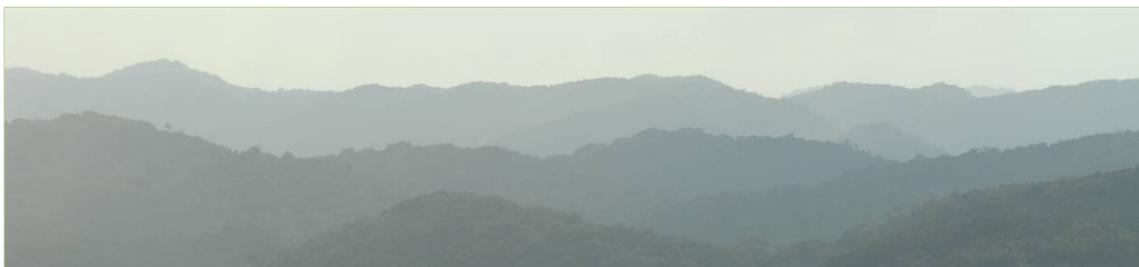




**Baseline Analysis of Biodiversity Impacts
of
Tourism Activity
in
Mountain Pine Ridge Forest Reserve
and
Chiquibul Forest Reserve**





Many thanks to:

**Members of the Forest Department
Members of the Cayo Tour Guide Association
Tour Guides
Tour Operators
Hotels and Lodges
Friends for Conservation and Development
Chris Minty
Sam Bridgewater**

For their input into this analysis



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Contents

Introduction	1
Physical and Ecoregional Characteristics	3
Summary of Tourism Activities	10
Summary of Non-Tourism Activities	13
A. The Project Area	15
1. Overview of Protected Areas	19
Mountain Pine Ridge Forest Reserve	19
Chiquibul Forest Reserve	21
Current Tourism Sites	22
2. Overview of Ecosystems	27
3. Overview of Species of Concern of Mountain Pine Ridge	37
Endemic Species	37
Species of Concern	38
Other Species	41
Population Trends	46
4. Waste Disposal	47
Human Waste	47
Solid Waste	48
5. Water Quality	50
6. Air Quality	54
7. Visitor Number and Trends	56
Visitor Numbers and Seasonal Flow	56
8. Visitor Experience	60
9. Local Communities	61
10. Threats to Human Health and Safety	63
11. Other Identified Issues	65
B. Major environmental issues: Matrix	76
C. Proposed Indicators	81
Annexes	
Annex One:	Baseline
Annex Two:	Monitoring Manual

Tables		
Table 1	Protected Area Categories, NPAPSP	1
Table 2	Focal Areas	3
Table 3	Tourism Sites	10
Table 4	Lodges within the Mountain Pine Ridge area	11
Table 5	A Sample of Tour Operators using Mountain Pine Ridge FR / Chiquibul FR	12
Table 6	Non Tourism Activities	13
Table 7	Protected Areas of the Project Area	16
Table 8	Protected Areas containing other sites	16
Table 9	Overview of Current Facilities at Tourism Sites in Mountain Pine Ridge Forest Reserve (January, 2007)	26
Table 10	Under-represented Ecosystems in Belize	31
Table 11	Ecosystems of the Project Area – Extent	32
Table 12	Ecosystems of the Project Area – Description, Location and Identified Threats	33
Table 13	Species of Concern - Mountain Pine Ridge	43
Table 14	Status of Species of Concern - Mountain Pine Ridge / Chiquibul Forest Reserves	44
Table 15	Sewage Disposal in the Project Area	47
Table 16	Solid Waste Disposal	48
Table 17	Results of Site Assessment for Litter (January, 2007)	49
Table 18	Summary of Water Quality Guidelines	51
Table 19	Water Quality Data from Macal and Rio On, downstream of project area, 2005	52
Table 20	Summary of Air Pollution Baseline (January, 2007)	54
Table 21	Summary of Noise Pollution (January, 2007)	55
Table 22	Tourism Statistics for Project Area	56
Table 23	Summary of Site Use (January 2007)	58
Table 24	Visitor Profile for Mountain Pine Ridge	59
Table 25	Summary of Visitor Days for Las Cuevas	59
Table 26	Principal Communities of the Project Area	61
Table 27	Total numbers of Accident for the last 6 months, for ten tour guides	63
Table 28	Management Characteristics of the Project Area	71
Table 29	Forest Resource Planning and Management Programme: Goals and Objectives for Mountain Pine Ridge Forest Reserve, 2006 - 2007	72
Table 30	Forest Department Workplan Objectives	73
Table 31	Legislation relevant to protection of the Mountain Pine Ridge / Chiquibul Forest Reserves	74
Table 32	Matrix of Major Environmental Issues	77
Maps		
Map 1	General Location of Project Area	2
Map 2	Elevation Map of Mountain Pine Ridge Forest Reserve	4
Map 3	Elevation Map of Chiquibul Forest Reserve	5
Map 4	Hydrology of the Project Area and Belize River Watershed within Belize	7
Map 5	Tourism Sites of Mountain Pine Ridge Forest Reserve	17
Map 6	Tourism Sites of Chiquibul Forest Reserve	18
Map 7	The Maya Mountain Massif	20
Map 8	Broad Ecosystems of the Project Area	28
Map 9	Ecosystems of the Mountain Pine Ridge Forest Reserve	29
Map 10	Ecosystems of the Chiquibul Forest Reserve	30
Map 11	British Forces Training Area in Chiquibul Forest Reserve	70

Photographs		
Photograph 1	Fast flowing waterfalls – one of the components of the hydrology of the Mountain Pine Ridge the Mountain Pine Ridge	6
Photograph 2	Petén-Veracruz Moist Forest	9
Photograph 3	Belizean Pine Forest	9
Photograph 4	Effects of the Southern Pine Bark Beetle on Needle-leaved Forest. Orchid Cascade	27
Photograph 5	<i>Dalechampia schippii</i>	37
Photograph 6	Morelet's Treefrog (<i>Agalychnis moreletii</i>) – Caracol aguada	39
Photograph 7	Yucatan Black Howler Monkey (<i>Alouatta pigra</i>)	39
Photograph 8	Chac's Rainfrog (<i>Caugastor chac</i>), Rio Frio Caves	40
Photograph 9	Sundew	42
Photograph 10	<i>Sobralia macrantha</i>	42
Photograph 11	<i>Schippia concolor</i>	42
Photograph 12	Big Rock Falls, a favoured swimming location for active visitors to Mountain Pine Ridge	60
Photograph 13	Caracol	66
Photograph 14	Las Cuevas	66
Photograph 15	Sign advising on entry to military training areas	68
Figures		
Figure 1	Ecoregion Classification for Mountain Pine Ridge Forest Reserve	8
Figure 2	Tour Operators: An example of Responsible Travel	14
Figure 3	Annual visitation to the project area between 1996 and 2005	57
Figure 4	Annual non-cruise ship visitation to between 1998 and 2005	57
Figure 5	Average monthly visitation to the project area between 1996 and 2005	58
References		106

Baseline Analysis of Biodiversity Impacts of Tourism Activity in the Mountain Pine Ridge and the Chiquibul Forest Reserves

Introduction

Tourism has fast become one of the major industries in Belize, contributing approximately 16% towards the gross domestic product in 2004. It is also one of the main employers, estimated to provide employment for one in four people (BTB, 2005). The major attractions for visitors are the cultural and natural resources, both marine and terrestrial. Included in these attractions are the waterfalls and wide open vistas of the globally significant Mountain Pine Ridge, and the biodiversity-rich matrix of tropical broadleaved forests in the Chiquibul.

This document forms part of Programme for Belize’s strategy for mainstreaming biodiversity conservation in the tourism industry in Belize through the development and dissemination of ecosystem-specific best practices for sustainable tourism. The PfB project seeks to achieve this by working with tourism operations to conserve biodiversity in Belize, creating a supply of sustainable tourism services that are linked with the market demand for sustainable tourism.

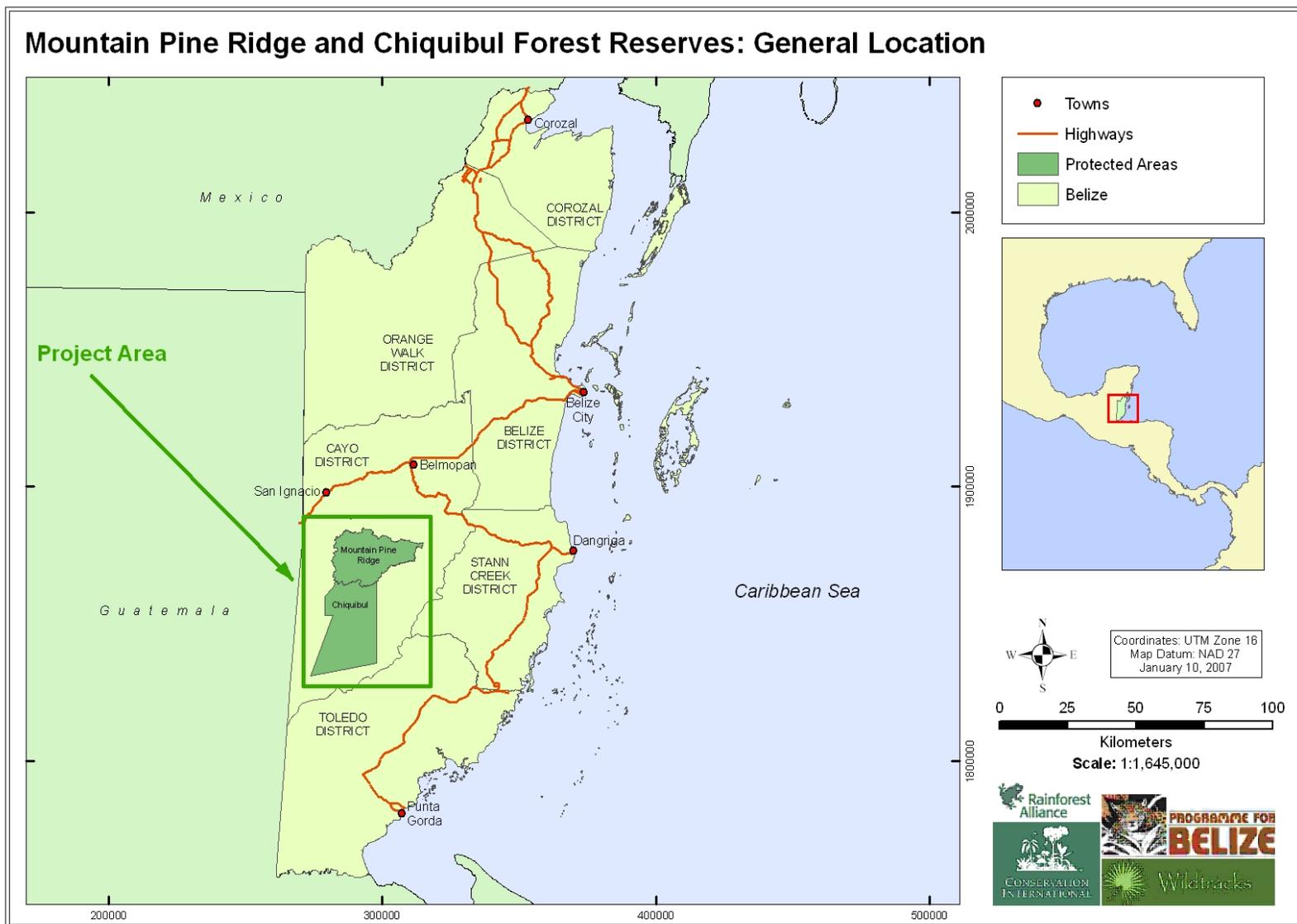
The goal of this consultancy is to provide baseline information on the ecosystems and human impacts, measuring and assessing the use and impact of tourism within the Mountain Pine Ridge and Chiquibul Forest Reserves. There is a special focus on tourism, to determine whether or not tourists have negative and / or positive impacts on these ecosystems and the potential impacts of tourism in the future. It also considers whether tour providers show responsible environmental and social practices.

The consultancy identifies and develops indicators, and the protocols to be used to monitor these indicators over time, in comparison with the baseline, as a part of an integrated Monitoring and Evaluation system. The need for monitoring and evaluation, and the subsequent implementation of specific strategies and actions to mitigate identified negative impacts, is critical if tourism use of the two target areas – the Mountain Pine Ridge and Chiquibul Forest Reserves - is to be environmentally sustainable. To be effective, the monitoring framework needs to be closely linked with the environmental management of the area, and with the objectives and activities of the tourism stakeholders.

Target Area

Mountain Pine Ridge and Chiquibul are two of the seventeen Forest Reserves within the National Protected Areas System of Belize. Of the seven different protected area categories (Table 1), Forest Reserves are the only national management category established for extractive use, with many being managed for timber extraction. Both lie on the Maya Mountain Plateau in Cayo District, in the west of Belize (Map 1). A third protected area – Thousand Foot Falls Natural Monument, is also included within the target area as a management unit of Mountain Pine Ridge, as is Big Rock Falls, a site that many tour guides are starting to incorporate in their Mountain Pine Ridge itineraries, located on the border of Eligio Panti National Park.

Table 1: Protected Area Categories, NPAPSP
Forest Reserve
National Park
Natural Monument
Wildlife Sanctuary
Nature Reserve
Marine Reserve
Archaeological Reserve



Map One: General Location of Project Area

A. Lloyd / Wildtracks
 See: Metadata

The project area has been identified as part of an ecoregional priority under several conservation planning initiatives, falling within the Conservation International **Key Biodiversity Area**, and being highlighted as one of The Nature Conservancy’s ecoregional priority areas – the **Maya Mountain Massif**.

Report Layout

The **Introduction** contains a summary of the Physical and **Ecoregional Characteristics, Tourism and Non-Tourism Activities** within the project area.

To avoid repetition, the main body of the report, Section A (**The Project Area**), contains eleven focal areas being considered within the baseline analysis (Table 2), each with a description of the **Current Status** of the focal area, a summary of the **Baseline Assessment** conducted in 2006, and **Recommendations** for ways in which the protected area managers and the tourism sector can use Best Practices to reduce or prevent future impacts.

Table 2: Focal Areas
1. Overview of Protected Areas
2. Ecosystems
3. Species of Concern
4. Waste Disposal
5. Water Quality
6. Air Quality
7. Visitor Numbers and Trends
8. Visitor Experience
9. Local Communities
10. Human Health
11. Other Issues

Section B (**Analysis of Major Environmental Issues**) seeks to summarize the assessment results and recommendations highlighted in the previous section

Section C presents the **Proposed Indicators**, developed during the analysis, and refined following consultation with tour guides using the Mountain Pine Ridge / Chiquibul area.

The Annexes contain the associated reports – the 2006 **Baseline** for each of the tourism sites within the project area, and the **Monitoring Manual**.

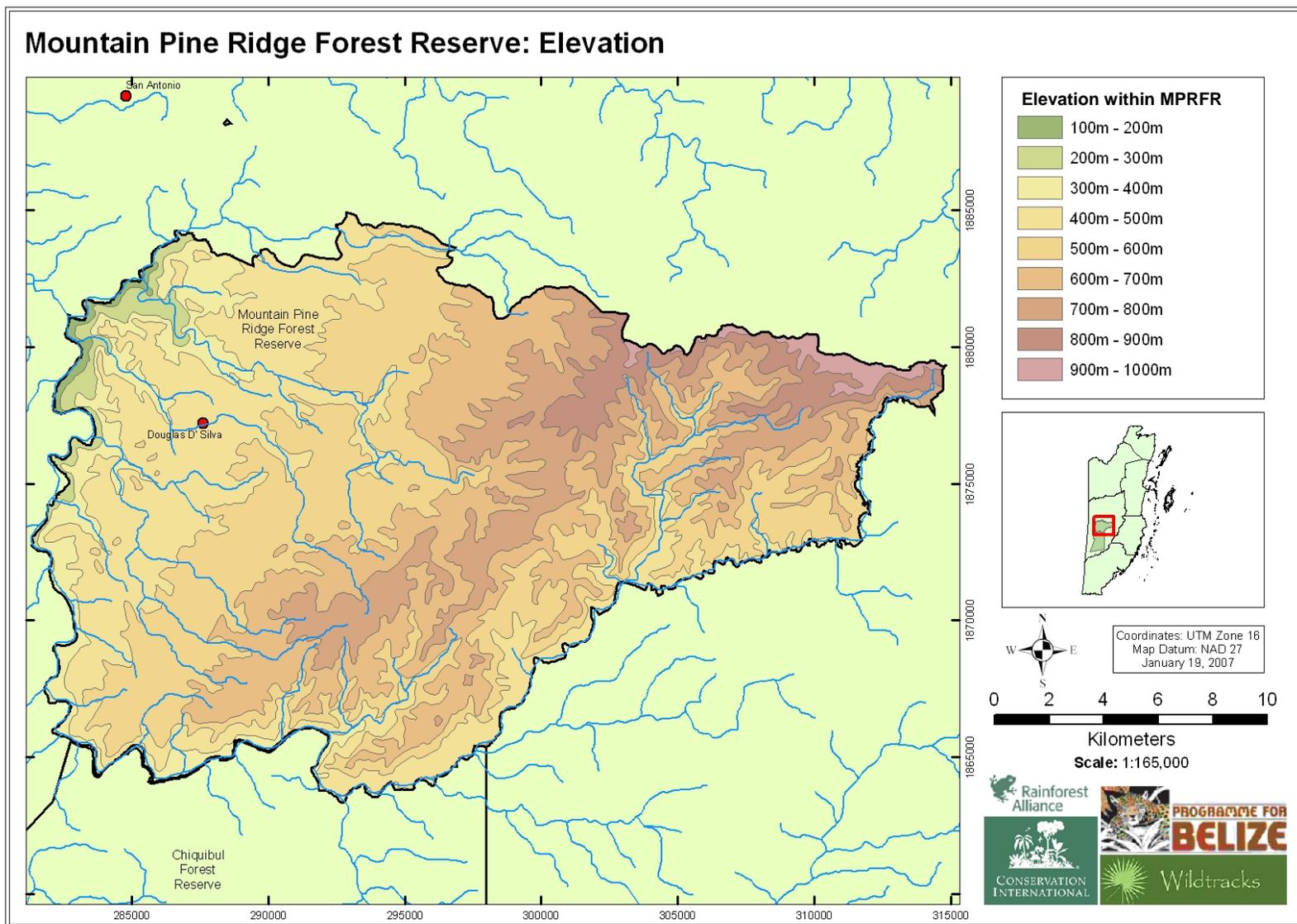
▪ **Physical and Ecoregional Characteristics**

Geology

The Maya Mountain Massif forms the prominent elevated area to the south west of Belize, and includes the metasediments of the Santa Rosa Group, some of the oldest rocks in Central America, deposited in the Carboniferous and Permian Periods some 225 to 350 million years ago (Ower, 1928; Dixon, 1956; Bateson and Hall, 1977).

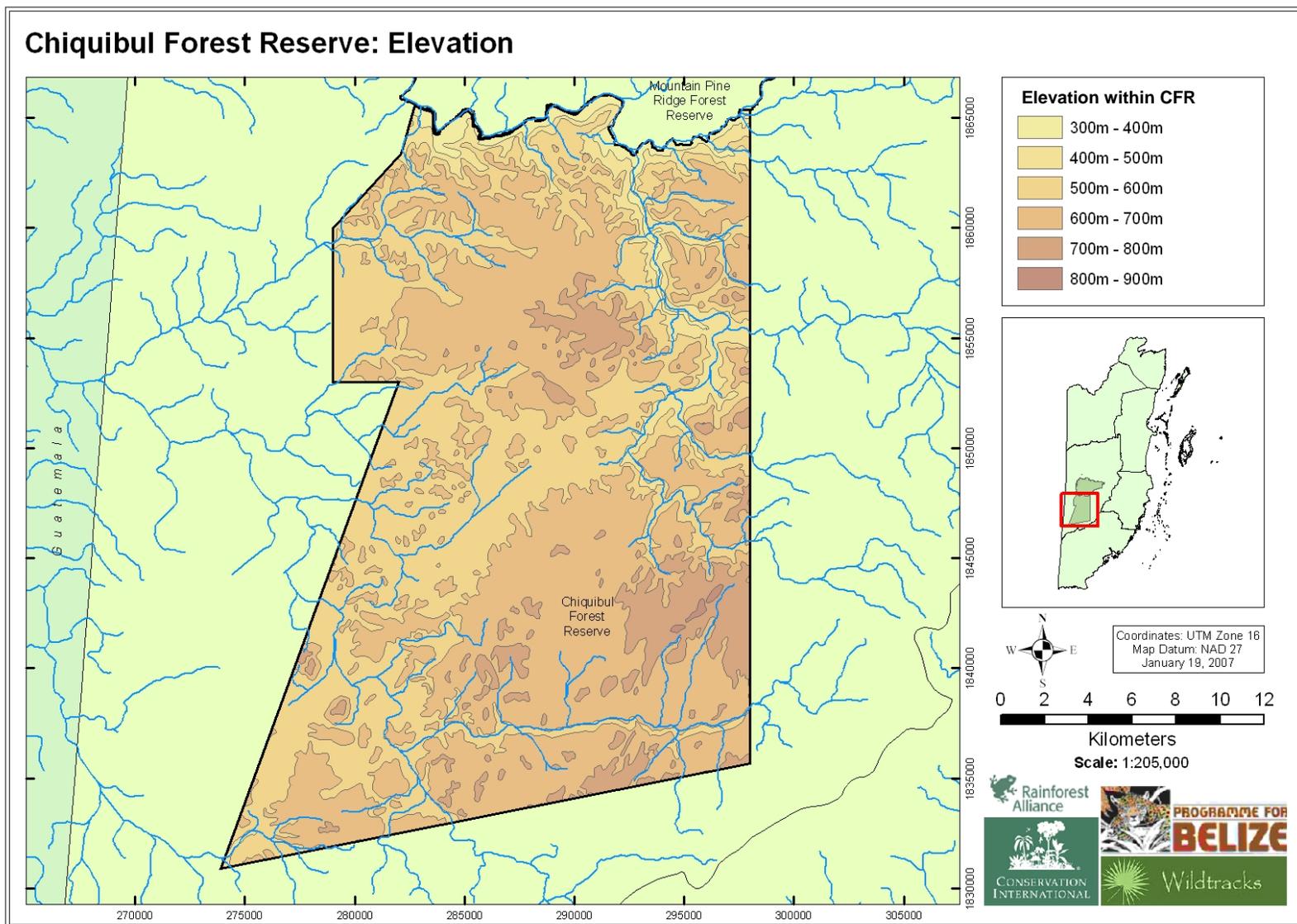
In early Triassic times (195 to 230 million years ago), these metasediments were subjected to tectonic uplift along two major fault systems – the Northern Boundary Fault to the northern edge of the Mountain Pine Ridge area, and the Little Quartz Ridge - Bladen Fault to the south of the Chiquibul Forest area. This uplift was accompanied by granite intrusions, clearly visible in the Mountain Pine Ridge area today. By the end of the Jurassic Period, the landmass began to subside and rift valley type basins began to form. In the early Cretaceous Period these rift valleys were flooded by oceanic waters and fossiliferous limestones were deposited over the entire area.

The beginning of the Tertiary Period (65 million years ago) saw renewed tectonic uplift, which has shaped the present topography, resulting in the formation of an upland plateau that dips gently to the west. Weathering of the limestone capping and erosion by stream action has exposed the underlying granite in some areas such as the Mountain Pine Ridge, and resulted in limestone formations of arches, sink holes and caves in others, including Chiquibul, evolving through time to become the present day Maya Mountain plateau (Maps 2 and 3).



Map Two: Elevation Map of Mountain Pine Ridge Forest Reserve

A. Lloyd / Wildtracks
See: Metadata



Map Three: Elevation Map of Chiquibul Forest Reserve

A. Lloyd / Wildtracks
See Annex Three: Metadata

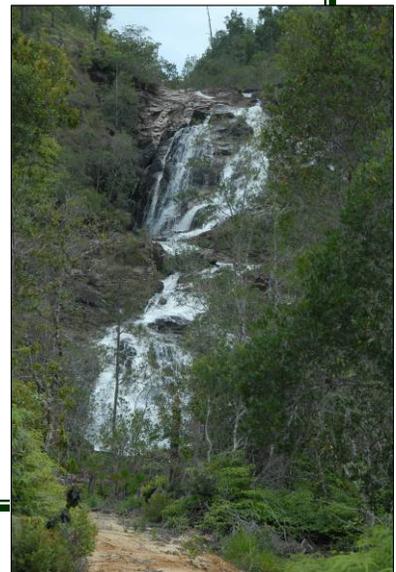
Hydrology

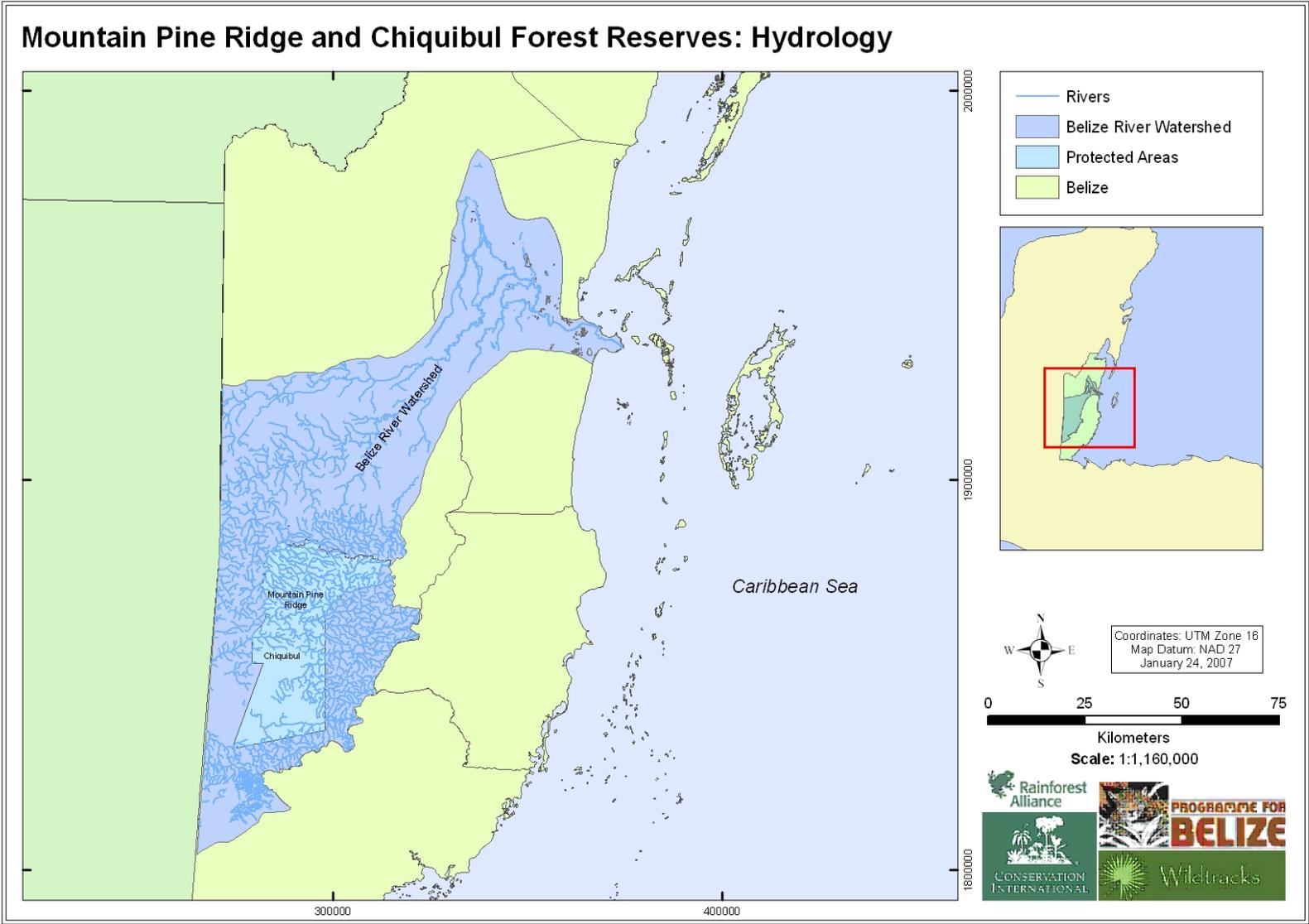
The Maya Mountain / Chiquibul area forms part of the upper drainage basin of the Belize River Watershed. With the gentle slope of the plateau to the west, sub-basins within the project area all align east-west, draining into the Macal and Mopan Rivers, then flowing north, then eventually east, into the Belize River, to enter the Caribbean Sea on the east coast of Belize (Map 4). The Belize River Watershed is the largest in Belize, with a total area estimated at 6,352.4 km² (BERDS, 2007), and includes two major tributaries, the Macal and the Mopan rivers. The Macal River drains the Mountain Pine Ridge area via the Rio On, Rio Frio, Raspaculo Branch and a large network of smaller creeks, with a total estimated drainage area of 2355.4km². The geology of the area encourages the formation of fast flowing rivers and steep waterfalls (Photograph 1).

The Mopan River originates from the Chiquibul River of the Chiquibul Forest Reserve, draining an estimated 1020.3km² sub-basin. The abundant karst areas that cap this region result in a series of sink holes and springs through which the river disappears and reappears (including the Chiquibul cave system), emerging in Guatemala, then flowing east back into Belize to join with the Macal River.

A three-stage hydroelectric system has been developed on the system, with two of the dams (Mollejon and Chalillo) being in or partially in the two protected areas. These have altered the flow regime of the system, and created a number of associated environmental impacts, but the majority of impacts on the Belize River watershed as a whole are downstream of the Mountain Pine Ridge / Chiquibul area, with domestic and industrial waste entering in Guatemala, San Ignacio and Spanish Lookout.

Photograph 1:
Fast flowing waterfalls – one of the components of the hydrology of the Mountain Pine Ridge the Mountain Pine Ridge





Map Four: Hydrology of the Project Area and Belize River Watershed within Belize

A. Lloyd / Wildtracks
See: Metadata

Ecoregions

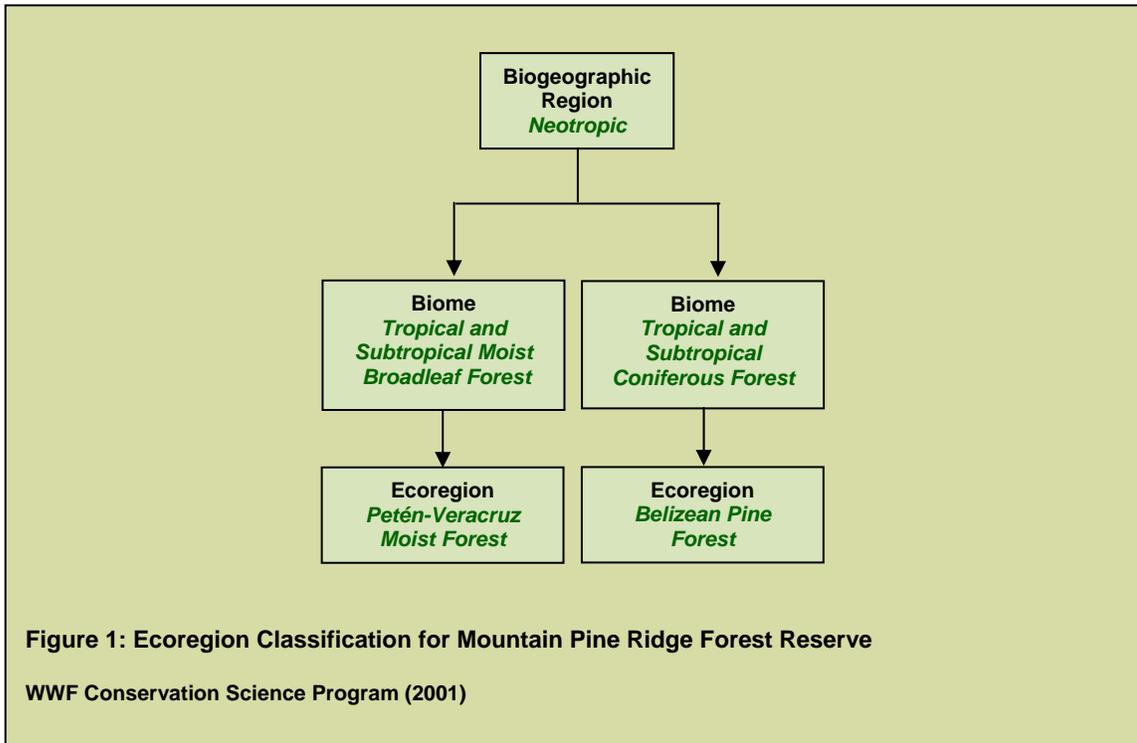
The 'Terrestrial Ecoregions of the World' initiative (Olson et. al., 2001), under the WWF Conservation Science Programme, has developed a broad classification system for ecoregions. Ecoregions can be defined as:

Relatively large units of land containing a distinct assemblage of natural communities sharing a large majority of species, dynamics, and environmental conditions...with boundaries that approximate the original extent of natural communities prior to land use."

WWF Conservation Science Programme, 2001

This initiative divides the terrestrial world into eight biogeographic regions and fourteen biomes (major global plant communities, determined by rainfall and climate). Two of the three biomes represented within Belize are found within the Mountain Pine Ridge / Chiquibul area (Figure 1):

- **Peten-Veracruz Moist Forest**
- **Belizean Pine Forest**



Peten-Veracruz Moist Forest

This large block of tropical forest stretches through Belize, Guatemala and southern Mexico, the northern limit being approximately 22°N, towards the northern extent of Veracruz State in Mexico, with the southern extent reaching approximately 15°N, just north of the southern border of Guatemala.

Throughout their range, these forests tend to be a matrix of moist tropical forest, bajo, wetlands and riparian habitats (Photograph 2). Species-richness is high (though the number of endemic species is low) with a high proportion of tightly linked ecological interactions. Many tree, vertebrate and invertebrate species occur at relatively low densities, resulting in large areas being needed for the support of viable populations, particularly of the larger predators. This ecoregion is classed as 'Critical/ Endangered' (World Wildlife Fund, 2001) as the rate of deforestation increases. Throughout Central America, this result is not only the loss of key predators, but also secondary local extinctions and changes in species composition when these key species are removed. These forests are very susceptible to change, with understory species being sensitive to even small disturbances in the microclimate, making them particularly vulnerable to habitat fragmentation (Olson et. al., 2001).



Photograph 2:
Petén-Veracruz Moist Forest

Most recent impacts on this ecoregion within the project area have been forestry, mining, and, overshadowing all other impacts, the widespread illegal harvesting of xate and associated impacts, by Guatemalans.

Belizean Pine Forest

The Belizean pine forest of the Maya Mountains represents one of the few examples of premontane pine forest in the Neotropics, and is considered to have a global status of 'critical/endangered' (Photograph 3; WWF, 2001). The vegetation, characterized by the presence of the predominant tree species *Pinus caribaea* and *Pinus oocarpa*, incorporates a range of habitats from pure pine stands to mosaics of pine and broadleaf forest, and also includes a number of endemic species restricted to the Pine Forest areas throughout Belize, such as *Dalechampia schippii*. The ecoregion also supports a distinctive bird fauna, with characteristic species such as the red-tailed hawk and black-headed siskin.

Fires, both natural and man-made, are an important process in the maintenance of this ecoregion, reducing understory competition by broadleaf species, and assisting in the seed dispersal of the pine trees.

Photograph 3:
Belizean Pine Forest



Most recent impact on this ecoregion within the project area has been the Southern Pine Bark Beetle, which decimated the pine trees of the area between 2000 and 2002. The area is slowly recovering through both natural regeneration and reforestation management.

▪ Summary of Tourism Activities

The protected areas of the western Maya Mountain plateau attracted over 39,000 visitors in 2005 (FD, 2006), approximately 16,700 (43%) of these passing through primarily to visit the Caracol Archaeological Reserve, stopping at Rio Frio Caves and Rio On Pools en route, the balance focusing on activities within the Mountain Pine Ridge and, to a lesser extent, Chiquibul area.

Eight recreational sites within the Mountain Pine Ridge area have been identified – five currently existing (Rio On Pools, Rio Frio Cave, Pinol Sands, Thousand Foot Falls and Big Rock Falls) and three future sites under development (Table 3; FD, 2006). Whilst Big Rock and Thousand Foot Falls are not within the Mountain Pine Ridge Forest Reserve, they are considered an integral part of the Mountain Pine Ridge tours, and have therefore been included within this project.

There are also plans for the development of Douglas D'Silva as a central hub for tourism activities, and for the future development of a camping ground adjacent to the Chalillo impoundment reservoir.

Table 3: Tourism Sites		
Site	Location (UTM)	
Mountain Pine Ridge Forest Reserve		
Current Sites	North	East
Rio On Pools	289457	1878986
Rio Frio Cave	286413	1878173
Pinol Sands	288997	1881653
Thousand Foot Falls*	302379	1886554
Big Rock*	289757	1884117
Future sites, under development		
Orchid Cascade	289908	1881452
Granite Falls	294851	1879073
Santa Maria Pool	294064	1878438
Chiquibul Forest Reserve		
Current Sites		
Las Cuevas	287300	1851400
Potential future sites		
Natural Arch	281300	1838000
Chiquibul Cave - Kabal	287202	1843340
Monkey Tail Camp	292900	1850400
* Sites within the Mountain Pine Ridge itinerary, but not within the Forest Reserve itself		

The majority of tours to the Mountain Pine Ridge / Chiquibul area originate in San Ignacio or one of the adjacent tourism lodges, and follow a set route, incorporating Rio Frio Cave and Rio On Pools as part of a day trip to Caracol Archaeological Reserve (the Archaeological Reserve is managed under the Institute of Archaeology, and is outside the remit and agreed project area of this consultancy). These two sites therefore receive the bulk of the visitation. Big Rock Falls is gaining popularity as a third site, though primarily for more adventurous visitors due to the problems of accessibility. It is also included within a number of adventure itineraries, and has received significant publicity over recent months in the international media. Pinol Sands, a fourth site, is favoured by local visitors, particularly during public holidays. A number of tour guides also highlight the Five Sisters Falls as a site being used in conjunction with the adjacent Big Rock Falls (both being in the Privassion Enclave area), though as this is within private grounds it has not been included within the assessment.

Chiquibul Forest Reserve has not yet been established as a tourism destination, however there have been a number of tourism initiatives within the Chiquibul Forest area, focused primarily on adventure tourism (expeditions such as Trekforce) and caving. Las Cuevas Research Station, situated within the Forest Reserve, is looking towards tourism activities in the future as a sustainability mechanism (Minty, 2006). Friends for Conservation and Development are also investigating tourism possibilities within the area, and have identified

three sites as potential future focal points for tourism activities – the Natural Arch, Chiquibul Chamber and Monkey Tail Camp (L. Gentle, pers. com.). Whilst not on any official tour itineraries, these locations have been subject to limited visitation – the Natural Arch has been the destination of several adventure tours, including the Toyota Tour 2005, and an independent group using all terrain vehicles.

Chiquibul Cave, reputed to be the longest cave system in Central America, and including the largest known chamber in the Western Hemisphere (Miller, 2000), has been the focus of a series of expeditions throughout recent history, setting the scene for cave adventure tourism combined with research. The third Chiquibul site, Monkey Tail Branch, has been used by the Royal Botanic Gardens, Edinburgh / University of Edinburgh as a botanical field study site (Z. Goodwin, pers. com.).

Access to the Chiquibul Forest Reserve is limited, with roads impassable in wet season from logging, gold mining and military vehicle use. All tours, expeditions and research groups planning to visit the area need to apply for permission from the Forest Department before entering the Forest Reserve, and are currently advised to seek armed support from the Belize Defense Force as a security measure, following the perceived increasing threat from illegal xateros in the area.

▪ **Identified Tourism Stakeholders**

A number of hotels and tour operators have been identified as using the Mountain Pine Ridge area as a tourism resource for their clients. Four of these, Hidden Valley Inn, Five Sisters Lodge, Pine Ridge Lodge and Blancaneaux Lodge, are located within the Mountain Pine Ridge area itself (Table 4).

Table 4: Lodges within the Mountain Pine Ridge area	
Hidden Valley Inn	<p>Occupancy: 12 cottages, 27 beds maximum. Description: 7200 acre private reserve adjacent to Thousand Foot Falls Natural Monument, with Butterfly Falls, Vulture Falls, Secret Pools and Falls on the property 15 resident staff + 15 off, on rotation 1 tour guide on site Tour sites offered: 1000 foot falls, Rio On, Rio Frio, Village experience to San Antonio, Garcia Sisters</p>
Five Sisters Lodge	<p>Occupancy: 23 cabanas /rooms. Total occupancy of 35 Description: Located in Privassion Enclave, adjacent to Big Rock Falls, Mountain Pine Ridge 25 resident staff on site, but on rotation 3 tour guides on site Tour sites offered: Tours to 1000 foot falls, Big Rock Falls, Rio On Pools and Rio Frio Cave</p>
Pine Ridge Lodge	<p>Occupancy: .. cabanas /rooms. Total occupancy of .. Description: Located on Chiquibul Road .. resident staff on site, but on rotation .. tour guides on site Tour sites offered: Tours to 1000 foot falls, Big Rock Falls, Rio On Pools and Rio Frio Cave</p>
Blancaneaux Lodge	<p>Occupancy: 10 cabanas, 7 villas. Total occupancy of 60 Description: Located in the Privassion Enclave, adjacent to Big Rock Falls, Mountain Pine Ridge. Has a 3 acre self-sustaining organic garden providing fruit and vegetables for lodge 65 resident staff, 45 non-resident 5 full time guides + 7 sub-contracted when needed Tour sites offered: Big Rock Falls, Rio On Pools and Rio Frio Cave</p>

Other hotels and tour operators, located in or adjacent to San Ignacio (Table 5), provide day tours to the area, with an estimated 30 to 40% of the registered 180 tour guides in Cayo using the Mountain Pine Ridge / Chiquibul area (Cambranes, pers. com. 2007). Several of these, however, have stopped advertising Mountain Pine Ridge Tours following the outbreak of the Southern Pine Bark Beetle infestation, which they say reduces the aesthetic appeal of the area, resulting in poor visitor satisfaction (Tour operators, pers. com., 2006). Thousand Foot Falls has also been dropped from many itineraries due to the bad state of the access road.

Table 5: A Sample of Tour Operators using Mountain Pine Ridge FR / Chiquibul FR		
Location	Activities offered	Availability
International		
Adventure Life	Part of 1 week package. Pook's Hill tour - Caracol, Rio On, Rio Frio	December - April
Nature Tours	Part of 3, 4 or 5-day package through Windy Hill	All year
Hidden Trails	Part of 1 week horse riding package, including Big Rock Falls	All year
NatureTrek	10-day mammal tour itinerary based from Las Cuevas	November
Backroads	1 week package including 1 day Mountain Pine Ridge, biking from Caracol to Rio Frio, Rio On	March, April
Non-Cayo		
Magical Journeys	Day tour from San Pedro / Belize City. 1,000 Foot Falls, Rio Frio, Rio On	All year, Monday and Thursday
Enjoy Belize	Day tour from Belize City 1,000 Foot Falls, Rio Frio, Rio On, Big Rock Falls	All year
Cayo		
Belize Explorer Travel	Based out of Cahal Pech; Day tours / packages Mountain Bike tours	All year
Mountain Equestrian Trails	Day tours – Horse riding	All year
Chaa Creek Inland Expeditions	Day tours - 1000 Foot Falls, Rio On and Rio Frio Cave	All year
Yute Expeditions	Day trips - 1000 Foot Falls, Rio On and Rio Frio Cave, Five Sisters Falls.	All year
Pacz Tours	Day trips - Rio On and Rio Frio Cave, Big Rock Falls.	All year
Crystal Paradise Resort	Day trips – 1,000 Foot Falls, Rio On and Rio Frio Cave, Big Rock Falls.	All year
Pook's Hill	Day tours - 1000 Foot Falls, Rio On and Rio Frio Cave, Big Rock Falls	All year
San Ignacio Hotel	Day tours - Rio On and Rio Frio Cave	All year
Maya Walk Tours	Day tours - 1000 Foot Falls, Rio On and Rio Frio Cave	All year
River Rat Belize	Day tours – Rio On, Rio Frio, Big Rock Falls, as part of Caracol tour	All year
Cayo Adventure Tours	Day tours – 1000 Foot Falls, Rio Frio, Rio On, Big Rock Falls, Horse riding	All year
Windy Hill	As part of 3, 4 or 5 day tours based at Hidden Valley Inn or Five Sisters Lodge - 1000 Foot Falls, Rio On and Rio Frio Cave	All year
Maya Mountain Tours	Day tours - 1000 Foot Falls, Rio On and Rio Frio Cave	Not marketing this tour at the moment

Many tour operators, both international and local, have made an effort to ensure that their tours are environmentally sustainable. Several have received awards for their operations - Hidden Valley Inn, for example, is the winner of the 2006 “Sustainable Tourism Award, presented by the Caribbean Tourism Association / Islands Magazine, and Chaa Creek Lodge has been awarded title of “Best Eco Lodge” from 2003 – 2006 by Caribbean Travel and Life. International operators using the area also are aware of the need for responsible travel and environmental sustainability – as exemplified by the Strategic Principles of Responsible Travel adopted by companies such as Backroads (Figure 2).

▪ Summary of Non-Tourism Activities

Whilst tourism is increasing within the two protected areas, the primary environmental impacts are currently from non-tourism activities (Table 6). A broad array of impacts from a variety of sources affect the two protected areas to an extent that far exceeds those associated with tourism.

Within Chiquibul, and the western broadleaf areas of the Mountain Pine Ridge, the operations of illegal Guatemalan xateros undoubtedly impact the biodiversity more than any other single factor, and probably more than all other factors combined. Xateros harvest the leaves of the xate palm (*Chamaedorea ernesti-augustii*), transporting them over the border for the international floricultural industry. They also hunt illegally within the protected areas to support themselves during the xate harvesting expeditions – to the extent that several vertebrate species are reported to have suffered drastic declines in abundance.

In the Mountain Pine Ridge, the 2000/2001 Southern Pine Bark Beetle infestation completely changed the age structure of the pine forests, and devastated their aesthetic appeal. Though a natural phenomenon, the scale of its impact was exacerbated by past management actions, and by current management limitations.

Other impacts include development projects - in particular the construction of the Chalillo Dam - which have had direct and indirect negative impacts that also far outweigh those of tourism. The scale of military training (both British and Belizean) within both protected areas dictates that associated impacts also greatly exceed those of tourism. Resource extraction – timber and minerals – whilst carefully controlled through extraction agreements, also impact the biodiversity to a far greater extent than tourism: both through physical removal / damage of the resources themselves and through increased road construction and use. Thus, whilst some tourism impacts are noted at the site level, their scale on the system as a whole is negligible when compared with these other factors.

Table 6: Non Tourism Activities	MPRFR	CFR
Legal Activities		
Forest Department - Forest Resource Planning and Management Activities		
Timber Concession co-management areas		
Access (including to Caracol Archaeological Site)		
Research (Forest Department and Las Cuevas)		
Military Training		
Mining		
Xate Concession		
Chalillo Dam Maintenance		
Illegal Activities		
Illegal Xate Harvesting		
Illegal Hunting		
Looting of Archaeological Resources		

Figure 2: Tour Operators: An Example of Responsible Travel

Backroads, an international tour company conducting mountain bike tours in the Mountain Pine Ridge/Chiquibul area, advertises itself as focusing on traveling responsibly and encouraging its guests to do the same. To ensure that the journeys offered have no inadvertent negative consequences, the company is alert to its potential impact. As a member of the Adventure Collection, Backpack implements the five Strategic Principles of Responsible Travel, which are integrated into all aspects of the company.

Strategic Principle I

Support of specific ongoing projects that further the overall concept of responsible travel, such as providing community support in the areas where the company works, through financial aid, material donations, people power and education

Strategic Principle II

A clearly defined strategy regarding accountability, respecting the rights of the local population, local laws and customs, and employing local staff whenever feasible

Strategic Principle III

A clearly defined strategy regarding accountability in the communities where trips take place, practicing a “take nothing but pictures and leave nothing but footprints” philosophy in all tours, and providing financial support for conservation projects throughout the world

Strategic Principle IV

Responsible travel education guidelines further the cause of responsible travel by educating staff, guests and community partners to:

1. Minimize waste on trips by using recycled materials and non-paper products as much as possible.
2. Practice the “Leave No Trace” ethic on all trips, and highlight this in materials.
3. Prepare travelers to minimize their impact while visiting sensitive environments and cultures.
4. Organize annual training seminars for leaders that emphasize deep cultural and natural-world knowledge of the area.
5. Purchase, consume and highlight local foods as part of the tour experience.
6. Design trips and activities to connect guests to local cultures.
7. Support local artisans by bringing guests to their workshops.
8. Use locally owned suppliers whenever feasible.

Strategic Principle V

Members are committed to a systematic review of their corporate performance regarding responsible travel.

Adapted from www.backroads.com, 2007

Section A

The Project Area

Mountain Pine Ridge Forest Reserve

and

Chiquibul Forest Reserve



Section A. The Project Area

The project area covers two of the seventeen Forest Reserves within the National Protected Areas System (Table 7):

- **Mountain Pine Ridge Forest Reserve**
- **Chiquibul Forest Reserve**

Table 7: Protected Areas of the Project Area				
Protected Area	Year of establishment	Most recent SI	Management / Co-management Body	Current Area (km²)
Mountain Pine Ridge Forest Reserve	1944	112 of 2000	Forest Department	430.4
Chiquibul Forest Reserve	1956	54 of 1995	Forest Department	598.2

These two forest reserves are core components of the Maya Mountain Massif, part of the Selva Maya, and one of the largest intact forested areas in Central America. It forms a major component of the Mesoamerican Biological Corridor, and is comprised in Belize of a total of thirteen protected areas (Maps 5 and 6; CI, 2004; NPAPSP, 2006).

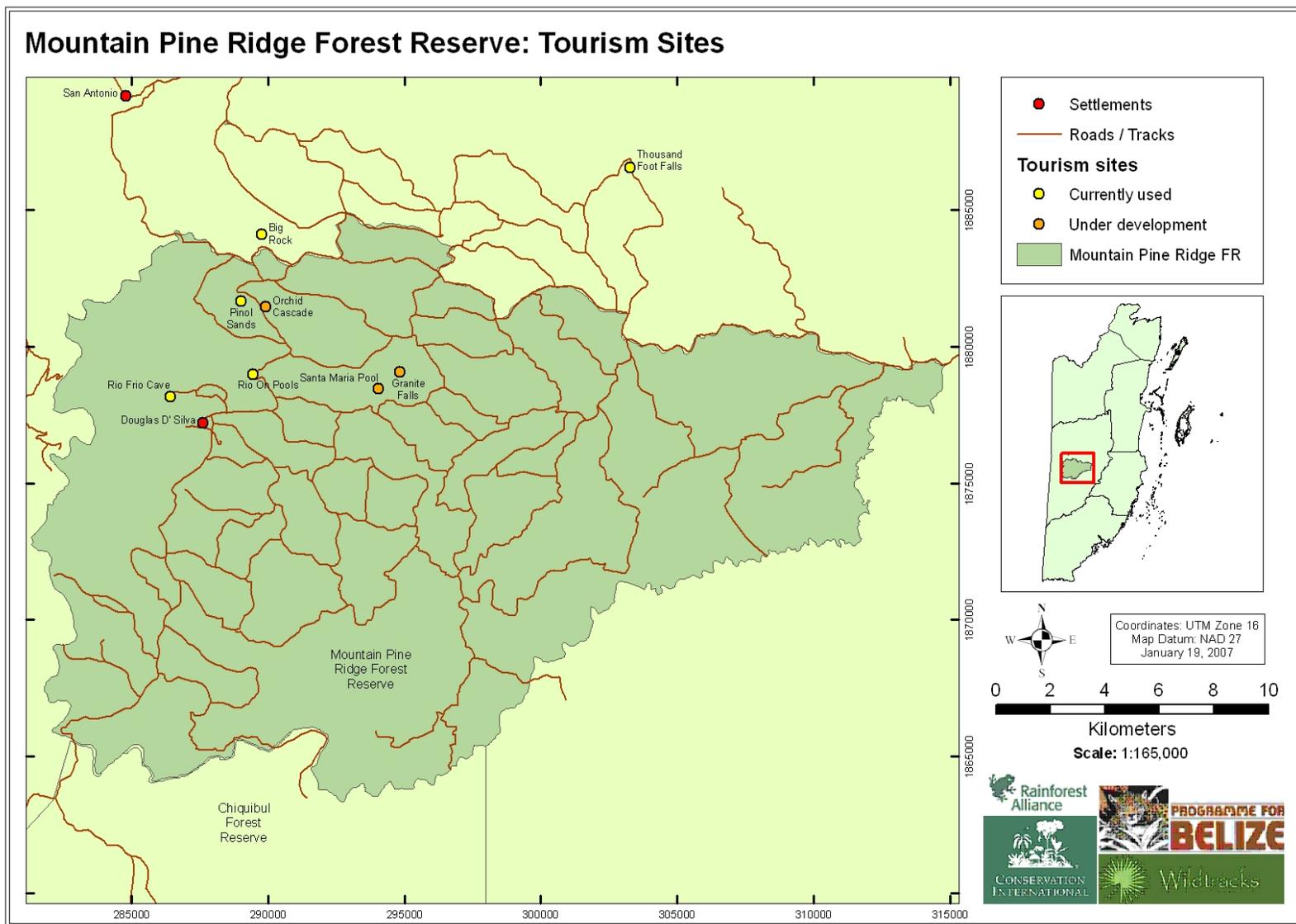
Following consultations with Programme for Belize and tour guides using the area, it was considered necessary to extend the scope of the project to also include two further sites (Table 8):

- **Big Rock Falls**
- **Thousand Foot Falls**

Table 8: Protected Areas containing other sites				
Protected Area	Year of establishment	Most recent SI	Management / Co-management Body	Current Area (km²)
Noj Kaax Me'en Elijio Panti National Park	2001	117 of 2001	Itzamna Society	51.2
Thousand Foot Falls Natural Monument	2004	79 of 2004	Forest Department	5.2

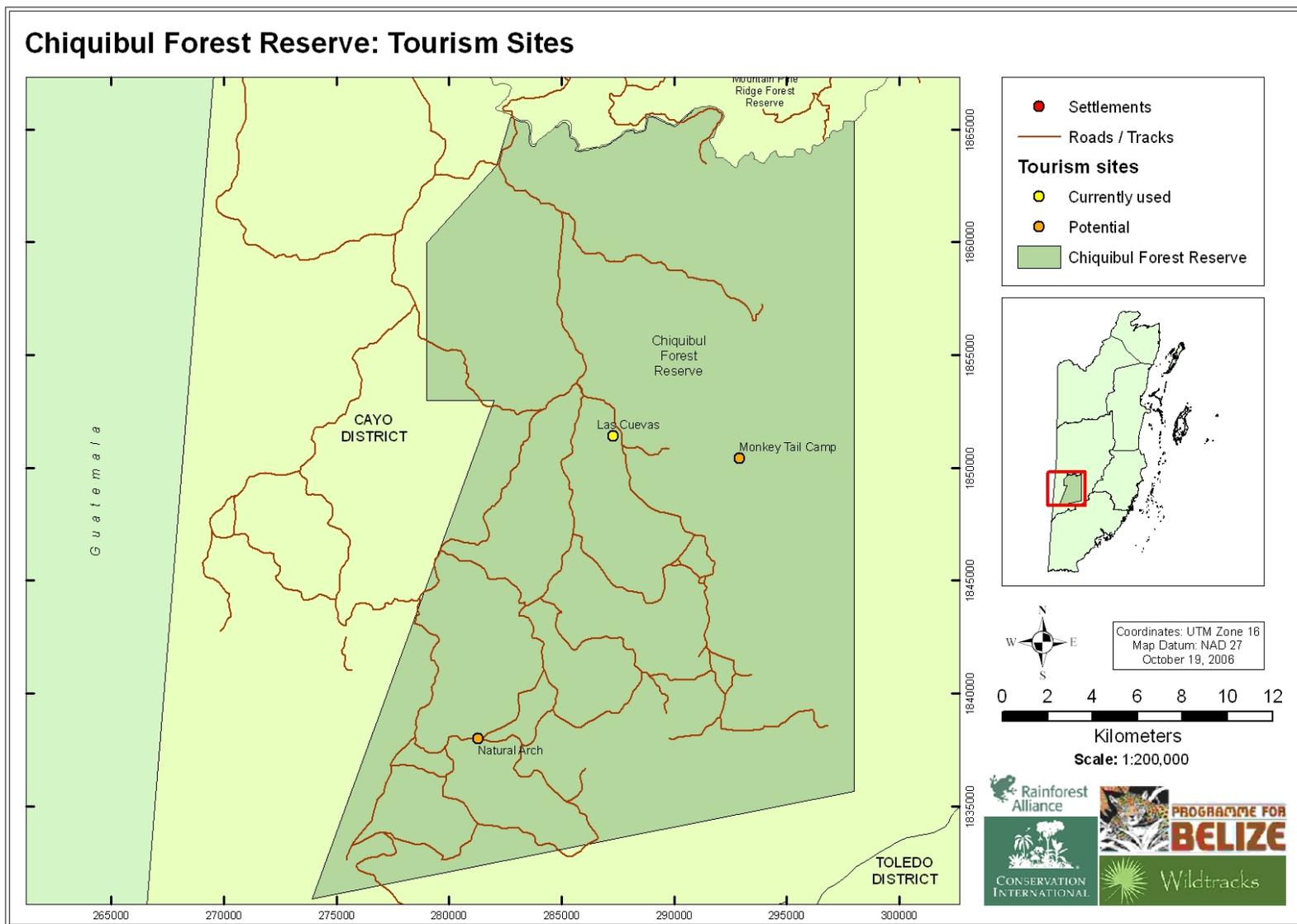
The first, Big Rock, lies on the boundary of Noj Ka'ax Me'en Elijio Panti National Park (co-managed by the Itzamna society), and the Privassion Enclave, adjacent to the Mountain Pine Ridge area.

The second, Thousand Foot Falls, has been declared as a National Monument, one of six in Belize designated for the protection of natural features of national significance, for 'education, research, interpretation and public appreciation'.



Map Five: Tourism Sites of Mountain Pine Ridge Forest Reserve

A. Lloyd / Wildtracks
 See: Metadata



Map Six: Tourism Sites of Chiquibul Forest Reserve

A. Lloyd / Wildtracks
 See: Metadata

1. Overview of Project Area

▪ Mountain Pine Ridge Forest Reserve

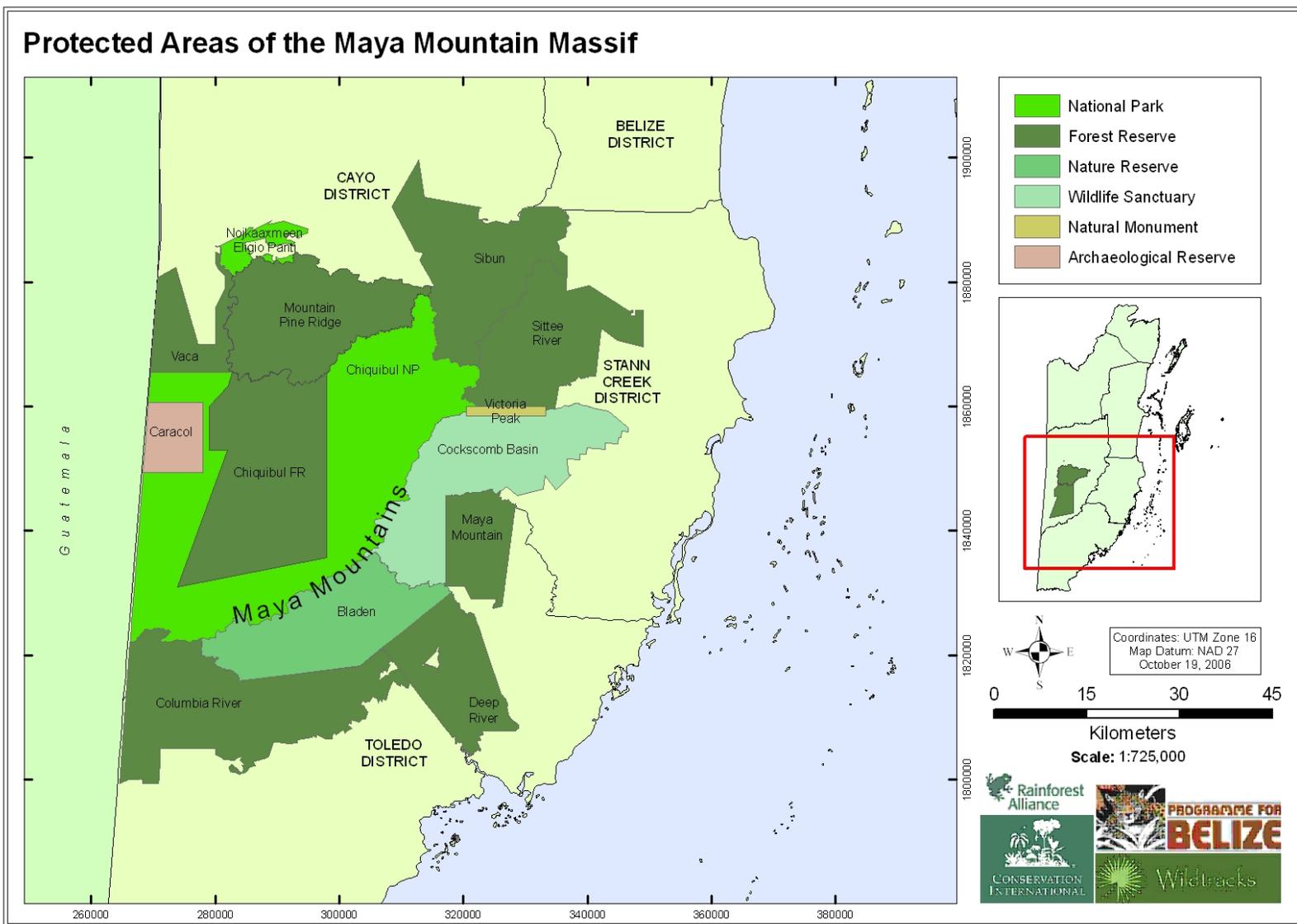
Mountain Pine Ridge Forest Reserve is situated in Cayo District in western Belize, in an upland area of principally granitic hills. Encompassing an area of approximately 430km² (NPAPSP, 2005), it is bounded to the west by the Vaca Forest Reserve, and to the south and east by the Chiquibul Forest Reserve and National Park, and the Sibun Forest Reserve. To the north, the reserve is partly buffered by Noj Kaax Me'en Eligio Panti National Park. Much of the boundary between the Mountain Pine Ridge Forest Reserve and the Vaca and Chiquibul Forest Reserves follows the Macal River, a tributary of the Belize River. The Mountain Pine Ridge Forest Reserve lies entirely within the Belize River watershed.

The landscape consists for the most part of uplifted granitic hills bordered to the north and south by the remnants of older sedimentary rocks. There is a relatively small region of limestone karst in the west – all that remains of the limestone capping once thought to cover the area. Elevation ranges from around 120m to 975m above sea level. Whilst the vegetation is dominated by pine forests, it also includes broadleaf forests, mixed pine and broadleaf forests, and fire-induced shrublands. The pine-dominated areas correspond to the poorer, non-calcareous soils, and are actively managed for pine productivity. There is generally a mixed broadleaf understory component that has traditionally been restricted by forest management activities. Grasslands and small wetland areas complete this landscape mosaic, which is largely maintained by natural and prescribed burning, and other forest management activities. Broadleaf forest also occurs, principally on the limestone areas in the western portion of the reserve, contiguous with the Chiquibul Forest, and in patches found on limestone outcrops and in riparian gullies within the Mountain Pine Ridge vegetation.

The Forest Reserve has national ecological importance in its protection of a major component of the upper Belize River watershed, and encompasses a variety of ecosystem types, including the majority of pre-montane pine forests, restricted to this area of Belize, and considered to be critical / endangered (WWF, 2001). It is also forms a significant portion of the Maya Mountain Massif, highlighted as one of few large blocks of natural forest ecosystems left in Central America (Map 9; CI, 2006; TNC, 2006).

The area has a long history of use – road infrastructure was first developed through the pine forests to access the timber resources of the Chiquibul Forest Reserve during the early 1900's. In October 1944, it was designated as a 608.2 km² protected area in its own right, (under Ordinance 56), to safeguard the extensive economically valuable pine forests of the 'Great South Pine Ridge' (De Vries, 2004). The boundary of the reserve was redefined in 1959 under SI 19, reallocating part of the land to the Sibun Forest Reserve and reducing the area to 536.3km², to ensure that the Forest Reserve would fit in better with geographic and administrative boundaries. In 1977 (SI 49 of 1977) the area was reduced further to 514.8km² to provide space for a farming enclave, and future tourism developments such as Blancaneaux and Five Sisters Lodges. Following consolidation, the most recent SI (SI112 of 2000), the NPAPSP lists the area as approximately 430km².

The extraction of timber resources is still a significant factor in management policies, and the reserve also fulfills an important role in the protection of biodiversity and water resources, providing protection for some of the upper tributaries of the Belize River watershed. Tourism has also been a significant factor in the history of the reserve for some decades now, with a variety of features of scenic value, including rivers, waterfalls and caves attracting visitors.



Map Seven: The Maya Mountain Massif

A. Lloyd / Wildtracks
See: Metadata

More recently, between 2000 and 2002, the region has been significantly affected by infestations of the Southern Pine Bark Beetle (*Dendroctonus frontalis*), the Mountain Pine Ridge suffering devastation of its pine resources from early 2000 to 2001, with over 25,000 hectares suffering an estimated 90% of the pine forests (Billings et. al., 2004). This has had an impact on both timber extraction and tourism, with a decline in the apparent abundance of wildlife with the opening up of the pine forest area by the infestation, suggesting that the decrease in canopy cover has led to much of the wildlife retreating to the broadleaf forest and riparian areas (Tour guides, pers. com. 2006). The reduction in the economic value of the timber resources in the Forest Reserve has resulted in a shift of management focus towards recreational tourism (FD, 2006). Restoration activities have been carried out by a consortium of partners – the Government of Belize, Silviculture Belize Ltd., Global Forest Nursery Development Inc. and Forest Securities, Inc. under a carbon sequestration initiative that plans to restore 365km² for economic benefit and the preservation of the environment. Suppression of further Pine Bark Beetle outbreaks and the control of fire are also important components of the co-management restoration projects and protected area work plan (Forest Department, 2006).

Whilst Mountain Pine Ridge Forest Reserve is managed by the Forest Department, a significant proportion of the area is co-managed by the Pine Lumber Company (PLC), which operates a carefully controlled timber concession in the east of the area under long term forest license.

There have been past incursions into the reserve by farmers from neighbouring communities, resulting in the exclusion of the Privassion Enclave, and broadleaf forest areas have recently been faced with heavy impacts from illegal xate extraction originating from Guatemala, even in tourism sites such as the Rio Frio Cave area.

Also included within the management remit of the Mountain Pine Ridge Forest Reserve is the Thousand Foot Falls Natural Monument, declared under SI 79 of 2004. This protected area has been excised from the surrounding private protected area of Hidden Valley Inn to provide public access to the Thousand Foot Falls, considered the highest waterfall in Central America, at approximately 1,600 feet. The Roaring Creek flows over a major geological fault line from the escarpment, before joining the Belize River further downstream.

▪ **Chiquibul Forest Reserve**

The Chiquibul Forest Reserve lies south of the Mountain Pine Ridge Forest Reserve, and was first explored for its timber resources in the early 1900's. It was designated as a Forest Reserve in 1956 (under Statutory Instrument 55) for the sustainable extraction of timber stocks, and watershed protection, and originally encompassed an area of 1,849km². In 1991, however, a large portion was re-designated as the Chiquibul National Park (Statutory Instrument 166), leaving 765km² within the Forest Reserve. The boundaries of the two reserves were subsequently re-evaluated and re-aligned in 1995 (Statutory Instrument 54) to more accurately reflect the requirements of both timber concessions and biodiversity conservation, leaving approximately 600km² within the Forest Reserve.

The Chiquibul area is rich in biodiversity, the mosaic of vegetation present being a result of the area lying at the border of the sedimentary rock and limestone substrata. The majority of ecosystem types are tropical broadleaf, with riparian forests following the creeks, and a single patch of isolated pine savanna, in the San Pastor region.

The primary management activity of sustainable timber harvesting has been implemented under a 40-year rotation designed as part of the Forest Planning and Management Project, and under co-management with Pine Lumber Company and New River Enterprises (D. Chan, pers. com.). This, however, has been overshadowed in recent years by enforcement issues. With extremely limited management presence (caused primarily by financial constraints), the

key challenge to enforcement is illegal xate collection, primarily by Guatemalans illegally crossing the border. This is impacting the entire Forest Reserve, with xateros not only cutting all usable leaves of the commercial *Chamaedorea* palm species at a non-sustainable rate, but also reportedly decimating populations of many vertebrate species through their extensive subsistence hunting, and rendering the area unsafe for tourism. The scale of this problem, with reportedly between 1,000 and 2,000 Guatemalan xateros operating in Belize, has been beyond the control of the Forest Department. Currently a collaborative initiative is being developed to implement adequate enforcement within both the Chiquibul Forest Reserve, and the adjacent Chiquibul National Park. A limited amount of material extraction, primarily thatch leaves (*Sabal mauritiformis*), by one of the lodges in the area, was recorded during the impact assessment.

An active gold mining concession is operative within the Ceibo Chico area, towards the southern boundary, with mining activities in the Ceibo Chico Creek drainage basin. The prospect area consists of four contiguous Exclusive Prospecting Licenses covering approximately 34km², and a 0.4km² Mining License, currently being implemented. The main impacts are on the state of the logging roads, and the bulldozing of new, access roads within the prospecting area.

Other than selective timber extraction and the provision of a recent license for the harvesting of xate, the majority of the Forest Reserve has no management planning for the area, or active natural resource management activities. There are concerns that the opening of the dry season road for these activities will open the area for unregulated tourism in the future.

A small area, centered on Las Cuevas Research Station, is managed in agreement with Las Cuevas Partnership (comprised of the Government of Belize, Maya Forest Enterprises Ltd., Conservation Management Institution, Royal Botanic Garden Edinburgh, University of Belize and Acadia University, Canada), with the remit of documenting the biodiversity of the Maya Forest, and contributing practical knowledge to Belize's sustainable development and conservation under the Convention of Biological Diversity. Priorities include understanding the maintenance and structure of the forest, evaluating human and natural impacts on the forest and linking science with conservation policy.

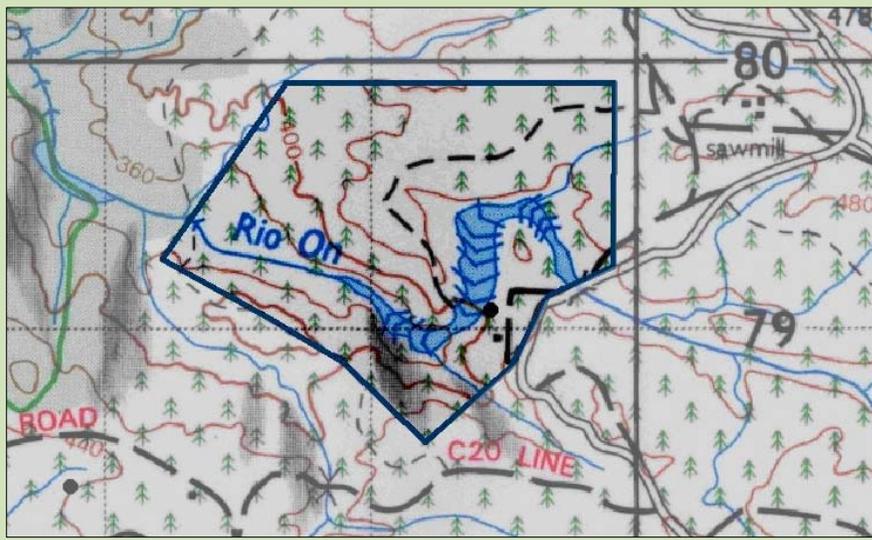
Las Cuevas and Friends for Conservation and Development, both key stakeholders in the area, recognize that tourism presents a viable resource as a sustainability mechanism, especially combined with the proximity of the Caracol Archaeological Reserve, already a major tourism destination. There is interest in expanding the tourism focus of the area to include adventure tourism, which has until now been restricted to sporadic organized activities such as the Trekforce Maya Divide trek and exploration of Chiquibul Caves by the Xmet group. Las Cuevas is investigating the potential for developing adventure tourism initiatives to assist in supporting the Research Station, with links to international companies such as Nature Trek, Reef and Rainforest and Island Expeditions.

▪ **Current Tourism Sites**

Under this project, five current tourism sites and three sites under development were identified within the Mountain Pine Ridge Forest Reserve. A further three potential sites have been identified from Chiquibul Forest Reserve, in addition to Las Cuevas Research Station. The Caracol road, whilst not being a site in its own right, does pass through the Chiquibul Forest Reserve, and is therefore also considered. Of these, the current and developing sites were assessed in greater depth for this project.

The total footprint of current tourism sites within the Mountain Pine Ridge Forest Reserve (Rio On, Rio Frio and Pinol Sands) is estimated to be 3km² at the maximum – 0.7% of the total protected area.

Rio On Pools Site Sheet



0.5km
Adapted from OS Map Sheet

Background

Location (UTM)	1878986N 289457E;
Location (creeks)	Rio On Core Recreation Zone – North (De Vries, 2004) SBL Plantation area (FRPMP Regeneration Areas, 2006)
Area (km ²)	1.00 sq km (designated for the purposes of the baseline)
Geology	Metasediments of the Santa Rosa Group
Land System / Soil	Mountain Pine Plateau: Ossory Suite, Cooma Subsuite Very acid (pH<5), base deficient, red and yellow soils, well drained and slightly droughty. Deeper and more developed soils with a brown to dark brown topsoil above red / yellow silty clay (King et. al.)
Ecosystem	Lowland Pine Forest: Tropical evergreen seasonal needle-leaved lowland hill forest
Ecosystem Condition	Over 90% of old growth pine killed by Southern Pine Bark Beetle, though scattered young trees 10-12m remain. Locally dense patches of tiger fern (indicative of fire). Relatively poor pine regeneration. No significant vegetation trampling, but a little trail braiding. Algae on some rocks worn by foot traffic – but limited to very short and narrow sections.
Tourism Activities	Swimming, scenic beauty, picnic area



Rio On Pools

Rio Frio Caves Site Sheet

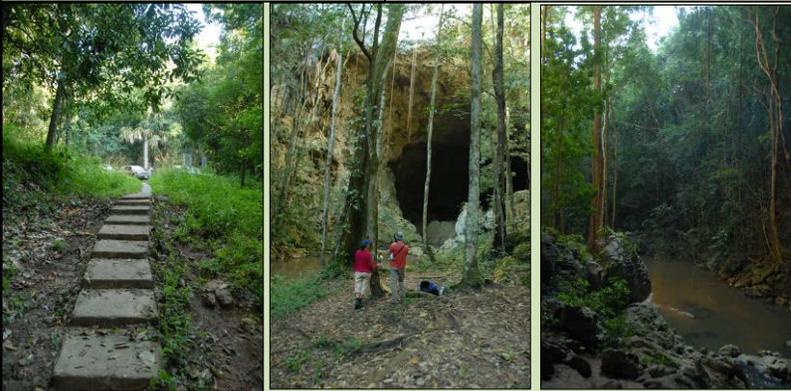


0.5km

Adapted from OS Map Sheet

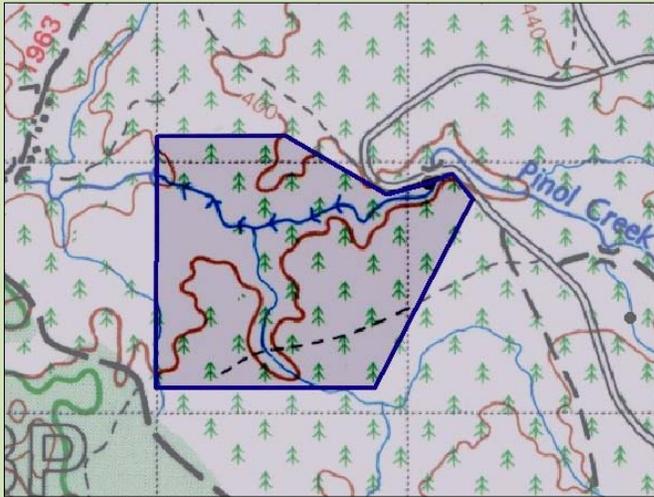
Background

Location (UTM)	286413N; 1878173E
Location	On Rio Frio Core Recreation Zone – West (De Vries, 2004) Not Pine (FRPMP Regeneration Areas)
Site Area	1 sq km (designated for the purposes of the baseline)
Geology	Cretaceous Limestone
Soil	Vaca Hills (Quartz ridge: Vaca Suite, Cuxu Subsuite. Neutral to alkali brown soils with high calcium content
Ecosystem	Lowland Broad-leaved Moist Forest: Tropical evergreen seasonal broad-leaved lowland hill forest on steep karstic terrain
Ecosystem Condition	Vegetation is broadleaf forest over steep karstic hills, grading into rolling hills. Understory vegetation cleared in an area of approx 0.5 hectare from car-park to creek and mouth of cave. Significant trail braiding at entrance to cave where concrete path ends. Cave highly impacted – cave soil is compacted, graffiti on walls, litter, impact from constant touching, little cave life (assassin bug, few bats) Near pristine outside the 0.5ha Visitor Use area – small footprint
Tourism Activities	Scenic interest, geology, education



Rio Frio Caves

Pinol Sands Site Sheet



0.5km

Adapted from OS Map Sheet

Background

Location (UTM)	288997N; 1881653E
Location	On Pinol Creek Core Recreation Zone - North (De Vries, 2004) Pinol Sphere within the 2006-2007 Annual Workplan (FRPM, 2006) At junction of Natural Regeneration, SBL Plantation and Not Pine areas, with the proposed trail being entirely within the 'Not Pine' area (FRPMP Regeneration Areas)
Site Area	1 sq km (designated for the purposes of the baseline)
Geology	Granite
Soil	Mountain Pine Plateau: Stopper Suite, Pinol Subsuite. Very acidic, base deficient, well drained soils with low to moderate iron content
Ecosystem	Whilst part of this site is mapped as Deciduous broad-leaved lowland shrubland, well-drained, over poor soils (Meerman, 2004), ground-truthing shows that the ecosystem type is Tropical evergreen seasonal needle-leaved lowland hill forest . The Fire induced lowland fern thicket is also not present, but is currently under reforestation regime, and should be included with the above ecosystem
Ecosystem Condition	Tropical evergreen seasonal needle-leaved lowland hill forest Pine savanna/pine woodland habitat, mixed with broadleaf. The pines are very heavily impacted by Southern Pine Bark Beetle, with fewer than 10% remaining. Regeneration is taking place in the area to the south of the creek, which lies within the SBL plantation zone. Not much past fire impact, with limited extent of tiger fern, but the condition of the vegetation much poorer than at Big Rock. On the proposed trail route, following the creek downstream, the largest pines are dead specimens, but 12-14m ones remain, as well as lots of seedlings / saplings. The density of pines is higher south of creek than the north. Beyond very limited visitor impacts near the car park and picnic area (vegetation clearance, limited trail braiding (within 200m), track sections impacting seepage area) there are no visible tourism-based impacts. There is currently no clear trail – this would need to be properly formed & demarcated to prevent significant braiding & trampling if visitation increases. Current condition is considered pristine in terms of visitor appreciation. The SBL plantation area, previously mapped as Fire induced lowland fern thicket consists of replanted pine, with a cleared understory of mixed grasses – not tiger fern.
Tourism Activities	Current: Bathing, paddling, picnic, Future: Hiking, scenic beauty

Table 9: Overview of Current Facilities at Tourism Sites in Use in the Mountain Pine Ridge Area (January, 2007)							
Facilities							
Site	Car Park	Shelter	Picnic Benches	Garbage Bins	Signs	Barbecue Grills	Trail System
Current Sites							
Rio On Pools							
Rio Frio Cave							
Pinol Sands							
Thousand Foot Falls*							
Big Rock*							
Future sites							
Orchid Cascade							
Granite Falls							
*Outside the Mountain Pine Ridge Forest Reserve, but included on many tour itineraries							

2. Overview of Ecosystems

Current ecosystem mapping of the vegetation in Mountain Pine Ridge / Chiquibul Forest Reserves indicates a complex mosaic of 16 tropical broadleaf and pine ecosystems under the UNESCO system of classification (Table 11 and 12; Maps 8, 9 and 10; Meerman, 2004), largely dependant on the geology of the area – pine being broadly associated with non-calcareous soils, whilst the broad-leaved forest ecosystems are broadly associated with limestone karst areas and riparian belts.

The pine forest ecosystems, dominated by *Pinus caribea*, have been managed since the 1940's for their timber stocks. Recently, the extensive infestation of Southern Pine Bark Beetle devastated the standing crop of mature pine trees in much of the Mountain Pine Ridge, radically changing the forest structure, impacting aesthetic appeal and reducing the wildlife value for tourism. In some areas, a significant understory of younger pines up to 14m in height survived the infestation, and subsequent natural regeneration, coupled with extensive forest restoration work, is speeding the restoration of the aesthetic appeal of the Mountain Pine Ridge, as well as the re-establishment of future timber stocks.

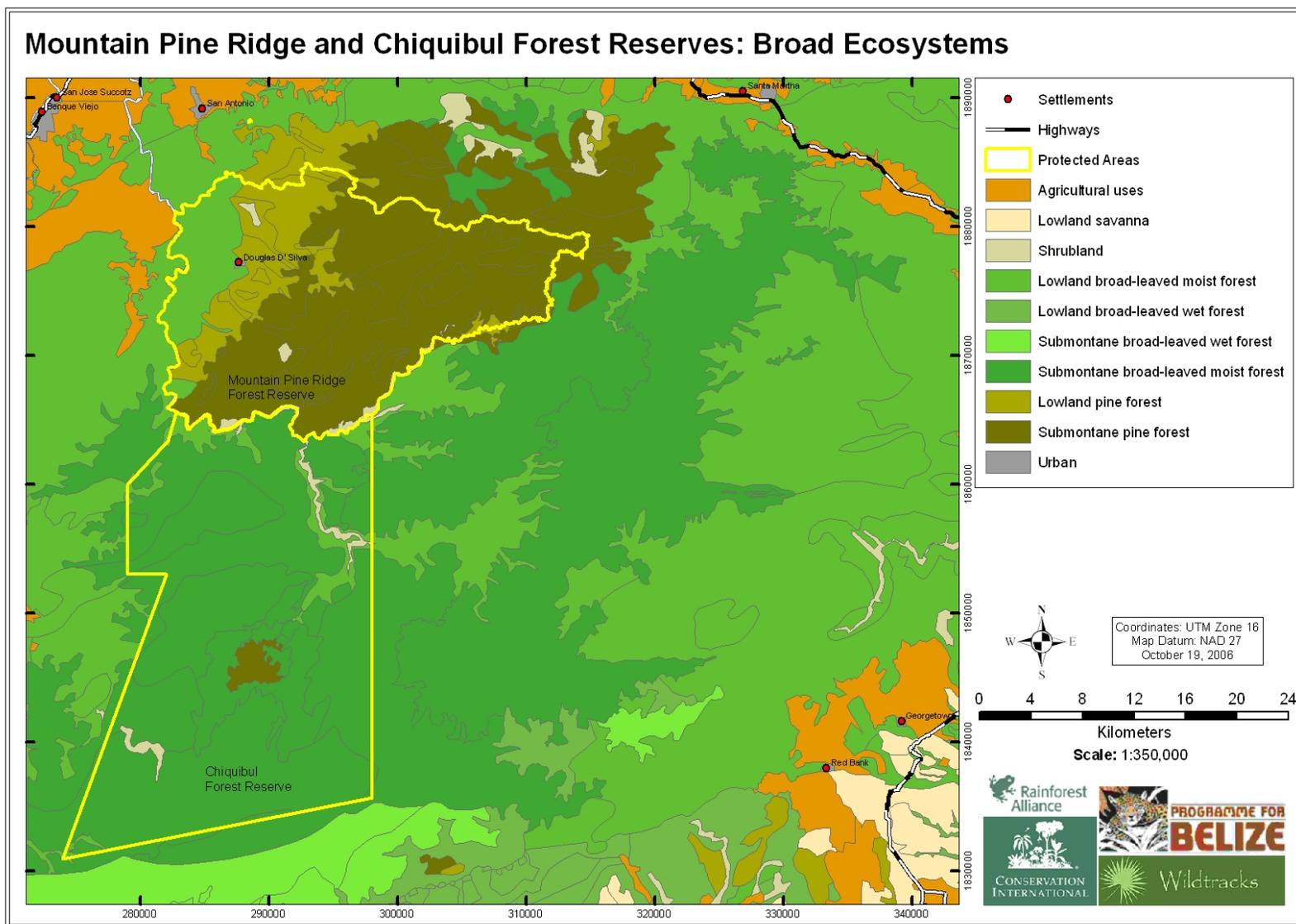
The majority of the current tourism locations lie within pine forest areas, and show at least a degree of Southern Pine Bark Beetle infestation, ranging from the near-pristine steep valley sides of Thousand Foot Falls with healthy, mature pine growth to the near-complete decimation of all mature pines at Orchid Cascade (Photographs 4). Most of the sites also show fire impacts, either from natural fires, or from prescribed burns as part of the protected area management.

For the purposes of mapping tourism use and for tourism-management, the vegetation within and around the focal localities can be considered as a relatively diverse mosaic of **Tropical evergreen seasonal needle-leaved lowland hill forest**, of varying condition, age-structure and species composition – reflecting forest-management practices (especially fire), topography, soil moisture and fertility, exposure, and of course the intensity of the Southern Pine Bark Beetle infestation. Scattered within this mosaic are tracts of **fire-induced fern thicket**, though these are generally relatively limited in extent within the focus localities and not located in the areas identified in the National Ecosystem Map (Meerman, 2004). The most extensive tracts of fire-induced fern thicket occur in the vicinity of the Granite Cairn Falls.



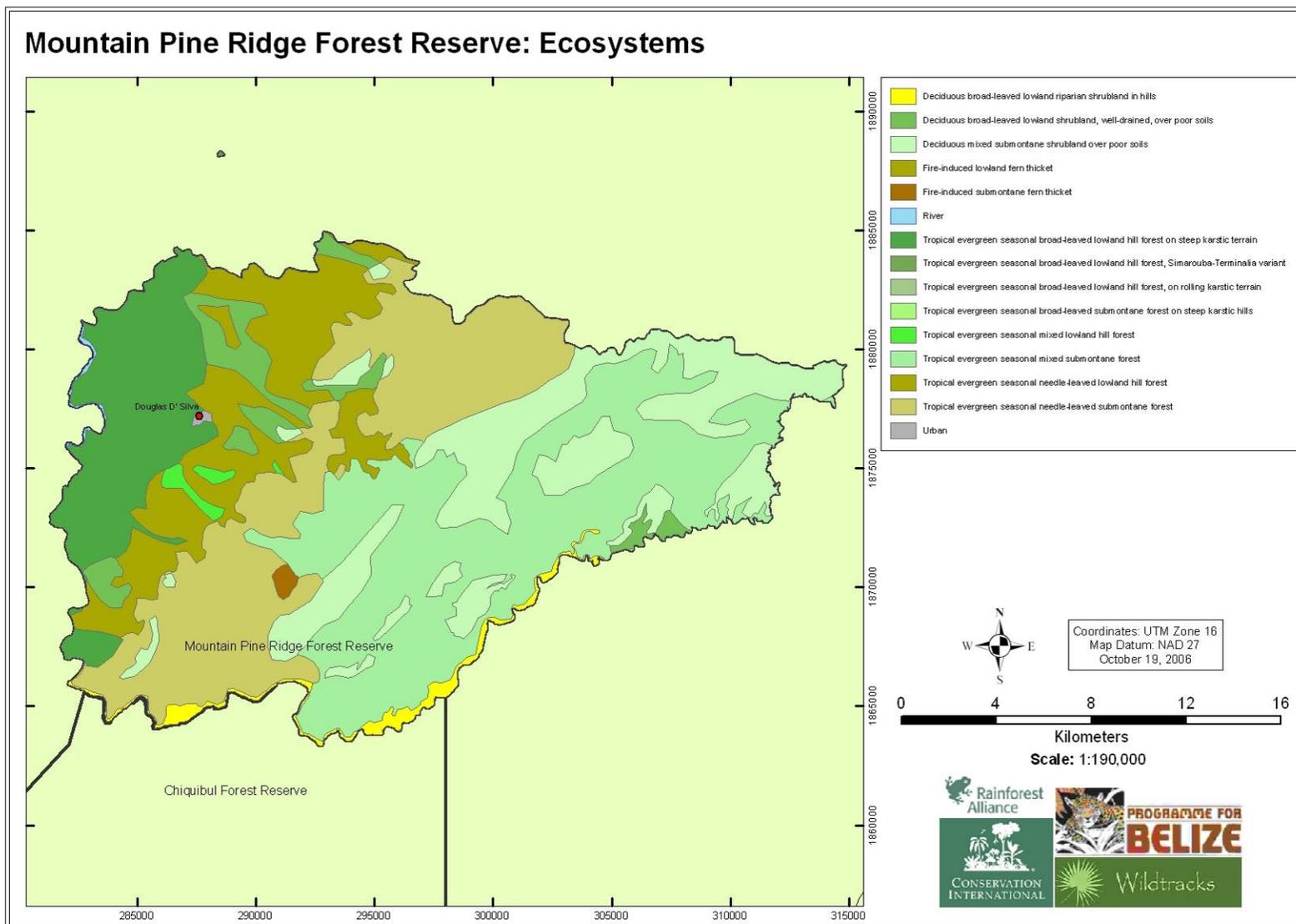
Photograph 4: Effects of the Southern Pine Bark Beetle on Needle-leaved Forest. Orchid Cascade

For the broad-leaved forest, ecosystem health is considered 'good' (functioning within the range of acceptability with no or minimal human intervention), though the Chiquibul Forest Reserve has been selectively (and extensively) logged since the early 1900's. Whilst this may have altered the species composition, with the depression of timber tree densities, and dissected the forest with many logging tracks, the overall structure of the forest remains intact. The major current impact on the area has been the illegal, widespread and unsustainable harvesting of *Chaemadoreia* sp. (xate), with associated hunting pressure, which has reportedly drastically reduced populations of many game species within the forest, including species not generally hunted within Belize, such as Baird's tapir, scarlet macaw and spider monkeys.



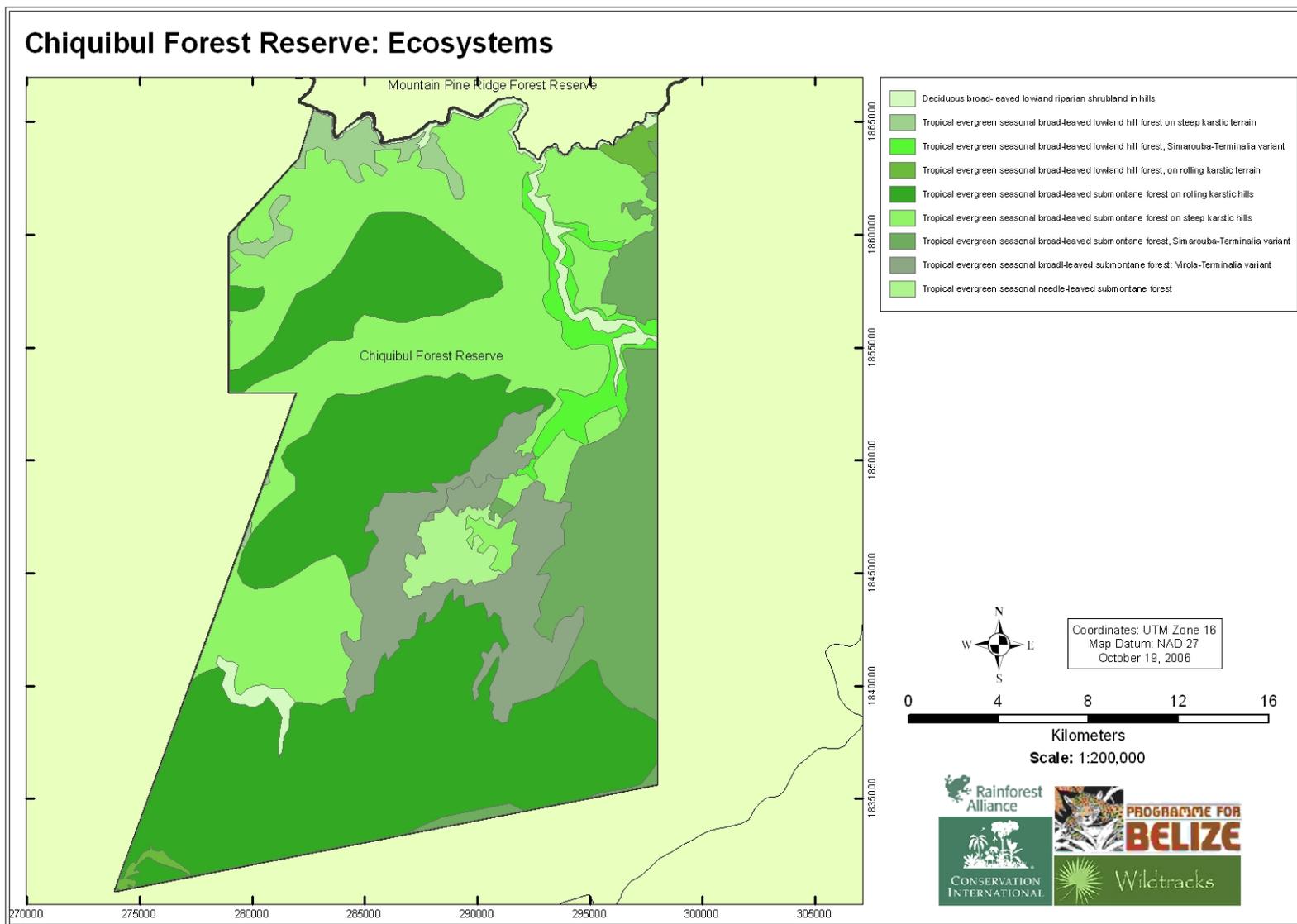
Map Eight: Broad Ecosystems of the Project Area

A. Lloyd / Wildtracks
See: Metadata



Map Nine: Ecosystems of the Mountain Pine Ridge Forest Reserve

A. Lloyd / Wildtracks
See: Metadata



Map Ten: Ecosystems of the Chiquibul Forest Reserve

A. Lloyd / Wildtracks
 See: Metadata

Four problems with current and past ecosystem mapping for the Mountain Pine Ridge render the resultant maps of limited use in terms of baseline information at this scale. Iremonger and Brokaw (1995), for example, erroneously mapped relatively densely-packed tall pine forests as shrubland, errors which have not yet been corrected in more recent national vegetation mapping initiatives (Meerman, 2004). Similarly, significant tracts of ‘fire-induced fern thicket’ have been identified and mapped in areas where they do not currently exist. The constant cycle of regeneration following fire also confuses the issues

An additional complication in the representation of the ecosystems of the Maya Mountains is in the strict application of UNESCO categorizations – which separates vegetation assemblages below the 500m elevation contour from those above. In reality there is no such sharp delineation, with any elevational gradients in species abundance and forest structure being ill-defined and gradual.

Several of these ecosystems are considered under-represented within the national protected areas system in Belize (Table 10). (NPAPSP, 2005).

Table 10: Under-represented Ecosystems in Belize
Mountain Pine Ridge Forest Reserve
Tropical Evergreen Seasonal Broad-leaved lowland hill forest on steep karstic terrain
Tropical Evergreen Seasonal mixed lowland hill forest
Tropical Evergreen Seasonal needle-leaved lowland hill forest
Chiquibul Forest Reserve
Tropical evergreen seasonal broad-leaved lowland hill forest on steep karstic terrain
Tropical evergreen seasonal broad-leaved submontane forest on rolling karstic hills

Ecosystem extent, location and identified threats are covered in Tables 11 and 12.

Table 11: Ecosystems of the Project Area – Extent						
Ecosystem	Legend (Meerman, 2004)	Extent in Mountain Pine Ridge (acres)	Extent in Chiquibul Forest Reserve (acres)	Total Extent in Project Area (acres)	Total Extent in Belize (acres)	% of total in Belize
Tropical Evergreen seasonal broad-leaved lowland hill forest, on rolling karstic terrain	19	1	1,177	1,178	92,543	1.27%
Tropical Evergreen seasonal broad-leaved lowland hill forest on steep karstic terrain	20	12,908	2,944	15,852	163,958	9.67%
Tropical Evergreen seasonal broad-leaved lowland hill forest, Simarouba-Terminalia variant	22	1	4,014	4,015	296,914	1.35%
Tropical evergreen seasonal mixed lowland hill forest	30	630	0	630	935	67.38%
Tropical evergreen seasonal needle-leaved lowland hill forest	32	14,627	0	14,627	24,856	58.85%
Tropical evergreen seasonal broad-leaved submontane forest on rolling karstic hills	33	0	61,099	61,099	71,866	85.02%
Tropical evergreen seasonal broad-leaved submontane forest on steep karstic hills	34	1	43,007	43,008	72,376	59.42%
Tropical evergreen seasonal broad-leaved submontane forest, Virola-Terminalia variant	35	0	13,963	13,963	135,857	10.28%
Tropical evergreen seasonal broad-leaved submontane forest, Simarouba-Terminalia variant	36	0	16,188	16,188	111,487	14.52%
Tropical evergreen seasonal mixed submontane forest	38	29,179	0	29,179	36,942	78.99%
Tropical evergreen seasonal needle-leaved submontane forest	39	24,283	2,592	26,875	43,151	62.28%
Deciduous broad-leaved lowland shrubland, well-drained, over poor soils	57	4,593	0	4,593	5,994	76.63%
Deciduous mixed submontane shrubland over poor soils	59	17,701	0	17,701	35,479	49.89%
Deciduous broad-leaved lowland riparian shrubland	61	1,650	2,841	4,491	7,012	64.05%
Fire-induced fern thicket	67	309	0	309	5,040	6.13%
Fire-induced submontane fern thicket	68	258	0	258	258	100.00%

Ecosystem information is based on Meerman, 2004

Table 12: Ecosystems of the Project Area – Description, Location and Identified Threats			
Broad Ecosystem Type	Ecosystem	Description and Location	
<p>Lowland Broad-leaved Moist Forest</p> <p>Overall Tourism Impact: -ve impact: Low...small numbers of visitors to specific sites, well controlled by accompanying tour guides. Some underbrushing in Rio Frio area, but very local and small footprint +ve impact: High. encouraging conservation of the natural resources</p>	Tropical Evergreen seasonal broad-leaved lowland hill forest, on rolling karstic terrain	<p>Tropical broad-leaved forest on well drained soils over foothills of calcareous rock, below 500m. A pronounced dry season gives elements of the forest a deciduous nature, and fire can spread into this ecosystem. Characteristics are midway between lowland tropical forest and submontane forest, with a canopy height of between 20 and 40m.</p> <p>This ecosystem is found in Chiquibul Forest Reserve, in two locations. The first is south of Blossom Berry Creek (a tributary of the Raspaculo), in the north east of the protected area, the second in the south west, in the Ceibo Chico area currently being prospected for gold. It also occurs (but has not been mapped) in the vicinity of the Rio Frio Cave. Tree species include <i>Attala cohune</i>, <i>Brachium alicastrum</i>, <i>Cedrela odorata</i>, <i>Ceiba pentandra</i>, <i>Chamaedorea ernesti-augustii</i>, <i>Coccoloba belizensis</i>, <i>Desmoncus orthacanthos</i>, <i>Metopium brownei</i>, <i>Protium copal</i>, <i>Sabal mauritiiformis</i>, <i>Spondias radlkoferi</i> and <i>Terminalia amazonia</i></p> <p>Tourism Impacts: Minimal – limited tourism access around Rio Frio Caves Other Impacts: Xate harvesting, selective logging, fragmentation by access tracks</p>	
	Tropical Evergreen seasonal broad-leaved lowland hill forest on steep karstic terrain	<p>Tropical broad-leaved forest on well drained soils over very steep slopes on calcareous rock, often with bare rock faces, below 500m. A pronounced dry season gives elements of the forest a deciduous nature, and fire can spread into this ecosystem, destroying the vegetation of the hill tops. The canopy height is between 25 and 30m.</p> <p>This ecosystem is found in Chiquibul Forest Reserve, in two locations. The first is south of the Chalillo Dam area, in the north west of the protected area, the second on the western boundary, north west of Puchituk Camp, and extending into the Caracol Archaeological Reserve, where it is the dominant ecosystem, with Tropical Evergreen seasonal broad-leaved lowland hill forest, on rolling karstic terrain being found on the shallower inclines. It is also the dominant ecosystem in the Rio Frio Cave area. There is a significant overlap in tree species with those of the rolling hills, though drought tolerant species become more predominant further up the slopes, including, <i>Bursera simaruba</i>, <i>Calophyllum brasiliense</i>, <i>Cedrela odorata</i>, <i>Cryosophila stauracantha</i>, <i>Metopium brownei</i>, <i>Sapindus saponaria</i>, and <i>Vitex gaumeri</i>. <i>Clusia sp.</i> and <i>Plumeria obtusa</i> are often found on the seasonally very dry hilltops.</p> <p>Tourism Impacts: Wildlife and scenic value encourage conservation; Underbrushing and impacts on trail in Rio Frio area, Other Impacts: Xate harvesting, selective logging, fragmentation by access tracks</p>	
	*Considered under represented in the national protected areas system		
	Tropical Evergreen seasonal broad-leaved lowland hill forest, Simarouba-Terminalia variant	<p>Tropical broad-leaved forest on mostly well drained soils overlying quartzite or shales, below 500m. With repeated burning, this sensitive ecosystem can become replaced by <i>Dicranopteris</i> with <i>Pinus</i>.</p> <p>This ecosystem is located in Chiquibul Forest Reserve, following the course of the Raspaculo River upstream of its junction with Blossom Berry Creek. It is also present in the east and south of the Thousand Foot Falls Natural Monument. Common species include: <i>Attalea cohune</i>, <i>Calophyllum brasiliense</i>, <i>Dendropanax arboreus</i>, <i>Desmonchus orthacanthus</i>, <i>Schizolobium parahybum</i>, <i>Spondias radlkoferi</i>, <i>Stemmadenia donnell-smithii</i>, <i>Swietenia macrophylla</i>, <i>Terminalia amazonia</i> and <i>Vochysia hondurensis</i>.</p> <p>Tourism Impacts: Wildlife and scenic value encourage conservation; Not generally accessible Other Impacts: Xate harvesting, selective logging, fragmentation by access tracks</p>	

Table 12: Ecosystems of the Project Area – Description, Location and Identified Threats / 2		
<p>Lowland Pine Forest</p>	<p>Tropical evergreen seasonal mixed lowland hill forest</p>	<p>Pine dominated forest with a broadleaf understory, on well drained soils over calcareous rocks, below 500m. This mixed needle-leaf and broadleaf ecosystem is found in small pockets along the tributaries of Mollejon Creek, and results from fire damage to broadleaf hill forest. <i>Pinus caribaea</i> becomes dominant, with common associates species including <i>Byrsonima crassifolia</i>, <i>Clusia sp.</i>, <i>Schippia concolor</i>, <i>Quercus spp.</i> and <i>Vochysia hondurensis</i>. Tourism Impacts: Wildlife and scenic value encourage conservation; fire impacts, trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls) Other Impacts: Forest management activities; Southern Pine Bark Beetle</p>
	<p>*Considered under represented in the national protected areas system</p>	
<p>Overall Tourism Impact: -ve impact: Low...moderate numbers of visitors to specific sites, well controlled by accompanying tour guides. Impact limited to trails. Low impact from horse riding activities +ve impact: High. encouraging conservation of the natural resources</p>	<p>Tropical evergreen seasonal needle-leaved lowland hill forest</p>	<p>Pine dominated forest with a broadleaf understory, on well drained soils over calcareous rocks, below 500m. This ecosystem extends over much of the Mountain Pine Forest Reserve, including the upper reaches of Orchid Cascade, it is also found in the immediate surroundings of Big Rock Falls, but is not recorded from Chiquibul Forest Reserve. It is rather more extensive than indicated in current national vegetation mapping initiatives (Meerman, 2004). The ecosystem is caused and maintained by fire, with prescribed burns being a predominant management activity in the management of pine timber stocks. Common broadleaf species found within this system include <i>Bursonima crassifolia</i>, <i>Clethra occidentalis</i>, <i>Clusia sp.</i>, <i>Schippia concolor</i>, <i>Quercus sp.</i> and <i>Vochysia hondurensis</i>. Endemics <i>Schippia concolor</i> and <i>Dalechampia schippii</i>. Broadleaf spp. decrease with increasing frequency of fire, and <i>Dicranopteris</i> can become dominant in areas where soils and flora have been severely degraded by fire. Tourism Impacts: Wildlife and scenic value encourage conservation; fire impacts; trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls) Other Impacts: Forest management activities; Southern Pine Bark Beetle</p>
	<p>*Considered under represented in the national protected areas system</p>	
<p>Submontane broad-leaved moist forest</p>	<p>Tropical evergreen seasonal broad-leaved submontane forest on rolling karstic hills</p>	<p>Tropical forest on mostly well drained soils overlying calcareous rocks, between 500 and 1,000m. Of the two protected areas, this ecosystem is recorded only in the central and south of Chiquibul Forest Reserve, including Las Cuevas Research Station and south in the Chiquibul Branch area. Common tree species include <i>Calophyllum brasiliense</i>, <i>Ceiba pentandra</i>, <i>Ficus spp.</i>, <i>Pseudobombax ellipticum</i>, <i>Schizolobium parahybum</i>, <i>Spondias radlkoferi</i>, <i>Stemmadenia donnell-smithii</i>, <i>Swietenia macrophylla</i> and <i>Vitex gaumeri</i>. Tourism Impacts: Wildlife and scenic value encourage conservation; Accessible through Las Cuevas and FCD Other Impacts: Research activities, Xate harvesting, selective logging, fragmentation by access tracks</p>
	<p>*Considered under represented in the national protected areas system</p>	
<p>Overall Tourism Impact: -ve impact: Low...very small numbers of adventure visitors, well controlled by accompanying tour guides. 4-wheel drive impacts to natural arch, but considered minimal +ve impact: Modest. encouraging conservation of the natural resources</p>	<p>Tropical evergreen seasonal broad-leaved submontane forest on steep karstic hills</p>	<p>Interspersed with tropical evergreen seasonal broad-leaved submontane forest on rolling karstic hills, this forest ecosystem is to be found under similar conditions, but on the steeper slopes, covering the majority of the northern portion of Chiquibul Forest Reserve, and areas including Grano de Oro and Engineers Camps. There is significant overlap in species composition with that found on the rolling hills, though more drought tolerant species such as <i>Calophyllum brasiliense</i> become more abundant higher on the hills. Tourism Impacts: Wildlife and scenic value encourage conservation; Accessible through Las Cuevas and FCD Other Impacts: Research activities, Xate harvesting, selective logging, fragmentation by access tracks</p>

Table12: Ecosystems of the Project Area – Description, Location and Identified Threats / 3		
<p>Submontane broad-leaved moist forest</p>	<p>Tropical evergreen seasonal broad-leaved submontane forest, Virola-Terminalia variant</p>	<p>Tropical broad-leaved forest on mostly well drained soils over non-calcareous rock, between 500 and 1,000m. This area surrounds the granite outcrop of San Pastor area. Tree species include <i>Euterpe precatoria</i>, <i>Schizolobium parahybum</i>, <i>Symphonia globulifera</i>, <i>Terminalia amazonia</i> and <i>Virola brachycarpa</i>. Tourism Impacts: Wildlife and scenic value encourage conservation; accessible through Las Cuevas and FCD Other Impacts: Research activities, selective logging, fragmentation by access tracks; Military training activities</p>
	<p>Tropical evergreen seasonal broad-leaved submontane forest, Simarouba-Terminalia variant</p>	<p>Tropical broad-leaved forest on mostly well drained soils overlying quartzite and shales, between 500 and 1,000m. This is located along the eastern boundary of Chiquibul Forest Reserve, in the Monkey Tail Branch headwaters area, and is in the valleys to the east of Thousand Foot Falls itself. Common tree species include <i>Attalea cohune</i>, <i>Dendropanax arboreus</i>, <i>Euterpe precatoria</i>, <i>Licania sp.</i>, <i>Pourouma aspera</i>, <i>Quararibea funebris</i>, <i>Schizolobium parahybum</i>, <i>Simarouba glauca</i>, <i>Stemmadenia donnell-smithii</i>, <i>Swietenia macrophylla</i>, <i>Vochysia hondurensis</i> and <i>Xylopia frutescens</i>. Tourism Impacts: Wildlife and scenic value encourage conservation; Accessible through Las Cuevas and FCD Other Impacts: Research activities, xate harvesting, selective logging, fragmentation by access tracks</p>
<p>Submontane Pine Forest</p>	<p>Tropical evergreen seasonal mixed needle and broad-leaved sub-montane forest</p>	<p>Mixed tropical needle and broad-leaved forest on mostly well drained soils overlying non calcareous rocks, between 500 and 1,000m. Large areas of east and south east Mountain Pine Ridge, in association with deciduous mixed submontane shrubland over poor soils. Species overlap with mixed needle-leaf and broadleaf forest on lower elevations in the Mountain Pine Ridge is very considerable, with the 500m elevational distinction being a largely arbitrary cutoff between two ecosystems that are to all intents and purposes largely the same. Tourism Impacts: Scenic value encourage conservation; fire impacts; trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls) Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire, Military training activities</p>
	<p>Tropical evergreen seasonal needle-leaved sub-montane forest</p>	<p>Pine forest on well drained forests between 500 and 1,000m found in upland areas in both protected areas, including the San Pastor area of Chiquibul Forest Reserve. This ecosystem forms the central 'spine' of the Mountain Pine Ridge, the dominant species being <i>Pinus caribaea</i>, with the presence of the endemic <i>Schippia concolor</i>. Again, the distinction between this ecosystem and its continuum below the 500m elevation is largely arbitrary, with an almost complete species overlap. Tourism Impacts: Scenic value encourage conservation; fire impacts; trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls) Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire; Military training activities</p>
<p>Overall Tourism Impact: -ve impact: Low...small numbers of researchers with minimal impact +ve impact: High. encouraging conservation of the natural resources</p>		
<p>Overall Tourism Impact: -ve impact: Low...small numbers of visitors to specific sites, well controlled by accompanying tour guides +ve impact: High. encouraging conservation of the natural resources</p>		

Table 12: Ecosystems of the Project Area – Description, Location and Identified Threats / 4		
<p>Lowland Pine Forest Overall Tourism Impact: -ve impact: Low...small numbers of visitors to specific sites, well controlled by accompanying tour guides +ve impact: High. encouraging conservation of the natural resources</p>	<p>Deciduous broad-leaved lowland shrubland, well-drained, over poor soils</p>	<p>Gently sloping fire-induced shrubland with grass on nutrient poor sandy soils below 500m. Where the limestone capping is still present, isolated islands of broadleaf forest occur. This ecosystem is rather less extensive than indicated in current national ecosystem mapping (Meerman, 2004), with most of the areas around Pinol Sands, Orchid Cascade, Rio On, Granite Cairn Falls and the Santa Maria Falls actually being tropical evergreen seasonal needle-leaved lowland hill forest. Tourism Impacts: Scenic value encourage conservation; fire impacts; trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls) Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire</p>
<p>Submontane Pine Forest Overall Tourism Impact: -ve impact: None +ve impact: High. encouraging conservation of the natural and cultural resources</p>	<p>Deciduous mixed submontane shrubland over poor soils</p>	<p>Whilst not represented in either Mountain Pine Ridge or Chiquibul Forest Reserves, this ecosystem has been mapped (Meerman, 2004) as occurring in the Thousand Foot Falls Natural Monument, downstream of the Thousand Foot Falls itself, and therefore has been included in this assessment, though its extent is more limited than mapped Tourism Impacts: Scenic value encourage conservation; fire impacts; not easily accessed Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire</p>
<p>Shrubland</p> <p>Overall Tourism Impact: -ve impact: Low (though locally medium in the Granite Cairn Falls area) +ve impact: High. encouraging conservation of the natural resources</p>	<p>Deciduous broad-leaved lowland riparian shrubland</p>	<p>Fast growing, short lived riparian trees growing on well drained, alluvial deposits over non-calcareous rock below 500m. Flash floods during storm events make this a highly disturbed ecosystem. It is found in low lying flood plain areas adjacent to the Raspaculo River, along the joint boundary of Mountain Pine Ridge and Chiquibul Forest Reserve, and follows the major tributaries west in Mountain Pine Ridge Forest Reserve, and south into Chiquibul Forest Reserve. Shrubby species include <i>Calathea sp.</i>, <i>Calliandra emarginata</i>, <i>Hamelia patens</i>, <i>Helicteres guazumifolia</i> and <i>Solanum sp.</i>; trees include <i>Castilla elastica</i>, <i>Ficus insipida</i>, <i>Guazuma ulmifolia</i>, <i>Lonchocarpus guatemalensis</i> and <i>Spondias radlkoferi</i>. Tourism Impacts: Scenic value encourage conservation; Other Impacts: Chalillo Dam has resulted in flooding of an area of this ecosystem; Military training activities; Activities associated with monitoring of Chalillo Dam environmental impacts</p>
	<p>Fire-induced fern thicket</p>	<p>Indicative of frequent fire impacts, this ecosystem is dominated by <i>Dicranopteris</i> or <i>Pteridium</i> species, dependant on soil type. A small patch is mapped on the southern side of Pinol Creek, though ground truthing showed that this area has little indication of <i>Dicranopteris</i>, and is currently one of the sites chosen for replanting under the SBL project. However quite extensive tracts occur on fire-damaged soils around Granite Cairn Falls. Tourism Impacts: Scenic value encourages conservation; fire impacts; trampling in fragile ecosystems (seepage areas, creek-side areas, waterfalls). Extensive road creation activities for future tourism access impacts aesthetic appeal of site, and alters natural drainage patterns Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire</p>
	<p>Fire-induced submontane fern thicket</p>	<p>This <i>Dicranopteris</i> dominated ecosystem is indicative of repeated fire impacts on hill top forests on non-calcareous hills between 500 and 1000m. A single area has been mapped in Mountain Pine Ridge, in the Starkey Hill area by No. 3 Fire Lookout. With fire prevention, this area might regenerate to the original pine. Tourism Impacts: Scenic value encourages restoration to pine ecosystem; fire impacts; Other Impacts: Forest management activities; Southern Pine Bark Beetle; fire</p>
<p>Urban</p>	<p>Urban</p>	<p>Douglas D'Silva</p>

3. Species Status of the Project Area

A number of species have been identified as ‘species of interest’, either through being Belize endemics, globally endangered, or indicative of changes in the environment or tourism impacts. In general, tourism positively impacts the species of the project area, having resulted in a shift from forestry management to one for tourism, based on conservation of the scenic and wildlife values of the area. The main identified potential tourism impact is the opening up of roads into the Chiquibul area, further fragmenting the broadleaf forest ecosystem. There are many non-tourism threats that have a far greater impact on species in both Mountain Pine Ridge and Chiquibul Forest Reserves.

▪ Endemic Species

Plants

Forty four plant species have been listed as endemic to Belize (Balick, 2000; BERDS, 2007), many of these being recorded only from the highly restricted Belizean Pine Ecoregion and its fire-adapted savanna ecosystems (Balick, 2000; WWF, 2001). Of these, three have been discounted following review of museum data, as also occurring in Guatemala, Honduras, and/or Mexico (Missouri Botanical Gardens, 2007). Of the remaining forty one species, fifteen are recorded from the project area.

Endemic Plant Species of the Project Area

Anemia bartletti
Axonopus ciliatifolius
Telanthophora bartletti
Calyptanthus bartletti
Dalechampia schippii
Galactia anomala
Koanophyllon sorensenii
Mimosa pinetorum
Neurolaena schippii
Oxandra proctorii
Pisonea proctorii
Schippia concolor
Scutellaria lundellii
Syngonanthus bartlettii
Zinowiewi pallida



Photograph 5: *Dalechampia schippii*

Dalechampia schippii (Photograph 5) and *Schippia concolor* are common throughout the Mountain Pine Ridge, occurring together at the majority of pine savanna sites, and have therefore been included as joint indicators of the integrity of the pine ridge ecosystem. Whilst both of these are considered to be fire-adapted and fire-tolerant, repeated intensive fire damage at these sites may degrade them to the point of local extinction. Tourism-related threats are minimal, other than the need for caution in the dry season with discarded matches, cigarettes and camp fires, as well as careful disposal of all glass. There is greater impact from forest management prescribed burns and fires started from military training activities within the area.

Neurolaena schippii, *Scutelleria lundellii* and *Calyptanthus bartlettii* have all been recorded within the Chiquibul Forest, and are not considered threatened by tourism impacts.

Fish

Poecilia teresae is one of Belize’s two endemic freshwater fish species (Fishbase, 2006), and is largely confined to the fast flowing streams of the Maya Mountains. It is one of a species-assemblage of four that inhabit the species-poor upper reaches of the Mountain Pine Ridge streams such as Rio On and Rio Frio, above waterfalls considered to be barriers to most fish movement (Greenfield and Thomerson, 1997). This species is widely distributed throughout the Mountain Pine Ridge area, and recorded at all sites surveyed. Tourism-related threats are few, and the majority of tour guides employ best practices to minimize water pollution (limiting use of sun screen and insect repellent before swimming, and use of carefully planned toilet facilities). Greater impact will come from any insect control activities at the three lodges (Five Sisters, Pine Ridge Lodge and Blancaneaux), and damming of the creeks for hydro-electric power, though at the scale at which these activities are carried out, even this can be considered minimal.

With no agricultural activities within the Mountain Pine Ridge Forest Reserve itself, there is little contamination of the headwater streams, though there is potential for deposition of agro-chemicals transported in rain clouds from the coastal plain, or from forestry activities.

The second endemic species is *Rhamdia typhla*, the Cave Chulin. This species has been recorded only from Las Cuevas, in the Chiquibul Forest Reserve, and has been elevated to species status (Greenfield et. al., 1982). Individuals of this species (originally considered a sub-species of *Rhamdia laticauda*), show varying degrees of eye reduction, as a result of evolving in the cave environment. Currently, tourism impact in this area is low, and regulated by the management body of Las Cuevas.

Amphibians

Rana juliani is Belize’s only endemic frog, and whilst restricted to the Maya Mountain Massif, it is considered common in the fast flowing streams, and probably occurs throughout much of the Chiquibul Forest Reserve (Lee, 1996). As with fish, the absence of upstream agricultural impacts ensures that the water quality essential for the viability of this species remains good throughout the area. Current tourism impacts on this species are considered minimal. Some amphibian research at Las Cuevas may have impacted local populations through excessive collecting without consideration for the status of this species (Kaiser, pers. com.).

▪ **Species of Concern**

The internationally recognized standard for identifying species of concern is the IUCN Red List (IUCN, 2006). Following analysis of current and potential impacts on these species, it is believed that tourism has a minimal impact in comparison with other sources and threats.

Critically Endangered

A species is considered to be **Critically Endangered** when the best available evidence indicates that it is facing an extremely high risk of extinction in the wild.

Critically Endangered Species	
<i>Agalychnis moreletii</i>	Morelet’s Treefrog

Highlighted in both the Global Amphibian Assessment, 2006 and NARMAP, 1995, *Agalychnis moreletii* (Photograph 6) has been recorded

from Las Cuevas, though some concerns exist about the level of unmonitored collection for undergraduate research projects. This species has also been recorded from the Mayan aguadas of Caracol, to the west of the project area, where clearance of pool side vegetation may have an impact on breeding success. Recent presence in Mountain Pine Ridge has not yet been confirmed, though it may be present in broadleaf forest areas where suitable breeding pools exist. Tourism impact on this species is likely to be minimal, localized and indirect – e.g. degradation of breeding sites through “beautification” management actions.



Photograph 6: Morelet’s Treefrog (*Agalychnis moreletii*) – Caracol aguada
Wildtracks

Endangered

A species is considered to be **Endangered** when the best available evidence indicates that it is facing a very high risk of extinction in the wild. Five species recorded in the project area are considered Endangered.

Endangered Species	
<i>Alouatta pigra</i>	Yucatan Black Howler Monkey
<i>Craugastor sabrinus</i>	Long-legged Streamfrog
<i>Eleutherodactylus sandersoni</i>	Sanderson’s Streamfrog
<i>Tapirus bairdii</i>	Baird’s Tapir
<i>Vertex gaudery</i>	Fiddlewood

The Yucatan Black Howler Monkey has been recorded in the past from the broadleaf forest areas of the Mountain Pine Ridge (NARMAP, 1995; Walker & Walker, 2006), and current

presence of howler monkeys has been confirmed by Forest Officers and tour guides (Tour guides, pers. com. 2006), though much of Mountain Pine Ridge is not considered prime habitat for this species, and only one troop has been reported.

Howler Monkeys are also known to be present in Chiquibul Forest Reserve, particularly in riparian areas adjacent to the Raspaculo River. Tourism impacts are minimal – there has been some fragmentation of broadleaf forest habitat with the widening of the Caracol Road, which passes through Chiquibul Forest Reserve. There is a far greater threat from hunting pressure from xateros, who are known to include howlers in their subsistence diet (BDF soldier, pers. com., 2006). Impacts from the construction of the Chalillo dam may have caused some movement away from the construction site, but it is likely that the groups will now have returned to the forest adjacent to the reservoir.



Photograph 7: Yucatan Black Howler Monkey (*Alouatta pigra*)
Z. Goodwin

Global Amphibian Assessment projected ranges for *Craugastor sabrinus* and *Eleutherodactylus sandersoni* include the limestone areas of Mountain Pine Ridge, and much of the Chiquibul Forest Reserve (GAA, 2006). This is still to be confirmed by observation.

Baird’s Tapir (*Tapirus bairdii*), the largest of Belize’s terrestrial mammals, is considered to be relatively abundant in the Chiquibul area, especially in riparian vegetation. Tourism impacts on this species are minimal – there has been far greater impact from the opening

up of the Mountain Pine Ridge by the Southern Pine Bark Beetle, the construction of the Chalillo Dam and subsequent flooding of the riparian vegetation, and hunting by xateros.

Vitex gaumeri, whilst being considered globally endangered, is a common tree species in Belize, and is not considered to be impacted by tourism.

Vulnerable

A species is considered to be **Vulnerable** when the best available evidence indicates that it is facing a high risk of extinction in the wild. Fifteen Vulnerable species are expected to occur within the project area, and none are considered to be impacted by tourism. Of greater impact is past and present logging of the commercial species (particularly *Cedrela odorata* and *Swietenia macrophylla*).

Vulnerable Species	
<i>Aegiphila monstrosa</i>	White Hulub
<i>Antrozous dubiaquercus</i>	Van Gelder's Bat
<i>Caluromys derbianus</i>	Central American Woolly Opossum
<i>Cedrela odorata</i>	Spanish Cedar
<i>Ceratozamia robusta</i>	Cycad
<i>Dendroica cerulea</i>	Cerulean Warbler
<i>Eleutherodactylus leprus</i>	Leprus Chirping Frog
<i>Craugastor psephosypharus</i>	Limestone Rainfrog
<i>Gaussia maya</i>	Palm
<i>Magnolia yoroconte</i>	
<i>Pinus oocarpa</i>	
<i>Pouteria amygdalina</i>	Silly Young
<i>Schippia concolor</i>	Mountain Pimento
<i>Sideroxylon stevensonii</i>	Chicle Faisan
<i>Swietenia macrophylla</i>	Mahogany
* <i>Pinus tecunumanii</i> now called <i>P. oocarpa</i> (Balick et. al., 2000)	

Least Risk / Near Threatened

A species is considered **Near Threatened** when it has been evaluated and does not qualify for Critically Endangered, Endangered or Vulnerable, but is close to qualifying for, or is likely to qualify for, a threatened category in the near future.

Whilst none of these species is considered impacted by tourism within the project area, several are severely impacted by other causes within the area. Game species such as *Crax rubra* and *Meleagris ocellata* have suffered severe declines following the incursions by xateros throughout the broadleaf forests of the project area. This is also reflected on the status of the top predators of the area, the puma and jaguar. Whilst still considered present, numbers are thought to be reduced by the combined effect of xatero activity in broadleaf forest areas, and also by the reduction of habitat suitability following the Southern Pine Bark Beetle infestation.

Least Risk / Near Threatened	
<i>Aspidosperma megalocarpon</i>	Malady Blanco
<i>Bassariscus sumichrasti</i>	Central American Cacomistle
<i>Crax rubra</i>	Great Curassow
<i>Crocodylus moreletii</i>	Morelet's Crocodile
<i>Diphylla ecaudata</i>	Hairy-legged Vampire Bat
<i>Craugastor chac</i>	Chacs Rainfrog
<i>Craugastor laticeps</i>	Broad-head Rainfrog
<i>Harpia harpyia</i>	Harpy Eagle
<i>Harpyhaliaetus solitarius</i>	Solitary Eagle
<i>Meleagris ocellata</i>	Ocellated Turkey
<i>Micoureus alstoni</i>	Alston's Woolly Mouse Opossum
<i>Panthera onca</i>	Jaguar
<i>Puma concolor</i>	Puma
<i>Rana juliani</i>	
<i>Vermivora chrysoptera</i>	Golden-winged Warbler
<i>Zamia polymorpha</i>	Mata Raton

Photograph 8: Chac's Rainfrog (*Craugastor chac*), Rio Frio Caves Wildtracks



▪ **Other Species**

Other species of note are those not necessarily highlighted as endemic or threatened, but those that are restricted to the Mountain Pine Ridge habitat in Belize, or may be used as indicators of a particular impact. A number of these species have been selected as indicators.

Indicator Species	
▪ <i>Selaginella sp.</i>	Selaginella
▪ <i>Drosera capillaris</i>	Sundew
▪ <i>Sobralia macrantha</i>	Orchid sp.
▪ Cave roosting bats	Bat sp.
▪ <i>Chamaedorea sp.</i>	Xate
▪ <i>Falco deiroleucas</i>	Orange-breasted Falcon

Birds

The **orange-breasted falcon** (*Falco deiroleucus*) is highlighted as vulnerable in the Central American portion of its range (Peregrine Fund), and very rare, perhaps extinct, south of Belize and Petén, Guatemala (Jones and Vallely, 2001; The Peregrine Fund, 2005). It is only known to nest in four areas in Belize, one of these being the Thousand Foot Falls (Jones and Vallely, 2001), attracting visitation from birding groups. The Peregrine Fund monitors known nesting sites within Belize, and has been engaged in a release programme in the Maya Mountains to try and boost the Belize population (The Peregrine Fund, 2005).

Bird species with ranges restricted to the Mountain Pine Ridge Forest Reserve:
Red-tailed Hawk
Stygian Owl
Greater Pewee
Plain Wren
Eastern Bluebird
Red Crossbill
Black-headed Siskin
Species indicative of pine forest/short grass savanna:
Acorn Woodpecker
Grace's Warbler
Rusty Sparrow
<i>Jones, 2003</i>

Bird species with ranges restricted to the Maya Mountains / Chiquibul Forest Reserve include:
Solitary Eagle
Harpy Eagle
Scarlet Macaw
Crested Owl
Violet Sabrewing
Keel-billed Motmot
Emerald Toucanet
Tropical Parula
Elegant Euphonia
<i>Jones, 2003</i>

Also highlighted is the scarlet macaw, the largest of the parrots in Belize, with a population countrywide thought to number fewer than 200 individuals (Matola, 2002). Whilst it was apparently once seen flying over much of the central forested areas of Belize, it is now considered to be restricted to the Chiquibul/Maya Mountain area, with a nesting range thought to be confined to the Raspaculo River area in the more remote Chiquibul region. A portion of this nesting area, in the upper Macal/Raspaculo River region, has recently been inundated, following the construction of the Chalillo Dam, though it is hoped that the birds will continue to use the area, and the artificial nest sites erected to replace those lost by the inundation.

Known nesting areas for this species are currently inaccessible to tourism, which therefore is not considered to have any negative impacts on the species here. Future access, whether tourism or non-tourism, should be carefully planned and controlled in the remaining known nesting areas. Tourism elsewhere in the seasonal feeding range (Red Bank hills) has had a

positive impact, raising public awareness of the plight of this species, and reducing illegal killing. Illegal xateros are known to kill scarlet macaws within the Chiquibul area to supplement food as they collect xate palm leaves, and it is believed there is also an illegal trade of nestlings to Guatemala for the pet trade.

Plants

The two main broad ecosystems - pine forest and broadleaf forest - currently show little impact from tourism – the tourism footprint within the project area is minimal compared with that of other activities and other impacts. However, as new sites are opened up, the creation of access roads and trails will increase the need for greater monitoring and regulation of tourism activities.

Perhaps the greatest tourism impacts to the environment are those in the fragile wetland and riparian systems, where trails cross seepage areas with *Selaginella*, and river side splash zones with *Drosera*. However, whilst damage to these plants and ecosystems is indicative of tourism impacts and the need for impact-relieving infrastructure, the impacts are likely to be far lower than those associated with prescribed burns in forestry management, or natural flash floods following storm events.

A number of orchid species are restricted to the Mountain Pine Ridge area, and have been subjected to collecting pressure (Tour guide interviews, 2006) - *Sobralia macrantha*, whilst not restricted to the Mountain Pine Ridge area, has been included as a good indicator of pressure from plant collection, being particularly showy, and a target for orchid collectors.

Orchids restricted in Belize to Mountain Pine Ridge:

- Habenaria lankesteri*
- Habenaria rodeiensis*
- Dichaea glauca*
- Batemannia grandifolia*
- Koellensteinia tricolor*
- Lacaena bicolor*
- Stanhopea graveolens*
- Stanhopea inodora*
- Oncidium cebolleta*
- Oncidium stipitatum*
- Encyclia michuancana*
- Scaphyglottis fasciculata*
- Masdevallia adamsii*

McLeish et. al. 1995

The condition of the pine forest (especially its aesthetic appeal) was significantly impacted by the Southern Pine Bark Beetle infestation, which has been a significant negative impact on tourism, several tour operators taking the area off their itinerary following poor feedback from visitors. Aesthetic appeal of the sites is now improving with natural and managed regeneration of the pine trees.



Photograph 9: Sundew (*Drosera sp.*)



Photograph 10: *Sobralia macrantha*



Photograph 11: *Schippia concolor*

Wildtracks

Baseline Assessment Results

A review of the site assessment results showed that the endemic species, *Dalechampia schippii*, *Schippia concolor* and *Poecilia teresae*, are wide-spread and abundant, occurring at all open pine ecosystem sites throughout the Mountain Pine Ridge (Table 13). The two plant species were noticeably absent from Rio Frio Cave, the only broadleaf forest site within the Forest Reserve. *Schippia concolor* may yet be found to occur on the upper slopes of the broadleaf forests around Rio Frio Cave, but *Dalechampia schippii* is a pine forest / savanna specialist. *Poecilia teresae* was found in all streams in the area.

Table 13: Species of Concern - Mountain Pine Ridge								
Species of Concern	Tourism Sites							
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
Endemic Species								
<i>Dalechampia schippii</i>								
<i>Schippia concolor</i>								
<i>Poecilia teresae</i>								
Threatened Species								
<i>Cedrela odorata</i>								
<i>Gaussia maya</i>								
<i>Schippia concolor</i>								
<i>Swietenia macrophylla</i>								
<i>Vitex gaumeri</i>								
Indicator Species								
<i>Selaginella sp.</i>								
<i>Drosera capillaris</i>								
<i>Sobralia macrantha</i>								
Cave roosting bats								
<i>Chamaedoraea sp. (Xate)</i>								
<i>Falco deiroleucas</i>								

The four threatened species, *Cedrela odorata*, *Gaussia maya*, *Swietenia macrophylla* and *Vitex gaumeri*, were only recorded from the broadleaf forest site. The only exception to this is as a result of management actions, at Rio On Pools, where Forest Department has been planting mahogany adjacent to the car park.

Presence and densities were similar in both open and non-open tourism sites, suggesting that at present, tourism impacts are not significantly affecting the natural vegetation, though tour guide interviews indicate that orchid collection by local visitors has been observed at at least one site (Tour guides, 2006). Tour guides are understandably uncomfortable dealing with confrontational situations when leading tour groups, so plant removal goes unchallenged.

Table 14: Status of Species of Concern - Mountain Pine Ridge / Chiquibul Forest Reserves			
	Current Status	Potential Tourism Impacts	Other Impacts
Endemic Species			
<i>Dalechampia schippii</i>	Abundant in Mountain Pine Ridge	+ve Encourages conservation of the natural environment	+ve Forest management activities (fire, underbrushing) maintains ecosystem
<i>Schippia concolor</i>	Abundant in Mountain Pine Ridge	+ve Encourages conservation of the natural environment	+ve Forest management activities (fire, underbrushing) maintains ecosystem -ve possibly seed collection
<i>Poecilia teresae</i>	Abundant in Mountain Pine Ridge	+ve Encourages conservation of the natural environment	-ve Changes in water quality through damming, sewage, oil / gasoline spills, diversion of flow
Threatened Species			
<i>Cedrela odorata</i>	IUCN: VU Common in Chiquibul*	+ve Encourages conservation of the natural environment	+ve Management for sustainable timber production -ve Target for selective timber removal under logging concession
<i>Gaussia maya</i>	IUCN: VU Present in Chiquibul, but no abundance data*	+ve Encourages conservation of the natural environment	Minimal – not a commercial species
<i>Schippia concolor</i>	IUCN: VU Abundant in Mountain Pine Ridge	+ve Encourages conservation of the natural environment	+ve Forest management activities (fire, underbrushing) maintains ecosystem -ve possibly seed collection
<i>Swietenia macrophylla</i>	IUCN: VU Occasional / common in Chiquibul*	+ve Encourages conservation of the natural environment	+ve Management for sustainable timber production -ve Target for selective timber removal under logging concession
<i>Vitex gaumeri</i>	IUCN: EN Common in Chiquibul	+ve Encourages conservation of the natural environment	Minimal – not a commercial species

* Abundance data from Bridgewater et. al., 2006

Table 14: Status of Species of Concern - Mountain Pine Ridge / Chiquibul Forest Reserves / 2			
Indicator Species	Current Status	Potential Tourism Impacts	Other Impacts
<i>Selaginella sp.</i>	Abundant in Mountain Pine Ridge in seepage areas – absence is an indicator of tourism impacts on the environment, in sites where it has been recorded	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Degradation of <i>Selaginella</i> in seepage areas through trampling, from poor visitor management and lack of appropriate infrastructure</p>	Natural impacts from storm events
<i>Drosera capillaris</i>	Abundant in Mountain Pine Ridge in creek splash zones – absence is an indicator of tourism impacts on the environment, in sites where it has been recorded	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Degradation of <i>Drosera</i> in splash zone areas through trampling, from poor visitor management and / or lack of appropriate infrastructure</p>	Natural impacts from storm events
<i>Sobralia macrantha</i>	Relatively common in Mountain Pine Ridge in riparian vegetation – presence is a good indicator of low tourism impacts on plant species through collection	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Removal of orchids and bromeliads, primarily by local visitors</p>	<p>-ve Fire (natural and management activities)</p>
Cave roosting bats	Present in caves in the Mountain Pine Ridge Rio Frio area, and in Chiquibul Forest area	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Excessive visitation, poor visitor noise management will disturb bat colonies, and may cause them to move from area</p>	-
<i>Chamaedorea spp. (Xate)</i>	Present in the Chiquibul area	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Presence of tourists in the area will reduce xate activity</p>	<p>-ve Xate concession in the Chiquibul area Illegal xate harvesting Associated impacts from selective logging activities</p>
<i>Falco deiroleucas</i>	Breeding in the Thousand Foot Falls area	<p>+ve Encourages conservation of the natural environment</p> <p>-ve Disturbance, particularly by helicopter tourism, may disturb nesting birds</p>	<p>-ve Military helicopter activities may disturb breeding birds</p>
<p>NB: Mountain Pine Ridge denotes the needle-leaf ecosystems Chiquibul / Chiquibul Forest denotes the broad-leaved forest ecosystems</p>			

Population Trends

Very little quantitative data is available on the abundance of flora or fauna within either of the two main broad ecosystems of the two protected areas, dictating that observations on population trends are largely anecdotal, and at best, informed opinions. Whilst such crude data is better than no data, it is not adequate for use in meaningful monitoring of potential impacts from tourism – detection of any changes might well be too slow to be able to feed into adaptive management. Nonetheless, it is relevant to use existing data whilst recognizing the limitations associated with its source and scale.

Mountain Pine Ridge

Many tour guides expressed the opinion that the impacts of the Southern Pine Bark Beetle not only reduced the aesthetic appeal of Mountain Pine Ridge, but also resulted in a significant reduction in the wildlife abundance, with wildlife retreating from the open pine savanna to the more sheltered perimeter of broadleaf forest and riparian belts that follow the creek courses. Natural regeneration is underway, and reports suggest that the current mix of regenerating broadleaf shrub layer and pine has resulted in a recent increase in the number of birds, in particular, with a shift to a greater species diversity, as generalists move into the area from adjacent broadleaf forest. Species assemblages will shift again as the pine forests regenerate, especially if management actions to reduce broadleaf species continue to be implemented, and pine forest specialists return to their former dominance.

Long-term management practices for timber production have ensured that much of the pine ridge exists as a dynamic mosaic of needle-leaved and mixed forests at varied successional stages. In many ways, the initial impact of the Southern Pine Bark Beetle was to shift succession towards a rather different route that if left unchecked might have resulted in a far greater predominance of broadleaf tree species within the forest. Subsequent management actions have been geared towards the re-establishment of pine as the dominant tree – and thereby maintaining the habitat for many of endemic plant species that depend upon relatively open pine forests that are maintained by periodic prescribed burns. Under such a complex pattern of land-use practices, it can be presumed that the relative abundance of individual species (of plants at least) will be in a continual state of flux at the site level, but probably relatively stable at the landscape scale. Subjective assessments of relative abundance of some selected species are included for specific sites.

Broad-leaved Forest

Historical timber extraction from the Chiquibul Forest Reserve may be expected to have skewed the relative abundance, age structure, and possibly distribution of some commercial timber species. The forest is now in the process of regenerating towards its natural state, with current long-term timber management being designed for both long-term economic and ecological sustainability. Illegal harvesting of xate palm leaves (by Guatemalan xateros) is considered completely unsustainable (Bridgewater, pers. com.) and is reducing the population viability of this species. Many vertebrate groups are said to be heavily impacted by illegal hunting pressure from the estimated 1,000 xateros operating illegally in Belize, with dramatic declines noted in the abundance of game species. Many non-game vertebrate species, including parrots and toucans, are said also to be hunted heavily for food by the xateros (BDF soldier, pers. com.). On a smaller scale, Belize Defense Force patrols are also reported to hunt whilst in the area, to supplement their field rations (BDF soldier, pers. com.). Studies within the Chiquibul have estimated jaguar densities to be significantly lower than in either Cockscomb or Gallon Jug, and the possibility that this may reflect hunting pressure on prey species within Chiquibul has been put forward as a possible explanation (Meerman, 2005). Whilst quantitative data is extremely limited, it is safe to state that tourism-related impacts on populations within this broad ecosystem, within the project area, are minimal in comparison with other factors.

4. Waste Disposal

There is as yet no comprehensive, overall development or management plan for the Mountain Pine Ridge / Chiquibul area, which is reflected in the lack of an organized waste disposal system. Each organization based in Douglas D'Silva, in the adjacent Privassion Enclave, at Chalillo or at Las Cuevas, or working in the Mountain Pine Ridge or Chiquibul area, is responsible for its own waste disposal.

Human waste

At the current levels of tourism visitation, there appears to be little impact on the environment from sewage. The only residential sites within the two protected areas are Douglas D'Silva and Las Cuevas, both of which are considered to have adequate sewage disposal, with sufficient distance from the creeks and rivers to avoid water contamination. There have been problems in the past - during construction of the Chalillo Dam, the construction workers site was designed for a capacity of 250, but had an actual occupancy of 500, overloading the septic system, and resulting in raw sewage draining into the Rio Frio (Ruiz, pers. com.). This was dealt with once reported.

Lodges adjacent to the sites have septic tank systems designed for the occupancy levels (Table 15).

Those tourism sites that are currently open have pit latrines, generally located sufficiently far from the creeks and rivers to avoid contamination. The exceptions are Big Rock Falls, which lies outside the Mountain Pine Ridge Forest Reserve (and lacks any amenities), and Thousand Foot Falls, which has a single flush toilet.

There is currently no water quality monitoring in place for assessing the impact of human waste disposal systems on the creeks and rivers of the Mountain Pine Ridge and Chiquibul areas (except for limited testing at Las Cuevas), but impacts are expected to be very low to non-existent at the current level of occupancy and visitation. Under the Environmental Compliance Plan, Belize Electricity Limited is to conduct water testing for impacts from the Chalillo dam site, which will highlight any major problems that may occur.

Tour guides are in consensus that there are insufficient pit latrine facilities for the current level of tourism, and those that do exist are considered sub-standard for the level of tourists visiting the sites. This is reflected in the presence of toilet paper at many of the sites (including in the Rio Frio Cave itself), suggesting that some visitors avoid the latrines. The Visitor Use Plan for the Mountain Pine Ridge (De Vries, 2004) suggests that where there is easy access for

Table 15: Sewage Disposal in the Project Area	
Site	Human Waste System
Douglas D'Silva	
Forest Department	A combination of septic systems or pit latrines for each building
Chalillo Contractors Camp	Septic system
MPR Lodges	
Hidden Valley Inn	Septic tank system
Blancaneaux Lodge	Septic tank system
Five Sisters Lodge	Septic tank system with biodigestors
Old Mai Gate	
Tourism Sites	
Rio On Pools	Pit latrines
Rio Frio Cave	Pit latrines
Pinol Sands	Pit latrines
Thousand Foot Falls	Free standing septic tank system
Big Rock	No facilities
Orchid Cascade	No facilities (not yet open)... pit latrines planned
Granite Falls	No facilities (not yet open) ...pit latrines planned
Santa Maria Pools	No facilities (not yet open) ...pit latrines planned
Las Cuevas	Septic tank systems

maintenance (eg. Rio Frio Cave), the current pit latrines should be replaced by composting toilets, an upgrade that should find favour with both the guides and visitors. Tour guides plan to lobby with Forest Department for the construction of a central toilet facility at Douglas D’Silva.

Guides for adventure tourism – such as the Maya Divide trekking groups – are responsible for ensuring that participants consider water pollution impacts when defecating, and when using soap products (washing themselves, clothes etc.).

Other sectors that operate within the Forest Reserves have more of an impact – large numbers of British Forces use the area for training, and employees working under the PLC logging concession, the current xate concession, and the illegal xateros all produce human waste that is left to decompose naturally...this may well be over 2,000 individuals that do not have access to toilet facilities whilst in the forest, a significant input of organic material, but probably one that can be accommodated by the natural decomposition processes.

Solid Waste

The Forest Department, logging concession holders, Las Cuevas, individual lodges and other operations in the area are responsible for their own solid waste disposal, with no central collection system. The majority have surface dump sites or pits adjacent to the facilities, and burn at regular intervals. Douglas D’Silva has a general dump area for the Forest Department and the small community (Table 16). Waste management in Belize is in its infancy, and dump sites in the Mountain Pine Ridge are no exception, with little discrimination between hazardous and non-hazardous waste. Recycling is carried out on a personal basis, and limited to glass drink bottles.

Forest Department is responsible for the maintenance of the tourism sites within Mountain Pine Ridge, and is assisted by the Cayo Tour Guide Association, which organizes litter sweeps of the Chiquibul Road (A10) and primary sites currently in use. The Visitor Use Master Plan (De Vries, 2004), developed for the Forest Department, does not adequately address this issue.

Generally, the rate of littering is low, with minimal visual impact. Of the five sites in use, three rated a score of 1 or 2 - No visual impact, or minimal impact (Table 17). Thousand Foot Falls was litter-free, a result of having an on-site caretaker. Pinol Sands and Rio Frio Cave both rated a higher score of 3 and 4 respectively, based primarily on litter left behind by police and/or military (for example, ration pack covers, cartridge shells, targets used in target practice). Tourism-originated litter levels are considered minimal, and reflect on the implementation of ‘best practices’ by tour guides, and on the

Table 16: Solid Waste Disposal	
Site	Solid Waste Disposal System
Douglas D’Silva	
Forest Department Buildings	FD Garbage disposal system
British Forces Camp	Self contained garbage disposal system
Chalillo Contractors Camp	Self contained garbage disposal system
MPR Lodges	
Hidden Valley Inn	Buried in adjacent garbage site
Blancaneaux Lodge	Taken to Georgeville dump site
Five Sisters Lodge	Taken to Georgeville dump site
Tourism Sites	
Rio On Pools	Garbage box emptied by FD
Rio Frio Cave	Garbage box emptied by FD
Pinol Sands	Garbage bins emptied by FD
Thousand Foot Falls	Garbage bins emptied by FD
Big Rock	No facilities
Orchid Cascade	No facilities (not yet open) garbage bins planned
Granite Falls	No facilities (not yet open) garbage bins planned
Santa Maria Pools	No facilities (not yet open) garbage bins planned
Las Cuevas	Garbage burnt or carried out

general cross section of tourists, the majority being aware of the impacts visitation can have on the environment.

Table 17: Results of Site Assessment for Litter (January, 2007)								
Indicator	Current Tourism Sites					Future Tourism Sites		
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
Garbage Score	2	4	3	1	1	2	1	1
No. pieces litter	71	33	51	0	13	2	0	0
Scores for Garbage:	1 No visual impact of garbage at site 2 Minimal garbage noticed at site 3 Garbage noticed but not intrusive to visitor enjoyment 4 High visual impact of garbage, resulting in –ve comments from visitors							

5. Water Quality

Whilst it was agreed that developing a water quality monitoring baseline was not within the remit of this consultancy, the impacts of activities - both tourism and non-tourism – on water quality within the Mountain Pine Ridge and Chiquibul Forest Reserves are important on the overall health and integrity of the aquatic ecosystems of the area. However, at the current level of visitation, they are overshadowed by other factors. For the purposes of this consultancy, water quality data from work conducted in the area in 2005 has been used (ESL, 2005).

The Mountain Pine Ridge plateau is dissected by numerous small creeks and rivers flowing into the Rio On and Rio Frio, and forming the headwaters of the Macal River. There are few tourism impacts on these streams, and with the poor nutrient value of the soils, there is no agriculture within the Mountain Pine Ridge, and therefore no agricultural chemical runoff.

Forest management activities, such as underbrushing and prescribed burning, along with natural fires, lead to a significant input of ash into the headwaters, raising nutrient levels temporarily, following rainfall. The removal of vegetation also increases the risk of erosion and subsequent sediment load in the aquatic system.

Tour guides emphasized the impact of road maintenance activities on water clarity (Tour guides, pers. com, 2006), and the need for better road drainage to direct flow away from streams during peak runoff, these two factors, when combined, causing turbidity from increased sediment load.

Fecal contamination of Rio Frio, upstream from the Rio Frio Cave, as a result of poor sewage disposal from the Chalillo construction workers compound at Douglas D' Silva has been a concern in the past (Section 3: Human Waste), but has since been mitigated. Concerns have also been expressed on the potential problems of water pollution from the diesel water pump in use on Rio Frio, upstream from Rio Frio Cave (De Vries, 2004).

The Big Rock Falls site has potential impacts from Blancaneaux Lodge, upstream, but with adequate sewage disposal and a policy of maintaining the natural environmental characteristics of the area, these impacts should be minimal, and there are no reports or signs of contamination (algal blooms, reduced fish density etc.).

Water quality characteristics considered relevant to recreational use in the Mountain Pine Ridge area include microbe content (eg. fecal coliforms), nuisance organisms, aesthetics, clarity, toxic chemicals, oil and debris (Australian Government, 2000). Guidelines have been adapted from a review of these characteristics and their relevance to the project area (Table 18).

Table 18: Summary of Water Quality Guidelines (adapted from National Water Monitoring Strategy, Australia, 2000)		
Parameter	Guidelines	Relevance
Microbial Content	In areas where swimming occurs, the median bacterial content should not exceed 150 faecal coliform organisms/100mL or 35 enterococci organisms/100mL	Rio On, Pinol Sands and Big Rock Falls are the three main sites highlighted by guides for swimming. Some local groups also paddle in the Rio Frio Cave area.
Nuisance Organisms	Macrophytes, filamentous algae, leeches etc. should not be present in excessive amounts	The Mountain Pine Ridge creeks are poor in nutrients, and low in macrophyte and algal content. Only one site showed signs of macrophytic plant growth and algal bloom – the stream by the car park at Big Rock Falls, used as a watering point for horse riding activities. Guides have mentioned the presence of leeches at Big Rock Falls
	Large numbers of midges and aquatic worms should be avoided	The streams support only a limited number of species, and therefore large numbers of organisms such as aquatic worms are not considered the problem they may be in lower lying rivers. Mosquitoes and other biting insects, however, can be a problem, though visitation doesn't generally overlap with early evening, the peak insect time. This should be considered a natural downside of being in a pristine environment, and should not be tackled with insecticide.
Aesthetic Quality	Visual clarity – horizontal sighting of a 200mm diameter black disc should exceed 1.6m	Water clarity is generally very good, particularly in areas where the natural vegetation remains. Tour guides have highlighted the problem of runoff from roads, and the need for better diversion of drainage ditches in areas that drain into creeks. Careful planning of roads and car park areas also needs to be considered – access roads to Granite Cairn Falls, for example, have significant erosion problems, with runoff causing heavy sediment loads downstream at the Santa Maria Pool site. Runoff from the Rio Frio Cave car park is currently channeled down the access path, straight into the Rio Frio, again causing increased sediment load and decreased water clarity
Toxic Chemicals	Toxic Chemicals – water should not contain any toxic chemicals	With the lack of agriculture in the drainage area, toxic chemicals are primarily associated with forestry activities. With extensive training in Belize on the use of pesticides and herbicides, under the Pesticide Control Board, these are unlikely to enter the water system. Should any spill occur, sites downstream would need to be closed and monitored until these chemicals are no longer present.
	Oil and petrochemicals should not be noticeable as a visible film on the surface, nor detectable by odour	Potential pollution from oil and other petrochemicals is possible from poorly maintained vehicles, especially in the case of Rio Frio and Pinol Sands, where runoff from the car park is channeled down the access path into the river. Similar problems may also exist where rainfall drains off roads into creeks, carrying oils with it – for example, at Pinol Sands, where the road crosses just upstream of the bathing site. Activities in and around Douglas D'Silva may also impact water quality – the proximity of the diesel water pump to Rio Frio, for example.

Baseline Assessment

In general, creeks and rivers of the Mountain Pine Ridge and Chiquibul area can be considered relatively pristine, with tourism impacts limited to trace amounts of suntan lotion and insect repellent, in only three or four of the tourism sites (and these are mitigated by tour guides following recommended best practices, and requesting visitors not to reapply chemicals before swimming (Tour guide interviews, 2006)). Currently, with the very recent shift of focus from forest management to visitor use, there is at times a disconnect between forest activities and their location in relation to tourism sites or tourism activities, resulting in reduced visitor satisfaction. It is hoped that more integrated planning in the future, and greater communication and collaboration between the management body and the tourism sector will ensure that forestry impacts upstream of tourism sites can be minimized.

Water quality data is available downstream of the project area (Table 19).

Table 19: Water Quality Data from Macal and Rio On, downstream of project area, 2005						
(adapted from ESL, 2005)						
Parameters	Rio On		Macal River		Guacamallo Bridge	
	180996N 282922E		1881242N 282590E		1865544N 282772E	
	Dry	Wet	Dry	Wet	Dry	Wet
pH	7.6	6.7	8.0	7.2	-	7.0
Conductivity (µScm)	46.3	-	86.6	-	-	-
Salinity (ppt)	0	-	0	-	-	-
Dissolved Oxygen (mg/L)	7.8	-	7.3	-	-	-
BOD (mg/L)	1.5	-	10.0	-	-	-
COD (mg/L)	6.0	5.0	13	7.0	-	13.0
Nitrate (mg/L)	9.2	0.3	9.7	0.5	-	0.2
Phosphate (mg/L)	0.15	1.8	0.12	2.0	-	1.7
Sulphate (mg/L)	1.0	-	1.0	-	-	-
Total Coliform (MPN/100ml)	-	-	9.0	-	-	-
Faecal Coliform (MPN/100ml)	-	-	4.0	-	-	-
Total dissolved solids (mg/L)	41*10 ²	81.0	40*10 ²	277.0	-	42.0
Total suspended solids (mg/L)	10.0	13.0	4.0	12.0	-	17.0
Hardness (mg Ca/L)	68.2	-	16.0	-	-	-
Calcium (mg/L)	28.1	-	2.61	-	-	-
Magnesium (mg/L)	2.99	2.9	1.09	2.03	-	2.9
Manganese (mg/L)	<20.0	-	<20.0	-	-	-
Mercury (mg/L)	<0.5	-	0.7	-	-	-
Iron (mg/L)	355	246	347	385	-	406

The results show that:

- pH is within the recommended DoE levels of between 6.5 and 10, tending towards slightly alkali (a reflection of the karst geology of the lower reaches of the Rio On)
- Higher phosphate levels in wet season may be indicative of inputs from terrestrial runoff in upstream areas affected by fire in the wet season.
- Low nitrate content is indicative of the general nutrient poor nature of the Mountain Pine Ridge area, and the lack of tourism impacts such as poor human waste disposal. These

readings, low in the dry season, are even lower in the wet season, suggesting dilution of the nitrate content of the water.

- Faecal coliform – this reading is low when compared to international standards (eg. USEPA: 400/100ml or the Australian National Water Monitoring Strategy guidelines of 150 faecal coliform organisms/100mL or 35 enterococci organisms/100mL (Table 18; NWMS, 2000) though exceeds the DoE standards of 1/100ml in the one site tested (the Macal River). The slightly higher levels may be as a result of the Mollejon Dam upstream.
- Suspended solids increase after rainfall, as would be expected. Tour guides comment on the decreasing water clarity experienced at sites following the combination of road maintenance and heavy rainfall, increasing sediment load.
- Manganese, Mercury and Iron all fall within recommended DoE water quality standards.
- These results suggest that the water is suitable as a source of potable water (ESL, 2005), and therefore within the limits expected of recreational waters.

The broadleaf ecosystems of the northern area of the Chiquibul Forest Reserve drain primarily into the Raspaculo River. The main impacts on this system are from the presence of the Chalillo Dam, constructed to provide an upstream storage facility for the Mollejon Dam. This relatively large scale dam has had a major impact on the immediate environment, with the inundation of approximately 10km² of broadleaf forest (including 21% of the national coverage of **Deciduous broadleaf riparian shrubland in hills**), and displacement of the associated fauna, including Baird's Tapir and the regional sub-species of the Scarlet Macaw.

Water quality downstream of the dam has been (and will continued to be) impacted, with alteration of both natural flow rates and water volume.

Also of concern are the Ceibo Chico mining activities, with gold panning in the Ceibo Chico Creek and Ceibo Grande River, both tributaries of the Chiquibul River.

6. Air Quality

One of the major attractions of the Mountain Pine Ridge is the excellent air quality, far from the air pollution found in many modern cities. There are a few impacts on the air quality in the area – primarily smoke, dust, and vehicle emissions. These impacts are even fewer on the Chiquibul Forest Reserve.

Three main sources of air pollution were identified during the baseline assessment:

- **Smoke**
 - Mountain Pine Ridge Forest Reserve
 - Forest management activities – prescribed burns
 - Natural fires
 - Campfires and barbecue smoke
- **Dust**
 - Mountain Pine Ridge Forest Reserve
 - Large vehicles (logging trucks, military vehicles) in dry season
- **Vehicle Emissions**
 - General traffic
 - Tourism vehicles running to maintain air conditioning or music

Baseline Assessment

During the baseline assessment, only one impact was recorded – a parked vehicle running for maintaining air conditioning at Big Rock Falls, whilst waiting for the return of visitors (Table 20).

Table 20: Summary of Air Pollution Baseline (January, 2007)								
Indicator	Current Tourism Sites				Proposed/Being Developed			
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
Parked Vehicles	0	0	0	0	1	0	0	0
Passing Vehicles	0	0	0	0	0	0	0	0
Forest Fires	0	0	0	0	0	0	0	0
Campfires and Barbecue Grills	0	0	0	0	0	0	0	0

Noise pollution

Also of concern is noise pollution in terms of both impacts on tourism, particularly from military sources - heavy vehicles, mortar fire and helicopters, and also tourism impacts - loud visitor groups and music (Table 21).

Baseline Assessment

Military noise impacts were considered very intrusive, and recorded at three sites, all associated with passing British Forces helicopters during military training exercises. One noise impact was recorded in the ‘Other Noise Impacts’, at Big Rock Falls, from farm equipment engaged in land maintenance activities within the Privassion Enclave. Negative tourism impacts caused by loud groups, or loud music, was recorded at one site – Rio Frio Cave, and associated with a large group of students.

The Mountain Pine Ridge lodges have opted for hydroelectric power, in an attempt to minimize noise impacts on their environment.

Table 21: Summary of Noise Pollution (January, 2007)								
Indicator	Current Tourism Sites					Proposed / Being Developed		
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
Parked Vehicles	0	0	0	0	1	0	0	0
Passing Vehicles	0	0	0	0	0	0	0	0
Loud Music	0	1	0	0	0	0	0	0
Visitor Groups	0	1	0	0	0	0	0	0
Military Noise Impacts	2	0	1	0	0	0	0	2
Other Noise Impacts	0	0	0	0	1	0	0	0

Military noise impacts within both the Mountain Pine Ridge and Chiquibul Forest Reserve include military vehicles, helicopters, live firing, explosives etc. In long term training areas in the UK, it has been demonstrated that wildlife will become accustomed to military activity, if it causes no disturbance other than noise (eg. no hunting or habitat removal). This is unlikely to be so in Chiquibul, where hunting is an ongoing issue of the xatero activity.

7. Visitor numbers and trends

Visitor Numbers and Seasonal Flow

A total of 39,361 visitors are recorded as visiting the Mountain Pine Ridge area in 2005, over 47% of these being local. Whilst tourism to the Mountain Pine Ridge area shows an overall increase over the last nine years (Figure 3), mirroring the pattern of non-cruise ship arrivals to Belize as a whole (Figure 4), the impact of the Southern Pine Bark Beetle in 2000 did have a significant impact on the number of people visiting the area. This was confirmed by many of the tour guides and tour operators interviewed, who generally felt that visitor satisfaction was greatly decreased following the extensive devastation of the Pine Ridge area, to the point where it was removed from several itineraries. The sharp increase in numbers recorded in 2002 is more a reflection of the increased visitation to the Caracol Archaeological Site (following site consolidation, road improvements and increased marketing by the Institute of Archaeology) than an increased interest in the wildlife and wilderness area of the Mountain Pine Ridge and Chiquibul Forest Reserves themselves.

Seasonal variation also follows the national trend, with increasing visitation between November and May, the cooler months of the year (and the recognised tourism season within Belize), with lowest numbers in August and September (Figure 5).

The Mountain Pine Ridge is a primary destination for international visitors staying in San Ignacio and the adjacent hotels and lodges, with tour operators offering a variety of activities from day tours to Rio On and Rio Frio Caves, as part of their Caracol itinerary, to exploring the area by mountain bike and horseback.

The area is also important for national tourism, with Rio Frio and Rio On both being high on the list of sites for primary and secondary level school excursions, and for fieldtrips by University of Belize students. Families are also attracted to the area for recreational activities, leading to the development of sites such as Pinol Sands, where the focus is on providing a safe environment for a family day out, including water based activities and facilities for picnics and barbecues.

Table 22: Tourism Statistics for Project Area	
Total visitation to Mountain Pine Ridge / Chiquibul area	39,361
% of total overnight tourism to Belize that visits Mountain Pine Ridge / Chiquibul area	17%
Average tours per week per tour guide	2
Average group size per tour	

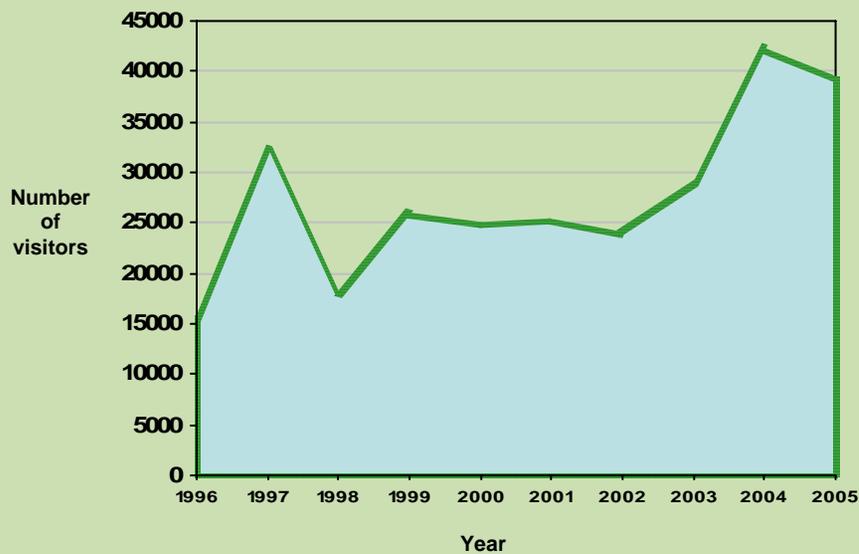


Figure 3: Annual visitation to the project area between 1996 and 2005
Forest Department, 2006

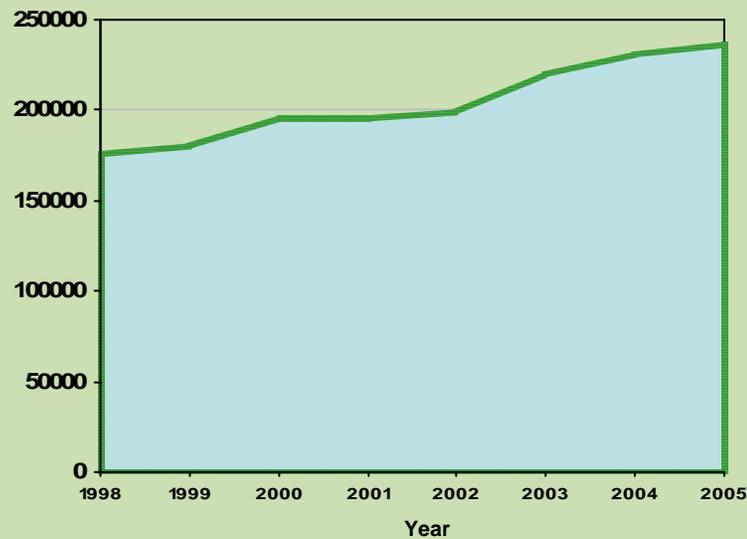
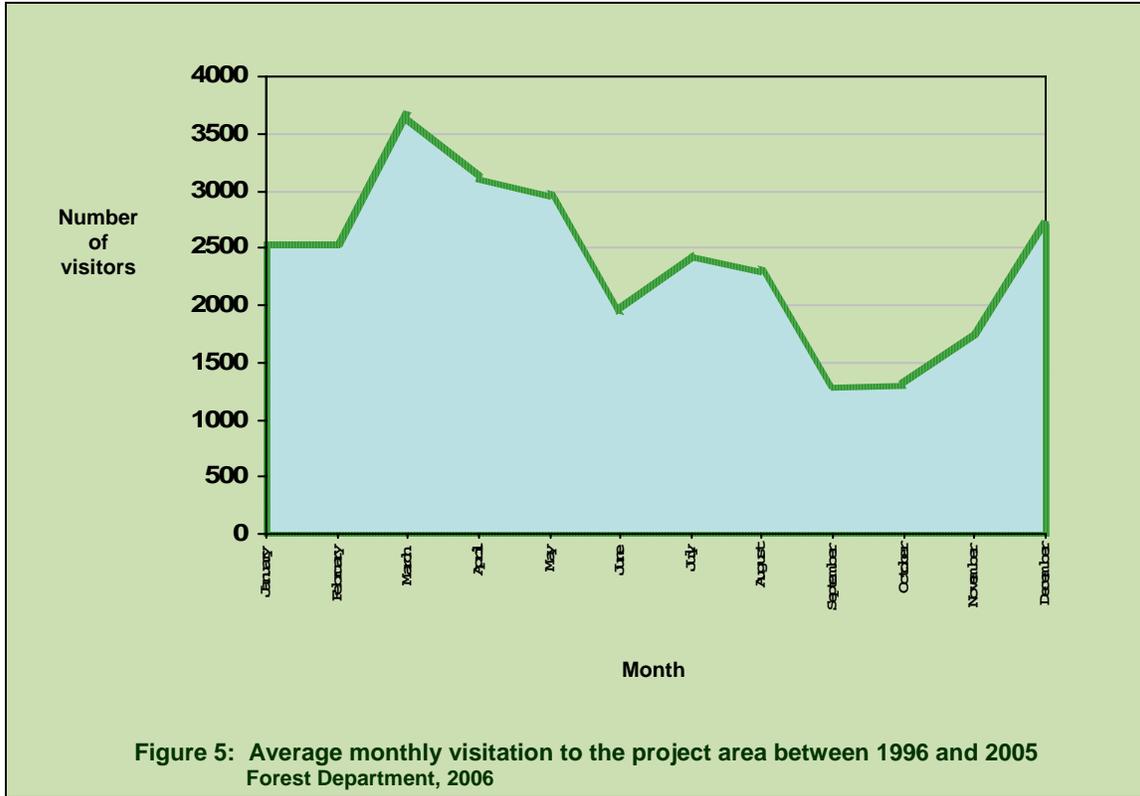


Figure 4: Annual non-cruise ship visitation to Belize between 1998 and 2005
Forest Department, 2006



Baseline Assessment

Interviews with tour guides during the development of the baseline analysis demonstrated that the majority of guides use four sites in their Mountain Pine Ridge Tours (Table 23) – the three assessed sites (Rio On, Rio Frio and Big Rock Falls) and the private site at Five Sisters Lodge. No guides visited Pinol Sands in the last six months, and didn't generally use the site unless they had a group including young children. Rio On and Rio Frio are also used as part of the Caracol tour. No interviewed tour guide used sites within Chiquibul National Park, the reason cited being the poor access and concerns over the large numbers of xateros operating in the area. Visitor profiles and impacts are summarized in Table 24.

Tour guides, on average, take one to two tours a week into the Mountain Pine Ridge area, or as a combined Mountain Pine Ridge / Chiquibul tour.

Table 23: Summary of Site Use (January 2007)								
	Current Tourism Sites				Proposed/Being Developed			
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
% Tour Guides	100%	100%	0%			0%	0%	0%

Table 24: Visitor Profile for Mountain Pine Ridge					
<i>Visitor Type</i>	<i>Visitor Flow</i>	<i>Primary Reason for Visit</i>	<i>Area Accessed</i>	<i>Acceptable Conditions</i>	<i>Level of Impact</i>
General Day Tour	High	Scenic values and swimming	Mountain Pine Ridge	Well maintained trails, clean (low mud), good water quality in swimming areas; safe	Medium
Archaeological Tour	High	Archaeology (Caracol)	Mountain Pine Ridge	Well maintained trails	Medium
School group	High	Learning experience	Mountain Pine Ridge Chiquibul Pinol Sands	Structured learning experience, safe	High
University Groups	Medium	Research Learning Experience	Mountain Pine Ridge Chiquibul	Structured learning experience, Research	High
Family	Medium	Fun, Swimming	Mountain Pine Ridge Pinol Sands	Well maintained trails, good water quality in swimming areas, safe	Medium
Expedition	Medium	Remoteness, challenging	Mountain Pine Ridge Chiquibul	Limited contact with other visitor groups; pristine	Low to Medium
Lodge Guest	Medium	Relaxation, scenic values	Mountain Pine Ridge 1,000 Foot Falls	Well maintained trails, good water quality in swimming areas, limited contact with other visitor groups	Low
Researcher	Low	Scientific research	Mountain Pine Ridge Chiquibul	Pristine conditions where possible (depending on research interest). Limited contact with other visitor groups	Low – Medium (dependent on research field)
Adventurous Individuals	Low	Remoteness, challenging	Mountain Pine Ridge Big Rock Falls	Limited contact with other visitor groups	Low
Birdwatching group (incl. Naturalists)	Low	Birds	Mountain Pine Ridge 1,000 Foot Falls Chiquibul	Pristine conditions where possible; Limited contact with other visitors at sites and on trails	Low
Horseriding	Low	Fun	Mountain Pine Ridge Big Rock Falls	Pristine conditions, well maintained trail	Medium to High
Mountain Biking	Low	Fun	Mountain Pine Ridge Big Rock Falls	Well maintained trails, clean (low mud), safe	Medium

There is very little visitation to Chiquibul Forest Reserve – 0% of interviewed tour guides use sites within the area, use being primarily by researchers staying at Las Cuevas. Figures show a steady increase in the number of visitor days in all categories between 1998 and 2005 (Table 25). A decrease in visitor numbers corresponds to the increasing security threat from Xateros.

Table 25: Summary of Visitor Days for Las Cuevas							
Visitor Days	1998/9	1999/0	2000/1	2001/2	2002/3	2003/4	2004/5
Scientific	298	481	900	1105	1567	978	1023
Students	115	145	129	235	578	529	656
VIP	9	4	3	7	27	10	63
Tourists	18	21	15	10	18	32	43
TOTAL	440	651	1047	1357	2610	1559	1785

8. Visitor Experience

The very extensive impacts of the 2000/2002 Southern Pine Bark Beetle infestation, including the loss of over 90% of mature trees, severely impacted the aesthetic appeal of the Mountain Pine Ridge area – with previously scenic views becoming hundreds of square kilometers of dead trees. This in turn had a significant negative impact on visitor satisfaction from tours to the area. Timber salvage and subsequent replanting, alongside natural regeneration, has significantly improved the visual appeal of the area – a positive trend that continues annually as the young trees overgrow the remaining dead ones. Initially visitor satisfaction was so impaired that several tour operators stopped inclusion of the Mountain Pine Ridge in their itineraries, though the observed regeneration of the mixed pine forests is encouraging renewed use of destinations in the area. It can be anticipated that prevalence of negative comments of visitors, concerning the appearance of the MPR, will continue to decline as the forests regenerate.

Visitor satisfaction is also low in terms of the road conditions – particularly those to Thousand Foot Falls. Many have commented that they would be more than happy to pay an entrance fee to the Mountain Pine Ridge area if the funds were then to be used for road maintenance (Tour guides, 2006). Again, many tour operators and tour guides have stopped using this site until the road has been significantly upgraded.

Generally, visitors expressed satisfaction with tours to the area, though normally balancing the stunning beauty of the waterfalls against the rough nature of the roads.

Where's the Forest?

Indianapolis, IN on 06/29/2005

I visited in November '03...it seems most of the forest was damaged/dead from what our guides told us was insect infestation?...Parts of the forest regenerate after some time (years?)...I will say, though, that the waterfalls were worth seeing, even if the forest was a disappointment...Make a point to see this area if you visit, and make sure you swim in the waterfalls!

Fodor's Online, 2005

Apparently the tours no longer travel to 1000 foot falls, patrons found the drive too long and the falls too far away. So, a stop at Big Rock Falls was substituted. It is a steep climb down to the water, but well worth it for the great view of the falls.

www.VirtualTourist.com, 2005

Photograph 12:
Big Rock Falls, a favoured swimming location for active visitors to Mountain Pine Ridge



9. Local communities

Mountain Pine Ridge Forest Reserve lies in Cayo District, in the west of Belize. Cayo, identified as being the district with the fastest growing population, and as having a total population of approximately 60,000 (2005 population estimates), with 58% being Mestizo. It is also recognized as having the largest proportion of foreign-born residents in the country.

Cayo District has one of the lowest levels of poverty in Belize, with the social and economic sectors having benefited from targeted development interventions such as microcredit provision, agricultural extension and training. The relatively robust economy is thought to be sustained by the high levels of subsistence and commercial agriculture, tourism and cross-border mercantile activity, cushioning it to some extent from the national macro-economic situation. Cayo District has the highest hotel development in mainland Belize, with a total of 73 hotels, and 1,391 beds (BTB, 2004). San Ignacio Town, the district centre, is the main jumping-off point for archaeological and nature tourism in the Maya Mountain area.

Several smaller communities lie along the two main access roads to the Mountain Pine Ridge, both of which originate from the Western Highway. The closest population is San Antonio, one of the largest stakeholder communities, located on the San Antonio road 9km south east of San Ignacio. Cristo Rey also lies on this road, with Negroman and Big Eddy being located on side roads. The Georgeville road starts at Georgeville, and passes adjacent to the El Progreso/Seven Miles, Barton Creek, Cool Shade and Sayab Creek communities.

Table 26: Principal Communities of the Project Area			
Principal Communities			
Community	Population (CSO, 2000)	Primary Occupation	Road distance to MPR Entrance Gate (km)
San Ignacio	13,260	Tourism and tourism service industries	26.2km
Benque Viejo	5,088	Some agriculture, construction, tourism, service industries in San Ignacio	38.8km
San Antonio	2,124	Agriculture. Some construction, tourism, service industries in San Ignacio	7.0km
Cristo Rey	750	Agriculture. Some construction, tourism, service industries in San Ignacio	9.6km
Georgeville	595	Work in San Ignacio/Belmopan	15.7km
Douglas D'Silva*	45	Forest Reserve management, Chalillo Dam maintenance	22.1km
* Lies inside Mountain Pine Ridge Forest Reserve			

These are primarily agriculture-based communities, currently with little impact on (and gaining little from) the Forest Reserves, though there is still some reliance on non-timber forest products – bay leaf thatch leaves, bush meat and medicinal plants – harvested around the northern boundary of the Forest Reserve (De Vries, 2004). Prior to the Southern Pine Bark Beetle infestation, the forestry industry provided opportunities for employment, but with the shift from forestry to recreation, these opportunities have decreased (community consultations, November, 2006). There is significant local employment in the three resorts located within the Mountain Pine

Ridge area, and in construction projects, as guides and tour operators, and running restaurants and other services in the general area.

The town of San Ignacio, an important tourism centre, lies to the north, on the banks of the Macal River, and is an important hub for tourism, most tour operators including a Mountain Pine Ridge tour, usually as part of a day trip to Caracol Archaeological Reserve, managed by the Institute of Archaeology.

Douglas D'Silva, the administrative headquarters of the Forest Department Western Division, is situated within the reserve, with Forest Department staff resident in the small community. The centre of operations for the construction of the Chalillo Dam is also located within the Douglas D'Silva area, though the compound is largely uninhabited following the completion of construction. Both the Belize Defence Force and the British Forces have a presence at Douglas D'Silva, with a largely tented British Forces training camp to the south west side of the site.

Whilst the sale of pine timber, seeds and other forest resources has been an important source of income in the past, the devastation by the Southern Pine Bark Beetle outbreak from 2000 - 2002 has had a significant effect on this, with a recent shift of emphasis from the commercial value of the pine stocks to one on the recreational value of the protected area, with its waterfalls, pools and caves (FD, in prep.).

Tourism lodges adjacent to the Mountain Pine Ridge Forest Reserve bring significant economic benefit to local communities, for example at the upper end of the market the Blancaneaux Lodge employs approximately 110 staff from the villages of San Antonio, Cristo Rey, 7 Miles, and from San Ignacio Town. This scale of employment undoubtedly makes a very significant input into these rural communities, a fact which is often overlooked in public awareness of the socio-economic benefits of protected areas - as lodges such as Blancaneaux owe much of their success to their proximity to the scenic beauty and natural resources of the protected areas.

Baseline Assessment

- Interviews with tour guides, tour operators, lodges and local community members indicated that the majority (estimated at over 80%) of tour guides utilizing the Mountain Pine Ridge / Chiquibul area originate from Cayo District.
- Tourism lodges provide significant employment opportunities to local communities

10. Threats to Human Health and Safety

Accidents

When questioned, tour guides cited the roads in the Mountain Pine Ridge as the biggest threat to human safety, with not only the wear and tear the bad road surface places on the vehicles, but also the problems of encountering large logging trucks. Conscious of this, Forest Department does ask the logging concession holders to ensure their drivers are aware of the tourism sector activities and focal areas, and to try and avoid use of large logging vehicles and machinery at times of maximum tourism activity.

Another safety concern that has been expressed is that of military vehicles – primarily British Forces, which are reported to frequently drive on the left hand side of the road, resulting in a suggestion for signs reminding British drivers of the correct side of the road for traffic in Belize (De Vries, 2004)

Several of the sites have also been highlighted as potentially dangerous – the steep access to Big Rock Falls, for example, and the slippery rocks of Rio On Pools. All tour guides interviewed talk to their guests about hazardous locations before allowing them to access these areas, and as a result, few injuries occur (Table 27).

Table 27: Total numbers of Accident for the last 6 months, for ten tour guides								
Indicator	Current Tourism Sites					Proposed / Being Developed		
	Rio On Pools	Rio Frio Cave	Pinol Sands	Thousand Foot Falls	Big Rock Falls	Orchid Cascade	Granite Cairn Falls	Santa Maria Pool
Minor Accidents	1	0	0	0	1	n/a	n/a	n/a
Major Accidents	0	0	0	0	0	n/a	n/a	n/a

Several of the new locations being developed, such as Orchid Cascade and Granite Cairn Falls, have the potential for serious injury once they are open to the public, especially at the visitor levels being planned – unless effective visitor control infrastructure is put in place, and guides act with extra caution.

A series of armed hold-ups in 2006 posed a significant risk to visitors, such that armed escorts of tourism convoys were instigated and are maintained to date. Whilst the perpetrators of these holdups were reportedly apprehended, the Belize Defense Force continues to provide armed escorts for visitors to the area. With the perceived reduction of threat, the need for continued military presence is questioned by some.

The presence of xateros has increased the risk of visiting Chiquibul Forest Reserve, with both expedition groups and researchers being recommended to access more remotes area only if accompanied by members of the Belize Defense Force. Whilst encounters with xateros are not uncommon, risks are reported to be more of theft of property than injury – though risk assessment may well change if tourism use of the Chiquibul were to increase.

Dams and Mercury

Chalillo Dam has been highlighted as a potential concern in terms of contaminant release. through the formation of methylmercury and its subsequent concentration in the food chain. Mercury is present in localized mineral deposits worldwide, but the greatest source in the

environment is in an inorganic form in the soil (primarily as a result of atmospheric deposition). Whilst concentrations in the atmosphere are very low, water catchments carry runoff containing soil particles and associated mercury deposits into the water systems that will eventually be trapped behind dam walls. Here, they settle into the hypolimnion – the poorly oxygenated region at the bottom of the reservoir. The sediments gathered here are anoxic, with sulfate-reducing bacteria that combine the inorganic mercury with methane (from decomposing submerged vegetation), forming methylmercury, a form more easily absorbed by fish and other aquatic life. The rate of methylation of mercury is dependant on the degree of bacterial activity, and this in turn is dependent on the amount of carbon available (SWQB, 2001).

It has been demonstrated repeatedly that fish tissue mercury concentrations rise significantly in the impoundments that form behind new dams, and then gradually decline to an equilibrium level as the carbon provided by the submerged vegetation becomes depleted (SWQB, 2001). Vegetation clearance at Chalillo before inundation should have removed much of the carbon potentially available to the bacteria and reduced the scale of methylation of mercury. With seasonally changing water levels, the problem of methylmercury production will, however, continue as low reservoir waters allow the growth of vegetation in the exposed substrate, this becoming a fresh source of carbon (and potentially methane) once the area is flooded again and the vegetation matter decomposes.

Fish can generally excrete inorganic mercury, but methylmercury is retained in the fish following ingestion. Due to the concentration of mercury in the food chain, predatory fish at or near the top of aquatic food chains and larger, older fish tend to have the highest concentration of mercury and, therefore pose the greatest risk to human consumption. A recent report by the Ministry of Health in Belize investigated the mercury level in fish at a number of sites on the Macal, Mopan and Sibun rivers, in relation to the location of the Chalillo dam (Flores et. al., 2005). Whilst the number of fish sampled was low (seventeen), results did show increased levels of mercury in the *Petenia splendida*, the primary predatory fish in the lower reaches of the Macal, and in the Belize River. However, as fishing is not permitted within the protected areas, risks of mercury ingestion by visitors are remote – and more likely to happen outside the protected areas themselves.

Smoke from prescribed and natural fires

Fires within the Mountain Pine Ridge pose a limited risk to visitors. Natural fires are infrequent, and controlled burning is a carefully managed activity. Risks are more associated with smoke than the fire itself - driving visibility may be reduced to very little (increasing the risk of vehicle accidents), and there is potential for injury / ill health resulting from smoke inhalation. The Forest Department, as the management body, minimizes any such risks by timing controlled burns for periods of below-peak visitation, and by manning fires to keep them under control. Fires are not considered a problem within Chiquibul Forest Reserve.

Live and blank ammunition from military training

There is an accumulation of lost ammunition resulting from use of the Mountain Pine Ridge as training grounds for British Forces and the Belize Defense Force, most of which is believed to be blanks. Such ammunition does pose a very limited but actual risk to visitors – either through collection after discovery, or through accidental discharges during forest fires. During one forest fire, ammunition discharges were heard to take place approximately every 2 minutes for the period of almost an hour – indicating the scale of lost munitions (Walker & Walker, pers. obs.). Chiquibul Forest Reserve is a designated live firing area, and as such there is a risk to visitors entering the area without permission, or leaving designated tracks (including the Chiquibul Road to Caracol).

11. Other identified issues

Forest Department Management Activities

Road maintenance generally has a positive impact on visitation, upgrading roads increases visitor comfort, decreases tour operator overheads, and is likely to increase visitation levels. Whilst development of new roads (e.g. to Granite Cairn Falls) has had a significant localized negative impact on biodiversity and aesthetic appeal, impacts of road maintenance are limited – and associated primarily with increased sedimentation in creeks and rivers as a result of increased runoff.

Impacts associated with infrastructure maintenance are mostly associated with visitor satisfaction, though may impact water quality at the site level – e.g. latrine overflow at Rio Frio Cave.

Prescribed burns (and air pollution) are largely responsible for the maintenance of the ecosystems in the Mountain Pine Ridge area, shaping both the species composition and forest structure. Prescribed burns are designed to favour pine production, and to lower competition with broadleaf tree species. Several of the endemic plants recorded from the Mountain Pine Ridge are pine associates, whose presence is due in part to a regime of infrequent burning. Prescribed burns therefore have a positive impact on some species, and negative on others. The impact of prescribed burns on air quality can be enormous, albeit temporary - thick, noxious smoke can cover many square kilometers during prescribed burns, but is generally carried westwards quite rapidly by the prevailing wind (the potential negative impact of prescribed burns to visitor health and safety is discussed in Sections 6 and 7).

Timber Concession Management Activities

Timber extraction has been a core activity in both reserves for many decades, in recent years this has been steered towards longer term sustainable harvest / management concessions. This shift, from purely extractive practices is designed to more adequately regulate extraction rates and modes, making sustainability of harvesting a long-term incentive for concession holders. These new management agreements and regulations should largely overcome the negative impacts on abundance of commercial timber species that characterized past logging operations. Many of the current impacts are therefore more associated with the creation and maintenance of access roads – impacting habitat integrity to some extent (in terms of localized fragmentation), increasing air-borne dust from increased traffic in the dry season, increased sedimentation from road-runoff into streams, etc. Additionally, logging roads within the Chiquibul are likely to provide enhanced access for the illegal Guatemalan xateros who are having devastating impacts on some taxa within the broadleaf forest ecosystems.

Access

Access roads and traffic impact the biodiversity of the Mountain Pine Ridge and Chiquibul forests both directly and indirectly. The term ‘access’ is being used to include tourism use and tourism management activities, management activities associated with Caracol Archaeological Reserve, the Mountain Pine Ridge and Chiquibul Forest Reserves, the Chiquibul National Park, timber extraction, mineral extraction, xate harvesting (legal and illegal), military training, research (including that based from the Las Cuevas Station), the Chalillo Dam, etc.

Impacts, whilst relatively low, include habitat fragmentation, habitat loss, air pollution (both from exhaust fumes and dust), increased sedimentation in streams, increased fire-risk, and increased (illegal) hunting. Most impacts associated with access are negative, though modest positive impacts include enhanced financial sustainability (once a fee structure has been developed and implemented), and easier access for enforcement activities.

Caracol Archaeological Reserve

Though whilst outside the immediate project area, Caracol is contiguous with the Chiquibul Forest, and therefore activities associated with Caracol may impact biodiversity in Chiquibul. The main impact of Caracol on the project area is the increased accessibility to the Chiquibul Forest Reserve, and the increased level of traffic through both Mountain Pine Ridge and Chiquibul Forest Reserves.



Photograph 13: Caracol Wildtracks

As with all other Chiquibul Forest areas, indications of xatero activity can be found throughout the protected area. The dynamic management of the Caracol

Archaeological Reserve for tourism has some very positive impacts on financial sustainability, protection of cultural resources and the provision of economic benefits to stakeholder communities, but there are also some associated negative impacts. Illegal hunting of game species (primarily ocellated turkeys and great curassow) by staff has taken place in the past, and tourism-related ‘beautification’ management projects have negatively impacted the breeding habitat of Belize’s only critically endangered terrestrial vertebrate – Morelet’s Treefrog.

Las Cuevas Research Station

Research activities based from Las Cuevas have greatly enhanced understanding of the biodiversity of the forest ecosystems, but only a few (such as the xate assessments) have been transcribed into works of significant relevance for management purposes. The presence of researchers and management staff does not appear to have reduced the activities of illegal xatero activity, as significant harvesting of xate leaves is evident close to the research station (Walker, pers. obs.). A small number of past research projects may have had a negative impact on biodiversity at the site level through excessive collecting, (e.g. of eggs and tadpoles of the critically endangered Morelet’s Treefrog, and of adults of the endemic Maya Mountain Frog), but generally the research activities at the Las Cuevas have a very small and low negative impact footprint on biodiversity of the area, far outweighed by the benefits of increased awareness of the area and its biodiversity value.



Photograph 14: Las Cuevas Wildtracks

Gold Mining at Ceibo Chico

Informal feedback on the impact of the gold-mining operations based at Ceibo Chico indicates that the operation is well managed and maintained, and currently impacting a relatively small portion of the 34km prospecting concession area, with a mining permit covering an area of approximately 39 hectares. The license holder is responsible for maintenance of access roads, which have recently been upgraded significantly. Increased accessibility into this remote area of the Chiquibul is a potential threat to biodiversity, though likely targets (game species) have reportedly already been heavily impacted by xateros.

Chalillo Dam

Construction of the Chalillo Dam has had both direct and indirect negative impacts on the biodiversity of both protected areas. Approximately 1,000 hectares of broadleaf forest and riparian shrubland ecosystems were lost, along with the areas for access roads and support facilities, removing a significant portion of the known breeding habitat for the regionally threatened sub-species of scarlet macaw, and severely impacted connectivity within the riverine and riparian ecosystems. Road construction has caused some habitat fragmentation, impairing movement of some species, and increasing fire risk. Indirect negative impacts include reduced public support for biodiversity conservation, resulting from the acrimonious battle between proponents and opponents of the dam construction.

Other than the potential impact on health (Section 10), dams have been shown to have both direct and indirect impacts on fish fauna, both in the immediate dam area, downstream (even as far as the estuary), and to a lesser extent, upstream. It is generally accepted that riverine fish population densities and abundance can be expected to decline following dam construction due to changes in water flow and deterioration of water quality (in a paper submitted to the World Commission on Dams, it was shown that approximately 73% of dams surveyed in 66 case studies showed negative impacts on fish biodiversity. Craig, 2000). Migratory aquatic fauna are impacted by the blocking of migratory routes up and downstream for those species that migrate as part of their lifecycle. Other direct impacts include the change of a fast flowing river ecosystem to a still-water reservoir.

More indirect impacts are by modification of the upstream and downstream aquatic environments through:

- Thermal stratification of the reservoir, releasing cold and anoxic hypolimnion water downstream
- Downstream flow alteration and alteration of inundation patterns of downstream floodplains
- Sediment and nutrient trapping in the reservoir
- Release of contaminants from trapped sediments into the food chain (such as mercury)

Now that construction has been completed, the reservoir filled, and the noise impacts finished, the wildlife is starting to re-establish itself in the forest adjacent to the reservoir. How successful this is may depend on noise impacts and disturbance from military training activities, and potentially from tourism in the future.

Illegal Xate Harvesting

Illegal Xate harvesting is occurring throughout the broadleaf forest areas of western Belize, reducing the viability of the xate itself, and also resulting in broad scale impacts on the wildlife, as the xateros hunt to supplement their diet whilst in the forest. It is broadly estimated that over 1,000 Guatemalan xateros are illegally operating in Belize, resulting in a severely depleted prey base throughout the broadleaf forest areas, reflected by lower densities of top predators – jaguar

and puma (Meerman, 2005). Recent studies indicate that almost 38 million xate leaves have been illegally harvested from the Chiquibul Forest Reserve, with a value of US\$300,000 (Bridgewater, et. al, 2006). There have been no formal assessments of the scale of impact on wildlife, though there is broad agreement amongst stakeholders that it is very significant, if not devastating.

Military

Certain areas of the both Mountain Pine Ridge and Chiquibul Forest Reserves have been and continue to be used for military training purposes by both the Belize Defense Force and the British Forces (Map 11). Both Chiquibul and Maya Mountain Forest Reserves are included in the British Forces main training area; there is the recognition that for jungle training, primarily in the Chiquibul area, this is only effective if the tropical broadleaf forest is maintained in its present state. Therefore BATSUB is committed to protecting the area, training for 5 to 6 weeks at a time in small subsections of the allocated training area for each exercise, giving the flexibility to move to another subsection to allow for research or other activities, with sufficient advance warning. Each sub-area is used in rotation approximately once every 12 months, by 2,500 troops, with guidelines for minimal impact.

- BATSUB states that it does not cut tracks into training areas, hunt animals, or leave rubbish.
- BATSUB recognizes that it is as accountable as anybody else regarding environmental impact or other actions

**Warrant Officer R. Jones, BATSUB,
Chiquibul Stakeholders Planning Workshop, 2005**



Photograph 13: Sign advising on entry to military training areas
Wildtracks

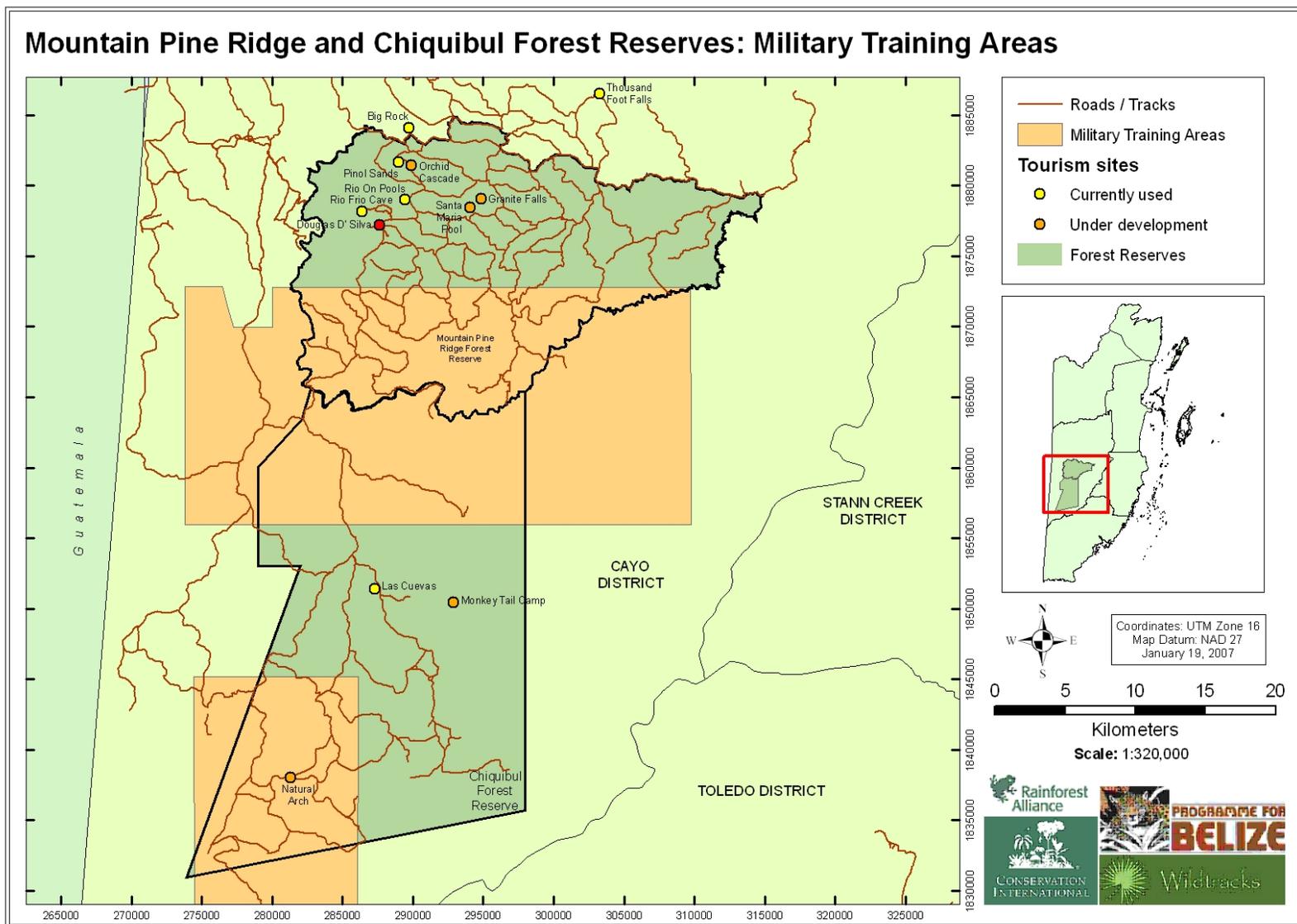
The Belize Defense Force also has a role in both the protection of tourists, and in the control of xate collection and border insurgencies.

+ve Impacts

- Presence of BDF and use of guarded convoys reduces safety threat to visitors
- Active patrolling to deter xate collection within broadleaf forest areas
- Presence of British Forces training units provides stabilizing influence in border region

-ve Impacts

- Live firing by both British Forces and BDF is a fire hazard
- BDF do shoot wildlife opportunistically to supplement rations whilst on patrol (BDF patrol member, pers. com.)
- Increased military vehicle traffic (especially British Forces), with negative impacts on roads
- Visual impact of heavy military presence in area (British Forces and BDF)
- Disturbance of peace and wilderness feel from noise of military vehicles, helicopters and live firing of large munitions on Baldy Beacon (British Forces and BDF)
- Negative comments and unprofessional behaviour from BDF tasked to guard visitor convoys to Caracol can undermine authority of tour guide in front of guests, and have also resulted in visitor offence
- Localized site impacts, e.g. (presumed) unauthorized live-firing at the Rio Frio Cave (Jan 2007, Walker & Walker, pers. obs.) causing physical damage to trees within the Visitor Use Area, and negatively impacting aesthetic appeal of the site; cartridge cases in water at Chalillo impoundment, clearance of camp area and harvesting of forest products (thatch and poles) for camp construction



Map Eleven: British Forces Military Training Areas in Chiquibul Forest Reserve

A. Lloyd / Wildtracks
See: Metadata

Management Characteristics

Mountain Pine Ridge and Chiquibul are two of seventeen Forest Reserves within the National Protected Areas System, with direct management by Forest Department. As a Forest Reserve (the only designation within the National Protected Areas System in Belize that allows for extractive use), Mountain Pine Ridge has traditionally been managed for its timber resources, whilst also being recognised for its importance in soil, watershed and wildlife protection (Table 28).

Thousand Foot Falls Natural Monument is included within the management remit of Mountain Pine Ridge. It is one of five Natural Monuments in Belize, designated to protect and preserve natural features of national significance. There is an on-site caretaker who maintains the site, but visitation is currently low, largely because of the very poor condition of the access road.

Table 28: Management Characteristics of the Project Area					
Protected area name and location	IUCN Category	Primary Visitor Activities	Managing Agency	Management Purpose	Primary Attractions
Mountain Pine Ridge Forest Reserve	VI	Sightseeing, swimming, horseback riding, mountain biking	Forest Department	for the protection of forests for management of timber extraction and/or the conservation of soils, watersheds and wildlife resources	Pine Forest, Mountains, Waterfalls, Scenic vistas, Caves
Chiquibul Forest Reserve	VI	Research	Forest Department	for the protection of forests for management of timber extraction and/or the conservation of soils, watersheds and wildlife resources	Rain forest, Wildlife, karst features
Thousand Foot Falls Natural Monument	III	Sightseeing, horseback riding	Forest Department	for the protection and preservation of natural features of national significance.	Waterfall, Scenic vista, Birding

The recent loss of pine trees following an infestation by the Southern Pine Bark Beetle has, however, resulted in a shift of emphasis from timber extraction to the provision of recreation facilities for tourism, and pine regeneration (FD, 2006).

The current Forest Resource Planning and Management Programme for the area highlights six 'working circles', each with a specific goal and set of objectives (Table 29):

- **Restoration**
- **Protection**
- **Recreation**
- **Production**
- **Watershed Management**
- **Military Use**

Table 29: Forest Resource Planning and Management Programme: Goals and Objectives for Mountain Pine Ridge Forest Reserve, 2006 - 2007		
FRPMP / MPRFR Management Programme	Goal	Objectives
Restoration	Optimization of the ecological timescale for the return to natural pine cover using a combination of silvicultural techniques to manipulate the proliferation of coniferous species of genetic material indigenous to the Mountain Pine ridge ecosystem.	To enhance new and existing natural regeneration using a variety of techniques including prescribed burns.
		To rehabilitate areas devoid of natural regeneration through transplanting or direct seeding methods.
Protection	Secure areas with young regeneration and areas designated for recreation from the negative impacts of wild fires. Limit the impacts of pest and disease on protected stand through constant and effective forest health monitoring combined with intervention techniques.	To finalize a draft fire protection plan.
		To continue the fire fighting programme.
		To establish forest health monitoring plots using data on existing plot locations where possible.
		To continue to intervene where pest or disease outbreaks are detected in order to combat and eliminate the outbreak.
Recreation	Optimization of the visitor use experience at eight recreational sites resulting in an optimization of net dollar returns to the consolidated revenue fund.	To guard against unwanted human activities such as hunting, camping in undesignated areas, littering, negligent use of fire, illegal logging and extraction of forest produce and squatting
		To develop and manage eight recreational sites (5 new and 3 existing) by means of building infrastructure and providing amenities.
		To formulate a fee structure for the eight sites based on visitor willingness to pay.
		To regularize the collection of revenue from the eight sites.
Production	Supervision of the sustainable forest management plan and monitoring of the LTFL (PLC) for the eastern block of the MPR. Monitoring and regulating the extraction of non-timber forest produce from the remainder of the Mountain Pine Ridge Forest Reserve.	To develop and institute a warden system to monitor the eight sites.
		To fulfill the contractual obligations and regulatory responsibilities of the GOB surrounding the LTFL.
		To generate revenue from the assessment and collection of royalties from the production of pine timber.
		To monitor and enforce the Forest Rules, License Conditions and principles of Sustainable Forest Management in the license area.
Watershed Management	Preservation of the integrity of roadways, bridges, streamside zones and fire prone areas for the protection of the watershed functions of the MPRFR.	To generate revenue from the assessment and collection of royalties from the extraction of NTFP's from the remainder of the MPRFR.
		To monitor the extraction of NTFP's from the remainder of the MPRFR.
Military Use	Limit activities of BATSUB and the BDF outside the impact area designated for heavy military activity. Foster improved coordination between FD and the military in regards to training in the reserves.	To maintain road drainages, water catchments and erosion control features of major roads.
		To prevent the development of erosion hazards and mitigate the symptoms of erosion.
Military Use	Limit activities of BATSUB and the BDF outside the impact area designated for heavy military activity. Foster improved coordination between FD and the military in regards to training in the reserves.	To formulate a program for cooperation with the military in fire management, road maintenance and use of other assets.
		To formulate a program for cooperation with the military in training opportunities such as in fire management for soldiers and navigation/security skills for FD and co-managers.

Many of the objectives within the workplan are ongoing, and have an impact, whether positive or negative on tourism within the area (Table 30).

Table 30: Forest Department Workplan Objectives		
Restoration	Impact on Tourism Features	Impact
To enhance new and existing natural regeneration using a variety of techniques including prescribed burns.	Improving scenic value Short term air pollution from prescribed burns and impact on aesthetic appeal	+ve -ve
To rehabilitate areas devoid of natural regeneration through transplanting or direct seeding methods.	Improving scenic value	+ve
Protection		
To finalize a draft fire protection plan.	Planning that will protect and improve scenic value	+ve
To continue the fire fighting programme.	Protecting scenic values and tourism infrastructure	+ve
To establish forest health monitoring plots using data on existing plot locations where possible.	Development of information that will contribute towards maintenance of scenic values	+ve
To continue to intervene where pest or disease outbreaks are detected in order to combat and eliminate the outbreak.	Maintenance of scenic values	+ve
To guard against unwanted human activities such as hunting, camping in undesignated areas, littering, negligent use of fire, illegal logging and extraction of forest produce and squatting	Maintenance of scenic values Protection of wildlife	+ve +ve
Recreation		
To develop and manage eight recreational sites (5 new and 3 existing) by means of building infrastructure and providing amenities.	Provision and management of eight recreational sites for tourism	+ve
To formulate a fee structure for the eight sites based on visitor willingness to pay.	Availability of funds for road, site and infrastructure management and development	+ve
To regularize the collection of revenue from the eight sites.	Availability of funds for road, site and infrastructure management and development	+ve
To develop and institute a warden system to monitor the eight sites.	Maintenance of sites Reduction of tourism impacts	+ve +ve
Production		
To fulfill the contractual obligations and regulatory responsibilities of the GOB surrounding the LTFL.	N/A	
To generate revenue from the assessment and collection of royalties from the production of pine timber.	Financial incentive to retain Mountain Pine Ridge as a protected area	+ve
To monitor and enforce the Forest Rules, License Conditions and principles of Sustainable Forest Management in the license area.	Maintenance of scenic values	+ve
To generate revenue from the assessment and collection of royalties from the extraction of NTFP's from the remainder of the MPRFR.	Financial incentive to retain Mountain Pine Ridge as a protected area	+ve
To monitor the extraction of NTFP's from the remainder of the MPRFR.	Maintenance of scenic values	+ve
Watershed Management		
To maintain road drainages, water catchments and erosion control features of major roads.	Road maintenance Maintenance of water quality	+ve +ve
To prevent the development of erosion hazards and mitigate the symptoms of erosion.	Road maintenance Maintenance of water quality	+ve +ve
Military Use		
To formulate a program for cooperation with the military in fire management, road maintenance and use of other assets.	Maintenance of scenic values Reduction of fire risk Increased road maintenance	+ve +ve +ve
To formulate a program for cooperation with the military in training opportunities such as in fire management for soldiers and navigation/security skills for FD and co-managers.	Maintenance of scenic values Reduction of fire risk	+ve +ve

Relevant Regulations and Laws

Belize has a relatively well-developed legal environmental framework based on both national and international policies and agreements (Table 31). Protection of the environment is considered within much of the land legislation - there are laws protecting wildlife and regulating forestry, though there is a major problem of implementation, with insufficient staff and vehicles in the Forest Department to cover the entire country. International conventions and agreements also affect land use policies, with the development of land-use planning tools such as the Meso-American Biological Corridor Programme, a component of the Convention on Biodiversity, under which areas such as the Maya Mountain Massif are recognised for their regional and global importance for biodiversity conservation.

Table 31: Legislation relevant to protection of the Mountain Pine Ridge / Chiquibul Forest Reserves	
ACT	
The Belize Tourist Board Act	Contains provisions for the development of tourism policies, which consider the effects and roles of all sectors in the development of tourism, especially the effect on the environment.
The Forest Act Forest Department	<p>The Forest Act provided the necessary legislation for the declaration of Mountain Pine Ridge and Chiquibul as Forest Reserves, and Thousand Foot Falls as a Natural Monument; for their administration, for the setting and collection of royalties, the protection and harvesting of forest produce, and the development of forest roads.</p> <p>This act also covers the protection of forests and wildlife. Whilst it is principally targeted at maintaining timber resources, it also ensures that the tourism resource of the Mountain Pine Ridge / Chiquibul area maintains the essential characteristics that draw people to the area – the scenic vistas, quality of water in the streams and rivers, and the wildlife, and sets penalties for illegal activities, gives power of enforcement of regulations to the Forest Officers.</p> <p>Sl. 49 of 1992: Forest (Protection of Trees) Regulations recognises the value of trees as environmentally protective, and as an important component of the natural vegetation, with an emphasis on the need for sustainable development and conservation</p> <p>Forest Fire Protection Act allows for the preparation and implementation of a fire protection plan</p>
Wildlife Protection Act Forest Department	<p>Regulates hunting of species and protects species against harassment and assists in the maintenance of wildlife populations in the area. The wildlife value of the Mountain Pine Ridge and Chiquibul area is considered to have significantly decreased following the Southern Pine Bark Beetle outbreak in the Mountain Pine Ridge, but as regeneration occurs, wildlife should start to increase (as commented on by all tour guides during interviews). The Chiquibul area is also considered to have decreased wildlife populations, with the influx of Xateros from Guatemala, being tackled partly through this legislation</p> <p>Whilst there is some illegal hunting within the Mountain Pine Ridge area, principally from the 7 miles community, this Act, combined with the Forest Act, gives the Forest Officers the legislation for enforcing the no-hunting regulations that exist for Mountain Pine Ridge.</p>
Solid Waste Management Authority Act Department of the Environment	Intended to govern the collection and disposal of solid waste.

Table 31: Legislation relevant to protection of the Mountain Pine Ridge / Chiquibul Forest Reserves / 2	
Public Health Act (1943) <i>Public Health Department</i>	<p>Provides regulatory power for the control of pollution in the air, water and on land. Addresses disposal of solid and liquid waste, and contamination of drinking water. Has responsibility for matters related to drainage and ventilation in building construction, regulations in connection with food preparation and service, sanitation and effluent disposal</p> <p>Any tourism construction or service within or adjacent to the Mountain Pine Ridge and Chiquibul Forest Reserves will have to follow the legislative guidelines developed by the Public Health Department.</p>
Water and Sewerage Act (1947) <i>Ministry of Natural Resources</i>	<p>Regulates and controls monitoring and use of drinking water, sewage disposal and maintenance of sewage systems. Also contains provisions for the avoidance of pollution to water bodies.</p> <p>This act regulates water and sewage disposal in the Mountain Pine Ridge area – whilst there are few inhabitants, primarily located in Douglas D' Silva, there have been past problems of water contamination following over-crowding of workers in the Chalillo compound. This has now been resolved.</p>
Environmental Protection Act No. 22 of 1992 <i>Department of the Environment</i>	<p>Through this Act, the Department of the Environment:</p> <ul style="list-style-type: none"> - requires that an Environmental Impact Assessment (EIA) take place before certain developments can be executed, and has over-riding legal authority over all tourism developments. - acts as an advisory body, making suggestions for mitigation against the harmful effects of any proposed action on the environment - monitors environmental health, air and water pollution - ensures protection and rational use of natural resources - prohibits dumping of garbage, toxic waste etc where it may directly damage or indirectly damage flora or fauna, or pollute water resources, requiring a permit, which will be issued dependant on: nature of substance to be dumped, method and frequency of dumping, and the dumping site chosen <p>An Environmental Impact Assessment (EIA) must be drawn up and approved by the DoE before any large scale development (such as dams) can take place, either within or adjacent to the Mountain Pine Ridge / Chiquibul area.</p> <p>EIAs are submitted to the National Environmental Advisory Committee for review – NEAC is made up of nominees from a wide range of ministries and departments, with two non-governmental representatives, ensuring that there is wide spread input from as broad a range of experts as possible for prevention of environmental damage before a development goes ahead.</p> <p>This legislation should ensure that any future large scale tourism (or other) development within or adjacent to the protected area will be constructed to the highest environmental standards, minimizing impacts to the environment, water and air quality</p>
Mines and Minerals Act (1989) <i>Ministry of Natural Resources</i>	<p>Regulates exploration and extraction of all non-renewable resources, and issued the permit and license for the Ceibo Chico operation. Also controls dredging, quarrying and sand mining.</p>
Petroleum Act <i>Ministry of Natural Resources</i>	<p>Regulates exploration and exploitation of petroleum and related products.</p>

Section B

Major Environmental Issues

Matrix



Table 32: Matrix of Major Environmental Issues			
Category	Cause	Impact	Indicator
Water			
	Uncontrolled erosion of roads following grading and heavy rainfall	Increased sediment load in water Reduction of visitor enjoyment,	Clarity of water (water quality indicators not included in this assessment)
	Damming	Change in water flow Reduction of visitor enjoyment,	Water flow (water quality indicators not included in this assessment)
	Damming	Change in water quality Reduction of visitor enjoyment,	Quality of water (water quality indicators not included in this assessment)
	Damming	Prevention of upstream/downstream movement of biodiversity	Changes in species presence of <i>Poecilia teresae</i> or atyiid shrimp species (water quality indicators not included in this assessment)
Soil			
	Excessive or poorly guided visitation	Soil compaction	Number of areas of trail that are wider than the limits of acceptability
	Lack of suitable infrastructure		Number of areas of trail where trail braiding occurs
	Impaired drainage		Number of shortcuts that exist
	Lack of suitable infrastructure	Reduced visitor satisfaction	No. of stretches of mud (major/minor)
	Poor trail design	Damage to tree roots	No. of steep areas where slipping occurs
	Horse riding / Mountain Bikes	Soil compaction Impaired drainage	No. of areas with soil erosion exposing roots
			Water crossing / running along trail
Air	Exhaust emissions from tour vehicles running engines for ac/music	Air quality deterioration	No. of parked vehicles with running engines at site
		Noise Pollution	
		Reduction of visitor enjoyment	
	Vehicle traffic	Air quality deterioration	No. of passing vehicles creating intrusive amounts of dust
		Noise pollution	
		Reduction of visitor enjoyment	
	Smoke from prescribed or natural fires	Air quality deterioration	No. of sources of intrusive smoke from prescribed or natural burns at site
		Health risks	
		Reduction of visitor enjoyment	
	Smoke from unofficial campfires / burn piles	Air quality deterioration	No. of intrusive camp or barbecue fires at site
		Reduction of visitor enjoyment	
		Health risks	
	Intrusive noises from military sources (helicopters, explosions, heavy vehicles)	Disturbance of wildlife	No. of intrusive military noise sources at site
		Noise pollution	
		Reduction of visitor enjoyment	

Table 32: Matrix of Major Environmental Issues / 2			
Category	Cause	Impact	Indicator
Air / 2			
	Antisocial behaviour	Disturbance of wildlife	No. of intrusive music sources at site
		Noise Pollution	
		Reduction of visitor enjoyment	
		Disturbance of wildlife	No. of intrusively loud visitor groups at site
		Noise Pollution	
Reduction of visitor enjoyment			
Energy			
	Poor fuel efficiency	Inefficient use of fossil fuels	% of tour guides who drive fuel efficient vehicles
	Poorly maintained vehicles		% of tour guides who have well maintained vehicles
	Poorly maintained roads		% of hotels in Mountain Pine Ridge area that use alternative energy sources
	Use of alternative energy sources		
Flora and Fauna			
	Visitor impact	Decrease in number of endemic species	Number of endemic species at site
	Fire (prescribed burning and natural)		
	Visitor impact	Decrease in number of threatened species	Number of threatened species at site
	Fire (prescribed burning and natural)		
	Hunting (including xatero activity)		
	Forestry management activities		
	Site management activities		
	Development, including dams		
	Visitor impacts	Decrease in number of key/indicator species	Number of key/indicator species at site
	Plant collection		
	Xatero activity		
	Fire (prescribed burning and natural)		
	Site management activities		
	Forestry management activities		
	Excessive or poorly guided visitation	Loss of vegetation cover	Trail width
Trail braiding			
Short cuts			

Table 32: Matrix of Major Environmental Issues / 3			
Category	Cause	Impact	Indicator
Flora and Fauna			
	Site clearance by management body	Loss of vegetation cover	Impacts of visitor use area on natural vegetation
	Visitor impacts		
	Visitor impacts	Damage to fragile seepage and splash zone habitats	Presence of <i>Selaginella</i> or <i>Drosera</i>
	Poor trail design		
	Lack of suitable infrastructure		
	Poor visitor management by guides		
	Poor visitor management by guides	Damage to fragile habitats	% of tour guides who employ appropriate visitor management techniques on trails
		Loss of vegetation cover	
	Poor guide practices / visitor management	Physical damage to trees	No. of new graffiti / machete cuts / other damage to trees
	Military activity		
Visitor Satisfaction			
	Lack of finance	Reduced visitation	Condition of access roads
		Low visitor satisfaction	
		Low visitor satisfaction	
	Poor guide practices	Low visitor satisfaction	Level of first aid preparedness of guides
		Health Risk	
	Good guide practices	Visitors adequately prepared for safe tour	Percentage of tour guides who provide information on hazardous species and locations
Protected Area			
	Lack of public and political support	Partial or total de-reservation	Legal status
	Lack of financial and management capacity	Poor management effectiveness	Management effectiveness rating
	Lack of financial sustainability mechanism	Insufficient funds for effective management, infrastructure maintenance and development	Financial sustainability
	Lack of mechanism for communication between management and tourism sector	Poor collaboration	Level of communication between management and tourism sector
Solid Waste			
	Poor solid waste disposal	Environmental pollution	% tour guides, tour operators and hotels engaged in best practices for disposal of solid waste / recycling
	Poor guide practices	Environmental pollution and degraded aesthetic appeal	Level of litter at sites
	Uninformed visitors		Number of items of litter at site
	Lack of infrastructure	Increased litter at sites	Presence / absence of litter bins

Table 32: Matrix of Major Environmental Issues / 4			
Category	Cause	Impact	Indicator
Solid Waste / 2			
Sewage	Collaboration between tourism stakeholders	Decreased litter at sites and increased stakeholder pride	% tour guides who participate in litter clean up activities at tourism sites
	Presence and implementation of written environmental policy by tour operators / hotels	Increased environmental sustainability	% of tour operators and hotels that have and use a written environmental policy
	Poor sewage management	Sewage contamination of soil / water	% Mountain Pine Ridge lodges engaged in best practices for minimizing impacts of sewage disposal
			% of tour guides who ensure their guests use provided facilities
	Visitor satisfaction with facilities	% of toilet facilities considered to be in good condition	
Environmental Education	Good interpretive signs and facilities	Greater environmental awareness and appreciation	Level and condition of interpretive signs and facilities
Socio-Economic	Implementation of tourism Best Practices	Increased standard of living in local communities	% tour guides / operators and lodges that use services in Douglas D'Silva
			% tour guides / operators and lodges that use local community services
			% tour guides / operators and lodges that buy lunch supplies locally
			% tour guides who use Mountain Pine Ridge lodges for services
			% of tour operators / lodges who employ local staff, guides and drivers
			% tour guides who originate from the local area

Section C

Proposed Indicators

Monitoring for Sustainable Tourism



Monitoring for Sustainable Tourism

Why Monitor?

Perhaps the most important question to ask before the designing of a monitoring programme is “Why monitor?” What are we hoping to achieve by putting a monitoring programme in place? With increasing tourism pressure on the natural environment in Belize, there is an increasing need to ensure that visitor use of the protected areas is environmentally sustainable, even in areas which currently have relatively low visitation, such as the Mountain Pine Ridge and Chiquibul Forest Reserves. There is also a requirement under the National Protected Areas System Plan for protected areas such as these to be sustainable in terms of their benefits to local communities. Monitoring of tourism impacts - both negative and positive – has the potential to feed into the development of a framework for the development of sustainable tourism

In order to monitor effectively, it is essential to gather baseline information against which all subsequent monitoring is compared. In the case of Mountain Pine Ridge and Chiquibul Forest Reserve, developing a baseline at this time, when tourism and tourism impacts appear to be minimal (especially in comparison to other impacts such as fire and Southern Pine Bark beetle), is of extra benefit, as it highlights best practices (both tour guide and management) that should be incorporated into tourism use and into conservation and visitor use management of the area.

Once the question of “Why monitor?” has been answered, a monitoring programme can then be developed, framed around knowledge of the following areas:

- What will be monitored?
- Who will monitor it?
- How will it be monitored?
- When will it be monitored?
- What happens with the results?

It should be noted that the justification for implementation of monitoring is to feed into management planning for the target area. It is imperative that the programme has the strong support of the Forest Department (the management body), which has the ultimate responsibility for the maintenance of the two Forest Reserve, and that it takes into account the management objectives for the areas.

Whilst proper implementation of Best Practices by tour operators and guides will serve to minimize negative impacts on the natural resources within visitation sites, some change is inevitable. Effective conservation management planning for the sustainable use of natural resources for tourism dictates that the scale of impacts that is considered acceptable (and justified in providing revenue and stakeholder support for the protected area) be defined by ‘Limits of Acceptable Change’. Monitoring of visitor impacts against the defined scale of limits or ranges of acceptable change enables the management body to know where and when mitigation actions are needed to address negative impacts as they approach the upper level of acceptability. The range of acceptable conditions, however, has not yet been developed for the protected areas, a step that requires a collaborative effort by both the management body and the tourism sector. This will assist in areas such as defining where restoration activities are required for visitor appreciation, at what level site specific carrying capacities be set, and how to minimize impacts of non-tourism activities on the tourism sites. Temporary ranges of acceptability have been developed for the purposes of this monitoring programme, to be replaced by those to be developed through the management body at a future date.

What will be monitored?

The impacts of tourism are to be seen in changes in the biological and social environment of an area – the erosion of footpaths, the compaction of soil, the increased income for protected area management, or increased socio-economic benefits for local communities, for example. Whilst each of the individual impacts recorded during the development of the baseline could be the target of lengthy investigation, for practical purposes of a monitoring programme, it is necessary to simplify the impacts, using ‘indicators’. These indicators should be capable of accurately detecting the changes taking place and the complex causes behind these changes. The results derived from analysis of the indicators also need to reflect the actual conditions on the ground, providing information that can feed back into tour guide practices and adaptive management within the Mountain Pine Ridge and Chiquibul Forest Reserve areas.

Indicators should have the following criteria:

- Measurability
- Accuracy
- Consistency and replicability
- Sensitivity to change
- Utility in the context of who monitors and how
- Cost effectiveness

Two levels of indicators have been developed for monitoring impacts in the Mountain Pine Ridge and Chiquibul Forest Reserves. **Level One** indicators are those that are relevant to all sites, whilst **Level Two** indicators are site specific.

Who will monitor it?

It is necessary to bear in mind **who** will monitor the indicators. The level of monitoring activities and techniques needs to be developed to fit within the capacity of the people involved in the monitoring. For the Mountain Pine Ridge / Chiquibul monitoring programme, it is important that there is significant ownership of the monitoring programme by tour guides, through involvement in the monitoring activities. It is necessary, therefore, to select a series of indicators that can be easily monitored with little scientific background. More technical indicators are also required to provide information on the state of the environment.

Each indicator is labeled to indicate the technical level requirement:

- ① The majority of monitoring techniques have been designed to be user friendly, within the technical capacity of the tour guides to be participating in the monitoring programme.
- ② A few indicators are more technical, and will require basic biodiversity assessment skills.
- ③ Some indicators require information from other monitoring programmes (such as the national Management Effectiveness assessment) or from published data

How will it be monitored?

For replicability, a set of guidelines has been developed for each indicator, providing information on how the baseline was established, and how and where subsequent monitoring should be implemented.

A series of methods (outlined in Annex Two) are used to provide the data:

1. Interviews

Tour guides, tour operators, and tour lodges within the protected area are interviewed on an annual basis using pre-set questionnaires (Annex 2). Information from these questionnaires is then analyzed to provide data outputs, which are then fed directly into the data sheets

2. Site visits

An annual visit to each of the identified current and future tourism sites, using site data collection forms (Annex 3). The order of site visits should tie in with general visitation, to allow visitation levels to be reflected as accurately as possible in the results.

3. Technical Assessment

An annual technical assessment of each site to provide updated information on the biodiversity component of the monitoring programme

3. Literature Review

An annual literature review of new reports on the protected area

When will it be monitored?

The nature of many of the indicators dictates that monitoring should be undertaken largely within regular visitation hours. Ideally monitoring should be carried out annually, during the dry season (to coincide with peak visitation).

What happens with the results?

Any monitoring programme is only as strong as the mechanism that facilitates the incorporation of results into appropriate management decisions and adaptive management planning. Unless monitoring results demonstrating impacts lead to specific management actions or changes in behaviour, a monitoring programme cannot be considered successful.

One mechanism is through defining acceptable limits or ranges for change, built into the conservation management planning cycle for the protected areas. In most situations, the protected area managers are responsible for the development and implementation of the visitor use monitoring programme. In this case, however, the initiative is being developed through the tourism sector. There needs to be a feedback mechanism between those who monitor, and those who manage, through formal agreements, increased communication and strong collaborative initiative.

Adaptive Monitoring

It is important to review the monitoring framework over time – acceptable ranges may change, new impacts may require the addition of new indicators. As the focus of management of the two protected areas continues to shift further towards the prioritization of tourism, and as Belize's international tourism industry continues to develop, the determination of visitation capacity (and limits of acceptable change) is likely to change over the years, with the potential for current low-visitiation sites to grow significantly in popularity and use, and the opening of new sites. Whilst the

monitoring matrices developed here aim to predict such shifts, it is highly likely that some changes will need to be made after the first 5 years of implementation. In such an event, care should be taken to retain comparability of data collection, storage and analysis, so that the benefits of long-term monitoring are not weakened.

The Indicators

Indicator Layout

Each indicator group is introduced by a statement as to the **Rationale** behind monitoring

Introduction to Indicators	
Rationale:	The reason behind using this indicator or group of indicators in the Monitoring Programme

Each identified indicator has five parameters: **Measures, Scale, Baseline, Acceptable Range** and **Future Measurement**.

Indicator Sections	
Measures:	A description of the condition being measured
Scale:	The scale that quantifies the indicator, and allows it to be compared against the baseline and subsequent monitoring results
Baseline:	A description of how and when the baseline was derived, and by whom
Acceptable Range:	The conditions that are considered acceptable environmentally, and for visitor use and/or visitor satisfaction, as they relate to the scoring system for the indicator
Future Measurement:	A description of how and where future measurements should be carried out

Level One Indicators

These indicators cover general impacts to the biodiversity and infrastructure within the project area, and the efforts made by tour guides to adopt Best Practices for minimizing their environmental impacts.

A. General

The condition of general infrastructure (the main access roads, the presence of directional road signs and central interpretive facilities) and the accessibility of protected area managers are important components of the tourism fabric of the project area.

Over time, scores are monitored as increasing, remaining constant or decreasing against the baseline (January 2007) and the most recent previous monitoring score.

B. Management Effectiveness

Both Mountain Pine Ridge and Chiquibul Forest Reserves are national protected areas, administered under the Forest Department. As with any protected area, management effectiveness is a key measure of how well the reserves are being managed, in terms of biodiversity protection, and maintaining visitor satisfaction. Under the National Protected

Areas Policy and System Plan, Belize has recently developed a protocol for assessing the management effectiveness of its protected areas (Young et. al., 2005), and conducted a full assessment of management effectiveness of all protected areas managed under the Forest Department of the Ministry of Natural Resources and Environment of Belize (Walker and Walker, 2006). This assessment provided an overview of the effectiveness of the FD-administered protected area system as a whole, including Mountain Pine Ridge and Chiquibul Forest Reserves, identifying both site-specific strengths and weaknesses, and those common across the protected areas being assessed.

The overall management effectiveness of the two Forest Reserves of the protected area can be measured against the national average, scored on a scale of 1 to 4. The assessment can also be broken down into seven indicator categories, to give more detailed indication of management effectiveness in different areas of protected area management:

1. Resource Information
2. Resource Administration, Management and Protection
3. Participation, Education and Socio-economic Benefits
4. Management Planning
5. Governance
6. Human Resources
7. Financial and Capital Management

Over time, scores are monitored as increasing, remaining constant or decreasing against the baseline (Walker and Walker, 2006) and the most recent previous monitoring score.

C. Tour Guides and Best Practices

The third set of First Level indicators is targeted at tour guide and tour operator use of the area, and implementation of environmental Best Practices in minimizing impacts of visitor use on the sites.

A. General Infrastructure	
Main Access Roads	
Rationale: The condition of the main access roads to the Mountain Pine Ridge / Chiquibul area has a great influence on the levels of visitation and visitor satisfaction (and vehicle maintenance costs for tour operators and guides).	
Condition of San Antonio Road	<p>Measures: Condition of the main access road via San Antonio</p> <p>Scale 1: 1 (Poor) to 4 (Very Good), based on average speed:</p> <ol style="list-style-type: none"> 1 0 – 20 mph 2 20 – 30 mph 3 30 – 35 mph 4 35 + <p>Baseline: Road condition assessment - recording start and end time, for average speed from Western Highway San Antonio turn off to FD barrier; interviews with tour guides. January 2007, Walker and Walker</p> <p>Acceptable Range: 3 - 4</p> <p>Future Measurement: Road condition assessment - recording start and end time, for average speed from Western Highway turn off to FD barrier; interviews with tour guides.</p> <hr/> <p>Scale 2: Number of areas where it is necessary to slow down to <15 kmph, averaged per km</p> <p>Baseline: Road condition assessment, January 2007, Walker and Walker</p> <p>Acceptable Range: 0</p> <p>Future Measurement: Road condition assessment - recording no. of times it is necessary to slow down to < 15kmph between Western Highway San Antonio turn off and FD barrier;</p>
①	
Condition of Georgeville Road	<p>Measures: Condition of the main access roads</p> <p>Scale 1: 1 (Poor) to 4 (Very Good), based on average speed:</p> <ol style="list-style-type: none"> 1 0 – 20 mph 2 20 – 30 mph 3 30 – 35 mph 4 35 + <p>Baseline: Road condition assessment - recording start and end time, for average speed from Western Highway Georgeville turn off to FD barrier; interviews with tour guides. January 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 - 4</p> <p>Future Measurement: Road condition assessment - recording start and end time, for average speed from Western Highway Georgeville turn off to FD barrier; interviews with tour guides</p> <hr/> <p>Scale 2: Number of areas where it is necessary to slow down to <15 kmph, averaged per km</p> <p>Baseline: Road condition assessment recording no. of times it is necessary to slow down to < 10mph between Western Highway Georgeville turn off and FD barrier; interviews with tour guides, January 2007, Walker and Walker</p> <p>Acceptable Range: 0</p> <p>Future Measurement: Road condition assessment - recording no. of times it is necessary to slow down to < 15kmph between Western Highway Georgeville turn off and FD barrier; interviews with tour guides</p>
①	
Condition of Chiquibul Road (A10) to Douglas D'Silva	<p>Measures: Condition of the main Chiquibul Road (A10) to Douglas D'Silva</p> <p>Scale 1: 1 (Poor) to 4 (Very Good), based on average speed:</p> <ol style="list-style-type: none"> 1 0 – 20 mph 2 20 – 30 mph 3 30 – 35 mph 4 35 + <p>Baseline: Road condition assessment - recording start and end time, for average speed from FD barrier to Douglas D'Silva, interviews with tour guides. January 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 - 4</p> <p>Future Measurement: Road condition assessment - recording start and end time, for average speed from FD barrier to Douglas D'Silva, interviews with tour guides</p> <hr/> <p>Scale 2: Number of areas where it is necessary to slow down to <15 kmph, averaged per km</p> <p>Baseline: Road condition assessment - recording no. of times it is necessary to slow down < 15kmph between FD barrier and Douglas D' Silva; interviews with tour guides. January 2007 (Walker and Walker)</p> <p>Acceptable Range: 0</p> <p>Future Measurement: Road condition assessment - recording no. of times it is necessary to slow down <15kmph between FD barrier and Douglas D' Silva; interviews with tour guides</p>
①	

A. General Infrastructure (continued)	
<p>Condition of Chiquibul Road (A10) beyond Douglas D’Silva</p>	<p>Measures: Condition of the main Chiquibul Road (A10) from Douglas D’Silva to Chiquibul National Park</p> <p>Scale 1: 1 (Poor) to 4 (Very Good), based on average speed:</p> <ol style="list-style-type: none"> 1 0 – 20 mph 2 20 – 30 mph 3 30 – 35 mph 4 35 + <p>Baseline: Road condition assessment - recording start and end time, for average speed from Douglas D’Silva to Chiquibul National Park, interviews with tour guides. January 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 - 4</p> <p>Future Measurement: Road condition assessment - recording start and end time, for average speed from Douglas D’Silva to Chiquibul National Park, interviews with tour guides</p> <hr/> <p>Scale 2: Number of areas where it is necessary to slow down to < 15kmph</p> <p>Baseline: Road condition assessment - recording no. of times it is necessary to slow down <15kmph between Douglas D’ Silva and Chiquibul National Park; interviews with tour guides. January 2007 (Walker and Walker)</p> <p>Acceptable Range: 0 - 1</p> <p>Future Measurement: Road condition assessment - recording no. of times it is necessary to slow down <15kmph between Douglas D’ Silva and Chiquibul National Park boundary</p>
<p>①</p>	
Signs	
<p>Rationale: Confusion from poor signage of the access roads to the Mountain Pine Ridge / Chiquibul area reduces visitor satisfaction</p>	
<p>Road Signs</p>	<p>Measures: Level of road signage within the project area</p> <p>Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 No directional signs within project area 2 Insufficient, poorly placed or poorly maintained directional signs within project area 3 Sufficient directional signs within project area, but poorly placed or maintained 4 Sufficient, well placed, well maintained directional signs within project area <p>Baseline: Site visit, interviews with tour guides. January 2007, Walker and Walker</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Site visit, interviews with tour guides</p>
<p>①</p>	
Interpretive Facilities	
<p>Rationale: Interpretive facilities, whether signs or a central interpretive facility, greatly increase visitor understanding and appreciation of the protected areas</p>	
<p>Interpretive Facilities</p>	<p>Measures: Facilities available for general interpretation of the Mountain Pine Ridge and Chiquibul Forest Reserves</p> <p>Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 No interpretation facilities, interpretation signs or literature 2 Limited number of site specific interpretive signs and literature 3 Basic interpretive facilities 4 Informative, well laid out interpretive facilities <p>Baseline: Site visit, interviews (tour guides and Forest Department) January 2007, Walker and Walker</p> <p>Acceptable Range: An increase in interpretive information and facilities from 1 to 4</p> <p>Future Measurement: Site visit, interviews (tour guides and Forest Department)</p>
<p>①</p>	

B. Management Effectiveness Indicators	
Level of Access to Protected Area Managers and Staff	
<p>Rationale: As the objectives for Mountain Pine Ridge and Chiquibul Forest Reserves move further towards tourism, it is important to have a flow of information from the management body on planned activities under the management programmes, to ensure informed and supportive tour guides and ensure conflicts between tourism and other activities are minimized.</p>	
<p>①</p> <p>Availability of protected area managers and staff</p>	<p>Measures: Level of access to protected area managers</p> <p>Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 No direct contact between protected area managers and tour guides 2 Tour guides do not feel protected area management or staff are available for information on the protected area or over enforcement issues 3 Protected area management and staff are sometimes available for information on the protected area or over enforcement issues 4 Protected area management and staff are always available for information on the protected area and over enforcement issues <p>Baseline: Interviews with tour guides. January 2007, Walker and Walker</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Interviews with tour guides</p>
Management Effectiveness Assessment	
<p>Rationale: Effective management – whether overall, within one of the seven indicator categories (Young et. al. 2005), or measured through security of land tenure, the level of communication between tour guides and protected area management and staff, and the wildlife value of the area – is an important measure of the capacity of the management body to provide a framework for sustainable tourism activities</p>	
<p>③</p> <p>Overall Management Effectiveness</p>	<p>Measures: Overall management effectiveness of the protected area in relation to all other protected areas under the Forest Department (94 protected areas in total)</p> <p>Scale: 0 (Poor) to 4 (Excellent)</p> <p>Baseline: Overall management effectiveness score from the National Management Effectiveness report, Walker and Walker, 2006</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Overall score from updated National Management Effectiveness report</p>
<p>③</p> <p>▪ Resource Information</p>	<p>Measures: Whether protected area managers have access to the baseline information they need for management</p> <p>Scale: 0 (Poor) to 4 (Excellent)</p> <p>Baseline: Resource Information score from National Management Effectiveness report, Walker and Walker, 2006</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Resource information score from updated National Management Effectiveness report</p>
<p>③</p> <p>▪ Resource Administration, Management and Protection</p>	<p>Measures: Processes that exist to address and manage legal uses of the site, outside influences, conflicting rights and uses, and illegal and prohibited activities, and visitors</p> <p>Scale: 0 (Poor) to 4 (Excellent)</p> <p>Baseline: Resource Administration, Management and Protection score from National Management Effectiveness report, Walker and Walker, 2006</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Resource Administration, Management and Protection score from updated National Management Effectiveness report</p>
<p>③</p> <p>▪ Participation, Education and Socio-economic Benefits</p>	<p>Measures: Level of involvement of local communities and stakeholders in the management of the protected areas, whether they are benefiting from the presence of the protected area, and whether there is recognition of the goods and services provided by the protected area</p> <p>Scale: 0 (Poor) to 4 (Excellent)</p> <p>Baseline: Participation, Education and Socio-economic Benefits score from National Management Effectiveness report, Walker and Walker, 2006</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Participation, Education and Socio-economic Benefits score from updated National Management Effectiveness report</p>

B. Management Effectiveness Indicators (continued)	
Management Effectiveness Assessment (continued)	
<p>③</p> <ul style="list-style-type: none"> ▪ Management Planning 	<p>Measures: Strengths and weaknesses in the management planning processes - management plans, operational plans, site design plans, and regulations and zoning – as well as the processes of management, including monitoring Scale: 0 (Poor) to 4 (Excellent) Baseline: Management Planning score from National Management Effectiveness report, Walker and Walker, 2006 Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body Future Measurement: Management Planning score from updated National Management Effectiveness report</p>
<p>③</p> <ul style="list-style-type: none"> ▪ Governance 	<p>Measures: Strengths and weaknesses of essential governance structures and processes Scale: 0 (Poor) to 4 (Excellent) Baseline: Governance score from National Management Effectiveness report, Walker and Walker, 2006 Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body Future Measurement: Governance score from updated National Management Effectiveness report</p>
<p>③</p> <ul style="list-style-type: none"> ▪ Human Resources 	<p>Measures: Management effectiveness in terms of human resources – the presence of sufficient, adequately educated and trained staff, with good morale to ensure high productivity Scale: 0 (Poor) to 4 (Excellent) Baseline: Human Resources score from National Management Effectiveness report, Walker and Walker, 2006 Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body Future Measurement: Human Resources score from updated National Management Effectiveness report</p>
<p>③</p> <ul style="list-style-type: none"> ▪ Finance and Capital Management 	<p>Measures: Effective management through availability of adequate funds, and necessary protected area infrastructure, equipment, signs and other assets in place and properly managed and maintained Scale: 0 (Poor) to 4 (Excellent) Baseline: Finance and Capital Management score from National Management Effectiveness report, Walker and Walker, 2006 Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body Future Measurement: Finance and Capital Management score from updated National Management Effectiveness report</p>
Legal Status	
<p>Rationale: The sites fall within two national reserves, both administered under the mandate of the Forest Department. Current legislation does not ensure permanent site security, as the Minister has discretionary powers to de-reserve any such areas - an action which could impact site naturalness and thereby jeopardize both visitor satisfaction and biodiversity.</p>	
<p>③</p> <p>Legal Status – Security as a protected area</p>	<p>Measures: Security of tenure of the Protected Area Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 Area is not recognized officially or through legislation as a protected areas 2 Area is recognized as a protected area but has been removed from the National Protected Areas System 3 Area is recognized as a protected area within the National Protected Areas System, but can be de-reserved by Ministerial fiat 4 Area is recognized as a protected area within the National Protected Areas System, and cannot be de-reserved without a fully participatory process <p>Baseline: Legal status score from National Management Effectiveness report, Walker and Walker, 2006 Acceptable Range: 4 Future Measurement: Legal status from updated National Management Effectiveness report</p>

B. Management Effectiveness Indicators (continued)	
Sustainability	
Rationale: Currently there is no entrance fee to support management of Mountain Pine Ridge and Chiquibul Forest Reserves. It is hoped that this will change in the future	
Sustainability ③	<p>Measures: The income generated from entrance fees</p> <p>Scale: 1 to 4</p> <ol style="list-style-type: none"> 1 There are no entrance fees 2 Entrance fees provide 25% of the funds required for supporting tourism related management activities in the protected areas 3 Entrance fees provide 50% of the funds required for supporting tourism related management activities in the protected areas 4 Entrance fees are sufficient to support tourism related management activities within the protected areas <p>Baseline: Forest Department January 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target, 3 is more realistic</p> <p>Future Measurement: Forest Department</p>
Wildlife Value	
Rationale: Whilst scenic and wilderness values, and access to archaeological sites, remain the primary attractions of the Mountain Pine Ridge and Chiquibul, wildlife sightings remain an important component of the overall experience - and as a broad indicator of the health of the system.	
Wildlife Value ①	<p>Measures: Average frequency of wildlife sightings over last year by interviewed tour guides</p> <p>Scale: 1 to 4</p> <ol style="list-style-type: none"> 5 There is little / no perceived wildlife value at the site 6 The average response by interviewed tour guides is that wildlife sightings have decreased over the last year 7 The average response by interviewed tour guides is that wildlife sightings have remained constant or increased over the last year 8 The average response by interviewed tour guides is that wildlife sightings are frequent and considered satisfactory for visitor satisfaction <p>Baseline: Average score given by interviewed tour guides for frequency of wildlife sightings over last five years, January 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 – 4. Whilst 4 is the preferred target as the ecological systems regenerate, the acceptable range takes into account the staff limitations and financial constraints faced by the management body</p> <p>Future Measurement: Tour guide interviews</p>

C. Tour Guide Use and Best Practices	
Health and Safety	
Rationale: Visitor safety should be foremost in the guide's preparation for a site visit, and monitoring implementation of appropriate measures is an important aspect of assuring sustainability of use of the resources.	
<p>①</p> <ul style="list-style-type: none"> ▪ First Aid Kits 	<p>Measures: Tour guide preparedness for incidences requiring first aid kit</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides carry a First Aid kit (Very Low) 2 25 – 50% of tour guides carry a First Aid kit (Low) 3 50 – 75% of tour guides carry a First Aid kit (Medium) 4 >75% of tour guides carry a First Aid kit (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ First Aid Training 	<p>Measures: The level of tour guide training in First Aid training</p> <p>Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who took part in First Aid training/ refresher course in the last 12 months</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who have completed a First Aid or refresher course in the last 12 months (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4 (Required by Belize Tourist Board)</p> <p>Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Dissemination of information on hazardous plants 	<p>Measures: The level of dissemination of information by tour guides to visitors, on hazardous plants</p> <p>Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who provide visitors with information on hazardous plants</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who provide visitors with information on hazardous plants (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Dissemination of information on hazardous locations 	<p>Measures: The level of dissemination of information by tour guides to visitors, on hazardous locations</p> <p>Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who provide visitors with information on hazardous locations</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides interviewed who provide visitors with information on hazardous locations (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>
Impact Prevention	
Rationale: Sustainable tourism relies on the prevention of negative impacts on the natural resources within the protected areas	
<p>①</p> <ul style="list-style-type: none"> ▪ Fragile Ecosystems 	<p>Measures: The awareness of tour guides interviewed of the need to take steps to prevent visitor impacts to fragile ecosystems</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who take steps to prevent visitor impacts to fragile ecosystems or species (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>

C. Tour Guide Use and Best Practices (continued)	
Impact Prevention (continued)	
<p>①</p> <ul style="list-style-type: none"> ▪ Recycling 	<p>Measures: The level of reuse and recycling by tour guides Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who use re-useable plates and cutlery</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides use re-useable plates and cutlery (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Visitor Management on Trails 	<p>Measures: The awareness of tour guides of the importance of keeping their visitors to defined trails Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who keep their visitors to defined trails</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides keep their visitors to defined trails (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Removal of Plants 	<p>Measures: The level of awareness of tour guides of the need to ensure the environment is not impacted by the removal of plants Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who do not allow removal of plants from the protected areas (eg. orchids, bromeliads)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who do not allow removal of plants from the protected areas (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Garbage Disposal 	<p>Measures: The level of awareness of tour guides of the need to dispose of garbage in appropriate locations outside of the protected areas Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who dispose of garbage in appropriate locations outside of the protected areas</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who dispose of garbage appropriately (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Toilet Facilities 	<p>Measures: The awareness of tour guides of the need to ensure that visitors use only the provided toilet facilities Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who ensure that visitors use only the provided toilet facilities</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who ensure that visitors use only provided toilet facilities (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Vehicles – Fuel Efficiency 	<p>Measures: The fuel efficiency of vehicles used by tour guides Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who feel that their vehicles are fuel-efficient</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides who use fuel efficient vehicles (Very Low) 2 25 – 50% of tour guides (Low) 3 50 – 75% of tour guides (Medium) 4 >75% of tour guides (High) <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 3 - 4 Future Measurement: Tour guide interviews</p>

C. Tour Guide Use and Best Practices (continued)	
Impact Prevention (continued)	
<p>①</p> <ul style="list-style-type: none"> ▪ Vehicles – Maintenance 	<p>Measures: The maintenance level of vehicles used by tour guides Scale: 1 (Very Low) to 4 (High) The percentage of tour guides interviewed who use well maintained vehicles</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides use well maintained vehicles 2 25 – 50% of tour guides use well maintained vehicles 3 50 – 75% of tour guides use well maintained vehicles 4 >75% of tour guides use well maintained vehicles <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
Visitation	
<p>Rationale: The scale of human presence inevitably impacts wilderness value - a key attribute of visitor appeal of Mountain Pine Ridge and Chiquibul. Whilst implementation of best practices by tour operators and guides should minimize such impacts, the volume of visitors in the project area at any one time remains a potential impact both on visitor satisfaction and on environmental sustainability. For financial sustainability, however, it is important that visitation meets the management needs, once an entrance fee system is in place, and that a balance can be maintained between environmental and financial sustainability.</p>	
<p>①</p> <ul style="list-style-type: none"> ▪ Total visitation 	<p>Measures: The number of visitors to Mountain Pine Ridge Scale: Actual annual visitor numbers Baseline: FD, January 2007 Acceptable Range: Should increase Future Measurement: FD figures</p>
Collaboration	
<p>Rationale: Sustainable tourism in protected areas requires a strong partnership between protected area management and tour guides / tour operators</p>	
<p>①</p> <ul style="list-style-type: none"> ▪ Communication 	<p>Measures: Level of communication between management and tourism stakeholders Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 There is no communication between management and tourism stakeholders 2 There is limited communication between management and tourism stakeholders 3 There is an informal, two-way flow of information between management and tourism stakeholders 4 There are regular meetings between management tourism stakeholders, with stakeholders being fully informed of management, conservation and research activities in the area <p>Baseline: Interviews with tour guides, January, 2007 (Walker and Walker) Acceptable Range: 3 – 4. Whilst 4 is the preferred target, the acceptable range takes into account the staff limitations and financial constraints faced by the management body Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Litter Collection 	<p>Measures: The degree of collaboration among tour guides for taking part in specific clean up campaigns for the project area Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides take part in specific clean up campaigns 2 25 – 50% of tour guides take part in specific clean up campaigns 3 50 – 75% of tour guides take part in specific clean up campaigns 4 >75% of tour guides take part in specific clean up campaigns <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Monitoring 	<p>Measures: Degree of participation in monitoring by tour guides using the project area Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides taking part in monitoring 2 25 – 50% of tour guides taking part in monitoring 3 50 – 75% of tour guides taking part in monitoring 4 >75% of tour guides taking part in monitoring <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker) Acceptable Range: 4 Future Measurement: Tour guide interviews</p>

C. Tour Guide Use and Best Practices (continued)	
Community	
Rationale: The equitable spread of benefits to local communities is one of the foundations of both sustainable tourism and the National Protected Areas Policy	
<p>①</p> <ul style="list-style-type: none"> ▪ Use of Local Services 	<p>Measures: The degree to which local businesses and services in San Antonio or other local communities benefit from tour activities in the project area</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tours use local businesses and services 2 25 – 50% tours use local businesses and services 3 50 – 75% tours use local businesses and services 4 >75% tours use local businesses and services <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Use of services in Douglas D'Silva 	<p>Measures: The degree to which businesses and services in Douglas D'Silva benefit from tour guide activities in the project area</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tours use businesses and services in Douglas D'Silva 2 25 – 50% of tours use businesses and services in Douglas D'Silva 3 50 – 75% of tours use businesses and services in Douglas D'Silva 4 >75% of tours use businesses and services in Douglas D'Silva <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour guide interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Local Tour Guides 	<p>Measures: The benefits of the project area as a tourism destination to tour guides who originate from the local area (Cayo District)</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour guides using the project area originate from the local communities 2 25 – 50% of tour guides using the project area originate from the local communities 3 50 – 75% of tour guides using the project area originate from the local communities 4 >75% of tour guides using the project area originate from the local communities <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 – 4</p> <p>Future Measurement: Tour guide interviews</p>
Tour Operators	
<p>①</p> <ul style="list-style-type: none"> ▪ Training Opportunities 	<p>Measures: The percentage of tour operators interviewed who seek to improve the quality of their service through providing training opportunities for their tour guides</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour operators provide or facilitate training opportunities 2 25 – 50% of tour operators provide or facilitate training opportunities 3 50 – 75% of tour operators provide or facilitate training opportunities 4 >75% of tour operators provide training opportunities <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 – 4. Dependent on the financial status of the operator</p> <p>Future Measurement: Tour operator interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Supplies 	<p>Measures: The scale of benefit to local businesses and services</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of tour operators use local businesses and services 2 25 – 50% of tour operators use local businesses and services 3 50 – 75% of tour operators use local businesses and services 4 >75% of tour operators use local businesses and services <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Tour operator interviews</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Environmental Policy 	<p>Measures: The percentage of tour operators interviewed who have a written environmental policy</p> <p>Scale: 0 (Very Low) to 4 (High) The percentage of tour operators interviewed who have a written environmental policy</p> <ol style="list-style-type: none"> 1 0 – 25% of tour operators have a written environmental policy 2 25 – 50% of tour operators have a written environmental policy 3 50 – 75% of tour operators have a written environmental policy 4 >75% of tour operators have a written environmental policy <p>Baseline: Tour guide interviews, January, 2007 (Walker and Walker)</p> <p>Acceptable Range: 3 – 4</p> <p>Future Measurement: Tour operator interviews</p>

Second Level Indicators

These indicators cover site-specific impacts to the biodiversity and infrastructure within the project area - both to tourism and by tourism. Each of the five current sites being used and the three sites under development has been assessed individually, and a baseline developed against which future assessments can be based.

Each site is assessed in terms of biodiversity and ecosystem condition, and then considered for its site condition (the naturalness, condition of infrastructure, and condition of key species), and secondly for the level of tourism and non-tourism impact.

A. Site Condition	
Site Footprint	
<p>Rationale: The site footprint in the Mountain Pine Ridge is considered as being the visible panorama from the visitor use area and car park. The scenic beauty of the sites is primarily due to the naturalness and lack of human impacts – no building, no roads or bridges, for example. The impact of the visitor use area on this naturalness is therefore a measure of the size of the area impacted by trails and infrastructure as a percentage of the total site footprint as defined by the view lines.</p>	
<p>②</p> <ul style="list-style-type: none"> ▪ Visitor Use Area 	<p>Measures: Defines the areas used by visitors, excluding car parks and trails – eg. picnic areas, swimming, seating areas, etc. Where practical, this measures the maximum length, width and area of these visitor-use areas, and can be used to assess impact of visitor use footprint as a percentage of the total site area, as well as changes in the footprint itself. Unit: m² Baseline: Site measurement, using GPS and direct measurements, GIS data. January 2007, Walker and Walker. Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site visit, using GPS (where feasible) and direct measurements, GIS data. Presented in m² and as a percentage of the total site area</p>
<p>②</p> <ul style="list-style-type: none"> ▪ Trails 	<p>Measures: Defines the total length and average width of trails at the site Unit: m² Baseline: Site measurement, using GPS and direct measurements, GIS data. January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site visit, using GPS (where feasible) and direct measurements, GIS data. Presented in m², and as a percentage of total site area</p>
<p>②</p> <ul style="list-style-type: none"> ▪ Car Park 	<p>Measures: Defines the length, width and total area of the car park(s), and the impact as a percentage of total site area. Demonstrates whether increasing use and tourism impacts are increasing the footprint Unit: m² Baseline: Site measurement, using tape measures and GPS to define perimeter, GIS data. January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site visit, using tape and GPS (where feasible) to define perimeter, GIS data. Presented in m², and as a percentage of total site area</p>
<p>②</p> <ul style="list-style-type: none"> ▪ Total Tourism Use Area 	<p>Measures: Defines the total area of the site impacted by tourism, and its impact as a percentage of total site area Unit: m² Baseline: Combined values of Visitor Use Area, Trails and Car Park areas. January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Combined values of Visitor Use Area, Trails and Car Park areas. Presented in m², and as a percentage of total site area</p>
Naturalness	
<p>②</p> <ul style="list-style-type: none"> ▪ Visitor Use Area 	<p>Measures: Impact of Visitor Use area on the natural vegetation Scale: 1 (Very Low) to 4 (High) 1 0 – 25% of area is assessed as natural 2 25 – 50% 3 50 – 75% 4 >75% Baseline: Visual site assessment, photographic coverage, January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment, comparison of photographic coverage</p>

A. Site Condition (continued)	
Naturalness (continued)	
<p>▪ Car Park Area</p> <p>②</p>	<p>Measures: Impact of car park area on the natural vegetation – the percentage of the Car Park Area that appears natural</p> <p>Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of area is assessed as natural 2 25 – 50% 3 50 – 75% 4 >75% <p>Baseline: Visual site assessment, photographic coverage, January 2007, Walker and Walker</p> <p>Acceptable Range: 2 – 4. Whilst a higher naturalness rating is preferred, anywhere within the range would be acceptable, though management actions are needed in some areas to harmonize parking areas within the overall landscape.</p> <p>Future Measurement: Site assessment, comparison of photographic coverage</p>
<p>▪ Trails</p> <p>②</p>	<p>Measures: Naturalness of trails (trail surface and trail infrastructure)</p> <p>Scale: 1 (High) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of area is assessed as natural 2 25 – 50% 3 50 – 75% 4 >75% <p>Baseline: Site assessment, photographic coverage, January 2007, Walker and Walker</p> <p>Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site</p> <p>Future Measurement: Site assessment, comparison of photographic coverage</p>
<p>▪ 360° Vista</p> <p>②</p>	<p>Measures: Impact of visitor use infrastructure (structures and trails) on the 360° vista</p> <p>Scale: 1 (High) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of area is assessed as natural 2 25 – 50% 3 50 – 75% 4 >75% <p>Baseline: Site assessment, photographic coverage, January 2007, Walker and Walker</p> <p>Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site</p> <p>Future Measurement: Site assessment, comparison of photographic coverage</p>
Site Infrastructure	
<p>Infrastructure</p> <p>①</p>	<p>Measures: The condition per item of infrastructure at the site (eg. changing room, picnic area etc.), and averaged over the site</p> <p>Scale: 1 (Poor) to 4 (Very Good)</p> <ol style="list-style-type: none"> 1 Needs replacing 2 Needs major repair 3 Needs minor repair 4 In good condition <p>Baseline: Site assessment, January 2007, Walker and Walker</p> <p>Acceptable Range: 4</p> <p>Future Measurement: Site assessment</p>
Site Access Road	
<p>Site Access Road</p> <p>①</p>	<p>Measures: The condition of the access road linking the site car park with the Chiquibul Road (A10)</p> <p>Scale: 1 (Very Poor) to 4 (Good)</p> <ol style="list-style-type: none"> 1 Only 4-wheel drivable 2 2-wheel drivable – rut depth > 6" 3 2-wheel drivable – shallow ruts 4 2-wheel drivable – no ruts <p>Baseline: Site assessment, measurement of deepest ruts, January 2007, Walker and Walker</p> <p>Acceptable Range: 3 - 4</p> <p>Future Measurement: Site assessment, measurement of deepest ruts</p>

A. Site Condition (continued)	
Species of Concern	
Rationale: Visitor impact on biodiversity is a key concern in sustainable use of sites within protected areas, with particular attention needing to be focused on species of concern - because of their rarity, endemism, fragility, collectability or as indicators of wilderness.	
<ul style="list-style-type: none"> ▪ Endemic Species 	<p>Measures: Endemic species recorded from project area that are present in site Scale: Number of the 19 endemic species recorded from the project area Baseline: Site assessment, literature review. January 2007, Walker and Walker Endemic Species: Total potential for Project Area = 19 Acceptable Range: No decrease in number of endemic species recorded at site Future Measurement: Site assessment, updated literature review</p>
<ul style="list-style-type: none"> ▪ Threatened Species 	<p>Measures: Threatened species (IUCN, 2006) recorded from project area that are present in site Scale: Number of the 17 threatened species (IUCN, 2006) recorded for the project area Baseline: Site assessment, literature review. January 2007. Includes Critically endangered, Endangered and Vulnerable species (IUCN, 2006) Threatened Species: Total potential for Project Area = 17 Acceptable Range: No decrease in number of threatened species recorded at site Future Measurement: Site assessment, updated literature review, tour guide interviews</p>
<ul style="list-style-type: none"> ▪ Key Species 	<p>Measures: The key species recorded in project area as present at site Scale: No. of key species at site Baseline: Site visit, literature review. January 2007. Key species: Total potential for Project Area = 5 Acceptable Range: No decrease in number of key species recorded at site Future Measurement: Site assessment, updated literature review, tour guide interviews</p>
B. Impacts	
Visual Impacts	
Rationale: Visual impacts on scenic beauty, whether caused by human activity or as part of a natural cycle, can have a major impact on visitor appreciation. Reaching the acceptable range may require restoration activities.	
<ul style="list-style-type: none"> ▪ Fire Damage 	<p>Measures: The visible fire-impacted area as a percentage of the 360° vista (defined as areas with blackened trunks and/or tiger fern) Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of area impacted visibly by fire 2 25 – 50% of area impacted visibly by fire 3 50 – 75% of area impacted visibly by fire 4 >75% of area impacted visibly by fire <p>Baseline: Site assessment, photographic coverage, January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment, comparison of photographic coverage</p>
<ul style="list-style-type: none"> ▪ Pine Bark Beetle Damage 	<p>Measures: The visible impact of Southern Pine Bark Beetle on the 360° vista Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 – 25% of area impacted visibly by Southern Pine Bark Beetle 2 25 – 50% of area impacted visibly by Southern Pine Bark Beetle 3 50 – 75% of area impacted visibly by Southern Pine Bark Beetle 4 >75% of area impacted visibly by Southern Pine Bark Beetle <p>Baseline: Site assessment, photographic coverage, January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment, comparison of photographic coverage</p>
<ul style="list-style-type: none"> ▪ Non-tourism site infrastructure 	<p>Measures: The visible impact of non-tourism site infrastructure (eg. Forestry roads / fire-lookout structures) on the 360° vista Scale: 1 (Very Low) to 4 (High)</p> <ol style="list-style-type: none"> 1 0 - 25% of area impacted visibly by non-tourism infrastructure 2 25 – 50% of area impacted visibly by non-tourism infrastructure 3 50 – 75% of area impacted visibly by non-tourism infrastructure 4 >75% of area impacted visibly by non-tourism infrastructure <p>Baseline: Site assessment, photographic coverage, January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment, comparison of photographic coverage</p>

B. Impacts (continued)	
Visual Impacts	
<p>①</p> <ul style="list-style-type: none"> ▪ Unofficial Campfires 	<p>Measures: The impact of unofficial campfires Scale: Number of camp fires recorded Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment. Record number of unofficial campfires</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Garbage 	<p>Measures: The level and impact of garbage on visitor satisfaction Scale 1: Visual impact of garbage: 1 No visual impact of garbage at site 2 Minimal garbage noticed at site 3 Garbage noticed but not intrusive to visitor enjoyment 4 High visual impact of garbage, resulting in –ve comments from visitors Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 1 Future Measurement: Site assessment</p> <hr/> <p>Scale 2: No. of items of litter picked up during the site assessment Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Graffiti / Machete Cuts 	<p>Measures: The level and impact of graffiti on trees, infrastructure, rocks and cave surfaces of the site Scale 1: Number of incidents of graffiti Baseline: Site assessment, January 2007, Walker and Walker. Divided into old and recent Acceptable Range: 0 fresh incidences of graffiti Future Measurement: Site assessment</p> <hr/> <p>Scale 2: Number of incidents of machete cuts Baseline: Site assessment, January 2007, Walker and Walker. Divided into old and recent Acceptable Range: 0 fresh incidences of machete cuts Future Measurement: Site assessment</p>
Impacts of Horses and Mountain Bikes	
Rationale: Both horse riding and mountain biking are gaining increasing popularity in the Mountain Pine Ridge area, but both can have significant impacts on trail condition	
<p>①</p> <ul style="list-style-type: none"> ▪ Horse Riding 	<p>Measures: Noticeable site impacts from horse riding Scale: 1 (High impact) to 4 (Little impact) 1 No signs of impact 2 Hoof prints and other impacts visible, but non-impacting on visitor use 3 Some degradation of visitor trails and car parks, with minor impact on visitor use 4 Significant degradation of visitor trails and car parks, with high impact on visitor use Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: Dependent on site. Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Mountain Bikes 	<p>Measures: Noticeable site impacts from mountain bikes Scale: 1 (High impact) to 4 (Little impact) 1 No signs of impact 2 Bike tracks and other impacts visible, but non-impacting on visitor use 3 Some degradation of visitor trails and car parks, with minor impact on visitor use 4 Significant degradation of visitor trails and car parks, with high impact on visitor use Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: Dependent on site. Requires FD/ tourism sector workshop Future Measurement: Site assessment</p>

A. Site Condition (continued)	
Trail(s)	
The overall condition of the trail(s), based on the following:	
<ul style="list-style-type: none"> ① ▪ Trail Width 	<p>Measures: The condition of the trail in terms of trail width Scale: No. of points at which width passes acceptable levels (too wide or overgrown) measured against the average width Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Trail Braiding 	<p>Measures: The condition of the trail in terms of trail braiding Scale: No. of points at which trail braiding occurs Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Short Cuts 	<p>Measures: The condition of the trail in terms of the development of short cuts Scale: No. of short cuts that have developed Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Seepage Areas 	<p>Measures: The condition of the trail in terms of passing through wet seepage areas Scale: No. of wet or seepage areas on trail without appropriate infrastructure for reducing visitor impact Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Minor Mud Stretches 	<p>Measures: The condition of the trail in terms of 'minor mud' (not too long, wide or wet) Scale: No. stretches of trail with minor mud Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Major Mud Stretches 	<p>Measures: The condition of the trail in terms of 'major mud' (long, wide and/or wet) Scale: No. stretches of trail with major mud Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Slippery Areas 	<p>Measures: The condition of the trail in terms of areas where there are signs of visitors slipping Scale: No. of areas on trail without appropriate infrastructure for reducing visitor impact from slipping Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Trail blocked by fallen vegetation 	<p>Measures: The condition of the trail in terms of being passable Scale: No. places in which the trail is blocked by fallen vegetation Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Exposed Tree Roots 	<p>Measures: The condition of the trail in terms of exposed tree roots Scale: No. of areas of trail where visitor impacts have resulted in exposure of tree roots Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Water Crossing Trail 	<p>Measures: The condition of the trail in terms of being impacted by water runoff across trail (even if currently dry) Scale: Number of areas on the trail impacted by water runoff across trail, without appropriate infrastructure for reducing visitor impact Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>
<ul style="list-style-type: none"> ① ▪ Water Running Along Trail 	<p>Measures: The condition of the trail in terms of being impacted by water running along the trail, following rainfall Scale: Number of areas on the trail impacted by water running along the trail, following rainfall, without appropriate infrastructure for reducing visitor impact Baseline: Site assessment, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment</p>

B. Impacts (continued)	
Noise Pollution	
Rationale: Wilderness value is a primary attraction of the sites: intrusive noise is incompatible with visitor appreciation of this attribute.	
① ▪ Parked Vehicles	<p>Measures: The noise impact of running, parked vehicles on the peace of the site Scale: Number of vehicles per monitoring period Baseline: 30 minute site assessment, recording number of vehicles parked with engines running (eg. for ac or music), January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment</p>
① ▪ Passing Vehicles	<p>Measures: The noise impact of passing, loud, non-military vehicles (eg. logging trucks) on the peace of the site Scale: Number of loud vehicles passing per monitoring period Baseline: 30 minute site assessment, recording number of noticeably loud, non-military vehicles passing the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of noticeably loud vehicles passing the site</p>
① ▪ Loud Music	<p>Measures: The noise impact of music on the peace of the site Scale: Number of intrusively loud music sources per monitoring period Baseline: 30 minute site assessment, recording number of intrusively loud music sources on the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of intrusively loud music sources on the site</p>
① ▪ Visitor Groups	<p>Measures: The noise impact of loud visitor groups on the peace of the site Scale: Number of loud visitor groups per monitoring period Baseline: 30 minute site assessment, recording number of intrusively loud visitor groups on the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of intrusively loud visitor groups on the site</p>
① ▪ Military	<p>Measures: The noise impact of military activities on the peace of the site Scale: Number of military-originated noise impacts per monitoring period Baseline: 30 minute site assessment, recording number of intrusive military noise impacts (helicopters, explosives etc.) on the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of noise impacts</p>
① ▪ Other Noise Impacts	<p>Measures: Other noise impacts on the peace of the site Scale: Number of other noise impacts per monitoring period Baseline: 30 minute site assessment, recording number of other intrusive noise impacts on the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of other impacts</p>
Air Pollution	
Rationale: Clean air is another key attribute of wilderness value, and as such is an important factor in visitor satisfaction and sustainable use.	
① ▪ Parked Vehicles	<p>Measures: The impact of running, parked vehicles on the air quality of the site Baseline: 30 minute site assessment, recording number of vehicles parked with engines running (eg. for ac or music), January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of vehicles parked with engines running (eg. for ac or music)</p>
① ▪ Passing Vehicles	<p>Measures: The impacts of dust from passing vehicles on the air quality of the site Baseline: 30 minute site assessment, recording number of passing vehicles that create intrusive dust on the site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of passing vehicles that create intrusive dust on the site</p>
① ▪ Forest Fires	<p>Measures: The impacts of smoke from prescribed and natural forest fires on the air quality of the site Baseline: 30 minute site assessment, recording number of sources of smoke from prescribed and natural forest fires impacting site, January 2007, Walker and Walker Acceptable Range: Dependent on site, generally 0 Future Measurement: 30 minute site assessment, recording number of sources of smoke from prescribed and natural forest fires impacting site</p>

B. Impacts (continued)	
Air Pollution (continued)	
<ul style="list-style-type: none"> ▪ Campfires and Barbecue Grills <p style="text-align: center;">①</p>	<p>Measures: The impacts of smoke from campfires and barbecue grills on the air quality of the site</p> <p>Baseline: 30 minute site assessment, recording number of sources of intrusive smoke from campfires and barbecue grills impacting site, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, generally 0</p> <p>Future Measurement: 30 minute site assessment, recording number of sources of intrusive smoke from campfires and barbecue grills impacting site</p>
Upstream Impacts	
<p>Rationale: Upstream impacts on a tourism site can be evident in changes in water flow through activities such as alteration of water flow, though damming for visitor activities or electricity generation, or diversion of water. Water clarity may also be impacted through poorly managed runoff from roads (particularly newly graded roads). Water quality may be impacted through the poor placement of latrine systems or grey water runoff from upstream tourism sites, or through mercury build up in the food chain following major damming activities.</p>	
<ul style="list-style-type: none"> ▪ Tourism Sites <p style="text-align: center;">②</p>	<p>Measures: The potential impact level of upstream tourism sites</p> <p>Scale: Presence and number of sites upstream</p> <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of impact from visitor activities upstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p>
<ul style="list-style-type: none"> ▪ Dams <p style="text-align: center;">②</p>	<p>Measures: The potential for impact from upstream dams</p> <p>Scale 1: Presence and number of dams upstream</p> <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of impact from dams upstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p> <p>Scale 2: Size of dam</p> <ol style="list-style-type: none"> 1 Small weir 2 Small, permanent weir 3 Small dam 4 Major hydroelectric dam <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of impact from dams upstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p>
<ul style="list-style-type: none"> ▪ Roads / Tracks <p style="text-align: center;">②</p>	<p>Measures: The potential for impact from road erosion runoff upstream</p> <p>Scale: Presence and number of road/tracks crossing river upstream</p> <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of water clarity impact from road erosion runoff upstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p>
Downstream Impacts	
<p>Rationale: The presence of dams downstream can alter the aquatic communities upstream, acting as a barrier to the migration of species such as shrimps and, in some sites, fish species</p>	
<ul style="list-style-type: none"> ▪ Dams <p style="text-align: center;">②</p>	<p>Measures: The potential for impact of dams downstream</p> <p>Scale: Presence and number of dams downstream</p> <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of impact from dams upstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p> <p>Scale 2: Size of dam</p> <ol style="list-style-type: none"> 1 Small weir 2 Small, permanent weir 3 Small dam 4 Major hydroelectric dam <p>Baseline: Analysis of project area, GIS data, January 2007, Walker and Walker</p> <p>Acceptable Range: Dependent on site, and level of impact from dams downstream</p> <p>Future Measurement: Analysis of project area, GIS data / Maps</p>

C. Visitation	
Tourism Visitation	
<p>Rationale: The scale of human presence at a particular site inevitably impacts wilderness value - a key attribute of visitor appeal of Mountain Pine Ridge and Chiquibul. Whilst implementation of best practices by tour operators and guides should minimize such impacts, the volume of visitors at a site at any one time remains a potential impact both on visitor satisfaction and on environmental sustainability.</p>	
<p>①</p> <ul style="list-style-type: none"> ▪ Visitors at Site 	<p>Measures: The observed level of visitation at the site during the 30 minute monitoring period. Scale: Number of people at site Baseline: Site assessment recording number of people at the site during the 30 minute monitoring period, January 2007, Walker and Walker. Acceptable Range: Forest Department recommended visitation level. Carrying capacity not yet developed for the project sites. Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment recording number of visitors at site during 30 minute monitoring period</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Maximum Visitation 	<p>Measures: The maximum level of visitation recorded at the site Scale: Number of people at site Baseline: Site assessment over Easter break, 2005 Acceptable Range: Forest Department recommended visitation level. Carrying capacity not yet developed for all the project sites. Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site assessment recording number of visitors at site during peak visitation (eg. Easter break)</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Vehicles at Site 	<p>Measures: No. vehicles at site during monitoring visit Baseline: Tour guide interviews, January 2007 Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: Site Assessment recording number of vehicles at site during 30 minute monitoring period</p>
Military Presence	
<p>①</p> <ul style="list-style-type: none"> ▪ Military vehicles 	<p>Measures: Military presence Scale: Number of military vehicles Baseline: No. military vehicles recorded at site during 30 minute monitoring visit Site Assessment, January 2007, Walker and Walker Acceptable Range: Requires FD/ tourism sector workshop to define acceptable range for each site Future Measurement: No. military vehicles recorded at site during 30 minute monitoring visit Site Assessment</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Military Personnel 	<p>Measures: Military presence Scale: Number of military personnel Baseline: Number of military personnel recorded at site during 30 minute monitoring visit Site Assessment, January 2007, Walker and Walker Acceptable Range: 1-2 This is highly dependent on the visitor profile. Some find any military presence negative to satisfaction, others finding it reassuring. Future Measurement: No. military personnel recorded at site during 30 minute monitoring visit Site Assessment</p>
<p>①</p> <ul style="list-style-type: none"> ▪ Impacts of Military Presence 	<p>Measures: Military presence Scale: 1 (High impact) to 4 (No/Very Low Impact) 1 High visual impact of military presence (target practice sites, camp fires, garbage), resulting in –ve comments from visitors 2 Military presence noticed but not intrusive to visitor enjoyment 3 Minimal military impacts, but noticed at site 4 No visual impact of military at site Baseline: Site assessment during 30 minute monitoring visit, January 2007, Walker and Walker Acceptable Range: 0 Future Measurement: Site assessment during 30 minute monitoring visit</p>

D. Site Health and Safety	
Accident Level	
Rationale:	
<ul style="list-style-type: none"> ▪ Minor Accidents ① 	<p>Measures: The frequency of minor accident for the site Scale: Average no. of minor injuries for the last six months per tour guide Baseline: Tour guide interviews, January 2007, Walker and Walker. Acceptable Range: 0 Future Measurement: Tour guide and Forest Department interviews</p>
<ul style="list-style-type: none"> ▪ Major Accidents ① 	<p>Measures: The frequency of major accident for the site Scale: Average no. of major injuries for the last six months per tour guide Baseline: Tour guide interviews, January 2007, Walker and Walker. Acceptable Range: 0 Future Measurement: Tour guide and Forest Department interviews</p>
Crime Level	
Rationale:	
<ul style="list-style-type: none"> ▪ Minor Crimes ① 	<p>Measures: The frequency of minor tourism-related crime incidents at the site Scale: Average no. of minor crimes for the last six months per tour guide Baseline: Tour guide interviews, January 2007, Walker and Walker. Acceptable Range: 0 Future Measurement: Tour guide and Forest Department interviews</p>
<ul style="list-style-type: none"> ▪ Major Crimes ① 	<p>Measures: The frequency of major tourism-related crime for the site Scale: Average no. of major crimes for the last six months per tour guides Baseline: Tour guide interviews, January 2007, Walker and Walker. Acceptable Range: 0 Future Measurement: Tour guide and Forest Department interviews</p>

References

- Australian and New Zealand Environment and Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand (2000).** Australian and New Zealand Guidelines for fresh and marine water quality.. Chapter 5: Guidelines of recreational water quality. Paper No. 4. Vol. 1. ISBN 09578245
- Balick M. J., Nee M. H. and D.E. Atha (2000).** Checklist of the vascular plants of Belize with common names and uses. Memoirs of the New York Botanical Garden, Volume 85. New York Botanical Garden Press. ISBN: 0-89327-440-2
- Balick M. J. and D. Johnson (1994).** The conservation status of *Schippia concolor* in Belize. Principles 38: 124-128
- Bateson, J.H. and Hall, J.H.S. (1977).** The Geology of the Maya Mountains, Belize. Institute of Geological Sciences, Overseas Memoir 3.
- BECOL (2001),** Macal River Upstream Storage Facility environmental Impact Assessment – Part 2 Support Documents – Volume II of IV (Tunich-Nah Consultants and Engineers). AMEC E&C Services Ltd.
- BECOL (2006)** Environmental Impact Assessment: Vaca Hydroelectric Project, Cayo District, Belize. Environmental Solutions Ltd.
- Belize Tourism Board (2004).** Tourism and Travel Statistics - 2003
- Billings R.F., S.R. Clarke, V. Espino Mendoza, P. Cordon, B. Melendez Figueroa, J. Ramon Campos and G. Baeza (2004).** Bark beetle outbreaks and fire: a devastating combination for Central America's pine forests. Unasylva No. 217. Vol. 55, 2004/2. FAO.
- Bridgewater S.G.M., P.Pickles, N.C. Garwood, M. Penn, R. M. Bateman, H.Porter Morgan, N. Wicks, N. Bol (2006).** *Chamaedorea* (Xate) in the Greater Maya Mountains and the Chiquibul Forest Reserve, Belize: An Economic Assessment of a Non-timber Forest Product. Economic Botany, 60(3), 2006. pp. 265-283.
- Brokaw N. and Lloyd-Evans (1987)** The Bladen Branch Wilderness. Manomet Bird Observatory
- Conservation International (2003)** Biodiversity Hotspots - Mesoamerica.
www.biodiversityhotspots.org
- Cornec, J.H. (1986).** Provisional Geological Map of Belize. Geology and Petroleum Office, Government of Belize
- Craig, J. F. (2000).** Large Dams and Freshwater Fish Biodiversity. Working Paper contributed to the World Commission on Dams (Thematic Review II.1: Dams, ecosystem function and environmental restoration
- De Vries, Gregory (2004).** Mountain Pine Ridge Forest Reserve: Visitor Use Master Plan, Forest Department. Ministry of Natural Resources, the Environment and Industry
- Dixon C.G. (1956).** Geology of Southern British Honduras. HMSO.
- Eagles, P.F.J., S. F. McCool and C. D. Haynes. (2002).**Sustainable Tourism in Protected Areas - Guidelines for Planning and Management. Best Practice protected Area Guidelines Series No. 8. World Commission on Protected Areas.IUCN
- Fairweather N. and D. Gray. (2002).** The Land Use of Belize 1989/92. Lands Information Centre, Government of Belize
- Farrell, Tracey A. and Jeffrey L. Marion (2001).** Identifying and assessing ecotourism visitor impacts at eight protected areas in Costa Rica and Belize. Environmental Conservation 28 (3):215-255
- Forest Department (in prep.)** 2006 – 2007 Workplan for the Mountain Pine Ridge Forest Reserve – Forest Resource Planning and Management Programme. Forest Department
- Greenfield D. W. and J. E. Thomerson (1997).** Fishes of the Continental Waters of Belize. University Press of Florida. ISBN: 0-8130-1497-2
- Greenfield D.W., T.A. Greenfield and R.L. Woods (1982).** A new subspecies of cave-dwelling pimelodid catfish, *Rhamdia laticauda typhla* from Belize, Central America. Brenesia (19/20)

- HaySmith L. (1999).** Identification of Ecological and Social Wildlife Indicator Species in Belize. University of Idaho
- Hobday, J. & D. Hobday, (2002).** An Assessment of the Visitor Experience at Four BAS-Managed Protected Areas.
- Iremonger, S. & N.V.L. Brokaw, (1995).** Vegetation Classification for Belize. In R. Wilson (ed.). Towards a National Protected Area System Plan for Belize, Synthesis Report. 114 pp. Programme for Belize
- IUCN (2006).** Red List. www.redlist.org
- Jacobs, N. and A. Castenada (1998).** The Belize National Biodiversity and Action Plan. Ministry of Natural Resources and the Environment, Belize.
- Jones H. L. (2003).** Birds of Belize. University of Texas Press. ISBN: 0-292-74066-2
- Jones H. L., A.C. Vallely (2001).** Annotated Checklist of the Birds of Belize. Lynx Ediciones. ISBN 84-87334-35-0
- King R. B., I. C. Baillie, J. R. Dunsmore, R. J. Grimble, M. S. Johnson, J. B. Williams and A. C. S. Wright (1989).** Land Resource Assessment of Northern Belize, Volumes I and II. Overseas Development Natural Resources Institute
- Kueny, J.A. and M.J. Day (2002).** Designation of Protected Karstlands in Central America: A Regional Assessment. *Journal of Cave and Karst Studies*, 64(3): 165
- Laurance W. F. and R. O. Bierregaard, Jr. (1997).** Tropical Forest Remnants: Ecology, Management and Conservation of Fragmented Communities. The University of Chicago Press. ISBN: 0-226-46898-4
- Lee, J.C. (1996).** The Amphibians and Reptiles of the Yucatan Peninsula. Comstock Publishing Associates, Cornell University Press. ISBN 0-8014-2450-X
- Lee, J.C. (2000).** A Field Guide to the Amphibians and Reptiles of the Maya World the Lowlands of Mexico, Northern Guatemala, and Belize. Comstock Publishing Associates, Cornell University Press. ISBN 0-8014-8587-8
- Lindberg, K.; Enriquez, J.; Sproule, K. (1996).** Ecotourism Questioned : Case studies from Belize, *Annals of Tourism Research*, Volume 23, Issue 3, July 1996, Pages 543-562
- Matola S. and E. Sho. (2002).** Field investigations of the Belize Scarlet Macaw (*Ara macao cyanoptera*). [www. Probeinternational.org](http://www.Probeinternational.org)
- Maya Forest Enterprises (2006).** Las Cuevas Research Station: Annual Report 2004-05
- McLeish, I.; Pearce, N.R.; Adams, B.R & Briggs, J.S. (1995).** Native Orchids of Belize. A.A. Balkema Publishers. ISBN 90-5410609-3
- Meerman J.C. & Sabido, W. (2004).** Central American Ecosystems Map: Belize. (Revised)
- Meerman, J.C. (2005).** NPAPSP - Protected Area System Assessment and Analysis: Gap Analysis. Report to the Protected Areas System Plan Office.
- Meerman, J.C. (2005).** NPAPSP – Protected Areas System Assessment and Analysis: Critical Species. Report to the Protected Areas System Plan Office.
- Meerman, J. C. and J. Clabaugh (ed.) (2006).** Biodiversity and Environmental Resource Data System of Belize. Internet address: <http://www.biodiversity.bz>
- Miller, B & C. M. Miller (1995).** National Protected Areas System Plan for Belize: Zoological Report. NARMAP
- Miller, T.E. (1996).** Geological and Hydrologic Controls on Karst and Cave Development in Belize. *Journal of Cave and Karst Studies* 58(2): 100 – 120.
- Miller, T. (2000):** Inside Chiquibul, Exploring Central America's Longest Cave. *National Geographic Magazine*, April 2000, pp 54-71.
- Missouri Botanical Gardens.** www.mobot.org
- New York Botanical Gardens.** Ethnobotany and Floristics of Belize: Family Index. www.nybg.org/bsci/belize/families.html
- Nicolait, L & Wright, T. (1999).** Wildlife Legislation and Institutional Framework in Belize., Publ. Wildlife Thematic Area for Central America, ORMA-IUCN

- Olson D.M., E. D. Dinerstein, K. E. Wikramanaya, N. D. Burgess, G. V. N. Powell, E. C. Underwood, J. A. D'Amico, I. Itoua, H. E. Strand, J. C. Morrison, C. J. Loucks, T. F. Allnutt, T. H. Ricketts, Y. Kura, J. F. Lamoreux, W. W. Wettengel, P. Hedao, and K. R. Kassem (2001)** Terrestrial ecosystems of the World: A New Map of Life on Earth. Bioscience Vol. 51 No. 11
- Penn, M.G., D.A. Sutton & A. Monro (2004).** Vegetation of the Greater Maya Mountains, Belize. Systematics and Biodiversity 2 (1): 21-44
- Rome A. (1999)** Ecotourism Impact Monitoring - A review of methodologies and recommendations for developing monitoring programmes in Latin America. Ecotourism Technical Report Series Number 1.
- Stuart S. et al. (2004),** Global Amphibian Assessment Science 306:1783-1786. See also www.globalamphibians.org
- Surface Water Quality Bureau (2001).** A White Paper on Mercury. New Mexico Department of the Environment, State of New Mexico.
- The Nature Conservancy (2003).** Landscape-scale Conservation. A Practitioner's Guide. (G. Low)
- The Nature Conservancy and University of Miami's Rosenstiel School of Marine and Atmospheric Science (2004).** The Diadema Workshop, March 19th – 20th, 2004
- The Nature Conservancy (2006).** Selva Maya, Ecoregional Planning Workshop, Belize
- The Peregrine Fund (2005).** Orange-breasted Falcon. Global Raptor Information Network. www.globalraptors.org
- UNEP (2002).** Global Mercury Assessment. UNEP Chemicals Programme. 2002. www.chem.unep.ch
- US.EPA (1997).** Mercury Report to Congress. Volume III.
- Walker P. (2005).** Vaca Falls Rapid Ecological Assessment (wet season). Tunich-Nah Consultants and Engineering for BECOL.
- Walker, P. & K. Kaiser (2006).** Preliminary Report on a Pilot Assessment of the Status of Belize's Threatened Amphibian Species, with associated Threat Analysis. Unpublished Wildtracks report, in prep.
- Wright A.C.S., Romney, D.H., Arbuckle, R.H. & Vial, V.E. (1959).** Land in British Honduras: Report of the British Honduras land use survey team. Colonial Research Publications (24). London: Her Majesty's Stationary Office.
- World Wildlife Fund (2001).** Conservation Science Programme 2001 *Terrestrial ecosystems*
- Young, B. E., S. N. Stuart, J. S. Chanson, N. A. Cox, and T. M. Boucher (2004).** Disappearing Jewels: The Status of New World Amphibians. NatureServe, Arlington, Virginia.
- Zisman, Simon (1996).** The Directory of Belizean Protected Areas and Sites of Conservation Interest.