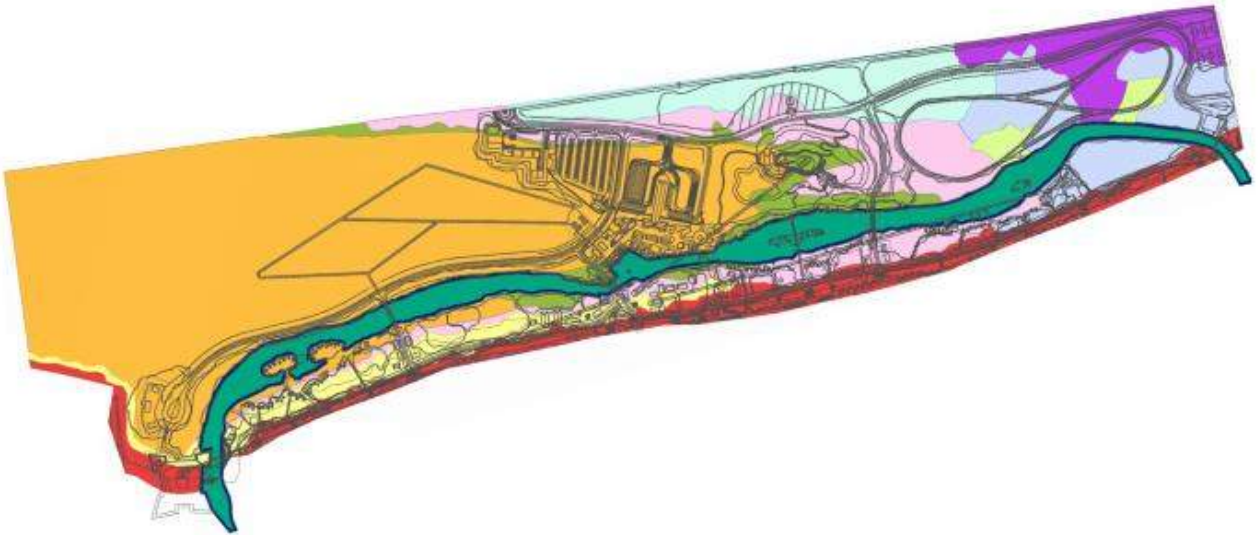




**TERRESTRIAL RESOURCE SURVEY
CARNIVAL GB PORT PROJECT**



Submitted to:

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INTRODUCTION

The 320-acre Carnival Property at Sharp Rock Point is a relatively undisturbed site along the Southern shore of Grand Bahama, located just outside the city of Freeport. The dominant topographical feature on the property is an extensive 155-acre Red Mangrove (*Rhizophora mangle*) wetland, also featuring an additional 60 acres of ephemeral wetlands dominated by Sabal Palm (*Sabal palmetto*), Sawgrass (*Cladium jamaicense*) and Cattail (*Typha domingensis*). A well-established 27-acre sandy dune with a diverse coastal shrubland exists on the southern shoreline, although dominated by invasive Casuarina (*Casuarina equisetifolia*) and Hawaiian Lettuce (*Scaevola taccada*). The southern eastern areas of the property are vegetated by 26 acres of dense old growth coppice forest, featuring a 30ft canopy with dark understory and exposed karst features. The highest ridge on the property, approximately 26 ft asl is in this coppice forest habitat.

SITE LOCATION

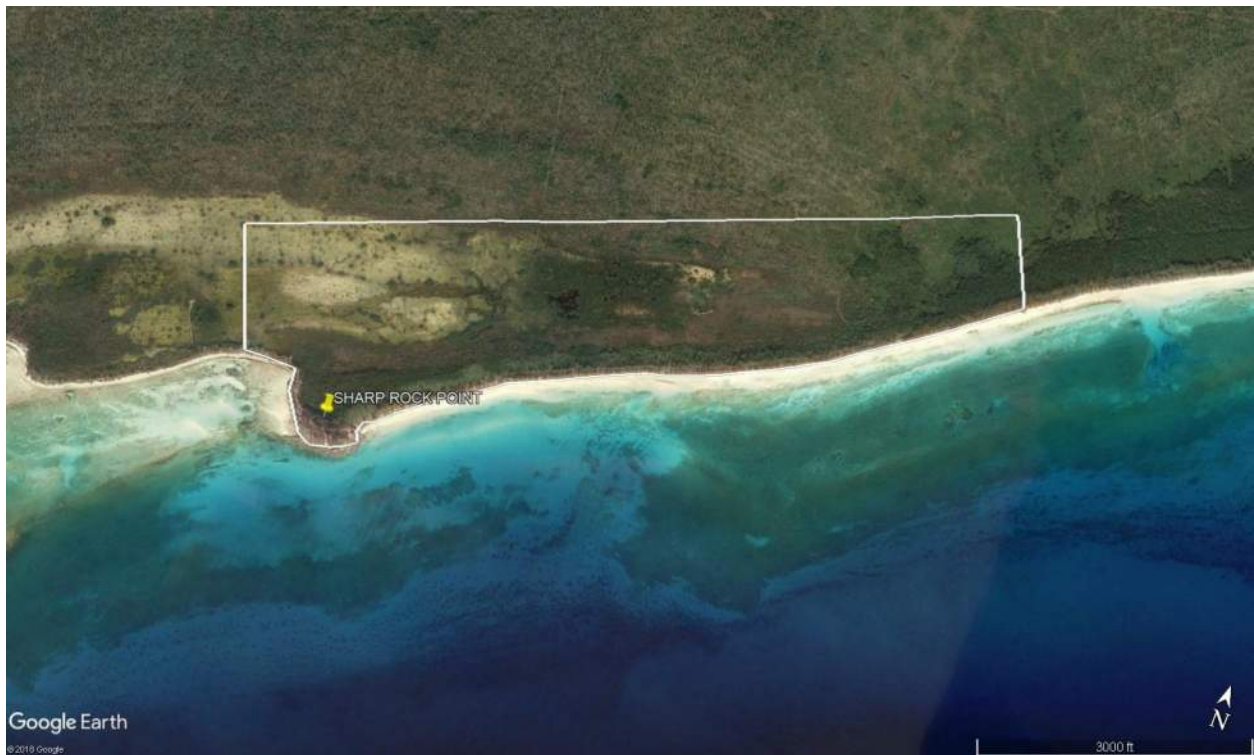
Figure 1. Grand Bahama Island, The Bahamas



Figure 2. Proximity of project site to City of Freeport



Figure 3. Carnival Port Project Site, Freeport, Grand Bahama



CLIMATE DATA

Ambient environmental conditions of the project site were collected during field assessments during the period of June 3-6, 2019. Environmental data was collected using a Kestrel 5200 Environmental Meter, and climate variables measured included Relative Humidity, Dew Point, Station Pressure, Air Speed, Temperature, Air Density, Barometric Pressure, Wind Chill, Heat Stress Index, Delta-T and Air Flow.

Sharp Rock Point Climate Readings - June 3, 2019 @ 10:43am		
Relative Humidity	%	65.5
Dew Point	Â°C	23.5
Station Pressure	mb	1016.7
Air Speed	mps	4.0
Temperature	Â°C	30.7
Air Density	kg/m ³	1.2
Barometric Pressure	mb	1016.6
Wind Chill	Â°C	30.7
Heat Stress Index	Â°C	36.5
Delta-T	Â°C	5.3
Air Flow	m ³ /s	0.4

Sharp Rock Point Climate Readings - June 4, 2019 @ 1:04pm		
Relative Humidity	%	67.4
Dew Point	Â°C	24.5
Station Pressure	mb	1017.5
Air Speed	mps	1.5
Temperature	Â°C	31.3
Air Density	kg/m ³	1.2
Barometric Pressure	mb	1017.5
Wind Chill	Â°C	31.3
Heat Stress Index	Â°C	38.4
Delta-T	Â°C	5.1
Air Flow	m ³ /s	0.2

Sharp Rock Point Climate Readings - June 5, 2019 @ 10:30am		
Relative Humidity	%	66.1
Dew Point	Â°C	23.3
Station Pressure	mb	1018.2
Air Speed	mps	1.8
Temperature	Â°C	30.4

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Air Density	kg/m ³	1.2
Barometric Pressure	mb	1018.2
Wind Chill	Â°C	30.3
Heat Stress Index	Â°C	35.8
Delta-T	Â°C	5.2
Air Flow	m ³ /s	0.2

SURFACE WATER QUALITY

<u>Site</u>	<u>Sharp Rock Point</u>		
<u>Description of Water Body</u>	Mangrove wetland body dominated by R. mangle. No direct connectivity to sea.		
<u>GPS</u>	26°34'29.18"N, 78°29'28.92"W		
<u>Date</u>	July 15, 2019		
<u>Data Point</u>	2	3	4
<u>Time</u>	2:15pm	2:20pm	2:24pm
<u>Temp (°C)</u>	32.9	33.55	35.9
<u>pH</u>	8.4	8.25	8.45
<u>Turbidity (NTU)</u>	25.8	43.7	20.1
<u>DO (mg/L)</u>	8.05	8.32	7.03
<u>TDS (g/L)</u>	9.47	7.52	9.69
<u>Salinity (ppt)</u>	8.83	6.92	9.04

Figure 4. Surface water quality sampling location



TERRESTRIAL HABITATS

Methodology

Floral surveys of the study site were conducted to include areas to be directly impacted by project activities during construction and operations. Walking releve surveys were conducted to generate comprehensive botanical lists for the sites and to delineate terrestrial habitat and their transition zones, assess the structure, composition and diversity of habitats within these areas. Walking transects were conducted throughout the study site to determine density, frequency and cover of tree, shrub and herbaceous species. GPS locations of special features, habitat boundaries and trees designated as “Protected” by the GBPA’s Environmental Bye-Laws were recorded using a Garmin 64 GPS. Observations of fauna along transects and around the project site was recorded to provide measures of abundance and species diversity.

Figure 5. Terrestrial Habitat Map - Carnival Project Site Grand Bahama



CASUARINA DOMINATED SANDY DUNE-COASTAL SHRUBLAND COMMUNITIES

The vegetation in this habitat is rarely above 1m tall, comprised mostly of sprawling, herbaceous and stunted, shrubby vegetation, Hurricane impacts evident as dunes showing signs of erosion and flattening due to flooding. Many individuals of dead Casuarina collecting in this zone, possibly washed inland once uprooted from its coastal habitats. Marine debris is heavy in this zone, collecting in the shrubby vegetation along the coastline of the property. Mostly woody debris and bottles.

Intertidal Zone – Southern shoreline of property





Casuarina equisetifolia is the dominant tree cover in this community, averaging 50ft tall and 15-50cm DBH. Good diversity of native beach vegetation established in the understory. Understory species include, *Tournefortia gnaphalodes*, *Coccoloba uvifera*, *Scaevola taccada* (invasive), *Suriana maritima*, *Ipomoea pes caprae*, *Ipomoea violacea*, *Cakile lanceolata*, *Sesuvium portulacastrum*, *Hymenocallis arenicola*, *Trema lamarckianum*, *Stylosanthes hamada*, *Poaceae sp*, *Cynanchum sp*, *Stachytarpheta jamaicensis*, and *Chrysobalanus icaco*.

Casuarina Dominated Coastal Shrubland







COASTAL SHRUBLAND – TRANSITION ZONE

The coastal shrublands along the southern shores of the property is also dominated by the extensive *Casuarina* stand. The understory has maintained good diversity despite the *Casuarina* invasion, supporting 30 species of plants, one of which is endemic to The Bahamas. Among the coastal shrublands of the property is *Erithalis fruticosa*, *Randia aculeata*, *Hibiscus rosa sinensis*, *Leuceana leucocephala* (invasive), *Pentalinon luteum*, *Cassytha filiformis*, *Ipomoea violaceae*, *Bursera simaruba*, *Vachellia choriophylla*, *Sabal palmetto*, *Lamb's quarters*, *Sida aculeata*, *Scaevola taccada* (invasive), *Hymenocallis arenicola*, *Borreria latifolia*, *Ambrosia hispida*, *Caesalpinia bonduc*, *Smilax havanensis*, *Eugenia foetida*, *Agave sisiliana*, *Metopium toxiferum*, *Chiococca alba*, *Guapira obtusata* (protected), *Guapira discolor*, *Caesalpinia bahamense*, *Tournefortia volibulis*, *Lasciacis divaricata*, *Eugenia axillaris*, *Lantana involucrata* and *Varronia bahamensis* (endemic).

The coastal road providing access to the southern shorelines of the property traverses the transition zone between the coastal shrublands and nearby coppice forest and ephemeral wetlands.

Coastal Shrubland



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BROADLEAF INTERIOR COPPICE

The south eastern regions of the property are vegetated by a broadleaf coppice forest, reaching canopy heights up to 30ft. The forest features a dark understory, developed successional vegetation and dark, humus rich soil. The invasive *Casuarina* along the coastal habitats do not penetrate this intact system. The northern extent of the coppice forests borders fire impacted zones, stemming from natural fires in the surrounding pine forests ecosystems.

The dominant canopy species in this habitat are *Bursera simaruba*, *Lysiloma latisiliquum*, and *Metopium toxiferum*, also including *Picramnia pectandra*, *Coccoloba diversifolia*, *Eugenia axillaris*, *Sabal palmetto*, *Chrysophyllum oliviforme*, *Sideroxylon foetidissimum*, *Psychotria nervosa*, *Guettarda scabra*, *Krugiodendron ferreum*, *Guapira obtusata* (protected), *Exostema caribeaum*, *Coccothrinax argentata*, *Exothea paniculata*, *Ocotea coriacea*, *Vachellia choriophylla*, *Ficus aurea* (invasive), *Simarouba glauca*, *Opuntia stricta*, *Eugenia foetida*, *Hibiscus rosa-sinensis*, *Drypetes laterifolia*, *Tetrazygia bicolor*, *Piscidia piscipula*, and *Calliandra formosa*.

INTERIOR BROADLEAF COPPICE



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FIRE IMPACTED HABITAT

Areas previously impacted by fire are devoid of high canopy coppice forests, currently reduced to pine shrublands dominated by *Coccothrinax argentata* and *Pteridium aquilinum*. Also, in the fire impacted areas are *Trema lamarckianum*, *Psychotria nervosa*, *Solanum erianthum*, *Wedelia trilobata* (invasive), *Capsicum annum*, *Cissus tuberculata*, *Ipomoea violacea*, *Eupatorium villosum*, *Duranta repens*, *Senna occidentalis*, *Ipomoea microdactyla*, *Stylosanthes hamada*, *Morinda royoc*, and *Myrica cerifera*. Pockets of coppice vegetation are scattered within the fire impacted areas of the site, functioning as hammocks with a higher canopy and density of broadleaf forest species. These hammocks are dominated by *Lysiloma latisiliquum*, *Exothea paniculata*, *Cassytha filiformis*, *Tabebuia bahamensis*, *Bursera simaruba*, *Coccoloba diversifolia* and *Drypetes laterifolia*.

FIRE IMPACTED COPPICE



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FIRE IMPACTED SABAL WOODLAND





SEMI-PERMANENTLY FLOODED/EPHEMERAL WETLANDS

Most of the habitat on the property can be classified as Semi permanently flooded or ephemeral wetlands, with surface water levels fluctuating throughout the year, coinciding with the rainy season. These ephemeral wetlands are dominated by *Sabal palmetto* and *Cladium jamaicense*, with the invasive *Typha domingensis* colonizing areas of standing water where available. Also, in these wet habitats are *Conocarpus erectus*, *Cassytha filiformis*, *Pluchea odorata*, *Ardisia escallandoides*, *Annona glabra* and *Schinus terebinthifolius*. Pockets of surface water dubbed as Pond apple holes, exists throughout the property, which are standing areas of water or highly saturated mucky soils, dominated by *Annona glabra*, along with *Centella asiatica*, *Typha domingensis* (Cattail), *Bacopa monnieri*, *Pluchea odorata*, *Agalinis maritima*, and *Oxypolis filiformis*.

Some of these exposed surface wetlands are dominated completely by *Typha* and *Oxypolis* and are also found in mixed population in these microhabitats on the property.

SEMI PERMANENTLY FLOODED WETLANDS





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PERMANENTLY FLOODED MANGROVE WETLAND

Permanently flooded wetlands are also extensive on the property, with a large brackish wetland dominated by *Rhizophora mangle*. The mangrove wetland does not have an open connection to the nearby sea, and do not exhibit the same tidal fluctuations.

MANGROVE WETLAND





SABAL PALM WOODLAND

To the north of the mangrove wetlands, the habitat transition to a less brackish mucky substrate, colonized by *Cladium jamaicense*, *Eleocharis interstincta*, *Conocarpus erectus*, *Tillandsia balbisiana*, and sporadic *Rhizophora mangle* individuals. As these areas transition to higher elevations, the substrate becomes even drier, allowing for establishment of the Sabal Palm dominated woodland, also including *Coccothrinax argentata*, *Metopium toxiferum*, *Tabebuia bahamensis*, *Jacquinia keyensis*, *Dicromena floridanum*, *Myrica fragrans*, *Pluchea symphitifolia*, *Smilax havanensis*, *Waltheria indica*, *Pentalinon luteum*, *Cassytha filiformis*, *Casuarina equisetifolia* (invasive), *Byrsonima lucida*, *Ernodea littoralis*, *Chiococca parviflora*, *Ipomoea sp*, *Achrostichum fern*, *Lysiloma latisiliquum*, *Morinda royoc*, *Erythroxylum rotundifolia*, *Stemodia maritima*, *Angadenia sp*, *Erithalis fruticosa*, *Melochia tomentosa*, *Guapira discolor*, *Pteridium aquilinum*, *Guettarda scabra*, *Andropogon sp*, *Agave braceana* and *Buchnera floridana*.

SABAL PALM WOODLAND





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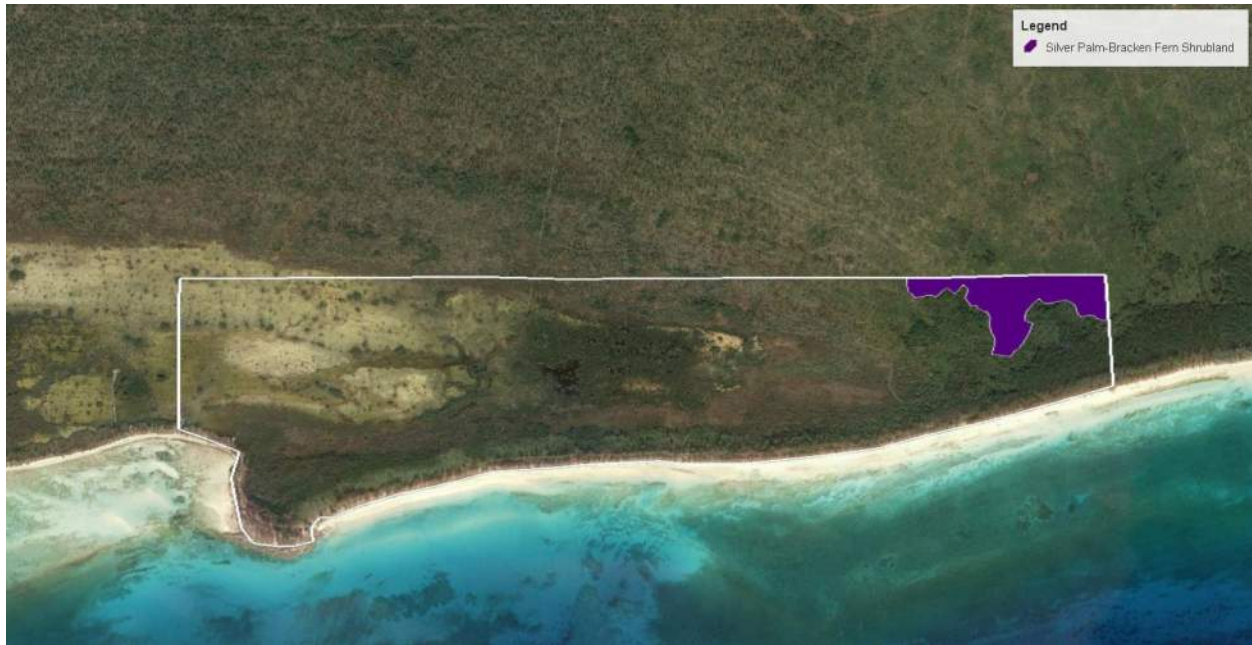
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SILVER PALM – BRACKEN FERN SHRUBLAND





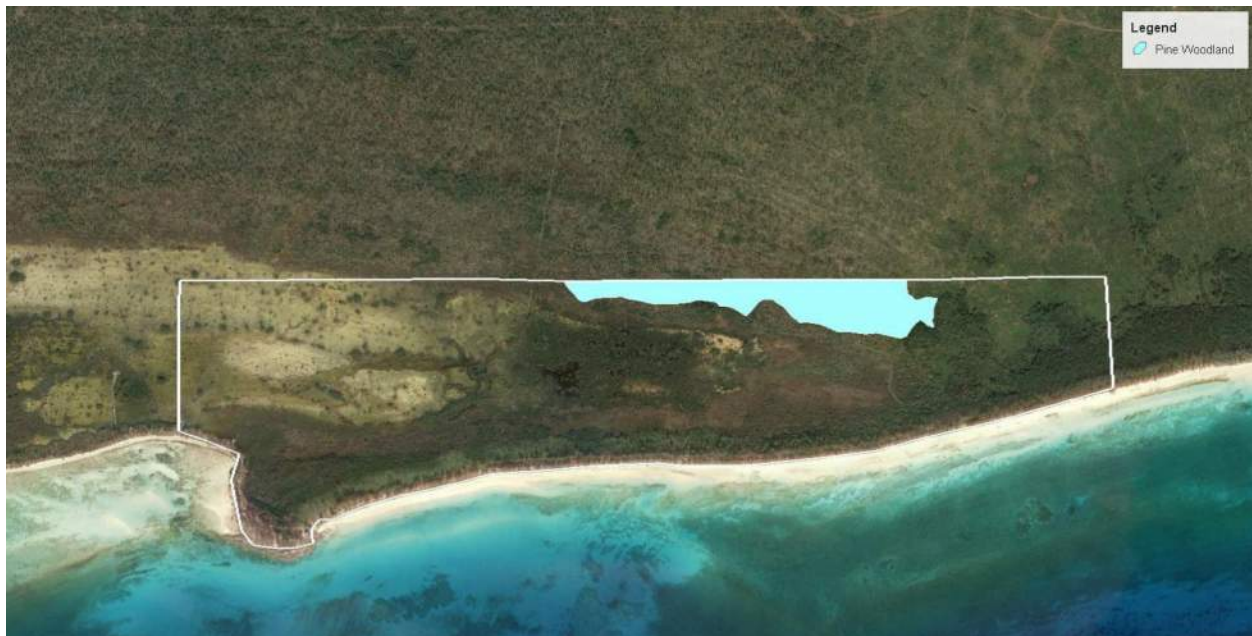


PINE WOODLAND

The Pinus habitat is restricted to just over 20 acres in the rockland areas north of the Mangrove wetland, where ground water is less brackish than the coastal habitats on the property. The Pine in this woodland habitat do not form a closed canopy, mostly forming small clusters between solitary individuals. Individuals average 6-8m tall with an average DBH of 15cm. Succession of saplings are evident in immediate areas of Pine clusters, with few solitary young individuals scattered in the habitat.

The substrate in this Pine woodland habitat is characteristic of the pine rockland habitat. Exposed weathered limestone rocks and boulders form pockets which collect soil and organic sediment. This habitat is less waterlogged than the Sabal woodlands and ephemeral wetlands on the property, however pockets of mucky soil are found in rocky depressions below the water table line. Surface water from the pine woodlands flow southward into the mangrove and ephemeral wetlands on the property.

PINE WOODLAND



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TERRESTRIAL FLORA

Family	Genus	Species	Common Name	Habitat
Polypodiaceae	Acrostichum	aureum	Giant Leather Leaf Fern	SW
Scrophulariaceae	Agalinus	maritima	Salt March Agalinus	EW/PW
Agavaceae	Agave	sisiliana	Sisal	CS/CC/CP
Agavaceae	Agave	braceana	Agave	PW
Asteraceae	Ambrosia	hispida	Bay Geranium	IT/SD/CS
Rutaceae	Amyris	elemifera	White Torch	CP
Schizaceae	Anemia	adiantifolia	Pine Fern	PW
Apocynaceae	Angadenia	sagraei	Lice Root	SW/PW
Annonaceae	Annona	glabra	Pond Apple	EW
Primulaceae	Ardisia	escallanoides	Marlberry	EW/CC/CP
Scrophulariaceae	Bacopa	monnieri		EW
Fabaceae	Bauhinia	variegata	Poor Man's Orchid	CS
Blechnaceae	Blechnum	serrulatum	Marsh Fern	EW/SW
Rubiaceae	Borreria	laevis	Buttonweed	CS
Boraginaceae	Bourreria	succulenta	Strongback	CP
Scrophulariaceae	Buchnera	floridana		SW
Burseraceae	Bursera	simaruba	Gum Elemi	CS/CC/CP
Malpighiaceae	Byrsonima	lucida	Guana Berry	EW/SW/PW
Fabaceae	Caesalpinia	bonduc	Nicker Bean	CS/CC/CP
Boraginaceae	Cakile	lanceolata	Sea Rocket	IT/SD
Fabaceae	Calliandra	formosa	White Calliandra	CC/CP
Scrophulariaceae	Capraria	biflora	Goat Weed	CS/SW
Solanaceae	Capsicum	annum	Bird pepper	FI
Celastraceae	Cassine	xylocarpa	Olive-Wood	CS
Lauraceae	Cassytha	filiformis	Love Vine	CS/CC/CP/SW
Casuarinaceae	Casuarina	equisetifolia	Australian Beefwood	SD/CS/SW
Orchidaceae	Cattleyopsis	lindenii		EW/MN
Apiaceae	Centella	asiatica	Centella	EW
Rubiaceae	Chiococca	alba	Snowberry	CC/CP
Rubiaceae	Chiococca	parviflora	Pineland Snowberry	PW
Asteraceae	Chromolaena	odorata	Bitter Bush	FI
Sapotaceae	Chrysophyllum	oliviforme	Satin Leaf	CP
Chysobalanaceae	Chysobalanus	icaco	Coco Plum	CS/CC/EW
Vitaceae	Cissus	tuberculata	Warty Cissus	FI
Cyperaceae	Cladium	jamaicense	Sawgrass	EW/SW
Polygonaceae	Coccoloba	uvifera	Seagrape	CS/CC
Polygonaceae	Coccoloba	diversifolia	Pigeon plum	CP
Polygonaceae	Coccoloba	swartzii	Swart'z Pigeon Plum	CP
Polygonaceae	Coccoloba	tenuifolia	Bahama Pigeon Plum	CP/PW
Areaceae	Coccothrinax	argentata	Silver Thatch Palm	CC/CP/PW
Combretaceae	Conocarpus	erectus	Buttonwood	EW/MW

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Boraginaceae	Cordia	sebestena	Geiger Tree	CS/CC
Celastraceae	Crossopetalum	rhacoma	Poison Cherry	CS
Apocynaceae	Cynanchum	blodgettii		SD/CS
Cyperaceae	Cyperus	planifolius	Coast Cyperus	CS
Cyperaceae	Dichromena	floridanum		SW/PW
Euphorbiaceae	Drypetes	laterifolia	Guiana Plum	CP
Verbenaceae	Duranta	repens	Pigeonberry	FI
Cyperaceae	Eleocharis	cellulosa	Spike Rush	EW
Rubiaceae	Erithalis	fruticosa	Black Torch	CS/CC
Rubiaceae	Ernodea	littoralis	Golden Creeper	SW/PW
Erythroxylaceae	Erythoxylum	rotundifolium	Rat Wood	SW
Myrtaceae	Eugenia	foetida	Stopper	CS/CC/CP
Myrtaceae	Eugenia	axillaris	Stopper	CC/CP
Rubiaceae	Exostema	caribeum	Prince Wood	CP
Sapindaceae	Exothea	paniculata	Butter Bough	CP
Moraceae	Ficus	aurea	Strangler Fig	CP
Asteraceae	Flaveria	linearis		CS/SW
Nyctaginaceae	Guapira	obtusata	Beefwood	CC/CP
Nyctaginaceae	Guapira	discolor	Narrow Leaf Blolly	CS/CC/SW
Rubiaceae	Guettarda	scabra	Velvet Seed	CP/SW
Asteraceae	Gundlachia	corymbosa	Horse Bush	CS
Malvaceae	Hibiscus	rosa-sinensis	Hibiscus	CS/CC/CP
Amaryllidaceae	Hymenocallis	arenicola	Spider Lily	SD/CS
Aquifoliaceae	Ilex	krugiana	Krug's Holly	CS/CC
Convolvulaceae	Ipomoea	pes-caprae	Railroad Vine	IT/SD/CS
Convolvulaceae	Ipomoea	violaceae	Moon-vine	SD/CS/FI
Convolvulaceae	Ipomoea	microdactyla	Wild Potato	FI
Primulaceae	Jacquinia	keyensis	Joewood	CS/CC/SW
Asteraceae	Koanophyllon	villosum	Jackmada	FI
Rhamnaceae	Krugiodendron	ferreum	Iron Wood	CC/CP
Verbenaceae	Lantana	involucrata	White Sage	CS/CC
Poaceae	Lasciacus	divaricata	Bamboo Grass	CP
Fabaceae	Leuceana	leucocephala	Jumbey	CC/CP
Fabaceae	Lysiloma	latisiliquum	Wild Tamarind	CP/SW
Malvaceae	Melochia	tomentosa	Velvet Leaf	CS/SW
Anacardiaceae	Metopium	toxiferum	Poison Wood	CC/CP/PW/SW
Rubiaceae	Morinda	royoc	Rhubarb	FI/PW/SW
Myrtaceae	Myrcianthes	fragrans	Naked Wood	CP/SW
Myrtaceae	Myrica	cerifera	Bay-Berry	FI/PW
Primulaceae	Myrsine	cubana		CP
Lauraceae	Ocotea	coriacea	Lancewood	CP
Orchidaceae	Oeceoclades	maculata	African Spotted Orchid	CP
Cactaceae	Opuntia	stricta	Prickly Pear Cactus	CC/CP
Apiaceae	Oxypolis	filiformis	Water Dropwort	EW
Passifloraceae	Passiflora	suberosa	Small Passion Flower	SD

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Apocynaceae	Pentalinon	luteum	Wild Allamanda	CS/CC/SW
Polypodiaceae	Phlebodium	aureum	Serpent Fern	CP
Simaroubaceae	Picramnia	pentandra	Snake-Root	CP
Pinaceae	Pinus	caribea var. bahamensis	Caribbean Pine	PW
Fabaceae	Piscidia	piscipula	Dogwood	CP
Plantaginaceae	Plantago	major	Common Plantain	CS
Polypodiaceae	Pleopeltis	polypodoides	Resurrection Fern	CP
Asteraceae	Pluchea	odorata	Marsh Fleabane	EW/SW
Rubiaceae	Psychotria	nervosa	Wild Coffee	CP
Dennstaedtiaceae	Pteridium	aquilinum	Bracken Fern	FI/PW/SW
Rubiaceae	Randia	aculeata	Box Briar	CS/CC
Apocynaceae	Rhabdadenia	biflora	Mangrove Swamp Vine	EW/MW
Rhizophoraceae	Rhizophora	mangle	Red Mangrove	MW
Arecaceae	Sabal	palmetto	Sabal Palm	CS/CC/EW/CP
Goodeniaceae	Scaevola	taccada	Hawaiian Lettuce	CS/CC
Anacardiaceae	Schinus	terebinthifolius	Brazilian Pepper	EW/CC/CP
Fabaceae	Senna	occidentalis	Stinking Pea	FI
Aizoaceae	Sesuvium	portulacastrum	Sea purslane	SD
Malvaceae	Sida	aculeata	Slippery Dick	CS/CC
Sapotaceae	Sideroxylon	foetidissimum	Mastic Tree	CP
Sapindaceae	Sideroxylon	salicifolia	Willow Busic	SW/PW
Simaroubaceae	Simarouba	glauca	Paradise Tree	CP
Iridaceae	Sisyrinchium	sp		SW
Smilacaceae	Smilax	havanensis	Razor Vine	CS/CC/CP/SW
Solanaceae	Solanum	erianthum	Wild Tobacco	FI
Asteraceae	Sphagneticola	triloba	Wedelia	FI
Verbenaceae	Stachytarpheta	jamaicense	Blue Flower	SD/CS
Scrophulariaceae	Stemodia	maritima	Obeah Bush	SW
Fabaceae	Stylosanthes	hamada	Pencil Flower	SD/CS/FI
Surianaceae	Suriana	maritima	Bay Cedar	CS/CC
Meliaceae	Swietenia	mahagoni	Caribbean mahogany	SW/PW
Bignoniaceae	Tabebuia	bahamensis	Five Finger	CP/PW/SW
Melastomaceae	Tetrazygia	bicolor		CP/PW
Bromeliaceae	Tillandsia	balbisiana	Cuttlefish	EW/MN/SW
Bromeliaceae	Tillandsia	fasciculata	Wild Pine	CP
Boraginaceae	Tournefortia	gnaphalodes	Sea Lavendar	IT/SD/CS
Boraginaceae	Tournefortia	volibulis	Soldier Vine	CS/CC
Anacardiaceae	Toxicodendron	radicans	Poison Ivy	SW/PW
Cannabaceae	Trema	lamarckianum	Pain in Back	CS/CC/FI
Passifloraceae	Turnera	ulmifolia	Bahama Buttercup	SD/CS
Typhaceae	Typha	domingensis	Cattail	EW
Fabaceae	Vachellia	choriophylla	Cinnecord	CS/CC/CP/PW
Boraginaceae	Varronia	bahamensis	Cat's Tongue	SW/PW
Malvaceae	Waltheria	indica	Wooly Buggar	SW/PW

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Rutaceae	Zanthoxylum	coriaceum	Hercules Club	CP
Endemic Species	SD-Sandy Dune Community	EW-Ephemeral Wetland	PW-Pine Woodland	
Protected Species	CS-Coastal Shrubland	MW-Mangrove Wetland	CP-Coppice Forest	
Invasive Species	CC-Coastal Coppice	SW-Sabal Woodland	FI-Fire Impacted	

HABITAT KEY: PW – PINE WOODLAND; SD – SANDY DUNE; CS – COASTAL SHRUBLAND; SW – SABAL WOODLAND; IT – INTERTIDAL ZONE; CP – BROADLEAF COPPICE; MW – MANGROVE WETLAND; FI – FIRE IMPACTED

During field surveys, 131 species of terrestrial flora distributed within 60 plant families were identified. Eight (8) invasive species were recorded on the property, with *Casuarina equisetifolia*, *Scaevola taccada* and *Schinus terebinthifolius* the most dominant species colonizing coastal and ephemeral wetland habitats. Three (3) species of protected trees were identified during surveys, *Pinus caribaeum* var. *bahamensis*, *Guapira obtusata* and *Swietenia mahagoni*. Pine were only recorded as trees species in the Pine Woodland on the property, *Guapira obtusata* were abundant within areas of the interior broadleaf coppice as mature tree and saplings, and few small saplings of *Swietenia mahagoni* were observed in the Pine woodland.

Terrestrial Fauna

<u>Family</u>	<u>Genus</u>	<u>Species</u>	<u>Common Name</u>	<u>Habitat</u>
<u>INVERTEBRATES</u>				
Nymphalidae	Agraulis	vanillae	Gulf Fritillary	PW
Gecarcinidae	Cardisoma	guanhumi	Land Crab	SD/CS/SW
Coenobitidae	Coenobita	clypeatus	Soldier Crab	CP
Tabanidae	Diachloris	ferrugatis	Horse Fly	SD/CS/PW
Cicadidae	Diceroprocta	bonhotei	Cicada	PW
Libellulidae	Orthemis	sp.	Antillean Skimmer	MW
Papilionidae	Papilio	andraemon	Bahamian Swallow Tail	SD/CS
Hesperdiidae	Polygonus	leo	Hammock Skipper	SD/CS
Acrididae	Schistocera	americana	American Bird Grasshopper	PW
Hesperdiidae	Urbanus	proteus	Long Tailed Skipper	CS/SW
<u>AVIAN</u>				
Charadriidae	Charadrius	vociferus	Killdeer	IT
Thraupidae	Coereba	flaveola	Bananaquit	CP
Columbidae	Columbina	passerina	Common Ground Dove	PW
Cuculidae	Crotophaga	ani	Smooth Billed Ani	PW
Thraupidae	Melopyrrha	violaceae	Greater Antillean Bullfinch	CP
Mimidae	Mimus	polyglottos	Northern Mockingbird	CP
Tyrannidae	Myiarchus	sagrae	La Sagra's Flycatcher	MW
Spindalidae	Spindalis	zena	Western Spindalis	PW
Scolopacidae	Tringa	solitaria	Sandpiper	IT

Tyrannidae	Tyrannus	dominicensis	Gray Kingbird	PW
Vireonidae	Vireo	crassirostris	Thick Billed Vireo	CP
Columbidae	Zenaida	aurita	Zenaida Dove	PW
REPTILIAN				
Teiidae	Ameiva	auberi	Lion Lizard	PW
Leiocephalidae	Leiocephalus	carinatus	Curly Tail Lizard	SD/CS/SW
Sincidae	Plestiodon	inexpectatus	Southeastern Five Lined Skink	SW
Dactyloidae	Anolis	sagrei	Brown Anole	CP

HABITAT KEY: PW – PINE WOODLAND; SD – SANDY DUNE; CS – COASTAL SHRUBLAND; SW – SABAL WOODLAND; IT – INTERTIDAL ZONE; CP – BROADLEAF COPPICE; MW – MANGROVE WETLAND

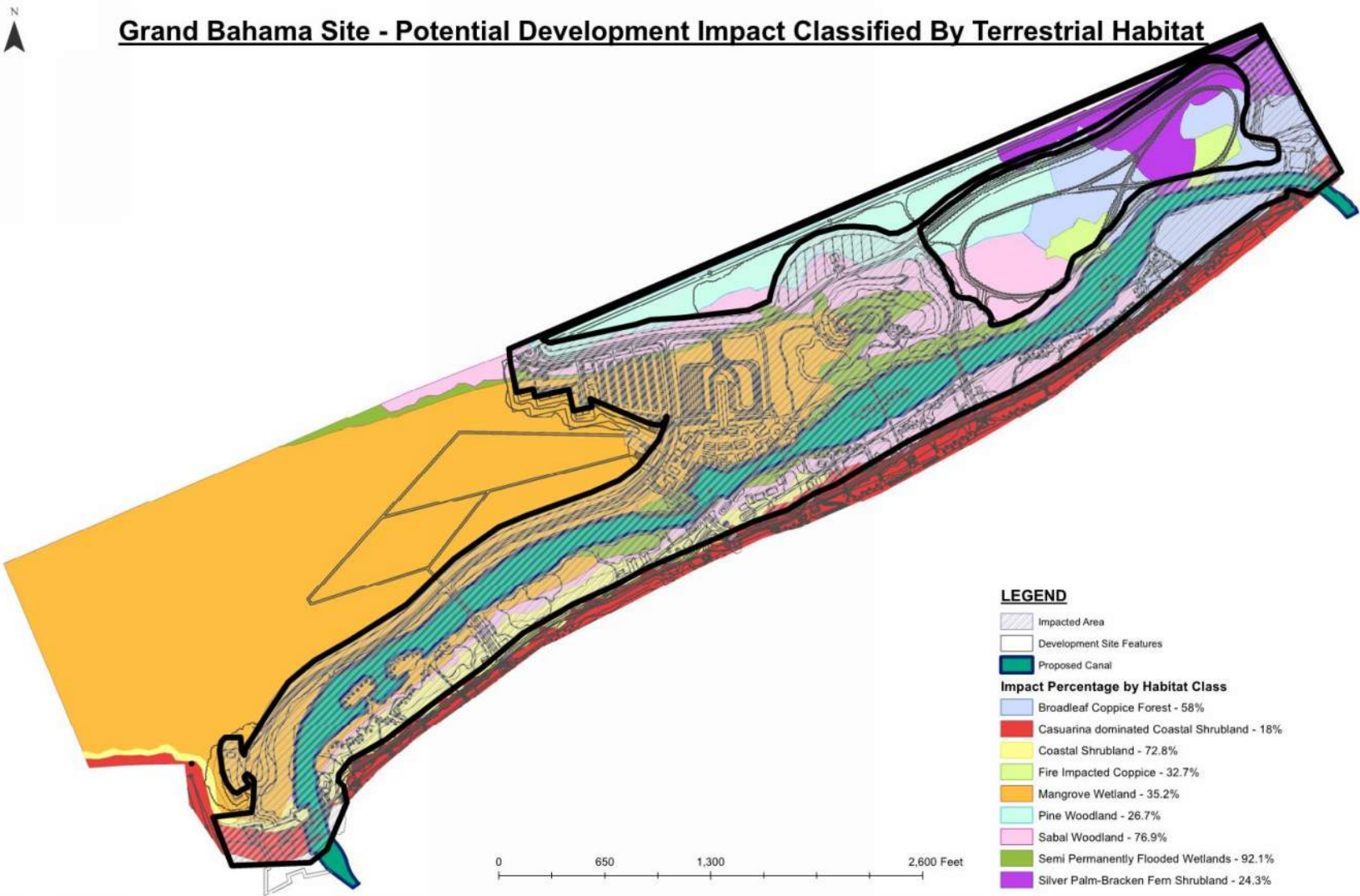


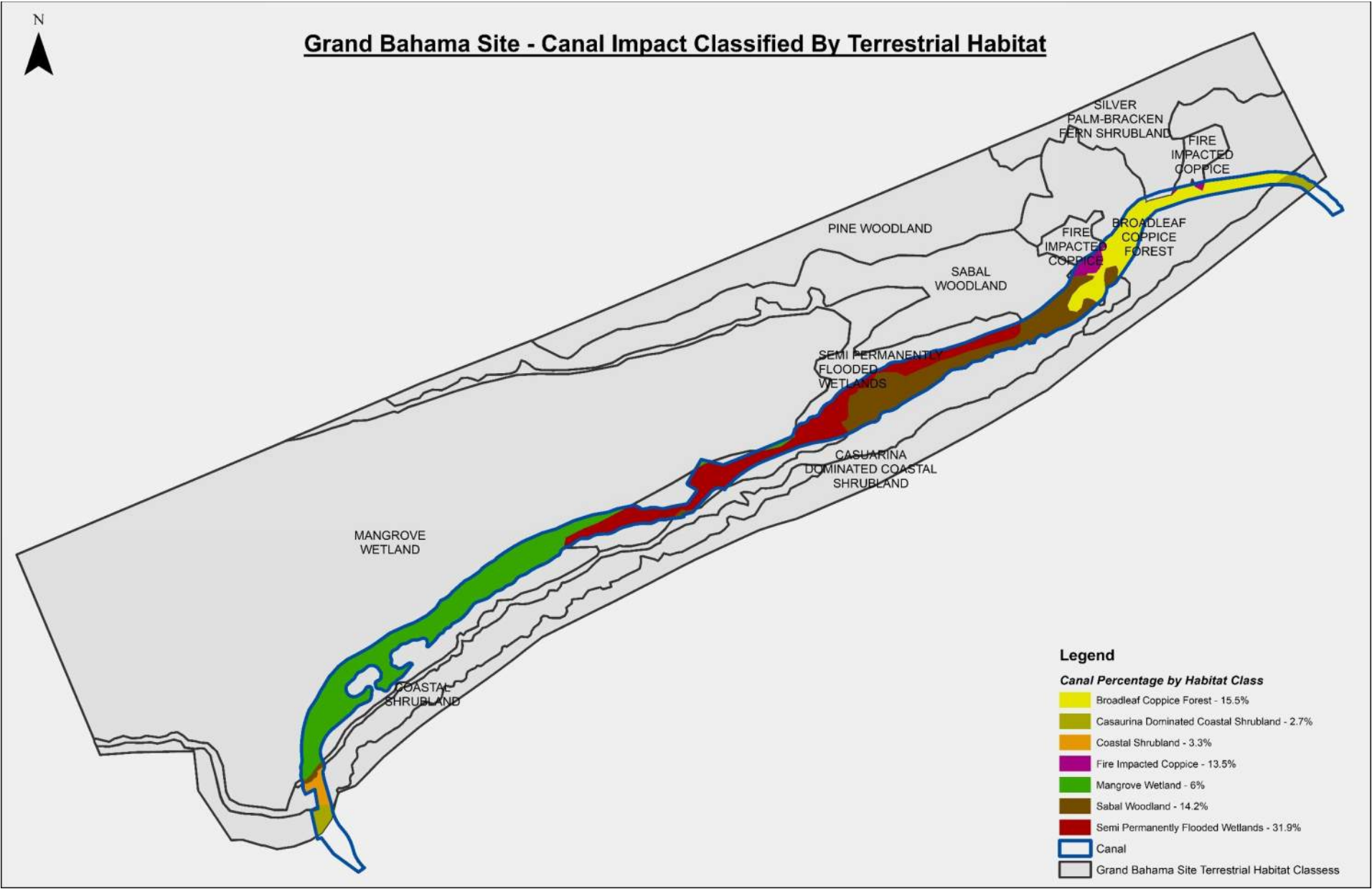


TERRESTRIAL HABITAT IMPACT ESTIMATE TABLE

ID	Habitat Class	Total Habitat Acreage	Impacted Area Acreage Within Habitat	Impact Percentage
1	Broadleaf Coppice Forest	25.48	14.78	58.01%
2	Casaurina Dominated Coastal Shrubland	26.43	4.77	18.03%
3	Coastal Shrubland	13.98	10.17	72.76%
4	Fire Impacted Coppice	3.96	1.29	32.65%
5	Mangrove Wetland	155.18	54.60	35.19%
6	Pine Woodland	21.61	5.76	26.66%
7	Sabal Woodland	41.56	31.97	76.91%
8	Semi Permanently Flooded Wetlands	20.23	18.62	92.05%
9	Silver Palm-Bracken Fern Shrubland	13.44	3.27	24.31%

TERRESTRIAL HABITAT IMPACT ESTIMATES





DISCUSSION

FIRE REGIME

The fire regime of the pine forests surrounding the property have impacted the site previously and should be considered for future site management. Coppice forested areas severely impacted by fire disturbance have lost its dominant forest structure, removing the closed canopy, understory and thick leaf litter of the forest floor. Once disturbed by fire, these impacted areas were populated by the weedy Bracken Fern and other climbing, vining species outgrowing the shrubby understory. Burnt remains of broadleaf species were evident in these fire impacted areas.

Evidence of fire was observed in the Sabal woodlands along the southern shore of the property. In these areas 90% of Palm trunks shows signs of charring from fire, some char marks reaching up to 8 ft along the Palm's trunk. The understory herbaceous Cladium also showed signs of charring from fire. It is suspected that fire spread into these areas during the dry seasons, as these ephemeral wetlands become inundated and remain wet during the rainy season.

MANGROVE WETLAND

The extensive mangrove system occupying most of the property functions primarily as a watershed for the surrounding areas, evidenced by the presence of similar mangrove wetlands along the southern coastline of Grand Bahama, and the surface flow of water from areas north of the property into this wetland area. The mangrove wetland is not directly connected to the open sea and as a consequence does not have a similar tidal amplitude as the nearby ocean as confirmed in the Hydrogeologic Study. The brackish nature of the wetland has been confirmed by water quality sampling, additionally the presence of typical freshwater/brackish water species such as Eleocharis and Cladium along its margins indicate low salt concentrations in this wetland.

An active bird community utilizes the red mangroves dominating the inundated areas and were observed nesting and feeding in these areas of the wetland. Aquatic fauna were observed in the deeper portions of the wetland west of the property boundary. A small school of 5 Tarpons were observed swimming in the wetland, along with small aquatic gastropods and snails along the wetland's edge.

The mangrove wetland on the property does not have an open connection to the nearby offshore environments and does not directly connect terrestrial and marine habitats and food webs. Aquatic algae and fauna observed in the wetland are known to inhabit brackish wetlands, with a tolerance for higher salinities approaching ocean water concentrations. The wetland has experienced some impacts from human activities in the past, as evidenced by overgrown roads, vehicle track lines and logging boundaries can be observed in the field and from satellite imagery.

INVASIVE SPECIES MANAGEMENT

Although the sandy dune and coastal shrubland habitats are dominated by Casuarina in its canopy, and Scaevola in its understory, a diverse community of native coastal plant species remain healthy and reproductive in these conditions. The erosion of the southern shoreline is evident on the property, due to the severe colonization of these coastal areas by Casuarina, a species known to encourage coastal

erosion and topple easily during rough weather. Toppled-dead Casuarinas are scattered throughout this habitat, along with dead branches broken during storms and severe weather. The Scaevola in the understory out completes its native relative Scaevola plumieri.

With regards to restoring the overall health of the dune, mitigation measures can be restricted to removal of Casuarina and Scaevola from these areas, allowing the resident native vegetation to flourish and take advantage of resources once capitalized by invasives. Removal of invasive species from these sensitive areas must be done with care to prevent damage to the dune crest as well as the resident flora there. The use of chainsaws and other hand tools is recommended over the use of heavy equipment for removal of trees. Smaller individuals of Casuarina averaging widths of 15-20cm DBH are mostly abundant on the foredune and dune crest, whereas larger individuals averaging 30-55cm DBH occur along the lee side of the road in the transition zone to coastal interior coppice forests. The Casuarina species is resilient and will stump sprout if a stump is left in the ground untreated.

The trunk of the tree should be cut as level to the existing grade as possible and treated with an effective herbicide to prevent re-sprouting. As coastal areas tend to be windy, application of herbicides during Casuarina removal should be painted on the cut surface by hand to prevent unintentional damage to nearby native vegetation. Wood generated from felling Casuarina trees can be utilized on property for construction, aesthetics, charcoal, signage and rustic furniture.

Similar management practices are recommended for removal of *Schinus terebinthifolius*, which have colonized the drier areas of the ephemeral wetlands on the property, and the transition zone from Sabal Woodland to Interior Broadleaf Coppice along the southern shores of the property. Complete root removal is also recommended for this species, and treatment of remaining cut surfaces with a suitable herbicide. Schinus is a heavy fruiting species which should be harvested during fruitless periods. Tree removal during fruiting will spread highly viable seeds to other areas of the property, expanding the extent of Schinus on the property.

Semi-permanent wetlands north of the southern shore habitats are mostly colonized by the invasive *Typha domingensis* (Cattail). The species propagates by wind dispersal of feather like seeds, and by suckering through an extensive rhizome system embedded in the mucky substrate. Eradication of Cattail requires complete removal of all rhizomes, as the species can readily sprout from remaining root material. Application of a topical herbicide will encourage die off of above ground plant parts, namely the leaves, allowing the species to sprout from remaining rhizome in the mucky substrate.

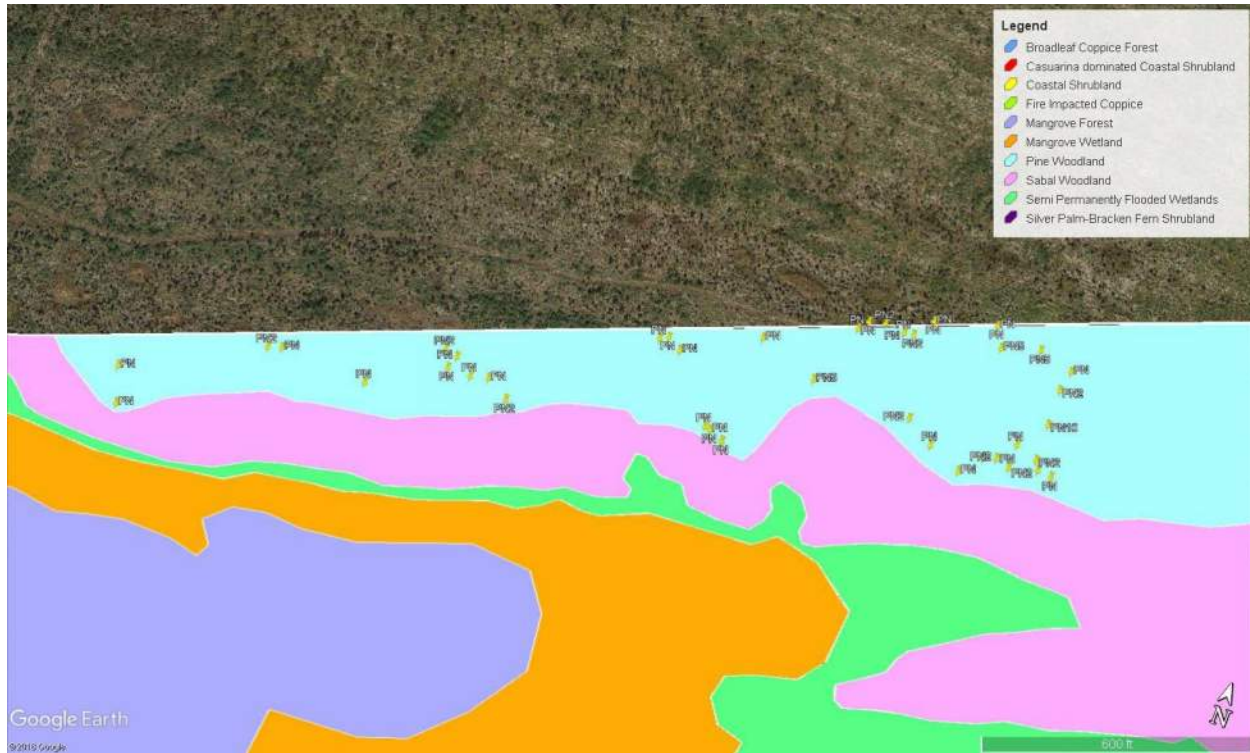
PROTECTED TREE SPECIES

Pinus caribea var. bahamensis and *Guapira obtusata* are two protected hardwood species present on the property. To the greatest extent possible, protected tree species should remain undisturbed in their natural habitat. In cases where disturbance is unavoidable, efforts should be made to relocate protected species, where possible, to a similar habitat to ensure viability of transplanted individuals. Where protected tree species are unable to be transplanted, whether due to low viability of transplanting activity or lack of suitable habitat on the property, removal of protected species should be documented for mitigation efforts at later stages of the project.

As the Pine on the property is restricted to a limited area along the northern boundary, and established

in the rocky substrate of the rocklands, it is recommended that *Pinus* individuals remain undisturbed as a mitigation measure against biodiversity loss due to project activities. Viability of mature Pine after transplanting is very low, even for young sapling species. Seventy-seven (77) individuals were observed in the Pine Woodland habitat.

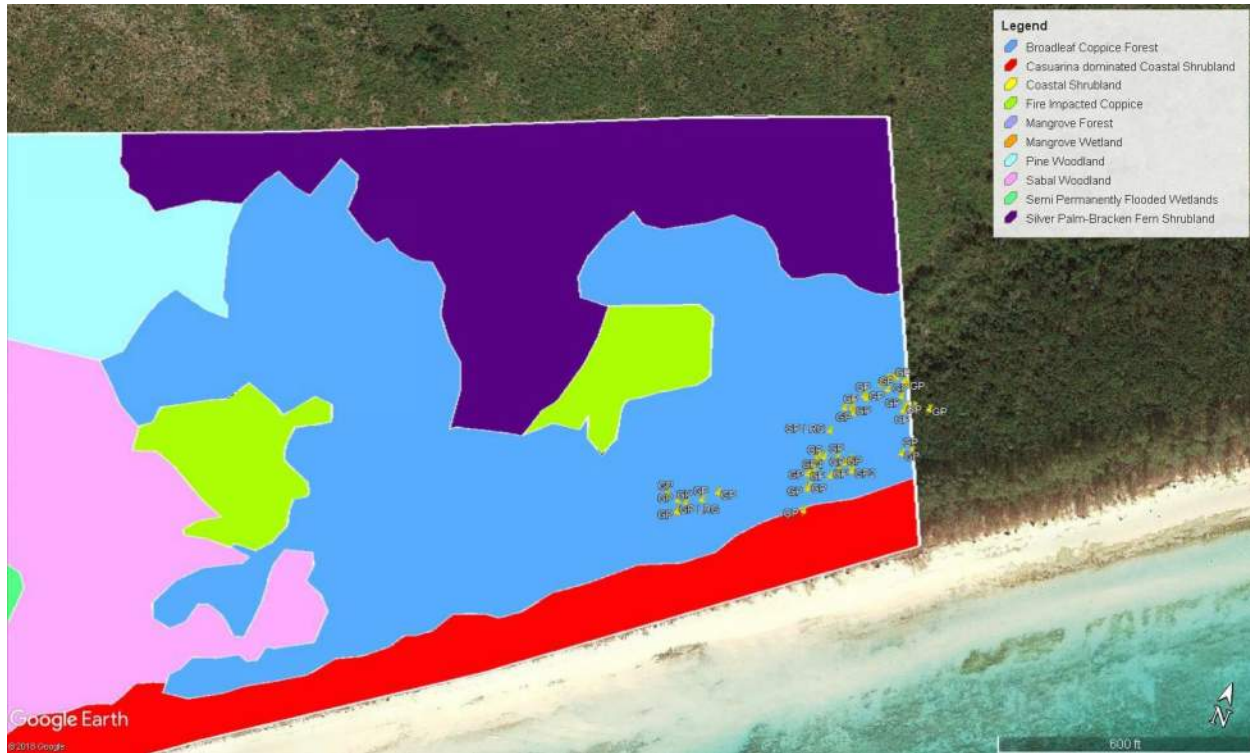
PROTECTED PINUS SPECIES OBSERVED IN PINE WOODLAND HABITAT



The Beefwood (*Guapira obtusata*) on the property is restricted to the interior broadleaf forests restricted to the south eastern corner of the property. This coppice habitat has a closed canopy 8-12m tall, with a dark, humid understory rooted in humus-rich organic substrate. Beefwood is abundant in this habitat and characterized by being one of the larger species dominating the canopy among the forest diversity. Average height of Beefwood in the coppice forest is 8-10m, with DBH widths reaching up to 40cm for very large individuals. High humidity in this habitat allows for establishment of climate sensitive plant species such as mosses and ferns, a frequent epiphyte on mature individuals of Beefwood and other species in this habitat.

Other large and showy specimen species occur throughout this old growth forest habitat, in addition to dissolution pits, depressions and weathered limestone rocks in this habitat. Like the Pine woodlands, the interior coppice habitat is restricted to one portion of the site, and efforts to preserve the protected Beefwood should also consider protection of the surrounding habitat to maintain the microclimate which supports the resident diversity in the coppice forest. Opportunities exist to create a forest trail through the interior coppice forest to highlight some of the larger specimens of beefwood and the wider floral and faunal diversity of the forests. Fifty-one (51) individuals were observed in the broadleaf coppice habitat.

PROTECTED GUAPIRA SPECIES OBSERVED IN THE BROADLEAF COPPICE HABITAT



OTHER SPECIES OF INTEREST

The Sabal Palmetto woodlands occur in the drier areas north and south of the mangrove wetland, however the substrate on these habitats range between the sandy and mucky substrate of the ephemeral wetlands versus the rockland substrate bordering the Pine woodlands on the property. During project activities, Sabal Palm individuals in sandy and mucky areas have a higher chance of viability after transplanting than individuals rooted in the rocky substrate. The uprooted individuals can be replanted elsewhere on the property to supplement native landscaping needs and maintain resident diversity.

The endemic *Agave braceana* is abundant on the property in the drier rockland areas of the Pine woodland and Silver Palm shrublands along the northern boundary of the property. The xeric species is drought and salt tolerant, with shallow roots allowing for easy transplanting of the species is necessary. The species exhibits a showy inflorescence extending up to 20 ft in the air, attracting many native species of nectar seeking fauna such as bees, wasps and hummingbirds.

HURRICANE DORIAN

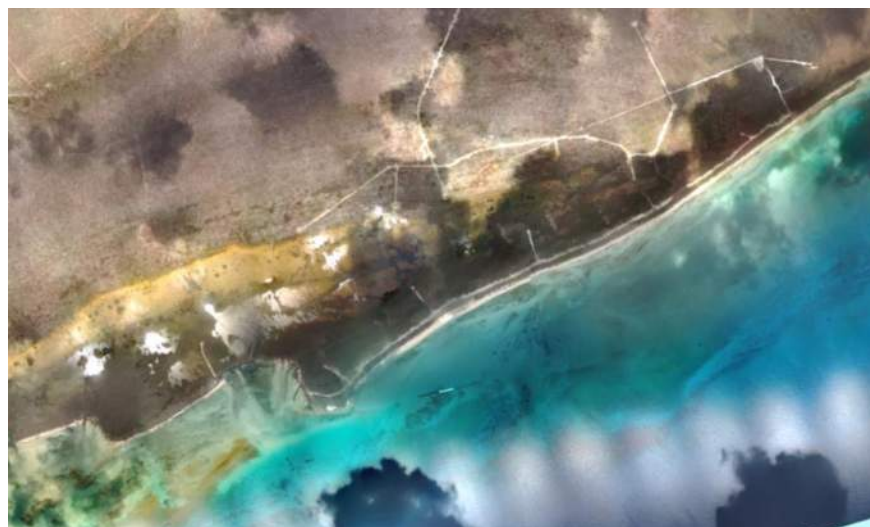
Hurricane Dorian impacted the northern islands of The Bahamas during September 1-3, 2019 as a category 5 hurricane presenting sustained winds of 185-200 mph. Among the islands impacted by the hurricane, Grand Bahama suffered extensive damage to infrastructure and the natural environment of the island and its nearby cays. The 329-acre Project site was directly impacted by high storm surge, hurricane force winds and heavy rainfall associated with Hurricane Dorian.

Expected impacts to the terrestrial areas of the site include toppling, defoliation and snapping of trees, erosion of coastal dunes and upland sediment, saltwater intrusion into terrestrial habitats and wetlands, and alteration site topography and terrestrial habitat extents. Aside from the direct damage inflicted by Hurricane Dorian, long term impacts such as invasive species colonization (flora and fauna), wildfire encroachment, altered surface water/groundwater/soil chemistry and species die off pose a threat to the ability of the terrestrial habitats and resident flora and fauna to regenerate and balance its ecological processes.

Figure 6. Pre-Hurricane Dorian Satellite Imagery of Project Site



Figure 7. Post-Hurricane Dorian Satellite Imagery of Project Site



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Figure 8. Pre-Hurricane Dorian imagery of eastern boundary road (facing NW, at hilltop)



Figure 9. Post-Hurricane Dorian imagery of eastern boundary road (facing NW, at hilltop)



Figure 10. Pre-Hurricane Dorian imagery of eastern boundary road (facing NW, at shoreline)



Figure 11. Post-Hurricane Dorian imagery of eastern boundary road (facing SE, at hilltop)



Figure 12. Aerial imagery of Post-Hurricane Dorian impacts on coastal and coppice vegetation



Figure 13. Aerial imagery of Post-Hurricane Dorian impacts on coastal Casuarina vegetation



APPENDIX A - PROTECTED SPECIES COORDINATES TABLE

ID	Name	Easting	Northing	Latitude	Longitude
1	PN	2461116.689	9652344.538	26.57701	-78.48853
2	PN	2459710.093	9651695.014	26.5753	-78.49287
3	PN	2458100.91	9651368.919	26.57449	-78.49781
4	PN	2459750.96	9651612.161	26.57507	-78.49275
5	PN	2461115.502	9652071.731	26.57626	-78.48855
6	PN2	2460020.579	9651872.041	26.57577	-78.49191
7	PN	2460053.056	9651883.589	26.5758	-78.49181
8	PN	2460275.498	9651880.675	26.57578	-78.49113
9	PN2	2460419.756	9652028.987	26.57618	-78.49068
10	PN	2460443.424	9651989.443	26.57607	-78.49061
11	PN	2460452.59	9652022.357	26.57616	-78.49058
12	PN	2460502.268	9651990.597	26.57607	-78.49043
13	PN2	2461726.308	9652276.489	26.57679	-78.48667
14	PN2	2460604.037	9651970.77	26.57601	-78.49012
15	PN	2460905.769	9652260.383	26.57679	-78.48918
16	PN	2461115.502	9652071.731	26.57626	-78.48855
17	PN	2460544.552	9652002.337	26.5761	-78.4903
18	PN	2460886.369	9652249.091	26.57676	-78.48924
19	PN	2460942.157	9652239.274	26.57673	-78.48907
20	PN	2461066.109	9652088.947	26.57631	-78.4887
21	PN	2461079.257	9652085.568	26.5763	-78.48866
22	PN	2461857	9652282.693	26.5768	-78.48627
23	PN10	2461815.486	9652398.265	26.57712	-78.48639
24	PN2	2461824.237	9652285.686	26.57681	-78.48637
25	PN2	2461814.002	9652307.308	26.57687	-78.4864
26	PN	2461761.339	9652324.459	26.57692	-78.48656
27	PN	2461320.571	9652454.016	26.5773	-78.4879
28	PN	2461339.686	9652479.851	26.57737	-78.48784
29	PN2	2461378.701	9652491.528	26.5774	-78.48772
30	PN	2461427.879	9652485.219	26.57738	-78.48757
31	PN2	2461450.692	9652489.304	26.57739	-78.4875
32	PN	2461485.652	9652540.91	26.57753	-78.48739
33	PN	2461631.903	9652587.427	26.57765	-78.48694
34	PN5	2461655.786	9652536.977	26.57751	-78.48687
35	PN5	2461746.748	9652567.86	26.57759	-78.48659
36	PN	2461759.213	9652266.224	26.57676	-78.48657
37	PN	2461631.903	9652587.427	26.57765	-78.48694
38	PN	2461697.1	9652265.004	26.57676	-78.48676
39	PN	2461652.333	9652213.205	26.57662	-78.4869
40	PN	2461573.161	9652248.022	26.57672	-78.48714
41	PN5	2461264.868	9652292.889	26.57686	-78.48808
42	PN2	2461816.969	9652489.222	26.57737	-78.48638
43	PN	2461828.975	9652544.015	26.57752	-78.48634
44	PN	2461485.652	9652540.91	26.57753	-78.48739
45	PN2	2461506.922	9652290.367	26.57684	-78.48734

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46	PN	2461427.879	9652485.219	26.57738	-78.48757
47	GP	2464379.152	9652910.613	26.57839	-78.47852
48	GP	2464327.681	9653033.262	26.57873	-78.47867
49	GP	2464320.426	9653069.491	26.57883	-78.47869
50	GP	2463953.366	9652611.255	26.57759	-78.47984
51	GP	2464281.341	9653061.446	26.57881	-78.47881
52	GP	2464291.65	9653036.189	26.57874	-78.47878
53	GP	2464294.346	9653065.34	26.57882	-78.47877
54	GP	2464300.741	9653072.74	26.57884	-78.47875
55	GP	2464363.855	9653023.063	26.5787	-78.47856
56	GP	2463985.627	9652633.713	26.57765	-78.47974
57	GP	2464398.48	9652925.543	26.57843	-78.47846
58	GP	2464224.074	9652980.301	26.57859	-78.47899
59	GP	2463904.258	9652613.925	26.57776	-78.47999
60	GP	2464230.899	9652965.887	26.57855	-78.47897
61	GP	2463933.751	9652610.869	26.57759	-78.4799
62	GP LRG	2463940.791	9652585.547	26.57752	-78.47988
63	GP	2463944.06	9652585.612	26.57752	-78.47987
64	GP	2464213.863	9652834.614	26.57819	-78.47903
65	GP LRG	2464202.838	9652896.228	26.57836	-78.47906
66	GP	2464237.652	9652955.108	26.57852	-78.47895
67	GP	2464014.476	9652663.378	26.57773	-78.47965
68	GP	2464262.827	9652839.216	26.5782	-78.47888
69	GP	2464272.348	9652853.952	26.57824	-78.47885
70	GP	2464246.528	9653002.566	26.57865	-78.47892
71	GP2	2464282.441	9652839.602	26.5782	-78.47882
72	GP2	2464285.925	9652828.759	26.57817	-78.47881
73	GP	2464253.138	9652999.059	26.57864	-78.4789
74	GP	2464271.892	9653043.074	26.57876	-78.47884
75	GP	2464399.671	9653031.043	26.57872	-78.47845
76	GP	2464191.982	9652783.263	26.57805	-78.4791
77	GP	2464195.251	9652783.327	26.57805	-78.47909
78	GP	2464216.513	9652700.092	26.57782	-78.47903
79	GP	2464205.56	9652758.07	26.57798	-78.47906
80	GP	2464205.703	9652750.799	26.57796	-78.47906
81	GP	2464198.019	9652808.842	26.57812	-78.47908
82	GP4	2464204.915	9652790.792	26.57807	-78.47906
83	GP	2464197.733	9652823.385	26.57816	-78.47908
84	GP	2464200.787	9652834.356	26.57819	-78.47907
85	GP	2464330.377	9653062.412	26.57881	-78.47866
86	GP	2464344.599	9653004.498	26.57865	-78.47862
87	GP	2464244.001	9652798.836	26.57809	-78.47894
88	GP	2464214.697	9652958.293	26.57853	-78.47902
89	GP	2464243.07	9652846.101	26.57822	-78.47894
90	GP	2464256.719	9652817.273	26.57814	-78.4789
91	GP	2464344.313	9653019.041	26.57869	-78.47862
92	GP	2464344.527	9653008.134	26.57866	-78.47862

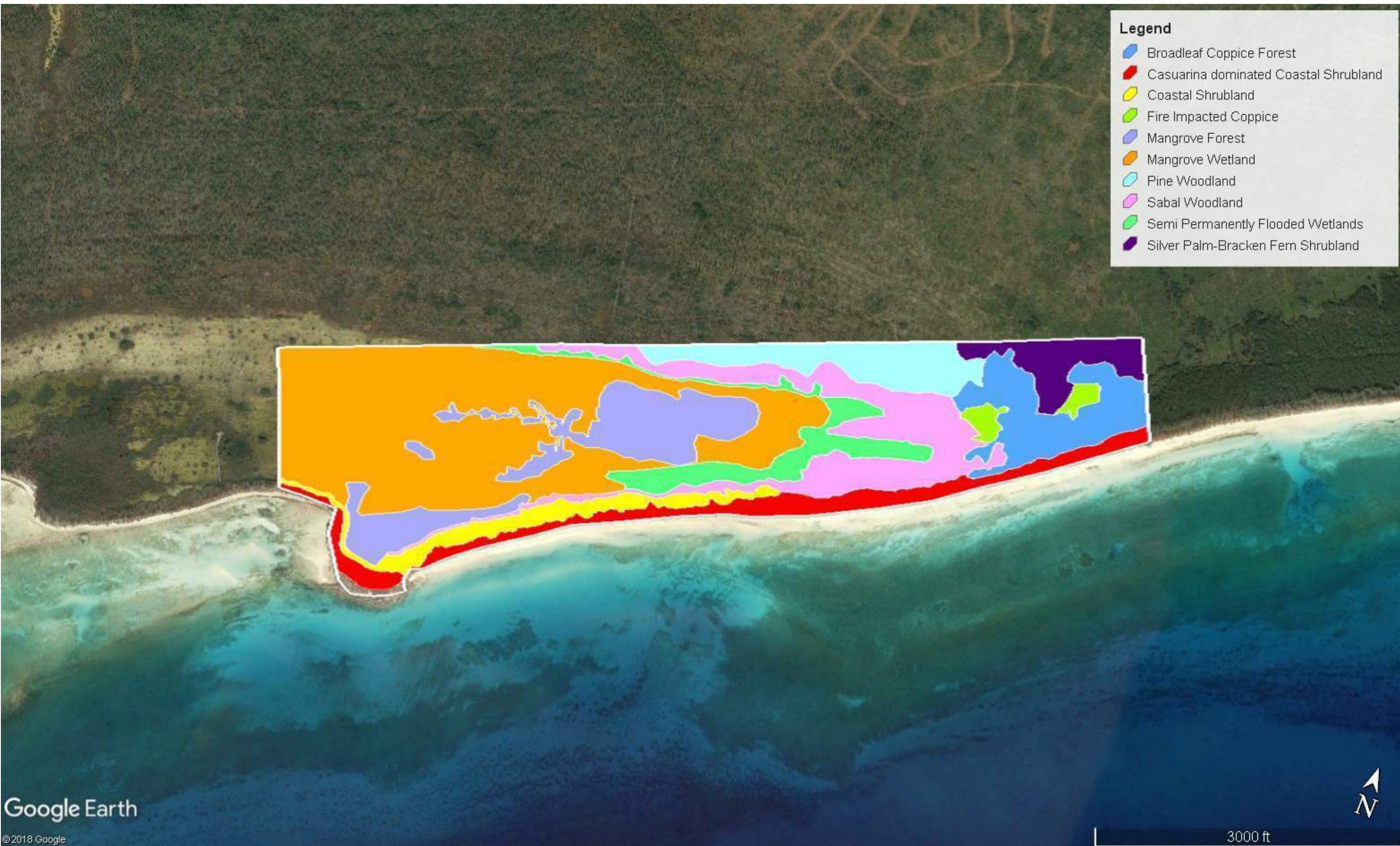
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APPENDIX B – TERRESTRIAL HABITAT MAPS

CARNIVAL GB PORT PROJECT - TERRESTRIAL HABITAT MAP

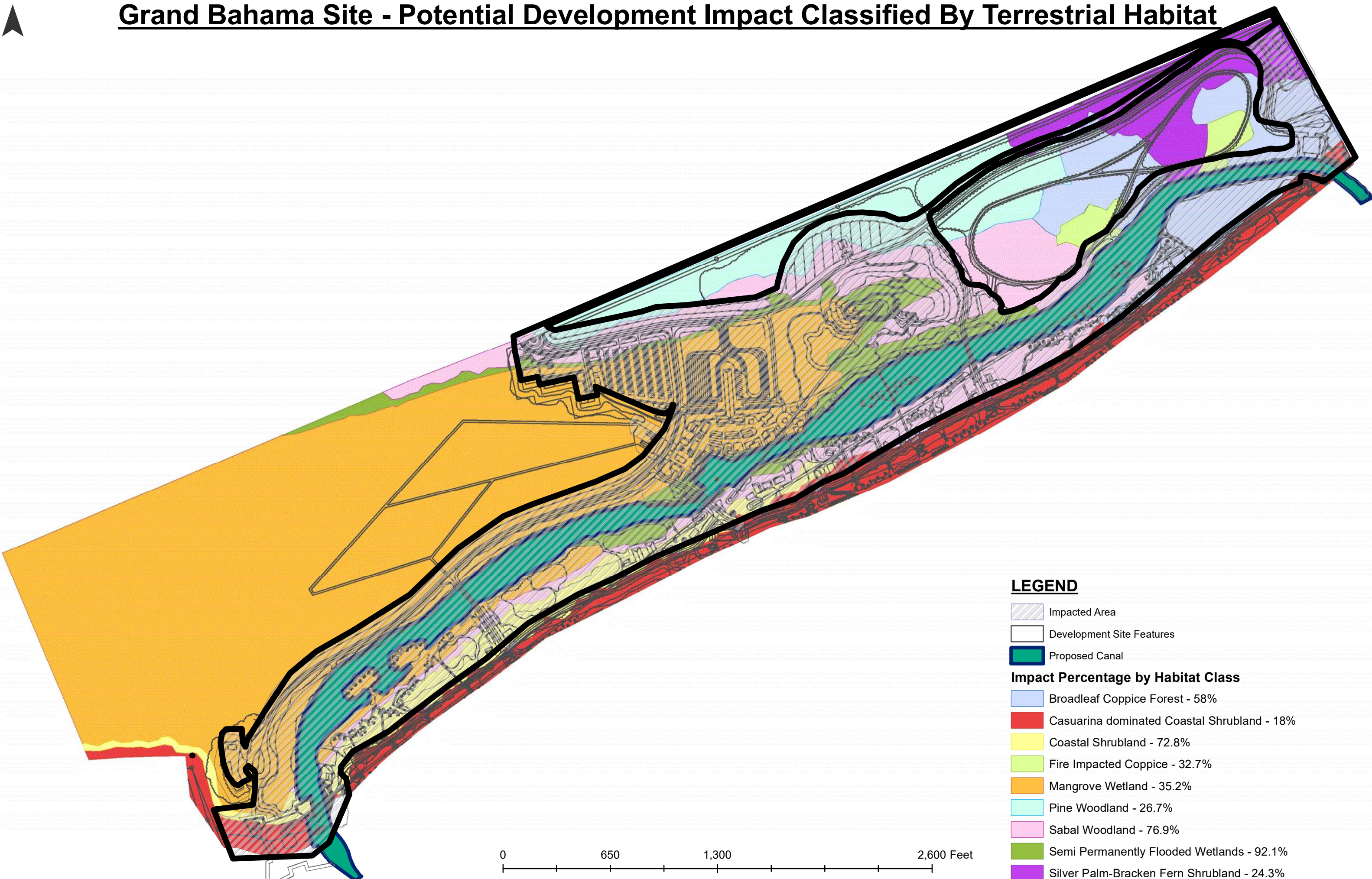
Legend

- Broadleaf Coppice Forest
- Casuarina dominated Coastal Shrubland
- Coastal Shrubland
- Fire Impacted Coppice
- Mangrove Forest
- Mangrove Wetland
- Pine Woodland
- Sabal Woodland
- Semi Permanently Flooded Wetlands
- Silver Palm-Bracken Fern Shrubland

















Grand Bahama Site - Potential Development Impact Classified By Terrestrial Habitat

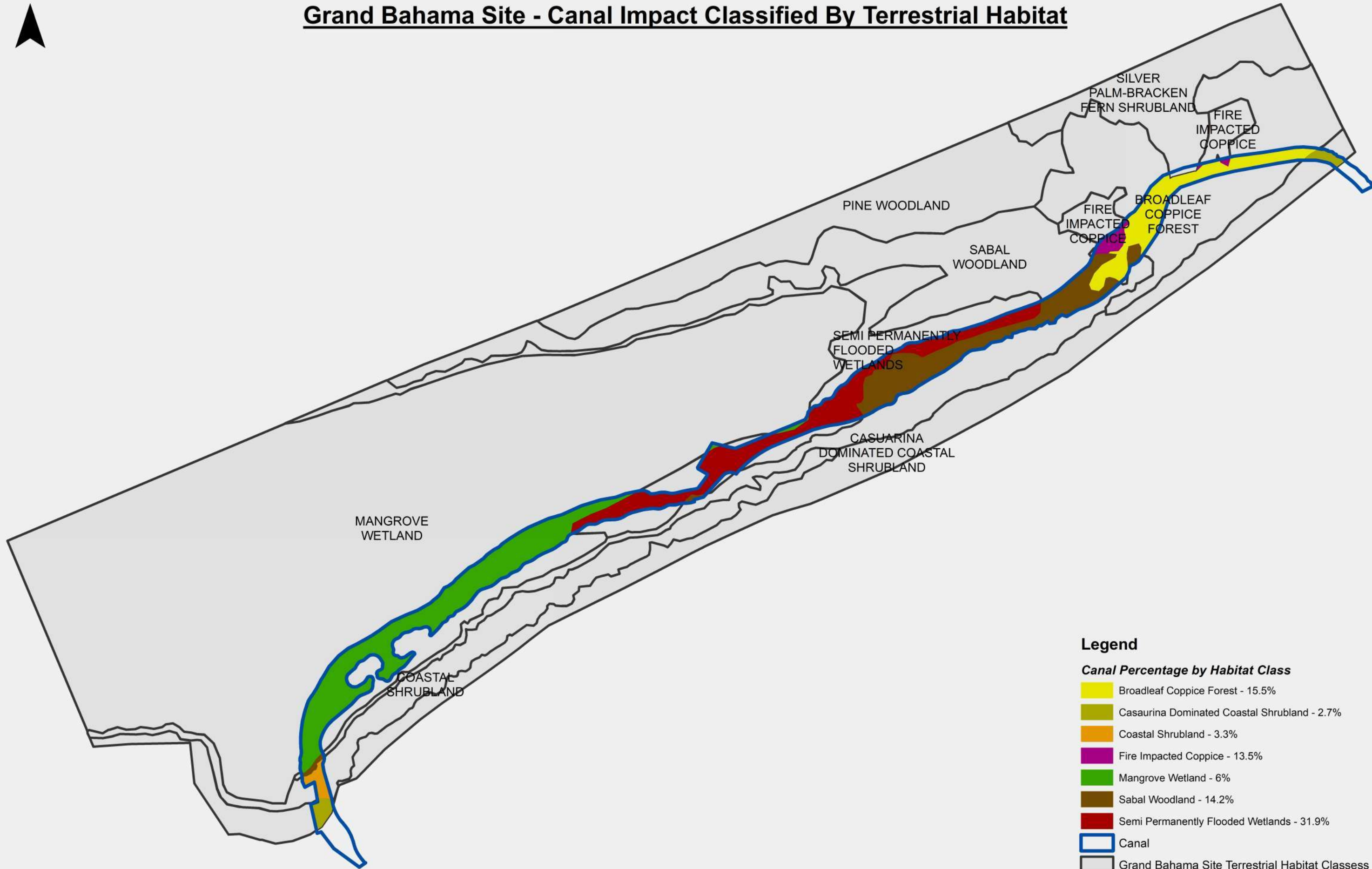


LEGEND

-  Impacted Area
-  Development Site Features
-  Proposed Canal
- Impact Percentage by Habitat Class**
-  Broadleaf Coppice Forest - 58%
-  Casuarina dominated Coastal Shrubland - 18%
-  Coastal Shrubland - 72.8%
-  Fire Impacted Coppice - 32.7%
-  Mangrove Wetland - 35.2%
-  Pine Woodland - 26.7%
-  Sabal Woodland - 76.9%
-  Semi Permanently Flooded Wetlands - 92.1%
-  Silver Palm-Bracken Fern Shrubland - 24.3%

N

Grand Bahama Site - Canal Impact Classified By Terrestrial Habitat

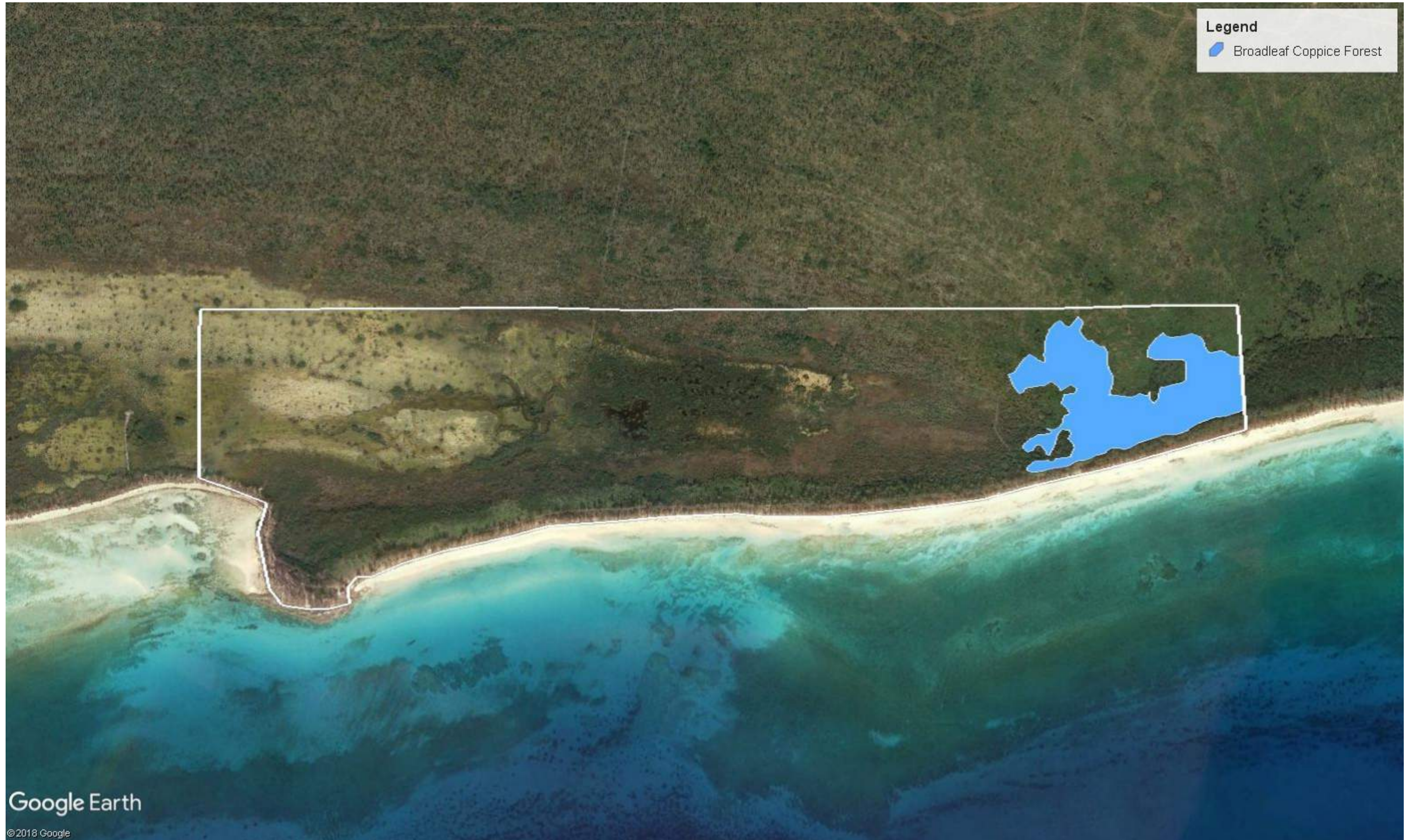


Legend

Canal Percentage by Habitat Class

- Broadleaf Coppice Forest - 15.5%
- Casuarina Dominated Coastal Shrubland - 2.7%
- Coastal Shrubland - 3.3%
- Fire Impacted Coppice - 13.5%
- Mangrove Wetland - 6%
- Sabal Woodland - 14.2%
- Semi Permanently Flooded Wetlands - 31.9%
- Canal
- Grand Bahama Site Terrestrial Habitat Classes

BROADLEAF COPPICE HABITAT MAP



INVASIVE CASUARINA EQUISETIFOLIA DISTRIBUTION MAP




COASTAL SHRUBLAND HABITAT MAP



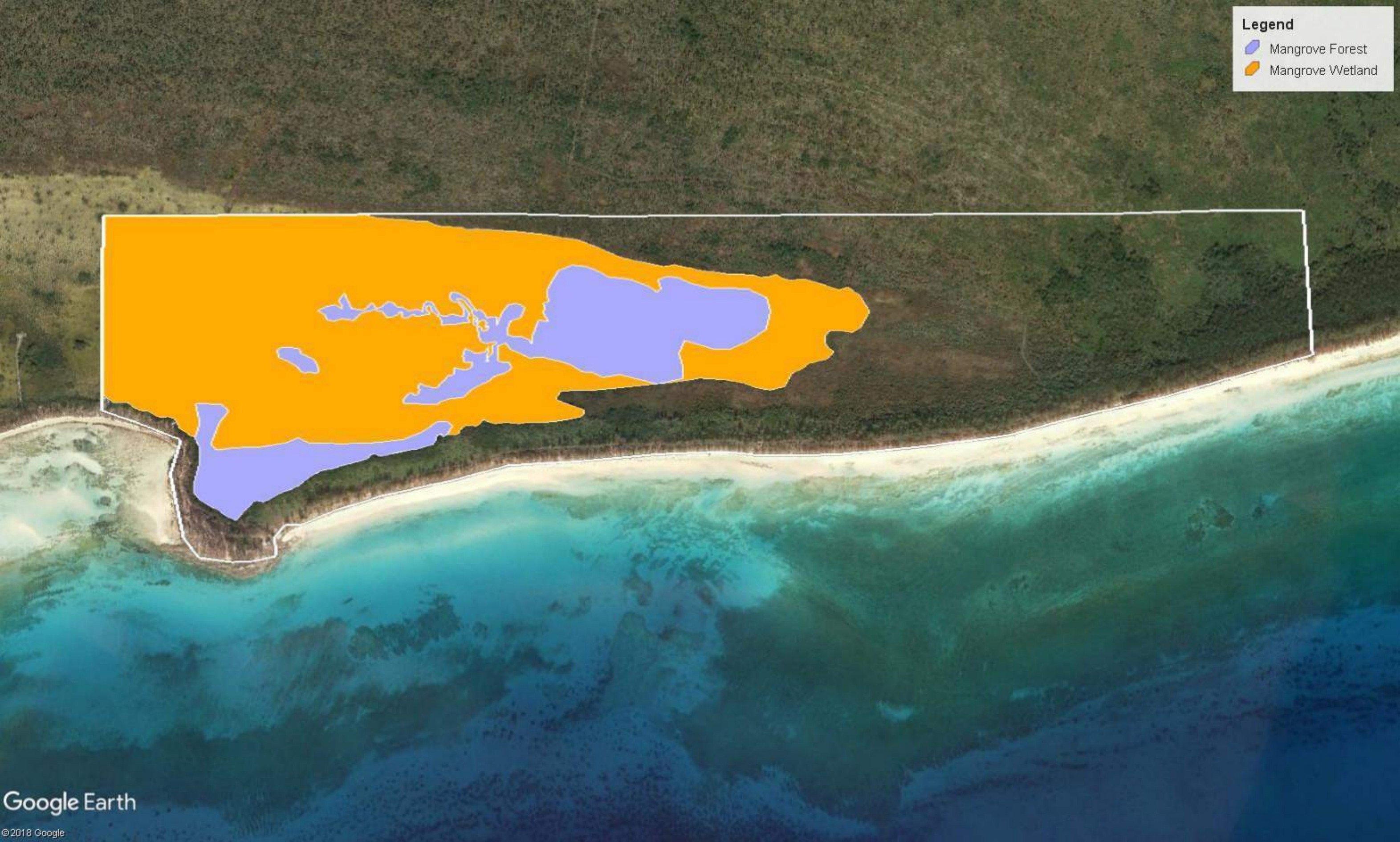
FIRE IMPACTED COPPICE HABITAT MAP



Legend

 Fire Impacted Coppice

MANGROVE FOREST AND WETLAND HABITAT MAP




PINE WOODLAND HABITAT MAP

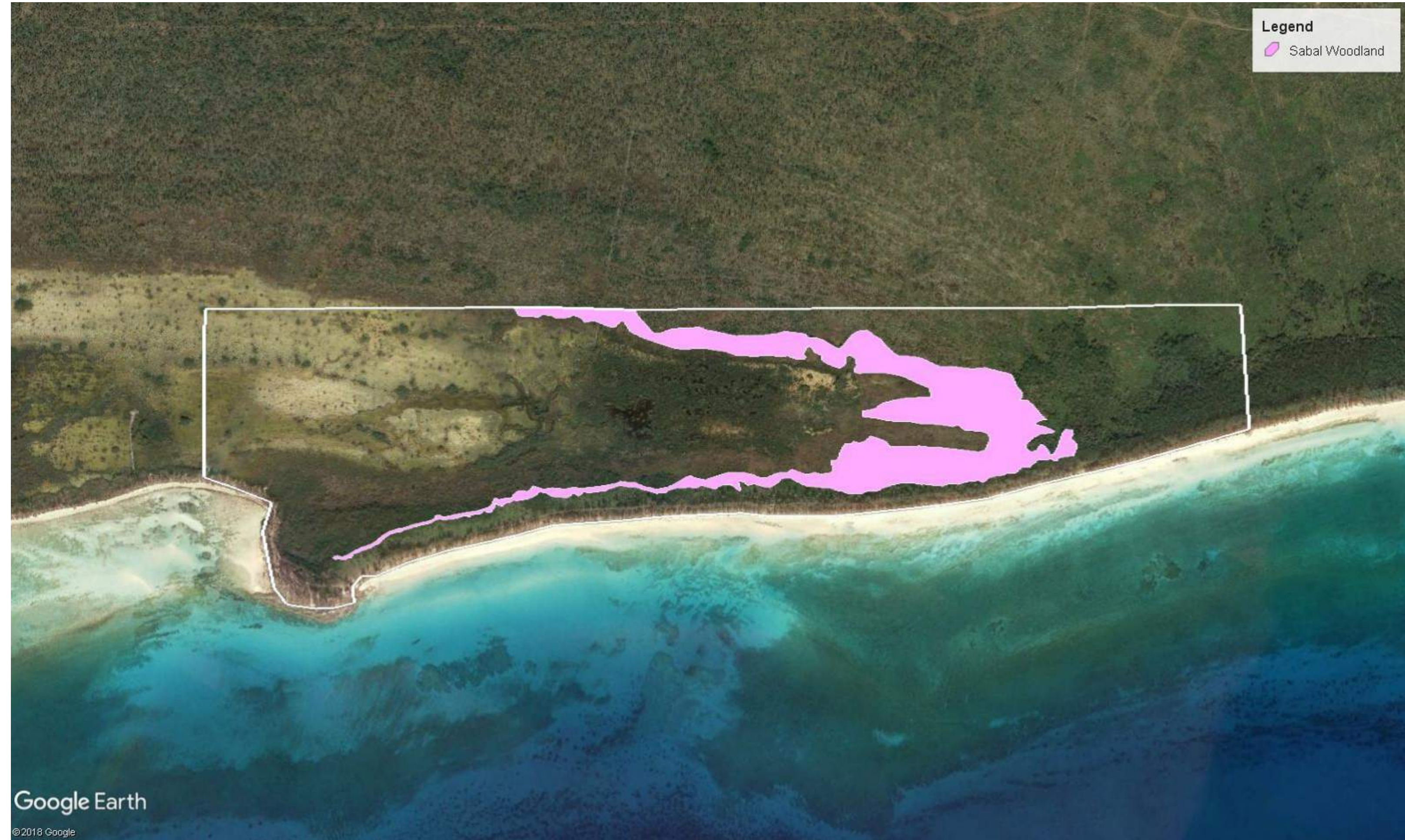
Legend
Pine Woodland



SABAL WOODLAND HABITAT MAP


Legend

 Sabal Woodland



SILVER PALM-BRACKEN FERN SHRUBLAND HABITAT MAP

Legend

 Silver Palm-Bracken Fern Shrubland



SEMI-PERMANENTLY FLOODED WETLANDS HABITAT MAP



PINUS CARIBEA VAR BAHAMENSIS DISTRIBUTION MAP

