State of the Protected Areas Report 2021

An assessment of Bladen Nature Reserve, Golden Stream Corridor Preserve and Maya Mountain North Forest Reserve

YA'AXCHÉ
CONSERVATION TRUST

March 2022

Harmony between nature and human development for the benefit of both

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Cover photo. Bladen Branch River in the Bladen Nature Reserve, Ya'axché Conservation Trust

Citation:

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Acronyms

ASPT-CR	Average Score Per Taxon- Costa Rica
BNR	Bladen Nature Reserve
BRIM	Biodiversity, Research, Inventory and Monitoring
BSR	Biodiversity Synthesis Report
CCAD	Central American Commission for Environment and Development
CRFR	Columbia River Forest Reserve
DBH	Diameter at Breast Height
EC	Electrical Conductivity
FD	Forest Department
GSCP	Golden Stream Corridor Preserve
IUCN	International Union for Conservation of Nature
KBA	Key Biodiversity Area
MGL	Maya Golden Landscape
MMM	Maya Mountain Massif
MMNFR	Maya Mountain North Forest Reserve
NPAS	National Protected Areas System
NTFP(s)	Non-timber Forest Products(s)
NTU	Nephelometric Turbidity Unit
PAM	Protected Areas Management
PA(s)	Protected Area(s)
PAP	Protected Areas Program
PPA	Private Protected Area
PTA(s)	Priority Target Areas
SPAR	State of the Protected Area Report
SVAP	Stream Visual Assessment Protocol
TFCG	Trio Farmers Cacao Growers Limited
Ya'axché	Ya'axché Conservation Trust

Preamble

Ya'axché's programs have been undergoing rapid growth over the last 6 years with extensive development in capacity and strategic direction. Its current program structure is now far from its humble beginnings but always staying true to its roots and its vision for conservation and livelihoods in the Toledo District, and more specifically, the Maya Golden Landscape (MGL). Within the last 14 years, Ya'axché has been able to add two protected areas to its Protected Areas Program, a major achievement in its relentless effort to accomplish its vision of *'Harmony between nature and human development for the benefit of both'*.

As part of its drive for evidence-based decision making and adaptive management approach, Ya'axché first introduced biodiversity research and monitoring in 2009 as a pilot with its first assessment of biodiversity across the MGL published in 2010—the first Biodiversity Synthesis Report. The main objective of this report was to provide Ya'axché and the general public with a snapshot of the status of biodiversity across the landscape, which included a mosaic of protected areas and community farmlands as study sites. Results of data analysis were then used to target priority areas for conservation action and/or education and awareness campaigns. This report had a 9-year run with its last issue published in 2019.

During the same time period, a number of changes took place within the Protected Areas Program (PAP) including the addition of more study sites and additional alignment with national priorities in research and monitoring. The research and monitoring program slowly transitioned to the Science Program within the wider PAP by having its own structure and program targets. Human resources gaps were filled, and the efficiency and effectiveness of management activities increased significantly. However, the only measure of efficiency and effectiveness in management of the PAs remained the Biodiversity Synthesis Report (BSR) with no publicly available information on other aspects of Protected Areas Management (PAM), such as enforcement and compliance activities. This gap is now addressed through the development of the first State of the Protected Areas Report (SPAR) for 2020.

In an effort to accommodate the growing need for management effectiveness assessments of its protected areas program, Ya'axché took the decision to incorporate a SPAR to its annual reporting and integrate the analysis of Biodiversity Research, Inventory and Monitoring (BRIM) as a tool to assess for status of PAs and the biodiversity within them. Notwithstanding the integration of the BSR into this report, research and monitoring activities outside the PAs will continue to be assessed and is presented as the Farmscape Biodiversity Report for 2021. Note that information presented in this report in some cases may cover multiple years serving as a reference point for subsequent reports.

Executive Summary

Ya'axché privately manages the Golden Stream Corridor Preserve (GSCP) and co-manages the Bladen Nature Reserve (BNR) and the Maya Mountain North Forest Reserve (MMNFR) along with the Government of Belize. For the last 24 years, Ya'axché has been actively involved in Protected Areas Management (PAM) and has grown to become one of the leading organizations in Belize promoting sustainable livelihoods, as well as conservation of natural resources. With the growth of the organization came the need for adequate assessments of management effectiveness, particularly within the Protected Areas Program (PAP). This report is the first of its kind at the organization and is intended to provide a summary of the status of multiple target areas relevant to the management, monitoring and conservation of resources within the Protected Areas (PAs).

Seven (7) Priority Target Areas (PTAs) have been selected for this report. These target areas are not absolute and may include other targets of interest in future iterations of this report. For this report we include: (i) Habitat Indicators, (ii) Rare, Threatened, Socio-Economic, and Culturally Important Species, (iii) Broad Ecosystems and Land Use Change, (iv) Ecosystem Services, (v) Sustainable Natural Resource Use, (vi) Enforcement and Compliance, and (vii) Biodiversity Knowledge for Adequate Management. All seven PTAs were chosen based on their ability to indicate changes in conditions over time and whether there was data available and/or baselines in the process of being established. A combination of data analysis and expert opinion guided the assessment of conditions thereafter.

Based on the 2021 assessments, **Habitat Indicator Species** remains *stable and in good condition* across all three PAs. While there is limited data on **Rare, Threatened, Socio-Economic, and Culturally Important Species**, the data suggests that these species remain in *good condition* across all three protected areas for the second-year assessment. **Broad Ecosystems and Land Use Change** show *negligible changes* for GSCP and BNR with *moderate concern in a deteriorating trend* for the MMNFR. **Sustainable Natural Resource Use** remains stable within *moderate concern* for the GSCP and is of *moderate concern with a deteriorating trend* in MMNFR. **Enforcement and Compliance** is *stable and in good condition* for GSCP with *moderate concern* for BNR, but with *stable conditions* and *moderate concern with a deteriorating*

trend for the MMNFR. **Biodiversity Knowledge for Adequate Management** has been improving within the protected areas with data providing sound evidence of good governance and conservation efforts for flora and fauna. The addition of camera surveys in the BNR has significantly improved the monitoring of important indicator species. For this reason and for the purposes of this report we consider the status in *good condition with an improving trend*.

The overall assessment of the PAs can be summed as follows: The **Bladen Nature Reserve** remains the most stable protected area with the vast majority of its forest cover intact and its biodiversity in *good condition*. The **Golden Stream Corridor Preserve** also remains *stable with some concern* over activities related to unauthorized extraction of NTFPs. The majority of its land area is currently forested, and its biodiversity is in *good condition*. **The Maya Mountain North Forest Reserve** is the *most unstable* protected area of the three. Most infraction and activities affecting its condition are concentrated in a small portion of the reserve which warrants *moderate concern* due to the deteriorating conditions observed. It still retains most of its land area under forest cover (>95%) despite the concerns.

Introduction
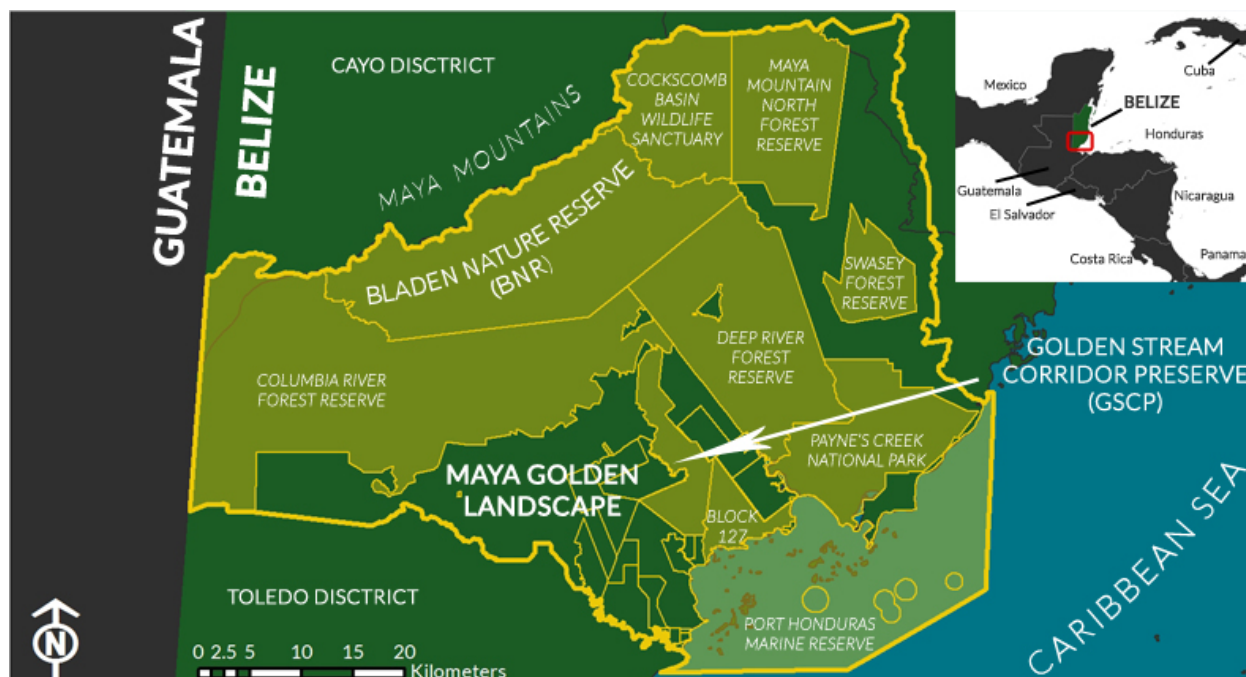
Map 1. Protected Areas within the Maya Golden Landscape in the Toledo District.

Ya'axché's Protected Areas Management (PAM) efforts are focused in the conceptual area of scope referred to as the Maya Golden Landscape (MGL) in the Toledo District, Belize. The MGL is a mosaic landscape comprised of protected areas, private lands, indigenous communal lands and agriculture lands. Ya'axché currently manages and co-manages three Protected Areas (PAs) with three distinct protected area designations under Belize's National Protected Areas System (NPAS). These three protected areas include the Golden Stream Corridor Preserve (GSCP), Bladen Nature Reserve (BNR) and the Maya Mountain North Forest Reserve (MMNFR) (Map 1).

The **Golden Stream Corridor Preserve** is a Privately Protected Area (PPA) in the Toledo District established in 1998 through the efforts of Ya'axché which at the time was comprised of a consortium of local community members and conservation experts, both national and international. The PA encompasses 15,000 acres of lowland broadleaf forests that connect the foothills of the Maya Mountains to the coastal lowlands of Toledo. Ya'axché is fully responsible for all management activities within this PA.

The **Bladen Nature Reserve** is Belize's largest nature reserve with this designation providing the highest level of protection for any PA under the NPAS Act. The PA spans approximately

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100,000 acres in the core zone of the Maya Mountain Massif (MMM). The remoteness of the PA provides an excellent shield from most anthropogenic impacts that other protected areas are affected by. Ya'axché holds co-management of this reserve along with the Government of Belize having major responsibility for the daily operational activities.

The Maya Mountain North Forest Reserve is an extractive reserve in the Toledo District with a long history of management absence up until 2015 when Ya'axché took on co-management of the reserve. By 2021, it had maintained no major extractive activities other than an agroforestry concession regulated by the Belize Forest Department (FD) and managed by Ya'axché on behalf of a community group from the Trio Village. The PA encompasses 36,000 acres, most of which is rugged terrain that remains forested landscape on the eastern flank of the MMM.
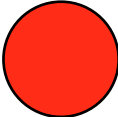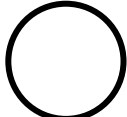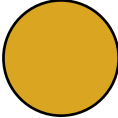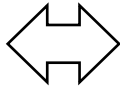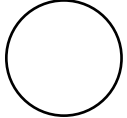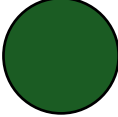
The purpose of this report is to assess the overall condition of all three PAs under Ya'axché's management and to communicate protected area conditions to management partners, donors, stakeholders and the general public. The report also highlights priority areas under Ya'axché's Biodiversity, Research, Inventory and Monitoring (BRIM) strategy as well as the individual PAM plans. It also provides recommendations for future work particularly in the areas of concern as assessed through the process of developing the state of the protected areas reports, periodically.

With the 2020 issue of the State of the Protected Areas Report (SPAR), information spanning up to the first 11 years is integrated into the subsequent issues of this report, forming part of the assessment of up-to-date condition and status. This is more prevalent with biodiversity data which has a consistent data set dating back to 2010. In other cases, such as land use change, and enforcement and compliance, the assessment of status was based on data collected exclusively for the year 2020. The 2020 report functions as a reference point for future iterations of the SPAR. In synthesis, information briefs within the report will at times contain multi-year analysis of data with the assessment year for comparison.
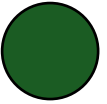
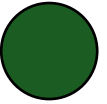The SPAR is summarized in table format for seven target areas based on a synthesis of research and monitoring activities, management activities and effectiveness evaluations, and internal expertise. An Information Brief providing details of specific target areas with relevance to one or more of the three PAs under Ya'axché's management mandate can be found at the end of each section assessment when data is available for publication.

Summary of State of the Protected Areas

In order to standardize the evaluation of condition and trend across target areas, we use the following evaluation key in the table below. The colors represent the condition status of the target area whether that be **significant concern**, **moderate concern** or **good condition**. Arrows represent the trend in condition such as **improving**, **stable** or **deteriorating**. The confidence of the assessment is represented by bold solid circle for **high confidence**, solid line if **medium confidence** or dotted circle if **low confidence** in the assessment. If the organization is still gathering baseline data on a particular target or if data is in the form of a one-time inventory, the trend arrows are omitted. If a target area is **not yet measured** or is **not applicable** to the protected area, the condition is assessed as "**Unknown**" and "**NA**", respectively.

Resource Condition		Trend in Condition		Confidence in Assessment	
🔴	Warrants Significant Concern	⬆	Condition is Improving	⬤	High
🟡	Warrants Moderate Concern	⬌	Condition is Stable	◯	Medium
🟢	Resource is in Good Condition	⬇	Condition is Deteriorating	◌	Low

Summary of Condition and Trends of Priority Targets

Priority Targets	Condition Status/Trend			Rationale
	GSCP	BNR	MMNFR	
I. Habitat Indicator Species	⬌	⬌	⬌	Ya'axché monitors indicator species on 12 transects distributed across a disturbance gradient within the MGL. On the 1-km long transects, point counts for 30 indicator birds and signs of 19 indicator mammals are recorded. The select birds and mammals belong to indicator groups that serve to reflect changes in habitat or underlying ecological conditions. Synthesis Reports with analyses for individual monitoring years can be found on Ya'axché's website. Transect data from GSCP and BNR since 2010 and from MMNFR since 2016 were analyzed for this report. Overall, trends in the index of abundance for habitat indicators in each PA allude to stable environmental conditions over time.
II. Rare, Threatened, Socio-Economic, and Culturally Important Species	🟡	🟢	🟢	The terrestrial ecosystems across GSCP, BNR, and MMNFR support at least 24 threatened mammals, including Yucatan spider monkeys (*Ateles geoffroyi yucatanensis*), and white-lipped peccaries (*Tayassu pecari*) and keel-billed motmots *(Electron carinatum)*. Nine (9) mammal and seven (7) bird species of conservation concern are monitored on biodiversity transects. Threatened birds are consistently low across all three reserves, with significant declines in the yellow-headed parrot (*Amazona oratrix*) in BNR since 2012. The only species with a significant increase in abundance is the mealy parrot in MMNFR. Trends vary for individual threatened mammal species in each reserve with the majority having low but stable indices of abundance over time. The abundance of pumas on GSCP and BNR transects has significantly increased since 2010; meanwhile, jaguar detection on GSCP transects has significantly declined during the same timeframe. Across the three reserves, 23 rare, threatened, and/or culturally important plants have been subject to studies to improve knowledge of

Priority Targets	Condition Status/Trend			Rationale
	GSCP	BNR	MMNFR	
				their distribution, population size, age structure, and phenology in order to inform better management practices at the local and national level. Eight threatened tree species are currently being propagated at Ya'axché's Golden Stream nursery for out-planting into the MMNFR. Of these eight species only two species were out planted in 2021 with a total of 162 seedling on the ground. The mature forest of BNR supports at least 53 species of bats, while 34 species have been documented in the secondary forest of GSCP.
III. Broad Ecosystems and Land Use Change				Ecosystems within the PAs are considered intact for all protected areas. In the case of GSCP, ecosystems remain stable, and many areas are still recovering from historical heavy land use types such as cattle farming and from damages sustained from Hurricane Iris in 2001. The BNR is the most stable of all with all ecosystems intact and negligible changes brought about by natural occurrences, such as flood damage along the banks of the Bladen Branch. The remoteness of this protected area contributes significantly to its preservation. In MMNFR, the lowland broad-leaved wet forest ecosystem is under the most pressure from agriculture activities. However, the area under pressure is small relative to the size of the PA. All other ecosystems within the MMNFR are shielded by rugged terrain and difficulty accessing these. Note: All three PAs retain a large portion of their land mass under forest cover.
				The **GSCP.** Enforcement & compliance patrols continue to deter any major clearings within its boundaries. There are small areas that are being monitored due to farm boundaries now being shared with that of the reserves. While intentional clearing within the reserve along the boundary line is unlikely, the risk of fires from nearby farms is high during the dry months of the year. 2021 saw no incidents of fire escaping into or near the reserve.

Priority Targets	Condition Status/Trend			Rationale
	GSCP	BNR	MMNFR	
				The **BNR** has most of its natural vegetation intact. Apart from negligible changes in forest cover along the banks of the Bladen Branch River, the reserve remains intact.
				In **MMNFR** just north of the agroforestry concession is an area under illegal cultivation which has degraded the forest conditions resulting in unsustainable use of an estimated 300 acres of land within the reserve. This area continues to be active and attracts more incursions and clearings contributing to the deteriorating trend in forest cover in the area.
IV. Ecosystem Services	●	●	●	In 2016-2017, a freshwater bio-assessment was conducted within four watersheds in the MGL (Bol, 2018). The study was done to develop baseline data and potential station sites for continuous monitoring in order to assess long-term trends of the stream condition. All sites ranked either as "good" or "excellent" based on integrated scores for stream physical, biological, and chemical parameters (using SVAP and ASPT-CR scoring criteria).
V. Sustainable Natural Resource Use	⬌	NA	⬇	Resource use in the **GSCP** is restricted to sustainable extraction zones established for NTFPs. Extraction of cohune leaves within two extractions zones is seasonal and monitored by the ranger team. Requests by community leaders remain very low.
				The **BNR,** by virtue of its designation, cannot allow the use of resources within the reserve. As such, sustainable natural resource use is not applicable to this PA.
				The **MMNFR** is by designation an extractive reserve. Since 2015, Ya'axché along with the Trio Farmers Cacao Growers (TFCG) have been developing an agroforestry concession to produce shade-grown cacao. This development has seen the conversion of 936 acres of forested land

Priority Targets	Condition Status/Trend			Rationale
	GSCP	BNR	MMNFR	
				into productive shade-grown cacao. A small number of permits were issued out by FD for the extraction of timber species for personal use. However illegal timber extraction became the primary concern within the reserve in 2021.
VI. Enforcement and Compliance	↔	↔	⬆	The **GSCP** continues to enjoy a relatively high level of compliance with rules and regulations. The Golden Stream Field Station serves as a key site for deployment of patrols. Easy access to trail systems allows for near real time monitoring of activities within the protected area.
				The **BNR** conditions are stable. Patrol effort continues with increased efforts in the more remote reaches of the reserve. While an increase in activity withing the far western portions of the reserve was evident, it does not pose any major impact. Increased presence in the area can reduce any escalation of illegal activities.
				MMNFR patrols continue to uncover evidence of increased illegal logging. Increased patrol effort was able to document illegal activities in a more comprehensive manner. Hotspots were identified and patrol presence resulted in a number of confiscations and one case successfully prosecuted.
VII. Biodiversity Knowledge for Adequate Management	⬆	⬆	⬆	In the last five years, Ya'axché has ramped up its efforts on research, inventory and monitoring. Its research and monitoring program has grown significantly with a dedicated team for data collection and technical staff for the analysis of data and reporting. As the program continues to grow, the knowledge of the biodiversity within the PAs continues to increase as well.

I. Habitat Indicator Species

Habitat Indicator Species			Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Migratory Birds	Index of Abundance				Eight (8) bird species monitored on the biodiversity transects are generalist migrant species without specific habitat requirements in Belize. Declines in the abundance of these birds could indicate deteriorating conditions of their migration routes among other stressors. Since monitoring began in 2010, significant declines in migratory birds have been observed in GSCP, the nearby Columbia River Forest Reserve, BNR, and Indian Creek Village (*see the information brief following this section*). Because this trend is seen across many sites in the MGL, including the intact forest habitat of the Bladen Nature Reserve, it is likely that external pressures are driving the decline.
					GSCP. There has been a significant decline in migration route health indicators in GSCP since monitoring began in 2010.
					BNR. There has been a significant decline in migration route health indicators in BNR since monitoring began in 2010.
					MMNFR. There are no linear trends in migratory bird index of abundance. 2021 results are comparable to the average over the last 3 years and since monitoring began in 2016.
Forest Birds and Mammals	Index of Abundance				Eleven (11) bird species and seven (7) mammal species are monitored as forest health indicators, as they are only found in primary forests or undisturbed secondary forests.

Habitat Indicator Species				Overall Condition	GSCP	BNR	MMNFR
Indicators of Condition	Specific Measures	Condition Status/ Trend		Rationale			
		GSCP	BNR	MMNFR			
					GSCP. Forest birds and mammals remain stable in GSCP since 2010. The index of abundance for each group in 2021 is comparable to the average index of abundance since monitoring began.		
					BNR. Forest birds are stable in BNR since 2010. Forest mammals, as a group, show a significant decline in BNR since 2010; this is being driven by a significant decline in the detection of howler monkeys in the savannah transect of BNR. A second, forested transect does not show the same trend, indicating that howler monkeys and the other forest-dependent mammals are stable in the BNR broadleaf habitat.		
					MMNFR. No linear trends exist for forest birds and mammals since 2016, indicating stability in the MMNFR forest. There is a noticeable decline in forest mammal index of abundance between 2016 and 2017, but it increases again and stabilizes between 2018-2021. This pattern might be caused by increasing human activity during the establishment of the cacao concession where the transects are located. Both the cacao and forested transects in MMNFR shared this pattern in forest mammal index of abundance.		
Savanna Birds	Index of Abundance				Three of the monitored bird species are linked to pine savanna ecosystems and are considered indicators of the health of that habitat.		
					GSCP. No linear trends exist for savanna birds in Golden Stream. Zero birds in this group were recorded in 2021, but that is not unusual in GSCP due to its limited proximity to savanna habitat. In comparison, the neighboring Columbia River Forest Reserve has seen a significant		

Habitat Indicator Species			Overall Condition	GSCP ⬌	BNR ⬌	MMNFR ⬌
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**		**Rationale**		
		GSCP	BNR	MMNFR		

Indicators of Condition	Specific Measures	GSCP	BNR	MMNFR	Rationale
					decline in savanna habitat indicators since 2010, which is driven by the significant decline in the detection of yellow headed parrot in that reserve over 12 years.
					BNR. There are no significant long-term trends for savanna birds in BNR since 2010, indicating stability for that indicator group. However, the average index of abundance for the last 3 years is slightly lower than the average since monitoring began, so this should be monitored closely in following years.
					MMNFR. There are no linear trends for savanna birds in MMNFR since 2016. The index of abundance in 2021 is comparable to the average over the last 3 years and since monitoring began in 2016.
Wetland Birds and Mammals	Index of Abundance	⬌	⬆	⬌	Three bird species are monitored as wetland indicators because of their link to healthy riparian or littoral habitat. Two mammal species are monitored as indicators of riparian forest health. Between the two, the neotropical river otter is rarely recorded on the transects while the Baird's tapir is consistently recorded.
					GSCP. No linear trends exist for wetland birds or mammals in GSCP, but averages in the last 3 years are similar to averages since monitoring began in 2010.
					BNR. There is a significant positive trend in wetland mammal indicators. This is being driven by the significant positive increase in the tapir index of abundance in the Bladen savanna transect. No trends are seen for

Habitat Indicator Species			Overall Condition	GSCP ⬌	BNR ⬌	MMNFR ⬌
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**	**Rationale**			
		GSCP | BNR | MMNFR				
			wetland birds since 2010, and averages for the last 3 years are similar to averages since monitoring began.			
			MMNFR. No linear trends exist for wetland birds or mammals in MMNFR, but averages in the last 3 years are similar to averages since monitoring began in 2016.			
Disturbed Forest Birds and Mammals	Index of Abundance	⬆ ⬌ ⬌	Three bird species and one mammal species are monitored as disturbance indicators. These species are known to tolerate and even thrive in fallow lands, forest gaps, and human impacted landscapes. Of the three, the bronzed cowbird and dickcissel have never been recorded on any transect since 2010. The results shared are for the plain chachalaca and jaguarundi.			
			GSCP. GSCP and the neighboring CRFR have seen a significant decline in disturbed forest birds since 2010. This indicates improved forest conditions over time. Jaguarundis are rarely recorded at the GSCP transects, and none were detected there in 2021.			
			BNR. There is no linear trend in index of abundance for disturbance indicators in BNR overall. 2021 is comparable to the average over the last 3 years and the last 12 years. When examining individual transects, the savanna transect shows a significant decline in disturbance indicator species over time (driven by a decrease in index of abundance of plain chachalacas). Detection of jaguarundis at the BNR transects are rare since monitoring began, and 2021 is no different.			

Habitat Indicator Species				Overall Condition	GSCP	BNR	MMNFR
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**		**Rationale**			
		GSCP	BNR	MMNFR			
					MMNFR. Zero plain chachalacas were recorded on transects in 2021, which is consistent with transect records since 2017. Similarly, zero jaguarundis have been recorded on the MMNFR transects since monitoring began in 2016; however, camera trap images taken between 2019 and 2021 have confirmed the presence of jaguarundis in the same target area of the agroforestry concession.			
Game Birds and Mammals	Index of Abundance				Three (3) commonly hunted game bird species are monitored as indicators of hunting presence and sustainable use. Six (6) game mammals, including white-lipped and collared peccaries, paca, and agouti are also monitored.		
					GSCP. There are no linear trends for game bird index of abundance, though this has remained very low since monitoring began in 2010. Game mammals are more commonly recorded in GSCP, but no trends are seen for this group since 2010. In comparison, the CRFR has seen a significant decline in game mammals over 12 years, and zero game birds have been recorded in the nearby Indian Creek Village transect since 2012.		
					BNR. There are no linear trends for game bird index of abundance in BNR. The 2021 index is comparable to the average over the last 3 years. Game mammals also do not show any linear trends over 12 years; however, this group should be monitored closely, as game mammal index of abundance in the last 3 years is lower than the average since monitoring began.		

Habitat Indicator Species					Overall Condition	GSCP	BNR	MMNFR
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**			Rationale			
		GSCP	BNR	MMNFR				
					MMNFR. There is no linear trend for game birds in MMNFR. The 2021 game bird index of abundance is similar to the average over the last 3 years and the average since monitoring began in 2016. Similarly, game mammals have no linear trends, though there is a noticeable decline in index of abundance between 2016 and 2017 which stabilizes between 2018 and 2021. This might be due to increase in human activity in the cacao concession where the transects are located. When examining individual transects, the cacao transect reflects the steep decline after the first year of monitoring while the forested transect in MMNFR showed a slight increase over 4 years (neither regression lines are significant for the individual transects).			

Information Brief: Indicator Species and Biodiversity Transects
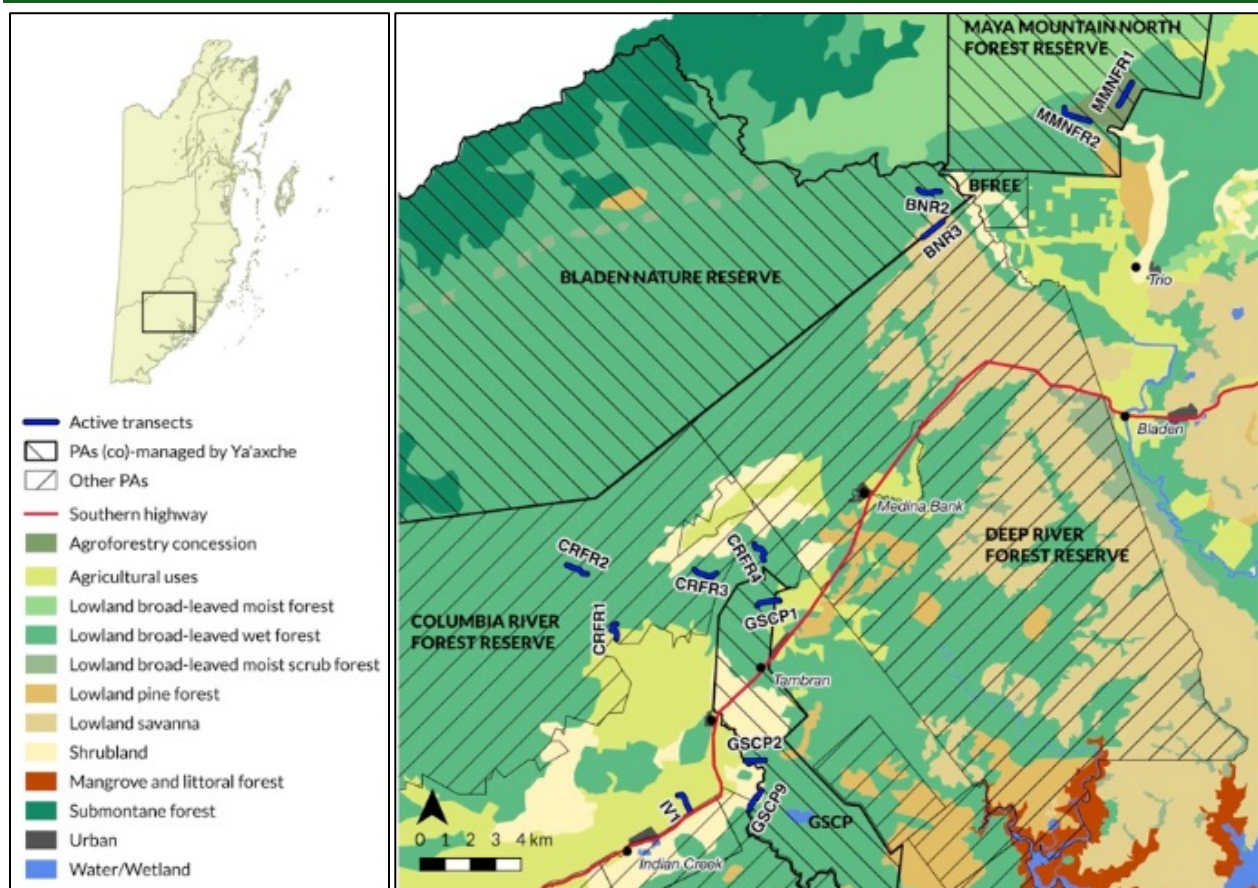
Map 2. Transect locations and ecotypes.

Ya'axché began monitoring biodiversity in 2006 with the establishment of bird and mammal transects. Over the years, the monitoring program has grown to encompass new target taxa and methodology but transects have remained at the core of the program. As of 2021, twelve (12) transects exist across the MGL. These are point-count and sign transect, all 1km in length, with stopping points every 200m to observe and listen. Birds are detected using sight and sound cues, while mammals are detected using direct sightings, tracks and an array of different signs such as scat, smell, sounds and scratch marks.

Transect Locations

Diverse habitats and a range of disturbance levels were chosen for transect locations to ensure that our monitoring program is representative of the land cover found across the landscape. Two transects are located in BNR, four in CRFR, three in GSCP, one in Indian Creek Village, and two in MMNFR. The location and ecotype of the transects is depicted in **Map 2**. Details of each of the transects can be found in **Table 1.**

Indicator Species

Target species include thirty-one (31) birds and nineteen (19) mammals, which are classified into six (6) indicator groups based

Table 1. Description of transect disturbance levels and the year that consistent and consecutive monitoring was established. Any data recorded on the transects prior to the year listed below were not included in this report.

Transect	Year Est.	Disturbance
BNR2	2010	Minimal
BNR3	2012	Minimal
CRFR1	2010	Minimal; 0-20% hurricane damage (2001); proximity of agriculture
CRFR2	2010	Minimal; 0-20% hurricane damage (2001)
CRFR3	2010	Minimal; 0-20% hurricane damage (2001)
CRFR4	2010	Minimal; 0-20% hurricane damage (2001)
GSCP1	2010	60-75% hurricane damage (2001); proximity of village and agriculture
GSCP2	2010	60-75% hurricane damage (2001); proximity of agriculture
GSCP9	2012	60-75% hurricane damage (2001); proximity of agriculture
IV1	2012	60-75% hurricane damage (2001); proximity of highway and agricultural clearings
MMNFR 1	2016	Up to 40% thinning of overstory with cacao crop planted underneath
MMNFR 2	2016	Minimal

on habitat preferences and ecology (Tables 2 & 3).

Species lists and indicator group assignment were based national and IUCN Red List conservation priorities, expert knowledge, ecological preferences as given in "Field Guide to the Mammals of Central America and Southern Mexico" (Reid, 2009) and "Birds of Belize" (Jones & Gardner, 2003), and validated by the local knowledge of Ya'axché's field ranger team.

Indicator groups are taken into account when analyzing bird and mammal data and are used to facilitate making conclusions from the monitoring results. For example, an increase of "Disturbed Forest indicators" could indicate habitat degradation, whereas decreased "Game species" richness could indicate a high level of hunting pressure and/or habitat degradation.

Table 2. Target mammal indicator species (n=19).

Common Name	Class	IUCN Status
Agouti	G	LC
Baird's Tapir*	W	EN
Brown Brocket Deer	NA	VU
Collared Peccary	G	LC
Jaguar	F	NT ▼
Jaguarundi*	D	LC ▼
Margay*	F	NT
Northern Naked-tailed Armadillo	NA	DD
Neotropical River Otter*	W	NT ▼
Nine-banded Armadillo	G	LC
Ocelot	F	LC
Paca	G	LC
Puma*	F	LC ▼
Red Brocket Deer	F	DD
White-lipped Peccary*	G	VU
White-nosed Coati	NA	LC
White-tailed Deer	G	LC
Yucatan Black Howler Monkey*	F	EN
Yucatan Spider Monkey*	F	EN

Table 3. Target bird indicator species (n=31).

Common Name	Migra-tory	Class	IUCN Status
American Redstart	Y	M	LC ↓
Black and White Warbler	Y	M	LC ↓
Blue-gray Gnatcatcher	Y	P	LC
Bronzed Cowbird	N	D	LC
Brown-hooded Parrot	N	F	LC
Cerulean Warbler	Y	F	NT ↓
Chestnut-sided Warbler	Y	M	LC ↓
Common Yellowthroat	Y	M	LC
Crested Guan	N	G	LC ↓
Dickcissel	Y	D	LC ↓
Golden-winged Warbler*	Y	F	NT ↓
Grace's Warbler	N	P	LC ↓
Great Curassow*	N	G	VU
Great Tinamou*	N	G	NT ↓
Hooded warbler	Y	M	LC
Keel-billed Motmot*	N	F	VU ↓
Keel-billed Toucan	N	F	LC ↓
Kentucky Warbler	Y	F	LC ↓
Little Tinamou	N	F	LC ↓
Louisiana Waterthrush	Y	W	LC
Magnolia Warbler	Y	M	LC
Mealy Parrot*	N	F	NT ↓
Northern Waterthrush	Y	W	LC
Painted Bunting	Y	M	LC
Plain Chachalaca	N	D	LC
Prothonotary Warbler	Y	W	LC ↓
Slaty-breasted Tinamou	N	F	LC ↓
Swainson's Warbler	Y	F	LC
Wood Thrush	Y	M	LC ↓
Worm-eating Warbler	Y	F	LC
Yellow-headed Parrot	N	P	EN ↓

*Assessed as part of the threatened bird or mammal indicator for the target "Rare, Threatened, Socio-Economic, & Culturally Important Species."

KEY: M = migration route health, P = pine savannah health, D = disturbed forest, F = forest health, G = game (hunting pressure), W = wetland health, NA = not assigned. LC = least concern, NT = near threatened, VU = vulnerable, EN = endangered, DD = data deficient.
Arrow indicates trend in global populations.

Three mammal species are monitored but are not assigned to an indicator class and are reported as indicator group "NA".

Methods

The core data collected in transects since 2010 were the number of species observed and the number of individuals observed per species. Birds were monitored twice daily: early morning and late afternoon. Large mammal monitoring was done simultaneously with bird monitoring, but signs and sightings were only recorded once during the day to avoid double counting. A more detailed description of the methodology used on the transects can be found in Ya'axché's BRIM strategy document (Wicks, 2009). The number of transect visits per year averages 34.1 in BNR (28 visits in 2021), 34.1 in GSCP (30 visits in 2021), and 33 in MMNFR (18 visits in 2021).

Analysis

The number of indicator species recorded on the transects was standardized across years and reserves through the creation of an index of abundance for each indicator group and for each species of conservation concern.

The index of abundance gives an indication of the status of an animal population, based on the numbers of animals seen per unit of time or distance, in a particular area over several years. In this case, the indices were calculated as the number of individuals observed per 1000m.

Data from all GSCP transects were analyzed and reported together for a comprehensive score for that reserve. For each BNR and MMNFR, data from transects were analyzed

and reported together and also separately because the transects in those reserves have habitat and/or land use types that are distinct from each other. The CRFR and village transects are reported for comparison against the protected areas managed by Ya'axché.

Indices of abundance over time were plotted and analyzed for trends using ordinary least squares regression techniques in PAST (Hammer et al. 2001).

Indicator Group Trends

Indices of abundance for each indicator group and protected area can be found in **Graphs 1-10**.

Indicator groups that show significant declines since monitoring began:

- GSCP migration route health birds
  ($y = -0.2507x + 6.2234$; $R^2 = 0.3816$; $p<0.05$)
- BNR migration route health birds
 ($y = -4.778x + 6.8033$; $R^2 = 0.5175$; $p<0.01$)

- CRFR migration route health birds
  ($y = -2.328x + 4.3826$; $R^2 = 0.5984$; $p<0.01$)
- Village migration route health birds
  ($y = -0.42733x + 6.5092$; $R^2 = 0.49196$; $p<0.05$)
- CRFR savanna habitat birds
  ($y = -0.016436x + 0.16063$; $R^2 = 0.47069$; $p< 0.05$)
- GSCP disturbed forest birds
  ($y = -0.286946x + 3.3092$; $R^2 = 0.72138$; $p < 0.001$)
- CRFR disturbed forest birds
  ($y = -0.21632x + 2.3772$; $R^2 = 0.66917$; $p < 0.05$)
- CRFR game mammals
  ($y = -0.82154x + 11.218$; $R^2 = 0.74822$; $p < 0.001$)

Indicator groups that show significant increases since monitoring began:

- BNR wetland mammals
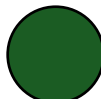 ($y = 0.043147x + 0.038954$; $R^2 = 0.72029$; $p < 0.001$)

No other significant trends exist.

Graphs 1-10. Indicator group indices of abundance per protected area. Monitoring began in 2010 in BNR, CRFR, and GSCP; 2012 in Indian Creek Village; and 2016 in MMNFR.
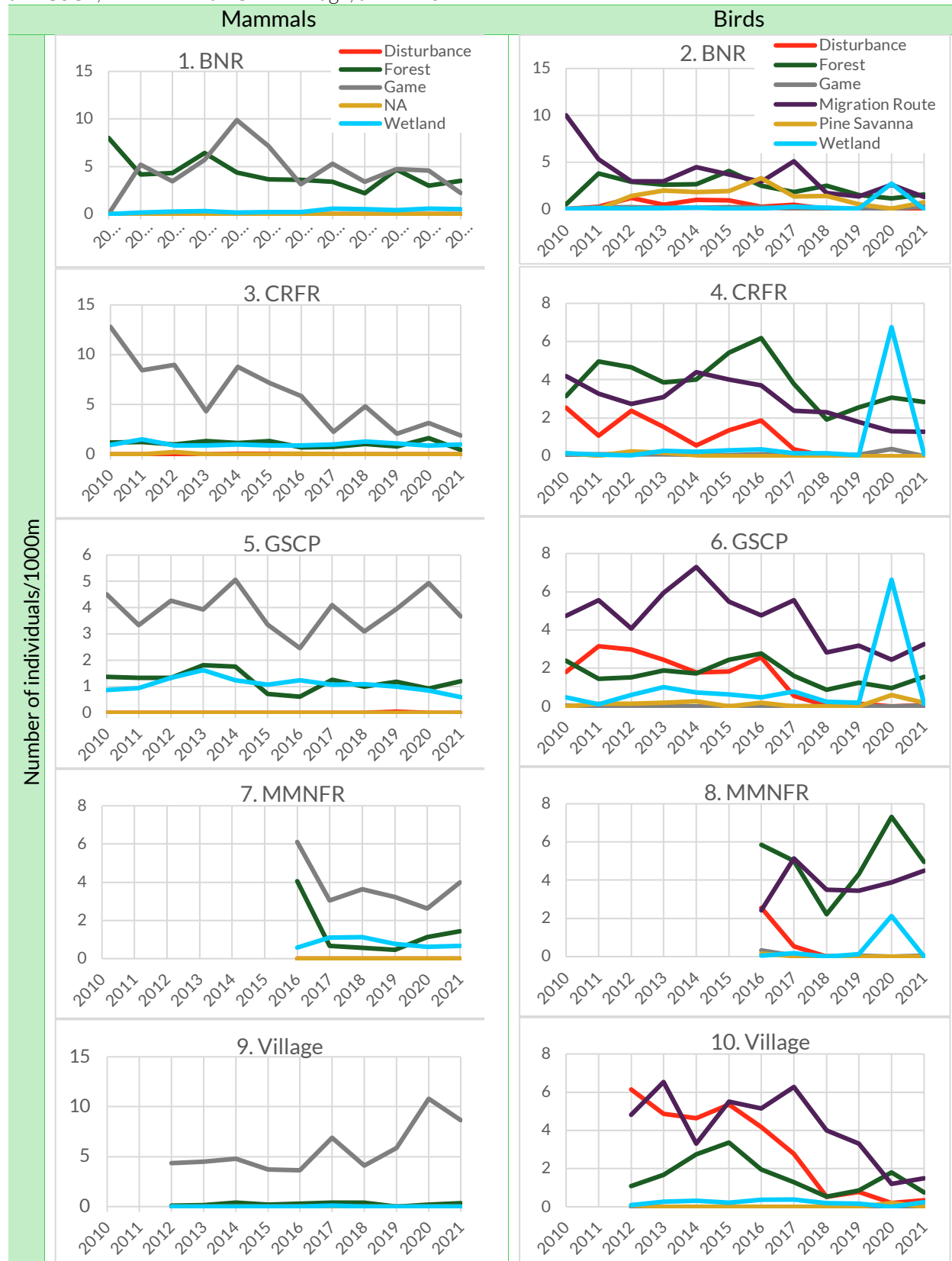
II. Rare, Threatened, Socio-Economic, & Culturally Important Species
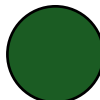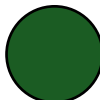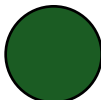
Rare, Threatened, Socio-Economic, and Culturally Important Species	Overall Condition	GSCP	BNR	MMNFR
		🟡	🟢	🟢

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Jaguars	Number of Individuals	Unknown	🟢	🟢	Jaguars are apex predators in jungles of the neotropics. A stable jaguar population over time indicates trophic integrity in the landscape. Camera trap surveys in BNR and MMNFR have allowed Ya'axché to capture, identify, and track the movement of individual jaguars in BNR and MMNFR since 2021 and 2019, respectively. More years of data are needed to assess trends.
					BNR. Cameras during the 2021 dry season recorded two (2) individual jaguars in BNR: a male and a female. A third individual, a male, was detected along with a recaptured individual during the wet season.
					MMNFR. In 2021, the MMNFR concession camera survey detected a recaptured male individual from BNR during the dry season. Two (2) more individuals, a male and female, were recorded during the wet season. Jaguar presence in both seasons denote that the top predators remain active all year round.
Threatened Birds	Index of Abundance	🟡	🟡	🟡	Seven (7) bird species monitored along the biodiversity transects are considered to be of *conservation concern* because they have either a threatened IUCN Red List status or a near-threatened status with decreasing global populations.
					These species include the cerulean warbler, golden-winged warbler, keel-billed motmot, great curassow, great tinamou, mealy parrot, and yellow-headed parrot. The cerulean warbler has never been recorded at any transect location in the MGL since monitoring began.

Rare, Threatened, Socio-Economic, and Culturally Important Species			Overall Condition	GSCP	BNR	MMNFR
Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale	
		GSCP	BNR	MMNFR		

Indicators of Condition	Specific Measures	GSCP	BNR	MMNFR	Rationale
					GSCP. The keel-billed motmot has never been recorded on the GSCP transects since monitoring began in 2010. Great curassows, mealy parrot, and golden-winged warblers are rarely recorded, and the indices of abundance for these species in 2021 are consistent with long-term records. The absence of some of these species is influenced by limited ranges and habitat types. Great tinamous have not been recorded in GSCP transects since 2018, and yellow-headed parrots were recorded in 2021 for the first time since 2016. These species should be monitored closely over the next few years.
					BNR. The golden-winged warbler has never been recorded on the BNR transects since monitoring began in 2010. The other threatened birds have been consistently recorded in most years. These species do not show clear or significant trends, however, the indices of abundance for all of these species in the last 3 years are much lower than the averages since monitoring began. Great curassows have not been recorded since 2017, and keel-billed motmot have not been recorded since 2018. These patterns should be observed closely in the following monitoring years.
					MMNFR. Yellow-headed parrots and keel-billed motmots have not been recorded in MMNFR since 2016. The golden-winged warbler is rarely recorded and was not recorded in 2021. The indices of abundance for great curassows and great tinamous have declined since 2016. This trend is not significant, but the pattern should be observed carefully over the next few years. Mealy parrots have seen a significant increase in index of abundance since 2016 ($y = 0.4119 + 0.0878$; $R2 = 0.8849$; $p < 0.01$).

Rare, Threatened, Socio-Economic, and Culturally Important Species		Overall Condition	GSCP 🟡	BNR 🟢	MMNFR 🟢

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Threatened Mammals	Index of Abundance	🟡	🟢	🟢	Of the mammals monitored along the biodiversity transects, nine (9) species are of conservation concern: Yucatan black howler monkeys, jaguars, jaguarundis, pumas, margays, tapirs, white-lipped peccaries, neotropical river otters, and Yucatan spider monkeys. The brown brocket deer has never been recorded on a transect and was not assessed.
					GSCP. Over the last 12 years, howler monkey abundance on the GSCP transects has declined, though not significantly. In the last 4 years, zero (0) howlers have been recorded. This mammal is usually recorded in GSCP; this is the first time that no howlers have been recorded in consecutive years. This trend should be monitored closely. In comparison, the nearby CRFR has recorded howler monkeys in only one year since 2010.
					Jaguar index of abundance has significantly declined in GSCP transects since 2010 $(y = -0.025773 + 0.55424; R^2 = 0.34007; p < 0.05)$.
					River otters have never been recorded on the GSCP transects. Jaguarundis, spider monkeys, margays, and white-lipped peccaries have rarely been recorded since 2010, but all have stable indices of abundance since monitoring began (no trends).
					Pumas have seen a significant increase in abundance since 2010 $(y = 0.043003 -0.097594; R^2 = 0.5923; p < 0.01)$.
					BNR. Over the last 12 years, there has been a significant decline in howler monkeys from the BNR transects overall $(y = -0.10628 + 1.4872; R^2 = 0.56418; p < 0.01)$; however, this is caused by a decline in the detection

Rare, Threatened, Socio-Economic, and Culturally Important Species			Overall Condition	GSCP 🟡	BNR 🟢	MMNFR 🟢

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale		
		GSCP	BNR	MMNFR			
					of howlers in the savanna transect. This negative trend is not seen in the forested transect of BNR.		
					Jaguarundis are rarely recorded on the BNR transects. River otters are also rarely recorded, but the average index of abundance in the last three years is higher than the average since 2010. Jaguars, tapirs, spider monkeys, margays, and white-lipped peccaries are regularly recorded, and all have stable indices of abundance since monitoring began (no trends).		
					Pumas have seen a significant increase in abundance since 2010 (y = 0.034033 -0.10781; R^2 = 0.64694; p < 0.01).		
					MMNFR. The neotropical river otter has never been recorded on a MMNFR transect. Jaguarundis, margays, white-lipped peccaries and spider monkeys are rarely recorded on the transects, and indices of abundance in 2021 are consistent with long-term records.		
					Howler monkeys, pumas, and tapirs are regularly recorded with stable indices of abundance.		
					Jaguars have seen a slight increase in index of abundance since 2016, but this trend is not significant.		
Bats	Number of Species, Relative Abundance	🟡	🟢	Unknown	During a 2016 survey, 53 bat species were recorded through mist and harp netting and acoustic monitoring in BNR (Foxley & Gartzia, 2014). Thirty-four (34) species were recorded in GSCP. Both are likely underestimates of true species richness.		
					Trapping results show a difference between bat assemblages in the mature forest of BNR and that of GSCP and between BNR and the agroforests and orange orchards outside of the reserves. BNR has the highest species diversity, including a high number of rare species. It is		

Rare, Threatened, Socio-Economic, and Culturally Important Species					Overall Condition	GSCP 🟡	BNR 🟢	MMNFR 🟢
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**			**Rationale**			
		GSCP	BNR	MMNFR				
					dominated by *Artibeus jamaicensis*, which has been linked to continuous mature forest habitat. GSCP has the lowest overall species richness in the study, which may be due to the structure of the secondary forest which is recovering from Hurricane Iris damages in 2001. The species assemblage in GSCP is composed of bats more common in disturbed and open areas.			
Rare and Endangered Trees	Abundance & Age Structure	🟢	🟢	🟡	**GSCP.** The broken ridge ecosystem type found in GSCP forms the ideal conditions for the growth of the Honduran rosewood (*Dalbergia stevensonii*). The reserve is considered one of the last remaining strongholds for the species due to deforestation elsewhere within its range. Populations have been monitored consistently since 2013 to track growth rates and phenology, which are critical for the creation of biologically relevant timber management plans at the national level. Propagation trials have been ongoing in Ya'axché's nursery since 2017 to learn best practices and growing conditions for the species. The development of a seedling guidebook is in progress for use and dissemination to the public in 2022.			
					BNR. A total of 227 tree species from 65 plant families have been recorded from the roughly 5,000 trees within 4 permanent sample plots in the BNR. Out of these, 72 species (32%) have distributions restricted to northern Mesoamerica. The BNR landscape, composed of limestone ridges, creates niche conditions that promote the evolution of species specialized to unusually high drainage, pH, and calcium levels compared to what is found in soils from more common substrata across the Neotropics. Notable rare, restricted, and/or ecologically important species include *Bartholomaea sessiliflora*, *Beilschmiedia hondurensis*, *Chiangiodendron mexicanum*, and *Guettarda davidseorum*. The rough			

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Rare, Threatened, Socio-Economic, and Culturally Important Species					Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
					terrain of the BNR landscape also contributes to the protection of trees from illegal extraction.
					MMNFR. Surveys for threatened timber species in 2020-21 revealed previously unknown populations of *Zanthoxylum* species (Dorgay, 2021). Due to a history of legal and illegal logging in the reserve, the age structure for several of the populations is skewed toward younger trees. These populations are now the target of conservation action through improved zonation in the reserve, increased patrols, and out-planting and monitoring of saplings over the next few years. In November 2021, restoration of agricultural clearings began, with 162 walking lady (*Vitex gaumeri*) and mahogany (*Swietenia macrophylla*) planted into a 6-acre site along the southern boundary of the reserve. See the information brief following this section for more details.
Native Bees	Number of Species				Starting in June 2019, Ya'axche has actively captured and documented native bee species across the MGL protected areas and farms (reported in Dorgay, 2021). To date, 52 bee species have been recorded. This is roughly 1/3 of the known species documented for the country of Belize, as 148 species are currently accepted nationwide. Across all areas sampled, stingless bees from the tribe Meliponini make up the majority of individuals captured. In total, 15 species of meliponines are known across the MGL. Ten of those have socio-economic value as honey producers. Numbers of species are reported here; subsequent years of native bee monitoring will establish trends. A native bee ID guide has been developed and made publicly available on Ya'axché's website.

Rare, Threatened, Socio-Economic, and Culturally Important Species			Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
					In GSCP, 13 native bee species from three (3) tribes have been recorded. Eleven (11) of these species belonged to the stingless bee tribe Meliponini; one (1) of these is an endemic species (*Tetragona mayarum*) found in Mayan forests. Another bee, *Scaptotrigona pectoralis*, is especially susceptible to pesticides and can be considered an indicator of chemicals in its environment (de Souza Rosa et al., 2015). In comparison, only eight (8) species from three (3) tribes have been recorded in the nearby CRFR.
					In BNR, 34 species of native bees belonging to 11 tribes have been recorded. Two (2) species are endemic to the region: *Tetragona mayarum* and *Paratetrapedia albilabris*. Two (2) species, *Melipona beechei* and *Scaptotrigona pectoralis*, are especially susceptible to pesticides and can be considered indicators of chemicals in their environment (Valdovinos-Nuñez et al., 2003). Two (2) bees, *Ancyloscelis apiformis* and *Epicharis lunulata*, are considered rare or uncommon (Michener, 1994).
					In MMNFR, 11 species of native bees from three (3) tribes have been recorded. One (1) species, *Nannotrigona perilampoides*, is especially susceptible to pesticides and can be considered an indicator of chemicals in its environment.

Information Brief: Threatened Trees of the MMNFR

The Maya Mountain North Forest Reserve is a Key Biodiversity Area (KBA), part of the Maya Mountain Massif (MMM), and is connected to the Mesoamerican Biological Corridor (MBC). It is also the location of historical logging concessions and has been subject to degradation from years of illegal extraction prior to Ya'axché's co-management.

In 2020, field surveys to identify populations of threatened trees were carried out in MMNFR with support from a 3-year Global Trees Campaign (GTC) project entitled Conservation of Threatened Timber Species in the Maya Mountain North Forest Reserve. The goals of the fieldwork were: (1) to locate previously unrecorded individuals of the target species; (2) to make preliminary estimates of population size and age class distribution of the target trees; and (3) to identify locations of seedbearing trees and collect seeds for propagation. Project data were used to recommend improved reserve zonation and to identify areas for restoration planting.

Six (6) species were the primary targets of the surveys, all of which are legally harvested in Belize (see **Table 4**).

An additional ten (10) secondary species were also recorded where found; this list includes non-timber threatened species that would benefit from improved zonation within the reserve.

Method and Survey Location

A combination of walk-through and controlled-intuitive methods were utilized in the target survey areas (Brewer, 2013). Surveys were carried out between June 23, 2020 and April 19, 2021 in the southernmost part of MMNFR. This area is the most accessible part of the reserve due to its proximity to existing roads, trails and communities and also due to its flat terrain. As such, it is also most at risk of illegal incursions and therefore was prioritized for surveying. Where trees were identified, geolocation, diameter at breast height (DBH), height, and phenological condition were recorded.

Table 4. List of Target Species in the MMNFR.

Threatened Tree Species	
Primary Targets	Secondary Targets
Aspidosperma megalocarpon	*Cedrela odorata*
Dalbergia stevensonii	*Chiangiodendron mexicanum*
Zanthoxylum caribbean	*Cymbopetalum mayanum*
Zanthoxylum ekmanii	*Persea schiedeana*
Zanthoxylum juniperinum	*Quercus insignis*
Zanthoxylum mollissimum	*Quiina schippi*
	Swietenia macrophylla
	Trichilia breviflora
	Vitex gaumeri
	Vitex kuylenii

Map 3. Location of threatened trees found during 2020-2021 surveys in the MMNFR.

Age Class Structure of Primary Targets

Aspidosperma megalocarpon (n=3)

Dalbergia stevensonii (n=41)

Zanthoxylum ekmanii (n=32)

Zanthoxylum juniperinum (n=17)

Age Class Structure of Secondary Targets

Cymbopetalum mayanum (n=10)

Swietenia macrophylla (n=19)

Vitex gaumeri (n=9)

Age Class Structure of Additional Species of Interest

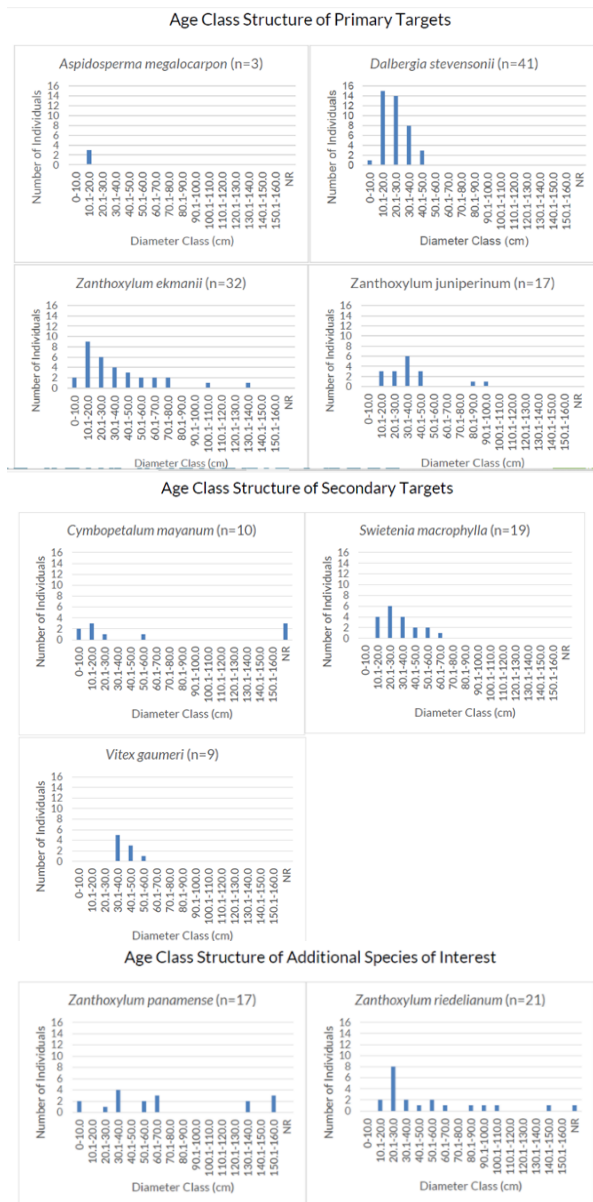Zanthoxylum panamense (n=17)

Zanthoxylum riedelianum (n=21)

Figure 1. Graphs showing the structure of population ages class based on diameter at breast height (DBH) for threatened species found in the MMNFR.

Survey Results

A total of 29 days were used to survey 6 priority habitat blocks within MMNFR. Accounting for forest visibility, the surveyed area totaled approximately 124 acres. 148 target trees of seven (7) primary and secondary target species were recorded (**Map 3**).

Zanthoxylum mollissimum, Zanthoxylum caribaeum, and several secondary species were not found in the surveyed area. However, additional prickly yellow species, *Zanthoxylum panamense* and *Zanthoxylum riedelianum,* were found growing in the same habitat as the other target species and were also recorded. The age class structures (based on diameter) of the surveyed species can be found in **Figure 1**.

These results show that the timber species *Dalbergia stevensonii, Aspidosperma megalocarpon, Zanthoxylum ekmanii,* and *Swietenia macrophylla,* have populations that are skewed toward younger and smaller stems; this is certainly a result of years of legal and illegal extraction of those species in the reserve. All species found during the surveys were included in subsequent seed collection and propagation trials at Ya'axche's Golden Stream nursery.

Propagation Trials

Propagation trials began in early 2021 to learn best practices for growing the target species and to produce trees for reinforcement planting into the reserve. A literature review of the target species and their close relatives was conducted to inform the growing conditions and experimental treatments.

For all species and trials, the germination rate, mean time to germinate, and seedling growth rate over the first two months were measured. Results from the first trial of 2021 were mixed (see **Table 5**); the treatments were adjusted for a second round of trials that began later in the year.

Table 5. Germination results and seed treatments for round 1 of propagation trials in 2021.

| Germ. %	Species	Trial/Treatment
65%	*V. gaumeri*	*Seed dormancy*
81%	*S. macrophilia*	*Seed size*
5%	*C. mayanum*	*Sunlight level*
13%	*Z. ekmanii*	*Seed dormancy*
0 survival	*A. megalocarpon*	*Growing medium*
0 survival	*D. stevensonii*	*Various*
0 survival	*Z. panamense*	*Growing medium*

Reinforcement Planting Locations

221 total seedlings of *S. macrophylla, V. gaumeri, C. mayanum,* and *Z. ekmanii* were successfully grown after the first round of propagation trials. On November 10, 2021, 162 trees (108 *Vitex gaumeri* and 54 Swietenia *macrophylla*) were planted into 0.3 acres of degraded forest, reinforcing nearby populations of these valuable timber species (**Photo 1**). The planting location is identified by the gold star in **Map 4.**

Photo 1. Students from Round River Conservation Studies, USA assisting with tree planting in the MMNFR.

Nursery propagation trials are ongoing at the time of writing this report. New seedlings produced through trials will be planted into MMNFR into the areas identified in **Map 4** as appropriate based on the species and their habitat. Area 1 is composed of high-quality forest in the southwest corner block; Area 2 is a degraded area along an area cleared for cattle pasture in the broken ridge block; Area 3 is composed of former annual crop plots in an agroforestry concession that need to be phased back into forest; Area 4 is within the agroforestry concession conservation zone; and Area 5 is the agroforestry concession cacao zone where additional shade canopy is needed to ensure productive cacao. Satellite imagery from PlantScope (Planet Team, 2020).
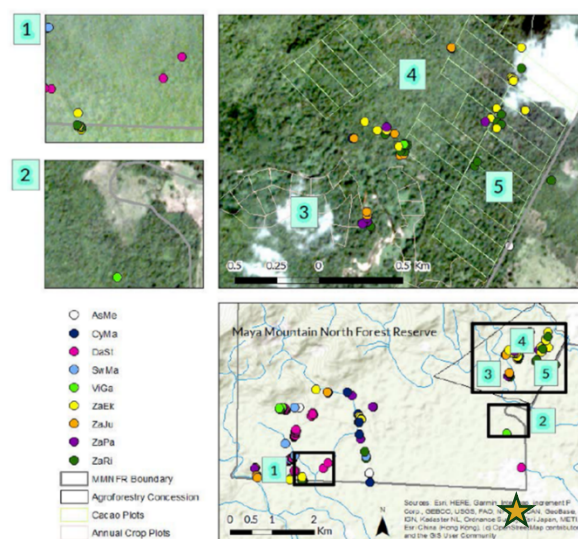
Map 4. Possible areas of southern MMNFR for planting of target species.

Benefits of Implementation

Long-term impacts of the ongoing restoration planting include:

- Improving the conservation status of threatened tree species by boosting local populations;
- Securing timber trees for future use;
- Complementing and enhancing the benefits of the reserve's agroforestry system by adding useful native trees into the system;
- Stabilizing soil for the watershed and communities downstream and protecting the health of the barrier reef;
- Ensuring that the wildlife corridor along the Maya Mountain Massif remains functional.

III.   Broad Ecosystems and Land Use Change

Broad Ecosystems & Land Use Change			Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Extent of Broadleaf Forest	Percent cover				The **GSCP** has for the most part benefitted from a stable relationship with the neighboring communities over the last two decades. As such, no incursions within the reserve have led to any major clearings within the boundaries of the reserve. GSCP retains an estimated 97% of its forest cover within 15,000 acres.
					The **BNR** enjoys widespread protections via its location at the center of the Maya Mountains block of protected areas. Restricted and patrolled access to the reserve ensures little opportunity for any forest areas to be cleared. The BNR retains 99.8% of its forest cover within an estimated 100,000 acres of reserve.
					The **MMNFR** retains most of its forest cover. The larger expanse of the reserve is still well intact due to remoteness and rugged terrain making access for clearings nearly impossible. The MMNFR excluding the concession area retains 98% forest cover within an estimated 35,000 acres. The concession area retains 71% of forest cover from within the 936 acres under development.
Extent of Deforestation	Percent cover				**GSCP**. No deforestation was detected in GSCP in 2021. Conditions are good and stable.
					BNR. No deforestation was detected in BNR in 2021. Conditions are good and stable.

Broad Ecosystems & Land Use Change			Overall Condition	GSCP ⬌	BNR ⬌	MMNFR ⬇
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**		**Rationale**		
		GSCP	BNR	MMNFR		
					MMNFR. 2021 saw another spike in clearings particularly for illegal cattle ranching and illegal farming. Up to an estimated 38 acres of forest were under cattle and/or were cleared for agriculture. The spike in clearing combined with areas already in some form of illegal agriculture amount to an estimated 1% of the entire protected area.		
Extent, Increase, and Impact of Agricultural Lands	Area of land cleared or under unsustainable development	NA	NA	⬇	No agriculture lands are found within the GSCP and the BNR, as such, this indicator does not apply to these two protected areas.		
					In MMNFR, the area of illegal land clearings within the vicinity of Governor Creek continues to degrade the forests near the eastern boundary line. Clearings extend to an estimated 2km into the reserve from the boundary line. An estimated 328 acres, give or take, is currently under unregulated and illegal cultivation. This trend continues to grow and warrants concern for future management of the area to avoid further incursions.		

Information Brief: Deforestation in MMNFR

Increased surveillance in the Maya Mountain North Forest Reserve was necessary in 2021 following a spike in illegal activity in 2020. Most of the infractions documented in the reserve were related to timber extraction. However, the highest impact on the forests of the MMNFR was related to illegal land clearings and conversions to cattle pasture or other agriculture practices. With the aid of satellite imagery, Ya'axché was able to detect land clearings that were not otherwise easily detected from the ground patrols.

Photo 2. Illegal land clearing in the MMNFR as seen by drone in March 2021.

In March of 2021 a clearing was detected along the southern boundary line of the reserve. The boundary line separates the reserve and a citrus orchard which allows easier access to the southern sector of the reserve. Follow up ground truthing of the area confirmed an estimated 8 acres of cleared forest. Subsequent patrol effort was essential in the eventual encounter, arrest and prosecution of one individual. The prosecution effort was a collaboration between Ya'axché and the Belize Forest Department.

Prior to the detection of the March clearings, Ya'axché was monitoring another area known for cattle ranching within the reserve. This area continued to degrade through 2021 to a total of 25.5 acres within the reserve and an additional 5 acres just outside of the boundary of the reserve. This area will continue to be monitored and evidence collected to build a case against the individual/individuals responsible for the clearings.

Photo 3. Drone orthomosaic showing 25+ acres of forest cleared in MMNFR.

IV. Ecosystem Services

Ecosystem Services			Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Freshwater Quality	Macro-invertebrate assemblages				Macroinvertebrates were collected from diverse riparian habitats and identified to family level. Macroinvertebrate assemblages were scored by assigning a sensitivity value from 1-10 to each family collected at the streams. The very pollutant tolerant families are assigned a value of 1, while a very sensitive intolerant families are assigned a value of 10. The sum of these is divided by the number of scoring taxa collected from each sample to obtain the Average Score Per Taxon- Costa Rica (ASPT-CR) index value. Higher ASPT scores indicate the stream to be of higher ecological status, while lower scores indicate a stream of degraded ecological status. An ASPT value greater than six [> 6] indicates high ecological status of the stream. All sites scored between 4-6 indicating waters with regular quality and medium contamination, which is rated as "good" on the scale.
	Dissolved oxygen				GSCP. Dissolved oxygen at one of two sites sampled in the Golden Stream watershed was 3.25 mg/L, below the 5 mg/L Mexico standard for aquatic life in warm surface waters. BNR and MMNFR. Dissolved oxygen in waterways were within the ideal range.
	Turbidity				Turbidity for all sites in all three reserves ranged from 0.1-10.2 NTU, which are within Mexico (<10NTU) and Costa Rica (<25NTU) standards for water quality.

Ecosystem Services				Overall Condition	GSCP ●	BNR ●	MMNFR ●

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
	Electrical conductivity	●	●	●	Salinization of freshwater resources, both from natural and man-made sources, is a growing water quality challenge. Salinity can negatively impact sectoral water use, health, biodiversity, and ecosystem services. Electrical Conductivity (EC) is a commonly measured parameter to assess salinity. The EC values for each tributary vary based on the substrate material and season. Calcareous sites on GSCP and BNR have higher values, while siliceous sites in MMNFR are expectedly lower in comparison. Conductivity in rivers generally ranges from 50-1500 µS/cm with ideal values below 500 µS/cm (Conductivity, 2012). **GSCP.** Electrical conductivity of the sites in the Golden Stream watershed ranges from 337-428.3 µS/cm in both seasons. **BNR.** Sites on the Bladen Branch of Monkey River range from 266-245 µS/cm in both seasons. This is significantly higher than the electrical conductivity at either of the sites in MMNFR that are part of the same watershed. **MMNFR.** Electrical conductivity is 107.4-122.4 µS/cm for the sites on the Trio River Branch of Monkey River during both seasons. Electrical conductivity is significantly lower for sites on the Governor's Creek Branch of Monkey River at 31.9 – 69.8 µS/cm during both seasons.
	Temperature	●	●	●	**GSCP.** The water temperature for sampled sites in the Golden Stream watershed ranges from 23°C - 26°C in both wet and dry seasons.

Ecosystem Services				Overall Condition	GSCP	BNR	MMNFR
					🟢	🟢	🟢

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
					BNR & MMNFR. The water temperature of the sites on the Monkey River watershed for the wet season ranges from 23°C – 26°C and slightly increases in the dry season from 27°C - 32°C.
	pH	🟢	🟢	🟢	The pH for all sites sampled was near neutral within range of 7-8.7.
	Stream physical condition	🟢	🟢	🟢	The Stream Visual Assessment Protocol (SVAP) is a qualitative scoring criterion of the different physical attributes of a stream, including channel condition, riparian zone, shade (canopy), bank stability, hydrologic alteration, pools, water appearance, nutrient enrichment, sedimentation, insect/invertebrate habitat, in-stream fish cover, barriers to fish movement, fishing pressure, presence of garbage and manure presence. The scores of each attribute are average to result in an overall site score. In 2016, all sites in all three reserves scored either in either the "good" or "excellent" range for stream physical condition.

V. Sustainable Natural Resource Use

Sustainable Natural Resource Use			Overall Condition	GSCP	BNR NA	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale		
		GSCP	BNR	MMNFR			
Knowledge	Up-to-date documentation for resource use is available in communities eligible to harvest resources in the reserve		NA		**GSCP.** Current knowledge of NTFPs remain unchanged. The sharing of information on extraction process for NTFPs was restricted in large part to limits on gatherings due to the pandemic. This section does not apply to **BNR**. **MMNFR**. The renewal of a conservation agreement with the Trio Farmers Cacao Growers was started in 2020 and was slated for final endorsement and signing in 2021. Final signing was delayed once again due to the restrictions brought about by the pandemic. However, resource use was and continued to be guided by the first agreement what expired at the end of 2020.		
Opportunity for Subsistence Activities	Subsistence users are engaged in subsistence management	NA	NA		**MMNFR** is the only PA with an active concession for cash crops and subsistence farming. The TFCG entered into its 6th year of development of the agroforestry concession where annual crops can be produced in a small, designated area. The annual crops section was used less frequently in 2021 with the increase in the yields of cacao from the concession.		
	Proportion of permits that are approved for subsistence use		NA	NA	The **GSCP** The GSCP extraction zones have benefited buffer communities who request extraction of construction material for traditional home building. All materials are NTFPs which were identified in consultation with the communities. This extraction process is guided by an outdated sustainable extraction plan. The update of the plan is pending with funding being the major limiting factor.		
Extent of Legal vs. Illegal	Incidence				**GSCP** Overall, extraction in the reserve has been under permits for NTFPs; however, GSCP recorded one incident of illegal timber		

Sustainable Natural Resource Use				Overall Condition	GSCP ⬌	BNR NA	MMNFR ⬇
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**		**Rationale**			
		GSCP	BNR	MMNFR			
Natural Resource Use		⬇	⬌	⬇	extraction. The target was rosewood (*Dalbergia stevensonii*), where 5 individual trees were cut and removed from the reserve. This trend was not present the year before where mahogany had been the primary target. Permitted extraction on the other hand was limited to 1 request for cohune leaves for home building.		
					The **BNR** The BNR remains stable. There is no legal extraction that is permitted in the reserve. However, for the first time in many years, illegal timber extraction was documented in the reserve. The target area was the western edge and the most remote corner of the reserve. All indications are that the illegal activities are of a transboundary nature and all timber products are transported across the Belize/Guatemala boarder via a network of horse trails. The main targets were mahogany (*Swietenia macrophylla*) and rosewood (*Dalbergia stevensonii*).		
					MMNFR saw continued illegal activity as documented the previous year. Illegal hunting, illegal timber extraction and illegal land clearings were the major concerns in 2021. Five incidents of illegal logging were reported in 2021. Main targets were Salmwood (*Cordia alliodora*), Mahogany (*Swietenia macrophylla*), Granadillo (*Platymiscium sp.*). Only one legally permitted extraction occurred in the form of a request for extracting a Guanacaste (*Enterolobium cyclocarpum*) for canoe building. The pressure for arable land was evident in the reserve with an estimated 13 acres of land cleared in the reserve which was converted to or intended for agriculture. Cattle ranching seems to be the primary driver of clearings in the vicinity of the reserve. The cacao concession entered its 6th year of development and production. A total of 54,602 lbs. of wet cacao bean were harvested by the TFCG for the 2021 season.		

Information Brief: Illegal Resource Extraction in the BNR

A considerable effort is required to cover ground within the 100,000-acre Bladen Nature Reserve. With limited manpower and other limited resources, presence in some sectors of the reserve is reduced to nearly nonexistent for most of the year. The remoteness of the reserve does contribute significantly to its ability to keep people away, but it does not do so entirely. For many years resource extraction was nearly absent following the boom in the illegal xaté harvesting in the Bladen Nature Reserve that went bust around 2010. The following decade proved to be relatively quiet for the western corners of the reserve.

Reconnaissance patrols in 2021, more than a decade later uncovered fresh signs of transboundary incursions into the BNR via the Columbia River Forest Reserve. Previous incursions for xaté extraction were via the Chiquibul National Park. The newly discovered evidence was significant logging activity within the Columbia River Forest Reserve that then spilled into the BNR. Networks of horse trails were documented and at least two semi-permanent camps observed. The prime target for these incursions was the illegal harvest and extraction of Mahogany (*Swietenia macrophylla*) and Rosewood (*Dalbergia stevensonii*).

Follow up patrols to the area required tactical and security support provided by the Belize Defence Force, Belize Police Department and the Forest Department. Additional evidence was collected during this

subsequent effort but unfortunately no detentions were possible at the time.

The challenges of organizing and deploying surveillance patrols to the hotspot were brought about by the ever-changing pandemic restrictions. Collaborations with other enforcement entities was limited as a

Photos 4 (*above*) and 5. Camp found near the BNR-CRFR boundary line.

result. Follow up surveillance patrols to the area in late 2021 proved that the incursions continued into the reserve and that the odds of future incursions into the 2022 dry season were high. Much effort will be required with a collaborative approach to curb these incursions which are not only impacting the forests of the western BNR but also the forests of the northeastern CRFR.

Photo 6. Large Mahogany tree cut, milled, and extracted.

Photo 7. Rosewood stump remains as evidence of logging.

VI. Enforcement & Compliance

Enforcement & Compliance				Overall Condition	GSCP	BNR	MMNFR
					↔	↔	⬆

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Effectiveness of Patrols	Number of patrols	↔	↔	⬆	As in previous years, the number of patrols within **GSCP** remained fairly high during 2021. The location of the field station and proximity to patrol routes allows for ease of access and wide coverage of the priority areas for patrols. A total of 186 patrols were deployed in 2021.
					The **BNR** generally enjoys the benefits of its remoteness. However, in 2021 an increased patrol effort netted a total of 186 patrols. Of note the ranger team increased patrols in the western sector of the reserve which does not have frequent ranger presence.
					Patrol effort in **MMNFR** was strategic in areas considered hotspots. While generally the PA receives the lowest number of patrols, the effort was on par with GSCP and BNR. Strategic patrolling led to one arrest and conviction. Other attempts to build cases against individuals committing infractions were started and rolled over to 2022. A total of 170 patrols were deployed in 2021.
Protected Area Rules and regulations infractions	Number of infractions	↔	↔	⬇	The **GSCP** documented 4 infractions documented in comparison to 8 infractions the year before. Illegal extraction of NTFPs was recorded 3 times and only one instance of illegal timber was recorded.
					The **BNR** documented 27 infractions. As reported in patrol effectiveness above, the increase in patrols in the western sector of the reserve uncovered evidence of infraction related to timber extraction. Transboundary incursions are now evident in the BNR. 15 observations of hunting were observed, 7 instances of logging and 5 instances of illegal entry.
					The **MMNFR** recorded a total of 35 infractions. 27 of the recorded infractions were associated to illegal logging and timber extraction. 5 instances hunting, 2 instances of illegal entry, 1 illegal land clearing.

Information Brief: Enforcement and Compliance Patrols - Incidents

An increase in targeted patrols in the MMNFR resulted in multiple detections of illegal logging in 2021. A total of 27 logging observations were documented in MMNFR with mahogany (Swietenia macrophylla) extraction at the center of the activity. The southeastern corner of the MMNFR is the only sector of the reserve that allows ease of access for any forest produce extraction. Prior to 2016 this area had been logged extensively and remained in recovery since. Since most of the harvestable timber was already extracted from this area illegal extraction was displaced to the foothills of the MMNFR.

Access to harvestable trees was via seasonal creeks and via the Trio Branch River. Once cut, target trees were converted into rough planks and set aside to dry and covered to prevent detection. When the weather turned at the start of the rainy season planks were floated down stream and out of the reserve. Numerous attempts to catch people in the act proved fruitless but the rains during the 2021 rainy season were heavy and this prevented additional extraction until the dry season 2021.

Hotspot entry points were identified and monitored throughout the remainder of 2021. After confiscation of lumber by the forest department logging activity slowed down but it is expected to increase once the rains subside. The evidence largely points at organized loggers with most of the activity occurring during the night. The restrictions on movement brought about by the pandemic were the ideal scenario for moving illegal produce under the cover of dark and with little enforcement presence. As restrictions loosen, it is expected that the activity will adapt to use new approached to avoid detection.
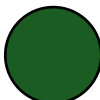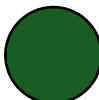
Photo 8 (*above*) and 9. Mahogany extraction via the Trio Branch River.

VII.   Knowledge of Biodiversity for Adequate Management

Knowledge of Biodiversity for Adequate Management	Overall Condition	GSCP	BNR	MMNFR

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
Baseline Data	Comprehensive species lists of key taxa				The 2021 update of mammal and bird lists and the creation of native bee lists in all reserves has been completed. Wildlife infographics for 19 farms have been created. A native bee of the MGL guide has been updated and printed.
					Since 2009, plants and bats have been surveyed thoroughly in **GSCP** and **BNR** and species lists are in use in the management of those reserves.
					The list of known mammal species for BNR prior to 2021 was compiled from the reports of multiple, external research projects, the data from which was not held by Ya'axche. In 2021, Ya'axche established a camera grid in eastern BNR to create its own baseline data on species presence and abundance. Through this effort, one (1) previously unrecorded species, the Northern naked-tail armadillo (*Cabassous centralis)*, was confirmed for the protected area. See the information brief following this section for more details.
					In **MMNFR**, which Ya'axché began managing more recently, bats have not yet been studied.
					In 2021, Ya'axche along with research partners Round River Conservation Studies conducted bird and tree surveys across the southern third of the protected area in order to update the known species lists for those taxa.

Knowledge of Biodiversity for Adequate Management			Overall Condition	GSCP ⬆	BNR ⬆	MMNFR ⬆
Indicators of Condition	**Specific Measures**	**Condition Status/ Trend**		**Rationale**		
		GSCP	BNR	MMNFR		
					In addition, camera surveys have been running in the reserve since 2019 to document mammals and additional wildlife.		
	Accurate ecosystem maps with descriptions	🟢	🟢	🟢	Ecosystem maps for all three reserves come from larger ecosystem maps for Belize that were produced as part of the Central American Ecosystems Map project (Worldbank/CCAD) in 2001 (Meerman and Sabido). The Belize maps were improved by Meerman using ground-truthed vegetation data in 2004 (Meerman, 2005). However, the resolution of the ecosystem maps could be improved for the MGL through the integration of on-the-ground survey data and drone classification of vegetation. Ya'axché is exploring the use of drones for ecotype mapping as of 2021. An aquatic ecosystem map for Belize is available, though the national aquatic ecosystems concept is a work in progress and is pending validation with field data (Esselman et al. 2005).		
	Accurate lists of threatened, socio-economically important and invasive species	⬆	⬆	⬆	Updated lists of threatened and socio-economically important species are in progress for the three PAs along with the establishment of accurate species lists. In all reserves, recent information on invasive species is lacking. *Gmelina arborea* and tilapia are two invasive taxa identified as potential threats in Belize, though a lower population and lower rates of urbanization and encroachment into forests of the MGL compared to other areas make invasive species less of a threat here. Surveys in 2009 did not identify *Gmelina* in BNR or GSCP,		

Knowledge of Biodiversity for Adequate Management		Overall Condition	GSCP	BNR	MMNFR
			⬆	⬆	⬆

Indicators of Condition	Specific Measures	Condition Status/ Trend			Rationale
		GSCP	BNR	MMNFR	
					but follow-up surveys should be done to confirm that it has remained absent, and that other invasive species remain absent.
	Accurate understanding of NTFP harvest limits	🟢	NA	🟢	**Cohune palm leaves are one of the most commonly used NTFPs by community members buffering the reserves. The leaves are harvested from the standing palm and used for thatch.**
					GSCP has two sustainable use zones where cohune leaves can be extracted by villagers after they make a request and obtain a permit from Ya'axché. In 2018, Ya'axché conducted a study on cohune leaf regeneration rates under different harvest intensities to identify the level of harvest (maximum number of leaves per tree) that is sustainable in GSCP, i.e., allows for continued reproduction and leaf regeneration of the species for long-term harvest. The resulting ideal harvest intensity was integrated into the management practice of the extraction zones.
					Cohune palms in the **MMNFR** can be expected to have similar regeneration rates and the same harvest strategy applied there.
	Accurate understanding of priority species life cycles and population dynamics	⬆	⬆	⬆	Priority species for life cycle and population dynamic studies in GSCP, BNR, and MMNFR are certain rare, threatened, data deficient, and/or timber trees that are lacking management plans at the national level. Since 2013, Ya'axché has gathered monthly phenology data on 7 tree species. Honduran rosewood (*Dalbergia stevensonii*) is also the subject of a stump regeneration study in MMNFR.

Information Brief: Wildlife Camera Trapping in BNR and MMNFR

Camera traps have been widely utilized as an indispensable tool to monitor the diversity, distribution, and activity patterns of wildlife. In 2019 and 2021, respectively, Ya'axché began monitoring biodiversity via camera traps in two co-managed protected areas, MMNFR and BNR. Wildlife monitoring allows us to understand the presence of species, particularly target species that have cultural, socio-economic, and ecological importance for Belize.

Bladen Nature Reserve

BNR during the dry season recorded 42 species (19 mammals and 23 birds), with 17 indicator species (11 mammals and 6 birds) as listed in Ya'axché's BRIM Strategy. The wet season recorded 58 species (21 mammals, 36 birds and 1 reptile), with 22 indicator species (11 mammals and 11 birds). Wildlife detected by the cameras include four of the five wildcats, and common prey species (game species), while birds include both native (gamebirds) and migrant birds.

The 2021 camera trap survey in BNR provided significant insights on the species richness and abundance index of species during the dry and wet season. It appears that majority of the carnivorous species, prey species and game bird species overlapped during both season, which denotes that wildlife activity pattern persist all year round. The first photographic evidence of the rare Northern naked-tailed armadillo (*Cabassous centralis*) was detected in BNR during the wet season. There was also a high encounter rate of white-lipped peccaries in BNR, which shows that BNR safeguards these species

that require a large tract of forest for their survival; similarly, to top predators such as jaguar and puma and a viable prey population.

Photo 10. An independent sighting of a *Cabassous centralis* in BNR during the wet season.

Photo 11. A squadron of white-lipped peccaries in BNR during the dry season.

Maya Mountain North Forest Reserve

MMNFR during the dry season recorded 41 species (21 mammals and 20 birds), with 19 indicator species (11 mammals and 8 birds) as listed in Ya'axché's BRIM Strategy. The wet season recorded 63 species (21 mammals, 39 birds, 1 insect and 2 reptiles), with 20 indicator species (11 mammals and 9 birds).

The camera trap survey yielded remarkable findings on species richness and abundance index of species for both the dry and wet seasons of 2020 and 2021. Five of the wildcats along with the prey species and

game birds overlapped in both seasons, ultimately indicating wildlife activity patterns remain active in the cacao concession. Notably, the concession is a disturbed landscape gradient embedded in the MMNFR which continues to support the level of biodiversity relatively equivalent to an undisturbed landscape. Species tolerance of disturbance that was detected in the camera includes jaguarundi, Mexican porcupine, forest rabbit, gray fox, and northern raccoon.

Photo 12. Jaguar detected in one of the camera stations in MMNFR Concession.

Photo 13. Puma detected in one of the camera stations in MMNFR Concession.

Implication of Camera Trapping Effort

Camera Trapping in BNR and MMNFR has yielded significant results on species richness and abundance index of species for both the dry and wet seasons. The majority of the wildcats, prey species, and game birds overlapping in both seasons are species of conservation concern and indicators species and their occupancy reflects a healthy forest where there is low hunting pressure. The high encounter rate of prey species (game species) with the presence of the wildcats also denotes that predator and prey in BNR and MMNFR remain active in their spatial-temporal niche, subsequently reflecting intact trophic level and management effectiveness of the protected areas. The findings from the camera trap also allow us to have a comprehensive understanding of the dynamics of predator and prey that can improve the species list for both mammals and birds, particularly for rare and elusive species not frequently encountered on transects (*Cabassous centralis*, white-lipped peccaries, jaguars, puma, crested guan, and great curassow). MMNFR concession has a unique position as a conserved landscape with sustainable agriculture activities that support a prominent level of biodiversity as habitat connectivity shows distinct species that thrive in both undisturbed and disturbed landscapes (jaguar, margay, jaguarundi, forest rabbit, northern raccoon, Mexican porcupine). Continuous monitoring in these PAs will also allow us to better understand the fluctuation of wildlife (indicator species) in their community structure. The monitoring is key to conserving and managing ecosystem, as it relates to improving management intervention of BNR and MMNFR.

Conclusions

Conditions across all three (3) protected areas did not change significantly from the previous reporting period. An increase in effort has had a marked impact on the amount of data collected for both enforcement & compliance and research & monitoring work. While the pandemic prevented adequate interagency collaboration, the times there was collaboration proved essential in planning ahead.

Golden Stream Corridor Preserve

Minor infractions related to NTFP extraction continue to be the only issue of concern documented in the reserve. The stability of activities allowed for increased presence in the other two protected areas. There are ample opportunities to strengthen the sustainable use of resources for traditional use and Ya'axché needs to widely disseminate its current approach to allowing access to these resources. Education and awareness efforts were unfortunately not very frequent due to restrictions but were effective in their purpose.

Wildlife monitoring in GSCP generally indicates stable to improving habitat conditions over the past 12 years. Threatened birds, especially game birds of conservation concern, and howler monkeys are rarely recorded in GSCP, possibly due to its proximity to communities. The presence of jaguars and migratory birds at the reserve transect locations has significantly declined. Planned camera monitoring in the farmscape surrounding GSCP in 2022 onward will assist in showing wider trends for jaguars across the landscape and help estimate the number of individuals present.

Bladen Nature Reserve

The BNR remained the most intact and undisturbed of the three protected areas

under Ya'axché's mandate. The remoteness of this reserve provides an opportunity to ensure adequate management of the area. Illegal timber extraction was a concern for the western sector of the BNR and will require significant interagency collaboration to stem the flow of illegal timber across our borders.

For the first time since Ya'axché took over management of the reserve, a new camera trap survey was established to monitor biodiversity in the BNR. Data suggests that biodiversity in the BNR is doing well with many incredible records including a rare Northern naked-tailed armadillo. However, despite the reserve having vast, intact stretches of forest, significant declines in migratory birds have been documented since 2010. Threatened birds have also been recorded in low numbers in recent years. These trends are not exclusive to BNR and may reflect wider changes in the landscape outside the reserve. Reports of other monitored species groups and ecosystem service indicators in BNR suggest stable and healthy forest condition. This offers more reason for increased surveillance of the BNR resources.

Maya Mountain North Forest Reserve

The MMNFR once again proved to be the most challenging protected area to monitor

in 2021. Illegal logging continued and illegal land clearings created increased pressures on the resources of the reserve as well as the resources of the organization. Extensive hotspot mapping was required to assess the areas of most importance and patrols were deployed accordingly. Early detection of illegal clearings using satellite imagery proved effective at addressing an escalating matter. It resulted in one case prosecuted successfully and a medium-term reduction in activities in the reserve.

Biodiversity research and monitoring since Ya'axche gained co-management in 2016 indicates stable habitat quality and the continued presence of threatened and culturally important species. Water resources in the reserve were of high quality in 2017 despite an agricultural presence within and immediately outside the reserve. This assessment needs to be repeated to detect any changes to water quality since that time. Tree species of timber and wildlife value are of moderate concern in the forest reserve, but patrols and planting activities in 2021 onward are expected to reduce threats and boost populations.

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