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Golden Stream Biodiversity Assessment

E. Bowen-Jones and Jose Pop

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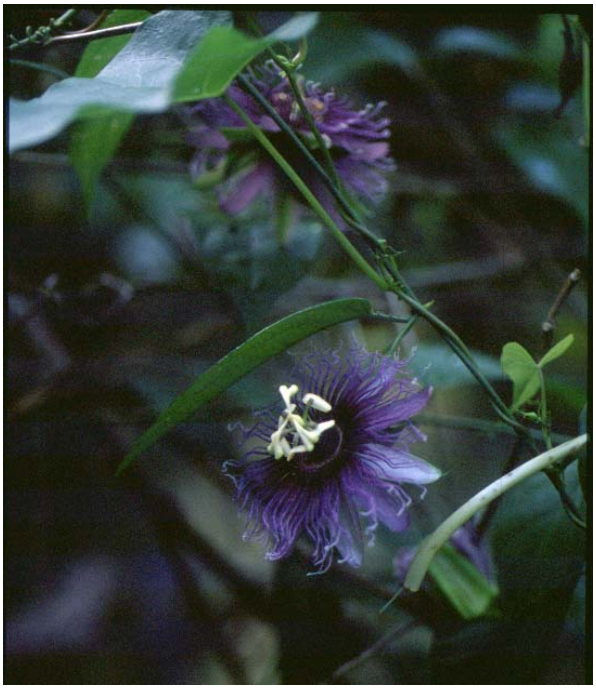

Fauna & Flora International,

in partnership with

Golden Stream Corridor Preserve NGO

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Biodiversity Assessment of GSCP Property & other areas within Golden Stream Watershed

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Fieldwork dates: 20th February to 18th April 2000

Introduction

Fauna & Flora International (FFI) is working with **Golden Stream Corridor Preserve NGO** (GSCP NGO) and with Maya communities in Toledo District, particularly Golden Stream and Indian Creek villages, Belize. The objective of the project is to sustainably manage and develop a corridor of forest within the Golden Stream watershed. This reserve has been established around the Golden Stream river to link the foothills of the Maya Mountains Forest Reserve with the core area of the newly-declared Port Honduras Marine Reserve. This corridor, once completed, will measure approximately 25km long as the crow flies.

Official recognition of the Golden Stream Corridor Preserve (GSCP) by the MesoAmerican Biological Corridor (MBC) Belize representative has led to the inclusion of the area in the Belize National Corridor scheme as the southeastern component of their section of the MBC.

These national and international roles for GSCP may be key to the future conservation of the area given that there is mounting resource-use pressure from logging and agricultural concerns, to which the current administration is sympathetic. The justification for this backing is based upon the fact that Belize has, on paper, a protected area system which totals 40% of the country's land-use. The GSCP area must therefore also pay its way, particularly in terms of generating income for local people whose support is crucial to the long-term sustainable management of the area.

Objective

To conduct an initial assessment of the biodiversity of the Golden Stream area, concentrating on threatened, and indicator taxa, and their geographical distribution within the watershed, to provide key biological information for conservation management.

Rationale

In 1998 Fauna & Flora International (FFI) was invited to begin working with Golden Stream Corridor Preserve NGO (GSCP NGO) based in Toledo District, Belize on the establishment of a reserve to conserve the forest around the Golden Stream River.

Toledo is the least developed district in the country and the majority of the populous are Maya people, the region also contains some of the best remaining forests in the country. These are of international conservation importance due to their intactness and their close proximity to the largest remaining forest areas in Guatemala (Peten) which border Toledo. Belize also, on paper, has the best protected-areas system in northern Central America. These forests contain many species of animal and plant that were once widespread across Central America but are now being confined to smaller parts of their original range due to habitat loss and fragmentation which is still occurring at an alarming rate. Much of the coastal area of Toledo is being cleared of its native forest for agriculture including citrus, and the Golden Stream watershed is one of the few areas where forest still runs from the foothills of the Maya Mountains in the west to the coast in the east.

Thus, GSCP NGO was established with the aim of conserving the remaining forest surrounding Golden Stream and providing a sustainable income to the surrounding Maya communities. In 1999, subsequent to an agreement with GSCP NGO, FFI was able to help this local NGO by purchasing a parcel of land (9,554 acres) from CLCC (Caribbean Land and Cattle Corporation) on their behalf as the first section of the reserve. The purchase was carried out through the FFI Arcadia Fund and saved the forest from imminent conversion into citrus plantation. However, it was the first phase of this project and in order to complete the connection between existing land that GSCP owns and the sea there need to be further purchases, or alternative partnership/management agreements. The gap that needs to be closed in order to complete the link between mountains and coast amounts to approximately 7km of river.

The function of the work presented here is to provide the organisations involved in management of this land – e.g. in the Golden Stream watershed – including GSCP NGO, Fauna & Flora International, and the Belizean government – with key biological information. Although preliminary work was carried out by FFI to establish the biological justification of the initial land purchase (Sharpe 1998), this was done over a period of 4 days, insufficient to make any valued judgements. It was also not possible to carry out the work in manner that allowed comparison between areas, as required to link into management planning.

The work presented was carried out to fill this information gap and was designed to assess the feasibility of zonation strategies, and identify multiple-use community buffer zone areas, as opposed to strict protection areas, within the GSCP project area. The data collected also have the potential to become the baseline for a GSCP biological monitoring programme that could be used to evaluate the conservation effectiveness of measures implemented in the area.

In order to maximise the potential of these data they were collected in areas that were pinpointed with a Garmin 12XL Global Positioning System, so that they can in future be linked into a simple Geographical Information System in order to aid future management-decisions. Methods of data collection were chosen to be relatively simple (and therefore possible to carry out in a limited time) and easily replicable (thus, possible for trained reserve guards to repeat as part of a carefully designed monitoring programme).

The data are also valuable on their own given that the previous biodiversity assessments in the area (Iremonger & Sayre 1994, and Parker *et al.*1993) concentrated on the Bladen Nature Reserve and Columbia River Forest Reserve respectively. Both areas are predominantly mid to high altitude – hill and montane forest – and therefore ecologically different to the lowland coastal habitats that GSCP contains.

Summary of Biodiversity - Related Recommendations

These recommendations cover all the points that are drawn out of the discussion sections throughout the biodiversity report, and which are shown as footnotes (marked by ^{Rx}) at the bottom of the relevant pages.

General

1. Further surveys should be conducted as soon as feasible in the foothills of the Maya mountains to confirm hunting levels, and reported seasonal populations of endangered species: yellow headed parrot (*Amazona oratrix*) and Central American spider monkey (*Ateles geoffroyi*).

2. Survey training for rangers once full-time staff have been appointed, in order to promote interest in flora and fauna, and in order to begin long-term biodiversity monitoring to asses the effectiveness of any conservation measures put in place.

3. A legal review of laws impacting on legal enforcement of wildlife laws in private areas, and on rivers should be carried out in order to provide a solid basis for improved GSCP enforcement work.

4. Effort should be made to obtain both Flick and St. Martin's parcels (located at the eastern end of Golden Stream) in order to complete the corridor rather than using Government Block 127. The purchase of the latter is not worth pursuing from a biodiversity standpoint. Flick may contain some of the best forest in the watershed, St. Martin's contains excellent mangrove habitat, and both offer a strategic way to prevent major international logging and intensive agriculture interests from surrounding the current GSCP lands.

5. Develop funding and public support both nationally and internationally by using culturally appropriate flagship species e.g. big cats – jaguar and puma for the international markets, and the ceiba tree (*Ceiba pentandra*), with its spiritual importance to the Maya, at a local level. With appropriate use of cultural interest this could also work for the international market, which may well be subject to consumer fatigue with the use of big cats as flagship species.

Trees and vegetation

6. Cohune (*Orbignya cohune*) and bay leaf palm plantations (species used for roofing of local housing and tourist lodges) should be started in local villages to reduce the need for illegal extraction from the reserve. The reserve should be used as a source for parent plants, not as a continuous source of materials, and this clearly indicated to the communities involved.

7. A tree nursery should be one of the first demonstration plots established at the resource centre as a functional sustainable development project. (There is ample pre-cleared land at the centre, which is located between two of the project communities and is therefore ideally suited for practical demonstration purposes). There are also areas within the GSCP lands, which are in need of habitat rehabilitation, there is also the need to establish a medium-term income source within community use areas. Native species present in GSCP are suitable for this purpose with faster growing santa maria (*Calophyllum brasilliense*) and salm wood (*Cordia alliodora*) being suitable for harvesting in 8-10 years, and mahogany (*Swietenia macrophylla*) and rosewood (*Dalbergia stevensonii*) for the longer term in 30-40 years. Links should be made to the FFI Global Trees programme to accomplish this.

8. There should be a complete ban on cutting wood from any corridor areas for 10 – 15 years with the exception of where fast growing timber species can be planted and harvested within this time frame in buffer and community areas.

9. Forest gardens should be considered as a component of the tree nursery project, or taking advantage of the structure that reforestation would provide. Non-Belizean species of fruit tree, etc. should be excluded from such schemes.

10. Native plants with potential ornamental or pharmaceutical value should be the investigated as part of the above schemes, and the current locally led initiatives to collate medicinal/herbal knowledge by growing medicinal plants should be supported.

Species-specific

11. The potential of an FFI West Indian Manatee (*Trichechus manatus*) project within the core area of the Port Honduras Marine Reserve should be explored, working in partnership – if and when appropriate – with TIDE. (See recommendations on involvement with other institutions). This could stem from implementing the Belize section of the UNEP West Indian Manatee action plan.

12. Parrot ranching should also be looked at as an option for further income generation, based upon current evidence for collection from artificial nest models developed in South America, given the proximity to North American markets.

Zonation

13. Although it is currently difficult to make specific zonation recommendations due to the incomplete coverage of the survey, the area from survey sites '2 to 4' should be considered for core, non-development areas. The area directly between Golden Stream and Tambran, where land was cleared by CLCC should be considered for demonstration/experimentation plots for various sustainable development alternative crops, etc. (see map page 8).

14. Whatever the decisions with regards final zonation of GSCP domestic livestock from Tambran and other communities should not be allowed onto the property. Preventing this will involve promotion/assistance with fencing domestic livestock, possibly in combination with a policy of claiming livestock found with GSCP boundaries. This will also prevent future problems that can be expected to arise from large carnivore/livestock conflicts leading to reprisals and poaching by community farmers.

Game hunting

15. Ranching, particularly of iguanas (*Iguana iguana*), hickety turtles (*Dermatemys mawii*) and paca (*Dasyprocta puctata*), should subject to feasibility analysis and then piloted within the community areas, and possibly combined with a release programme after appropriate research. This should reduce domestic hunting needs and be combined with rigorous reserve enforcement of a no-hunting policy for an initial 2-year period.

16. This moratorium should be followed by experimental approaches to limited off-take/ community hunting initiatives backed up by rigorous monitoring and evaluation. Models for this could include source/sink areas used on a rotational basis, with permits, quotas, and community monitoring with periodic external validation.

17. Integrate measures to control hunting into the management plan for the area, as a matter of prime importance, and particularly ensure its consideration in public awareness activities through the GSCP centre and outreach programme. This should be based upon understanding the attitudes and social status of the hunters and consumers of game-meat in the area as well as the institutional structures involved, and may require further research.

Ecotourism

18. Mangrove and lagoon areas should be the focus of any tourism-related schemes that are developed over the next 10 years, combined with short walks around the outreach centre, and demonstration plots. The remainder of the core area should be left undisturbed until wildlife populations have recovered sufficiently to provide realistic and regionally competitive attractions.

19. The potential significance of ecotourism to the local community economies should be downplayed in the short-term.

20. Feasibility of alternative charismatic species ecotourism should be assessed with regards animals such as Neotropical river otters (*Lutra longicaudis*) and kinkajous (*Potos flavus*), which are present in good numbers on and near the Golden Stream River rather than species such as big cats and primates.

Survey methods

The taxa focussed upon during this work were those considered important from a conservation or a human resource use point of view, that facilitate rapid assessment of biodiversity by representing a broad taxonomic spread and therefore indicating wider biodiversity. Additionally, the taxa selected were present

in sufficient numbers and diversity to make data collection over a short period of time feasible, and were taxa on which the field team had previous experience.

Therefore, the primary foci groups were:

1. Trees/vegetation and site assessment
2. Medium/large mammal species
3. Birds
4. Bats

Survey methods were designed in order to provide the maximum amount of information about variations in the diversity within the GSCP area, and thus only secondarily on any differences in abundance between these sites. Full inventories were therefore a secondary product of this work, but should be sufficient for the purposes of establishing monitoring procedures for GSCP.

With the remit of assessing the biodiversity of GSCP, and given the time available for the this assessment it was decided that in order to cover as much of the whole area as possible, 4 days would be spent at each site. This was the maximum possible time given the logistics of carrying food and gear for 3 people in a small canoe. It also gave the team enough time to cover seven sites reasonably thoroughly whilst sampling the minimum number of sites to allow meaningful statistical comparison in order determine quantitative differences between the sampled diversity. The sampling was also carried out in a random stratified manner – using standard transects - in order to help reach meaningful conclusions about variation.

Thus, survey areas were visited progressing from the foothills of the Maya Mountains in the west towards the coast in the east, through all 7 sites. The first 6 sites were on the GSCP plot (see map page 8), the final being in Block 127. Originally, the plan had been to carry out two survey periods in Block 127, however, logging taking place in the area – despite government permission for the survey – meant that the team was restricted to working in the east of the block nearest the coast. Site 6 within the GSCP land is apparently very similar to the western portion of Block 127, according to information from rangers who had previously worked in it as loggers, and habitat quality in Site 6 & 7 were also similar. Thus, Site 7 can be taken as probably being representative of the forest in Block 127 as a whole.

Brief Description of Survey Sites (see map of area, page 8)

Site 1: The survey site was approximately 3km northwest of the Southern Highway at GPS coordinates 16Q 0310651, UTM 1814444, on the GSCP border with the block in which Tambran village is situated. The vegetation here is the composed of the only limestone based hill forest that was surveyed (although it is now established that GSCP goes further back into the Maya Mountains), with semi-evergreen seasonal forest. This habitat represents some of the most intact forest in GSCP, and the forest further up in the hills is likely to be even better. It has been subject to some undercutting, but the species composition is more diverse than elsewhere, and timber species remain. Hunting is a major problem in this area being situated between Tambran and Golden Stream, and collection of palms and other NTFPs (Non-timber forest products) occurs regularly. Tambran also allow their domestic livestock to enter into the property causing immediate problems of degradation of soil, and seed banks, as well as future potential problems with predator/livestock conflict which may encourage poaching of big cats, etc.

Site 2: This area is a mosaic of ex-milpa's (agricultural clearings) which have now become scrub, selectively cut secondary semi-evergreen seasonal forest, and relict riparian forest next to the river where patches were spared from farming. It is approximately 2km in a direct line southeast of the Southern Highway at GPS coordinates 16Q 0308918, UTM 1807969, within GSCP. Although it is a much longer walk that this suggests if one follows the footpath by the Golden Stream riverbank is easily accessed from the co-operative citrus plantation on the southern bank of the river. It is, therefore, subject to human activity from Indian Creek village on an infrequent basis, but the biodiversity present is noticeably higher than the better forest of Site 1.

Site 3: The site is 4.8km in a line southeast of the Southern Highway 2km from Golden Stream river at coordinates 16Q 0311702, UTM 1806817, 2.5km to the east of the river inside GSCP. Inland in the dry season this area is without water except for that in a small creek, which is of remarkably bad quality (and may have been contaminated by past logging activities) and the residual permanent water in the main swamp (see map page 8). The forest is seasonally flooded near the latter area and otherwise composed of semi-evergreen seasonal inland and riparian forest on the banks of Golden Stream. The distribution of mammals and birds during the dry season is therefore markedly higher towards the river, although this may alter with the change in seasons. Access to the site is not as difficult as might be predicted since an old logging road still links the area to the concessions that are currently in use to the northeast of GSCP.

Site 4: Approximately 5.5km southeast of the Southern Highway and 0.5 km northeast of Golden Stream river within GSCP at 16Q 0310449, UTM 1804085, Site 4 is very similar to Site 3 in terms of habitat. However, some of the vegetation is of higher quality than the previous example having been subject to selective logging leaving larger individuals, and higher numbers of commercial species. The availability of water is also higher, and access to this area for local communities – in the middle of GSCP - is very limited with only one ill-defined path.

Site 5: This area is similar to sites 3 & 4, but there is the appearance of broadleaf/needle mixed forest at the start of an area of a vegetation type including Caribbean pine (*Pinus caribacea*). This habitat extends southeastwards through Sites 6 & 7 until it meets the mangrove areas nearer the coast. The site is 6.5km in a line southeast of the Southern Highway at GPS coordinates 16Q 0311020, UTM 1804141 0.5km northeast of Golden Stream river and the property begins to thin in breadth. There is a strip of good secondary habitat near to the river, which lasts 500m or so, before turning into poor quality scrub caused by over-exploitation under past logging regimes.

Site 6: At GPS coordinates 16Q 0313527, UTM 1802504 in the southeastern portion of the GSCP area, 9km a direct line from the Southern Highway where the property borders governmental Block 127, and 8km in a direct line from the coast. This area is very similar to Site 5, but the better secondary habitat extends back further to 800m before becoming the same type of poor scrub, dominated by cutting grass.

Site 7/Block 127: This is the area of government Block 127 – currently under timber concessions – south of Bob Creek just north of where the main mangrove system starts 4.5km from the river mouth of Golden Stream at 16Q 0314557, UTM 1798618. Once more the area is dominated by scrub recovering from very heavy timber extraction. The licenses that were granted in this area were apparently for rosewood (*Dalbergia stevensonii*) but evidence suggests that most commercial timber species were removed, and regeneration has been slow as a result of this and ground compaction. Tyre marks from the logging machinery are still evident years later. As a result biodiversity is the lowest in the GSCP area.

Survey Activities

The following were the standardised survey activities carried out over 4 days at each of the 7 sites:

1. **Rough habitat/site assessment** was carried at a superficial level by creating an index for understorey density; and counting the number, and types of trees of known species over an estimated 1.5m in diameter at breast height- approaching commercial size. This was carried out on one randomly positioned 1km long transect at each site which was cleared of the minimum understorey vegetation to allow easy movement and then marked with flagging tape. Trees within 3m either side of the transect were recorded to establish species present and numbers of individual timber species. Due to the high level of local knowledge of the FFI Field Assistant and rangers (some of whom are ex-loggers) trees were identified using Maya or Creole names. These local names were then used to provide scientific names where possible using various texts and information from Martin Meadows (cited in FFI/Earthvoice 1998). Site habitat quality was evaluated by generating indices for variables associated with the timber and non-timber trees, understorey density, number of forest types, and habitat types which were ranked and used to produce an overall average ranked index.

2. **Indices of relative hunting pressures and accessibility in the sites** throughout the corridor were produced based on ranger reports of hunting, shotgun cartridges or other hunting signs discovered, and hunters either seen or heard during survey work, together with an evaluation of relative ease of access. Given the time available it was not possible to revisit sites to find out whether cartridges and other signs of hunting were the result of a one-off or a regular occurrence. Therefore, a suite of potential measures of hunting were used that included some historical aspects e.g. reports of past hunting activity from rangers, and the total number of variables recordable per site was used in order to generate an index of relative disturbance.

3. **Diurnal and nocturnal faunal transect for both mammals and birds** were carried out to facilitate quantitative comparisons of species richness throughout the project area. The same 1km transects that were used for the tree data collection and had been marked, measured and cleared (to a minimum that allowed quiet movement) were used. These were walked three times at approximately 0.5km per hour to allow maximum chance of observation of animals, with minimum disturbance. The effective transect width for sightings varied depending on the line of sight allowed through the under-story vegetation. Due to the latter, and there being insufficient time to repeat transects, it was not possible to calculate meaningful quantitative density estimates. GPS fixes were, however, taken with a Garmin 12XL at the start and finish of each transect worked to fix them spatially for mapping. Identification of mammals was carried out using Reid (1997) and Emmons (1990), whilst birds were visually recorded using Howell & Webb (1995) for residents; Scott (1999) for north-American migrants; and distributions were then compared with those recorded in Miller & Miller (1998).

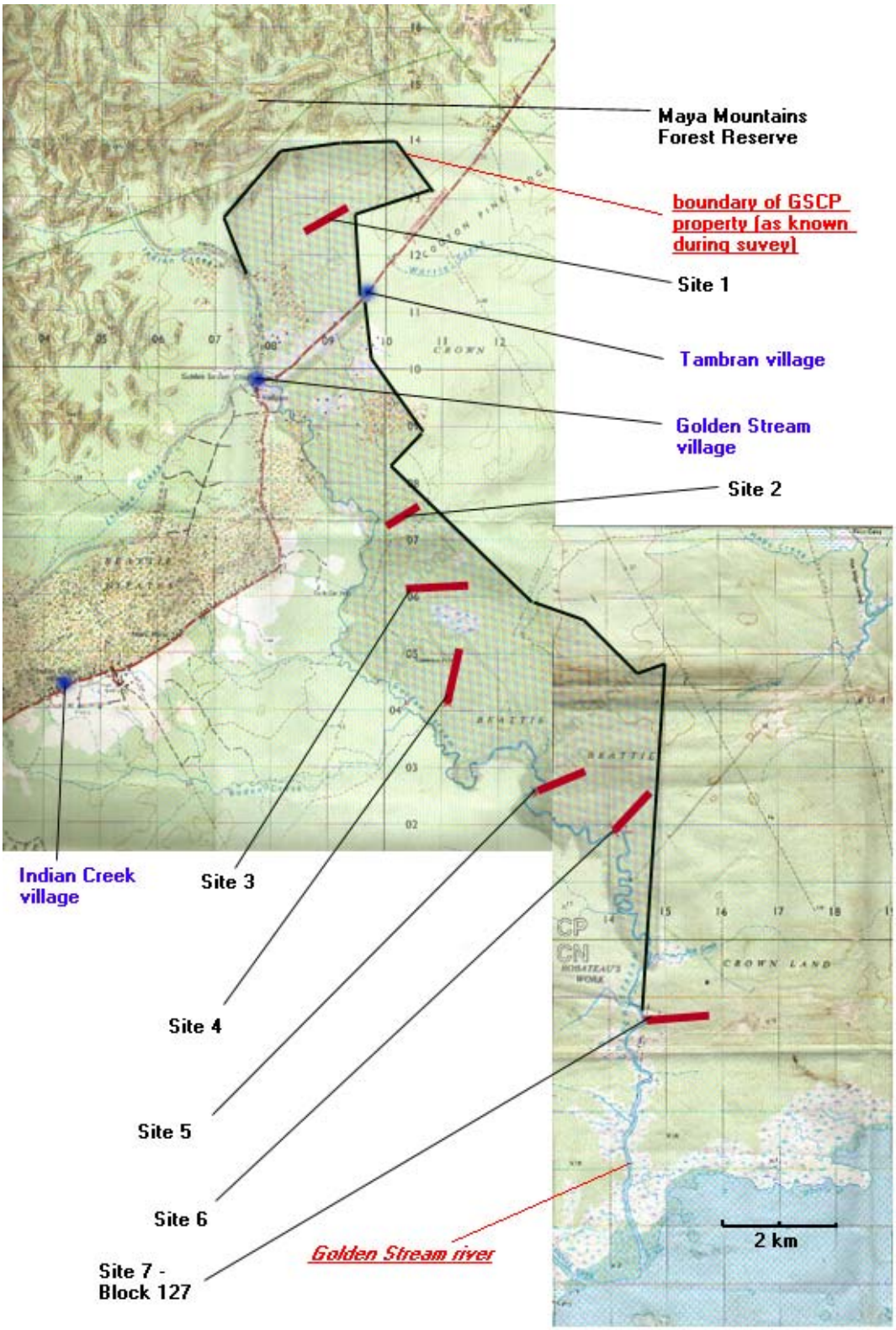
   Supplementary data was provided from **camera trap indices of mammal activity** generated by setting up the two camera traps available to the survey team in the optimum positions based upon mammal activity signs to see how many vertebrates passed by within the time spent in each site. The aim was also to generate secondary information on the overall diversity of mammals – by discarding data produced on other taxa - plus to try and generate publicity/project resource materials.

4. **Bat species richness and abundance** was evaluated using standardised mist netting as an index of mammalian species richness that could be linked to the habitat assessments being carried out in the area. All netting carried out was sub-canopy between 0 & 6m from the ground using combinations of 30 and 18ft nets depending on the density of vegetation. The temperature, lunar state, and weather were recorded at each site, and the maximum number of productive hours that were available were used in order to net as many animals as possible. On capture the following characters were recorded for each animal: species, sex, age, weight, and forearm length. The bats were identified using McCarthy (1992?) and Reid (1997). Due to the nature of the project the taking of specimens was generally avoided, and therefore identification of some species (marked with a '?') must be regarded as tentative although genera and differentiation between species *per se* is taken as accurate.

5. **Inventories of overall mammal and avian presence/absence** were carried out whilst present and doing other work, including 'transect' along Golden Stream itself by canoe, in order to generate general species richness indices for each site, and the project area overall. The presence/absence of animals was determined through vocalisation; visual sighting off transects; and secondary signs such as tracks, scats and feeding/scratching marks.

6. **An incidental list of reptiles, and amphibians**, was also compiled with identification where possible from Stafford & Meyer (2000) and Meyer & Farneti Foster (1996).

Map Of The GSCP Project Area, Showing Survey Sites Used During The March/April 2000 Biodiversity Work



* The boundary and site locations shown are approximate, and should not be used for accurate map reference purposes. An accurate map with biodiversity data on it will be published in the future once survey work is completed and boundaries verified.

Results

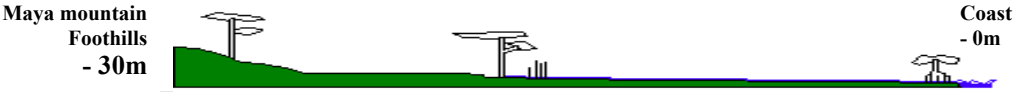
In some of the results tables in the following sections there are (World Conservation Union) IUCN Threat Categories given. These are provided in order to show how endangered given species are at a global level. The following abbreviations are used:

CR = Critically Endangered – there is an 80% chance that the species will be extinct in 10 years or 3 generations;
EN = Endangered – there is a 50% chance that the species will be extinct in the same period;
VU = Vulnerable – there is 20% chance that the species will be extinct in this period;
LRn/t = Lower Risk not threatened – species that are close to the threshold of the Vulnerable category;
DD = Data Deficient – there is a lack of the data needed to make a meaningful assessment of threat.

1. Site habitat assessments

Table 1 below represents summary data on the rough habitat classifications that were produced in each of the 7 sites:

Table 1: Site habitat assessment data from GSCP survey 2000



Variable		Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
GPS coordinates		16Q 0310651 UTM 1814444	16Q 0308918 UTM 1807969	16Q 0311702 UTM 1806817	16Q 0310449 UTM 1804085	16Q 0311020 UTM 1804141	16Q 0313527 UTM 1802504	16Q 0314557 UTM 1798618
Natural forest types	Hill forest	**X**						
	Semi-evergreen seasonal forest	**X**	**X**	**X**	**X**	**X**	**X**	**X**
	Riparian forest		**X**	**X**	**X**	**X**	**X**	
	Seasonally flooded swamp forest			**X**	**X**	**X**		
	Broadleaf/Needle mixed forest					**X**	**X**	**X**
	Mangrove							**X**
Approx. No. years since last cut (***L***) (logging or farming – taken as average if both)		11	12.5	10	15	9	9	8
***L* ranked oldest to youngest**		**3**	**2**	**4**	**1**	**5**	**5**	**7**
Observed habitat status* ***H*** (1 high quality, 5 low quality)	Primary (1)							
	Undercut secondary (2)			**X**	**X**			
	Selectively cut secondary (3)	**X**	**X**	**X**		**X**	**X**	
	Scrub (4)	**X**	**X**			**X**	**X**	**X**

Average (***H***)		3.5	3.5	2.5	2	3.5	3.5	4
***H* ranked highest to lowest quality**		**3**	**3**	**2**	**1**	**3**	**3**	**7**
Under-story density (***U***) (1 low, 4 high density)		2	2	1	1	3	4	4
***U* ranked lowest to highest density**		**3**	**3**	**1**	**1**	**5**	**6**	**6**
Species of timber tree present	mahogany (*Swietenia macrophylla*)	√			√			
	salm wood (*Cordia alliodora*)		√					
	santa maria (*Calophyllum brasilliense*)				√	√	√	√
	Quamwood (*Schizologium parahybum*)	√						
	iron wood (*Dialium guianense*)	√	√	√			√	√
	rose wood (*Dalbergia stevensonii*)				√	√	√	√
	Gombolimbo (*Bursera simaruba*)	√	√		√			
	Sapadilla (*Manilkara zapota*)	√	√					
	Mylady (*Aspidosperma megalocarpon*)			√				
	Bay cedar (*Guazuma ulmifolia*?)							
	Tambran		√					
	Yemeri (*Vochysia hondurnensis*)	√		√	√	√	√	√
	Nargusta (*Terminalia amazonia*)	√	√	√	√	√	√	√
	Caribbean pine (*Pinus caribacea*)					√		
No. of timber species on transect (*T*)		7	6	4	6	5	5	5
***T* species richness ranked**		**1**	**2**	**7**	**2**	**4**	**4**	**4**
No. of individual timber trees recorded from 1km transect (***I***) - over 1.5m DBH		23	13	19	15	10	14	12
***I* abundance ranked**		**1**	**5**	**2**	**3**	**7**	**4**	**6**
Species of non-timber tree present (D = dominant species)	Crab tree (*Pithecellobium* sp.?)						√	√
	Bitter wood (*Vateria lundellii*)	√	√				√	
	Cohune palm (*Orbignya cohune*)	**D**	**D**					
	Waree cohune (*Astrocaryum mexicanum*)	√						
	Bay leaf palm			**D**			√	√
	Give & take palm (*Cryosophila argentea*)	√	√				√	√
	Palmitta				**D**	**D**		√
	Chicle		√					
	Ceiba (*Ceiba pentandra*)	√				√		
	Hog plum (*Spondias mombin*)	√	√	√	√			
	Coco plum					√		
	Cecropia sp		√					
	Bay cedar (*Guazuma ulmifolia*)	√		√			√	
	Acacia		√		√			
	Milk tree						√	
	Bri-dri (*Inga edulis*)						√	
	Poison tree	√						
	Pimienta sp.	√						
	traditional fruit (*Pachira* sp.)		√				√	
	Mamee (*Alseis yucatanensis*)		√		√			√
	Pigeon plum					√	√	√
	wild crabu				√	√	√	√
	May flower	√						
	Ficus sp.	√		√	√			
	Strangler fig	√	√					
	Hormiga (*Ormosia toledoana*)							√
	Breadnut (*Brosimum alicastrum*)	√	√	√				

No. of known non-timber spp. on transect *N*	13	10	5	6	5	10	8
***N* species richness ranked**	**1**	**2**	**6**	**5**	**6**	**2**	**4**
Average ranking - (r*L* +*rH* + r*U* + r*T*+ r*I* + r*N)/6*	2.0	2.84	3.67	2.16	5	4.0	5.67
Overall vegetation site ranking	**1**	**3**	**4**	**2**	**6**	**5**	**7**

The overall **index of vegetation** generated ranks the seven areas as follows from good to bad:

1. Site 1
2. Site 4
3. Site 2
4. Site 3
5. Site 6
6. Site 5
7. Site 7

Observations on Site 7 (Government Block 127)

Government Block 127, Site 7, has been logged 3 or 4 times in the last 20 years and is now composed of scrub (**Fig. 1**). Vegetation is dominated by cutting grass up to 20ft high, with very few young trees of any description – all sub legal commercial size – growing up from the seed-bank produced by mother trees that were removed during previous logging operations. The ground is heavily churned up from machinery whose tracks can still be seen years later, and this has probably limited regeneration, through ground compaction and probable increased run-off during the wet season. This is now compounded by out-competition of slower growing tree species by faster emergent plants such as grasses. The logging licenses in this area were apparently for rosewood extraction, but due to the species composition of young trees present, and the lack of larger seed producing trees of the same species, it is clear that far more species of timber tree were removed. Now more logging is taking place to extract the last remaining stands of rosewood that the western portion of the land that apparently exist. It is questionable as to whether any natural regeneration can occur if logging practices are similar to those of past companies.

Discussion of site assessment results

The overall vegetation site ranking is based upon indices that were generated from rapid assessment in the field. These indicate that from a vegetation point of view the area that was worked to the west of Southern Highway – Site 1 - was the best i.e. where GSCP adjoins the foothills of the Maya mountains. At the time that the work was carried out this was the only area within the property possessing hill forest (see map of GSCP, page 8). However, subsequent to these surveys it was discovered that GSCP possesses land that reaches further up into the Maya mountain forest reserve, which has probably been subject to less human interference than all other vegetation throughout the corridor. This is worthy of further work given the potential variation in species present on slopes, limestone based soils, and slightly higher elevations. However, the trend throughout the corridor is for the forest nearer the coast to be less biodiverse, and less abundant in timber species due to heavier past extraction regimes.

Naturalness of habitat is missing throughout the entire GSCP area with a few exceptions of possible expansion into the Flick and St. Martin's parcels on the southern bank of the river east of the existing CLCC parcel, linking onto the sea. These two areas contain near pristine low-lying mangrove (*Laguncularia racemosa* **Fig. 2**). However, with the exception of some small areas of herbaceous vegetation on the Golden Stream river's banks (**Fig. 3**), and the swamp in the centre of the CLCC area (**Fig. 4**), there are no totally undisturbed areas of vegetation. There is no primary forest in any of the areas looked at during this biodiversity survey. Even the best areas of forest, such as Sites 3 and 4, have in parts been subject to quite intensive undercutting that have removed the larger individuals of timber species from the forest[R1].

[R1]Allow a minimum of 10 – 15 years for natural regeneration before considering options for sustainable harvest of non-planted timber.

Figure 1: Scrub in Site 7 (Block 127) – created by successive, under-regulated logging activities

Figure 2: Mangrove at the river mouth

Figure 3: Herbaceous riparian vegetation on the banks of Golden Stream

Figure 4: Main GSCP swamp from the air

Figure 5: Site 1: forest that has been selectively logged leaving some of the best habitat, in terms of vegetation, in the corridor.

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Figure 6: The emergent ceiba (*Ceiba pentandra*) is a true forest giant, with spiritual importance to the Maya.

Figure 7: The gombolimbo tree (*Bursera simaruba*) is present in drier areas of the corridor. Its Creole name of 'tourist tree' refers to its peeling bark.

Figure 8: Attractive species such as this ground bromeliad may have potential to provide income in the future as ornamentals.

Figure 9: Other plants such as this vine (possibly *Aristolochea* sp.) have been used as traditional medicine by the Maya – in this case as an emetic – and may hold commercial potential.

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In general the vegetation present in the area examined is a mosaic of regenerating, secondary areas that have been subject to disturbance. This has varied from small-scale agricultural (milpa) clearance or near clear felling of larger areas at the worst, to low intensity undercutting and selective felling of timber species leaving some larger individuals at best – Site 1 (**Fig 5**). Thus, the better areas of forest are dominated by cohune palms (*Orbignya cohune*) which appear to have filled the niche left by the larger timber trees that were extracted, and now represent the most numerous and sometimes largest individual trees present (10-15m tall). In other areas where the logging companies involved had more rigorous procedures some of the larger emergents such as ceiba (*Ceiba pentandra*) have been left reaching heights of 25 – 30m. However, the dominant group of trees throughout the area are the palms including several commercially and locally important species such as cohune (used for thatching village houses, with edible nuts); bay leaf (sold for thatching tourist lodges); and palmitta (used for structural purposes in local buildings). Also present are faster growing timber species that may be useful, in conjunction with the slower growing, more commercially valuable species such as mahogany (*Swietenia macropylla*) or rosewood (*Dalbergia stevensonii*), for generating local income. They may also be valuable for replanting more degraded areas near the river e.g. salm wood (*Cordia allioora*) and santa maria (*Calophyllum brasilliens*) which reach harvestable size in 7/8 years[R2].

Ceiba trees are easily recognisable (**Fig. 6**) and are the largest emergents in the GSCP forests. They are well known by the Maya local communities that the GSCP project is working with because in Maya folklore, which although badly eroded is still present at various levels of consciousness, the tree links the upper and under-worlds. The symbolism in this is powerful when one sees the massive rooted, huge-trunked trees reaching way above the canopy. These trees are becoming increasingly rare as commercial loggers search for ways to increase profits by taking non-hardwood trees. The ceiba would perhaps be a good flagship species for GSCP, it is charismatic, and possesses 'cultural value' through linking the people and their heritage to the forest[R3] (Bowen-Jones & Entwistle *in prep*). Other tree species also have 'aesthetic value' from the visitor point of view, including the gombolimbo (*Bursera simaruba*) – **Fig. 7**, and these should be used in marketing the area to an international audience.

During the vegetation surveys other plant species of interest were recorded whenever possible, with particular emphasis on those that could hold commercial potential for community income generation. (**Figs. 8 & 9).**[R2]

2. Hunting pressure and accessibility

Following the methodology used in a similar biodiversity assessment in Ecuador (Bowen-Jones *et al.* 2000) it was decided to create a subjective ranking of hunting pressure and accessibility. The summary data is presented in table 2 below. The exercise was carried out in order to facilitate comparison and correlation with other variables gathered during the Belize biodiversity survey 2000. The overall ranking for hunting pressure and accessibility e is as follows from low to high vulnerability:

1. Site 4
2. Site 2
3. Site 3 & 5
5. Sites 6
6. Site 7 & 1

Recommendations:

[2]Consider habitat restoration in ex-agricultural areas in terms of tree planting, linked to a tree nursery based initially on demonstration plots near to the GSCP resource centre, using both faster and slower growing native timber trees, cohune palms, etc. Make internal FFI project links to the Global Trees Programme.

Consider other plant species' commercial potential either as ornamentals, or from a pharmaceutical aspect. The latter could mean linking in with on-going local projects - growing traditional medicinal plants before this knowledge is lost to the communities by the death of the remaining shamans.

[3]Develop the ceiba as a culturally and ecologically appropriate local flagship species for the awareness materials in both the GSCP resource centre, and the outreach programme.

Table 2: Qualitative estimation of hunting pressure and accessibility

The subjective index for **hunting pressure** is based on evidence from ranger interviews, evidence of hunting – e.g. camps[a], shotgun cartridges[b], fires for smoking out game[c], burnt palms to catch iguanas[d], hearing shots[e], and ranger reports[f]. That for **accessibility** takes into account distance from the communities[a], road[b], footpaths[c], logging roads[d] and active logging areas[e], and ability to enter the area by boat from the river mouth[6]. Each area was given a rating from **1 – 3** (1 being low), and explanations are given through the numbers assigned corresponding to the evidence listed above.

Variable	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
	Maya mountains foothills						Coast
Hunting pressure	3[b,c,f]	1[f]	2[e,f]	1	2[a,d,f]	3[a,b,d,f]	3[a,d,f]
Accessibility	3[a,b,c]	2[a,b,c]	2[c,d,e]	1[c]	2[d,f]	2[d,e,f]	3[c,d,e,f]
Index	6	3	4	2	4	5	6
Ranked index of vulnerability	**6**	**2**	**3**	**1**	**3**	**5**	**6**

As previously stated in the methods, this analysis is limited by the lack of precision at a temporal level in terms of when, and how regularly, hunting takes place where evidence was present. It is also not possible to judge interdependence of factors such as logging roads and presence of hunting camps and cartridges which are likely to be closely inter-linked. However, it seems reasonable to assume that the relative level of human disturbance at each site is likely to be similar to that shown given the use of both short and long-term variables (such as access and ranger reports) which should balance the immediate evidence.

Discussion of analysis of vulnerability to exploitation

From the ranked index it can be seen that the most vulnerable areas in the corridor to current and future illegal/unsustainable exploitation are those nearest to the communities in the west of the corridor, and those in the east nearest to the river mouth. (Having said this, the Guatemalan commercial poachers penetrated up river as far as Site 4, on foot along the riverbank from boats left downstream). The current level of hunting within the GSCP area nearest the communities is already unsustainable, particularly given the reduced carrying capacity of much of the degraded forest. Efforts must be made to tackle this problem - which is at the moment prohibitive to ecotourism and other local income generation - through awareness and education, provision of well designed alternative income generation options to the local communities, increased feelings of ownership by the nearest communities, and effective enforcement strategies.[R4]

3. Presence/absence data for terrestrial and arboreal medium/large mammal species.

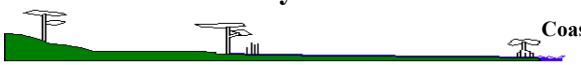
In total 32 species of medium/large mammals were recorded from the areas surveyed within the GSCP corridor (see Table 3 below), a further 8 species were reported by local staff/rangers from specific localities. Twenty-three of the species recorded or reliably reported from the GSCP area are either threatened or CITES listed. This group includes national priority species e.g. the national mammal – the tapir (*Tapirus bardii*), important resource species such as paca (*Agouti paca*) – **Fig. 10** - that are eaten and sold as meat; and those with 'flagship potential'. The latter will be could be important in order to maximise the potential for raising the project's profile both at community and international activities.

The **index of species richness** generated ranks the seven areas as follows from high to low:

1. Site 3
2. Site 2
3. Site 6
4. Site 5
5. Site 4
6. Sites 7 & 1

[R4]Integrate measures to control hunting throughout the management plan for the GSCP area.

Table 3: Mammalian Inventory and Biodiversity Data from GSCP Survey 2000

Maya mountain foothills  **Coast**

No. Individuals*, Presence (X)/Absence or Reported (R)

Site No.				**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Species		**Threat**							
Taxon	***Latin name***	**Common name**	**category**							
Didelphimorphia										
Didelphidae	*Didelphis marsupialis*	common opossum			X					
	Didelphis virginiana	Virginia opossum			X					
	Philander opossum	gray four-eyed opossum			X			X	3	
	Micoureus alstoni	Alston's mouse opossum	LRn/t	X	X					
Xenarthra										
Myrmecophagidae	*Tamandua mexicana*	northern tamandua	CITES III	R						
Dasypodidae	*Cabassous centralis*	naked-tailed armadillo	DD	R				R		
	Dasypus novemcinctus	nine-banded armadillo		R		X		X	X	
Primata										
Cebidae	*Alouatta pigra*	Yucatan black howler	CITES I				6			
	Ateles geoffroyi	Central American spider monkey	CITES I, VU	R						
Rodentia										
Sciuridae	*Sciurus yucatanensis*	Yucatan squirrel		X	X			X	X	
	Sciurus deppei	Deppe's squirrel	CITES III	X	X	X	2		2	X
Geomyidae	*Orthogeomys hispidus*	hispid pocket gopher		R						
Erethizontidae	*Coendou mexicanus*	Mexican porcupine	CITES III						X	
Dasyproctidae	*Dasyprocta punctata*	Central American agouti	CITES III		6	1	1		2	X
Agoutidae	*Agouti paca*	paca	CITES III	X	X	X		1	1	
Carnivora										
Procyonidae	*Procyon lotor*	northern raccoon						R		X
	Nasua natrica	white-nosed coati	CITES III	X			R			
	Potos flavus	kinkajou	CITES III	4	X	6		X	2	X
Mustelidae	*Mustela frenata*	long-tailed weasel		R		R	R			
	Eira barbara	tayra	VU, CITES III	R		R				
	Conepatus semistriatus	striped hog-nosed skunk			X	X	X		X	
	Lutra longicaudis	Neotropical river otter	CITES I	R	R	X	X	X		
Felidae	*Leopardus pardalis*	Ocelot	CITES I			X	X			
	Herpailurus yagurondi	jaguarundi	CITES I	R						
	Puma concolor	puma	CITES I			X				
	Panthera onca	jaguar	LRn/t, CITES I	X	X	X		X	X	
Trichechidae										
Sirena	*Trichechus manatus*	West Indian manatee	VU, CITES I							X
Perissodactyla		**Odd-toed Ungulates**								
Tapiridae	*Tapirus bairdii*	Baird's tapir	VU, CITES I		1	X	X	X	X	
Arttiodactyla		**Even-toed Ungulates**								
Tayassuidae	*Tayassu tajacu*	collared peccary	CITES II		X	X		X	X	
	Dicotyles pecari	white-lipped peccary	CITES II		R	X	X	R		X
Cervidae	*Odocoileus virginianus*	white-tailed deer	CITES III			X				
	Mazama americana	red brocket deer	CITES III		X	X	1	X	X	X
Site No.				**1**	**2**	**3**	**4**	**5**	**6**	**7**
Species richness				7	14	15	9	10	13	7
Site species richness index				**6**	**2**	**1**	**5**	**4**	**3**	**6**
Camera trap abundance index				0	0	0	1	1	0	0

*individuals are recorded when seen recorded visually on transects

Figure 10: A paca (*Agouti paca*)- a large Neotropical rodent, and one of the favourite game meat species in the GSCP area.

Figure 11: A West-Indian manatee (*Trichecus manatus*), one of the endangered large mammals in the Golden Stream watershed.

Figure 12: A juvenile puma (*Puma concolor*), caught on camera-trap during the survey.

all photos E. Bowen-Jones/Fauna & Flora International

Figure 13: Central American spider monkeys (*Ateles geoffroyi*) are reported from the Maya mountain foothills in an area with GSCP.

Figure 14: Yucatan howler monkeys (*Alouatta pigra*) are present in low densities due to past hunting pressures, although with better protection their populations should increase.

Figure 15: Kinkajous (*Potos flavus*) are relatively common, and can be seen at close quarters in even in relatively degraded habitat. This makes them ideal attractions for night walks as part of potential future ecotourism initiatives.

Transect data yielded relatively few sightings of terrestrial mammals and although the explanation, which is validated by the camera trap results, is that densities were clearly very low there are other factors which may have reduced the number of records. The first of these is that during the survey period the dry season reached its peak, and the amount of leaf litter on the forest floor – particularly in areas of semi-deciduous forest – made it virtually impossible to move without making some noise. This may have scared some of the more timid species away before they were within visual range. The second factor may have been the availability of water limiting faunal distributions, since there was a noticeable increase in both mammal and bird activity, and sightings, closer to the Golden Stream river. There may be seasonal shifts in movement patterns – particularly for animals with larger home ranges – which might mean that transects inland from water bodies within GSCP in the dry season are bound to achieve lower success than in the wet season. However, tracks of mammals which were readily identifiable, were frequently found on transects and paths, probably originating from the rains two months prior to the survey period. This meant that the presence/absence data was quite extensive despite lack of visual sightings.

The assertion that mammalian densities are low within GSCP is backed up by the camera trap data, with only 2 records in 28 days of deployment. Once more the success of this technique may have been limited by the time involved. It may be that leaving traps in place for longer than 4 days per site may have yielded more results, but on the other hand some authors have reported carnivores being trapped more over the first 24 hours when the smell of the people setting the trap up is stronger. Additionally, a greater number of camera trap units would provide a greater chance of success, since more sites with potential high mammal activity (based upon tracks, scats, etc.) could be covered.

Discussion of meduim/large mammal survey data

Mammals generally require more time and effort to survey in a quantitative manner than, for example, birds and given the nature of this rapid assessment information gathered on mammal populations was mainly qualitative. However, even from the data available it is very clear that most mammal population densities are very low. This observation is backed up by the camera trap success rate, which although limited by numbers of units available, yielded very few results. From the author's experience in well-protected areas of Central America with the same mammalian fauna one would expect to see several agouti (*Dasyprocta punctata*) per day in good habitat. As the transect-data indicates here, the densities of this (the commonest and most widespread as well as one of the most ecologically significant medium sized mammals) is extremely low. In Site 1, to the west of the main road, no agoutis were recorded, and rangers agreed that they hardly, if ever, saw them despite this being the most regularly patrolled area. Yet, in terms of vegetation this area was considered to contain some of the best areas of forest in the corridor. The correlation with distance from human populations, and the relative ease of access here, are the two obvious factors which may explain this result. Shotgun cartridges, less that one-month-old, were found on both visits that the author paid to the area at the beginning and end of the fieldwork period. Rangers also report that people from Tambran even eat coatis (*Nasua natrica*), which as carnivores probably do not taste as good as herbivorous game species – suggesting there is a serious lack available game meat from the preferred species. Solutions in the form of alternatives to subsistence and commercial hunting must be found[R5].

At the same time, the best localities for mammalian species richness were those neither close to the river mouth or the road, for which access people must expend more effort in hunting. However, it is important to recognise that there may be other reasons why mammalian populations in the GSCP are low at the moment. With the structure of the forest altered from it natural state, and an absence of large trees due to logging, there may be a lack of appropriate den sites for many larger species of animal. Add to this the fact that the best areas in the GSCP corridor are those that are composed of medium quality secondary forest with areas of dense scrub –which contains more fruit trees and hence more food - and it can be seen that the mosaic of regenerating habitats means that herbivore distribution is atypical. This could mean that the mammal fauna present is more at risk from direct anthropogenic influences than in a 'natural regeneration' scenario. Population densities are already reduced due to lack of good habitat in areas where the understorey is relatively open due to undercutting, making hunting with guns easier. Whether or not this is true, the mammalian population in the area is highly vulnerable and this makes good protection, and public awareness crucial.

Recommendations:

[6]Use large charismatic mammals as appropriate international flagships with an ecological emphasis at local levels.

The observation that mammal and bird sightings (and activity) were concentrated in areas nearer the river and swamp, due to the absence of water in small streams in the dry season, makes these areas very important for the overall conservation of the fauna in the area. Added to this Neotropical river otters (*Lutra longicaudis*) and manatees (*Trichechus manatus*) – **Fig. 11** - are only found in and around the river, the former being present in very good numbers. Tapirs are also heavily dependent on the areas of herbaceous vegetation amongst the riparian forest on the riverbanks, and are, like the other river dwelling animals easily disturbed and targeted for exploitation. At the moment the tapir populations in Golden Stream appear to be little affected by the otherwise widespread hunting of this species, unlike in other areas of the Neotropics where they have been widely locally exterminated. However, there was a report towards the end of the survey, that villagers from the project communities had taken buckets up to a village in the Maya mountains to help themselves to some of the meat from a tapir that had been shot there. Attitudes towards wildlife are changing within the Maya communities, and should be the subject of careful monitoring and specific education/awareness activities.[R5]

Threats to the fauna of the area do not just come from local exploitation. Commercial hunters are operating throughout Toledo District, and therefore people from villages further afield than Indian Creek and Golden Stream – e.g. Big Falls – are currently hunting in GSCP. Meat of paca (*Agouti paca*), armadillo (*Dasypus novemcinctus*) and iguana (*Iguana iguana*) are not only being sold from buckets or 'door to door' salesmen, but is also appearing on menus in restaurant and being sold frozen in shops in Punta Gorda. Thus, outreach programmes being run by GSCP need to be targeted at hunters as a specific group, awareness activities need to reach communities other than those closest to the corridor, and ranger training needs to include good training on enforcing rules on hunting within the corridor. [R5]

A major current threat to fauna in the whole of southern Toledo, in protected and non-protected areas alike is from large-scale commercial, well outfitted groups of Guatemalans crossing over the border and systematically 'cleaning out' the larger rivers in the District. This has been going on for some time, and during the survey period, these poachers – who had been working their way up the coast through Sarstoon Temash National Park, Rio Grande and Deep River - took large numbers of animals from Golden Stream. This happened on the weekend, when the response from the authorities was likely to be least effective. It involved using a large skiff, smaller canoes, and people walking on foot up the riverbank in order to capture as many iguana, hickety turtles (*Dermatemys mawii*), paca, etc. as they could fit into the boats. They are without doubt well organised, probably armed, and opportunistic in the extreme. It is probably the same group who in the last six months have killed over half a dozen manatees and then taken them over the border for open sale as meat.*-see footnote overleaf

The low prey densities within GSCP, probably also restrict the larger carnivore populations, which otherwise contain most of the expected species. In the past GSCP is reported to have contained very high jaguar densities (Sharpe 1998), and tracks and signs were found in all but two of the study areas. However, some of the sign was very old (e.g. tracks dating back to the wet season), and given the size of territory that these animals maintain (50km^2) there is no reason to assume high populations. Reports are widespread of an American hunter using dogs in GSCP area between the 1970's and 1980's who is said to have killed many jaguars, and the population could still be recovering. The second largest felid in the Neotropics, the puma (*Puma concolor*), is also present – once identified by tracks and once caught by a photo-trap (**Fig. 12**). All of the smaller Belizean cat species are probably also present. However, given that neighboring habitat is still being lost to logging, the stability of these populations is questionable since human/carnivore conflict is likely to increase. Due to the negative associations held by local communities, jaguars may not make the best choice for an educational/ awareness focus for the project at ground level. They are often regarded as a nuisance due to predation on domestic livestock, or feared due their potential threat to human life – the ceiba tree is much more appropriate as a local flagship. However, at an international fundraising level it may be beneficial to mention the presence of top predators, as this has become an expectation amongst target international donors. Thus, perhaps the GSCP/FFI project should adopt both local and international flagship species.[R6]

Recommendations:

[6]Use large charismatic mammals as appropriate international flagships with an ecological emphasis at local levels.

Additionally, Central American spider monkeys (*Ateles geoffroyi*) – **Fig. 13** - listed as VU by the IUCN (1998) - are reported from the hill forest in the west of the corridor on a seasonal basis. As another threatened species this is worthy of further surveys to confirm their presence and the size of populations involved. Yucatan howler monkeys (*Alouatta pigra*) – **Fig. 14** are present in the GSCP area, but at substantially lower levels than expected. Only six individuals – one family – were recorded during the survey, and this was verified by howling heard in the distance, which was always from the same site. There are probably another2 groups in BLE's land – again from reports of rangers, and from vocalisations. However, given the area of land involved (over 12,000ha), this is a very low population, and although no direct evidence was collected, rangers report some of the local Maya communities as eating monkey. The fact that the groups involved rarely howl during the day - usually associated with learned response to heavy hunting pressure adds credence to this. Primates represent a potentially important ecotourism resource, and for the first 10/20years of this project protection and enforcement strategies should be geared towards allowing the recovery of mammal populations and forest to have an attractive enough area to allow this form of income generation[R9]. However, at the moment there is not enough in the area, with respect to fauna, in order to be competitive with other natural protected areas in Belize, let alone Costa Rica or areas of Guatemala. It may be, though, that alternative ecotourism/visits by conservationists and scientists could become possible if the area is developed into a working model of sustainability with ongoing biological monitoring which others can take part in. Additionally, the high population of otters may prove to be a draw depending upon the feasibility of viewing them, as could the presence of other easier to see mammals such as kinkajous – **Fig. 15** [R10].

***Footnote:**
Despite the predictability of the return of these poachers, no effective reponse has been planned from the Belize authorities at local or national governmental level. When the GSCP Director and author tried to organise a boat to go and arrest the Guatemalan poachers, on a tip off of where they would be camped the following day, there was no skiff available in Punta Gorda, and the police, and BDF (Belize Defence Force) were unable to help. According to the Director of the Toledo Institute for Development and Environment (TIDE) this is a typical situation, and their manatee protection programme is unable to function, because Fisheries and Forestry officers hardly ever accompany them on patrol. Without a Fisheries or Forestry officer present there can be no arrest or detainment of poachers even if they are caught butchering a manatee. GSCP, TIDE, Sarstoon Temash Institute for Indigenous Management, and other organisations affected by this must join forces to lobby for a suitable solution to this yearly problem before some areas loose important animal populations. The development of the capacity to handle this kind of emergency without relying on direct government support would be preferable.

Recommendations:

[7]Develop a project to build and improve upon TIDE's work on manatee conservation.
[8]Local organisations including GSCP should co-ordinate, network and lobby in order to get into a position to do something about the large-scale poaching outfits from Guatemala.
[9]Set up a monitoring programme using primates and other taxa to determine efficiency of protection measures, and detect increases in population to levels worthy of expanding ecotourism interest.
[10]Examine the potential for establishing the GSCP centre and project as a model for sustainable projects, as well as the potential for alternative charismatic mammal tourism e.g. hides for otter viewing and night walks for kinkajou's based upon appropriate feasibility analysis.

4. **Presence/absence data for birds**.

Table 4 below summarises all the data that was collected on birds during the GSCP survey 2000 as well as recording additional data from Sharpe (1998). The table, therefore, also represents a complete inventory of the species of bird recorded from the GSCP area to date, as well as the data collected from the standardised transects.

The **index of species richness of birds** generated ranks the seven sites as follows:

1. Site 4
2. Site 2
3. Site 1
4. Site 3
5. Site 6
6. Site 5
7. Site 7

Visual recognition of birds in the field was normally easy given the author's and FFI Field Assistant's past ornithological experience in the region, and good weather conditions. The field guides used provided good coverage of the avifauna, and the only limiting factor was the variable density of undergrowth. In some areas of scrub this was extremely dense, and therefore the line of sight on some transects was very limited. To counter this the transects were walked as slowly and silently as possible to maximise the chance of hearing and identifying birds by call (particularly to listen for shy birds with low frequency calls such as currasows (*Crax rubra*). Although the field team's knowledge of birdcalls was limited, initial assistance was provided by Philip Balderamos in increasing the number of species that were recognisable. With additional records of the birds seen in each site, although not recorded on the transects, and the addition of species reported by Sharpe (1998) at a different time of year, the inventory can be seen as a good start point towards a complete record of birds in GSCP.

Table 4: Avian Inventory and Biodiversity Data from GSCP Survey 2000

Key to species records:

Tinamus major	= Species recorded between 20th Feb & 18th April 2000
*Podilymbus podiceps**	= Additional species recorded from Sharpe (1998) between 6th & 10th November 1998
Crypturellus boucardi	= species recorded in 2000 not recorded by Sharpe (1998)

Presence/Absence
X = present, T = recorded on transect. R = Reported from Area.

Maya mountains foothills

Site No.				**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Species									
Taxon	***Latin name***	**Common name**	**Threat category**							
Tinamiformes										
Tinamidae										
	Tinamus major	great tinamou		X		T	T	T	T	
	Crypturellus soui	little tinamou		X	X				T	T
	Crypturellus cinnamomeus	Thicket tinamou						X		
	Crypturellus boucardi	slaty breasted tinamou			X					
Podicipediformes										
Podicipedidiae	*Podilymbus podiceps**	Pied-billed grebe								
Perlecaniformes										
Pelecanidae	*Pelecanus occidentalis*	brown pelican								X
Phalacrocoracidae	*Phalacrocorax brasilianus*	Neotropical cormorant								X
Ahingidae	*Anhinga anhinga*	Anhinga						X	X	
Fregatidae	*Fregata magnificens*	Magnificent frigate-bird		T						X
Ciconiiformes										

Ardeidae	*Tigrisoma mexicanum*	bare-throated tiger-heron			X	X	X			X
	Bubulcus i. Ibis	cattle egret				X				X
	Butorides virescens	green heron					X			
	Egretta caerulea	little blue heron				X			X	X
	Egretta tricolour	Tricoloured heron								
	Egretta thula	snowy egret				X			X	
	Casmerodius albus	great egret				X				
	Ardea herodias	great blue heron					X			X
	*Nyctanassa violacea**	Yellow-crowned heron								
	Cochlearius cochlearius	boat-billed heron								X
Ciconiidae	*Mycteria americana*	wood stork				R		X		
	Jabiru mycteria	jabiru stork				R				
Threskiornithidae	*Euocimus albus*	white ibis								X
Anseriformes										
Anatidae	*Cairina moschata*	Muscovy duck				X	X	X		
	Anas discors	blue-winged teal				X				
Falconiformes										
Cathartidae	*Carthartes aurata*	turkey vulture		X	X	X	X	X		X
	Carthartes burrovianus	lesser yellow-headed vulture						X		
	Caragyps atratus	black vulture		X			X			X
	Sarcoramphus papa	king vulture					X			
Pandionidae	*Pandion haliaetus*	Osprey								X
Accipitridae	*Elanoides forficatus*	American swallow-tailed kite						X		
	*Elanus leucurus**	white-tailed kite								
	Elanus caeruleus	black-shouldered kite		X						
	*Harpagus bidentatus**	Double-toothed kite								
	Ictinia plumbea	Plumbeous kite		X						
	Geranospiza caerulescens	crane hawk					X			
	Leucopternis albicollis	white hawk		X						
	Buteogallus anthracinus	Common black-hawk							X	X
	Buteo brachyurus	short-tailed hawk								
	Buteo nitidus	gray hawk		T		T		X	T	T
	Buteo magnirostris	Roadside hawk		X						
	Harpia harpyja	harpy eagle	LR/nt			X				
Falconidae	*Herpethotheres cachinnans*	Laughing falcon		T			X		X	
	Micrastur ruficollis	barred forest-falcon						X		
	Micrastur semitorquatus	Collared forest-falcon			X	X				
	Falco rufigularis	bat falcon		X						
	Falco deiroleucus	Orange-breasted falcon	LR/nt			X				
	*Falco peregrinus**	Peregrine falcon								
Galliformes										
Cracidae	*Ortalis vetula*	plain chachalaca			T	T	X	X		T
	Penelope purpurascens	Crested guan				R				
	Crax rubra	great curassow				T		T	T	X
Gruiformes										
Armidae	*Aramus guarauna*	Limpkin					X			
Rallidae	*Aramides cajanea*	gray-necked wood-rail					X	X	X	
	Laterallus ruber	ruddy crake		T						
	*Gallinula chloropus**	Common moorhen								
	*Fulica americana**	American coot								
Heliornithidae	*Heliornis fulica*	Sungrebe						X	X	
Charadriiformes										
Jacanidae	*Jacana spinosa*	Northern jacana				X				
Scolopaciidae	*Actitis macularia**	Spotted sandpiper								
Laridae	*Sterna nilotica**	gull-billed tern								
	Sterna maxima	royal tern								X
	Sterna sandvicensis	Sandwich tern								X
Columbiformes										
Columbidae	*Columba leucocephala*	white-crowned pigeon								X
	Columba speciosa	scaled pigeon		X				T	X	T
	Columba nigrirostris	short-billed pigeon		T	T	T	T		X	X
	Zenaida asiatica	white-winged dove		T						
	Columbina passerina	Common ground-dove		X						
	Columbina talpacoti	ruddy ground-dove		T	T		X			
	Claravis pretiosa	blue ground-dove							X	
	*Leptotila verreauxi**	white-tipped dove								
	Leptotila p. plumbeiceps	grey-headed dove		T	T		X		X	
	Geotrygon m. montana	ruddy quail-dove				T				
Psittaciformes										
Psittacidae	*Aratinga astec*	Aztec parakeet			T	X	T	X		

	Pionopsitta h. haematotis	brown-hooded parrot			X					X
	Pionus senilis	white-crowned parrot				X	X			
	Amazona albifrons	white-fronted parrot		T	T	T	X		T	
	Amazona a. autumnalis	red-lored parrot		T	T	T	X	X		
	Amazona oratrix	Yellow-headed parrot	EN	R						
Ciculiformes										
Cuculidae	*Coccyzus minor*	Mangrove cuckoo							R	R
	Piaya cayanna	Squirrel cuckoo		X	T	X	T		X	
	Crotophaga sulcirostris	Groove-billed ani			X			X		
Strigiformes										
Strigidae	*Strix virgata*	Mottled owl		X				X		
Caprimulgiformes										
Caprimulgidae	*Nyctidromus albicollis*	Pauraque		X		X				
Apodiformes										
Apodidae	*Panyptila cayennensis*	lesser swallow-tailed swift		X			X			
	*Streptoprocne zonaris**	white-collared swift								
Trochilidae	*Threnetes ruckeri**	band-tailed barbthroat								
	Phaethornis superciliosus	long-tailed hermit		T	T	T	T			T
	Phaethornis longuemareus	little hermit		T	T	T	T	T	T	T
	Phaeochroa cuvierii roberti	scaly-breasted hummingbird								
	Florisuga m. mellivora	white-necked jacobin					X			
	Amazilia candida	white-bellied emerald			T					
	Amazilia t. tzacatl	rufous-tailed hummingbird		X	T	T	T	T	T	T
Trogoniformes										
Trogonidae	*Trogon m. melanocephalus*	black-headed trogon		T			T	T	T	T
	Trogon violaceus braccatus	Violaceous trogon		T						
	Trogon m. massena	slaty-tailed trogon		X		T	X		T	T
Coraciiformes										
Momotidae	*Hylomanes momotula*	tody motmot		R						
	Momotus momota	blue-crowned motmot		X			X	X		
	Electron carinatum	keel-billed motmot	LRn/t	R						
Alcedinidae	*Ceryle t. torquata*	ringed kingfisher				X		X	X	X
	Ceryle alcyon	belted kingfisher			T		X			
	*Chloroceryle amazona mexicana**	Amazon kingfisher								
	Chloroceryle americana	green kingfisher		X	X		X			
	Chloroceryle aenea stictoptera	Pygmy kingfisher						X	X	X
Piciformes										
Bucconidae	*Notharchus macrorhynchos*	white-necked puffbird					R			
	Macacoptila panamensis inornata	white-whiskered puffbird		T						
Galbulidae	*Galbula ruficauda melanogenia*	rufous-tailed jacamar		X	T					
Ramphastidae	*Aulacorhynchus prasinus*	Emerald toucanet		R						
	Pteroglossus torquatus	Collared aracari		T	T	X	X		X	
	Ramphastos sulfuratus	keel-billed toucan		T	T	T	T	X	X	T
Picidae	*Centurus pucherani perileucus*	black-cheeked woodpecker			T				X	
	Centurus aurifrons	Golden-fronted woodpecker						T		
	Veniliornis fumigatus	Smoky-brown woodpecker		T	T	T	T	T	X	X
	Dryocopus lineatus	Lineated woodpecker		X		T				
	Campephilus guatemalensis	pale-billed woodpecker		T	T	T	T	T		X
	Celeus castaneus	Chestnut-headed woodpecker			T					X
Passeriformes										
Furnariidae	*Xenops minutus mexicanus*	plain xenops								X
Dendrocolaptidae	*Dendrocincla anabatina*	tawny-winged woodcreeper								X
	Dendrocincla certhia	barred woodcreeper				X				
	Dendrocincla h. homochroa	ruddy woodcreeper		T		X				
	Xiphorhynchus flavigaster	ivory-billed woodcreeper			X		T			
	*Sisttasomus griseicapillus**	Olivaceous woodcreeper								
	*Glyphorynchus spirurus pectoralis**	wedge-billed woodcreeper								
Formicariidae	*Taraba major melanocrissa*	great antshrike					T			
	Thamnophilus doliatus	barred antshrike		T	X		T	T	T	X
	Dysithamnus mentalis sptentrionalis	plain antvireo			T				T	
	Myrmotherula s. schisticolor	slaty antwren				T				
	Microrhopias quixensis	dot-winged antwren			T					X
	Cercomacra tyrannina crepera	dusky antbird			T		T	T		
	Formicarius moniliger	Mexican antthrush			T				T	
Tyrannidae	*Ormithion semiflavum*	Yellow-bellied tyrannulet							X	
	Elauenia flavogaster subpagana	Yellow-bellied elaenia						X		
	Todirostrum sylvia schistaceiceps	slate-headed tody-flycatcher			X	X				
	*Tolmomyias sulphurescens cinereiceps**	Yellow-olive flycatcher								
	Todirostrum cinereum	Common tody-flycatcher			X					
	Platyrinchus cancrominus	stub-tailed spadebill							T	

	Rhynchocyclus brevirostris	eye-ringed flatbill								
	Onychorhynchus coronatus mexicanus	royal flycatcher			X	X	X			
	Terenotriccus erythrurus fulvigularis	ruddy-tailed flycatcher				T				
	Myiobius s. sulphureipygius	Sulphur-rumped flycatcher			T			T		
	Contopus virens	Eastern wood pewee					T			
	Contopus cinereus	Tropical pewee				T		T		
	Empidonax flaviventris	Yellow-bellied flycatcher						T		
	Attila spadiceus	bright-rumped attila		X						
	Thytipterna h. holerythra	rufous mourner								
	Myiarchus tyrannulus	brown –crested flycatcher		T						
	Myiarchus tuberculifer	dusky-capped flycatcher					X	X		
	Pitangus sulphuratus	great kiskadee		T		X		X		
	Megarynchus pitangua	boat-billed flycatcher	X			T				
	Myiozetetes similis	social flycatcher				T				X
	Myiodynastes luteiventris	Sulphur-bellied flycatcher		T						
	Tyrannus tyrannus	Eastern kingbird								X
	Tyrannus melancholicus	Tropical kingbird				X	X			X
	*Tyrannus forticatus**	Scissor-tailed flycatcher								
Cotingidae	*Schiffornis turinus veraepacis*	Thrushlike mourner	X		T		T	T		T
	Tityra semifasciata	Masked tityra			X			T		
	Tityra inquistor fraserii	black-crowned tityra		T			X	X		
	Lipaugus u. unirufus	rufous piha	X							
Pipridae	*Manacus candei*	white-collared manakin		X	X	T	X	X		
	Pipra m. mentalis	red-capped manakin	X		T	T		T		T
Hirundinidae	*Progne chalybea**	grey-breasted martin								
	Tachycineta a. albilinea	Mangrove swallow				X	X	X		
	Stelgidopteryx serripennis	Northern rough-winged swallow	X							
	*Hirundo rustica**	barn swallow								
Corvidae	*Cyanocorax morio*	brown jay	T	X	X		T			T
Troglodytidae	*Thyorthorus maculipectus*	spot-breasted wren					X			T
	Henicorhina leucosticta	white-breasted wood-wren	T		T	T	T	T		T
	Mircocerculus philomela	Nightingale wren			T					T
	*Troglodytes aedon**	house wren								
Sylviidae	*Ramphocaneus melanurus*	long-billed gnatwren	X							
	Polioptila plumbea brodkorbi	Tropical gnatcatcher								X
Turdidae	*Catharus ustulatus**	Swainson's thrush								
	Catharus mustelinus	wood thrush	T		X	T		X		
	Turdus grayi	clay-coloured robin				T				
Mimidae	*Dumetella carolinensis*	grey catbird		X		T	T			
Vireonidae	*Hylophilus o. ochraceiceps*	tawny-crowned greenlet		T				T		X
	Hylophilus d. decurtatus	lesser greenlet	X				T			
	*Vireo olivaceus**	red-eyed vireo								
	*Vireo magister**	Yucatan vireo								
Parulinae	*Vermivora pinus**	blue-winged warbler								
	Vermivora peregrina	Tenessee warbler		X	X					
	Dendroica petechia	Yellow warbler		X						
	Dendroica coronata	Yellow-rumped warbler		T						
	Dendroica pensylvanica	Chestnut-sided warbler								
	Dendroica magnolia	Magnolia warbler		X						
	*Dendroica caerulescens**	black-throated blue warbler								
	Mniotilta varia	black-and-white warbler	T		X	T		T		X
	Setophaga ruticilla	American redstart		T	X	X				X
	Helmitheros vermivorus	worm-eating warbler		T						
	Seiurus aurocapillus	Ovenbird				T		X		
	Seiurus motacilla	Louisiana waterthrush	X							
	Seiurus noveboracensis	Northern waterthrush	T	X		X				
	Oporornis formosus	Kentucky warbler				T	X			X
	*Geothlypis trichas**	Common yellowthroat								
	Chamaethlypis poliocephala	grey-crowned yellowthroat						T		
	Wilsonia citrina	Hooded warbler		T	T	T				
	Basileuterus culicivorus	Golden-crowned warbler			T					
Coerebinae	*Coereba flaveola*	Bananaquit					X			
Thraupinae	*Euphonia hirunadinacea*	Yellow-throated euphonia				X				
	*Euphonia gouldi**	olive-backed euphonia								
	Thraupis episcopus cana	blue-grey tanager		X						X
	*Thraupis abbas**	Yellow-winged tanager								
	Habia rubica	red-crowned ant-tanager	T							
	Habia fuscicauda	red-throated ant-tanager	T	T	T	T	T	T		T
	*Piranga rubra**	Summer tanager								

	Phlogothraupis s. sanguinolenta	Crimson-collared tanager				X			
	Ramphocelus p. passerinii	scarlet-rumped tanager				X	X	X	
Cardinalinae	*Saltator atriceps*	black-headed saltator				T	X		
	Saltator maximus	buff-throated saltator				T			
	*Saltator coerulescens**	Grayish saltator							
	Caryothraustes p. poliogaster	black-faced grosbeak							X
	Cyanocompsa cyanoides concreta	blue-black grosbeak		X					X
	Passerina cyanea	indigo bunting	X		X				
Emberizinae	*Arremon aurantiirostris*	Orange billed sparrow		T		X			
	Arremonops chloronotus	green-backed sparrow				T			
	Sporophila aurita corvina	Variable seedeater	X	X		X	X		
	Sporophila torqueola	white-collared seedeater		X					
	Tiaris olivacea	Yellow-faced grassquit	X		X				
Icteridae	*Dives dives*	Melodius blackbird	X		X				
	Quiscalus mexicanus	great-tailed grackle	X						
	Icterus dominicensis prosthemelas	black-cowled oriole	T	X		T	X		
	Icterus spurius	Orchard oriole			X		X		
	Icterus m. mesomelas	Yellow-tailed oriole						X	
	Icterus galbula	Baltimore oriole			X		X		
	Amblycercus h. holosericeus	Yellow-billed cacique		X	T	T		X	
	Psarocolius montezuma	Montezuma oropendola	T	X	T	T	T	T	X

Site No.	**1**	**2**	**3**	**4**	**5**	**6**	**7**
No. of species recorded on transect	30	35	27	36	19	25	17
Ranked index of avian species richness	**3**	**2**	**4**	**1**	**6**	**5**	**7**
Total number of species recorded from area	62	61	60	68	57	54	57

Discussion of bird species richness data

A total of 193 species were recorded during the March/April 2000 survey period. Sharpe (1998) recorded an additional 31 species during his November fieldwork making a total of 224 species recorded in total from the GSCP area. This represents about 41% of the all species know to occur in Belize given a total of approximately 540 verified records (Miller & Miller 1998). The overall number of species also equals that recorded during a rapid assessment carried out in the Columbia River Forest Reserve (Parker *et al.* 1993) over a much larger elevational range, 350-750m, as opposed to 0-25m in GSCP. It also suggests that when further work is carried out in the hill forest now known to be part of GSCP the overall number of species of birds recorded in the area is likely to rise substantially.

The species that Sharpe (1998) recorded that were not found during this work were mostly migrants – many of them warblers – and much of the difference could be due to the different stages of the north/south migration between North and South America during which the two surveys were carried out. Many of the birds that were recorded during this work and had not been recorded by Sharpe (1998) were the less conspicuous species and this is simply due to more time being spent in the field.

The species richness indices generated from the transect counts suggest that numbers of bird species are closely tied into the quality of habitat with the first 4 sites. The total numbers of bird recorded from each site was, however, much greater than those recorded on the transects. These total counts were not done in a comparative manner but the difference was predominantly due to the comparative ease of seeing birds in cleared areas e.g. from the river, or swamp, and the differing species compositions of areas in general. At Site 7 where species richness on the transects in the forest was very low due to poor habitat quality, there were however, other mangrove and coastal species present which were unrecorded elsewhere. The same applied to Site 1 where there were areas of hill forest leading into the Maya Mountains forest reserve. However, the majority of the Sites (2 – 6) were similar in major habitats, and variation there was mostly attributable to past disturbance of vegetation from logging and agriculture.

Noticeably more game birds were present in the areas furthest from habitation e.g. currassows (*Crax rubra*), and tinamous (Tinamidae) despite habitat often being more scrubby. Also, the highest species richness of birds recorded corresponded to the highest ranked site from a vegetation standpoint, excluding Site 1 which directly abuts a project community. Once more education, awareness and alternative income generation must be part of the integrated solution to the problem of unsustainable hunting of game birds. This must be, in part, building an appreciation of the important ecological role of birds like currasows –

Figure 16: Juvenile harpy eagle (*Harpia harpyja*) perched in the crown of an emergent tree.

Figure 18: Mottled owl (*Strix virgata*)

Figure 17: Red-lored parrot (*Amazona autumnalis*) with owner in Indian Creek village.

Figure 19: Grey-necked wood rail (*Aramides cajanea*) at water's edge

all photos E. Bowen-Jones/Fauna & Flora International

Figure 20: Turkey vultures (*Carthartes aurata*) are one of the species that are found throughout the GSCP area, from farmland – this individual is sunning itself on a fence – to primary forest.

Figure 21: Laughing falcons (*Herpethotheres cachinnans*) are the most conspicuous of the 6 falcon species recorded from the GSCP and are easily recognised by their call.

Figure 22 (above): A white whiskered puff-bird (*Macacoptila panamensis*), one of the stricter forest species.

Figure 23: Slaty-tailed trogons (*Trogon massena*) are found in both secondary and primary forest.

which are locally extinct in the west of the corridor - and guan (*Penelope purpurascens*), which were not recorded during the survey and are reportedly now very scarce[R11]. This effort should also be targeted at schools to encourage children from the communities adjoining the GSCP area to find other means of entertainment rather than using smaller birds as target practice with their slingshots.

The killing and capture of animals from the GSCP and other areas of forest for recreation is another factor that requires careful strategies to be put in place. During the survey a juvenile harpy eagle (*Harpia harpyja*) – **Fig. 16 -**was recorded from GSCP land, which may form part of its hunting territory, probably ranging from the Maya mountains. This species has been recorded less than 5 times in Belize according to Miller & Miller (1995), is listed as threatened by IUCN (1998) and is nearly extinct through much of Central America. However, verbal accounts collected by the author suggest that more than one of these rare, slow breeding forest eagles have been killed by local people in the recent past. This has occurred on both sides of the Guatemala/Belize border, with one report being from the project area in the last year. They were not killed for money but on one occasion because people thought the bird a threat to human life. With the removal of much of this species' prey base by human hunting, potentially restricting this species' breeding ability, such losses could become crucial[R12].

A second threatened species is reported from GSCP's hill forest during December/January. This is the yellow-headed parrot (*Amazona oratrix*) which may be using seasonal food resources in this area. The species is being captured throughout Belize, some for the pet trade that has made it virtually extinct in the wild in Mexico. Although there have been no specific reports of this problem from GSCP, protection efforts should focus on this species once more information has been established about its status in the area. Pet parrots are fairly common in Toledo, and are present in the project communities (**Fig. 17**). Again this should be a focus for public awareness efforts, but there should also be an evaluation of the potential of alternative income generation by breeding using parrot boxes, and supplying to the US given the proximity of this market[12].

Figs. 18 – 23 illustrate some of the variety of birds found in the GSCP area.

5. Abundance/species richness data for bats

The summary data for the abundance and species richness of bats caught during the survey period is given in Table 5 below. A total of 23 species were recorded from the GSCP survey work. With harp traps, and deployment of mist-nets at canopy levels plus more work in the foothills of the Maya mountains this number is likely to rise substantially, however, as this stands it is 32% of the 70 species recorded from Belize by McCarthy (1998).

The overall ranking for bat abundance is:

1. Site 1
2. Site 3
3. Site 6
4. Site 7
5. Site 2
6. Site 4
7. Site 5

And the overall ranking for bat species richness:

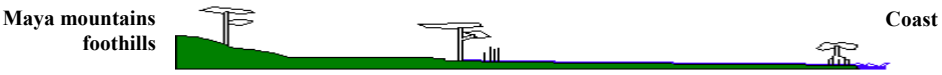
1. Site 2
2. Site 6
3. Site 1
4. Site 5
5. Site 4
6. Site 7
7. Site 3

Recommendations:

[R11]Target a broad stakeholder group for awareness and education including school children, from the perspective of broadening their general appreciation for the environment and dispelling some of the abiding myths about certain species.

[R12]Assess the feasibility and desirability of local parrot farming based upon the South American experience and taking into full account the biology of the species involved, as well as the permit system that would be needed in order to undercut illegal parrot trading. Link into, expand, and improve the work done by Belize Zoo on the latter issue.

Table 5: Bat species richness and abundance recorded during GSCP survey 2000



Site No.				1	2	3	4	5	6	7
Taxon	*Species* *Latin name*	Common name								
Chiroptera		**Bats**								
Emballonuridae		*Sac-winged Bats*								
	Rhynchonycteris naso	proboscis bat			0.23					
	Saccopteryx sp.	white-lined bat		X	X			X	X	
	Balantiopteryx io	least sac-winged bat	LRn/t	X						
Mormoopidae		*leaf-chinned bats*								
	Pteronotus parnellii	common mustached bat		2.11	0.11	1.92	0.8	0.07		
Phyllostomidae		*Leaf-nosed Bats*								
Phyllostominae	*Micronycteris sylverstris*	tricoloured bat?		0.17	0.11				0.56	
	Micronycteris microtis						0.16			
	Tonatia brasiliense	pygmy round-eared bat		0.17				0.07		
	Tonatia saurophila	stripe-headed round-eared bat					0.16			
Glossophaginae	*Glossophaga soricina*	common long-tongued bat					0.16	0.07	0.09	
	Golssophaga morenoi?	western long-tongued bat			0.22					0.67
Carolliinae	*Carollia perspicillata*	Seba's short-tailed bat				0.48				
Stenodermatinae		*Tailless Bats*								
	Sturnira lilium	little yellow-shouldered bat			0.22					
	Artibeus lituratus	great fruit-eating bat			0.68			0.07	0.46	0.67
	Artibeus intermedius	intermediate fruit-eating bat			0.11			0.28	0.28	0.67
	Artibeus jamaicensis	jamaican fruit-eating bat		0.11	0.22	0.32			0.09	0.67
	Artibeus toltecus	Toltec fruit-eating bat		0.17					0.09	
	Artibeus watsoni	Thomas' fruit-eating bat		0.05			0.48			
	Uroderma bilobatum	common tent-making bat			0.11		0.16	0.07	0.84	
	Platyrrhinus helleri	Heller's broad-nosed bat						0.07	0.09	
	Vampyrodes caraccioli	great stripe-faced bat							0.19	
	Vampyressa pusilla	little yellow-eared bat					0.16			
Desmodontinae		*Vampire Bats*								
	Desmodus rotundus	common vampire bat		0.11						
Vespertilionidae		*Plain-nosed Bats*								
	Myotis elegans	elegant myotis			0.22					
Relative abundance index (total per 100ft net hour)				2.89	2.23	2.72	2.08	1.4	2.69	2.68
Ranked abundance index				**1**	**5**	**2**	**6**	**7**	**3**	**4**
Number of species recorded				9	11	4	7	8	10	5
Ranked bat species richness				**3**	**1**	**7**	**5**	**4**	**2**	**6**

Netting sites were selected as potentially optimal flyways in the judgement of the author's past experience working with bats in the Neotropics and elsewhere. The results were limited by the need to be able to carry in the equipment, and therefore the use of mist nets but no harp traps. Thus, the abundance results can only be regarded as relative in terms of the types of bats that can be caught in mist nets e.g. the Neotropical fruit bats and not many Vespertilionids. However, in terms of providing information on the variation in abundance the results are probably representative of the taxa. The diversity information was similarly limited, although additional data was generated by visits to caves near Site 1 at the bottom of the Maya mountains and daylight observation of some species of sac-winged bat near the Golden Stream river.

Figure 24: *Balantiopteryx io* is a small sac-winged bat that is considered threatened. So far it has been recorded once in GSCP from the caves in the foothills of the Maya mountains.

Figure 25*:Pteronotus parnellii* is one of the smaller 'fishing bats'.

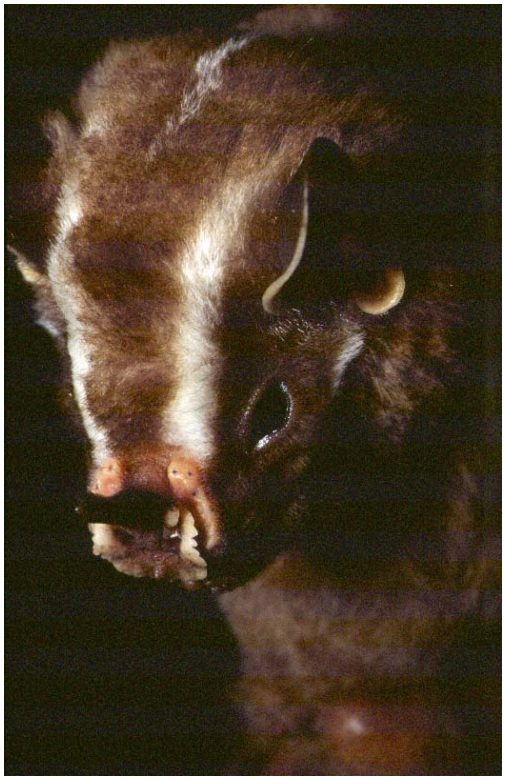


Figure 26: *Vampyrodes caraccioli* is a large Neotropical fruit bat, which along with others of the same family is an important seed disperser.

Figure 27: *Tonatia saurophila* is one of the few larger leaf-nosed bats that was recorded from GSCP.

all photos E. Bowen-Jones/Fauna & Flora International

Figure: 28: *Tonatia brasiliense* is a smaller member of the same genus of the leaf-nosed bat family. This was the only individual recorded during the survey.

Figure 29: *Rhynchonycteris naso* is another sac-winged bat, which uses the grizzled pattern on its back as camouflage when roosting on tree-trunks.

Figure 30: This nectar-feeding bat belongs to the genus *Glossophaga*. There are a number of highly similar, small species in this taxa, all of which are important as pollinators.

all photos E. Bowen-Jones/Fauna & Flora International

The total number of bats caught in a night varied from 54 to 0 individuals, the former being composed of over 30 individuals of *Pteronotus parnellii* caught at Site 1. These were presumed to have emerged from a nearby roost, since they all hit the net within 10 minutes of one another. At the other extreme Sites 3 and 7 yielded nights of 0 and 2 bats caught in a night. The first of these was probably due to the state of the moon, which became a limiting factor in positioning of nets when over half full. The second probably was probably due to an almost total absence of flyways – making netting difficult, and food – due to lack of both insects and fruit - in the dense scrub of Site 7 (Block 127).

In order to try and compensate for variations in the amount of time nets were up, and the net area used due to these physical and environmental constraints, the data was converted into records of the number of bats captured per 100ft of net per hour. All nets were regarded as set at the same height because all were below the canopy at a maximum of 6m, and therefore the difference in capture rates and species trapped was assumed to be minimal.

Discussion of bat abundance/species richness data

Bats are easier to sample in a quantitative manner over a short time period than non-volant (flying) mammals, even if in a limited fashion, but they sometimes also display different species richness/abundance patterns.

In this case the highest recorded diversities are at sites where abundance was low and vice versa. This is due to the fact that often primary forest areas have more niches available to a greater range of species, but as a consequence of this and inter-related factors the actual number of individuals per species recorded is lower. Additionally, greater effort in primary forest will continue to produce more 'rare' species, whereas the effort/species richness curve levels off faster in secondary habitats. In this case the most abundant sites including Site 1 and 3 were those where large numbers of *Pteronotus parnellii* (**Fig 25**) were present. However, species richness in the second of the two sites was the lowest for the entire corridor. The sites that ranked high in the vegetation analysis (1 – 4) ranked as medium abundance and higher species sites with the exception of Site 3 where capture rate and hence species richness was extremely low. This was probably attributable to the lunar state (nearly full) more than any other factors. These data also have the advantage of being more closely linked to habitat than other measures of biodiversity based on larger taxa of mammals and birds, since there is no reported hunting of micro-bats for commercial/consumptive purposes in the region.

Threat categories for the IUCN are in the process of being re-worked, and will come in some cases from relevant Action Plans. In this case the *Global Action Plan for Microchiropteran Bats* is in its final pre-publication version (Hutson *et. al. in press*) and the authors recognise both *Balantiopteryx io* (**Fig. 24**) and *Myotis elegans* as all Lower Risk near threatened. For the majority of these species, however, precise information on regional distribution, populations, and threats is lacking, and Reid (1997) lists species such as '*rare to locally common'*. Many mammalogists consider that rarity on its own should be the basis of threat categories for bats, and many data deficient species are likely to be far more threatened than currently thought (A. Entwistle *pers. comm.*). Further monitoring and investigation of bats should be a constituent of ongoing work in the GSCP area, and could form a good educational tool for both permanent and outreach exhibits[R13].

The species richness of bats recorded is also heavily skewed towards the Neotropical fruit-bats (Stenodermatinae) – **Fig. 26**. Once more this is in part due to the capture techniques used, but this also probably represents the bat fauna that can best adapt to modified habitats such as those seen in the GSCP area. Neotropical fruit bats are in general leaf or foliage roosters, and do not necessarily require tree cavities to survive.

This is in contrast to the larger Phyllostomids – leaf-nosed bats – **Figs. 27 & 28**, which are noticeably absent from the recorded data, and were not observed flying either below or above the canopy. Thus, there

[R13]Use bats as examples of diversity and variety of ecological functions in apparently similar groups, as part of the outreach and awareness programmes.

may be a depauperate bat fauna due to the habitat alterations from logging and agriculture in the regions near past. However, in the west of the corridor where the limestone hills begin there are caves that with further work, and other techniques may yield more species of smaller Emballonurids – sac-winged bats (**Fig. 24 & 29**), Vespertillionids – plain-nosed bats, etc. Additionally, as the number of larger, older trees increases within the corridor through the conservation measures therein, numbers of larger, forest-dwelling species such as Phyllostomids may be seen to increase, increasing the present species richness of bats. This diversity is of great importance in terms of ecological function, and healthy populations of Stenodermatinae, often caught with fruit in mouth, plus Glossophaginae (**Fig. 30**) – specialist nectar feeders - and hence good pollinators - is a good sign in terms of forest regeneration.

6. An incidental list of reptiles, and amphibians

This was compiled with identification where possible, to add to the general biodiversity information available at the site. Table 6 below provides summary details of the species recorded:

Table 6: Incidental reptile and amphibian records from GSCP survey 2000

				Presence /Absence (X = present, R = reported)						
				Maya mountain foothills						Coast
Site No.				**1**	**2**	**3**	**4**	**5**	**6**	**7**
	Species									
Taxon	***Latin name***	**Common name**	**Threat category**							
Reptilia										
Crocodilia	*Crocodylus moreletii*	Morelet's crocodile	DD				R	X	X	
Tesudines	*Dermatemys mawii*	Hickety/ Central American river turtle	EN					X	X	
Squamata -Sauria										
Corytophanidae	*Basiliscus vittatus*	Striped basilisk		X		X		X	X	
Iguanidae	*Iguana iguana*	Bamboo chicken/ green iguana					X	X	X	
Polychrotidae	*Norops sp. lemurinus?*	Ghost anole		X	X		X	X		
Scincidae	*Eumeces sumichrasti*	Sumichrast's skink		X		X	X			
	Sphenomorphus cherriei	Brown forest skink				X	X	X		
Teiidae	*Ameiva festiva*	Middle american ameiva					X			
Squamata - Serpentes										
Boidae	*Boa constrictor*						R		R	
Colubridae	*Leptophis ahaetulla*	Green parrot snake						X		
	Tretanorhinus nigroleuteus	River snake								
	Pseustes poecilonotus	Puffing snake			X					
Elaphidae	*Micrurus sp.*	Coral snake			X	X	X			
Viperidae	*Bothrops asper*			R			R	R		
Anura										
	Bufo marinus	Marine toad		X	X					
	Bufo campbelli	Rainforest toad		X			X			
	Eleutherodactylus rugulosus	Central American rainfrog					X			
	Rana vaillanti	Rainforest frog				X	X	X		
	Rhinophrynus dorsalis	Mexican burrowing frog		R						

Amphibians and reptiles were recorded from transects, mist net, camera trap, and bird observation sites. Identification was made in situ if possible, and photographic records were made where feasible in order to confirm these identifications, and enable others. A selection of photos of these records is given from **Figs. 31 to 34**).

Figure 31: A favorite food species for local and international markets alike, the green iguana (*Iguana iguana*) has been present in good numbers in GSCP, although following recent poaching the population appears to be temporarily diminished. It may also make an excellent candidate for income generation through ranching for both eggs and meat.

Figure 32: Venomous snakes are not common in GSCP, but the most commonly encountered are coral snakes (*Micrurus* sp.).

Figure 33: Other non-venomous snakes present include the semi-arboreal parrot snake (*Leptophis ahaetulla*).

Figure 34: the Central American rain-frog (*Eleutherodactylus rugulosus*) is one of 5 frog species from GSCP. More species will be found when additional surveys take place in the Maya mountain foothills.

Discussion of amphibian/reptile data

The above information is to be used as an initial step towards an eventual complete inventory of these two important taxa. Due to the constraint of time, money and manpower the only data collected during the GSCP survey 2000 was composed of incidental records. However, it is clear that with a more concerted effort on the herpetological side many more than the 19 species listed above would be recorded i.e. more than one species of *Norops*. Other anurans will undoubtedly be recorded from the land that was not surveyed, and is now confirmed as being on our property, further up in the Maya mountains. The latter is the area in Belize that has produced most new records of frogs in the last decade.

The Golden Stream river has a high population of iguanas (which may have been significantly reduced from their illegal capture by Guatemalan commercial poachers), and its banks provide nesting sites for these animals away from easy human access. Iguanas (*Iguana iguana*) – **Fig. 31** -and their eggs are commonly eaten in local communities, but all accounts suggest that their numbers have decreased over recent time. This is probably due to unsustainable off-take – being fuelled by sale in shops and restaurants – and the trend for this species may be following that of the hickety turtles (*Dermatemys mawii*), which according to local consumers are locally extinct in many of Toledo's larger rivers where they were once plentiful.

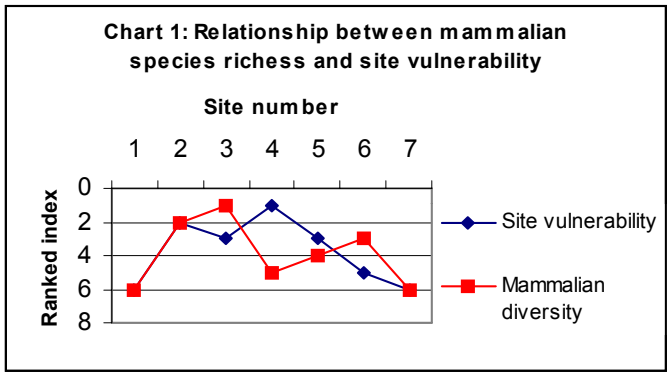
Apparently past hunting of crocodiles in the area reduced the populations in Golden Stream. The highest density of crocodiles in the country, however, is reported from Paynes Creek National Park less than 10 miles up the coast. Given the ability of both American (*Crocodylus actus*) and Morelet's (*C. moreletii*) crocodiles to tolerate salt water, it may be that the two sub-adult individuals seen during the survey originated from this source. Additionally, a large adult estimated to be about 3m in size (two independent sightings) frequents an area near site 4, and the potential for re-establishment of a breeding population is clear. This should be the subject of further monitoring activities.

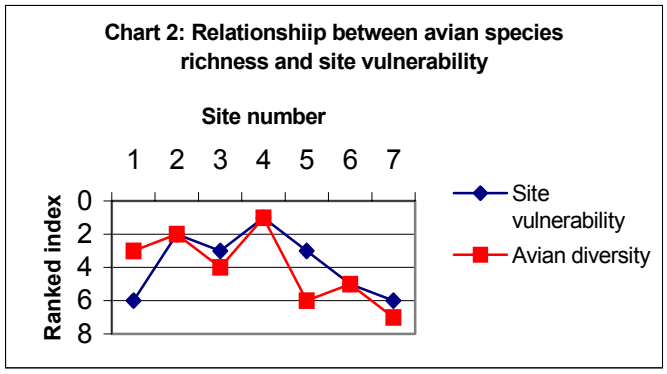
Comparison between the seven areas surveyed

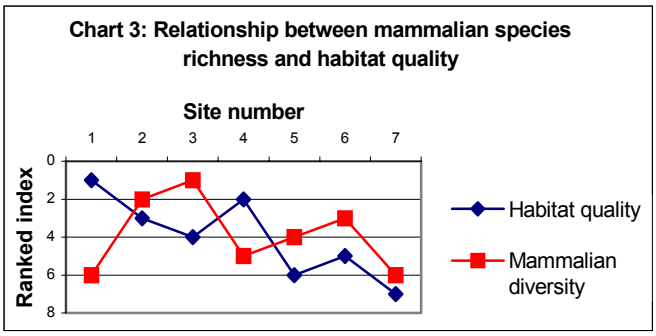
Following the methods used in Bowen-Jones *et al.* (2000) the indices created from each of the various biodiversity analyses were compared using rank correlations to assess whether there was significant variation in the biodiversity evaluated during the survey. The relationships between such variations in biodiversity and hunting pressure and habitat quality were then examined.

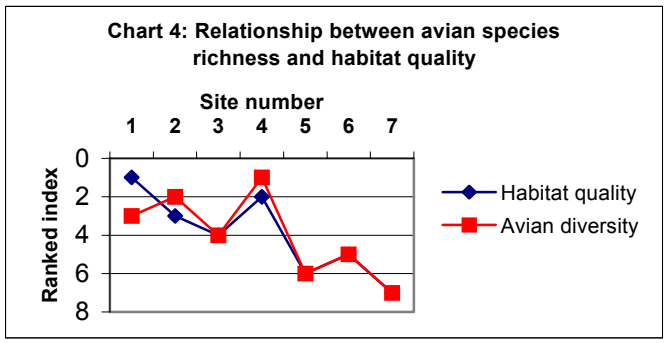
Table 7: Summary table of biodiversity indices generated per site surveyed, with mean species richness ranking and overall site value added. The latter is calculated as the mean of habitat quality, site vulnerability (an index of hunting and access), and species richness ranking).

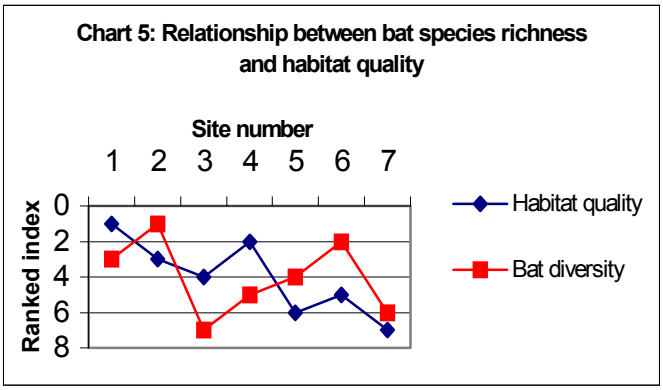
Variable	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7
Habitat quality	**1**	**3**	**4**	**2**	**6**	**5**	**7**
Site vulnerability	**6**	**2**	**3**	**1**	**3**	**5**	**6**
Mammalian species richness	6	2	1	5	4	3	6
Avian species richness	3	2	4	1	6	5	7
Bat species richness	3	1	7	5	4	2	6
Bat abundance	1	5	2	7	2	3	4
Mean species richness index	2	0.83	2.16	1.83	2.3	1.67	3.16
Species richness ranking	**4**	**1**	**5**	**3**	**6**	**2**	**7**
Overall site value	3.7	2	4	2	5	4	7
Ranked site value	**3**	**1**	**4**	**1**	**6**	**4**	**7**

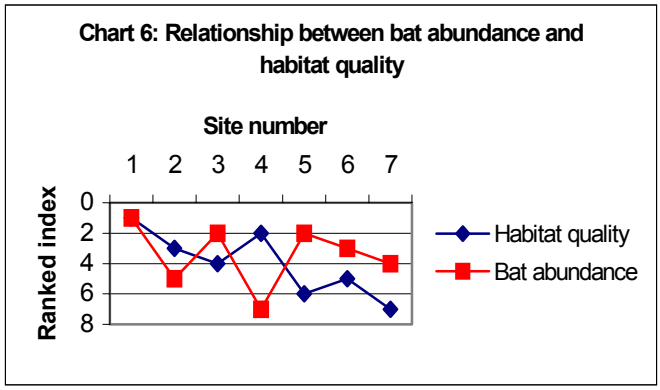












Quantitative comparison

All likely relationships between variables were tested statistically, but the only significance was found between avian species richness and habitat quality. This was the case even when using the relatively blunt statistical instrument of Spearman's rank correlation (non-parametric): r = 0.893 significant at 99% confidence limits. A further relationship between avian species richness and site vulnerability was found to be nearly significant at r = .64, higher than the mammalian species richness versus site vulnerability that was non-significant at r= 0.51 despite what one might expect. However this is probably due to the low sample size involved. Finding significance at a sample size of seven indicates a very strong correlation given that it is the minimum usually allowable for statistical evaluation.

Discussion of variation in biodiversity throughout the GSCP corridor areas surveyed, and the conservation implications therein

Relationships between biodiversity variables measured

As can be seen from the above results the relationships between the variables examined in this study can be differentiated, and the most obvious patterns are between:

- Avian species richness is strongly positively correlated with habitat quality. This is not particularly surprising given the suggested use of birds as indicators of good habitat – as suggested by various authors including Parker *et al.* (1996). However, in this case the habitats included are those of varying quality within secondary forest, making the results more interesting. [R14]
- Mammalian species richness, habitat quality and vulnerability appear to be correlated from Charts 1 and 3. This is the most favoured taxon for food, from those sampled, and one would expect correlations (although reptiles may be just as important for local consumers, who may also be displaying equal preference for iguanas and turtles as paca and armadillo). However, once more low sample size probably accounts for this not standing up to statistical investigation.

Factors limiting biodiversity within the GSCP area therefore include:

Habitat Quality: Extrapolating from these results, it is possible to suggest that underlying differences in biodiversity in each sample site are due to habitat quality. This has shown to be a critical determinant of species richness by numerous other authors, and this process is again demonstrated here in the less-hunted taxa – birds and bats.

Hunting: At the moment, though, sites are being heavily affected by hunting and disturbance, depending on the vulnerability of each area, as seen in the mammalian species richness results, and from secondary evidence. Thus, the area does possess the faunal densities that one would expect from a 'natural' or undisturbed regeneration system.

Habitat regeneration: Additionally, the amount of past habitat alteration, including the past presence of heavy machinery, is probably limiting the regeneration of vegetation in the GSCP corridor. Habitat regeneration in the GSCP area is probably also limited by the degree of hunting pressure. The worst habitat - thick scrub areas - within the corridor is now the last refuge for game birds such as currasow. Together with high availability of fruit, the difficulty of hunting ground-dwelling birds in these areas means that they are relatively safe. However, this species, in common with other preferred meat species such as paca, have a very important role in distributing seeds. In Ecuador this has been found to include the most important timber species (chanul - *Humirastrum proceum*) has virtually ceased to reproduce, as a consequence of the currassow being made locally extinct and similar ecological links are likely to be found within the GSCP ecosystem.

Given the problem with over-hunting in the survey area, and the potential knock-on effects for long-term ecosystem disruption the following suggestions have been made to link into management planning:

Potential zonation and use options for the GSCP corridor

- Due to the above described interplay of factors, a general hunting ban/moratorium should be enforced throughout the corridor – possibly for an initial two years, after which it may be possible to allow limited, controlled hunting for non-commercial purposes by local villagers.
- Monitoring of wildlife populations will need to be instated in order to gather data that will make sound decision making about future controlled hunting possible.
- A core area should be established (using further data from the BLE and hill forest areas) in the least accessible, and most biodiverse areas i.e. around Sites 2, 3 and 4. This is based upon a calculation of the mean – compromise -between habitat quality, site vulnerability, and ranked mean species richness (see **Table 8**).
- Although Site 3 only ranks fourth – probably due to the lack of water – it is sandwiched between the two best sites, and also in the area that contains the GSCP wetland. This is already known to harbour species found nowhere else in the reserve, and at other times of year may become even more important providing habitat complementary to the other two sites.

[R14]Use birds as the basis of monitoring of habitat regeneration, training rangers in bird identification skills.

- For this core area even low impact sustainable use such as ecotourism should be carefully evaluated, and probably minimsed, until wildlife populations have been allowed to recover elsewhere.
- In effect these three sites will act as 'sources' for the recovery of low-density animal populations in the current 'sink' areas providing that there is adequate enforcement in the corridor as a whole.
- The rest of the corridor should be made available to true local stakeholders in a limited fashion, which engenders responsibility. This could be in the form of setting up a rotational system whereby certain areas with healthy wildlife populations are made available for non-commercial, GSCP licensed hunters who can take a pre-agreed number of animals of non-endangered species. This would, of course, require careful monitoring and would not be a catchall solution. However, in combination with tree replanting/nursery, and iguana/paca ranching schemes, could form a model approach to monitor and refine over the long-term.[R15] If such a system were successful and propagated to other nearby areas, it could become an important tool in creating a functional sustainable-use buffer zone to national protected areas in the Maya Mountains such as Bladen Nature Reserve. Thus, the concept of a landscape approach to conservation within Belize could be promoted.
- However, with logging currently taking place on the northern side of the border, it will be crucial to design a final core area that links with well protected land on the BLE side of the river, containing crucial groups of howler monkey etc.
- At the same time, some buffer zone areas will have to be established on the logging concession side, depending on the level of timber extraction, and infrastructure, and hence accessibility after operations have ceased.
- In Block 127 (Site 7), the government should be encouraged to put the adjoining production areas into conservation management – perhaps linked into habitat rehabilitation/ tree planting with a view to community led, sustainable forestry. This is something that some individuals in the Toledo Forestry Department could become involved with, and indeed might welcome.
- If the concessions to the north of GSCP are exploited to the extent that Block 127 is they will become virtually worthless scrub, which will either be cleared for citrus/cattle, or will take many years to regenerate into even passable wildlife habitat, much less viable forestry areas.
- With the current emphasis on making the most out of increasing numbers of tourists, and ecotourists to Belize, the government should be involved with coalitions of Toledo based NGO's in promoting the region.[R16]
- Toledo is the most interesting area of Belize for those interested in Mayan cultures as well as the natural world. There will be increasing economic value to the region, and country in using its natural resources in a sustainable manner, that maintains Maya societies, and Maya landscapes in a manner that is aesthetically and spiritually appealing to visitors and local people alike.

[R15] Further analysis of the potential systems to put in place here, are likely through the developing FFI Consumptive Wildlife-use Programme.

[R16]FFI/GSCP should form sound working relationships with other similar local NGO's in order to promote Toledo, and further conservation in the district.

Conclusions

1. Given the constraints that the team was working under the biodiversity survey undertaken to investigate the overall biodiversity of GSCP and variations therein was a success.
2. A key area in the north of GSCP was not surveyed, due its presence within the CLCC land parcel being discovered towards the end of the author's work in the area.
3. Key taxa that indicated the overall biodiversity of the area were successfully examined yielding interesting information including:
4. Government Block 127 was the worst site examined in terms of habitat quality, avian species richness, and overall biodiversity value.
5. Sites 2,3,and 4 form the best area in terms of lowest hunting pressure and access combined with highest biodiversity.
6. GSCP contains a minimum of thirty-two species of medium/large mammal, 224 species of bird (41% the national total), 23 species of bats (32% the national total), and 18 species of reptiles and amphibians. These figures will rise with further work in the hill forest area now known to be part of GSCP.
7. Amongst these are several globally threatened species, and many other near-threatened ones including jaguar (*Panthera onca*), Baird's tapir (*Tapirus bardii*), West Indian manatee (*Trichechus manatus*), harpy eagle (*Harpia harpyja*) and Hickety river turtle (*Deratemys mawii*).
8. The GSCP forest is composed of a mosaic of regenerating habitats recovering after differing logging and agricultural regimes. Some areas contain a variety of timber tree species that may be threatened by trade (S. Oldfield *pers. comm*) and hold potential for local income generation.
9. Major threats to biodiversity come from unsustainable local and international commercial game hunting as well as logging and habitat loss along the GSCP borders.

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