicate a balanced ecosystem.

With respect to the herpetofauna of the MMA wetlands, the *Cochranella* spp. (a species of the Centrolenidae glass-frogs), the spectacled caiman (*Caiman crocodilus*), and green anaconda (*Eunectes murinus*), one of the largest snakes in the world, are observed inhabiting the ecosystem. Non-aquatic species including the ameiva and tegu lizard (*Ameiva ameiva* and *Tupinambis teguixin*), and the much-feared labaria snake (*Bothrops atrox*), are reputed by the locals to be fairly common within the wetland area.

The spectacled caiman (*Caiman crocodilus*) is native to Guyana

Hyla sp. *© WWF-Guianas / Waldyke Prince*

and lives in a range of habitats from lowland wetlands to riverine freshwater. It can also tolerate salt-water habitats, and as a result is the most common of all crocodilian species found in Guyana. Caimans eat a variety of invertebrates such as insects, crustaceans, molluscs and fish, while the older ones are capable of taking larger prey such as small mammals.

3.2.5.4 Macro-invertebrates

Seventy macro-invertebrate families were observed, with 30 of these directly associated with the wetlands system as aquatic and semi-aquatic groups. These wetland families include the larvae of some Coleoptera and Diptera (black fly, shore fly, lake fly and mosquitoes) and the naiads of Odonata and Ephemeroptera. Aquatic hemipterans (water boatman, water strider, backswimmer) and semi-aquatic insects (flea beetle, leafhopper) predominate in wetland environments.

Common squirrel monkey (Saimiri sciureus) *© WWF-Guianas / Aiesha Williams*

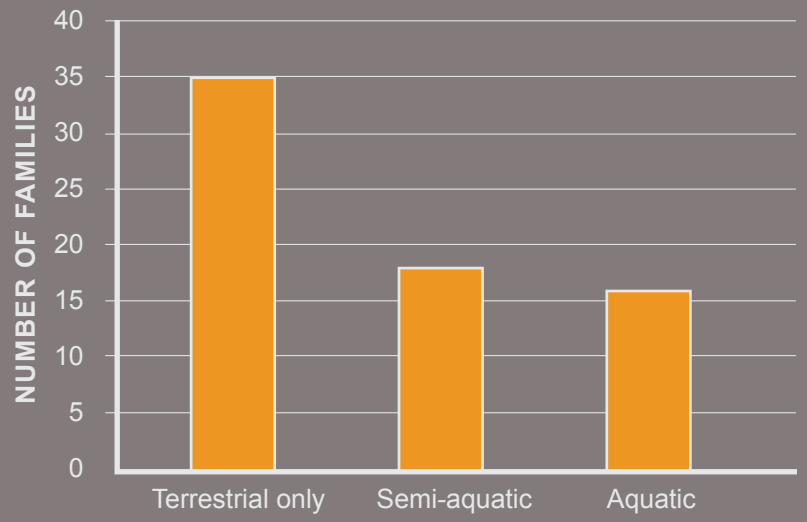


Fig. 9: Families of insects collected and categorized by life-history association

Most of the aquatic insects, for example the naiad of the dragonfly and water boatman, serve as food for fish and other aquatic predators. Others, such as the aquatic Diptera larvae, serve mainly as scavengers and filter feeders, contributing thereby to the improvement of the quality of water.

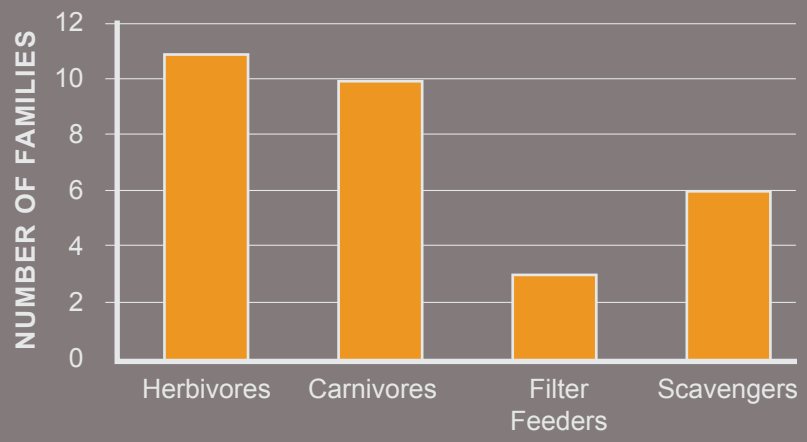


Fig. 10: Aquatic and semi-aquatic insect families categorized by their ecological function at the MMA

Non-insect macro-invertebrates observed were snails of the genera *Pomacea* (species unidentified) (family: Ampullariidae), and species of freshwater shrimp of the family Palaemonidae (Crustacea: Decapoda). Shrimps are important in the decomposition process as they feed on dead material and serve also as food sources for birds and fish.

Of the 35 families of insects that are mainly terrestrial, over 57% are families that are herbivorous) as adults and/or juveniles (see Fig. 11), feeding on plants that are associated with the edge of aquatic bodies, with some plants being considered semi-aquatic. The decomposers, that is, carrion, scavengers and dung-feeders are the second ecological category that dominates this terrestrial habitat which surrounds an aquatic system. An equal share of pollinators, the adult of Lepidoptera, Hymenoptera and some Diptera, and carnivores or natural predators (e.g. the tiger beetle, ladybird beetle, assassin bug, parasitic wasp) are recruited from this site. These natural predators serve as population regulators for the herbivorous insects. Both groups of insects serve as food for adult dragon and damselflies, birds and some mammals.

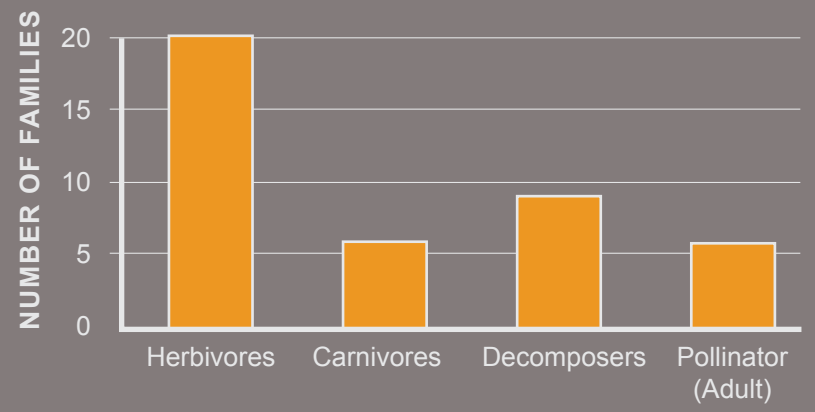


Fig. 11: Terrestrial insect families categorized by their ecological function at the MMA

General site characteristics

3.2.6
Land ownership, management and conservation

The MMA area was established by the Mahaica-Mahaicony-Abary Agricultural Development Authority (MMA-ADA) Act 27 of 1977, Cap 69:11. The MMA Conservancy was not specifically intended for nature conservation but to serve as a water reservoir for irrigation of coastal agricultural lands located within Region 5, between the Berbice and Abary Rivers. This water conservancy is managed by the MMA-ADA, also established under the MMA-ADA Act. The Board of Directors of the MMA-ADA is the decision-making body which manages the affairs of the conservancy with respect to water distribution and conservancy rehabilitation works.

However the MMA-ADA, from the conservancy's inception, had conducted monitoring of biological and chemical parameters for a number of years. These monitoring activities were mainly to record the ecological changes occurring as a result of the construction of the dams. However, this monitoring was discontinued.

The West Coast Berbice (W.C.B.) and Upper Mahaicony River communities are located relatively close to the MMA wetlands. W.C.B. communities, with a population of more than 40,000, are the recipients of water from the conservancy.

Moraikobai (St Francis) Village (upper Mahaicony River) is the only Amerindian titled village located closest to the MMA wetlands. Other land tenures around the MMA area fall within two categories: these are the freehold and leasehold. The freehold lands are those located at the first depth (lands immediately behind villages). The owners either have a transport or a certificate of title to the lands. The leasehold lands are the second depth and beyond and are state lands; some people in that area have leases for their lands.

Sunrise over the MMA Conservancy and wetlands *© WWF-Guianas*

3.2.7
Anthropogenic influences and uses

Water storage for irrigation of agricultural lands and flood control is the primary utilization of this rich, human-constructed wetland ecosystem. More than 400,000 acres of lands cultivated with rice, cash crops, or which have livestock on the West Coast of Berbice are irrigated with the water of the MMA wetlands. As is the case with the EDWC, the MMA wetlands experienced successive ecological changes to its vegetative cover, faunal species diversity and migration due to the damming of rivers and human-controlled flow of water systems. Withdrawal of water from the conservancy has also influenced the area; however the full extent is unknown. With its large water-storage capacity, the MMA aids in flood control especially for the communities and cultivated lands of the WCB, since such a large reservoir minimizes the extensive flooding areas below the conservancy. On the other hand, in extreme rain however, overtopping of the conservancy dam is known to also cause flooding of areas below the conservancy. The restriction of the flow of the Abary River, caused through the damming when the conservancy was constructed, also causes flooding of upland communities such as Moraikobai. Flooding has caused loss of crops and earnings.

Other uses of the MMA conservancy include farming, recreation and light tourism, especially on the part of some residents of Georgetown who own vacation homes on the perimeter of the conservancy. There is also fish and wildlife harvesting primarily for domestic consumption, although there have been reports of minimal commercial hunting and fishing of the muscovy duck (*Cairina moschata*), black-bellied whistling duck (*Dendrocygna autumnalis*), pale-vented pigeon (*Patagioenas cayennensis*) and peacock bass/ lukanani (*Cichla ocellaris*). There have also been reports of trapping of seed finches within the wetlands environs, especially for the local songbird trade.

In terms of ecological usage, at least two caiman surveys have been conducted in the area; one, the *Development of Species Management Plans for Wildlife Trade in Guyana, A Survey of the Spectacled Caiman Population in the Central Coastal Lowlands of Guyana*, was conducted by the Environmental Protection Agency in 2002, and funded by WWF-Guianas and the Guyana government.

Sluice gates at the MMA Conservancy *© WWF-Guianas / Waldyke Prince*

3.3

SITE 3 – WETLANDS

Sample sites: *Lake Mainstay, Lake Tapakuma, Lake Capoey (including the adjoining Calabash Lake).*

Ecological profile

3.3.1 Location

The Essequibo Coast lakes and wetlands are located in the Administrative Region 2, Pomeroon-Supenaam, in the north-western part of Guyana. The closest point of these wetlands to the Atlantic shoreline lies 3.04km away, (Mashabo), and the furthest point (Tapakuma) lies 9.05km away[7] (see Fig. 12).

[7] Between coordinates 58° 31' 32.713'' W 6° 59' 15.75'' N (UTM 21N 331455 Easting 772663 Northing) and 58° 34' 25.088'' W 7° 23' 6.128'' N (326315 816620).

Mashabo Lake - part of the Essequibo Coast wetlands *© WWF-Guianas / Elroy Charles*

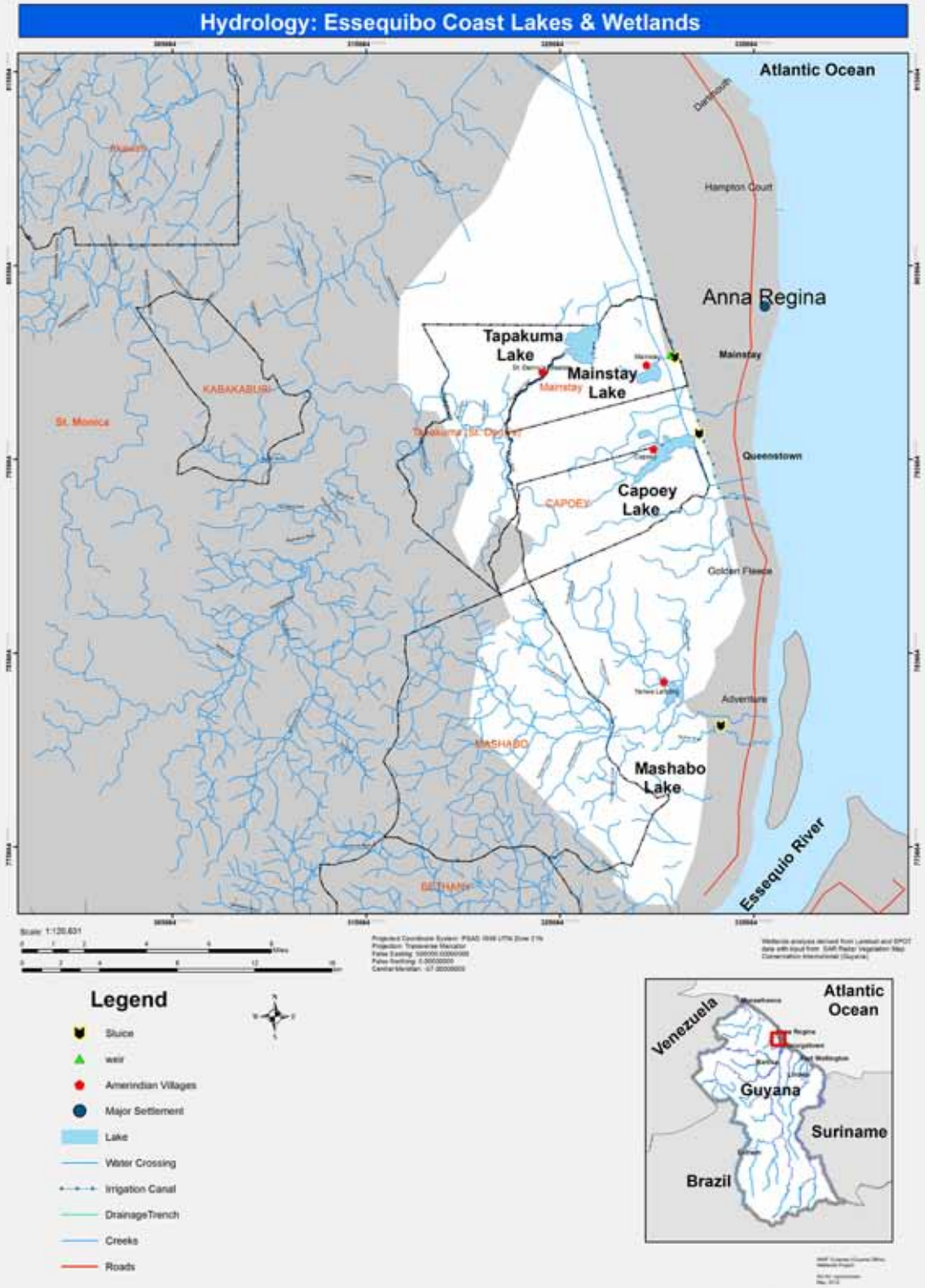


Fig. 12: Map showing location and hydrology of the Essequibo Coast lakes and wetlands

3.3.2
Wetland type

The Essequibo Coast wetlands are a Ramsar Type O (inland permanent freshwater lake), W (shrub-dominated) and Xf (tree-dominated) wetlands. At elevations ranging from minus 3.4m (minus 11ft) (lake beds) to about 8.2 metres (27ft), expansive swamps surround the lakes; this feature changes with variations in land elevation. The natural banks of the lakes have been reinforced in some places with earthen material to allow water containment and controlled flow for irrigation purposes.

3.3.3
Hydrogeomorphology

The lakes and associated swamps cover a surface area of approximately 429.62km[8]. Mashabo Lake has the largest area of surface water. The lakes are depressions in white sand soil, below which there is an impervious kaolin layer. Organic peat (pegasse) is also found in certain parts of the wetland.

Because of extensive rice cultivation on the Essequibo coast, these lakes are managed as reservoirs with regulated outputs into natural streams and the agricultural irrigation systems. This represents the main hydrological output from the lakes. This artificial regulation of the natural flooding regime of the lakes has had visible impacts on their ecology; it is likely that some impacts have not yet been determined. At Mashabo for example, there is evidence that the now “permanent” flooding has caused the death of many trees intolerant to permanent submersion of their roots.

Offtake from this wetland is through water withdrawal for domestic, industrial and agricultural uses, while the wetlands recharge comes mainly from inflow from rivers (Tapakuma, Ituribisi and Ikuraka Rivers), from groundwater (throughflow), surface run-off and direct precipitation (see Fig. 13). The heaviest rains are experienced during May to August and from November through January.

[8] Mashabo Lake-15.11 Km2, Capoey/Calabash Lake- 2.54 Km2, Mainstay Lake 0.73 Km2, Tapakuma Lake 2.24 Km2.

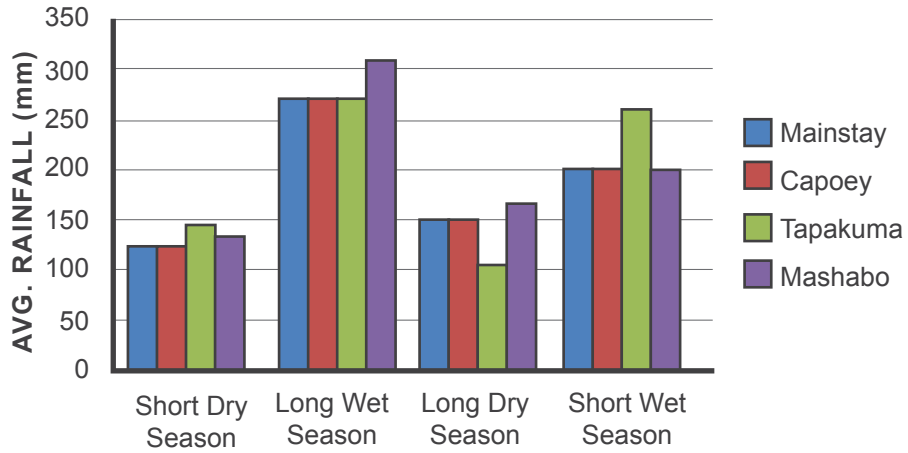


Fig. 13: Bar chart showing the seasonal rainfall pattern[9] for the Essequibo Coast lakes and wetlands

Throughout the wetlands, the water is characteristically dark brown in colour, locally known as “blackwater”, due to dissolved tannins from decomposing vegetation in the water. Such dark waters impede light penetration (visibility depths range from 71-96cm); primary production is therefore limited to the uppermost layers with the consequential suppression of algal blooms. These waters are also quite acidic; natural pH ranges from 2.3 to 4.9 with an average in the system of 4.12. Such acidity contributes to limiting the kinds of organisms that can survive there; other water quality parameters are within the normal range for this type of aquatic system (see Table 5).

[9] Calculations based on field measurements by Hydromet 2007 – 2010 dataset converted to seasonal/ quarterly rainfall averages at various locations within the vicinity of the sample sites. A spline operation was carried out to interpolate each set of seasonal data via a minimum curvature technique providing national coverage. Isohyets for each season were created and mapped.

Table 5: Water chemistry measurements taken at four sample points within the Essequibo wetland site

Parameters	Average Values[10]	Range[11]	
		Highest	Lowest
Electrical conductivity (µS)	28.88	34.8	23.2
pH (pH)	4.12	4.93	2.31
Temperature from pH meter (°C)	28.45	29.1	27.6
Dissolved oxygen (%)	6.28	6.89	5.83
Turbidity (NTU)	1.80	2.7	1.2
Total dissolved solids – TDS (mg/L)	13.40	16.41	10.87
Visibility depth (cm)	87.85	96	71
Salinity %	0.10	0.23	0.01

[10] Average values across the four sample points within the wetland site.
[11] Minimum and maximum values across the four sample points within the wetland site.

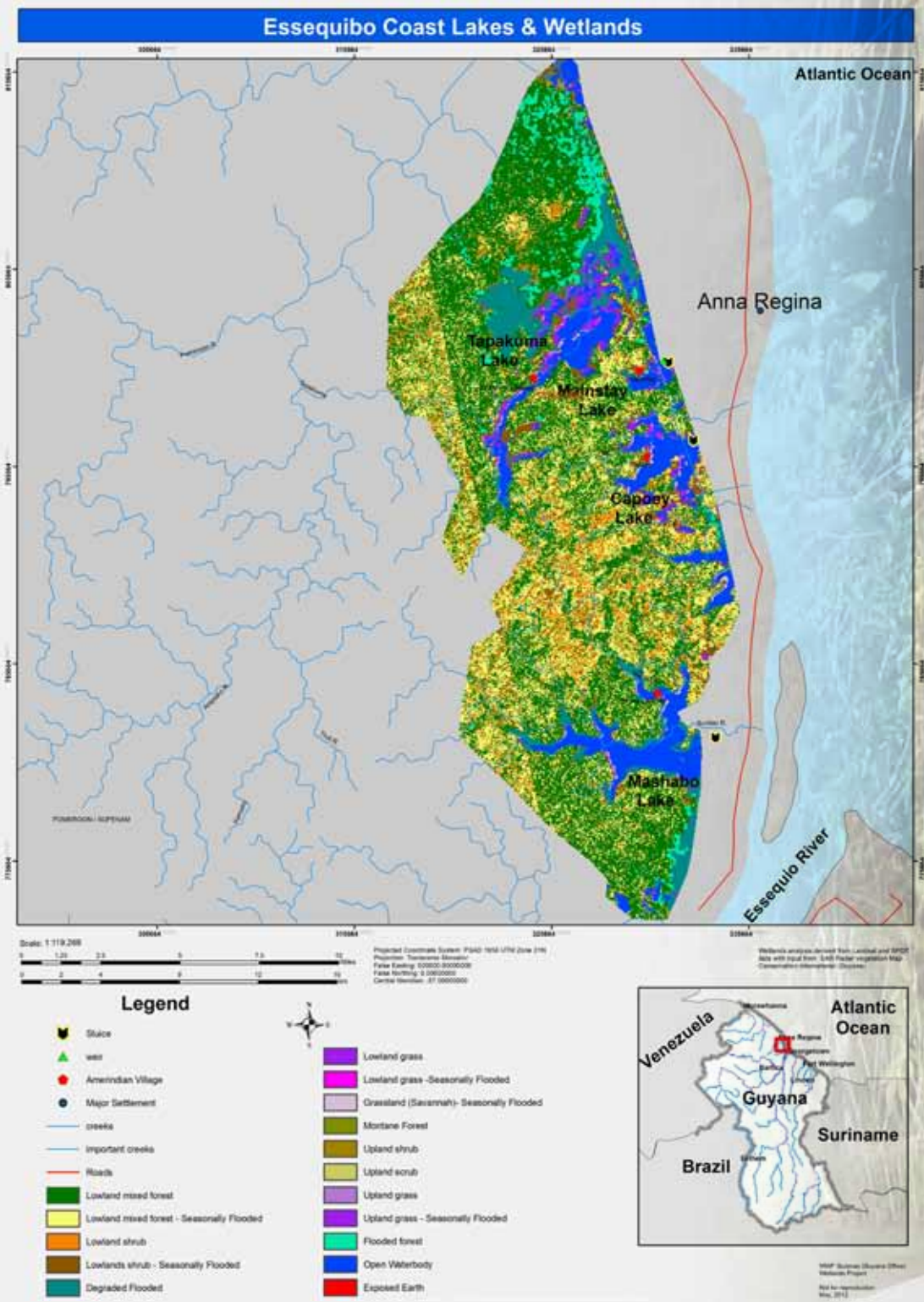


Fig. 14: Map showing the vegetation and land cover types of the Essequibo Coast wetlands

Neotropical cormorant (Phalacrocorax brasilianus) *© WWF-Guianas / Sopheia Edghill*

3.3.4
Vegetation cover

Bank vegetation of the lakes includes grasses, sedges, other succulents and shrubs in the lower moist areas, and woody shrubs and trees at more elevated levels. Among these are culturally important species, such as the Ité palm (*Mauritia flexuosa*), and economically important species such as the awara (*Astrocaryum vulgare*) and kuru (*Astrocaryum* sp.). These palms depend greatly on moist environments for growth and productivity. This type of vegetation is also critical for stabilizing the banks of the lakes, which are mostly of white sandy soils. Such soils are easily eroded if they are not well covered and “bound” by the root systems. The bank vegetation is an important source of food, habitats and breeding areas for the diversity of faunal species typical of the wetlands ecosystems.

Ité Palm (Mauritia flexuosa) within the Essequibo Coast wetland *© WWF-Guianas*

Covering large areas of the water surface, is the emergent succulent bisi-bisi (*Eleocharis* sp.), with moco moco (*Montrichardia* sp.) and the large Ité palms occupying relatively shallow waters in fair-sized clumps, or lining some edges of the lakes. Another species, the floating-leaved fragrant water lily (*Nymphaea* sp.), was less dominant but common to all lakes. These types of vegetation provide habitats for fish and other animal life. *Cichla ocellaris* (peacock bass/lukanani) for example is often caught from the edges of bisi-bisi and moco moco clumps. Many other species are found living amid these plants and in the cover of the floating *Nymphaea* leaves.

The moco moco stalk and that of the bisi-bisi are used as a substrate by the freshwater sponges which inhabit the lakes. The sponges do not harm the plants, which provide an increased surface area for their growth.

3.3.5 Faunal species

3.3.5.1 Fish

The diversity of the fish species yielded at the time of survey of the lakes was notably low and of little to no special conservation status (CITIES/ IUCN Redlist; see Annex 1). The lakes are however populated by the popular food and sport fish species, the lukanani/peacock bass (*Cichlosoma bimaculatum*); larger individuals are found in Lakes Tapakuma and Mashabo. Other species of importance food-wise for most communities, but which were only found in some lakes, include the mid-sized catfish, *Pinirampus pirinampu*, the oil-rich characoids Leporinus spp. (known locally as tibikuri) and the freshwater barracudas (or huri) (*Hoplias malabaricus*).

The remainder of the fish diversity comprised piranhas, other charachoids, cichlids (patwas and sunfish), catfishes and knifefishes, including the electric eel (locally called numb fish). The greatest biomass contributor among the fish appears to be the *Bryconops* species which are captured in large schools, but utilized only at subsistence levels.

Hassar (Hoplosternum littorale) *© WWF-Guianas / Calvin Bernard*

3.3.5.2 Birds

Some of the waterfowl which inhabit and are more frequently sighted within the Essequibo Coast wetlands are ducks, herons, gallinules, kingfishers, some aquatic raptors such as the black-collared hawk (*Busarellus nigricollis*) and rufous crab hawk (*Buteogallus aequinoctialis*), egrets, anhinga, sandpipers and osprey. Many of these birds depend on these wetlands for their food, mainly fish, suggesting the presence of substantial fish diversity within this area. Some of these species feed mainly on other smaller vertebrates such as reptiles and frogs, and aquatic invertebrates. The wetlands also provide the birds with roosting and nesting sites. Notable also are the three species of ducks which were sighted at the Essequibo Coast wetlands. Ducks are an economically important aquatic bird species, especially as a delicacy for many Guyanese. Their presence at this wetland, in addition to the healthy habitats and good supply of food including aquatic vegetation, invertebrates and fish, potentially indicate a lower risk for the ducks of decimation faced within this locality.

The most observed groups of non-aquatic birds within the environs of this wetland are psittacids (parrots and macaws), flycatchers and raptors-vultures and caracaras. These land birds live in the forest, grass or shrub-land surrounding the wetlands. This wetland serves as another source of food and provides roosting and nesting sites. Many of these birds especially the psittacids are cavity nesters, making use of standing dead trees and tree hollows of wetlands. Parrots, macaws and parakeets feed on the fruits, seeds, flowers and berries of the various species of palms which grow in the swamps and marshes and the grassy areas especially, and contribute towards seed dispersal as they fly with some of these palm-fruits from one point to another. It is apposite to note that although the red-bellied macaw (*Orthopsittaca manilata*) is common within Essequibo, a consequence of the abundance of ité palms (*Mauritia flexuosa*), in some other countries the species has been adversely affected by habitat loss and unmitigated harvesting for the wildlife trade. The red-bellied macaw has a unique niche in permanent wetlands and also in wet forested areas which have an abundance of ité palm, important for feeding, nesting and roosting. Their large numbers here, as is the case of the other psittacines, validates the important value of this wetland.

The mainly insectivorous birds are the tyrant flycatchers, antbirds, anis, tyrant-flycatchers and funarids such as spinetails. Their density and diversity are indicative of an abundance of insect life and a rich wetland ecosystem. As such, many occupy specific ecological niches, playing significant roles in the control of specific insect populations within these ecosystems.

Great egret (Ardea alba) *© WWF-Guianas / Aiesha Williams*

3.3.5.3
Other vertebrates
(mammals, amphibians and reptiles)

The aquatic mammals seen at this wetland are otters and the capybara. The capybara (*Hydrochaeris hydrochaeris*), the world's largest rodent, is a herbivore; it grazes on all types of aquatic vegetation thereby contributing to preventing vegetation overgrowth. They trim the vegetation as they forage for food, pruning and removing pieces of vegetation as they eat. Their faeces become fertilizers that provide nutrients for plants within the wetlands ecosystem, which in turn provides shelters and food for herbivores. This aquatic mammal in turn serves as food to top predators such as the green anaconda and the jaguar. They are easily seen grazing in the shallow, flooded areas with low vegetation cover. Some other non-aquatic species of mammals are also present within the environs of this wetland. These include armadillos, deer, rodents, tapirs and peccaries, which would normally utilize the wetland as a source of water, food and means of movement/migration. The herbivorous mammals, feeding mainly on fruits, seeds and/or leaves, are important elements for maintenance of ecological integrity, especially as seed dispersers. The rodents especially are known for their cache-hoarding through fruit/seed burial and partial retrieval of the potential seed stores. This offers opportunity for the non-retrieved seeds to germinate.

Boat-billed heron (Cochlearius cochlearius) *© WWF-Guianas / Waldyke Prince*

Some frog species, snakes such as the Amazon tree-boa snake (*Corallus hortulanus*) and labaria snake (*Bothrops atrox*), turtles, and caimans are the herpetofauna known to inhabit the Essequibo Coast wetlands and environs. The spectacled caiman (*Caiman crocodilus*) especially, the most common species of caiman in Guyana, was the reptile observed most frequently in this wetland. It is among the most common top predators in most freshwater wetlands, feeding on fish, frogs and smaller reptiles. Hatchlings of caimans feed on smaller fish and crustaceans, but become prey themselves because of their small size. The water-snake (*Helicops* spp.) is a fish-eating snake which feeds mainly on small characid fishes and amphibians, and also contributes to the ecological balance of the wetlands. The green anaconda (*Eunectes murinus*), another large tropical wetlands top predator, feeds on several species throughout its life cycle, capturing smaller species during its juvenile stages and larger prey as it grows. Larger species have been known to feed on large terrestrial mammals, e.g. the brocket deer, aquatic species such as the capybara, and smaller rodents.

Scinax rubra *© WWF-Guianas / Waldyke Prince*

3.3.5.4 Macro-invertebrates

A large range of insect diversity inhabits the Essequibo lakes and wetlands. Over 83 different families of insects were sampled from this area; approximately 15 families are aquatic and semi-aquatic during the whole or part of their life cycle; 48 families are associated with wetland areas. Such presence, and importantly the diversity, is indicative of the healthy status of this environment, as many of these species require high levels of dissolved oxygen to thrive. The common families are leaf beetles (Coleoptera: Chrysomelidae), leafhopper (Hemiptera: Cicadellidae), Ants (Hymenoptera: Formicidae), nymphalid butterflies (Lepidoptera: Nymphalidae), with numerous dragon and damselflies.

Some common species observed were the ladybird, bloodworm larvae, common housefly, mayfly naiad, leafhopper with some semi-aquatic types, water boatman, water strider, and various species of ants, along with their naiad or juvenile aquatic stages, and grasshoppers with an abundance of semi-aquatic types found on spikerushes (*Eleocharis* sp.).

The majority of insect species sampled were aquatic plant herbivores (e.g. a blue leafhopper (Cicadellidae) feeding on Nymphaea (water lilies) and leaf beetles feeding on water hyacinth and other aquatic plants), and herbivores of terrestrial plants associated with the wetland areas, insects such as leaf beetles, leafhoppers, and planthoppers. While these insects feed on plants, they also serve as food for other species, such as some predatory insects like the dragonfly, as well as birds. Most of the pollinators are terrestrial adult butterflies, while their larvae feed both on terrestrial and aquatic plants.

Numerous aquatic insects (damsel and dragonfly naiads, the water boatman, giant water bugs, water diving beetles, etc.) are carnivorous. It was observed that the naiads of dragonflies are ferocious feeders of the dipteran larvae. The most recognized family, Gerridae (water skimmers or skaters) dwell on the surface of the water and feed as scavengers. Except for the skaters, many of the aquatic insects such as diving beetles (Coleoptera: Dytiscidae), giant water bugs (Hemiptera: Belostomatidae) and backswimmers (Hemiptera: Notonectidae)-) are considered divers with leg adaptations for swimming and diving. These insects sometimes cling to submerged aquatic weeds, rocks and pebbles. Few of the insects sampled from this site were considered burrowers such as the bloodworm (Diptera: Chironomidae). Some were sampled from between the sands of Capoey via their kicking action. Others, such as mayfly naiads, feed on live and decaying vegetation, ensuring the breakdown of waste material, the recycling of nutrients and cleansing of the environment. These naiads and other aquatic insects are common food for fish.

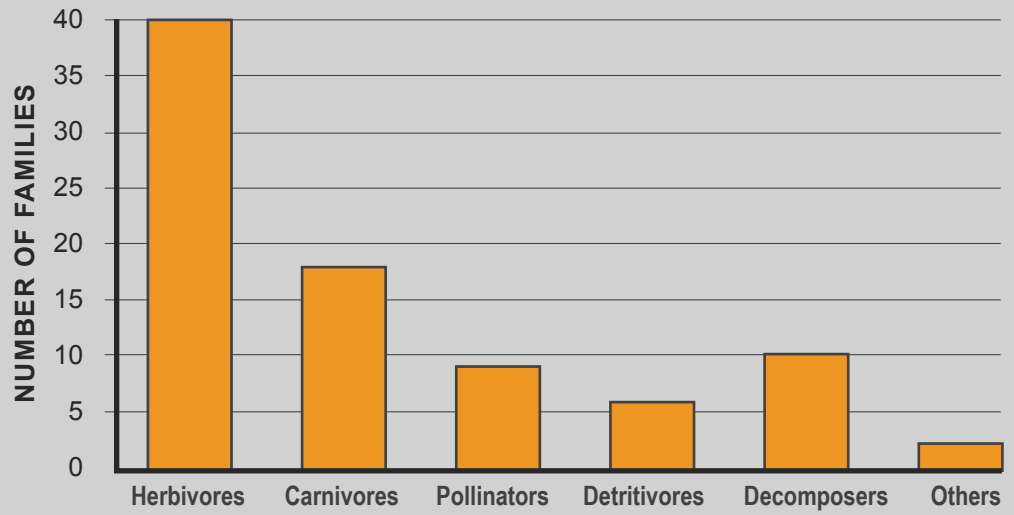


Fig. 15: Insect families from the Essequibo lakes and wetlands categorized by ecological function

An example of a semi-aquatic grasshopper (nymph) *© WWF-Guianas / Elroy Charles*

Non-insect macro-invertebrates sampled from the lakes were solely zoo plankton; a notably higher density was determined in the waters of Lake Mainstay. The non-insect aquatic macro-invertebrates such as shrimp, snails and –significantly- sponges were the groups readily observed; at least three species of freshwater sponges were observed in the lakes. That sponges are present is a good indication that the lakes are still very much unpolluted. However, in some communities this indicative value was not appreciated by residents, because of the association of sponges with skin irritation, and there are reported plans for their eradication.

General site characteristics

3.3.6 Land ownership, management and conservation

No formal conservation status is assigned to this wetland; the area is however managed for irrigation purposes.

At the national level, the area of the Essequibo Coast lakes and wetlands is managed by the National Drainage and Irrigation Authority (NDIA) of the Ministry of Agriculture, with the participation of various stakeholders including the Water Users Association, Region 2 rice farmers, and the Hydrometeorological Service. The NDIA has responsibility for the irrigation of agricultural lands which are predominantly rice fields. In addition to the NDIA, the Hydrometeorological Service of the Ministry of Agriculture monitors the water level, rainfall and river flow linked to Essequibo coast lakes, as with the country's other waterways.

A number of townships or villages exist further from the immediate environs of the Essequibo wetlands as freehold, leasehold or private lands along the coastline. The residents of these townships and villages, including those stretching from Supenaam to Anna Regina and Charity, cultivate primarily rice (over 30,000 acres), but also other crops and livestock, which benefit from the water supply of the conservancy, regulated by the NDIA.

Mainstay/Whyaka, Tapakuma, Mashabo and Capoey are the Amerindian villages located within this wetlands Site, on Amerindian titled lands. Residents are primarily of the Arawak peoples. The Indigenous communities depend in part on the resources of this wetland for their livelihoods. These Amerindian villages govern and manage their titled lands, but do not have corresponding legal bases to manage the water bodies and river channels. They however play an integral role in the management and monitoring of these wetlands.

Main administrative area, Capoey Village *© WWF-Guianas / Aiesha Williams*

3.3.7
Wetland community conservation initiatives

Though the Village Councils of each of the four Amerindian communities employ various measures for managing the resource on their titled lands, there are limited known deliberate wetland conservation and management initiatives undertaken. Mainstay Village has established a community forest conservation area, referred to as a Community Heritage Park, with the aim of preserving a “plantation” of culturally significant species for the knowledge and use of future generations (Chunoo, 2008). The area is approximately 50 acres in size and includes a portion of the swamp which is part of the floodplain of the lake.

3.3.8
Anthropogenic influences and uses

The Essequibo Coast wetlands provide substantial benefits to residents of the immediate environs of the water body, but also are extremely important to communities and business located further away, and even to the national economy. Water storage and withdrawal for irrigation of the rice fields and to a lesser extent for cash crops and livestock within the Region 2 coastlands are the primary economic uses associated with the Essequibo Coast wetlands. As a matter of fact, rice production is the largest land-use activity on these coastal lands; the land is privately owned or leased and managed primarily by Essequibo Coast residents outside of the wetland site. Though the lakes are natural, networks of constructed canals, sluices and dams have rendered the natural lakes larger, forming this extensive wetland with a consequential extended storage capacity, and facilitating a relatively reliable and sufficient source of water. This has however altered the seasonal patterns of the natural lakes, despite the formation of this now expanded wetland ecosystem. The original seasonal changes in water levels and hydrological flow have been altered, thereby influencing the ecological variations within the system. Detailed impact assessment studies are required to clarify the positive and negative influences of these anthropogenic interventions on the wetlands ecosystem. As such, communities adjacent to the lakes have reports of negative impacts, including human health concerns, scarcity of food fishes, flooding causing damage to crops especially during extreme rains, or the low water levels during drought contributing to health issues, including skin infections, and also impacting on general traditional ways.

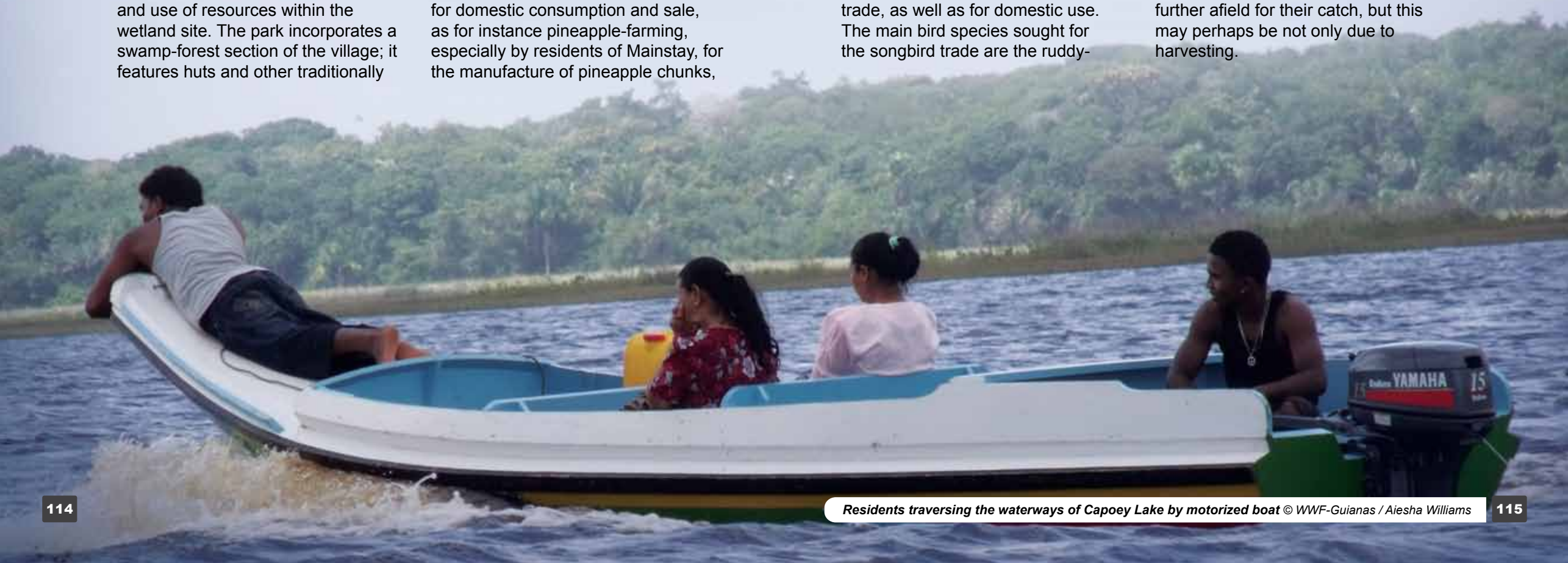
Recreation and nature-based tourism including water sports are another important use of these wetlands, and an incipient economic activity.

Mashabo Lake, Essequibo Coast wetlands *© WWF-Guianas / Elroy Charles*

This is most evident however at Lake Mainstay which was designated by the Lake Mainstay Amerindian community as a tourism site; approximately five acres of titled Amerindian lands were leased to a private company which established the Lake Mainstay Resort. This entity is one of the country's main resorts; it hosts the annual Lake Mainstay Regatta, several types of pageantry and is the venue for a variety of recreational activities. The Mainstay/Whyaka Village also operates a Heritage Park. This is managed mainly by the (local) Women's Group; on offer are tours showcasing the community's culture and use of resources within the wetland site. The park incorporates a swamp-forest section of the village; it features huts and other traditionally structures constructed of palms and other plant materials. At the time of this survey however, the park was not being operated optimally. Lake Capoey is also utilized for recreation by mainly local residents. There is some negative impact in the generation and virtually insufficient management of solid waste.

Other important activities facilitated by these expansive wetlands include accessing water for domestic use (but not for drinking or cooking); transportation by motorized boats and to a lesser extent dugout canoes; small-scale farming both for domestic consumption and sale, as for instance pineapple-farming, especially by residents of Mainstay, for the manufacture of pineapple chunks, jams and cheese; and harvesting of timber and non-timber forest products mainly for domestic consumption, although non-timber forest products (NTFP) craft are made for sale occasionally.

Fishing and wildlife harvesting are also supported within this wetland because of its diverse species of wildlife. Fishing is mainly targeted at four species of food fish, the lukanani (*Cichla ocellaris*), imehri (catfish) (*Trachelyopterus galeatus*), haimara (*Hoplias* spp.) and huri (*Hoplias malabaricus*). The wildlife harvesting is intended for the live and bushmeat trade, as well as for domestic use. The main bird species sought for the songbird trade are the ruddy-breasted seedeater (*Sporophila minuta*), lined seedeater (*Sporophila lineola*), and chestnut-bellied seed finch (*Oryzoborus angolensis*). Some other species are harvested both for subsistence and the wild-meat trade on the Essequibo coast: the more demanded tapir (*Tapirus terrestris*), the red brocket deer (*Mazama americana*), white-lipped peccary (*Tayassu pecari*), paca (*Cuniculus paca*), red-rumped agouti (*Dasyprocta leporina*), Capybara (*Hydrochaeris hydrochaeris*) and the Muscovy duck (*Cairina moschata*). There have been reports of scarcity of wildlife, or harvesters being required to travel further afield for their catch, but this may perhaps be not only due to harvesting.



Residents traversing the waterways of Capoey Lake by motorized boat *© WWF-Guianas / Aiesha Williams*

3.4

SITE 4 – LOWER CANJE BASIN

Sample sites: *Manarabisi Swamp, Sandaka Swamp, Guysuco Conservancy, Halcrow Conservancy*

Ecological profile

3.4.1 Location

The Canje River, of the County of Berbice, is a fairly large tributary of the Berbice River. Just before the mouth, it drains a significant area between the Berbice and Corentyne Rivers including wetlands modified by the agricultural activities in the area. The area defined here as the Lower Canje Basin lies between the Calabash tributary, close to the mouth of the Canje River (~ 17km inland from the coastline at Albion), and further up the Canje River, approximately 16.2km NW of the confluence of the Duck and Corentyne Rivers. Within this area four locations were sampled: the Manarabisi and Sandaka swamps, and the GUYSUCO and Halcrow conservancies. The Corentyne main road which runs between New Amsterdam and Corriverton, and connects Guyana to Suriname via the Molson Creek area, is a major piece of infrastructure on the outer environs of these wetlands: the Manarabisi swamp - a natural, flooded coastal savannah from the Corentyne river, modified on the edges by constructed dams; the Sandaka Swamp - another flooded savannah further inland and closer to the Canje river, modified by low dams and small canals; the GUYSUCO Conservancy, an area of savannah impounded by medium-height dams to hold water for the sugar plantations; and the Halcrow Conservancy - contiguous to the GUYSUCO Conservancy but further east toward the Corentyne River and also a water reservoir.

A section of the Lower Canje wetlands, Halcrow Conservancy *© WWF-Guianas / Sopheia Edghill*

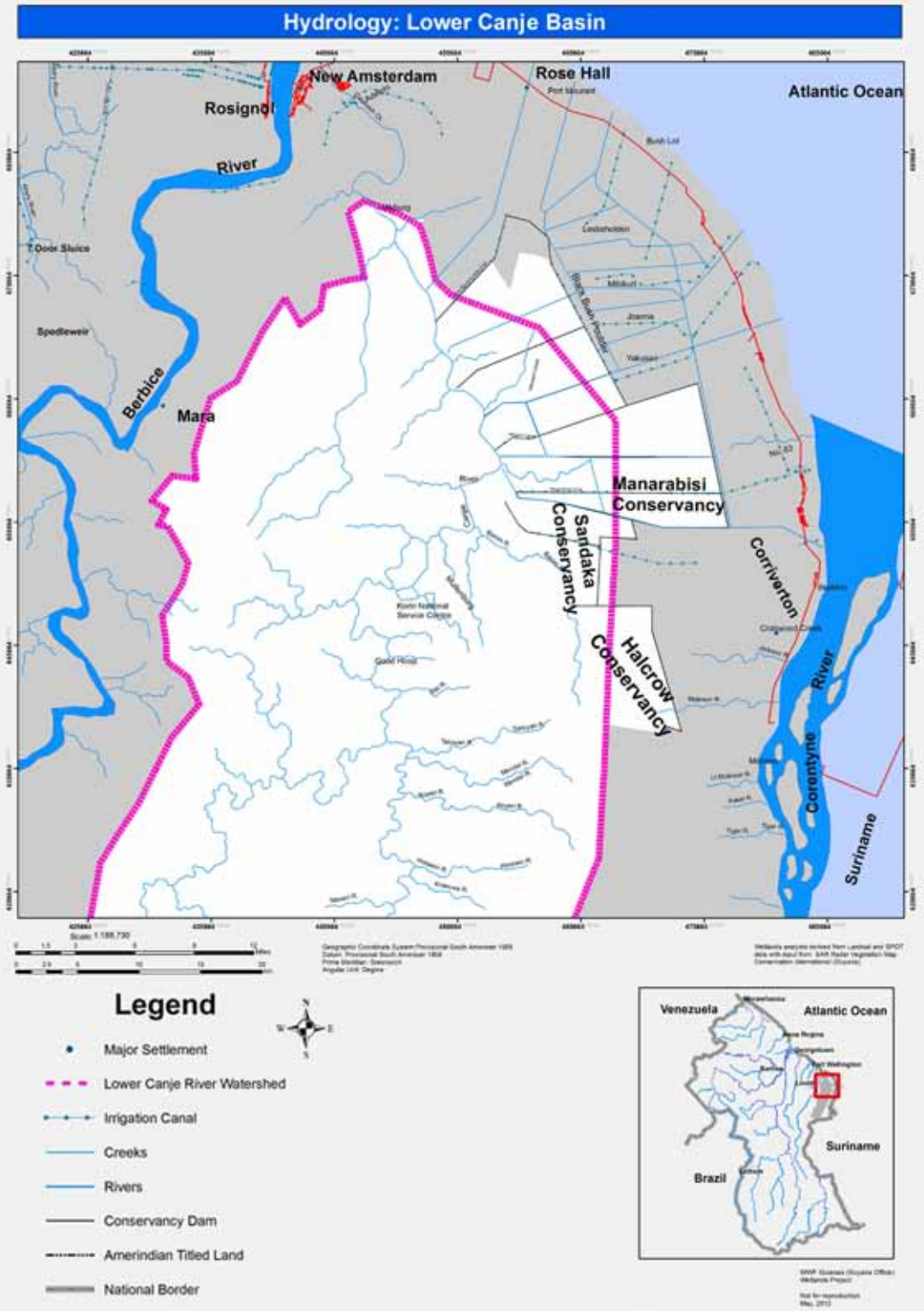


Fig. 16: Map showing location and hydrology of the Lower Canje Basin and wetlands

3.4.2 Wetland type

The area consists of sections of shallow open water, marshes, seasonal swamps, savannahs and forest, and constructed water conservancies as irrigation water-storage reservoirs. Consequently the Lower Canje wetlands may be classified as Ramsar Wetland Type 6 (water storage area), 9 (canals and drainage channels, ditches), W (shrub-dominated wetlands), Xf (freshwater, tree-dominated wetlands).

3.4.3 Hydrogeomorphology

The geology is mainly very dense clay of the Demerara formation, on flat lands prone to flooding, further compounded by constructed earthen dams of varying sizes. A build-up of organic material exists in certain areas due to the extensive periods of controlled flooding. The swamps and the conservancies are however somewhat different in hydrology. The wetland water input is via human controlled and natural flow/ flooding from the Canje River, precipitation (rainy season during December-January and May-August) and run-off. Certain sections of the constructed conservancies, located to the eastern section of the wetland, receive water by run-off from the inland swamps connected to the Canje River. The output from the unaltered natural swamps are via natural and man-made run-off routes without control structures, whereas the constructed conservancies are well-controlled to maintain water levels in the various parts of the sugar plantation at different times in the growing season.

There is white water in the Manarabisi Swamp and Halcrow Conservancy area, and “black water” (brown in colour) at the Sandaka swamp and GUYSUCO Conservancy area. This grouping is also reflected in other water quality parameters. This is a very good example of the dynamism that is characteristic of the tropical wetlands in fluctuating between wet and dry seasons.

Wimple piranha (Catoprion mento) *© WWF-Guianas / Calvin Bernard*

Table 6: Water chemistry measurements taken at four sample points within the Lower Canje Wetland

Parameters	Average Values[12]	Range[13]	
		Highest	Lowest
Electrical conductivity (µS)	153.89	302	1.06
pH (pH)	6.2	8.75	5.17
Temperature from pH meter (°C)	29.95	31.9	28.5
Dissolved oxygen (%)	1.4625	3.64	0.15
Turbidity (NTU)	52	99.9	13.4
Total dissolved solids – TDS (mg/L)	73.4325	144.9	0.43
Salinity %	0.07	0.14	0

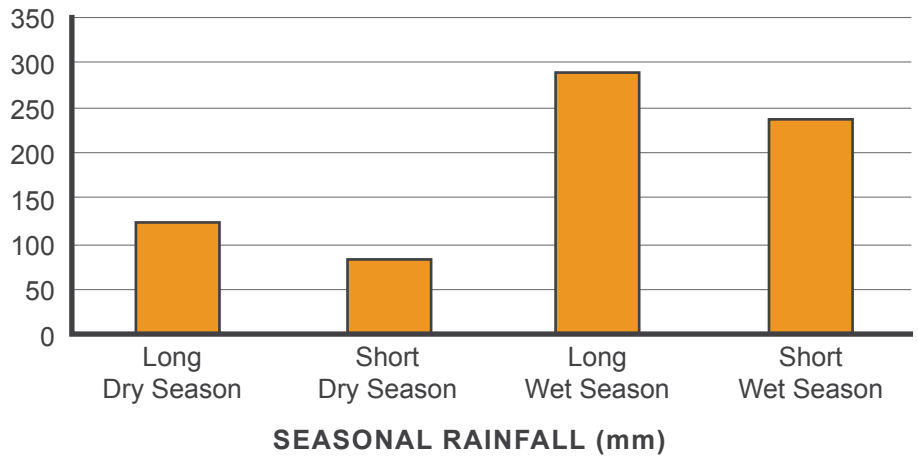


Fig. 17: Bar chart showing the seasonal rainfall pattern for the Lower Canje Basin

[12] Average values across the four sample points within the wetland site.
[13] Minimum and maximum values across the four sample points within the wetlands site.

3.4.4
Vegetation cover

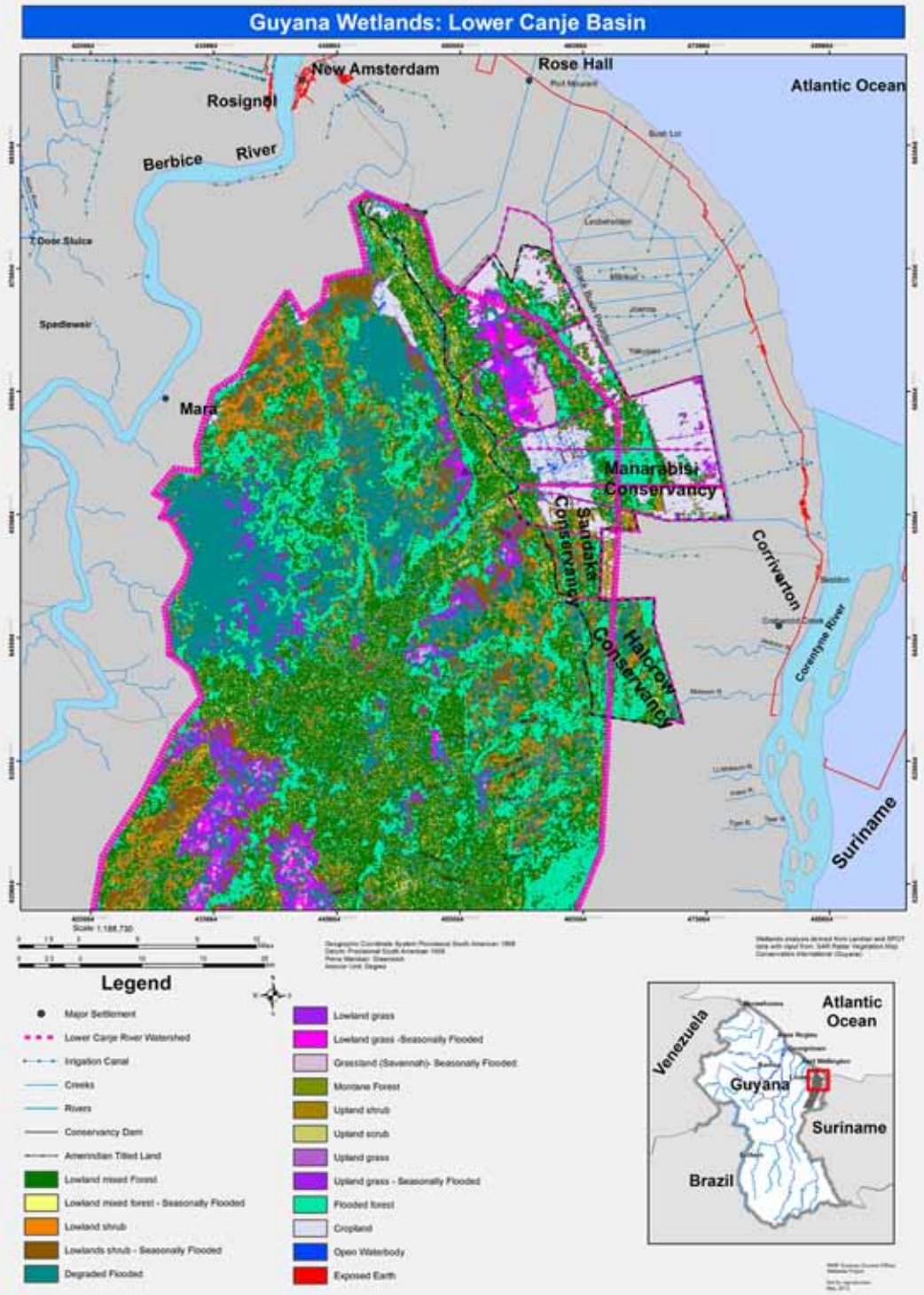


Fig. 18: Map showing the vegetation and land cover types of the Lower Canje Basin

Generally the area comprises lowland marsh and seasonally flooded grassland savannah, with islands of swamp forest and high-ground bush. The observed terrestrial floral diversity included various species of grasses, shrubs, and large trees, with the composition at the individual sites reflective of the use of the site and history in relation to human actions. More specifically, certain sections are covered with grasses and sedges (para grass, *Urochloa* sp. and carpet grass, *Axonopus* sp.), but mostly shrubs and small trees dominate, many of which are natural invaders of disturbed areas because of their means of dispersal, high growth rates and ability to withstand a range of harsh conditions. The prominent shrubs include the thorny bush (*Solanum jamaicense*), a shrubby and a flat growing variety of *Mimosa* sp., *Vernonia cinerea*, two species of *Ludwigia*, the carrion crow bush (*Cassia alata*), two sage species (*Lantana*), and a few unidentified succulents. The small trees include the congo pump (*Cecropia* sp.), glamma cherry (*Cordia oblique*), palms (*Bactris* sp.) and silk cotton (*Ceiba* sp.), kokerite palm (*Maximiliana maripa*), Manicole Palm (*Euterpe oleracea*). A number of cash crop or garden vegetable type species were also observed at certain sections, indicative of the human influence within the area.

These shrubs and trees have a significant cultural value to the coastal communities. The carrion crow bush, sages and congo pump are all used in various ways for traditional medicines and personal care (black sage for cleaning teeth); the glamma cherry fruit is popular at Easter as an adhesive for kite making; and the silk cotton is associated with the burial of prominent Dutch figures in the colonial period, and thus have many legends of ghosts associated with them. In addition to these species, a Cucurbitaceae vine commonly called “corilla bitters”, found at the Manarabisi swamp, is also used in local medicine.

The aquatic and sub-aquatic flora is of equal diversity as the more terrestrial forms. These include the full range of morpho types for aquatic flora – submerged, floating, floating-leaved and emergent. Floating vegetation includes the water fern (*Salvinia* sp.)

A section of the Lower Canje wetlands *© WWF-Guianas / Sopheia Edghill*

and floating grasses. The water lettuce (*Pistia* sp.), bladderwort (*Utricularia* sp.), floating vines (*Ludwigia helminthorrhiza* and *Ipomea* spp.), water hyacinth (*Eichornia crassipes*) and the floating form of the *Mimosa* sp. can be observed at certain sections of the wetlands. Floating-leaved type vegetation consists mainly of lilies and related plants and includes species such as the fragrant lily (*Nymphaea* sp.), *Nymphoides* sp., and the burhead (*Echinodoras*). The emergent species include sub-aquatic species and range in size/form from grasses to large trees. Across the entire system the *Heliconia* sp. and *Montrichardia* sp. are most common, with a giant papyrus type *Cyperus* sp. Some other emergent species include the monkey apple (*Annona glabra*), spike rush (*Eleocharis* sp.), fire flag (*Thalia* sp.), Ité palm (*Mauritia flexuosa*), aquatic fern (*Blechnum* sp.), yellow-eyed grass (*Xyris* sp.), the shrub-like *Ludwigia* sp. and a palm (*Euterpe* sp.).

3.4.5 Faunal Species

3.4.5.1 Fishes

The observed fish diversity of the area comprises 29 species of 13 families and 6 orders in this study undertaken in 2011, while a previous study of the Halcrow section of wetlands in 2006 recorded 20 species of nine families (Environmental Management Consultants, 2006). Some of these include the orders Characiformes, Perciformes, Siluriformes, and Cyprinodontiformes with Siluriformes (see species list, Appendix 2).

None of the species observed are of any known conservation importance. However, there are species consumed locally for food; species in the genera *Crenicichla*, *Cichlasoma*, *Serrasalmus*, *Hoplias*, *Hoplerythrinus*, *Aequidens* and *Trachelyopterus* are all popular food fish, but *Hoplosternum* (the hassar) is by far the most expensive on the market and the most targeted species from these areas. Other species from the genera *Astyanax*, *Gasteropelicus*, *Pyrrhulina*, *Moenkhausia* and *Nannacara* are all attractive for the pet trade, but it is unclear whether there is harvesting of such species from these areas.

3.4.5.2 Birds

Some of the waterfowl inhabiting this wetland include groups such as ducks, herons, gallinules, kingfishers, and some raptors, and species such as green ibises, large-billed terns, American wood storks, sungrebes, limpkins, Canje pheasants and anhingas.

Eight species of the heron family were observed within the East Canje wetlands; these include the great egret, cocoi heron, striated heron, boat-billed night heron, little blue heron, black-crowned night heron, capped heron, and rufescent tiger heron. Such a diversity of herons signals a diverse and healthy population of several species of fish for the birds' sustenance. Herons

American wood stork (Mycteria americana) *© WWF-Guianas / Aiesha Williams*

have an important role in population control for several species of fishes, invertebrates and some species of amphibians. They also feed on frogs, crustaceans, and small reptiles such as caiman hatchlings. These birds feed in shallow water and in temporary pools as the water diminishes. Thus, they are important in cleaning up small pools, and minimizing pollution, for instance in areas contaminated by decaying carcasses. The boat-billed heron is distinctive from all other herons with its thick, spoon-like bill. Like many other herons, they feed on a broad range of aquatic prey such as crabs, shrimp, small fish, amphibians and insects. They are always found close to aquatic ecosystems, mangrove swamps, freshwater marshes, and along rivers.

Both species of the gallinules - azure and purple gallinules (*Porphyrio flavirostris* and *P. martinica*), along with three other species of rails (Rallidae family), were recorded in the Lower Canje wetlands. These species are not easily spotted, especially the azure, though they are very attractive wetland birds. Freshwater marshes are important habitats for these birds.

Three migratory species were also recorded in this wetland; they include the black-bellied plover, yellow Warbler and the solitary sandpiper.

Some of the terrestrial species associated with this wetland are toucans, parrots, macaws, guans, pigeons, some of the flycatchers, and raptors such as laughing falcon. The toucans, parrots and macaws are important seed dispersers, foraging mainly among palms within the wetlands. The tyrant flycatchers, antbirds, anis, cuckoos and funarids such as spinetails, are mainly insectivores, and significantly help to control the insect populations within the lakes' ecosystems.

3.4.5.3 Other vertebrates *(mammals, amphibians and reptiles)*

The Neotropical river otter and the capybara are the aquatic mammals that are known to be found within the Lower Berbice area. West Indian manatees and giant river otters are found along the Canje River, and have not been recorded in the flood wetlands thus far.

Red howler monkey (Alouatta seniculus) *© WWF-Guianas / Laurens Gomes*

Some key terrestrial mammals associated with the Lower Canje wetlands include the rodents such as the paca and red-rumped agouti, the primates such as the capuchin monkey, squirrel monkey and red howler monkey (*Alouatta seniculus*), the ungulates including brocket deer and tapir, and species including the jaguar and lesser anteater. Most of these depend on the wetland as a source of food and water and means of movement, while contributing to the ecological balance and biologically diversity of the wetland area.

Aquatic herpetofauna observed within the area include a number of frog species such as the Hyla sp., the spectacled caiman (*Caiman crocodilus*) and green anaconda (*Eunectes murinus*). Other species associated closely with the wetlands include the more commonly observed frogs like the *Leptodactylus fuscus*, the marine toad also known as the cane toad (*Bufo marinus* now renamed *Rhinella marinus*), and the *Eleutherodactylus johnstonei* (a non-native species). Other terrestrial species include the ameiva lizard (*Ameiva ameiva*), labaria Snake (*Bothrops atrox*), tegu lizard (*Tupinambis teguixin*) and the yellow-footed tortoise (*Chelonoidis denticulata*).

Lesser yellow-headed vulture (Cathartes burrovianus) *© WWF-Guianas / Sopheia Edghill*

3.4.5.4 Macro-invertebrates

Approximately 16 macro-invertebrate families are directly associated with the wetland, namely Coleoptera (Dytiscidae, Hydrophilidae, Gyrinidae), Hemiptera (Corixidae, Notonectidae, Belostomatidae and Gerridae), Ephemeroptera (Baetidae) and juveniles of Odonata and Plecoptera. The remaining groups of insects are categorized as semi-aquatic, because they associate with the vegetation within the lakes or ponds.

Common groups **sampled from all the areas** within the Lower Canje Basin were Diptera: Anthomyiidae (flowerfly), Coleoptera: Chrysomelidae, Alticinae (flea beetle), Hydrophilidae (water beetle), Diptera: Muscidae (common housefly), Ephemeroptera: Baetidae (mayfly), Hemiptera: Cicadellidae (leafhopper), Coreidae (leaf bug), Gerridae (water skater), Hymenoptera: Formicidae (fire ants), Odonata: Anisoptera and Zygoptera (damsel and dragonfly respectively, both adult and naiads) (see photo), and the Orthoptera: Acrididae (grasshopper). With the exception of the common aquatic groups, such as the mayfly, water beetle, water skater and the naiads of dragon and damselflies, the rest of the common insects were mainly **sampled from wetland-associated vegetation or habitats**.

Herbivores (see Fig. 19) play an important role within this wetland system and can either increase or decrease plant diversity. A major portion of the herbivory (the eating of plants) was by plant grazers such as insects with chewing mouthparts, as for example leaf beetles, grasshoppers and butterfly caterpillars. Some of these types were semi-aquatic, grazing on aquatic vegetation. Most aquatic groups were predators, attacking their prey by piercing tissues and cells and sucking the fluids, or by ingesting their prey. Hemiptera: Belostomatidae (giant water bug) and Odonata prefer the first feeding type, whereas Plecoptera and Coleoptera: Dytiscidae prefer the latter feeding pattern. The few aquatic decomposers of vascular plant tissue included Diptera: Chironomidae, which were also found between rotting flowers of water lilies, and Diptera: Simuliidae larvae, found in a Sandaka pool that had cattle excrement.

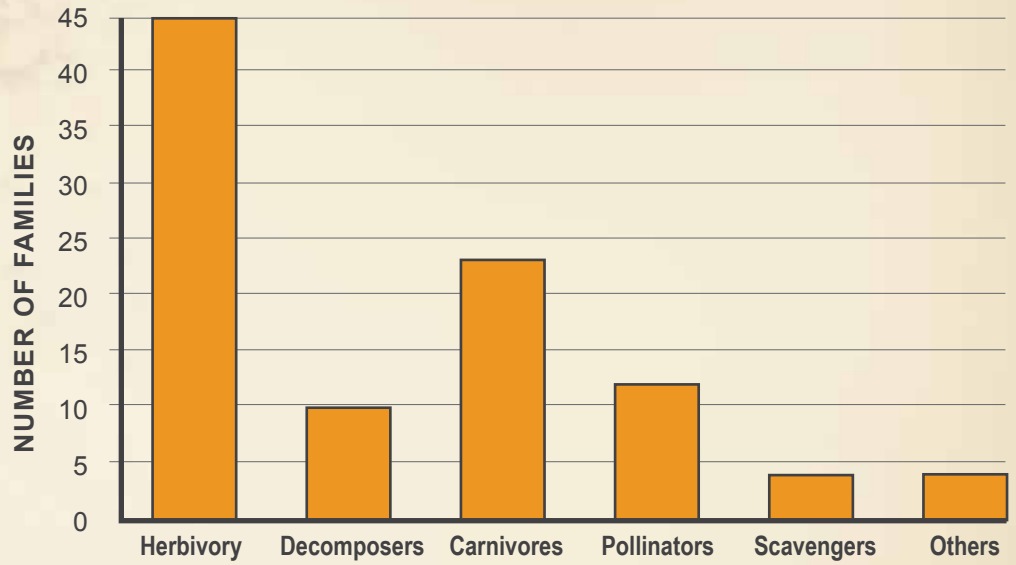


Fig. 19: Insect families categorized by ecological function within the Lower Canje Basin

The non-insect macro-invertebrates observed were mainly freshwater shrimp (Decapoda) and snails (*Pomaceae*) which were found at all sites. These are obviously well supported with food, through the rich primary production by plants. A leech (Hirudinidae) species was observed at the Halcrow conservancy site.

Common green dragonfly found in all areas of the Lower Canje Basin *© WWF-Guianas / Elroy Charles*

3.4.6 Land ownership, management and conservation

The entire Lower Canje Basin is administered within a combination of land ownerships arrangements, including private, free/leasehold and state lands. Most of the population resides closer to the coastline, along the Corentyne main road, with villages and townships existing on mainly private lands. Where the Lower Canje wetlands are defined is situated further inland, and consists mainly of state-owned lands. Some sections have been altered for irrigation of cultivated lands and come mainly under the legal management of the Guyana Sugar Corporation (GUYSUCO) for water storage for large-scale sugar and other cultivation. Other sections, mainly more coastally located, are either free-holder or owned by GUYSUCO, private farmers, and cattle ranchers, and mainly used as a cattle grazing area, or for sugar, rice and other cash crop cultivation.

Though this wetland is managed and utilized as a water reservoir, there are some biodiversity conservation initiatives GUYSUCO employs to maintain the biodiversity and water quality of the area. GUYSUCO implements an Environmental Management Plan (EMP) for the areas under its jurisdiction. The EMP is in respect to the conservancies under GUYSUCO's jurisdiction, restricting wildlife harvesting and fishing, prohibiting logging, grazing of livestock, and contamination of liquid and solid wastes (Homer, 2007). Some EIAs have been conducted which give an overview of the biodiversity of the area, as prerequisites for GUYSUCO's expansion projects.

Canes transported through constructed canals *© WWF-Guianas / Aiesha Williams*

3.4.7
Anthropogenic influences and uses

The Lower Canje wetlands, including the Canje River also, are an important source of water for irrigation purposes, mainly for sugar and to a lesser extent rice, and even, on a smaller scale, cattle ranching and cash crop cultivation. Sugar is planted both by private farmers and also by GUYSUCO, the latter on a large scale, for sugar production at the Skeldon, Rose Hall, Albion, and Providence factories, for sale locally and internationally. There is need for a substantial amount of water to irrigate the large-scale sugar and rice fields, hence the construction of a network of canals and sluices which enable the channelling and pumping of water to the cultivated lands. Both the constructed and natural waterways are used to transport the harvested cane to the sugar estates. The canals, dams and the withdrawal of water over time can negatively affect the natural functions and seasonal changes of the wetlands; this is more so exasperated by extreme weather patterns. There are some aspects of biodiversity which have however benefited from the irrigation systems utilized, including an expanded wetland system and growth and development of certain species.

More concentrated ecological impact studies are essential to precisely identify and understand the threats and pressures to this area.

Apart from irrigation and the agricultural sector supported by the wetlands, wildlife harvesting is also facilitated by the Lower Canje wetlands. Local trappers and exporters source wildlife from the wetlands and its environs for the local and international live pet trade. Songbirds such as the ruddy-breasted seedeater (*Sporophila minuta*), lined seedeater (*Sporophila lineola*), and chestnut-bellied seed finch (*Oryzoborus angolensis*) and psittacids, including some parrots and macaws, are sourced from the Lower Canje area and drive the trade within and from this area. The local bushmeat traders also source wildlife from this wetland; some target species include the Muscovy duck, tapir, red brocket deer, white-lipped peccary, paca, red-rumped agouti, capybara and the red-footed tortoise (*Geochelone carbonaria*). Wildlife harvesting may have contributed to the changes in the population and distribution of certain species, and is noted by harvesters, since they need to explore new areas and travel farther to harvest.

Constructed earthen dam to facilitate irrigation of agricultural lands *© WWF-Guianas / Aiesha Williams*

3.5 SITE 5: NORTH WEST WETLANDS

Sample sites: Moruka Swamp (Manawarin Swamp), Assakata Lake and flooded area, Baramanni Lake, and Almond Beach Swamp (George and Arnold Ponds).

Ecological Profile

3.5.1 Location

The north-western portion of Guyana can be considered a single wetland system with expansive swamps and highly interconnected river systems interspersed with “bush islands” which link the coastal brackish water swamps to freshwater swamps, rivers and ponds further inland. There is ecological rationale, however, in separating the brackish water systems from the freshwater systems for a proper treatment of these two subunits. It is estimated that the blurred boundary between these systems exists from 58° 51’ 56.333” W 7° 35’ 53.744” N[14] at the south-eastern end to 59° 48’ 21.667” W 8° 19’ 5.705” N at the north-western end (See Fig. 20). The freshwater area covers the Moruka swamp in the south towards the northern flooded areas, while the brackish water segment stretches from the Waini River point to the mouth of the Moruka River, reaching the north-western sea-coast including Shell Beach, declared a Protected Area in 2011.

[14] PSAD UTM 21N -6,650,122.719 924,946.923 and UTM 21N -6,545,558.351 844,887.824

A section of the Moruka River and swamp *© WWF-Guianas*

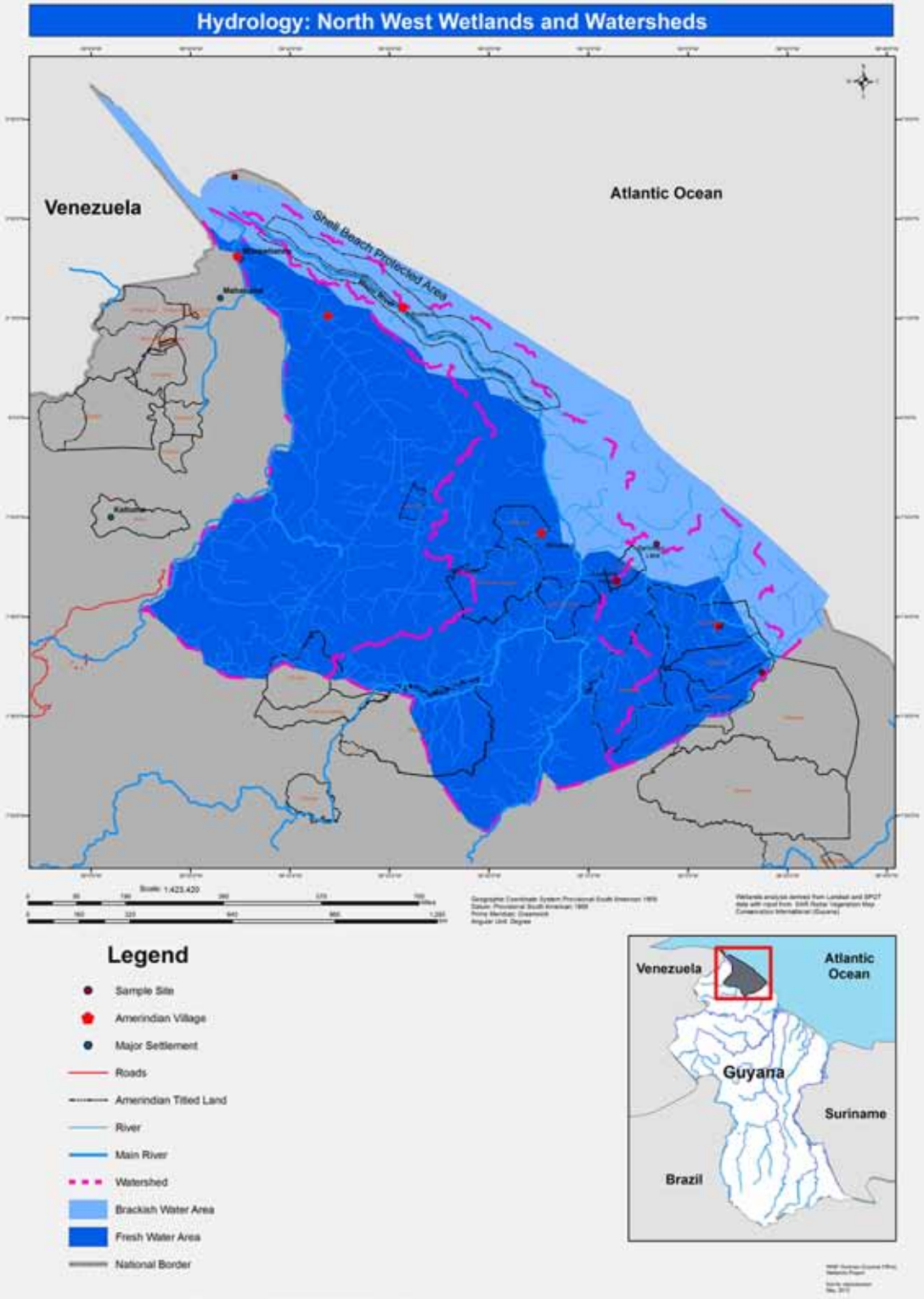


Fig. 20: Map showing location and hydrology of the North West wetlands

3.5.2 Wetland type

The general characteristics of the freshwater subunit includes swamps, permanent ponds and seasonally flooded areas, covering a range of the Ramsar classification types of inland freshwater wetlands including Types O (permanent freshwater lakes), P (seasonal/intermittent freshwater lakes), Tp (permanent freshwater marshes/pools) and Xf (freshwater, tree-dominated wetlands). The brackish water subunit, however, of the North West area is a mixture of intertidal mangrove swamps (Ramsar Type I) and coastal brackish water lagoons (Ramsar Type J); however most of the former cover the area.

3.5.3 Hydrogeomorphology

The intertidal swamps, located beyond the peak of the shell deposits on the shoreline, are relatively shallow depressions, with gently sloped banks leading into them, with widths of as little as 10-15m during the dry season. The northern portions of these swamps have shell banks, and bottom substrates that are a mixture of soft silty clay and shells. Further inland the substrate changes to a dark greyish-black silty to sticky clay, rich in organic material, and to open water lagoons and lakes (like Baramanni Lake), with banks hidden during the high tide, revealing only prop roots or tree branches at the edge of the water. The slopes of the banks visible at low tide are gentle to only moderately steep.

The intertidal swamps are, generally speaking, fairly shallow (measured at approximately 1.25m at Arnold pond). The coastal lakes/lagoons are much deeper (approximately 7m at Baramanni), most likely because their direct connection to river systems allows for a greater degree of sediment mobility rather than facilitating deposition.

The entire North West freshwater wetland subunit is represented by seasonally flooded low areas, dissected with a network of rivers and small tributaries, with substrate of mainly organic material and/or clay, with islands of high grounds of sand, and water pools, lakes and ponds more noticeable during the dry season; also see van Andel (2003). Areas sampled had very obscure banks of peaty organic material, sand and clay. The Assakata lake in particular possesses false banks formed by a dense mat of organic material, with roots floating and supporting small palms and shrubs. Further away from the lake there are seasonally flooded lower areas; as the elevation of the land increases, the base material becomes white sand, upon which the local community is set. The northernmost area of this wetland is covered with heavier clay material. More south, white sand and decaying organic matter, along with clay is also the base for the Moruka swamp.

Shelly substrate in the Shell Beach area of the North West wetlands *© WWF-Guianas / Aiesha Williams*

The Moruka area has a similar layout of flooded organic and clay lower areas, with sand islands where communities are located.

The brackish water wetlands, because of their proximity to the ocean, are influenced greatly by the ebb and flow of the tides in the Pomeroon, Moruka and Barima and Waini River systems. The area is also recharged by significant direct rainfall, highest from May to July, causing the rivers and flooded lands to become one, with a throughflow of groundwater. Where the intertidal swamps are close enough to the sea, as is the case with portions of George pond, there is a fair amount of seawater intake during spring tides, as waves break on the shore and spill over. The freshwater wetland subunit however is charged overall from precipitation (also highest from May to July), surface run-off, inflow/ overtopping of rivers, and groundwater (throughflow).

Table 7: Water chemistry measurements taken at sample points within the North West freshwater wetlands

Parameters	North West Freshwater		North West Brackishwater		
	Moruca swamp (Manawarin)	Assakata pond	Baramanni Lake	Arnold Pond	Shell Beach mangrove swamp
Electrical conductivity (µS)	30.1	1.68	-	19.82	30.1
pH (pH)	5.12	4.64	4.12	7.69	5.12
Temperature from pH meter (°C)	28.5	29.9	28.8	32.5	28.5
Dissolved oxygen (%)	2.00	5.9	3.04	7.54	2
TDS	15.17	0.721	2.61	7.14	15.17
Visibility depth (cm)	112[15]	127	-	-	-
Salinity	0.01%	0	2.58	7.4	0.01

The water is brown in colour, which is characteristic of the entire wetland area, slightly acidic with practically zero salinity in the freshwater subunit, and brackish, with a tendency towards salinity more towards the coast and during high tide (see Table 7). A low pH at Baramanni Lake reflects its openness to freshwater intrusion and the likely reason for the relatively low levels of dissolved solids. There is variation in the quantity of dissolved solids and also the electrical conductivity throughout this vast area.

[15] Estimated.

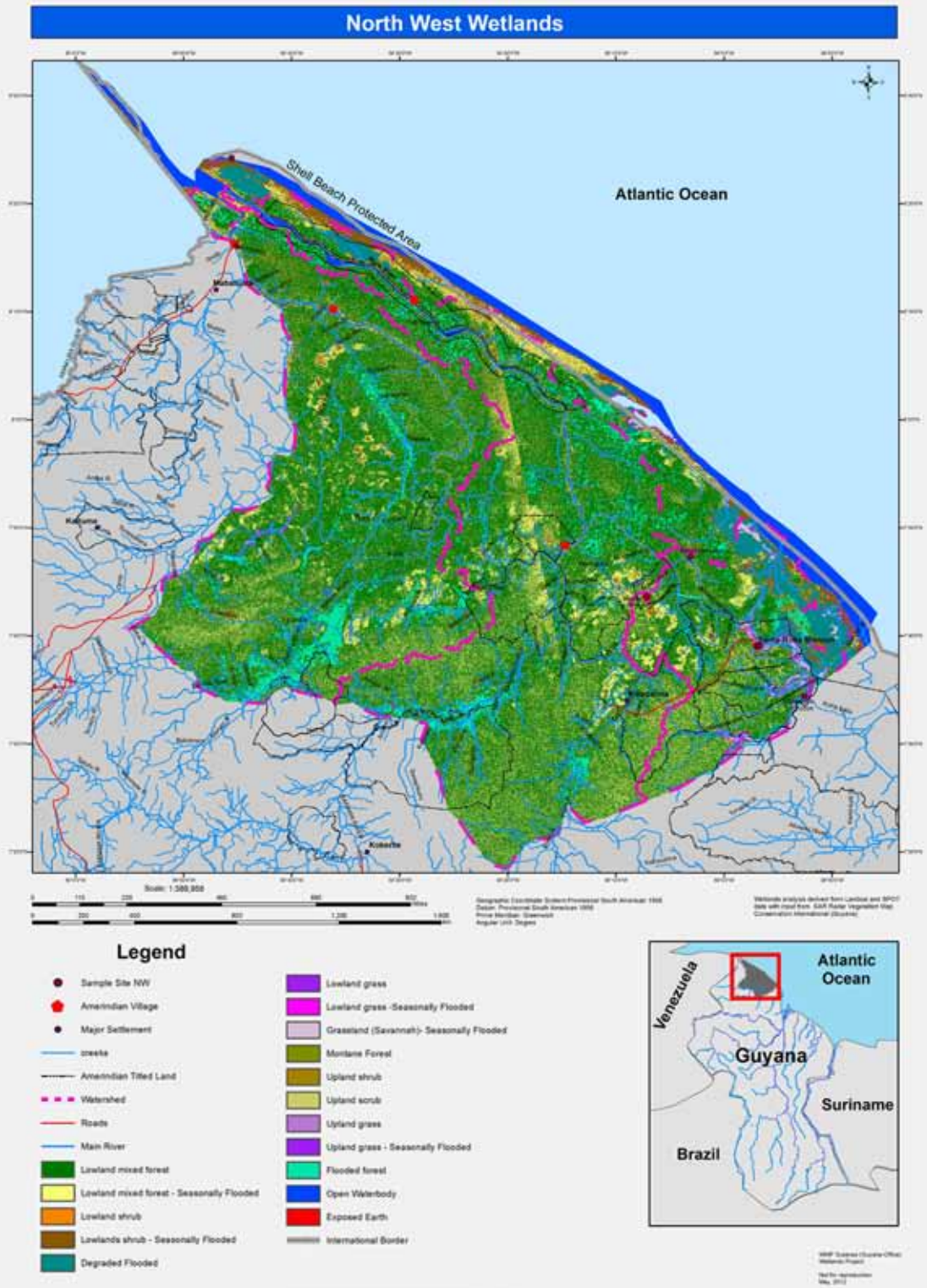


Fig. 21: Map showing the vegetation and land cover types of the North West wetland area

3.5.4
Vegetation cover

The wetland vegetation of this North West freshwater subunit comprises a mixture of seasonally flooded savannas and mixed forests, and swamp forests of mainly palms. There is evidence that this current vegetation of the extended flooded savannah in the south-eastern sections (Moruka area), was formed over decades by annual fires during the dry season, which cleared large tracts of vegetation. As a result, the plant diversity is greater over at the forested north-western sections of the wetland (Assakata area). The brackish water subunit on the other hand is covered primarily with a mixture of mangrove and mixed swamp forests (70%), herbaceous and *Typha* and salt-water swamps (~29%) (GFA Consulting Group 2009). The mangrove swamps are found at the Waini, Baramanni and mouth of the lower Moruka Rivers, and approximately 2–3km from the shoreline, mainly at the northern sections of the area. Further on beyond the mangroves are found primarly swamp forests or open shrubby or savannah type areas.

Mangroves at the Pomeroon River mouth *© WWF-Guianas / Aiesha Williams*

According to van Andel (2003), the dominant tree families of this area are Mimosaceae, Clusiaceae, Bignoniaceae, Ebenaceae, Myristicaceae, Humiriaceae, Myrtaceae, Arecaceae and Caesalpiniaceae. These include species commonly known as Ité palms (*Mauritia flexuosa*), manicole palms (*Euterpe oleracea*), white cedar (*Tabebuia insignis*), *Symphonia globulifera*, *Macrosamanea pubiramea*, *Diospyros guianensis*, *Bactris campestris*, *Pentaclethra macroloba*, *Eperua falcata*, *Philodendron surinamense*, and grasses and sedges such as *Oryza rufipogon*, *Rhynchospora* spp., *Fuirena umbellata*, *Cyperus haspan* and *Rapatea paludosa*.

Some of the aquatic species include ferns (e.g. *Blechnum* sp.), shrubs (*Montrichardia* sp.), emergent species including grasses (e.g. *Lagenocarpus guianensis*), the succulent *Ludwigia* sp., spike rush (*Eleocharis* sp.), yellow eye (*Xyris* sp.), a sedge (*Rhynchospora corymbosa*), a floating-leaved lily (*Nymphaea* sp.) and a submerged coontail (*Ceratophyllum* sp.). The mangrove areas contain all three species of mangroves, namely the red mangrove (*Rhizophora mangle*), the white mangrove (*Laguncularia racemosa*) and the black mangrove (*Avicennia germinans*). The aquatic vegetation provides protection for the shoreline from erosion, and good habitats for fish to hide and breed.

Mangroves

Mangrove trees are a species indigenous to Florida and a major contributor to the state's marine environment. The mangrove tree is a halophyte, a plant that thrives in salty conditions. It has the ability to grow where no other tree can, thereby making significant contributions that benefit the environment. Their coverage of coastal shorelines and wetlands provides many diverse species of birds, mammals, crustaceans, and fish with a unique, irreplaceable habitat. As mangrove leaves drop into tidal waters, they are colonized within a few hours by marine fungi and bacteria that convert difficult to digest carbon compounds into nitrogen-rich detritus material. The resulting pieces covered with micro-organisms become food for the smaller life-forms such as worms, snails, shrimp, molluscs, mussels, barnacles, clams, oysters, and the larger commercially important striped mullet. These detritus-eaters are food for carnivores including crabs and fish. Subsequently birds and game fish follow in the food chain, culminating with man. Many of these species, whose continued existence depends on thriving mangroves, are endangered or threatened. The beneficial effects mangroves have on the marine ecology can be summarized as follows:

- **Basis of a complex marine food chain**
- **Creation of breeding habitats**
- **Creation of nurseries that offer protection for maturing offspring**
- **Filtering and recycling of nutrients**
- **Stabilization of bottom sediments**
- **Water quality improvement**

3.5.5 Faunal Species

3.5.5.1 Fish

Based on the ecological condition of this wetland, the richness and diversity of fish species can be considered fair to high. The families observed during the WWF 2010-2011 field survey or prior surveys include Characiformes, Siluriformes and Perciformes, all falling within the groups of carnivores, detritivores, benthivores, insectivores and one omnivore.

Previous studies, through interviews with residents of the area, have indicated the presence of substantially more species, revealing a highly diverse area. A number of fish species are recorded as present in this area, both in this study and in prior studies. Many are food fishes, for both the residents and the water wildlife of the North West wetlands.

Apart from direct research observations, residents of the areas have indicated that they fish some other species. These include hassar, patwa (chiclids), huri (*Hoplias malabaricus*), yarrow (*Erythrinus* sp.), snook, longtail, cassi, dawalu (*Ageniosus brevifilis*), lukanani (*Cichla ocellaris*), gilbaker, cuirass, snapper, cuffum, mullet, kwakwari, imehri (*Trachelyopterus galeatus*), haimara (*Hoplias aimara*), waburi, hassar, sweet-water cuirass, larima (*Pimelodus blochii*) and cuffum.

Wattled jacana (Jacana jacana) *© WWF-Guianas / Aiesha Williams*

3.5.5.2
Aquatic Birds

The aquatic birds typical of Guyana's wetland ecosystems as well as some other more uniquely coastal species can be found inhabiting the North West wetlands. However a few differences in the species diversity are notable, primarily because of the difference in this habitat, which is closer to the Atlantic Ocean, and the other sites under review. The inclusion of species such as the scarlet ibis (*Eudocimus ruber*), American flamingo (*Phoenicopterus ruber*), brown pelican (*Pelecanus occidentalis*) and magnificent frigatebird (*Fregata magnificens*). Other species include ducks, hawks and eagles, herons, jacanas, swallows, kingfishers, terns, sandpipers, ibises, anhingas and Neotropical cormorants, and black skimmers. Most of the aquatic birds observed within this area depend on this wetland ecosystem for their breeding, roosting and/or foraging.

The attractive scarlet ibis, seemingly appearing as a large, brilliant red patch on mud flats and shallow marshes, aggregate in large flocks. These wetlands are important habitats providing sites for nesting and feeding for this ibis. The magnificent frigatebirds are coastal birds mainly seen soaring over the ocean; however they breed on shore within areas such as mangrove swamps.

The black skimmers (*Rynchops niger*), one of the species known to the North West wetlands, are extremely dependent on wetland ecosystems for their foraging, breeding and roosting. These are birds known for their extraordinary foraging ability and specialized beak, since they are able to submerge their beaks and snap up fish or crustaceans while skimming over the surface of waterbodies. Though they are aquatic birds they do not dive or swim; they however use their sense of touch (with their bills) to locate and catch their prey.

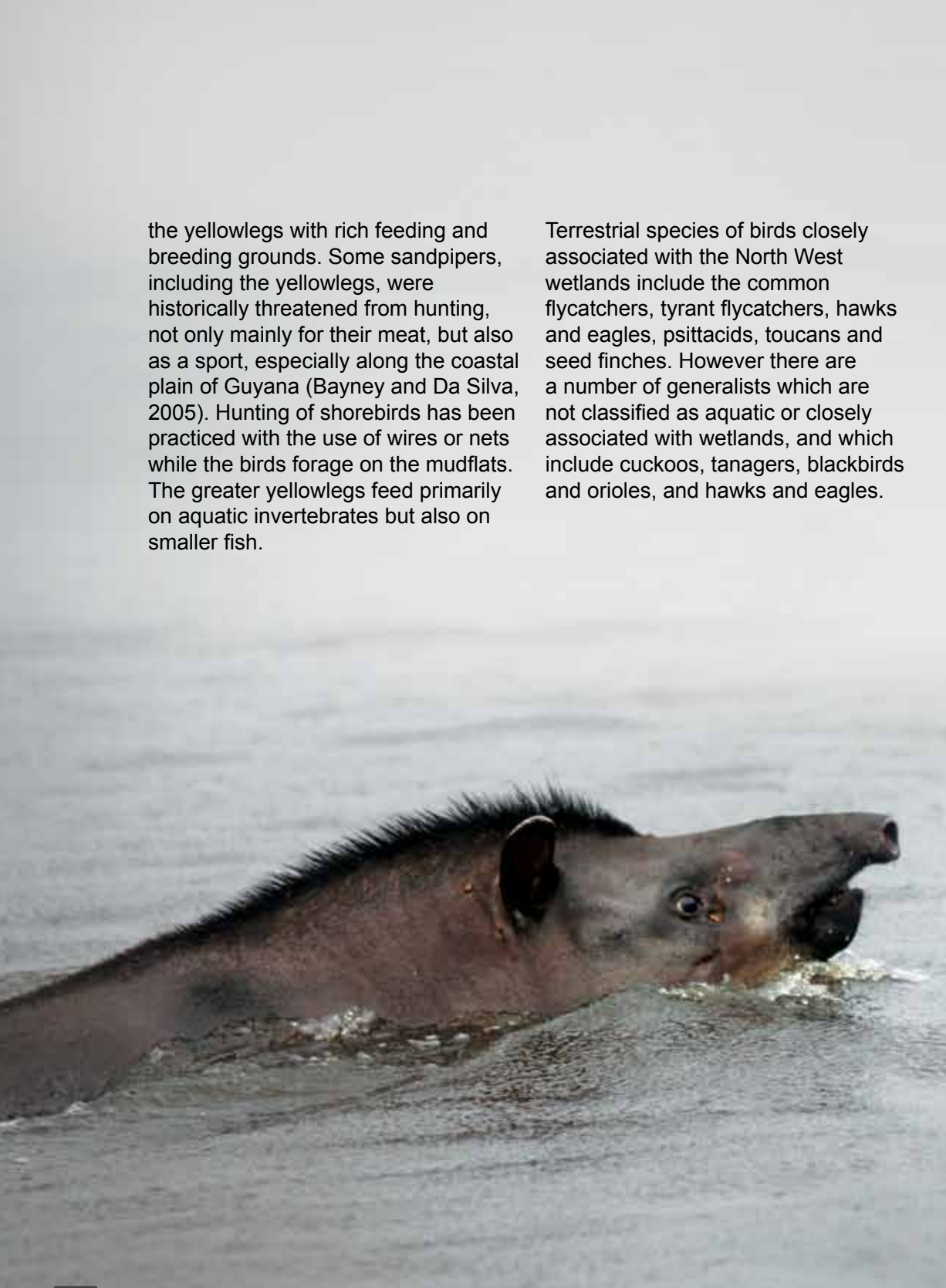
Ospreys (*Pandion haliaetus*) also occur in this wetland; they are primarily reliant on this wetland for their food, since their diet consists entirely of fish. The osprey soars high above the open wetlands, and once it spots a fish prey, even under water, it swoops down to grab with suitably adapted claws.

One of the migratory shorebirds, the greater yellowlegs, (*Tringa melanoleuca*), also occurs in the North West wetlands. These wetlands serve

Scarlet ibis (Eudocimus ruber) and snowy egrets (Egretta thula) *© WWF-Guianas / Waldyke Prince*

the yellowlegs with rich feeding and breeding grounds. Some sandpipers, including the yellowlegs, were historically threatened from hunting, not only mainly for their meat, but also as a sport, especially along the coastal plain of Guyana (Bayney and Da Silva, 2005). Hunting of shorebirds has been practiced with the use of wires or nets while the birds forage on the mudflats. The greater yellowlegs feed primarily on aquatic invertebrates but also on smaller fish.

Terrestrial species of birds closely associated with the North West wetlands include the common flycatchers, tyrant flycatchers, hawks and eagles, psittacids, toucans and seed finches. However there are a number of generalists which are not classified as aquatic or closely associated with wetlands, and which include cuckoos, tanagers, blackbirds and orioles, and hawks and eagles.



Tapir, locally known as the bush cow (Tapirus terrestris) *© WWF-Guianas / Aiesha Williams*

3.5.5.3 Other vertebrates *(mammals, amphibians and reptiles)*

Importantly, a few of the resident aquatic mammals within the wetlands of the North West area include some globally endangered or vulnerable species (according to CITES and/ or the IUCN Redlist): the Neotropical and giant otters (*Lontra longicaudis* and *Pteronura brasiliensis*), and manatees (*Trichechus manatus*). Other aquatic mammals such as capybaras, the world's largest rodent, and river dolphins (*Inia geoffrensis*), the world's largest river dolphin, are also found here. The herpetofauna include a number of snakes, frogs, caiman, and turtles especially. Some of these species are the spectacled caiman (*Caiman crocodilus*), Amazon tree boa (*Corallus hortulanus*), green anaconda (*Eunectes murinus*), cat-eyed snake (*Imatodes* spp.), labaria turtle (*Rhinoclemmys punctularia*), tree frogs (*Scinax rubra*), *Hyla* sp., and the smoky jungle frog (*Leptodactylus pentadactylus*).

A notable mammal species of this wetland, being the world's largest river dolphin, furthermore not found widespread in Guyana, is the charismatic river dolphin (*Inia geoffrensis*). They feed especially on bottom-feeding fish, and occasionally small turtles and crabs. River dolphins, in general, are globally threatened; however they are relatively frequently seen within the North West waterways, especially by residents.

Additionally, globally endangered sea turtles nest on the beaches annually, more so the leatherback and green sea turtles, and less frequently the hawks bill and olive ridley. These turtles use only the beaches of the north-west coastline of Guyana to nest; none of the other sections of Guyana's coastline are nesting sites. Female leatherback sea turtles (*Dermochelys coriacea*) are the most "famous" reptiles and most frequent sea turtle visitors to the shelly beaches of the North West brackish swamp. They have a wider distribution than any other reptile, since they migrate over long distances to nest, mature and feed. The nesting female leatherbacks and their hatchlings have made Shell Beach an important and unique area in Guyana, since this is the only location in the country favoured for the annual turtle nesting season. Hatchlings' contribute to the wetlands ecosystem as part of the food chain, since the hatchlings are consumed by birds, reptiles and fish that inhabit the wetlands of Shell Beach.

Another significant species of turtle is the spot-legged turtle, locally known as the labaria turtle. This species is dependent on a range of wetland habitats, being found both in freshwater and brackish habitats, especially along the coastal plain (Wariss, Isaac, and Pezzuti, 2012).

They are dependent on these ecosystems for reproduction, feeding and growth. This dependency can be seen especially in their movements and use of aquatic habitats, even with the seasonal changes in weather conditions and consequently the natural changes in the wetlands.

Interestingly, the reproductive activities of the smoky jungle frog depend on aquatic conditions (World Association of Zoos and Aquariums, WAZA). Reproduction takes place in temporary waterbodies where the mating frogs release eggs and sperm simultaneously; the male also forms a foam nest. The tadpoles are further developed in ponds or lakes.

Terrestrial species of vertebrates in these wetlands include deer, tapir, rodents, peccaries, and some species of cats, primates and paca.

3.5.5.4 Macro-invertebrates

Common insects collected in this region include webspinners (Embioptera), mayflies (Ephemeroptera), leafhoppers (Cicadellidae), black ants (Formicidae), grasshoppers (Acrididae), long-horned grasshoppers (Tettigonidae), stoneflies (Plecoptera), and naiads and adults of Odonata, Coleoptera (Dytiscidae), Diptera (Calliphoridae, Culicidae, Muscidae, Simuliidae), Hemiptera (Cicadellidae, Gerridae), Hymenoptera (Formicidae), Lepidoptera (Lycaenidae) and Orthoptera (Tettigonidae); however the absence of some other prevalent aquatic insects, for example the Notonectidae (water boatman), Belostomatidae (giant water bug) and Chironomidae (bloodworm larvae) from samples of brackish water may be indicative of the effect of salinity on these insects.

The importance of aquatic insects as food items for other animals, particularly in the food webs associated with wetland environments, cannot be overemphasized. These insects fill this and other functions, to the sustenance of the wetland ecosystem. Within this site, some insects such as grasshoppers, planthoppers, leafhoppers and leaf beetles are herbivores, feeding on terrestrial vegetation, while other herbivores such as the semi-aquatic leafhopper, semi-aquatic leaf beetle, shore fly and semi-aquatic grasshopper feed on aquatic vegetation. The insects include those with chewing mouthparts, like the seed beetle, leaf beetle, weevil, grasshopper and the larvae of many butterflies and moths, and those with piercing, sucking mouthparts that suck plant sap and tissues, such as leafhopper, planthoppers and aphids. The predators can be terrestrial (for example, the ladybird beetle and robber fly), semi-aquatic (the adult damsel and dragonfly), or aquatic (diving water beetle, whirligig beetle and naiads of dragonflies and damselflies). Decomposers of both the terrestrial and aquatic kind include the darkling beetle, black fly, common housefly and ant. Other functions of insects include the scavengers (water strider and carrion fly), pollinators, which are mainly the adult Lepidoptera, adult Lycaenidae and adult carrion fly; filter feeders (aquatic dipteran larvae and mayfly naiads), and parasites (the mosquito adult). Incidentally- within this site the Culicidae (mosquitoes) were numerous, especially within the Shell Beach swamp.

In addition, two morpho species of sponges were observed at each site. These were generally colonies found on rotting logs submerged in the water. The presence of sponges is a good sign of the health of the habitat, in particular an indication that the water is free from toxins, has low turbidity and particularly low levels of suspended solids. Because of their simple biology and filter feeding behaviour, sponges would be rapidly destroyed if the levels of the above were to increase. Other aquatic and semi-aquatic invertebrates known to be found within the North West include a few species of snails and crabs.

A common dragonfly found in the freshwater lakes of the North West *© WWF-Guianas / Elroy Charles*

3.5.6 Land ownership, management and conservation

No formal conservation status exists for the North West freshwater wetlands. However the recently declared Shell Beach Protected Area (October 2011) is more coastally located, and covers almost the entire area defined here as the North West brackish section. Conservation of the freshwater wetland contributes to the maintenance of the important Shell Beach protected area.

Prior to the declaration of Shell Beach as a protected area, the Guyana Marine Turtle Conservation Society (GMTCS) was appointed as the lead agency to coordinate the activities for this area. Since its declaration, the area is under the jurisdiction of the Protected Areas Commission and Board, and a management structure for on-the-ground functioning of the protected area is to be formed, with the continued progress of protected area establishment and management in the country. A management plan for the protected area is under development, and will include the participation of the local communities surrounding and within the area, as was the case for the formation and delineation of the Protected Area.

The North West area has been a home and a resource-use area for three main groups of Amerindian peoples which include Caribs, Arawaks and Warraus; however a number of other Guyanese peoples live in or utilize the area. A number of titled and untitled Amerindian Villages and communities exist in this area; the untitled communities exist as settlements on state lands. Some of the communities include those of the Moruka Sub-Region, including Manawarin, Waramuri, Santa Rosa, and, northwards, Assakata, Warapoka, Red Hill, Almond Beach, Morawhanna, Kwabanna, Little Kaniballi, Santa Cruz, Three Brothers, Gwennie Beach and Mabaruma (see Fig. 20). The titled villages are managed by elected Village Council bodies, while the non-titled communities are managed by Senior Councils. The leadership of these villages work with the residents to maintain the resources and manage the usage within their lands, with some titled communities having rules and practices governing the use, which contributes to conservation of wetlands.

White-faced whistling duck (Dendrocygna viduata) *© WWF-Guianas / Aiesha Williams*

3.5.7
Wetland community conservation initiatives

Over the decades, through the sea turtle conservation and monitoring programmes, the message of wise use of resources and protecting vulnerable species and places have been advocated among residents and researchers and organizations working within this area.

Since its formation in 2000, most of the conservation initiatives are organized by the GMTCS in collaboration with the local communities and other conservation, funding and government institutions. Organizations/institutions such as WWF, Fauna and Flora International, the Environmental Protection Agency, the KfW Development Bank/GFA Consulting Group, the Ministry of Amerindian Affairs, and researchers such as Dr Peter Prichard have worked with the residents of the region especially towards the protection of the turtles and their nesting beaches. The programmes are geared around sea turtle monitoring, research, protection, education and awareness, and alternative livelihood initiatives. Community members of the area are trained and hired as Turtle Wardens to patrol the beaches annually during the turtle-nesting season to monitor the nesting turtles and nests, and to prevent poaching and attack of nests by other animals.

These efforts have continued for over a decade, and have been concentrated throughout the beaches of the now Shell Beach Protected Area in Guyana. Similar marine turtle conservation initiatives are also ongoing within Suriname and French Guiana, and other major nesting sites.

3.5.8
Anthropogenic influences and uses

With such an ecologically rich area, a number resource use and extractive activities exist and have influenced the changes and present status of the entire North West wetlands (brackish and freshwater). These include timber and NTFP harvesting (including heart of palm), fishing, hunting, farming, wildlife trapping, mining, and travel and tourism especially at Shell Beach and Almond Beach and Moruka, by both indigenous and non-indigenous peoples, both residents and non-residents. The specific influences of these activities within this specific area require further studies to measure their impact. Some of these activities are for subsistence purposes, but many are also main commercial activities. Resource use at a commercial level tends to have the most impact on the wetland resources; however there are too few studies to measure these impacts.

Mining, especially for gold, conducted in the northernmost parts of the North West region affects both the water

Dead turtle found on Shell Beach
© WWF-Guianas

A leatherback sea turtle being measured at the Shell Beach Protected Area *© WWF-Guianas / Glenny King*

quality and forest cover of the region. The effect of mining is felt both on human health and at the ecological level, destroying habitats, hydrological flow, and feeding areas in its wake. The burning of the savannah areas during the dry season, especially the south-eastern section of the area defined (Moruka swamp), also has significant influence on the biodiversity of the region, but this is both positive and negative. It is believed that this seasonal burning (also naturally occurring during El Niño) has contributed to the formation of the open swamp lands and savannahs (van Andel 2003).

The principle and possibly easiest means of **travel** throughout the North West Region is by boat, since surface areas can be covered in a shorter time by boat, especially during the wet season; this is true even for flooded forest areas. Both motorized boats and paddle boats and dugout canoes are utilized; the former is operated on a commercial basis. Miners operating in Region 1 access the mining areas and transport their materials via the waterways of this area also.

Though the area experiences some amount of **nature-based tourism** seasonally, this region is however not yet a major tourism destination. The area however certainly has the potential to attract tourists, once marketed and prepared for such. At present this region is utilized for recreation by primarily residents of the local communities, but former residents also return for visits. One of the locally known and very much anticipated events within the Region is the annual Moruka Day Celebration (March/April), which is marked by a number of aquatic sporting competitions and cultural events. All the communities of the Moruka sub-region participate in this event, and a number of non-residents and holidaying Guyanese emigrants formerly from the region visit the area during this time. The Shell Beach area also experiences a small amount of nature tourists who visit the beaches during the sea turtle nesting season. A limited amount of bird watchers also tour the area. As an interesting note, the Assakata Lake is reputed to “explode” at least twice per year, and as a result of these seasonal “explosions”, the lake becomes cleared of all debris. The villagers rarely use the lake for fishing, but access to the lake is facilitated for visitors as an occasional tourist activity.

Shell Beach *© WWF-Guianas / Aiesha Williams*

The harvesting of non-timber forest products, mainly seeds, fruits, lianas and palm fronds, at primarily subsistence level with occasional sale, poses limited damage to the ecosystem. The heart of palm harvesting of the manicole palm (*Euterpe oleracea*) is however commercial, and is one of the main sources of income for many residents, especially in the northernmost communities, including Assakata, Red Hill, Kariabo, Warapoka, Kamwatta, Little Kaniballi and Kwabanna (Allan 2002). The local residents normally harvest and supply Amazon Caribbean (Guyana) Limited Company (AMCAR), with the harvest mainly in exchange for foodstuff and clothing – equivalent to the monetary value of the number of palm hearts supplied. Since the entire tree has to be cut, this trade threatens the habitat and feeding grounds of many species of birds and mammals. Many of the faunal species which depend on the palms are also harvested for trade and domestic consumption. Some of these harvested species include several species of macaws and parrots, primates, as well as tapirs (*Tapirus terrestris*), capybaras (*Hydrochaeris hydrochaeris*), labbas/pacas (*Cuniculus paca*), red brocket “savannah” deer (*Mazama americana*), red-rumped agoutis (*Dasyprocta leporina*), nine-banded armadillos (*Dasypus novemcinctus*), red-footed tortoises (*Geochelone carbonaria*) and the green iguana (*Iguana iguana*).

Fishing is a very important livelihood activity for the residents of the wider North West region. It provides an invaluable and reliable source of protein. Some residents within communities closer to more commercial zones however have reduced their own fishing activities, and now purchase fish from fishers of other villages. Usually residents fish within the smaller tributaries and sub-tributaries of the Moruka River, Upper Waini, Baramanni River and other waterways, and the ponds and pools within the flooded savannahs. There are reports of reduced fish catches and fishers having to travel farther afield to fish. Large-scale commercial fishing, mainly by non-locals but also local fishers, is practiced mainly out in the Atlantic Ocean off the North West sea-coast, where many of the threats to sea turtles occur. The harvesting or slaughter of nestling turtles and the poaching of eggs from nests along beaches threaten the sea turtles.

For residents of these areas, the flooding of farms, businesses and residential areas, and the spin-off economic and health effects are the main complaints.

Heart of Palm assembled just after harvesting *© WWF-Guianas / Aiesha Williams*

3.6

SITE 6 – RUPUNUNI (NORTH AND SOUTH-CENTRAL) WETLANDS

Sample sites: Surama , Surama Village; Airstrip Pond, near Karanambu; Oma Pond, Yakarinta Village; Devil Pond, Kwatamang Community, Annai Sub-district; Grass Pond, Rewa Village; Sand Creek Pond, Sand Creek Village; and Itch Pond, Shulinab Village.

Ecological profile

3.6.1 Location

The Rupununi wetlands cover an area of 33,218.9 square kilometres, encompassing parts of Region 8 and Region 9. This wetland represents one the richest, most diverse wetlands within Guyana.

Flooded savannah at Shulinab, Rupununi *© WWF-Guianas / Aiesha Williams*

Fig. 22: Map showing the location and hydrology of the Rupununi wetlands and watershed

3.6.2
Wetland type

The Rupununi savannah as a singular system would be classed as a Ramsar Type P (seasonal/ intermittent freshwater lakes), since the area floods on an annual basis, interconnecting various scattered wet areas and leaving only islands of higher land. During the dry season, the area is a mixture of individual wetland units which may be classed as Ramsar Types M (permanent rivers/streams/creeks), N (seasonal/ intermittent/irregular rivers/streams/ creeks), O (permanent freshwater lakes), Tp (permanent freshwater marshes/pools), P (seasonal/ intermittent freshwater lakes) and Ts (seasonal/intermittent freshwater marshes/pools).

3.6.3
Hydrogeomorphology

The Rupununi is primarily a wetland-savannah ecosystem, but also that of a seasonally flooded mixed-forest landscape, with mountain ranges connected to neighbouring Brazil, and with many rivers and creeks dissecting the area. The landscape is shaped by early plutonic and volcanic rock formations, regional metamorphism, rifting, uplifting, with oscillating periods of sedimentary deposition and erosion. The entire area is of Precambrian lowland, with the South Rupununi of the Kanuku Formation and the North of the Takatu Formation (Daniel 2001; Watkins and Oxford 2010). The north and south savannahs are separated by the Kanuku Mountains. All mountains in the Rupununi landscape are rock outcrops with enough soil cover to support the plant life seen on them.

The Rupununi wetlands are a collection of permanent ponds, lakes, oxbow lakes, rivers and creeks, as well as seasonally flooded forests and savannahs. The individual waterbodies identifiable during the dry season are a smorgasbord in geomorphology and hydrology. The soils on which these waterbodies are located include sands with gravel, earth and silt and sticky clays. Their contours and dimensions are also varied, and include small,

gently sloping depressions which can hardly be recognized as ponds in the dry season, and large lakes with steep banks by means of which the lakes' boundaries are clearly recognized.

The Rupununi region receives a mean annual rainfall of 1500-2000mm, higher towards the South (ter Steege, et al., 2000). The highest rain occurs specially during the major wet season from May to September, directly contributing to the recharge of the wetlands along with seasonal inundation of the savannahs and forests. However, it is the run-off from the surrounding highlands, main river channels, and in some areas the movement of ground water, which contributes most significantly to the recharge of the Rupununi wetlands. In some cases the run-off comes directly into isolated wetlands, and in other areas it comes indirectly through water courses of various dimensions. The major river systems contributing to the Rupununi wetlands are the Essequibo, Rupununi, Rewa and Takatu rivers, with a number of tributaries (see Fig.22). During the wet seasons the Rupununi wetlands share a connection to the Amazon River via the Takatu and Rio Branco drainage systems, which enriches the species exchange between the two systems (Watkins and Oxford, 2010; de Souza, et al., 2012). The entire Rupununi area also includes over 750 lakes, ponds and inlets.

Aerial view of Rupununi wetlands and savannahs *© WWF-Guianas / Aiesha Williams*

Table 8: Water chemistry measurements taken at four sample points within the Rupununi wetlands

Parameters	Average Values[16]	Range[17]	
		Highest	Lowest
Electrical conductivity (µS)	14.962	20.64	11.33
pH (pH)	4.1875	7.11	4.6
Temperature from pH meter (°C)	24.03333	30.1	27.7
Dissolved oxygen (%)	5.448333	7.47	4.82
Turbidity (NTU)	6.466667	9.7	3.3
Total dissolved solids – TDS (mg/L)	2.473333	7.42	5.24
Visibility depth (cm)	15.625	102.75	31.25
Salinity %	0	0.01	0

The waterbodies sampled during the field study included three clear-, two white- and one brown-coloured ("black water") water ponds, in the North and South Central savannahs. As expected, the pH at the brown-water location, Grass Pond, was mildly acidic (4.60), and neutral at the other sites (range from 6.03–7.11). Dissolved oxygen was generally within the expected range at all location (overall range 4.82–7.47mg/L) and lowest at Grass Pond also. Electrical conductivity (11.33–20.64 µS), total dissolved solids (5.24–7.42 mg/L) and turbidity (3.3–9.7 NTU) were all low and within expected ranges. Similar results were reflected in the much broader-scale monitoring of the entire North Rupununi wetlands under the 2003 – 2006 Darwin Initiative-funded project, "Sustainable Management of the Rupununi: linking people, wildlife and environment."

Members of the wetlands field team sampling in the Rupununi *© WWF-Guianas / Waldyke Prince*

[16] Average values across the four sample points within the wetland site
[17] Minimum and maximum values across the four sample points within the wetlands site

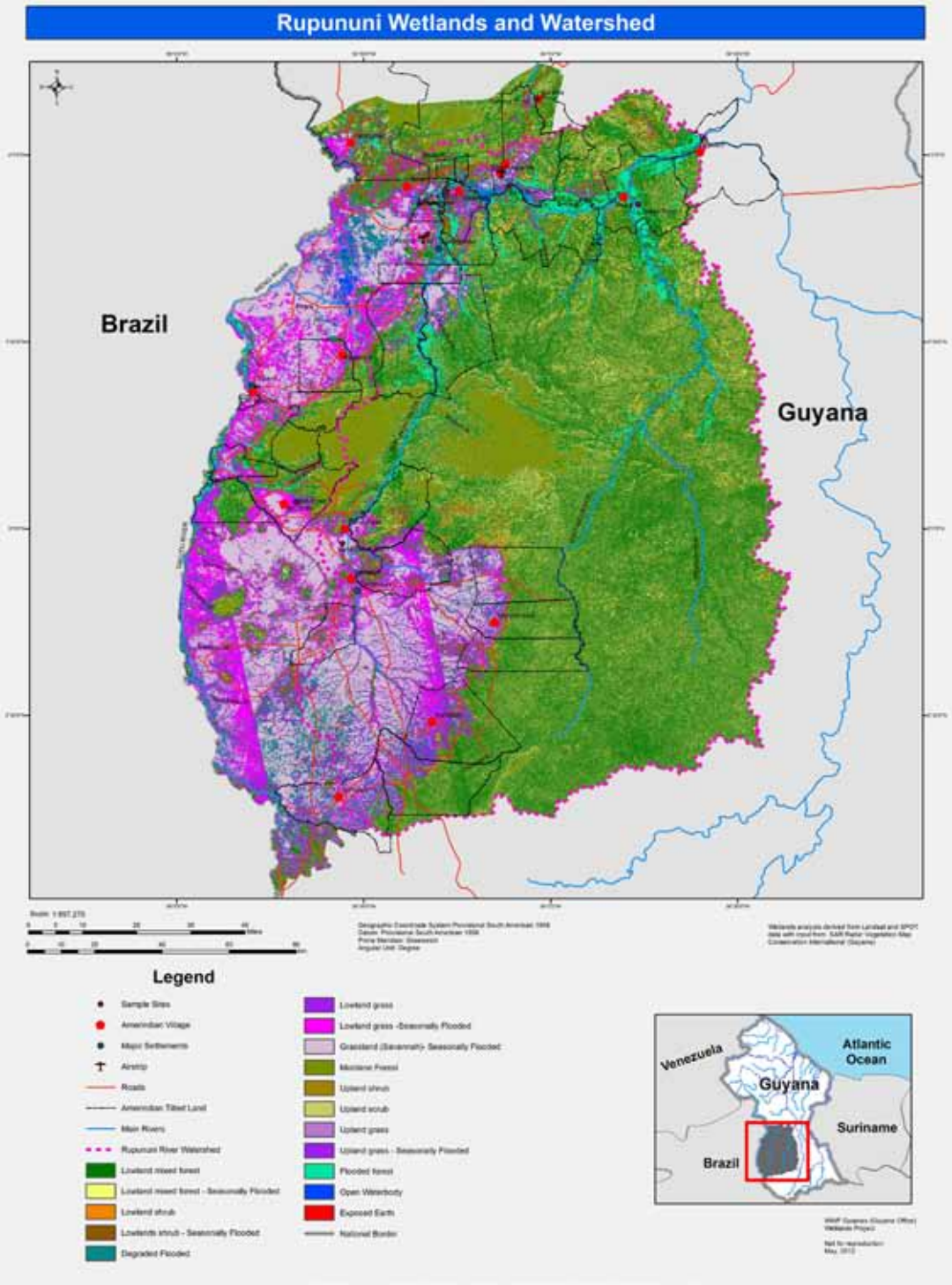


Fig. 23: Map showing the vegetation and land cover types of the Rupununi wetlands and watershed

3.6.4 Vegetation cover

The Rupununi wetlands are made up of a combination of seasonal tropical lowland forest, savannahs and wetland vegetation types. Savannah areas are covered with grasses and shrubs, with scattered, large tree species, or clumps of trees called “bush islands”. The forested areas are covered with seasonally flooded, tropical mixed forests, although there are smaller patches of swamp forests populated mainly with palms, especially closer to waterbodies.

Some of the more notable tree species of this area are greenheart (*Chlorocardium rodiei*), one of the most hard and durable woods, native to northern parts of South America, primarily Guyana; crabwood (*Carapa guianensis*), of important medicinal value, as well as of importance as part of the diet of many wetland species, and the rosewood (*Aniba rosaeodora*) which is listed as endangered by the IUCN, and as being wiped out in French Guiana between 1910 and 1930 (IUCN). Other notable tree species found are the *Eschweilera fanshawei* also native to Guyana, *Eschweilera potaroensis*, endemic to Guyana, the timber species *Pouteria penicillata*, wallaba (*Eperua* spp.), mora (*Mora excelsa*), silverballi (*Ocotea* spp.), bullet wood (*Manilkara bidentata*), and the important food species kokerite (*Attalea regia*), Ité palm (*Mauritia flexuosa*) and arapipi (*Astrocaryum jauari*). Some of these species line the edges of permanent or seasonal waterbodies, and of course populate the forested areas.

The seasonally flooded savannah consists mainly of grasses interspersed with shrubs and bush islands of major tree species and/or palms. According to Daniel (2001), the grasses *Trachypogon plumosus* and *Andropogon angustatus* are the most dominant, while occasionally scattered among the grasses are shrubs such as the *Curatella americana*, known locally as the “caimbé” or “sandpaper tree”, the huria or nance, *Byrsonima crassifolia*, *Plumeria inodora* and Mystaceae. Closer to waterbodies within the savannahs, palms such as Ité palms and the razor grasses (*Seleria* spp.) are primarily found.

The aquatic vegetation within waterbodies is also diverse and includes emergents, which would include many of the palms and other tree species, as well as the floating and submerged types of vegetative cover. Some of the floating and submerged aquatic vegetation include giant Amazonian water lilies (*Victoria Amazonica*), floating grasses, Nymphaea (small lilies), water hyacinths, bisi-bisi, and spike rushes.

3.6.5 Faunal Species

3.6.5.1 Fish

The Rupununi, well known for fish diversity, is the spawning area for fish species migrating from the Essequibo and Rupununi Rivers. De Souza, et al (2012) recorded 433 species, 13 orders, and 41 families (during 2002, 2003, 2005 and 2007),

Jabiru stork (Jabiru mycteria) © WWF-Guianas / Aiesha Williams

with the more dominant species being Characiformes, Siluriformes, Perciformes and Gymnotiformes (see Appendix 2). The WWF 2011 field study however only yielded 64 species with 56 genera, 23 families and 6 orders, owing to the rapid nature of survey (see Appendix 2). This area shows a significant diversity of fish, possibly the most important for South America due to the seasonal connection to the Amazon and the diverse habitats Watkins and Oxford, 2010. With respect to endemics, the catfishes - *Peckoltia braueri*, *Hypancistrus* sp., *Typhlobelus* sp., *Panaque* sp., and *Peckoltia cavatica* are found within the Rupununi region and in no other location in Guyana. The highly endangered *Arapaima gigas*, one of the largest, scaled freshwater fish in the world, is also endemic to this region of Guyana.

Across the Rupununi region, there is a good representation of species from the various feeding guilds, with the expected dominance of the general carnivores such as *Hoplias malabaricus* and *Pygocentrus nattereri* and only a few planktivores (*Anchoviella* sp).

Many of the species of the Rupununi wetlands are valuable for food, the pet trade and sport fishing. The only species of conservation value is the *Arapaima gigas*, for which the North Rupununi communities have developed and implemented (to some extent) a management plan for the species. However, on the grounds of uniqueness alone, the entire area is valuable for conservation.

3.6.5.2 Aquatic birds

Approximately 643 species of birds inhabit the Rupununi, a number of which are endemic to the Guianas, showing a high diversity when compared with the total species count for the whole of Guyana (more than 800 species). A number of these are considered species of Important Bird Areas (IBAs) by Birdlife International. The waterfowl of the Rupununi include ducks, herons, gallinules, kingfishers, ibises, terns, swallows, kites, storks, grebes and a few specific species such as the Neotropical cormorant, anhinga, black skimmer and osprey.

Among some of the more attractive species the Jaburi Stork (*Jabiru mycteria*), a CITES Appendix I species (prohibited for trade), is the largest wetland bird of South America. Jabirus are easily seen in open wetland areas like the Rupununi, either striding across shallow waters or savannahs, or flying above waterbodies with their expansive wings. Largely dependent on wetland ecosystems, they forage mainly by wading in shallow water, feeding primarily on fish, aquatic macro-invertebrates, molluscs and small amphibians.

The maguari stork (*Ciconia maguari*), another notable species dependent on this wetland, feeds on frogs, crustaceans, small reptiles such as caiman hatchlings, and small-sized fish. These storks feed in shallow water and in temporary pools as the water diminishes. The purple gallinule

and grey-necked wood-rail inhabit the lakes and ponds, and are primarily insectivores. Waterfowl such as ducks prefer dry land rather than the water. They have shorter beaks which make it easier to feed on grass, aquatic weeds and aquatic invertebrates, which are quite abundant in the wetlands.

A number of raptors are also found within the Rupununi wetlands, which include the black-collared hawk (*Busarellus nigricollis*), osprey (*Pandion haliaetus*), slender-billed kite (*Helicolestes hamatus*), and snail kite (*Rostrhamus sociabilis*). These birds prey on fish and reptiles, and the laughing falcon is a specialist: a snake-eating raptor. The caracaras are scavengers and invertebrate consumers. The kites, with the exception of the snail kite, feed mainly on insects and small vertebrates, helping to control their populations. Snail kites feed exclusively on apple snails of mainly the Poaceae species. As previously described, they possess specially modified bills, like a natural toolkit, to extract the soft body of the snail out of its shell, leaving the shell intact. Thus, they can be termed as the keystone predator for these snails, and are crucial in controlling the populations of these species of snails within the lakes and other wetlands of the Rupununi area.

A few migratory species also inhabit these wetlands, including the least tern (*Sterna antillarum*), spotted sandpiper (*Actitis macularius*), osprey, piratic flycatcher (*Legatus leucophaius*), tropical kingbird (*Tyrannus melancholicus*), and fork-tailed flycatcher (*Tyrannus savanna*).

Toucans, parrots, parakeets and macaws, some raptors, over a dozen species of flycatchers, tyrant flycatchers, antbirds, cuckoos, swallows, woodcreepers, wrens, swifts, woodpeckers and other groups inhabit the Rupununi area. The raptors include the gigantic harpy eagle (*Harpia harpyja*), crested eagle (*Morphnus guianensis*), king vulture (*Sarcoramphus papa*), and yellow-headed vultures (*Cathartes* sp.). Vultures, eagles and caracaras, being carrion eaters and scavengers, act mainly as carrion disposers. The foraging behaviour and diet of such birds, along with the role of several species of invertebrates such as millipedes (decomposers) are very vital for the health of the wetlands ecosystems.

3.6.5.3 Other vertebrates *(mammals, amphibians and reptiles)*

The keystone aquatic mammals within the wetlands of the Rupununi are the giant river otter and the Neotropical river otter. These species are major fish predators and help to regulate the populations of several species of fishes. The giant river otter is classified as **Endangered** by the IUCN, and listed on Appendix 1

Black skimmer (Rynchops niger) *© WWF-Guianas / Waldyke Prince*

(**Most Endangered**) by CITES, the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The Neotropical otter is classified as **Threatened** by the IUCN.

The herbivorous aquatic mammal, the capybara (*Hydrochaeris hydrochaeris*) is also found within this wetland. In addition all four of the species of caimans in Guyana are found in the Rupununi; these are the black caiman (*Melanosuchus niger*), spectacled caiman (*Caiman crocodilus*), and two species of dwarf-caimans; Schneider's (*Paleosuchus trigonatus*) and Cuvier's (*Paleosuchus palpebrosus*). The caimans are one of the aquatic species pivotal to keeping these aquatic ecosystems healthy and balanced; similarly the caiman depends on the wetland ecosystem at every part of its life stage. The presence of such diversity of caimans, as one of the top predators of freshwater wetland systems, reflects the health and richness of the Rupununi wetlands.

Black caimans, a CITES Appendix I species, are found widespread within the Rupununi wetlands, especially to the North. Their diet is made up of a range of both aquatic and terrestrial species. A young black caiman's diet is similar to that of all crocodilians, and includes small vertebrates such as fish and frogs, and aquatic macro-invertebrates. Adult black caimans prey on animals as large as the capybara. Carrion is also consumed willingly by caiman- of all sizes. The black caiman has an extremely important role in the Rupununi ecosystem, and its loss would have far-reaching negative implications for the ecological balance of the Rupununi ecosystems.

The Rupununi waterbodies are also inhabited by several species of aquatic turtles, including the **Threatened** (IUCN) giant river turtle (*Podocnemis expansa*), and yellow-headed river turtle (*Podocnemis unifilis*). The river turtles are both predators and scavengers, feeding on carcasses of small-sized vertebrates. Their reproductive behaviour and survival are dependent largely on the seasonal variations occurring in these wetlands. As with most aquatic turtles, the river turtles depend on the sandy river banks to lay and hatch their eggs in, hence during extreme weather patterns causing longer periods of overtopping of banks, turtle reproduction and survival are threatened. Turtle laying and hatching on sandy river banks also expose them

Red brocket deer (Mazama americana) *© WWF-Guianas / Aiesha Williams*

Black caiman (Melanosuchus niger) *© WWF-Guianas / Waldyke Prince*

to raiding of nests both by humans and animals.

There are a number of other important aquatic species of turtles, snakes, frogs and other herpetofaunal species within the Rupununi wetlands.

There are as well a number of terrestrial mammal species inhabiting this region, ranging from all eight species of Guyana primates, rodents, the ungulates including two deer, the Brazilian tapir, to six species of cats including the jaguar.

3.6.5.4 Macro-invertebrates

Some of the aquatic macro-invertebrates encountered within the Rupununi wetlands are freshwater shrimp, family Palaemonidae (Crustacea: Decapoda) and crabs of the family Pseudothelphusidae (Decapoda), snails of the genus *Aylacostoma* (Gastropoda: Thiaridae). These snails are known from areas with clear, flowing water and high oxygen content. Additionally, two species of freshwater clams, *Castalia* sp. and *Paxyodon* sp. (Hyriidae), were observed particularly at Surama Pond and Oma Pond.

With respect to the insect groups, 64 families were recorded. The total aquatic and semi-aquatic families numbered 11, with the most notable aquatic families being the diving water beetle, (Dytiscidae), the whirligig beetle (Gyrnidae), the water beetle (Hydrophilidae), the water stick insect (Nepidae), the water skater (Gerridae), the dipteran and coleopteran larvae, and the naiads of Odonata and Ephemeroptera. The largest proportion of families (56%) collected were associated with the wetland ecosystem; however, few species among these families were semi-aquatic.

Common groups that were collected from most areas included Coleoptera: Chrysomelidae, Alticinae (flea beetle), Eumolpinae (leaf beetle), Coccinellidae (ladybird), Diptera: Culicidae (mosquito), Syrphidae (hoverfly), Ephemeroptera: Baetidae (mayfly), Hemiptera: Cicadellidae (leafhopper), Gerridae (water skater), Hymenoptera: Formicidae (ants), Odonata (damselfly) and Orthoptera: Acrididae (grasshopper).

A large number of groups were herbivorous, feeding on plant tissues such as leaves, stems or flowers. Predators also dominate this area; for example, the ladybird beetle, a predator of Sternorrhyncha (aphids, whiteflies, scales, mealybugs), was prevalent within this area, near the edges of ponds or lakes. Other predators include those that feed on aquatic dipteran larvae and are also fed upon by fishes.

3.6.6
Land ownership, management and conservation

The Rupununi wetlands have not formally been designated with any conservation status; however the North Rupununi Wetlands area was prioritized as a proposed Ramsar Site, once the country becomes a signatory to the Convention. The Iwokrama Rain Forest Reserve, established under the Iwokrama Act in 1996, and the Kanuku Mountains Protected Area (KMPA), declared under the Protected Areas Act in 2011, are respectively located on the periphery and within the area defined here. Iwokrama is approximately 3,600km^2, (371,000 hectares or 1.6% of Guyana's land mass), and is dedicated by the government of Guyana to the global community for research into the sustainable management and utilization of tropical rainforest for the benefit of Guyana and the international community. The exact demarcation of the KMPA is being worked out; the area is approximately 5,000km^2, with Conservation International-Guyana acting as the lead agency during the planning and consultation process prior to the PA establishment.

Apart from the two protected areas, there are also the titled lands of more than thirty Amerindian Villages with their respective elected Village Councils. In addition, the North Rupununi District Development

Aerial view of Iwokrama Field Station/River Lodge *© WWF-Guianas / Aiesha Williams*

Board (NRDDB) and the Kanuku Mountain Community Representative Group (KMCRG) have established community organizations which manage the affairs of the communities of the North Rupununi (associated with Iwokrama), and the South Rupununi (associated with KMPA). Both organizations provide forums for discussions and decision-making among village leaders, and with external bodies such as international conservation organizations. These communities are made up of primarily Makushi and Wapishana, and, to a lesser extent, Arawak Amerindian peoples.

These non-governmental and community-based institutions, along with the relevant government agencies and local and international NGOs and funding institutions such as WWF-Guianas and the Karanambu Trust, work together for the conservation of the broader area. Many of these efforts are wetlands management initiatives, especially within the North Rupununi area.

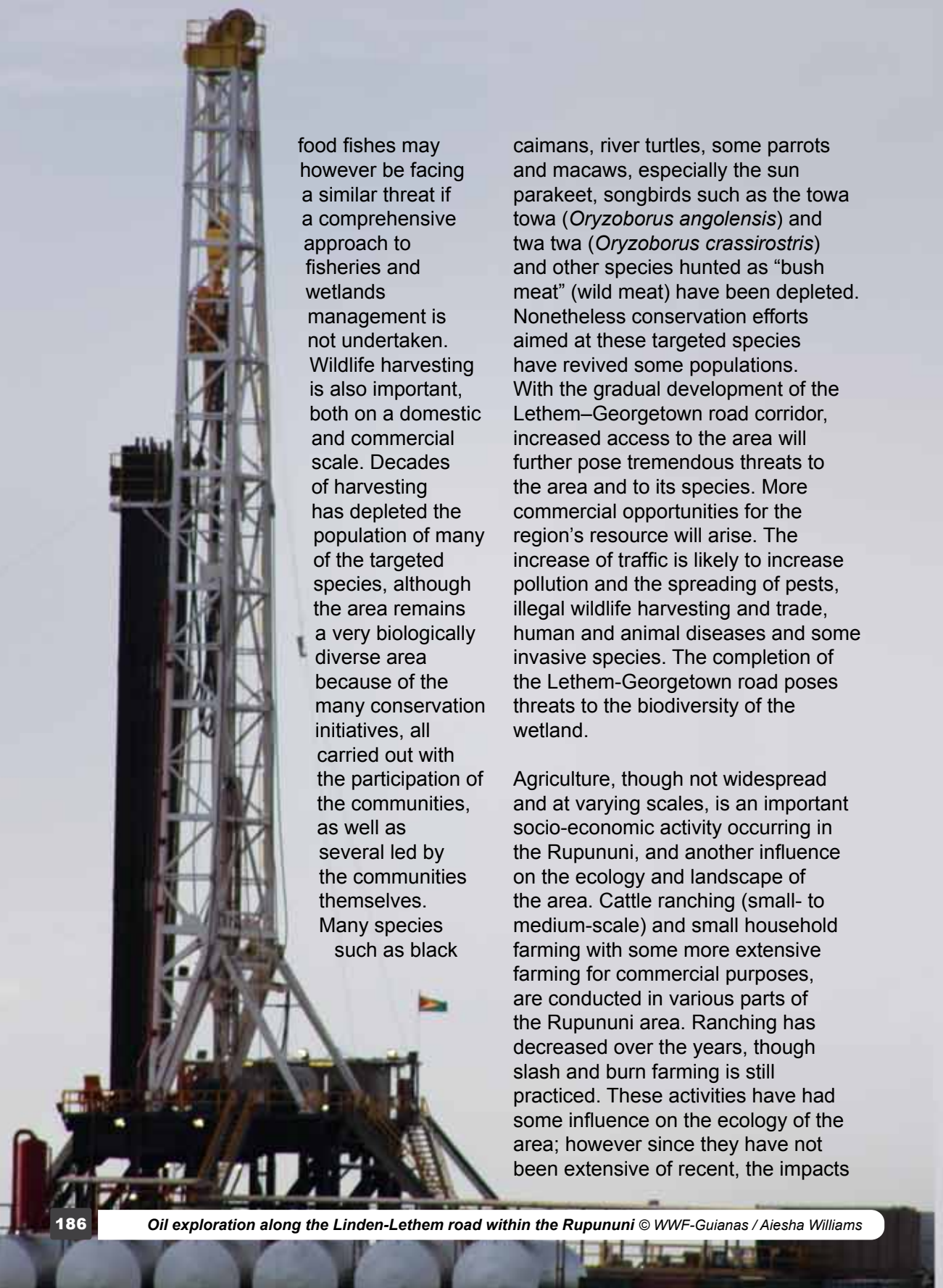
3.6.7 Wetland community conservation initiatives

There are a number of community conservation initiatives which contribute to the maintenance and management of this diverse area. These initiatives are managed by community groups, organizations and the respective Village Councils of the Rupununi, often in collaboration with conservation organizations and donors, along with the relevant government agencies. Some of these wetlands conservation initiatives include those that target particular aquatic species such as the black caiman, river turtles, arapaima and other fish species, and giant otters. However there are also initiatives which work at the ecosystem or sub-ecosystem level, such as the North Rupununi Adaptive Management Plan (NRAMP) initiative, and the community-based conservation programmes of the Iwokrama International Centre, Karanambu Trust and Conservation International. Organizations like WWF-Guianas, the IUCN, and a number of research institutions and universities support the conservation work of this important area. The projects and initiatives over the years have been innumerable, and may have exceeded any other single location in Guyana, contributing to the maintenance of the biodiversity of the area and the existing collection of data and resources.

3.6.8 Anthropogenic influences and uses

With the high diversity of fish species, fishing is a main livelihood and to some extent an economic activity of the Rupununi wetlands. Decades ago, commercial harvesting of the arapaima fish, to supply both the Rupununi but primarily the Brazilian market, had driven the Arapaima population to endangered status. The species is now protected, and a management plan has been passed to ensure monitoring and regulated harvesting by residents. Some other

Researchers (residents of Rupununi communities) during river turtle monitoring, measuring distance of turtle nests from water's edge *© Lakeram Haynes*



food fishes may however be facing a similar threat if a comprehensive approach to fisheries and wetlands management is not undertaken. Wildlife harvesting is also important, both on a domestic and commercial scale. Decades of harvesting has depleted the population of many of the targeted species, although the area remains a very biologically diverse area because of the many conservation initiatives, all carried out with the participation of the communities, as well as several led by the communities themselves. Many species such as black caimans, river turtles, some parrots and macaws, especially the sun parakeet, songbirds such as the towa towa (*Oryzoborus angolensis*) and twa twa (*Oryzoborus crassirostris*) and other species hunted as "bush meat" (wild meat) have been depleted. Nonetheless conservation efforts aimed at these targeted species have revived some populations. With the gradual development of the Lethem–Georgetown road corridor, increased access to the area will further pose tremendous threats to the area and to its species. More commercial opportunities for the region's resource will arise. The increase of traffic is likely to increase pollution and the spreading of pests, illegal wildlife harvesting and trade, human and animal diseases and some invasive species. The completion of the Lethem-Georgetown road poses threats to the biodiversity of the wetland.

Agriculture, though not widespread and at varying scales, is an important socio-economic activity occurring in the Rupununi, and another influence on the ecology and landscape of the area. Cattle ranching (small- to medium-scale) and small household farming with some more extensive farming for commercial purposes, are conducted in various parts of the Rupununi area. Ranching has decreased over the years, though slash and burn farming is still practiced. These activities have had some influence on the ecology of the area; however since they have not been extensive of recent, the impacts may be minimal. Rice cultivation, along with petroleum drilling and gold mining, are being explored, and may be emergent industries in the Rupununi. Such industries will pose major ecological pressures, especially associated hydrological consequences and associated human immigration issues, and also social and health risks. The impacts include land and water pollution, disruption of hydrological flow, seasonal variations and habitat loss.

Oil exploration along the Linden-Lethem road within the Rupununi *© WWF-Guianas / Aiesha Williams*

3.6.9 Beliefs/culture/rules linked to Rupununi wetland sites

According to Fernandes (2004), "traditional Makushi culture included seasonal rituals and festivals, parishara dances and songs and a rich folklore involving complex human-animal myths and food taboos. Although many of these beliefs and practices have faded, a significant amount of Makushi culture is retained today in the remnants of the local folklore among the Rupununi communities."

Arapaima (or Warapa in Makushi) (which is an endangered species of the North Rupununi wetland), plays a large part in the folklore, with a number of myths and taboos related to the species. Fernandes (2005) reports that, "the most frequently mentioned belief was that the Arapaima represented an "Oma", which is a Makushi word for demon or evil spirit", a belief which though treated dismissively nowadays, was told in eleven communities. In the traditional Makushi culture, there was a supernatural belief that anyone who consumed the arapaima fish would be tormented by evil spirits, leading to illnesses such as scales and bursting sores on the skin, or they would be electrocuted by lightning. As a result, this fish was never harvested until in the 1900s, when outsiders (settlers from the coast and other indigenous groups as well as Brazilians) came and harvested the fish, at first for subsidence and later for money. Fernandes mentions that "other, less prevalent, myths spoke of the Arapaima as the 'mother and father of the fishes', or that the fish are 'like human beings because the [sic] nurse their young with milk'. The belief that the Arapaima represented the "mother and father of the fishes" is particularly interesting, since the story follows that if Arapaima are killed, the other fish would disappear from lack of care. This belief parallels understanding of the North Rupununi ecology, were [sic] the Arapaima is a top predator and a keystone aquatic species." (Fernandes, D. 2005.) There is also another belief about fish. At the beginning of the rainy season, many species of fish are known to migrate upstream to spawn. During this period of time, a Makushi injunction is practiced which forbids a pregnant woman (and her partner) from participating in fishing parties. The belief is that when the fish smell the couple, they will be unable to continue their journey and thereby fulfil their biological destiny. Some of the affected fishes will then swim close to the river bed while others will even turn back from their migratory journey.

CHAPTER 4

TOWARDS THE PROTECTION OF GUYANA'S WETLANDS

Wetlands are recognised as important ecosystems not only in maintaining the well-being of the Earth globally, but simultaneously also that of a country's biodiversity and other facets, important for a country's development and its peoples' well-being. In the Guianas, WWF has given similar status to wetland landscapes. While it is true that the value of wetlands are partially known, Guyana needs to make deliberate and strategic efforts to both fully understand as well as protect the country's wetland ecosystems. The suggested recommendations below, though not exhaustive, are offered by WWF to decision-makers and stakeholders, for the protection and management of these highly important ecosystems.

Wise use of wetlands is the maintenance of their ecological character, achieved through the implementation of ecosystem approaches* within the context of sustainable development**

*Including inter alia the Convention on Biological Diversity's "Ecosystem Approach" (CBD COP5 Decision V/6) and that applied by HELCOM and OSPAR (Declaration of the First Joint Ministerial Meeting of the Helsinki and OSPAR Commissions, Bremen 25-26 June 2003).

** The phrase "in the context of sustainable development" is intended to recognize that while some wetland development is inevitable, and that many developments have important benefits to society, developments can be facilitated in sustainable ways by approaches elaborated under the convention, and it is not appropriate to imply that "development" is an objective for every wetland.

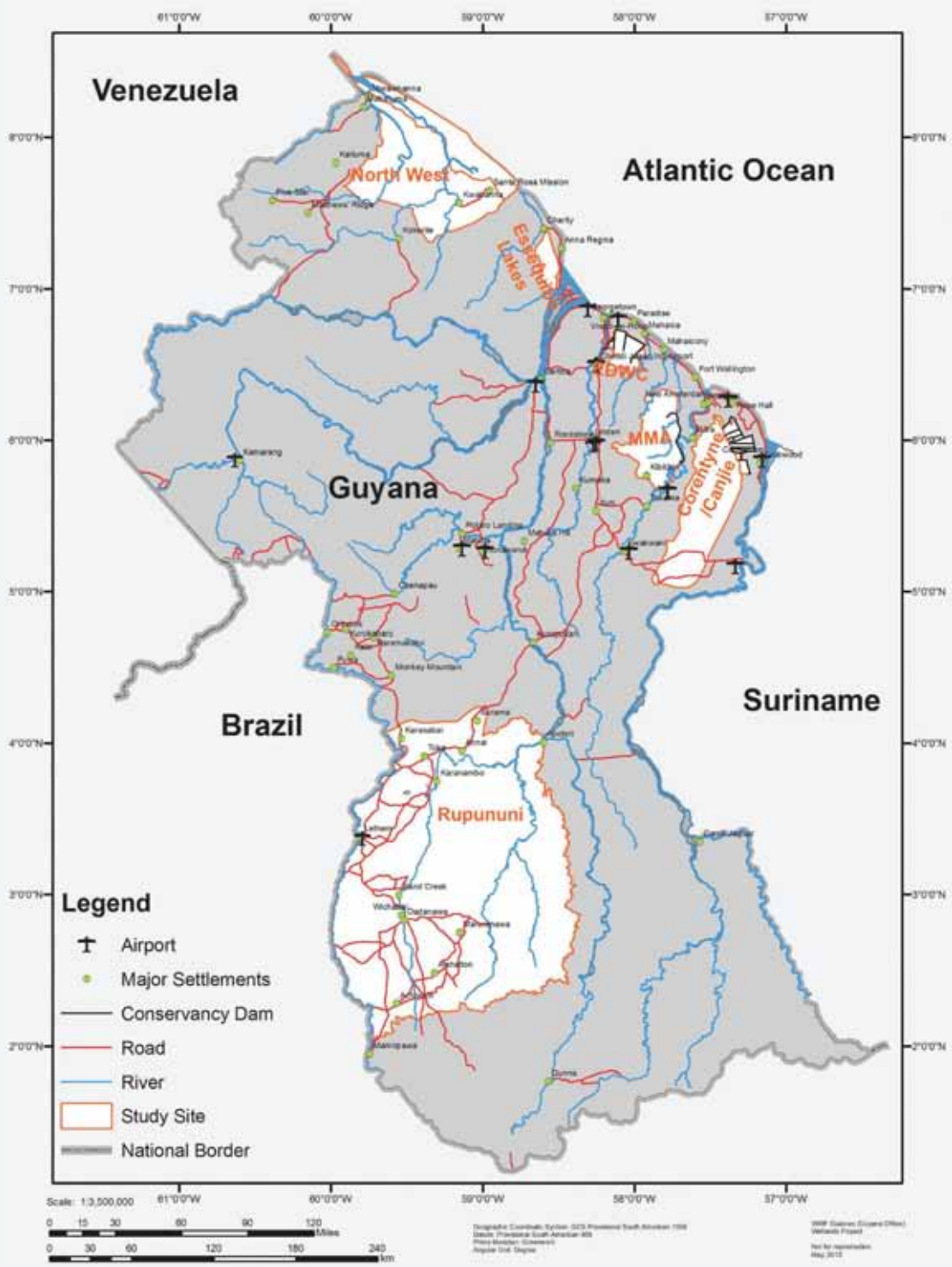


Fig. 24: Map of Guyana with major wetland sites

4.1
Protection of wetlands

Guyana's Protected Areas Act 2011 brings the country closer to being on par with its neighbours on in-situ natural resources management. At present, most of Guyana's protected areas are geared mainly towards protecting terrestrial ecosystems, though with spin-off effects of conserving water resources and species, especially in those protected areas which have sections of wetlands. The national protected areas system should however also **specifically target protection of wetland ecosystems**. Coupled with the **ratification of the Ramsar Convention on Wetlands and designation of Ramsar Sites**, a protected areas system incorporating wetlands conservation will greatly improve the protection of Guyana's wetlands. This combination, of a national framework and legislation as well as international commitments, will help to strengthen the country's wetland conservation and management efforts. The declaration of Shell Beach in 2011 as a protected area partially promoted wetlands protection; the omission, however, of more of the aquatic area from the PAS limited the wetland protection benefits. Guyana's protected areas system should seek to **incorporate more ecological criteria in the identification and demarcation of areas**. The most appropriate location and size of an area, selected with good ecological information and with socio-economic considerations, will improve the success of protected area systems in maintaining wetlands and other ecosystems and functions.

In addition, **various categories for protected areas, from strict protection to sustainable use**, should be applied to wetlands protection in Guyana. This is necessary since the country's economy and Guyana's peoples entirely depend on the exploitation of the land's natural resources for sustenance and development. Applying such an array of protection statuses for designation of various protected areas, in this case wetlands, will help to improve utilization of resources without detriment. Promotion of broad stakeholder participation, in Amerindian protected areas, and in other categories of protected areas permitting managed use within the 2011 Protected Areas Act, is a facet vital and integral to areas that are protected for their wetland functions.

The Rupununi and North West wetland sites especially require such a dedicated, people-centred approach to any form of protected areas management, once designated. The Shell Beach protected area within the North West wetlands, established as a "managed resource protected area" under the Protected Areas Act 2011, and in consultation with associated local

Ringed kingfisher (Megaceryle torquata) *© WWF-Guianas / Waldyke Prince*

communities, permits recreational and "low-level ecologically sustainable activities". Though this area is small in comparison to the larger wetland area, the protected section seeks to maintain an important part of the ecosystem. There is, however, **a need to define what should be considered as ecologically sustainable activities within a legally established protected area**. These sustainable activities permitted within this protected area should not hamper or alter wetland ecosystem functions and services of the wider North West wetlands. The management system developed for Shell Beach should incorporate the invaluable wetland goods and services utilized by local peoples and the broader country, but also its dynamic hydrological characteristic, including tidal and freshwater river system influences and endangered and globally threatened species. Protecting the Rupununi wetlands is similarly vital and requires an approach which considers both the local communities' needs and the value of wetland ecosystems. Especially for those sites on the borders with Venezuela, Brazil and Suriname, it is more beneficial that a **transboundary approach** be incorporated also.

Giant river turtle (Podocnemis expansa) *© WWF-Guianas / Erlan Sleur*

4.2
Wetlands ecosystem management

In order for wetlands management in Guyana to be sustainable and effective, deliberate interventions and not merely spin-offs of terrestrial and other types of ecosystem management and conservation initiatives should be allowed to occur. Wetland ecosystems are highly sensitive to anthropogenic and other external effects, and, as one of the most biologically diverse ecosystems, need systematic and well-targeted interventions. The wetland protection benefits derived from the management and protection of other types of ecosystems may just be enough for wetlands with limited threats and pressures. However, since wetlands are naturally dynamic systems, with increased pressures and demands, it will be necessary to investigate the special characteristics of such areas and devise management systems that take account of their interconnectedness with other parts of the entire wetland system.

There are a number of existing instruments, approaches and lessons to be learnt as guidance in order to ensure effective preservation of these wetlands and their associated values and functions. These approaches span the spectrum, from strict protection to managed and wise-use initiatives. In neighbouring Suriname, for example, the concept of multiple-use management areas (MUMA) is applied to the management of some of its coastal wetlands. This idea may well be applicable to some of Guyana's wetlands, and is in need of further investigation. The Ramsar Convention on Wetlands encourages a wetlands wise-use approach for the utilization of wetland resources and its services, and as a mechanism for sustainable development (see Ramsar Mission Statement). The convention looks at wetlands management holistically, ensuring that not any one approach or mechanism is applied, but rather a combination. It also promotes management at a basin-wide scale, taking into consideration integrated river basin management, thereby maintaining all the services and resources of the entire ecosystem.

In the context of Guyana, a cross-sectoral and decentralized form of management is encouraged, ensuring that decision-making, policies and management actions are well guided and inclusive of all stakeholders. This also ensures both ecological and socio-economic benefits. Of course this wise-use approach is not without challenges, since it incorporates an all-encompassing approach to management. Guyana has limited resources, experiences and information, and these limit its capabilities and interventions on wetlands. Undertaking comprehensive wetlands management requires up-to-date and detailed information on the ecosystem, including the characteristics and services of the area. It is also necessary to have a good spread of professionals and other personnel, experienced and willing to learn wetlands wise-use approach. Financial resources are necessary as well to ensure successful interventions. These are definitely challenges posed to Guyana's efforts to maintain the wetland ecosystems and services. However, opportunities exist to support national initiatives via the Ramsar Convention and its Secretariat, which provide a suit of resources to aid the efforts of Contracting Parties. In addition, local, regional and international organizations and individuals have also shown interest in advancing wetlands management.

Many Guyanese, especially Amerindian communities, depend on wetland resources and services for their livelihood and well-being, so deliberate efforts towards wetlands management and the wise-use approach should also include local peoples. It is necessary to utilize as well as ensure that community-based initiatives and traditional ecological knowledge systems play a major role in wetlands management for Guyana. Often local communities can be the ones to initiate and lead management interventions, but certain capacities need to be enhanced to ensure success and longevity of such initiatives. The participation of local communities should be included at all levels of decision-making, including the implementation of those decisions. Appropriate mechanisms such as policies, awareness-raising and capacity building can ensure local peoples' active participation in wetlands management.

The experiences of North Rupununi communities with the support of the North Rupununi District Development Board (NRDDB) are a good example of wetlands community-based initiatives. The steps that were taken to manage the vital resource, arapaima (*Arapaima gigas*) in that wetland are worthy of emulation. Though there may be hiccups and challenges, the North Rupununi may well be the best and oldest example of community participation in resource management as a whole within Guyana. These experiences can be shared, both successes and failures, with other areas, especially throughout the wider Rupununi. The North West area has also applied some community participation as a part of management interventions. However, there needs to be much more of a concentrated effort towards wetlands management in the longer term. The Amerindian Act 2006, and other legal instruments have laid the basis for Amerindian and local community participation in the country's natural resource development and management.

As a further consideration, critical direct threats to wetlands should be readily assessed and addressed in a holistic manner, integrating people's needs, the importance, and the ecological functions of the site. For Guyana generally, gold mining, and to some extent, logging, unsustainable large-scale agriculture, and the wildlife trade pose the greatest threat to wetland resources management However, there should be detailed threat analyses to first understand the impacts on each wetland site. The threat analyses should be continuously updated, since with time and prolonged exploitation the impacts can change. Understanding the critical threats to a specific site helps to concentrate management interventions where they are most needed. Knowing the nature of the impacts of the threat can help determine the best intervention, and thereby influence a better and holistic approach, which is necessary to ensure maximum effectiveness in protecting wetlands.

National legal instruments which target wetlands and water conservation and management are also necessary to ensure deliberate efforts are aimed at maintaining this important ecosystem. Well-placed policies targeted towards the protection and conservation of Guyana's wetlands ensure that developmental activities are not to the detriment of wetlands, and careful measures are taken to conserve and protect this type of ecosystem. Where, for instance, activities such as oil and gas exploration and rice cultivation are under consideration for the Rupununi wetlands, impact assessments need to be one of the obligatory requirements for the protection of such fragile landscapes.

Designing wetland conservation objectives within national policies and devising a specific wetland protection framework, not only legislates the protection of wetland ecosystems, but also all other ecosystems and resources associated with wetlands, as well as the well-being of the national economy and local communities, since all are tied to wetlands ecosystems with their numerous functions. National legal instruments guide local and national actions for the maintenance of wetlands, which not only will have local benefits but also regional and international benefits, especially evident in the nation's achievements in international commitments. With well-designed, wetland-friendly policies, local agencies, government departments, communities and districts are legally committed to working closely. This can minimize the process of decision-making becoming isolated, which, if decisions are then not applied, will be to the detriment of wetlands and their associated functions. Legal frameworks can also create incentives for protecting and conserving wetland sites, especially for investors and developmental projects, and also community initiatives. Some existing legal instruments require review in order to maximize efforts for wetlands conservation and management.

Spectacled caiman, wide-spread throughout most wetlands of Guyana *© WWF-Guianas / Waldyke Prince*

4.3
Concentrated wetland research

Collecting detailed information on specific wetland sites and their associated functions and characteristics requires attention. From the onset research is necessary to gather baseline information and to determine the status of the site, but even as time passes and management needs increase, additional and more detailed and specific information will be required to inform management decisions. As highlighted previously, there exists limited and fragmented information on wetlands in Guyana. However, the most detailed information gathered so far has been for the Rupununi and the North West wetlands. Hence there is still much needed research work to be carried out for Guyana's wetlands. It is necessary to have an improved knowledge base on areas such as the ecological character and services, the impacts of various exploitation activities, socio-economic benefits, associated traditional knowledge, and even on what works best for site management. Such important research work will help to guide the development of approaches for management, for the types of developmental and usage activities the wetlands can tolerate, the opportunities for payments for ecosystem services and other such crucial choices. The information gathered during research no doubt enhances and supports the ability of decision-makers to manage wetlands, and becomes the basis for grounds to protect these ecosystems. Continuous monitoring is also vital to give an insight into changes occurring at the site, and the possible cause of such changes. Site monitoring can also highlight the kinds of approaches applicable and best for the site over time, and be a guide if changes in management approaches are necessary.

There are a number of research institutions, conservation organisations, grant agencies and universities interested in and willing to conduct wetland research projects. Guyana, however, needs to tap into these resources and opportunities. Further research topics also need to be identified, since not only information on the wetland areas is needed, but also on the mechanisms and facilities which are required to enable research work to take place. Also essential is addressing intellectual property rights, both in protecting researchers- local and foreign, and the sovereignty of the country's resources.

Some wetlands research topics of importance to Guyana

- Carbon stock assessments of a site
- Ecological succession in semi-natural wetlands
- Migration of fish species
- Impacts of specific exploitation activities on wetlands or the particular resource or species
- Species population trends and distribution – especially for globally endangered and traded species
- Traditional ecological knowledge related to the wetlands, species, particular communities or peoples
- Climate vulnerability and the role of particular wetlands in mitigating climate change impacts
- Extent of mercury and other forms of pollution on specific wetland ecosystems and species
- Valuation of the ecosystem benefits and services
- Site-specific, detailed inventories and assessments
- Medicinal, cosmetic and other properties of wetland species
- Status of wetlands – comparative trends
- Effectiveness of wetland management interventions

4.4
Incorporating wetlands into the low carbon development agenda

Wetlands are important reservoirs for carbon, about 14% of the terrestrial biosphere carbon pool, and should be incorporated and managed as such within any low carbon development scheme. However, at present, Guyana's Low Carbon Development Strategy (LCDS) focuses primarily on forest carbon. Wetlands not only play a role in carbon sequestration but also provide other important ecosystem services which serve in storing or preventing emissions of carbon and other gases which have a role in climate change. Draining and degradation of wetlands increase the release carbon and other forms of greenhouse gasses, thereby compromising efforts towards low carbon development. Both freshwater and marine wetlands are vital facets of the low carbon development of Guyana. Mangrove swamps also can be considered one of the most important in carbon sequestration among marine ecosystems. Wetlands help in maintaining forest ecosystems, and similarly healthy forests contribute to healthy wetlands; hence the roles of both should be examined simultaneously in carbon sequestration and Guyana's LCDS. It is therefore important to assess this important ecosystem service of Guyana's wetlands and examine its application in carbon schemes as Guyana implements its LCDS.

Gold mining within Guyana's interior areas affects wetlands and waterways *© WWF-Guianas / Aiesha Williams*

Field survey checklist for data collection

Species – Flora and Fauna

Primarily dominant aquatic species. Also specifically noting: any endemic, endangered, invasive, threatened, socio-economically important species. Identification as far as possible should be down to species level.

Fauna:

- Aquatic macro-invertebrates (insects, crustaceans, molluscs)
- Amphibians
- Fish
- Aquatic mammals
- Reptiles
- Aquatic birds

Flora:

- Bank/Shore vegetation
- Water body vegetation (floating and submerged)
- Influential surrounding vegetation (in the landscape- define distance from main water body)

Physical and hydrological features

- Source of wetland; recharge origins; outputs
- Drainage; water-flow regime; tidal influences and stream order
- Water type (black, white, clear)
- Influential catchment area/river basin

Water Quality:

- Conductivity
- Temperature
- pH
- Dissolved oxygen
- Salinity
- TDS/ TSS
- Mercury

Dimensions of major water body:
(with information on changes during season once available)

- Area (km^2)
- Width
- Length
- Depth (also water-level fluctuations)

Soil:

- Bottom substrate type: organic, sand, clay/mud, rocks
- Shoreline/ bank substrate: organic, sand, clay/mud, rocks

Climate for the general location: (from Hydromet)

- Average rainfall
- Relative humidity
- Temperature range

Other data needed in relation to the wetland:

- Settlements/ towns/villages
- Land uses (present and proposed)
- Industrial activities
- Subsistence activities
- Extraction (water and species)- commercial and subsistence
- Social and cultural values

Species List

Note: This Species List in no way represents a complete list of all species for each wetland site, but contains available data garnered through WWF's 2010-2011 field survey, and from other prior field surveys, as well as from reports of residents near the site areas.

Appendix 2 Key:

√	Indicates species presence
√*	Indicates a species recorded in previous surveys, but not during the WWF 2010-2011 wetlands field survey
X	Indicates anecdotal evidence of species presence, reported via formal and informal interviews
N/E	Status was not yet evaluated
-	Information not available or known, or not applicable

The word **'wetlands'** in the Habitat column indicates an aquatic species, with the accompanying adaptations for living in wetland ecosystems.

The word **'associated'** indicates a terrestrial species, which is however closely associated with wetland ecosystems.

IUCN term definitions summarized*:

CRITICALLY ENDANGERED - A taxon is Critically Endangered when it is facing an extremely high risk of extinction in the wild in the immediate future.

ENDANGERED - A taxon is Endangered when it is not Critically Endangered but is facing a very high risk of extinction in the wild in the near future.

VULNERABLE - A taxon is Vulnerable when it is not Critically Endangered or Endangered but is facing a high risk of extinction in the wild in the medium-term future.

LOWER RISK - A taxon is Lower Risk when it has been evaluated, does not satisfy the criteria for any of the categories Critically Endangered, Endangered or Vulnerable.

Taxa included in the Lower Risk category can be separated into three subcategories:

Conservation Dependent - Taxa which are the focus of a continuing taxon-specific or habitat-specific conservation programme targeted towards the taxon in question, the cessation of which would result in the taxon qualifying for one of the threatened categories above within a period of five years.

Near Threatened - Taxa which do not qualify for Conservation Dependent, but which are close to qualifying for Vulnerable.

Least Concern - Taxa which do not qualify for Conservation Dependent or Near Threatened.

DATA DEFICIENT - A taxon is Data Deficient when there is inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status. A taxon in this category may be well studied, and its biology well known, but appropriate data on abundance and/or distribution is lacking. Data Deficient is therefore not a category of threat or Lower Risk. Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. It is important to make positive use of whatever data are available. In many cases great care should be exercised in choosing between DD and threatened status. If the range of a taxon is suspected to be relatively circumscribed, if a considerable period of time has elapsed since the last record of the taxon, threatened status may well be justified.

NOT EVALUATED - A taxon is Not Evaluated when it is has not yet been assessed against the criteria.

*** For more information please see the IUCN website:**
<http://www.iucnredlist.org/static/categories_criteria_2_3>

APPENDIX 2 - **BIRDS**

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Accipitridae	*Busarellus*	*nigricollis*	Black-collared hawk	√	√	√	√	√	√	Least Concern, v. III	Associated
Accipitridae	*Buteo*	*albicaudatus*	White-tailed hawk				√			Least Concern, v.III	
Accipitridae	*Buteo*	*magnirostris*	Roadside hawk	√	√	√	√	√	√	Least Concern, v.III	
Accipitridae	*Buteo*	*nitidus*	Grey-lined hawk				√	√*		Least Concern	
Accipitridae	*Buteogallus*	*aequinoctialis*	Rufous crab hawk			√	√	√		Least Concern, v. III	Associated
Accipitridae	*Buteogallus*	*anthracinus*	Common black hawk			√		√		Least Concern	Associated
Accipitridae	*Buteogallus*	*meridionalis*	Savanna hawk	√	√	√	√		√	Least Concern	
Accipitridae	*Buteogallus*	*urubutinga*	Great Black hawk	√		√*				Least Concern	
Accipitridae	*Circus*	*buffoni*	Long-winged harrier		√	√*	√	√		Least Concern	Associated
Accipitridae	*Elanoides*	*forficatus*	Swallow-tailed kite					√	√	Least Concern	
Accipitridae	*Geranospiza*	*caerulescens*	Crane hawk		√	√				Least Concern	Associated
Accipitridae	*Harpia*	*harpyja*	Harpy eagle					√*		**Near threatened v.3.1**	
Accipitridae	*Helicolestes*	*hamatus*	Slender-billed kite			√				Least Concern	Wetlands
Accipitridae	*Ictinia*	*plumbea*	Plumbeous kite					√		Least Concern	
Accipitridae	*Leptodon*	*cayanensis*	Grey-headed kite					√		Least Concern	
Accipitridae	*Morphnus*	*guianensis*	Crested eagle					√*		**Near Threatened v.3.1**	
Accipitridae	*Rostrhamus*	*sociabilis*	Snail kite			√		√*	√	Least Concern	Wetlands
Anatidae	*Cairina*	*moschata*	Muscovy duck	√	√	√	√	√	√	Least Concern, III	Wetlands
Anatidae	*Dendrocygna*	*autumnalis*	Black-bellied whistling duck	√	√		√	√*		Least Concern, v. III	Wetlands
Anatidae	*Dendrocygna*	*viduata*	White-faced whistling duck				√	√		Least Concern	Wetlands
Anhingidae	*Anhinga*	*anhinga*	Anhinga	√	√	√	√	√	√	Least Concern	Wetlands
Apodidae	*Chaetura*	*cinereiventris*	Grey-rumped swift		√		√			Least Concern	Associated
Apodidae	*Tachornis*	*squamata*	Fork-tailed palm swift	√	√	√	√	√	√	Least Concern	
Aramidae	*Aramus*	*guarauna*	Limpkin		√	√			√	Least Concern	Wetlands
Ardeidae	*Ardea*	*alba*	Great egret	√	√	√	√	√	√	Least Concern	Wetlands
Ardeidae	*Ardea*	*cocoi*	Cocoi heron	√	√	√	√	√	√	Least Concern	Wetlands
Ardeidae	*Bubulcus*	*ibis*	Cattle egret	√		√	√	√*		Least Concern	Associated
Ardeidae	*Butorides*	*striata*	Striated heron	√	√	√	√	√	√	Least Concern	Wetlands
Ardeidae	*Cochlearius*	*cochlearius*	Boat-billed heron	√	√	√		√		Least Concern	Wetlands
Ardeidae	*Egretta*	*caerulea*	Little blue-heron		√	√		√		Least Concern	Wetlands
Ardeidae	*Egretta*	*thula*	Snowy egret	√	√		√	√		Least Concern	Wetlands
Ardeidae	*Egretta*	*tricolor*	Tricoloured heron		√			√		Least Concern	Wetlands
Ardeidae	*Nyctanassa*	*violacea*	Yellow-crowned night-heron							Least Concern	Wetlands
Ardeidae	*Nycticorax*	*nycticorax*	Black-crowned night-heron	√	√	√	√	√*	√	Least Concern	Wetlands
Ardeidae	*Pilherodius*	*pileatus*	Capped heron		√	√			√	Least Concern	Wetlands
Ardeidae	*Tigrisoma*	*fasciatum*	Fasciated tiger heron						√	Data Deficient	Wetlands
Ardeidae	*Tigrisoma*	*lineatum*	Rufescent tiger heron			√	√	√	√	Least Concern	Wetlands
Bucconidae	*Chelidoptera*	*tenebrosa*	Swallow-winged puffbird					√*		Least Concern	
Caprimulgidae	*Caprimulgus*	*nigrescens*	Blackish nightjar		√	√*	√	√		Least Concern	Associated
Caprimulgidae	*Chordeiles*	*pusillus*	Least nightjar						√	Least Concern	
Caprimulgidae	*Hydropsalis*	*climacocerca*	Ladder-tailed nightjar		√		√			Least Concern	Associated

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Caprimulgidae	*Nyctidromus*	*albicollis*	Common pauraque		√	√	√	√	√	Least Concern	
Cardinalidae	*Pitylus*	spp.	Grosbeak					√*		-	
Cardinalidae	*Saltator*	*coerulescens*	Greyish saltator		√	√	√	√*		Least Concern	
Cathartidae	*Cathartes*	*aura*	Turkey vulture			√	√	√		Least Concern	
Cathartidae	*Cathartes*	*burrovianus*	Lesser yellow-headed vulture	√	√	√	√	√*		Least Concern	
Cathartidae	*Cathartes*	*melambrotus*	Greater yellow-headed vulture					√		Least Concern	
Cathartidae	*Coragyps*	*atratus*	Black vulture	√		√	√	√	√	Least Concern	
Cathartidae	*Sarcoramphus*	*papa*	King vulture					√*		Least Concern	
Cerylidae	*Chloroceryle*	*aenea*	Pygmy kingfisher		√	√*	√	√	√	Least Concern	Wetlands
Cerylidae	*Chloroceryle*	*amazona*	Amazon kingfisher	√	√	√	√	√	√	Least Concern	Wetlands
Cerylidae	*Chloroceryle*	*americana*	Green kingfisher	√	√		√	√*	√	Least Concern	Wetlands
Cerylidae	*Chloroceryle*	*inda*	Green-and-rufous kingfisher	√		√		√*	√	Least Concern	Wetlands
Cerylidae	*Megaceryle*	*torquata*	Ringed kingfisher	√	√	√	√	√	√	Least Concern	Wetlands
Charadriidae	*Hoploxypterus*	*cayanus*	Pied plover					√*		Least Concern	Wetlands
Charadriidae	*Pluvialis*	*squatarola*	Black-bellied plover			√*				Least Concern	Migratory
Charadriidae	*Vanellus*	*chilensis*	Southern lapwing	√	√	√	√	√	√	Least Concern	Wetlands
Ciconiidae	*Ciconia*	*maguari*	Maguari stork		√					Least Concern	Wetlands
Ciconiidae	*Jabiru*	*mycteria*	Jabiru						√	Least Concern, v. I	Wetlands
Ciconiidae	*Mycteria*	*americana*	American wood stork			√				Least Concern	Wetlands
Columbidae	*Columba*	*cayennensis*	Pale-vented pigeon	√	√	√	√	√	√	Least Concern	
Columbidae	*Columba*	*plumbea*	Plumbeous pigeon		√	√	√	√	√	Least Concern	
Columbidae	*Columbina*	*passerina*	Common ground dove	√	√	√	√			Least Concern	
Columbidae	*Columbina*	*talpacoti*	Ruddy ground dove	√	√	√	√	√*		Least Concern	
Columbidae	*Leptotila*	*rufaxilla*	Grey-fronted dove			√*		√*		Least Concern	
Columbidae	*Leptotila*	*verreauxi*	White-tipped dove	√	√	√	√	√	√	Least Concern	
Columbidae	*Patagioenas*	*subvinacea*	Ruddy pigeon			√*		√*		**Vulnerable v.3.1**	
Corvidae	*Cyanocorax*	*cayanus*	Cayenne jay					√*		Least Concern	Migratory
Cotingidae	*Querula*	*purpurata*	Purple-throated fruitcrow					√*		Least Concern	
Cracidae	*Mitu*	*tomentosa*	Crestless curassow						√	Least Concern	Migratory
Cracidae	*Ortalis*	*motmot*	Little chacalaca		√	√	√	√*		Least Concern	
Cracidae	*Penelope*	*jacquacu*	Spix's guan					√*	√	Least Concern	
Cracidae	*Pipile*	*cumanensis*	Blue-throated piping guan					√		Least Concern	
Cuculidae	*Crotophaga*	*ani*	Smooth-billed ani	√	√	√	√	√	√	Least Concern	
Cuculidae	*Crotophaga*	*major*	Greater ani	√		√	√	√		Least Concern	Associated
Cuculidae	*Piaya*	*cayana*	Squirrel cuckoo			√		√		Least Concern	Associated
Cuculidae	*Piaya*	*melanogaster*	Black-bellied cuckoo					√		Least Concern	
Cuculidae	*Piaya*	spp.	Cuckoo	√						Least Concern	
Cuculidae	*Piaya*	*minuta*	Little cuckoo			√		√		Least Concern	
Cuculidae	*Tapera*	*naevia*	Striped cuckoo	√		√		√*		Least Concern	
Dendrocolaptidae	*Xiphorhynchus*	*guttatus*	Buff-throated woodcreeper		√	√	√	√		Least Concern	
Emberizidae	*Ammodramus*	*humeralis*	Grassland sparrow					√	√	Least Concern	

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Emberizidae	*Oryzoborus*	*angolensis*	Chestnut-bellied seed finch					√*		Least Concern	Associated
Emberizidae	*Oryzoborus*	*crassirostris*	Large-billed seed finch			√				Least Concern	Associated
Emberizidae	*Paroaria*	*gularis*	Red-capped cardinal	√		√*			√	Least Concern	Associated
Emberizidae	*Sporophila*	*lineola*	Lined seedeater	√	√	√				Least Concern	Migratory
Emberizidae	*Sporophila*	*minuta*	Ruddy-breasted seedeater		√	√	√	√	√	Least Concern	Associated
Emberizidae	*Sporophila*	*plumbea*	Plumbeous seedeater			√			√	Least Concern	
Emberizidae	*Volatinia*	*jacarina*	Blue-black grassquit	√	√	√	√	√*		Least Concern	Associated
Eurypygidae	*Eurypga*	*helias*	Sunbittern		√			√*		Least Concern, v.3.1	Wetlands
Falconidae	*Buteo*	*albonotatus*	Zone-tailed hawk				√			Least Concern	
Falconidae	*Caracara*	*cheriway*	Northern crested caracara			√			√	Least Concern	
Falconidae	*Daptrius*	*ater*	Black caracara					√	√	Least Concern	Associated
Falconidae	*Falco*	*deiroleucus*	Orange-breasted falcon			√*				**Near Threatened v.3.1**	
Falconidae	*Falco*	*peregrinus*	Peregrine falcon			√				Least Concern	Migratory
Falconidae	*Falco*	*rufigularis*	Bat falcon		√		√	√*	√	Least Concern	Associated
Falconidae	*Falco*	*sparverius*	American kestrel					√*		Least Concern	
Falconidae	*Herpetotheres*	*cachinnans*	Laughing falcon	√	√	√	√	√		Least Concern	
Falconidae	*Ibycter*	*americanus*	Red-throated caracara					√*		Least Concern	
Falconidae	*Micrastur*	*ruficollis*	Barred forest falcon					√*		Least Concern	
Falconidae	*Milvago*	*chimachima*	Yellow-headed caracara		√	√	√	√	√	Least Concern	
Formicariidae	*Formicarius*	*analis*	Blackfaced ant-thrush					√*		Least Concern	
Fregatidae	*Fregata*	*magnificens*	Magnificent frigatebird					√*		Least Concern	Wetlands
Furnariidae	*Berlepschia*	*rikeri*	Point-tailed palmcreeper	√			√			Least Concern	Associated
Furnariidae	*Celeus*	*flavus*	Cream coloured woodpecker					√*		Least Concern	
Furnariidae	*Certhiaxis*	*cinnamomeus*	Yellow-chinned spinetail	√	√	√	√	√	√	Least Concern	Associated
Furnariidae	*Deconychura*	*longicauda*	Longtailed woodcreeper					√*		**Near Threatened v.3.1**	
Furnariidae	*Dendroplex*	*picus*	Straight-billed woodcreeper		√	√*				Least Concern	Associated
Furnariidae	*Glyphorynchus*	*spirurus*	Wedge-billed woodcreeper			√*		√*		Least Concern	
Furnariidae	*Melanerpes*	*cruentatus*	Yellow-tufted woodpecker					√*		Least Concern	
Furnariidae	*Synallaxis*	*albescens*	Pale-breasted spinetail	√	√	√				Least Concern	Associated
Furnariidae	*Synallaxis*	*ruficapilla*	Rufous-capped spinetail						√	Least Concern	Associated
Galbulidae	*Galbula*	*albirostris*	Yellow-billed jacamar			√*		√*		Least Concern	Migratory
Galbulidae	*Galbula*	*galbula*	Green-tailed jacamar	√	√	√			√	Least Concern	
Heliornithidae	*Heliornis*	*fulica*	Sungrebe			√		√*		Least Concern	Wetlands
Hirundinidae	*Atticora*	*fasciata*	White-banded swallow						√	Least Concern	Wetlands

APPENDIX 2 - **BIRDS**

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Hirundinidae	*Hirundo*	*rustica*	Barn swallow	√	√	√*	√	√*	√	Least Concern	Migratory
Hirundinidae	*Phaeoprogne*	*tapera*	Brown-chested martin			√*	√			Least Concern	
Hirundinidae	*Progne*	*chalybea*	Grey-breasted martin	√	√	√	√	√	√	Least Concern	Associated
Hirundinidae	*Tachycineta*	*albiventer*	White-winged swallow	√	√	√	√	√	√	Least Concern	Wetlands
Icteridae	*Cacicus*	*cela*	Yellow-rumped cacique			√	√	√	√	Least Concern	
Icteridae	*Cacicus*	*haemorrhous*	Red-rumped cacique					√*		Least Concern	
Icteridae	*Chrysomus*	*icterocephalus*	Yellow-hooded blackbird			√	√	√		Least Concern	Associated
Icteridae	*Icterus*	*chrysocephalus*	Moriche oriole	√				√*		Data Deficient	
Icteridae	*Icterus*	*nigrogularis*	Yellow oriole	√	√	√	√	√*	√	Least Concern	
Icteridae	*Molothrus*	*bonariensis*	Shiny cowbird	√		√	√	√		Least Concern	
Icteridae	*Molothrus*	*oryzivora*	Giant cowbird		√		√	√*	√	Least Concern	
Icteridae	*Psarocolius*	*decumanus*	Crested oropendola			√*	√	√		Least Concern	
Icteridae	*Psarocolius*	*viridis*	Green oropendula					√*		Least Concern	
Icteridae	*Quiscalus*	*lugubris*	Carib grackle			√		√		Least Concern	
Icteridae	*Sturnella*	*militaris*	Red-breasted blackbird		√	√	√	√	√	Least Concern	
Jacanidae	*Jacana*	*jacana*	Wattled jacana	√	√	√	√	√	√	Least Concern	Wetlands
Laridae	*Larus*	*atricilla*	Laughing gull							Least Concern v.3.1	Wetlands
Laridae	*Phaetusa*	*simplex*	Large-billed tern	√		√			√	Least Concern	Wetlands
Laridae	*Sternula*	*antillarum*	Least tern						√	Least Concern	Wetlands, Migratory
Laridae	*Sternula*	*superciliaris*	Yellow-billed tern	√		√			√	Least Concern	Wetlands
Mimidae	*Mimus*	*gilvus*	Tropical mockingbird	√	√	√				Least Concern	
Momotidae	*Momotus*	*momota*	Blue-crowned motmot					√*		Least Concern	
Nyctibiidae	*Nyctibius*	*griseus*	Common potoo			√		√	√	Least Concern	
Odontophoridae	*Odontophorus*	*gujanensis*	Marbled woodquail					√*		**Near Threatened v.3.1**	
Opisthocomidae	*Opisthocomus*	*hoazin*	Hoatzin (Canje pheasant)	√	√	√				Least Concern	Wetlands
Pandionidae	*Pandion*	*haliaetus*	Osprey	√		√*	√	√	√	Least Concern	Wetlands, Migratory
Parulidae	*Dendroica*	*aestiva*	Yellow warbler			√*		√*		N/E	Migratory
Parulidae	*Geothlypis*	*aequinoctialis*	Masked yellowthroat		√		√			Least Concern	Wetlands
Parulidae	*Phaeothlypis*	*rivularis*	Riverbank warbler	√	√	√		√*		Least Concern	Wetlands
Pelecanidae	*Pelacanus*	*occidentalis*	Brown pelican					√*		N/E	Wetlands
Phalacrocoracidae	*Phalacrocorax*	*brasilianus*	Neotropical cormorant	√	√	√	√	√	√	Least Concern	Wetlands
Phoenicopteridae	*Phoenicopterus*	*ruber*	American flamingo					√*		Least Concern v.3.1	Wetlands
Picidae	*Campephilus*	*melanoleucos*	Crimson-crested woodpecker			√				Least Concern	
Picidae	*Campephilus*	*rubricollis*	Red-necked woodpecker			√				Least Concern	
Picidae	*Celeus*	*elegans*	Chestnut woodpecker					√		Least Concern	
Picidae	*Dryocopus*	*lineatus*	Lineated woodpecker		√	√	√	√	√	Least Concern	

APPENDIX 2 - **BIRDS**

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Picidae	*Picumnus*	spp.	Piculet			√		√*		Least Concern	
Picidae	*Picumnus*	*exilis*	Golden-spangled piculet			√*				Least Concern	
Picidae	*Picumnus*	*spilogaster*	White-bellied piculet			√*				**Vulnerable v.3.1**	
Picidae	*Veniliornis*	spp.	Veniliornis woodpecker	√						-	
Picidae	*Veniliornis*	*sanguineus*	Blood-coloured woodpecker			√				Least Concern	Migratory
Pipridae	*Manacus*	*manacus*	White-bearded manakin					√*		Least Concern	
Pipridae	*Pipra*	*aureola*	Crimson-hooded manakin							Least Concern	
Pipridae	*Pipra*	*erythrocephala*	Golden-headed manakin			√*				Least Concern	
Polioptilidae	*Polioptila*	*plumbea*	Tropical gnatcatcher		√	√			√	Least Concern	
Psittacidae	*Amazona*	*amazonica*	Orange-winged parrot	√	√	√	√	√	√	Least Concern	Associated
Psittacidae	*Amazona*	*dufresniana*	Blue-cheeked parrot		√					**Near Threatened v.3.1**	Associated
Psittacidae	*Amazona*	*farinosa*	Mealy parrot		√					Least Concern	Associated
Psittacidae	*Amazona*	*ochrocephala*	Yellow-crowned parrot			√	√	√*	√	Least Concern	Associated
Psittacidae	*Ara*	*ararauna*	Blue-and-yellow macaw	√		√	√	√*	√	Least Concern	Associated
Psittacidae	*Ara*	*chloropterus*	Red-and- green macaw					√*		Least Concern	Associated
Psittacidae	*Aratinga*	*pertinax*	Brown-throated parakeet	√	√	√	√	√	√	Least Concern	Associated
Psittacidae	*Diopsittaca*	*nobilis*	Red-shouldered macaw	√	√	√*	√	√	√	Least Concern	Associated
Psittacidae	*Forpus*	*passerinus*	Green-rumped parrotlet		√	√				Least Concern	Associated
Psittacidae	*Forpus*	*passerinus*	Green-rumped parrotlet			√*				Least Concern	
Psittacidae	*Forpus*	*sclateri*	Dusky-billed parrotlet					√		Least Concern	Associated
Psittacidae	*Orthopsittaca*	*manilata*	Red-bellied macaw	√	√	√	√	√	√	Least Concern	Associated
Psittacidae	*Pionus*	*menstruus*	Blue-headed parrot			√*		√*	√	Least Concern	Associated
Psittacidae	*Pyrrhura*	*picta*	Painted parakeet						√	Least Concern	Associated
Rallidae	*Anurolimnas*	*viridis*	Russet-crowned crake		√					Least Concern	
Rallidae	*Aramides*	*cajanea*	Grey-necked wood rail			√		√*	√	Least Concern	Associated
Rallidae	*Gallinula*	*chloropus*	Common moorhen							Least Concern	Associated
Rallidae	*Porphyrio*	*flavirostris*	Azure gallinule			√	√			Least Concern	Wetlands
Rallidae	*Porphyrio*	*martinica*	Purple gallinule			√			√	Least Concern	Wetlands
Rallidae	*Porzana*	*albicollis*	Ash-throated crake		√	√	√			Least Concern	Wetlands
Ramphastidae	*Pteroglossus*	*aracari*	Black-necked aracari			√*		√*		Least Concern	
Ramphastidae	*Ramphastos*	*tucanus*	White-throated toucan, red-billed toucan		√	√*	√	√	√	Least Concern	
Ramphastidae	*Ramphastos*	*vitellinus*	Channel-billed toucan					√*	√	Least Concern	

APPENDIX 2 - **BIRDS**

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Ramphastidae	*Rhamphastos*	*toco*	Toco toucan	√		√				Least Concern	Associated
Rynchopidae	*Rynchops*	*niger*	Black skimmer					√		Least Concern	Wetlands
Scolopacidae	*Actitis*	*macularius*	Spotted sandpiper			√*	√		√	Least Concern	Wetlands, Migratory
Scolopacidae	*Calidris*	spp.	Sandpiper			√				Least Concern	Wetlands, Migratory
Scolopacidae	*Calidris*	*minutilla*	Least sandpiper							Migratory	Wetlands, Migratory
Scolopacidae	*Calidris*	*pusilla*	Semipalmated sandpiper			√*				Migratory	Wetlands, Migratory
Scolopacidae	*Tringa*	*flavipes*	Lesser yellowlegs	√	√		√			Least Concern	Wetlands, Migratory
Scolopacidae	*Tringa*	*melanoleuca*	Greater yellowlegs				√	√*		Least Concern	Wetlands, Migratory
Scolopacidae	*Tringa*	*solitaria*	Solitary sandpiper							Migratory	Wetlands, Migratory
Sternidae	*Sterna*	*nilotica*	Gull-billed tern							Least Concern	Wetlands, Migratory
Strigidae	*Bubo*	*virginianus*	Great horned owl	√		√		√		Least Concern	
Strigidae	*Otus*	*choliba*	Tropical screech owl			√		√*		Least Concern	
Strigidae	*Pulsatrix*	*perspicillata*	Spectacled owl					√*		Least Concern	
Thamnophilidae	*Cercomacra*	spp.	Antwren					√*		-	
Thamnophilidae	*Cercomacra*	*tyrannina*	Dusky antbird			√		√*		Least Concern	
Thamnophilidae	*Cymbilaimus*	*lineatus*	Fasciated antshrike			√*		√*		Least Concern	
Thamnophilidae	*Frederickena*	*viridis*	Black-throated antshrike					√*		Least Concern	Migratory
Thamnophilidae	*Hypocnemis*	*cantator*	Guianan warbling antbird			√*				**Near Threatened v.3.1**	
Thamnophilidae	*Myrmeciza*	*atrothorax*	Black-throated antbird					√*		Least Concern	
Thamnophilidae	*Myrmornis*	*torquata*	Wing-banded antbird					√*		**Near Threatened v.3.1**	
Thamnophilidae	*Pygiptila*	*stellaris*	Spot-winged antshrike			√*				Least Concern	
Thamnophilidae	*Sakesphorus*	*canadensis*	Black-crested antshrike			√		√*	√	Least Concern	
Thamnophilidae	*Sclateria*	*naevia*	Silvered antbird			√		√		Least Concern	Associated
Thamnophilidae	*Taraba*	*major*	Great antshrike			√				Least Concern	
Thamnophilidae	*Thamnophilus*	*doliatus*	Barred antshrike	√	√	√	√	√		Least Concern	Associated
Thamnophilidae	*Thamnophilus*	*murinus*	Mouse-coloured antshrike			√		√*		Least Concern	
Thraupidae	*Chlorophanes*	*spiza*	Green honeycreeper			√*		√*		Least Concern	
Thraupidae	*Cissopis*	*leveriana*	Magpie tanager					√*		Least Concern	
Thraupidae	*Coereba*	*flaveola*	Bananaquit	√	√			√	√	Least Concern	
Thraupidae	*Conirostrum*	*bicolor*	Bicoloured conebill					√*		Least Concern	Associated
Thraupidae	*Dacnis*	*cayana*	Blue dacnis		√					Least Concern	
Thraupidae	*Euphonia*	*finschi*	Finsch's euphonia			√				Least Concern	
Thraupidae	*Euphonia*	*violacea*	Violaceous Euphonia			√*		√*		Least Concern	
Thraupidae	*Geothlypis*	*aequinoctialis*	Masked yellowthroat				√			Least Concern	
Thraupidae	*Ramphocelus*	*carbo*	Silver-beaked tanager	√	√	√	√	√		Least Concern	

APPENDIX 2 - BIRDS

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Thraupidae	*Tachyphonus*	*rufus*	White-lined tanager			√		√*		Least Concern	
Thraupidae	*Tangara*	*cayana*	Burnished-buff tanager			√*	√			Least Concern	
Thraupidae	*Tangara*	*mexicana*	Turquoise tanager			√		√		Least Concern	
Thraupidae	*Thraupis*	*episcopus*	Blue-grey tanager	√	√	√	√	√		Least Concern	
Thraupidae	*Thraupis*	*palmarum*	Palm tanager	√	√	√	√	√	√	Least Concern	
Threskiornithidae	*Eudocimus*	*ruber*	Scarlet ibis					√		Least Concern, v. II	Wetlands
Threskiornithidae	*Mesembrinibis*	*cayennensis*	Green ibis		√	√		√	√	Least Concern	Wetlands
Tinamidae	*Crypturellus*	*erythropus*	Red-legged tinamou				√		√	Least Concern	
Tinamidae	*Tinamus*	*major*	Great tinamou					√	√	Least Concern	
Trochilidae	*Amazilia*	spp.	Emerald (hummingbird)			√	√	√	√	Least Concern	
Trochilidae	*Amazilia*	*brevirostris*	White-chested emerald							Least Concern	
Trochilidae	*Amazilia*	*fimbriata*	Glittering-throated emerald					√*		Least Concern	
Trochilidae	*Campylopterus*	*largipennis*	Grey-breasted Sabrewing					√*		Least Concern	
Trochilidae	*Discosura*	*longicaudus*	Racket-tailed coquette			√				Least Concern	
Trochilidae	*Glaucis*	*hirsutus*	Rufous-breasted hermit			√*		√*		Least Concern	
Trochilidae	*Phaethornis*	spp.	Hermit hummingbirds			√*		√		Least Concern	
Trochilidae	*Phaethornis*	*longuemareus*	Little hermit			√*				Least Concern	
Trochilidae	*Phaethornis*	*ruber*	Reddish hermit					√		Least Concern	
Trochilidae	*Phaethornis*	*superciliosus*	Long-tailed hermit					√*		Least Concern	
Trochilidae	*Threnetes*	*leucurus*	Pale-tailed barbthroat	√	√					Least Concern	
Troglodytidae	*Campylorhynchus*	*griseus*	Bicoloured wren						√	Least Concern	
Troglodytidae	*Donacobius*	*atricapillus*	Black-capped donacobius	√	√	√	√	√		Least Concern	Associated
Troglodytidae	*Thryothorus*	*coraya*	Coraya wren	√		√		√	√	Least Concern	Associated
Troglodytidae	*Thryothorus*	*leucotis*	Buff-breasted wren	√		√				Least Concern	
Troglodytidae	*Troglodytes*	*aedon*	House wren			√				Least Concern	
Troglodytidae	*Troglodytes*	*aedon*	Southern house wren	√	√	√*	√	√*		Least Concern	
Trogonidae	*Trogon*	*viridis*	Amazonian white-tailed trogon		√	√	√	√	√	Data Deficient	
Turdidae	*Turdus*	*leucomelas*	Pale-breasted thrush	√	√			√*		Least Concern	
Turdidae	*Turdus*	*olivater*	Black-hooded thrush			√*				Least Concern	
Tyrannidae	*Arundinicola*	*leucocephala*	White-headed marsh tyrant	√	√	√	√	√	√	Least Concern	Wetlands
Tyrannidae	*Attila*	*cinnamomeus*	Cinnamon attila	√	√	√		√		Least Concern	Associated
Tyrannidae	*Attila*	*spadiceus*	Bright-rumped attila					√*		Least Concern	
Tyrannidae	*Camptostoma*	*obsoletum*	Southern beardless tyrannulet	√		√*		√*		Least Concern	
Tyrannidae	*Elaenia*	spp.	Elaenia species				√			Least Concern	
Tyrannidae	*Elaenia*	sp.	Great elaenia			√				Least Concern	
Tyrannidae	*Elaenia*	*flavogaster*	Yellow-bellied elaenia	√	√	√*	√	√	√	Least Concern	
Tyrannidae	*Fluvicola*	*pica*	Pied water tyrant	√		√		√*	√	Least Concern	Wetlands
Tyrannidae	*Legatus*	*leucophaius*	Piratic flycatcher		√		√		√	Least Concern	Wetlands, Migratory

APPENDIX 2 - **BIRDS**

Family	Genus	Species	Common name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	North West	Rupununi	IUCN Redlist, CITES	Primary habitat preference
Tyrannidae	*Lipaugus*	*vociferans*	Screaming piha					√		Least Concern	
Tyrannidae	*Lophotriccus*	*galeatus*	Helmented pygmy tyrant					√		Least Concern	
Tyrannidae	*Megarynchus*	*pitangua*	Boat-billed flycatcher	√	√		√	√*		Least Concern	Associated
Tyrannidae	*Myiarchus*	*tyrannulus*	Brown-crested flycatcher	√	√	√	√			Least Concern	Associated
Tyrannidae	*Myiodynastes*	*maculatus*	Streaked flycatcher					√*		Least Concern	
Tyrannidae	*Myiopagis*	*gaimardii*	Forest elaenia			√*		√*		Least Concern	
Tyrannidae	*Myiozetetes*	*cayanensis*	Rusty-margined flycatcher		√	√	√	√*	√	Least Concern	Associated
Tyrannidae	*Phaeomyias*	*murina*	Mouse-coloured tyrannulet			√	√			Least Concern	
Tyrannidae	*Philohydor*	*lictor*	Lesser kiskadee	√	√	√	√	√	√	Least Concern	Associated
Tyrannidae	*Pitangus*	*sulphuratus*	Greater kiskadee	√	√	√	√	√	√	Least Concern	
Tyrannidae	*Todirostrum*	*cinereum*	Common tody-flycatcher	√	√	√		√*	√	Least Concern	
Tyrannidae	*Todirostrum*	*maculatum*	Spotted Tody-flycatcher			√	√	√*		Least Concern	Associated
Tyrannidae	*Todirostrum*	*pictum*	Painted tody-flycatcher	√						Least Concern	
Tyrannidae	*Tyrannulus*	*elatus*	Yellow-crowned tyrannulet	√		√				Least Concern	
Tyrannidae	*Tyrannus*	*dominicensis*	Grey kingbird					√*		Least Concern	Migratory
Tyrannidae	*Tyrannus*	*melancholicus*	Tropical kingbird	√	√	√	√	√	√	Least Concern	Associated, Migratory
Tyrannidae	*Tyrannus*	*savana*	Fork-tailed flycatcher	√	√		√	√	√	Least Concern	Migratory
Vireonidae	*Hylophilus*	*pectoralis*	Ashy-headed greenlet	√						Least Concern	Associated
Vireonidae	*Hylophilus*	*thoracicus*	Lemon-chested greenlet				√		√	Least Concern	

APPENDIX 2 - **MAMMALS**

Order/Family	Genus	Species	Common Name/Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Coast	Mangrove	North West Freshwater	North West Brackish	Rupununi	IUCN Red list
Atelidae	*Ateles*	*paniscus*	Black spider monkey							√*	√*	**Vulnerable v.3.1**
Carnivora	*Panthera*	*onca*	Jaguar	X		√*	X		X	√*	√*	**Near Threatened v.3.1**
Carnivora	*Puma*	*concolor*	Puma	X					X		√*	Data Deficient
Caviidae	*Hydrochaeris*	*hydrochaeris*	Capybara	X	X	√	X		X			Least concern
Cebidae	*Alouatta*	*seniculus*	Red howler monkey	√	√	√	√		√	√*	√*	Least concern
Cebidae	*Cebus*	*apella*	Brown capuchin			√				√*	√*	Least concern
Cebidae	*Cebus*	*olivaceus*	Wedge-capped capuchin						√*	√	√*	Least concern
Cebidae	*Saimiri*	*sciurieus*	Squirrel monkey	√		√			√	√	√	Data deficient
Cetartiodactyla / Cervidae	*Mazama*	*americana*	Red brocket deer	X	X	√*	X		X		√*	Data Deficient
Cetartiodactyla / Cervidae	*Odocoileus*	*virginianus*	White-tailed deer/Savannah deer								√*	Least Concern
Cetartiodactyla / Tayassuidae	*Pecari*	*tajacu*	Collared peccary	X					X		√*	Least Concern
Cetartiodactyla / Tayassuidae	*Tayassu*	*pecari*	White-lipped peccary	X			X		X		√*	**Near Threatened v.3.1**
Cingulata: Dasypodidae	*Dasypus*	*novemcinctus*	Nine-banded armadillo				X		X		√*	Least Concern
Cricetidae	*Oecomys*	spp.	Field rat			√						Data deficient
Iniidae	*Inia*	*geoffrensis*	Amazon/ Pink river dolphin							√*		Data Deficient
Mustelidae	*Eira*	*barbara*	Tayra								√*	Least Concern
Mustelidae	*Lontra*	*longicaudis*	Neotropical river otter	√	X	√	√		√	√*	√*	Data deficient
Mustelidae	*Pteronura*	*brasiliensis*	Giant river otter	√	√				√		√	**Endangered v.3.1**
Myrmecophagidae	*Myrmecophaga*	*tridactyla*	Giant anteater	√	√						√*	**Vulnerable v.3.1**
Myrmecophagidae	*Tamandua*	*tetradactyla*	Southern tamandua/ Lesser anteater			√*				√*	√*	Least Concern
Perissodactyla/ Tapiridae	*Tapirus*	*terrestris*	Brazilian tapir	X	X		X		X	X	√*	**Vulnerable v.3.1**
Pilosa / Megalonychidae	*Choloepus*	*didactylus*	Two-toed sloth	X								Least Concern
Pitheciidae	*Pithecia*	*pithecia*	White-faced saki							√*	√*	Least Concern
Procyonidae	*Nasua*	*nasua*	South American coati			√*					√*	Least Concern
Procyonidae	*Potos*	*flavus*	Kinkajou							√	√*	Least concern
Procyonidae	*Procyon*	*cancrivorus*	Crab-eating raccoon	√		√	√			√*	√	Least concern
Rodentia/ Cuniculidae	*Cuniculus*	*paca*	Paca/ Labba		X		X		X	X	√*	Least Concern
Rodentia/ Dasyproctidae	*Dasyprocta*	*leporina*	Red-rumped-agouti		X	√*	√		X	√*	√*	Least Concern
Sirenia/ Trichechidae	*Trichechus*	*manatus*	West Indian manatee						√	√		**Vulnerable v.3.1**

APPENDIX 2 - HERPETOFAUNA

Class	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Lakes	North West	Rupununi	IUCN Red list
Amphibia	Bufonidae	*Rhinella*	*marina*	Cane toad	√	√	√	√	√	√	Least concern
Amphibia	Centrolenidae	*Cochranella*	spp.	Glass frog	√			√			
Amphibia	Hylidae	*Dendropsophus*	*marmorata*	Marbled tree frog	√						Least concern
Amphibia	Hylidae	*Dendropsophus*	*minutus*	Lesser tree frog	√	√	√*	√	√	√	Least concern
Amphibia	Hylidae	*Dendropsophus*	*leucophyllata*	Clown tree frog			√*				Least Concern
Amphibia	Hylidae	*Hyla*	spp.	Tree frogs					√	√	Data deficient
Amphibia	Hylidae	*Hypsiboas*	*boans*	Gladiator frog						√	Least concern
Amphibia	Hylidae	*Hypsiboas*	*cinerascens*	Demerara Falls tree frog			√*				Least Concern
Amphibia	Hylidae	*Hypsiboas*	*crepitans*	Emerald-eyed tree frog			√*	√	√		Least concern
Amphibia	Hylidae	*Hypsiboas*	*geographica*	Map tree frog			√*				Least Concern
Amphibia	Hylidae	*Pseudis*	*paradoxa*	Paradox/Paradox-ical frog/Shrinking frog					√		Least concern
Amphibia	Hylidae	*Scinax*	spp.	Snouted tree frog							Least concern
Amphibia	Hylidae	*Scinax*	*ruber*	Red-snouted tree frog		√	√	√	√	√	Least concern
Amphibia	Hylidae	*Scinax*	sp. 1	-			√				Least concern
Amphibia	Leptodactylidae	*Eleutherodactylus*	*johnstonei*	Lesser Antillean whistling frog			√*	√			Least Concern
Amphibia	Leptodactylidae	*Leptodactylus*	spp.	Leptodactylid frog							Least concern
Amphibia	Leptodactylidae	*Leptodactylus*	*fuscus*	Whistling frog			√				Least concern
Amphibia	Leptodactylidae	*Leptodactylus*	*pentadac-tylus*	Smoky jungle frog					√		Least concern
Amphibia	Leptodactylidae	*Leptodactylus*	sp. 1	Leptodactylid frog			√			√	Least concern
Amphibia	Leptodactylidae	*Leptodactylus*	sp. 2	Leptodactylid frog						√	Least concern
Amphibia	Pipidae	*Pipa*	*pipa*	Suriname toad					√*		Least Concern
Reptilia	Alligatoridae	*Caiman*	*crocodilus*	Spectacled cai-man	√	√	√	√	√	√	Least concern
Reptilia	Alligatoridae	*Melanosuchus*	*niger*	Black caiman						√	**Lower Risk/ Conservation dependent v.2.3**
Reptilia	Boidae	*Boa*	*constrictor*	Boa constrictor					√*		N/E
Reptilia	Boidae	*Corallus*	*caninus*	Emerald tree boa		X			X		N/E
Reptilia	Boidae	*Corallus*	*hortulanus*	Amazon Tree boa			√	√	√	√*	N/E
Reptilia	Boidae	*Eunectes*	*murinus*	Green anaconda			X		X	√	N/E
Reptilia	Cheloniidae	*Chelonia*	*mydas*	Green sea turtle					√*		**Endangered v.3.1**
Reptilia	Cheloniidae	*Eretmochelys*	*imbricata*	Hawksbill sea turtle					√*		**Critically Endan-gered v.3.1**
Reptilia	Cheloniidae	*Lepidochelys*	*olivacea*	Olive ridley					√*		**Vulnerable v.3.1**
Reptilia	Colubridae	*Drymarchon*	*corais*	Indigo snake/Ti-ger snake					√*		Least Concern
Reptilia	Colubridae	*Helicops*	spp.	Helicops water snake			√				-
Reptilia	Colubridae	*Imantodes*	spp.	Cat-eyed snake					√		-
Reptilia	Colubridae	*Liophis*	*cobella*	Water snake/Man-grove snake					√*		N/E

APPENDIX 2 - HERPETOFAUNA

Class	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Lower Canje Basin	Essequibo Lakes	North West	Rupununi	IUCN Red list
Reptilia	Colubridae	*Spilotes*	spp.	Yakman snake/ Chicken snake			√				N/E
Reptilia	Colubridae	*Spilotes*	*pullatus*	Chicken snake/ Yellow rat snake/ Tiger rat snake			√*				N/E
Reptilia	Dermochelyidae	*Dermochelys*	*coriacea*	Leatherback sea turtle					√		**Critically Endangered v. 2.3**
Reptilia	Emydidae	*Rhinoclemmys*	*punctularia*	Spot-legged turtle / Labaria turtle					√*		N/E
Reptilia	Gekkonidae	*Gonatodes*	spp.	Dwarf gecko		√					N/E
Reptilia	Gekkonidae	*Thecadactylus*	*rapicauda*	Gecko /Ganga sacka					√*		N/E
Reptilia	Iguanidae	*Iguana*	*iguana*	Green iguana					√*	√	N/E
Reptilia	Kinosternidae	*Kinosternon*	*scorpioides*	Mud turtle					√*		-
Reptilia	Leptotyphlopidae	*Leptotyphlops*	spp.	Blind snake					√*		N/E
Reptilia	Podocnemididae	*Podocnemis*	*expansa*	Giant river turtle						√	**Lower Risk/ Conservation Dependent v.2.3**
Reptilia	Podocnemididae	*Podocnemis*	*unifilis*	Yellow-spotted river turtle/Yellow-headed river turtle						√	**Vulnerable v.2.3**
Reptilia	Scincidae	*Mabuya*	*nigropunctata*	Skink/Mabuya			√*		√*		N/E
Reptilia	Sphaerodactylidae	*Gonatodes*	*humeralis*	Trinidad gecko			√*		√*		N/E
Reptilia	Teiidae	*Ameiva*	*ameiva*	Giant ameiva lizard	√	√	√	√	√	√	N/E
Reptilia	Teiidae	*Cnemidophorus*	*lemniscatus*	Rainbow whiptail lizard					√		N/E
Reptilia	Teiidae	*Kentropyx*	*calcarata*	Striped forest whiptail					√*		N/E
Reptilia	Teiidae	*Tupinambis*	*teguixin*	Tegu / salipenter	√	√	√	√	√*		N/E
Reptilia	Testudinidae	*Chelonoidis*	*denticulata*	Yellow-footed tortoise			√*			√*	**Vulnerable v.2.3**
Reptilia	Tropiduridae	*Tropidurus*	*hispidus*	Collared lizard						√	N/E
Reptilia	Viperidae	*Bothrops*	*atrox*	Labaria snake			√	√	√*		N/E

APPENDIX 2 - FISH

Order	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Canje Basin	Essequibo Coast	North West Freshwater	North West Brackish	Rupununi
Beloniformes	Belonidae	*Pseudotylosurus*	spp.	Needle fish							√
Beloniformes	Belonidae	*Pseudotylosurus*	*microps*	Needle fish							√
Characiformes	Acestrorhynchidae	*Acestrorhynchus*	spp.	Dog fish/Pike characin		√					
Characiformes	Acestrorhynchidae	*Acestrorhynchus*	*microlepis*	Dog fish/Pike characin	√	√		√	√		√
Characiformes	Anostomidae	*Leporinus*	spp.	Tibicouri				√			√
Characiformes	Anostomidae	*Schizodon*	*fasciatus*	Headstander							√
Characiformes	Characidae	*Astyanax*	spp.				√				
Characiformes	Characidae	*Astyanax*	*bimaculatus*	Silver bait/Two spot astyanax			√				
Characiformes	Characidae	*Astyanax*	*fasciatus*	Silver bait/Banded astyanax		√	√				
Characiformes	Characidae	*Bryconops*	*affinis*	Orangefin tetra		√		√			
Characiformes	Characidae	*Bryconops*	*melanurus*	Tetra				√*			
Characiformes	Characidae	*Catoprion*	*mento*	Wimple piranha	√	√		√			√
Characiformes	Characidae	*Chalceus*	*macrolepidotus*	Pink-tailed chalceus							√
Characiformes	Characidae	*Chalceus*	spp.								√
Characiformes	Characidae	*Characidae*	spp. 1	-			√				
Characiformes	Characidae	*Characidae*	spp. 2	-			√				
Characiformes	Characidae	*Characidae*	spp. 3	-			√				
Characiformes	Characidae	*Charax*	*gibbosus*	Glass headstander		√	√				
Characiformes	Characidae	*Hemigrammus*	*cylindricus*								√
Characiformes	Characidae	*Hemigrammus*	*levis*	-							√
Characiformes	Characidae	*Hemigrammus*	spp.	Tetra				√*			√
Characiformes	Characidae	*Metynnis*	spp.	-				√			
Characiformes	Characidae	*Metynnis*	*argenteus*	Silver dollar				√			√
Characiformes	Characidae	*Metynnis*	*maculatus*	Silver Dollar/Spotted metynnis	√			√*			
Characiformes	Characidae	*Moenkhausia*	spp.	Tetra			√				√
Characiformes	Characidae	*Moenkhausia*	*lepidura*	Tetra							√
Characiformes	Characidae	*Myleus*	spp.	-				√			
Characiformes	Characidae	*Myleus*	*rhomboidalis*	Pacu				√			
Characiformes	Characidae	*Odontostilbe*	*gracilis*	-				√			
Characiformes	Characidae	*Parapristella*	*aubynei*	Silver bait/Glassfish							√
Characiformes	Characidae	*Pristobrycon*	*calmoni*	Piranha							√
Characiformes	Characidae	*Pygocentrus*	*bilineatus*	Piranha				√			√
Characiformes	Characidae	*Pygocentrus*	*denticulatus*	Gold piranha					√		
Characiformes	Characidae	*Pygocentrus*	*nattereri*	Red-bellied piranha/Ca-shew piranha							√
Characiformes	Characidae	*Pygopristis*	*denticulata*	Piranha	√	√		√	√		
Characiformes	Characidae	*Roeboides*	*thurni*	-			√				√
Characiformes	Characidae	*Serrasalmus*	spp.	Piranha				√			
Characiformes	Characidae	*Serrasalmus*	*eigenmanni*	Pinche piranha/Black pirai	√	√	√				√
Characiformes	Characidae	*Serrasalmus*	*rhombeus*	Black piranha	√	√		√	√		
Characiformes	Characidae	*Tetragonopterus*	*chalceus*	Silver tetra							√
Characiformes	Characidae	*Triportheus*	spp.	-							√
Characiformes	Chilodontidae	*Caenotropus*	*maculosus*	Headstander							√

APPENDIX 2 - FISH

Order	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Canje Basin	Essequibo Coast	North West Freshwater	North West Brackish	Rupununi
Characiformes	Curimatidae	*Curimata*	spp.							√	
Characiformes	Curimatidae	*Curimata*	*cyprinoides*	Toothless characin	√			√	√	√	√
Characiformes	Curimatidae	*Curimata*	*vittata*	Long-tailed curimata							√
Characiformes	Curimatidae	*Curimatella*	spp.	-							√
Characiformes	Curimatidae	*Curimatopsis*	*crypticus*	-				√			
Characiformes	Curimatidae	*Cyphocharax*	*festivus*	-							√
Characiformes	Curimatidae	*Cyphocharax*	*spilurus*	Cuticuru							√
Characiformes	Cynodontidae	*Hydrolycus*	*armatus*	Payara/Sabre-toothed characin							√
Characiformes	Cynodontidae	*Hydrolycus*	*scomberoides*	Payara/Biara/Sabre-toothed characin/Vampire tetra				√			
Characiformes	Erythrinidae	*Erythrinus*	*erythrinus*	Trahira/Red wolf fish				√			
Characiformes	Erythrinidae	*Hoplerythrinus*	*unitaeniatus*	Yarrowma/Yarrauma/ Gold wolf fish			√			√	
Characiformes	Erythrinidae	*Hoplias*	*malabaricus*	Huri/Wolf fish/Tiger fish	√	√	√	√	√	√	√
Characiformes	Gasteropelecidae	*Carnegiella*	*strigata*	Marbled hatchet fish							√
Characiformes	Gasterosteidae	*Gasteropelicus*	*sternicla*	Silver hatchet fish			√	√	√		
Characiformes	Hemiodontidae	*Hemiodus*	*thayeria*	Halftooth							√
Characiformes	Heptapteridae	*Rhamdia*	*quelen*	Silver catfish				√			√
Characiformes	Lebiasinidae	*Nannostomus*	*digrammus*	Two-striped pencil fish				√			
Characiformes	Lebiasinidae	*Nannostomus*	*marginatus*	Pencil fish					√		√
Characiformes	Lebiasinidae	*Nannostomus*	*trifaciatus*	Three-striped pencil fish							√
Characiformes	Lebiasinidae	*Pyrrulina*	spp.	Pencil fish			√				
Characiformes	Lebiasinidae	*Pyrrhulina*	*brevis*	Pencil fish				√*			
Characiformes	Lebiasinidae	*Pyrrhulina*	*filamentosa*	Pencil fish		√	√		√		√
Characiformes	Prochilodontidae	*Prochilodus*	spp.								√
Characiformes	Prochilodontidae	*Prochilodus*	*rubrotaeniatus*	Yakatu							√
Clupeiformes	Engraulidae	*Anchovia*	spp.	Anchovy	√						
Clupeiformes	Engraulidae	*Anchoviella*	spp.	Anchovy/Bamboo leaf fish							√
Clupeiformes	Engraulidae	*Pterengraulis*	*atherinoides*	Wingfin anchovy/Bamboo leaf fish							√
Cyprinodontiformes	Poeciliidae	*Poecilia*	spp.	Caca belly			√				
Cyprinodontiformes	Poeciliidae	*Poecilia*	*reticulata*	Caca belly/Guppy			√			√	
Cyprinodontiformes	Rivulidae	*Kryptolebias*	*marmoratus*	Mangrove rivulus/Mangrove killifish			√				
Cyprinodontiformes	Rivulidae	*Rivulus*	spp.				√				
Elopiformes	Megalopidae	*Megalops*	*atlanticus*	Tarpon/Cuffum						√	
Gymnotiformes	Apteronotidae	*Apteronotus*	*albifrons*	Ghost knifefish/Black ghost		√		√			
Gymnotiformes	Gymnotidae	*Electrophorus*	*electricus*	Electric eel				√			
Gymnotiformes	Gymnotidae	*Gymnotus*	*carapo*	Banded knifefish			√				
Gymnotiformes	Sternopygidae	*Sternopygus*	*macrurus*	Luga luga/Numb fish/ Long-tailed knifefish				√			
Perciformes	Cichlidae	*Acarichthys*	*heckelii*	Patwa/Thread-finned acara						√	√

APPENDIX 2 - FISH

Order	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Canje Basin	Essequibo Coast	North West Freshwater	North West Brackish	Rupununi
Perciformes	Cichlidae	*Acaronia*	*nassa*	Patwa/Big-eye chiclid				√*			√
Perciformes	Cichlidae	*Aequidens*	*tetramerus*	Patwa/Saddle chiclid			√				
Perciformes	Cichlidae	*Apistogramma*	*ortmanni*	Dwarf patwa/Dwarf cichlid				√*			√
Perciformes	Cichlidae	*Biotodoma*	*cupido*	Patwa/Cupid chiclid							√
Perciformes	Cichlidae	*Bujurquina*	*vittata*	Banded acara				√*			
Perciformes	Cichlidae	*Cichla*	*ocellaris*	Lukanani/Peacock bass	√	√		√			√
Perciformes	Cichlidae	*Cichlasoma*	spp.	Patwa			√				
Perciformes	Cichlidae	*Cichlasoma*	*bimaculatum*	Common patwa/Congo fish/Congo patwa/Black acara			√	√*		√	
Perciformes	Cichlidae	*Crenicichla*	spp.	Sunfish/Pike chiclid			√				√
Perciformes	Cichlidae	*Crenicichla*	*acutirostris*	Sunfish/Pike cichlid							√
Perciformes	Cichlidae	*Crenicichla*	*alta*	Sunfish/Pike cichlid			√				√
Perciformes	Cichlidae	*Crenicichla*	*lugubris*	Sunfish/Pike chiclid				√			√
Perciformes	Cichlidae	*Geophagus*	spp.								√
Perciformes	Cichlidae	*Geophagus*	*surinamensis*	Patwa/Red-striped earth-eater							√
Perciformes	Cichlidae	*Guianacara*	*sphenozona*	Patwa							√
Perciformes	Cichlidae	*Heros*	*severus*	Patwa/Severum	√						
Perciformes	Cichlidae	*Mesonauta*	*festivum*	Festival patwa		√		√			√
Perciformes	Cichlidae	*Mesonauta*	*guyanae*	Festival patwa							√
Perciformes	Cichlidae	*Nannacara*	*anomala*	Dwarf patwa/Golden eye cichlid			√				
Perciformes	Cichlidae	*Satanoperca*	*leucosticta*	Patwa/Earth-eaters	√	√					√
Perciformes	Polycentridae	*Polycentrus*	*schomburgkii*	Guyana leaf fish/Guiana leaf fish		√	√	√	√		
Perciformes	Sciaenidae	*Plagioscion*	*squamosissimus*	Basha/Drum/Silver croaker							√
Siluriformes	Aspredinidae	*Bunocephalus*	spp.	Catfish							√
Siluriformes	Aspridinidae	*Bunocephalus*	*coracoideus*	Banjo catfish							√
Siluriformes	Auchenipteridae	*Ageneiosus*	*inermis*	Driftwood catfish				√			
Siluriformes	Auchenipteridae	*Ageneiosus*	*marmoratus*	Bottlenose catfish	√						
Siluriformes	Auchenipteridae	*Auchenipterus*	spp.	Catfish			√				
Siluriformes	Auchenipteridae	*Tatia*	*intermedia*	Catfish				√*			
Siluriformes	Auchenipteridae	*Trachelyopterus*	*galeatus*	Imehri			√	√	√		√
Siluriformes	Callichthyidae	*Callichthys*	*callichthys*	Hassa/Hassar				X		√	
Siluriformes	Callichthyidae	*Hoplosternum*	*littorale*	Hassa/Hassar			√	X			
Siluriformes	Doradidae	*Acanthodoras*	*cataphractus*	Zip fish/Spiny catfish/ Chocolate raphael							√
Siluriformes	Doradidae	*Amblydoras*	*hancockii*	Armoured catfish/Blue-eyed catfish							√
Siluriformes	Doradidae	*Doras*	spp.	Zip fish		√					
Siluriformes	Heptapteridae	*Pimelodella*	spp.	Catfish		√		√*			√
Siluriformes	Loricariidae	*Farlowella*	spp.	Armoured twig catfish/ Stick catfish							√
Siluriformes	Loricariidae	*Hypoptopoma*	*guianense*	Armoured catfish							√

APPENDIX 2 - FISH

Order	Family	Genus	Species	Common Name/ Local Name	MMA Conservancy	EDW Conservancy	Canje Basin	Essequibo Coast	North West Freshwater	North West Brackish	Rupununi
Siluriformes	Loricariidae	*Hypostomus*	*plycostomus*	Smoke Hassar'	√						
Siluriformes	Loricariidae	*Hypostomus*	*punctatus*	Smoke Hassa/Hassar/ Spotted hypostomus							√
Siluriformes	Loricariidae	*Hypostomus*	*squalinus*	Smoke Hassa/Hassar							√
Siluriformes	Loricariidae	*Loricaria*	*cataphracta*	Armoured catfish/Choco-late loricariid			√				√
Siluriformes	Loricariidae	*Rineloricaria*	spp.	Whip-tailed catfish							√
Siluriformes	Pimelodidae	*Hemisorubim*	*platyrhynchos*	Porthole shovelnose catfish							√
Siluriformes	Pimelodidae	*Pimelodus*	*blochii*	Four-lined pimelodella catfish/Bloch's catfish							√
Siluriformes	Pimelodidae	*Pinirampus*	*pirinampu*	Flat-whiskered catfish				√			
Siluriformes	Pimelodidae	*Pseudoplatystoma*	*fasciatum*	Barred sorubim				√			
Siluriformes	Pseudopimelodidae	*Microglanis*	*poecilus*	Dwarf marbled catfish							√
Siluriformes	Pseudopimelodidae	*Pseudopimelodus*	spp.	Catfish							√
Synbranchiformes	Synbranchidae	*Synbranchus*	*marmoratus*	Marbled swamp eel/Com-mon eel/Mud eel			√				√

APPENDIX 2 - INSECTS

Order	Family	Subfamily/ Genus/Tribe	Species	Common Name/ Local Name	MMA	EDWC	Lower Canje Basin	Essequibo Coast	North West Fresh water	North West Brackish water	Rupununi	Ecological Function	Primary Habitat
Coleoptera	-	-	-	Aquatic beetle larva	√	√	√	√	√	√	√	Carnivorous	Aquatic
Coleoptera	Attelabidae	-	-	Leaf-rolling weevil			√	√				Herbivorous	Land
Coleoptera	Bruchidae	-	-	Seed beetle		√			√	√	√	Herbivorous	Land
Coleoptera	Buprestidae	-	-	Jewel beetle	√		√	√	√		√	Herbivorous	Land
Coleoptera	Cantharidae	-	-	Solider beetle					√			Carnivorous	Land
Coleoptera	Carabidae	-	-	Ground beetle							√	Carnivorous	Land
Coleoptera	Cerambycidae	-	-	Longhorn beetle				√		√		Herbivorous	Land
Coleoptera	Chrysomelidae	*Alticinae*	-	Flea beetle	√	√	√	√	√		√	Herbivorous	Land/Semi- aquatic
Coleoptera	Chrysomelidae	*Cassidinae*	-	Tortoise beetle			√					Herbivorous	Land
Coleoptera	Chrysomelidae	*Crypto-cephalinae*	-	Leaf beetle			√	√				Herbivorous	Land
Coleoptera	Chrysomelidae	*Diabrotica*	spp.	Leaf beetle/Cucumber beetle				√			√	Herbivorous	Land
Coleoptera	Chrysomelidae	*Epitrix*	spp.	Flea beetle			√					Herbivorous	Land
Coleoptera	Chrysomelidae	*Eumolpinae*	-	Leaf beetle	√	√	√	√	√	√	√	Herbivorous	Land/Semi-aquatic
Coleoptera	Chrysomelidae	*Hispinae*	-	Leaf beetle					√			Herbivorous	Land
Coleoptera	Chrysomelidae	*Lamproso-matinae*	-	Leaf beetle				√				Herbivorous	Land
Coleoptera	Chyrsomelidae	*Galerucinae*	-	Leaf beetle		√						Herbivorous	Land
Coleoptera	Cicindelidae	-	-	Tiger beetle	√							Carnivorous	Land
Coleoptera	Coccinellidae	-	-	Ladybird	√	√	√	√	√	√	√	Carnivorous	Land
Coleoptera	Curculionidae	-	-	Weevil	√	√	√	√	√	√	√	Herbivorous	Land
Coleoptera	Curculionidae	-	-	Aquatic weevil				√				Herbivorous	Semi-aquatic
Coleoptera	Dysticidae	-	-	Diving water beetle		√	√	√	√	√	√	Carnivorous	Aquatic
Coleoptera	Gyrinidae	-	-	Whirligig beetle			√	√	√	√	√	Carnivorous	Aquatic
Coleoptera	Hydrophilidae	-	-	Water scavenger beetle			√	√			√	Carnivorous	Aquatic
Coleoptera	Lampyridae	-	-	Candle fly/Firefly		√	√					Carnivorous/ Pollen feed-ers	Land
Coleoptera	Scarabaeidae	-	-	Dung beetle		√	√			√	√	Decompos-ers	Land
Coleoptera	Scarabaeidae	*Melolonthini*	-	Plant-feeding dung beetle				√				Herbivorous	Semi-aquatic
Coleoptera	Scolytidae	-	-	Wood beetle			√				√	Herbivorous	Land
Coleoptera	Tenebrionidae	-	-	Darkling beetle	√	√		√	√	√	√	Decompos-ers	Land
Dictyoptera	Blattodea	-	-	Roach	√		√	√	√		√	Decompos-ers	Land
Dictyoptera	Mantodea	-	-	Praying mantis				√	√		√	Carnivorous	Land
Dictyoptera	Phasmatodea	-	-	Stick insect/ Walking stick			√					Carnivorous	Land
Diptera	-	-	-	Aquatic dipteran larva	√	√	√	√	√	√	√	Filter feed-ers	Aquatic
Diptera	-	-	-	Aquatic dipteran pupa	√	√	√	√	√	√	√	-	Aquatic
Diptera	Anthomyiidae	-	-	Flower fly	√	√	√		√		√	Carnivorous/ Herbivores	Land
Diptera	Asilidae	-	-	Robber fly				√		√	√	Carnivorous	Land
Diptera	Bombyliidae	-	-	Bee fly	√					√		Carnivorous/ Pollinators	Land
Diptera	Calliphoridae	-	-	Carrion fly	√	√	√	√	√	√	√	Scavengers/ Pollinators	Land

APPENDIX 2 - INSECTS

Order	Family	Subfamily/ Genus/Tribe	Species	Common Name/ Local Name	MMA	EDWC	Lower Canje Basin	Essequibo Coast	North West Fresh water	North West Brackish water	Rupununi	Ecological Function	Primary Habitat
Diptera	Cecidomyiidae	-	-	Gall midge		√						Herbivores/ Carnivores	Land
Diptera	Chironomidae	-	-	Lake fly/Blood worm	√	√	√	√				Scavengers	Semi-aquatic/ Aquatic
Diptera	Chironomidae	*Chironomus*	spp.	Lake fly/Blood worm	√	√	√	√			√	Scavengers	Land/Semi-aquatic
Diptera	Culicidae	-	-	Mosquito	√	√	√	√	√	√	√	Parasites	Land/Semi-aquatic
Diptera	Ephydridae	-	-	Shore fly	√	√	√		√	√		Herbivorous	Land/Semi-aquatic
Diptera	Ephydridae	*Ochthera*	spp.	Shore fly	√	√						Herbivorous	Land/Semi-aquatic
Diptera	Micropezidae	-	-	Stilt-legged fly	√							Saprophagous /Scavengers	Land/Semi-aquatic
Diptera	Muscidae	*Musca*	*domestica*	Common housefly	√	√	√	√	√	√	√	Decomposers	Land
Diptera	Other Nematoceran	-	-	-		√		√			√		
Diptera	Platystomatidae	-	-	Signal fly		√						Saprophagous/ Scavenger	Land
Diptera	Psychodidae	-	-	Moth Fly	√								
Diptera	Simuliidae	-	-	Black fly	√	√	√		√	√		Decomposers -Carrion	Land
Diptera	Syrphidae	-	-	Hoverfly	√	√	√	√	√	√	√	Saprophagous/Carnivorous	Land
Diptera	Tabanidae	-	-	Horse fly	√		√			√	√	Carnivorous	Semi-aquatic/ Aquatic
Diptera	Tachinidae	-	-	True fly	√	√	√			√	√	Carnivorous	Land
Diptera	Tephritidae	-	-	Fruit fly		√		√				Herbivorous	Land
Embioptera	Clothodidae	-	-	Web-spinner		√	√		√			Herbivorous	Land
Ephemeroptera	Baetidae	-	2 spp.	Mayfly	√	√	√	√	√	√	√	Herbivorous/ Filter feeders	Aquatic
Ephemeroptera	Heptageniidae	-	2 spp.	Mayfly	√							Herbivorous/ Filter feeders	Aquatic
Hemiptera	Achilidae	-	-	Planthopper	√	√		√	√	√	√	Herbivorous	Land/Semi-aquatic
Hemiptera	Aleyrodidae	-	-	Whitefly	√							Herbivorous	Land
Hemiptera	Aphididae	-	-	Aphid	√					√		Herbivorous	Land
Hemiptera	Aphididae	*Myzus*	spp.	Aphid	√	√					√	Herbivorous	Land
Hemiptera	Auchenorrhyncha	-	-	Planthopper nymph			√					Herbivorous	Land
Hemiptera	Belostomatidae	-	-	Giant water bug		√	√	√				Carnivorous	Aquatic
Hemiptera	Cercopidae	-	-	Froghopper							√	Herbivorous	Land
Hemiptera	Cicadellidae	-	-	Leafhopper	√	√	√	√	√	√	√	Herbivorous	Land
Hemiptera	Cicadellidae	-	-	Semi-aquatic leafhopper	√	√	√	√			√	Herbivorous	Land/Semi- aquatic
Hemiptera	Cicadellidae	*Idiocerinae*	-	Leafhopper	√	√	√					Herbivorous	Land/Semi-aquatic
Hemiptera	Cicadidae	-	-	Cicada				√				Herbivorous	Land
Hemiptera	Cixiidae	-	-	Planthopper	√	√	√	√			√	Herbivorous	Land
Hemiptera	Coreidae	-	-	Leaf-footed bug	√	√	√	√			√	Herbivorous	Land
Hemiptera	Corixidae	-	-	Water boatman	√	√	√	√				Carnivorous	Aquatic

APPENDIX 2 - INSECTS

Order	Family	Subfamily/ Genus/Tribe	Species	Common Name/ Local Name	MMA	EDWC	Lower Canje Basin	Essequibo Coast	North West Fresh water	North West Brackish water	Rupununi	Ecological Function	Primary Habitat
Hemiptera	Delphacidae	-	-	Planthopper		√	√	√	√			Herbivorous	Land
Hemiptera	Derbidae	-	-	Planthopper			√	√	√	√	√	Herbivorous	Land
Hemiptera	Dictyopharidae	-	-	Planthopper								Herbivorous	Land
Hemiptera	Fulgoridae	-	-	Fulgoroid				√	√		√	Herbivorous	Land
Hemiptera	Gerridae	-	-	Water strider	√	√	√	√	√	√	√	Carnivorous	Aquatic
Hemiptera	Heteroptera	-	-	Others- bugs			√					Herbivorous/ Carnivorous	Land
Hemiptera	Issidae	-	-	Planthopper		√	√					Herbivorous	Land
Hemiptera	Lygaeidae	-	-	Plant bug		√						Herbivorous	Land
Hemiptera	Membracidae	-	-	Froghopper	√	√	√	√	√		√	Herbivorous	Land
Hemiptera	Miridae	-	-	Plant bug	√	√	√	√	√	√	√	Herbivorous/ Carnivorous	Land
Hemiptera	Nepidae	-	-	Water stick insect		√		√			√	Carnivorous	Aquatic
Hemiptera	Notonectidae	-	-	Backswimmer	√	√	√	√				Herbivorous	Land
Hemiptera	Pentatomidae	-	-	Plant stink bug	√	√	√	√	√		√	Herbivorous	Land
Hemiptera	Plataspididae	-	-	Shield bug			√					Herbivorous	Land
Hemiptera	Pseudococ-cidae	-	-	Mealybug				√				Herbivorous	Land
Hemiptera	Psyllidae	-	-	Plant lice				√				Carnivorous	Land
Hemiptera	Reduviidae	-	-	Assassin bug	√		√					Herbivorous/ Carnivorous	Land
Hemiptera	Tingidae	-	-	Lacewing bug			√	√			√	Herbivorous	Land
Hemiptera	Tropiduchidae	-	-	Planthopper	√							Herbivorous	Land
Hymenoptera	-	-	-	Others- wasps	√		√	√			√	Pollinators	Land
Hymenoptera	Apidae	-	-	Honey bee				√		√	√	Population regulators	Land
Hymenoptera	Brachonidae	-	-	Parasitic wasp		√	√	√				Population regulators	Land
Hymenoptera	Chalcididae	-	-	Parasitic wasp	√	√	√					Pollinators	Land
Hymenoptera	Euglossinae	-	-	Green bee				√				Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Other- Ants	√	√	√	√	√	√	√	Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Black ant	√	√	√	√	√	√	√	Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Formicine ant	√	√	√	√	√	√		Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Cop-cop ant		√		√			√	Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Myrmicine or fire ant			√	√			√	Decompos-ers	Land
Hymenoptera	Formicidae	-	-	Ponerine ant	√		√		√	√		Decompos-ers	Land
Hymenoptera	Ichneumonoi-dea	-	-	Parasitic wasp	√	√	√	√			√	Parasitic	Land
Hymenoptera	Sphecidae	*Dasyproc-tus*	spp.	-							√	Herbivorous	Land
Hymenoptera	Vespidae	-	-	Wasp	√			√			√	Decompos-ers	Land
Isoptera	-	-	-	Wood ant		√		√			√	Herbivorous	Land

APPENDIX 2 - INSECTS

Order	Family	Subfamily/ Genus/Tribe	Species	Common Name/ Local Name	MMA	EDWC	Lower Canje Basin	Essequibo Coast	North West Fresh water	North West Brackish water	Rupununi	Ecological Function	Primary Habitat
Lepidoptera	-	-	-	Moth		√	√	√				Herbivorous	Land
Lepidoptera	Hesperidae	-	-	Skipper butterfly	√	√	√	√				Herbivorous	Land
Lepidoptera	Lycaenidae	-	-	Other-yellows			√		√	√		Herbivorous	Land
Lepidoptera	Lycaenidae	*Thecla*	spp.	-			√	√				Herbivorous	Land
Lepidoptera	Noctuidae	-	-	Looper caterpillar				√				Herbivorous	Land
Lepidoptera	Nymphalidae	*Agraulis*	*vanillae*	Passion butterfly				√		√		Herbivorous	Land
Lepidoptera	Nymphalidae	*Anartia*	spp.				√			√		Herbivorous	Land
Lepidoptera	Nymphalidae	*Anartia*	*jatrophae*	White peacock butterfly								Herbivorous	Land
Lepidoptera	Nymphalidae	*Dryadula*	*phaetusa*	Orange tiger butterfly	√		√					Herbivorous	Land
Lepidoptera	Nymphalidae	*Hamadryas*	spp.	Cracker butterfly			√					Herbivorous	Land
Lepidoptera	Nymphalidae	*Heliconius*	*erato*	Red postman	√						√	Herbivorous	Land
Lepidoptera	Nymphalidae	*Junonia*	*evarete*	Peacock butterfly/Man-grove buckeye				√		√		Herbivorous	Land
Lepidoptera	Nymphalidae	*Philaethria*	*dido*	Dido longwing				√				Herbivorous	Land
Lepidoptera	Papilionidae	*Battus*	spp.	Swallowtail								Herbivorous	Land
Lepidoptera	Pieridae			Whites and yellows -but-terfly						√		Herbivorous	Land
Lepidoptera	Pieridae	*Aphrissa*	spp.	Sulphur butterfly			√					Herbivorous	Land
Lepidoptera	Pieridae	*Aphrissa*	*statira*	Statira sulphur butterfly	√							Herbivorous	Land
Lepidoptera	Pieridae	*Eurema*	spp.	Grass-yellow butterfly			√					Herbivorous	Land
Lepidoptera	Pieridae	*Phoebis*	spp.	Sulphur butterfly	√		√					Herbivorous	Land
Lepidoptera	Pieridae	*Phoebis*	*sennae*	Cloudless sulphur but-terfly				√				Herbivorous	Land
Lepidoptera	Riodinidae	-	-	Metalmarks butterfly							√	Herbivorous	Land
Lepidoptra	Nymphalidae	*Danaus*	*plexippus*	Monarch butterfly			√					Herbivorous	Land
Lepidoptra	Nymphalidae	*Dryas*	*iulia*	Brush-footed butterfly			√					Herbivorous	Land
Megaloptera		-	-	Alderflies	√		√	√				Herbivorous	Land
Odonata	Anisoptera	-	-	Dragonfly naiad	√	√	√	√	√	√	√	Carnivorous	Aquatic
Odonata	Anisoptera	-	-	Dragonfly	√	√	√	√	√	√	√	Carnivorous	Semi-aquatic
Odonata	Zygoptera	-	-	Damselfly	√	√	√	√	√	√	√	Carnivorous	Semi-aquatic
Odonata	Zygoptera	-	-	Damselfly naiad	√	√	√	√	√	√	√	Carnivorous	Aquatic
Odonata	Zygoptera	*Acanthagri-on*	spp.	Damselfly	√	√	√					Carnivorous	Semi-aquatic
Odonata	Zygoptera	*Coenagri-onidae*	-	Damselfly					√			Carnivorous	Semi-aquatic
Odonata	Zygoptera	*Ischnura*	spp.	Damselfly	√	√	√					Carnivorous	Semi-aquatic
Orthoptera	Acrididae	-	-	Grasshopper	√	√	√	√	√	√	√	Herbivorous	Land/Semi-aquatic
Orthoptera	Acrididae	-	-	Aquatic grasshopper	√			√			√	Herbivorous	Land/Semi-aquatic
Orthoptera	Gryllotalpidae	-	-	Mole cricket		√	√					Herbivorous	Land
Orthoptera	Tetrigidae	-	-	Pygmy grashopper	√			√				Herbivorous	Land/Semi-aquatic
Orthoptera	Tettigoniidae	-	-	Bush cricket/ Longhorn ‘grasshopper’	√	√	√	√	√	√	√	Herbivorous	Land
Orthoptera	Tridactylidae	-	-	Pygmy mole cricket	√	√						Herbivorous	Land
Plecoptera	-	-	-	Stonefly		√	√	√	√			Detritivo-rous/ Car-nivorous	Aquatic
Thysanoptera	-	-	-	Thrips					√			Herbivorous	Land
Trichoptera	-	-	-	Caddisfly				√				Detritivorous	Aquatic

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