TECHNICAL REPORT: BASELINE ASSESSMENT OF SEAGRASS AND MANGROVE COVER AND DYNAMICS IN THE PORT HONDURAS MARINE RESERVE, BELIZE

Emil A. Cherrington

Water Center for the Humid Tropics of Latin America & the Caribbean (CATHALAC), 111 City of Knowledge, Panama City, Panama • TEL (507) 317-3200 • emil.cherrington@cathalac.org

Edited April 2013

Abstract: An assessment was conducted to determine the baseline status of the areal extent of mangrove cover and seagrass cover within the Port Honduras Marine Reserve (PHMR) in southern Belize. That assessment consisted of compiling and analyzing existing data sources, most of which had been generated using remote sensing techniques to map ecosystems directly from satellite imagery. While there are some discrepancies in terms of the extant data on seagrass cover, the analysis would nevertheless indicate that within the PHMR proper, there are some 1,767 acres of mangrove ecosystems, an additional 7,380 acres of seagrass meadows, and some 936 acres of coral reefs, in total comprising just over 10% of the Reserve's surface area. In addition, mangrove ecosystems cover an additional 12,879 acres in coastal areas adjoining the Reserve. Within the PHMR, the mangrove islands consist principally (95.8%) of dwarf mangrove, with the 4.2% remainder being medium-height mangroves, while in the area adjoining and including the PHMR, composition consists of 88.5% dwarf mangrove, 7.6% medium-height mangrove, and 3.9% tall mangrove. Revision of previous studies also indicates that mangrove and seagrass cover within the PHMR are stable (0% change), while outside the Reserve, a mere 60 acres of coastal mangrove have been cleared in a nearby defunct Forest Reserve, amounting to a 0.41% reduction in overall mangrove cover over a 32-year period.

Key words: Belize, Port Honduras Marine Reserve, mangrove, seagrass, habitats, TIDE, CATHALAC, SERVIR

I. BACKGROUND

Mangroves and seagrass meadows are considered among the most productive of the coastal marine ecosystems (McField & Kramer 2007; Wabnitz 2007). The regional Healthy Reefs for Healthy People Initiative (HRI) has identified the monitoring of the areal extent of mangrove and seagrass ecosystems as key to monitoring the status of the ecosystems of the Mesoamerican Reef Ecoregion. Within that Mesoamerican Reef Ecoregion, the Belize Barrier Reef System – the largest barrier reef system in the Americas – is itself comprised of an assemblage of interconnected coral reef, mangrove, and seagrass ecosystems.

As emphasized by the HRI, the productivity of the ecosystems within the Mesoamerican Reef – as well as the ecosystem services they provide to nearby human populations – are threatened by coastal infrastructural development, and a range of other development pressures (McField & Kramer, 2007). In that context, in early 2013, the Toledo Institute for Development and Environment (TIDE), contracted CATHALAC to conduct a baseline assessment of the current and historical extent of mangrove cover and seagrass cover within and adjoining the Port Honduras Marine Reserve (PHMR).

The PHMR was established by the Government of Belize in 2000 and is currently co-managed by the Fisheries Department and TIDE, along with the adjoining Payne's Creek National Park (co-managed with the Forest Department). The Reserve is Belize's second largest Marine Reserve (following the South Water Caye Marine Reserve), and, along with the abutting Payne's Creek National Park, forms part of the ecologically important Maya Mountain Marine Corridor complex.

(Connectivity of the PHMR's mangroves with the reef is also shown in **Figure 1** below.) Nevertheless, having regularly updated data on dynamics related to ecosystem cover is essential to proper management of the Reserve.

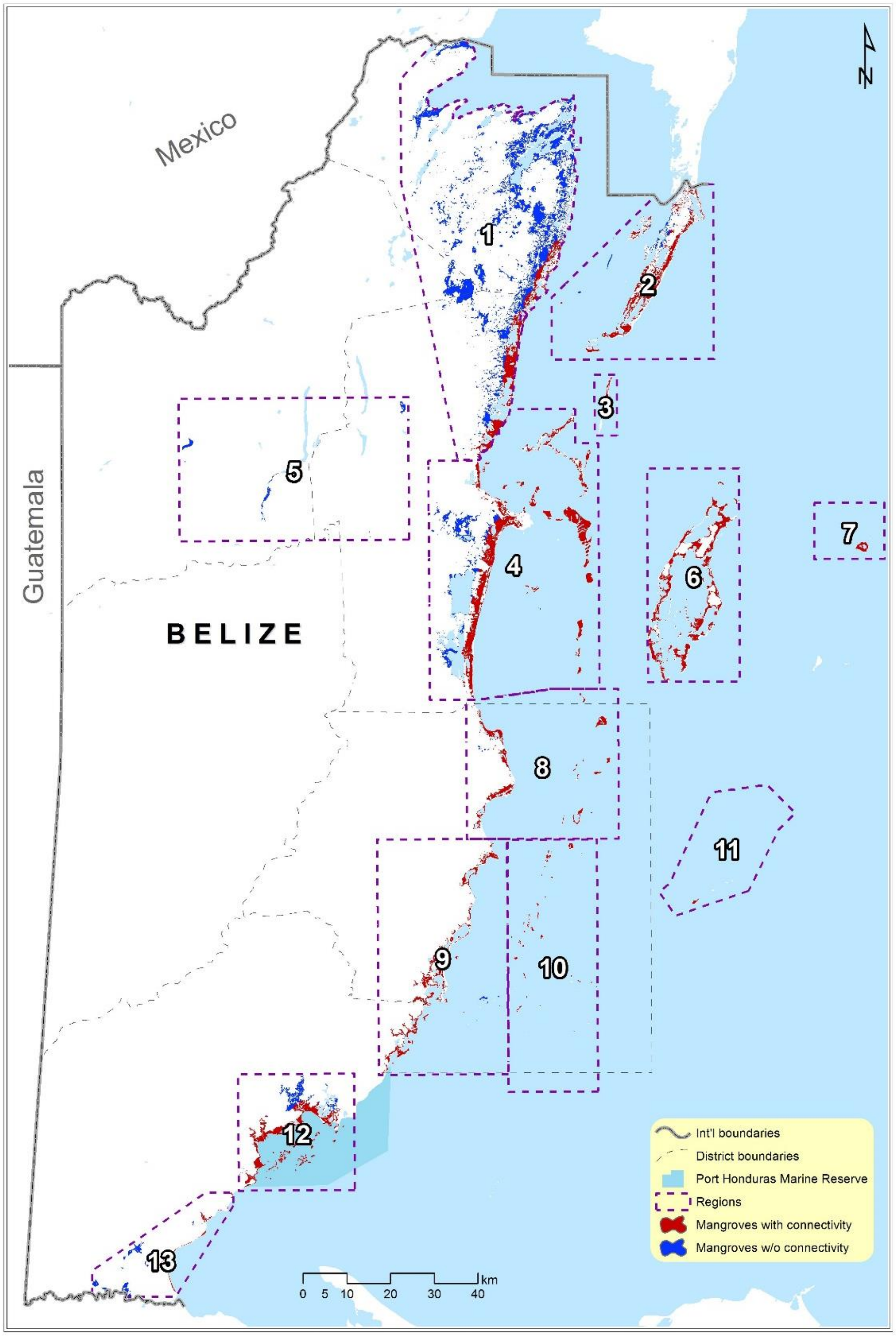

Figure 1: Mangrove connectivity and geographic regions where Belize's mangroves are found, including the PHMR *(modified from Cherrington et al. 2010: 18)*

II. OBJECTIVES

This assessment's main objectives were as follows:

- To utilize satellite imagery along with existing ancillary datasets to determine the current Honduras Marine Reserve
- To utilize historical satellite data to examine the spatio-temporal dynamics of those ecosystems, where possible

III. METHODOLOGY

This study's methodology consisted of the following overall work flow:

i. Data compilation from existing sources
ii. Extraction of data for the PHMR and the broader Port Honduras area
iii. 'Validation' of the results against satellite imagery
iv. Generation of statistics on ecosystem dynamics, and baseline estimates of ~current areal extent of mangrove and seagrass ecosystems

Data compilation

Data on mangrove cover was compiled from pre-existing forest cover / mangrove cover datasets developed by CATHALAC in 2010 and 2012, which in turn were based substantially on Simon Zisman's baseline assessment of mangrove cover across Belize (see Cherrington et al. 2010, and Zisman 1998).[1] In contrast, the data on seagrass cover for the PHMR was compiled from the following 4 principal sources:

i. A seagrass dataset for Belize, compiled in 1993 by the then Coastal Zone Management Unit (CZMU), digitized from the 1984 Belize Environmental Profile (Hartshorn et al. 1984)
ii. The Belize National Marine Habitat Map generated in 1997 by the CZMU's successor, the UNDP-GEF Coastal Zone Management Project (CZMP).[2]
iii. A digitization / generalization of the National Marine Habitat Map realized by Jan Meerman in 2004 in the context of the National Protected Areas Policy & System Plan (NPAPSP) project
iv. A marine ecosystem map for the wider Mesoamerican Reef, generated by Damaris Torres-Pulliza of the University of South Florida's Institute for Marine Remote Sensing in 2006 under the The Nature Conservancy (TNC)-funded 'Bahamas and Meso-American Reefs and Seagrass Mapping Project.'[3]

[1] Further details on the generation of the national-level mangrove cover data for Belize can be found in Cherrington et al. (2010), Cho-Ricketts & Cherrington (2011), and Cherrington et al. (2012).
[2] Further information on the seagrass data generated by the Coastal Zone Management Authority & Institute can be found in Matus (1997).
[3] Further details on the seagrass data for the Mesoamerican Reef can be found in Wabnitz et al. (2007).

Data extraction

As indicated in the previous section, there exist a number of datasets describing the areal extent of mangrove and seagrass ecosystems in Belize, and within the wider Mesoamerican Reef Ecoregion. As the scope of this project was the Port Honduras Marine Reserve and the coastal areas immediately abutting the Reserve, a geographic buffer was defined to define the extent of the analysis to be conducted. Where the geographic extent of the PHMR is estimated at 100,002 acres[4] (405 km^2), a buffer was applied, extending the area of analysis[5] to approximately 249,952 acres (101 km^2). That study area is depicted in **Figure 2** below (an enlargement of **Figure 1**).

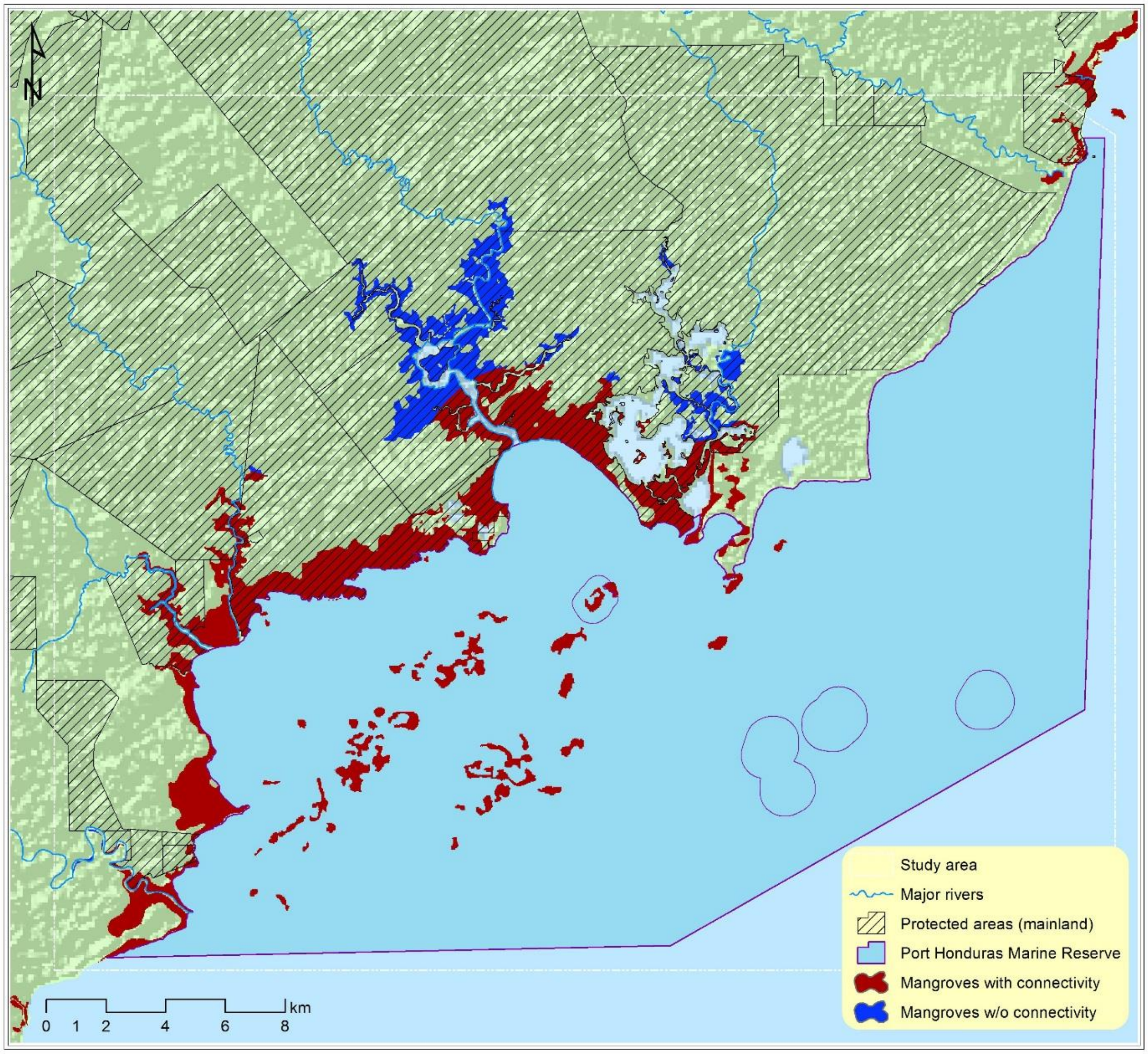

Figure 2: The Port Honduras Marine Reserve and the study area encompassing it

[4] As with various protected areas in Belize, the official area of the PHMR listed in the Government of Belize's official Gazette differs from the area that can be determined by spatial analysis (also refer to Zisman, 1996). In this case, the area differs by only 2 acres, while in the case of other areas, the discrepancies can be much larger (Zisman, 1996).
[5] That area of analysis is hereafter referred to as the "greater PHMR area."

Data validation

While this study did not involve field validation, field validation of some of the sources of the data utilized (e.g. the mangrove cover data generated by Cherrington et al. 2010, and the seagrass cover data from the 1997 National Marine Habitat Map) had already been validated through field surveys (see: Matus 1997, Cho-Ricketts & Cherrington 2011). With regard to the mangrove cover data, field data collected by TIDE for the Port Honduras area showed that the 2010 mangrove map for that area possessed an overall 95.8% accuracy (slightly higher than the national average of 90.7%). The breakdown of the accuracies of the 'mangrove' and 'non-mangrove' classes is also presented below in **Tables 1-2**.

Table 1: Results of field validation of mangrove sites identified using the 2010 map of mangrove cover (*source: Cho-Ricketts & Cherrington 2011: 5*)

Location	Mangrove	Non-Mangrove	Total
Port Honduras	46	2	48
Belize City / Drowned Cayes	47	1	48
Sarteneja	53	6	59
Turneffe	48	0	48
Placencia	46	2	48
Total	**240**	**11**	**251**
% actual mangroves	**95.62**	**4.38**	

Table 2: Results of field validation of non-mangrove sites identified using the 2010 map of mangrove cover (*source: Cho-Ricketts & Cherrington 2011: 5*)

Location	Non-mangrove	Mangrove	Total
Port Honduras	10	0	10
Belize City / Drowned Cayes	9	1	10
Sarteneja	2	8	10
Turneffe	6	4	10
Placencia	6	4	10
Total	**33**	**17**	**50**
% actual non-mangroves	**66.0**	**34.0**	

With regard to the seagrass cover data for the PHMR, revision of Matus (1997) indicates that the field validation of the National Marine Habitat Map did not include field surveys within the Port Honduras area. Nevertheless, Matus (1997: 35) indicates the class accuracy for the seagrass class as consisting of:

- "70% chance that a seagrass dominated pixel was actually classified correctly," and
- "80% chance that a seagrass dominated site in the field is classified correctly on the map"

Nevertheless, following compilation of seagrass maps from the four sources listed previously, it was noted that while the seagrass cover data generated by Jan Meerman in the context of the 2005 NPAPSP was quite similar to the seagrass cover data from the CZMAI's National Marine Habitat Map (i.e. Matus 1997) – by virtue that the NPAPSP data which is now integrated into Meerman's subsequent 2004 and 2011 editions of the Belize ecosystems maps – these data are markedly different from the seagrass data generated by Torres-Pulliza's Bahamas and Meso-American Reefs and Seagrass Mapping Project' data (i.e. Wabnitz et al. 2007).

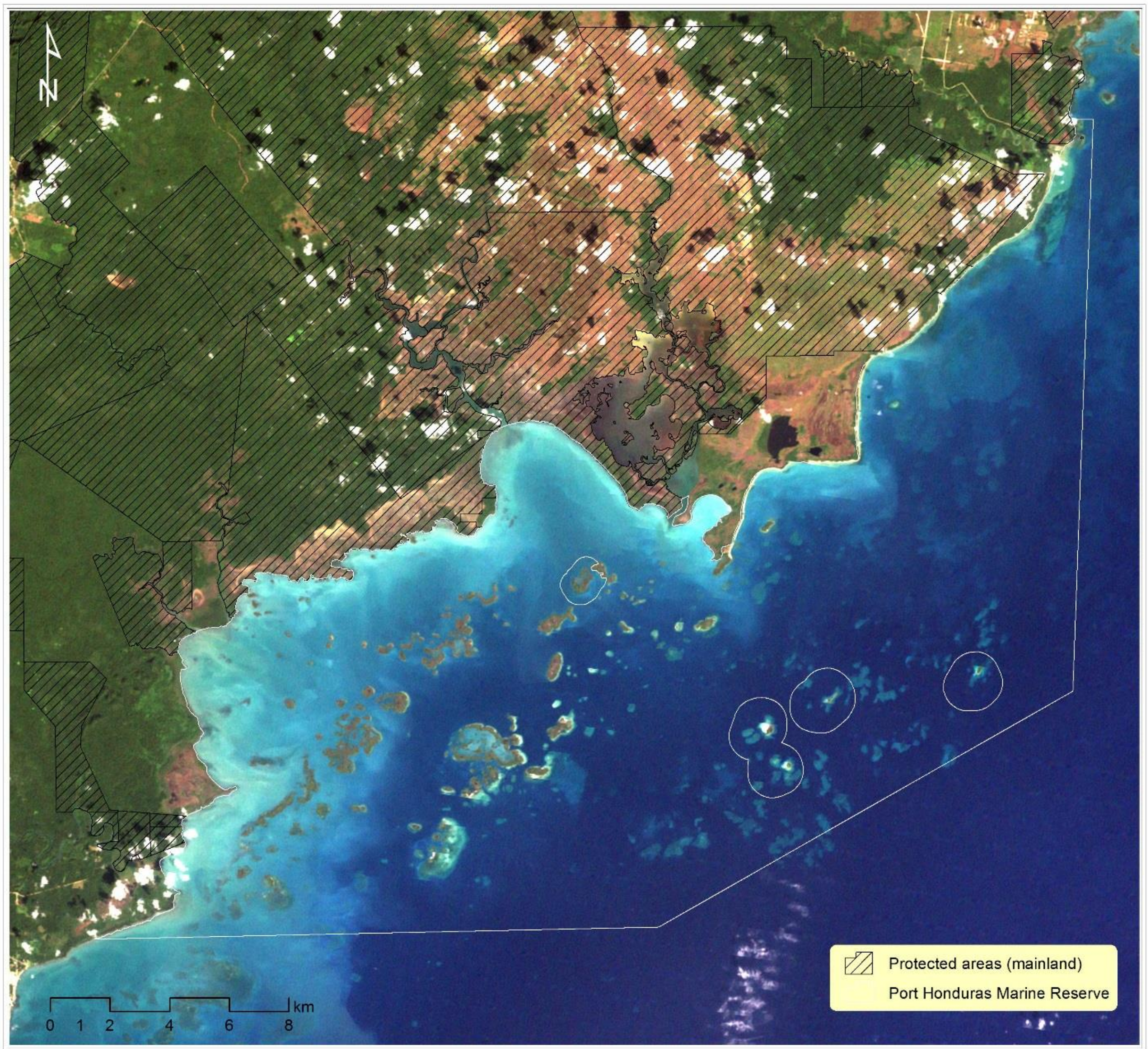

Figure 3: Recent true color Landsat ETM+ imagery of the Port Honduras Marine Reserve, captured on December 18, 2012 (*data source: NASA / USGS*)

In fact, in this phase of the project, both the Matus (1997) and the Wabnitz et al. (2007) data were subjected to visual comparison with a range of true-color Landsat satellite images captured from January 1987 through December 2012 (the most recent available imagery, see **Figure 3** above). This study's preliminary conclusion – based largely on visual assessment – is that Matus (1997) may have over-classified seagrass cover based on the amount of turbid water that is regularly present within the Gulf of Honduras. It was seen in reviewing those Landsat images that, across the year, the amount of visible turbid water changes considerably and appears bright in the image (like the sediments near the Punta Ycacos Lagoon in **Figure 3**), possibly leading to confusion with seagrass as other parts of the image with shallower depths also appear bright. **Figures 4-5** thus compare the satellite imagery depicted in **Figure 3** with the seagrass cover maps extracted from Matus (1997) and the Wabnitz et al. (2007), respectively.

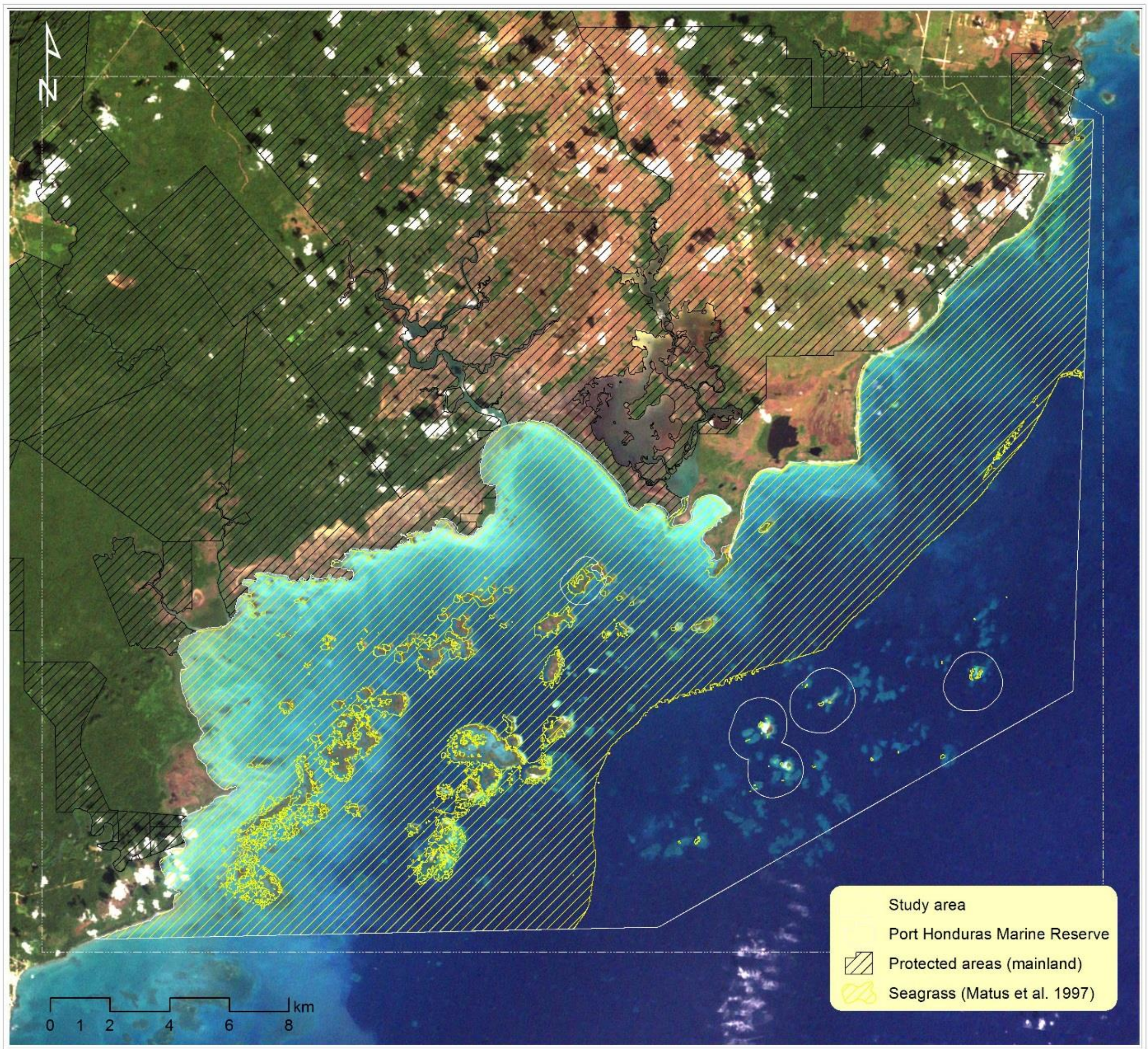

Figure 4: Seagrass cover in the PHMR, extracted from Matus (1997)

It is also evident from **Figure 4** above that not only might turbid waters have been mapped as seagrass meadows, but the outer, eastern boundary of the seagrass map seems drawn arbitrarily, as the gradient off which it is based is not apparent in the imagery. In fact, the upper northeastern section of that boundary is an almost straight line, indicating that the estimate of seagrass cover for that section of the map may merely have been digitized by hand based on a general idea of where seagrass should be, and not necessarily based on the image classification.

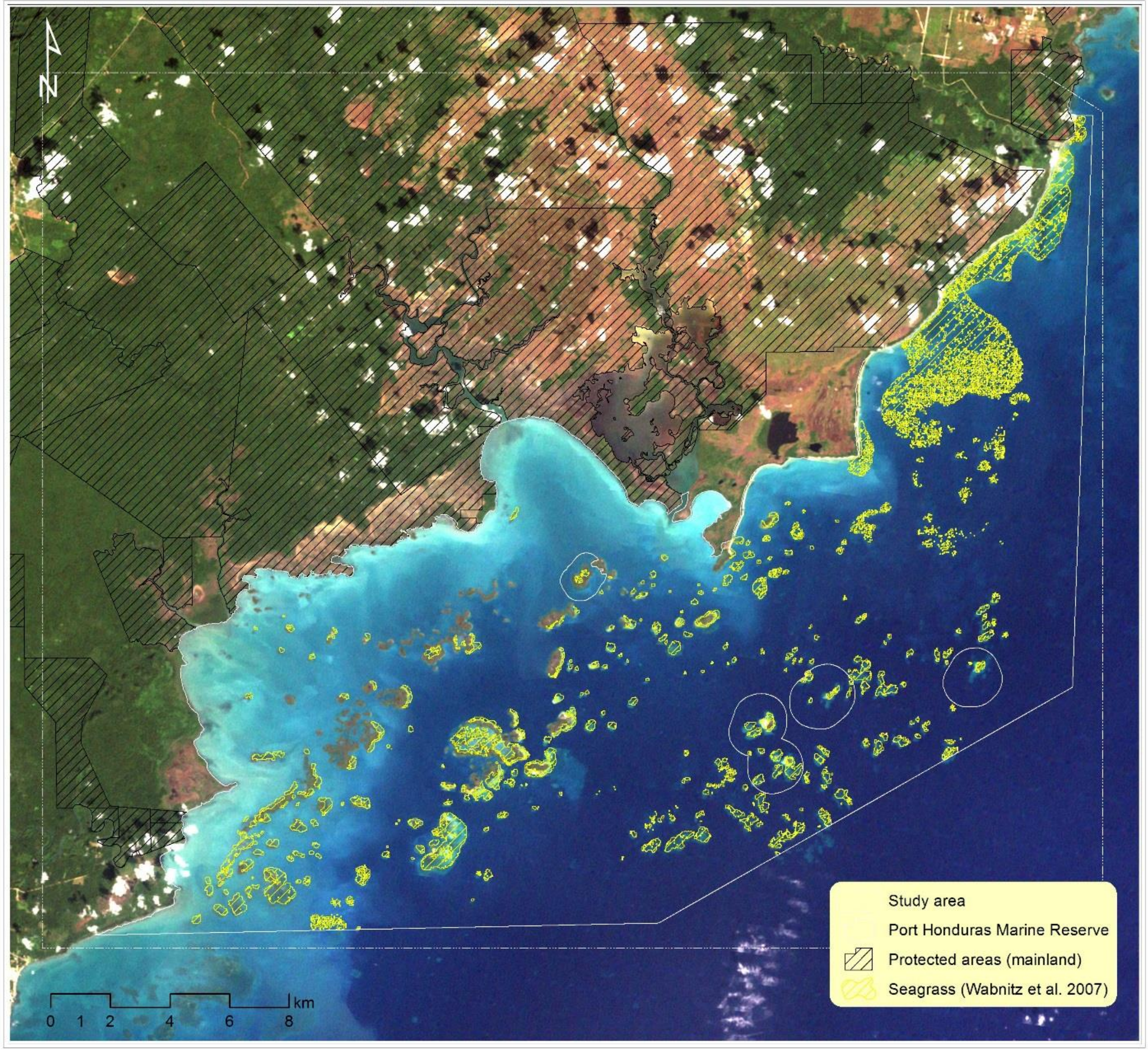

Figure 5: Seagrass cover in the PHMR, extracted from Wabnitz et al. (2007)

By contrast, the data from Wabnitz et al. (2007) – shown in **Figure 5** – would *seem*, from visual inspection, to represent less of the turbid water. In any event, it is possible that the Wabnitz et al. data represents a more conservative estimate of seagrass cover than does the Matus (1997) data.

Generation of statistics on dynamics, baseline areal extent

Based on the data which were extracted from the different source datasets, statistics on areal extent – across time, where possible – were compiled, and these are presented in a series of tables in the following section of this study.

IV. RESULTS

In terms of the mangrove cover within the PHMR proper and the 'greater PHMR area,' statistics on the former are presented in **Tables 3** and **5**, while statistics on the former are presented in **Tables 4** and **6**. It can be seen from **Table 4** that in the greater PHMR domain, change in mangrove cover has been minimal (some 60 acres cleared in total between 1980 and 2010, of almost 15,000 acres of mangrove), representing an overall decline of mangrove cover of merely 0.4%, which is lower than the approximately 2% of mangrove cover that was lost across Belize between 1980 and 2010. The area cleared – specifically in the period between 2004 and 2010 was within the now-defunct Monkey Caye Forest Reserve, near Monkey River Town, illustrated in **Figure 6** below.

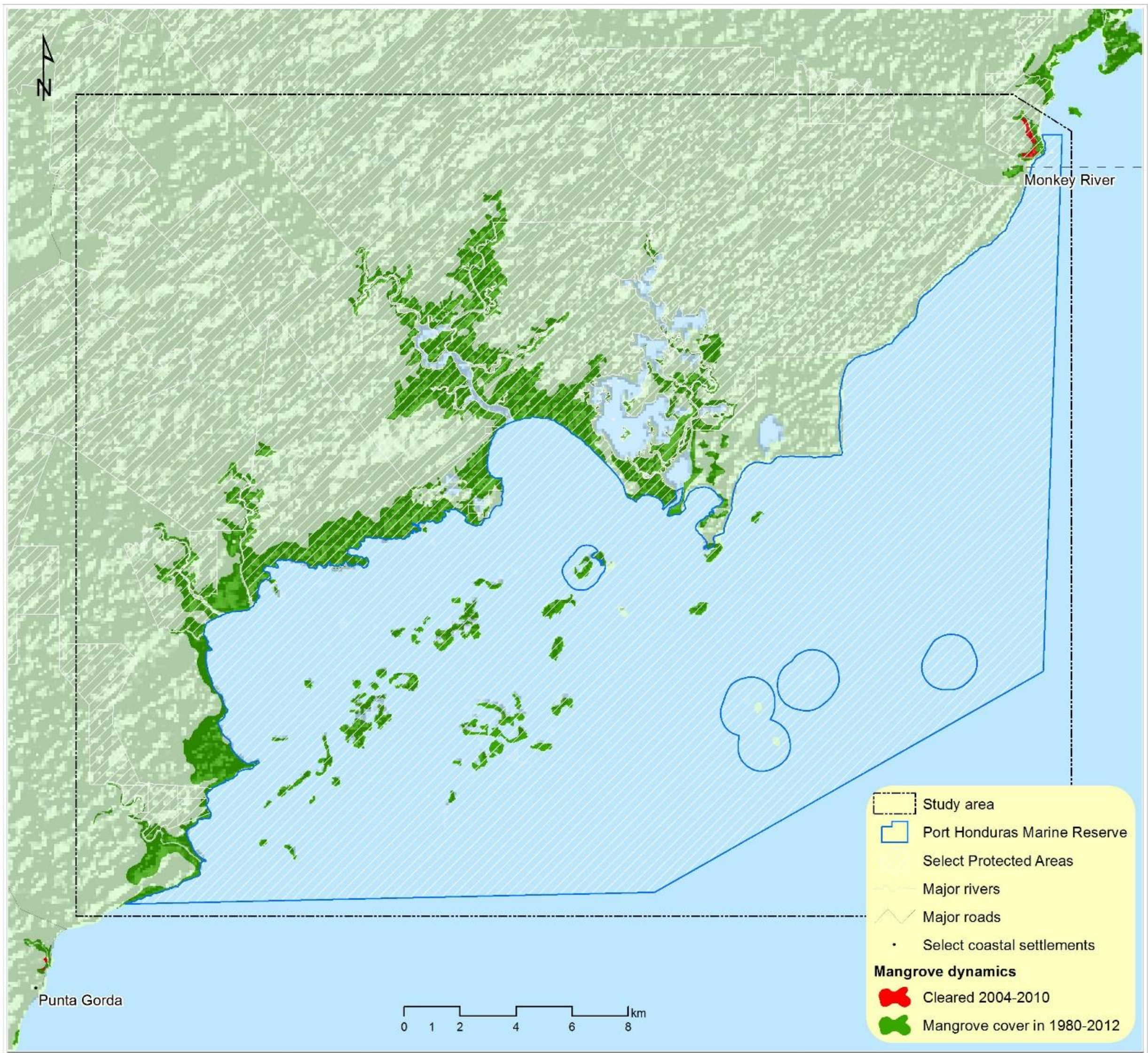

Figure 6: Mangrove dynamics in the greater Port Honduras Marine Reserve area (based on Cherrington et al. 2010 and Cherrington et al. 2012)

As also illustrated in **Figure 6** and indicated in **Table 3**, it is estimated that within the PHMR proper, the total area of mangrove in 2012 was estimated to be 1,767 acres, with an additional 12,879 acres located in the coastal mainland adjoining the PHMR.

Table 3: Mangrove cover dynamics for the PHMR

Ecosystem	Acreage	Ha.	Data source	Source year	% Change
Mangrove	1,767	715	CATHALAC	1980	N/A
Mangrove	1,767	715	CATHALAC	1989	0.0%
Mangrove	1,767	715	CATHALAC	1994	0.0%
Mangrove	1,767	715	CATHALAC	2000	0.0%
Mangrove	1,767	715	CATHALAC	2004	0.0%
Mangrove	1,767	715	CATHALAC	2010	0.0%
Mangrove	1,767	715	CATHALAC	2012	0.0%

Table 4: Mangrove cover dynamics for the greater PHMR area

Ecosystem	Acreage	Ha.	Data source	Source year	% Change
Mangrove	14,706	5,951	CATHALAC	1980	N/A
Mangrove	14,705	5,951	CATHALAC	1989	0.0%
Mangrove	14,705	5,951	CATHALAC	1994	0.0%
Mangrove	14,705	5,951	CATHALAC	2000	0.0%
Mangrove	14,705	5,951	CATHALAC	2004	0.0%
Mangrove	14,646	5,927	CATHALAC	2010	0.4%
Mangrove	14,646	5,927	CATHALAC	2012	0.0%

As indicated in **Tables 5-6** following, within the PHMR, the mangrove islands[6] consist principally (95.8%) of dwarf mangrove, with the 4.2% remainder being medium-height mangroves, while in the area adjoining and including the PHMR, composition consists of 88.5% dwarf mangrove, 7.6% medium-height mangrove, and 3.9% tall mangrove.

Table 5: Mangrove composition within the PHMR, 2012

Mangrove type	Acreage	Ha.	Proportion
Dwarf	1,693	685	95.8%
Medium height	73	30	4.2%
Tall	-	-	-
TOTAL	**1,767**	**715**	**100%**

[6] Since the PHMR is a Marine Reserve, the only mangrove ecosystems found within its boundaries are mangrove islands.

Table 6: Mangrove composition within the greater PHMR area, 2012

Mangrove type	Acreage	Ha.	Proportion
Dwarf	12,962	5,245	88.5%
Medium height	1,115	451	7.6%
Tall	569	230	3.9%
TOTAL	**14,646**	**5,927**	**100%**

With regard to seagrass cover, as already presented in the validation section of the Methodology, it would appear that the data from the University of South Florida (USF) researcher Torres-Pulliza (i.e. Wabnitz et al. 2007) offers a more congruent estimate of seagrass cover for the PHMR. Nevertheless, **Table 7** below summarizes the different areal estimates from the different efforts. In the case of the data from the CZMAI, the NPAPSP and USF, all three were based on supervised classification analysis of Landsat satellite imagery. It should also be underscored that based on analysis of available Landsat satellite imagery, and the literature, it seems unlikely that the seagrass cover within the PHMR is changing – at least on a scale that can be detected by satellite imagery. As such, as dredging – or other activities which would result in the removal of seagrass – has not been documented, it should be concluded that seagrass cover has remained constant in the PHMR.

Table 7: Seagrass cover estimates for the PHMR

Ecosystem	Acreage	Ha.	Data source	Source year	Publication year
Seagrass	79,930	32,347	CZMU	N/A	1993
Seagrass	66,733	27,006	CZMAI	1996	1997
Seagrass	69,695	28,205	NPAPSP	1996	2005
Seagrass	7,380	2,987	USF	2002	2007

In summary, in terms of baseline estimates of the cover of the different coastal and marine ecosystems examined, **Table 8** presents the breakdown of the areal extent (cover) of the three principal ecosystems found within the Port Honduras Marine Reserve. For purposes of comparison, coral reef extent was also extracted from Matus (1997).[7] These are illustrated in **Figure 7**, on the following page.

Table 8: Baseline ecosystem cover estimates for the PHMR

Ecosystem	Geographic domain	Acreage	Ha.	% of PHMR	Data source
Coral reefs	PHMR	936	379	0.9%	Matus, 1997
Mangrove	PHMR	1,767	715	1.8%	Cherrington et al., 2012
Mangrove	greater PHMR area	14,646	5,927	N/A	Cherrington et al., 2012
Seagrass	PHMR	7,380	2,987	7.4%	Wabnitz et al., 2007

[7] Visual assessment also indicated that the coral reef data from Matus (1997), particularly for the PHMR, was less generalized (i.e. more specific) than the seagrass cover data.

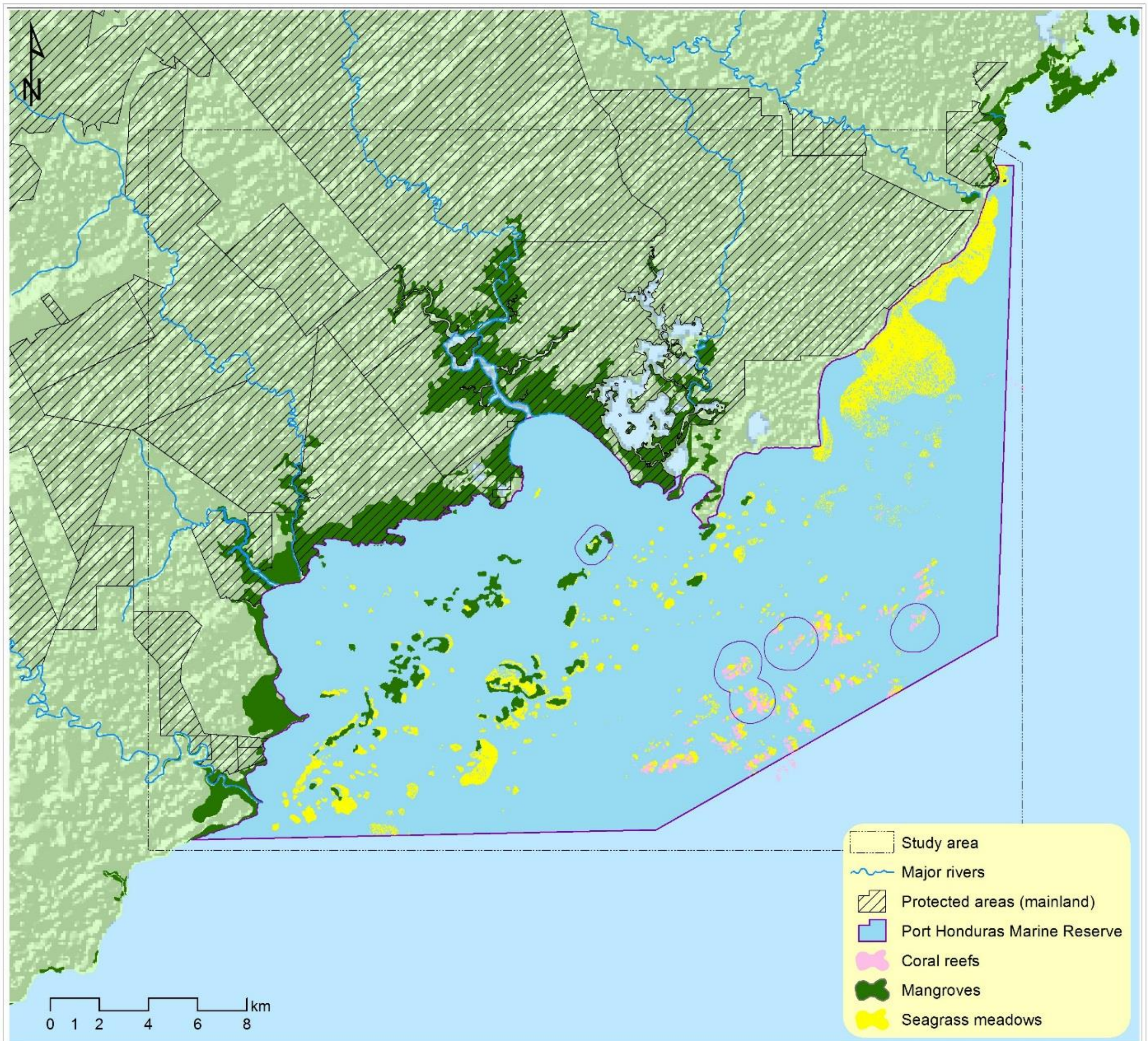

Figure 7: Ecosystem types within the Port Honduras Marine Reserve

V. DISCUSSION

Following from the findings reported in the previous section, issues that warrant some discussion and consideration include:

- Implications of the stability of mangrove cover in the PHMR area
- The revision of the seagrass data for the PHMR

In contrast with the dearth of multi-temporal data on seagrass cover, data on mangrove cover for the study area includes 7 time-steps extending from November 1980 through May 2012. With the exception of the mangrove cover within the [defunct] Monkey Caye Forest Reserve, mangrove cover within the study area has remained stable over the almost 32-year study period, even as the Payne's Creek National Park was not established until 1994, and the PHMR was not created until six years later, in the year 2000. The satellite data also indicate that – with the exception of Monkey Caye Forest Reserve – the mangrove cover of the area has been intact over the past ~32 years. It should be noted that the area of mangrove ecosystems outside of the Port Honduras Marine Reserve but nonetheless interfacing with the Reserve exceeds the mangrove cover within the PHMR proper.

Also, as can be seen in **Figure 6**, there are intact mangrove ecosystems abutting the PHMR which do not fall within the protected areas system. However, one can also see that the only mangroves which were cleared were those near Monkey River Town, even though those mangroves were within a Forest Reserve – one which the draft report on the Rationalization Exercise of the Belize National Protected Areas System (Wildtracks, 2012) has listed as 'defunct.' Otherwise, there are not any other significant settlements near those mangroves which might bring development pressures, but what occurs in the future certainly remains to be seen. The 1980-2010 mangrove cover study, among other things, characterized the susceptibility of mangroves to fragmentation / disturbance, and based on extremely low historical rates of mangrove deforestation, the mangroves of the Port Honduras / Punta Ycacos area were categorized as having a very low susceptibility to disturbance (Cherrington et al. 2012).

Nevertheless, in revising which areas in Belize may be susceptible to deforestation overall, in the context of the regional REDD-CCAD-GIZ project which seeks to develop capacities for implementing Reduced Emissions from Deforestation and Forest Degradation (REDD+) schemes in Belize and the broader Central American region, CATHALAC is currently undertaking an assessment of future deforestation susceptibility across Belize. However, at the time of the publication of this report, those results are not yet available.

With regard to the seagrass cover data, because of the discrepancies between the data generated by the CZMAI (i.e. the Landsat-based National Marine Habitat Map), and that generated by the University of South Florida's Institute for Marine Remote Sensing (i.e. the also Landsat-based 'Meso-American Reef and Seagrass Map'), it should be noted that overall, the data on seagrass should be treated with caution. Where the CZMAI and the USF studies utilized satellite image inputs from different dates – and under different marine environmental conditions - it is the recommendation of this report that the seagrass mapping be re-attempted, but utilizing multi-temporal data to control for the effects of turbid water. Soliciting expert opinion on the various seagrass outputs would also be warranted.

VI. CONCLUSIONS

In terms of baseline data on the areal extent of mangrove, seagrass, and coral reef ecosystems within the Port Honduras Marine Reserve, these are summarized in **Table 8**, and illustrated in **Figure 7**. Within the PHMR, there are approximately 1,767 acres of mangroves, and a further 7,380 acres of seagrass meadows, complementing an estimated 936 acres of coral reefs which are located largely in the southeast of the Reserve. As a testament to the management activities of TIDE, and the Forest and Fisheries Departments, the mangrove Revision of previous studies also indicates that mangrove and seagrass cover within and adjoining the PHMR have been relatively stable (0% change within the PHMR, and 0.4% adjoining in the PHMR, over a ~32 year period). In terms of other conclusions, while mangrove cover outside of the PHMR has changed slightly, in terms of baselines, it is assumed that seagrass cover within the Reserve, has remained unchanged to the extent that such change can be detected by moderate resolution satellite imagery such as Landsat. Nevertheless, it is recommended that TIDE and its partner agencies in the Government of Belize (i.e. the Forest and Fisheries Departments) continue to take advantage of data from existing initiatives to continue to monitor how the areal extent of these ecosystems, especially mangrove cover.

ACKNOWLEDGEMENTS

This study was funded under a contract with the Toledo Institute for Development & Environment (TIDE). The 1980-2010 mangrove data utilized in this study were also developed by CATHALAC in 2010, under contract KL-23 with the World Wildlife Fund, with funding from the WWF and the United Kingdom's Department for International Development (DfID). The efforts of Celia Mahung, TIDE's Executive Director, and Joe Villafranco, TIDE's Program Manager, are appreciated. CATHALAC's Director General, Ing. Matias Carrera Delgado, and the CATHALAC Administrator, Alexis Vega Maldonado, should also be acknowledged, as well as the support of CATHALAC Research Scientists Betzy Hernandez and Octavio Smith. Previously funded research that has been integrated into this research owes heavily to Dr. Simon Zisman – a prominent mangrove ecologist – and to a host of others, including Janet Gibson of the Wildlife Conservation Society, Melanie McField of the Healthy Reefs Initiative, Nadia Bood of the World Wildlife Fund, Jan Meerman of Belize Tropical Forest Studies, Dan Irwin of NASA, Leandra Cho-Ricketts, Elma Kay, and Ivanna Waight of the Environmental Research Institute of the University of Belize, and Percival Cho and Tanya Santos of the Belize Forest Department. Additionally, the satellite data utilized in this study were largely obtained via the Regional Visualization & Monitoring System (SERVIR, in Spanish), a regional environmental monitoring system that CATHALAC has been implementing since 2005, jointly with the U.S. National Aeronautics & Space Administration (NASA), and the U.S. Agency for International Development (USAID). Satellite imagery were also obtained via the U.S. Geological Survey (USGS).

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ANNEX A: Recommendations for future monitoring of changes in mangrove and seagrass cover in the PHMR

This report has indicated the status of mangrove and seagrass cover in and around the PHMR, as of early 2012, when the most recent mangrove data was available.[8] In terms of monitoring future changes in mangrove cover and seagrass cover, there are two principal options open to TIDE:

1. Generate its own data on mangrove and seagrass cover
2. Extract data for the PHMR and surroundings from nationally available datasets

Generation of data 'from scratch'

With regard to the former option, the imagery from NASA's Landsat satellites which was used to generate both the seagrass data and the mangrove data are publicly available (see http://glovis.usgs.gov or http://reverb.echo.nasa.gov/). Provided that TIDE were to acquire personnel with the necessary skills (or train existing personnel from scratch), the Institute could use the freely available Landsat imagery to map changes in mangrove and seagrass cover.[9] In the case of mangrove cover, it is recommended that this would be done following the methodology laid out in Cherrington et al. (2010), which describes how the technique known as spectral mixture analysis (SMA) was utilized to determine areas of cleared mangrove. Generation of the mangrove cover using the same technique used for the previous maps would also guarantee standardization of methodology[10], and that the data generated would be comparable.

In terms of the generation seagrass cover data, Wabnitz et al. (2007) merely indicates that a supervised classification was performed but did not provide details (e.g. which water column corrections were performed on imagery, how turbid water was addressed, etc.). Thus, conducting a new supervised classification from scratch might or might not provide results similar to that of Wabnitz et al. (2007), as not having access to that methodology precludes replicating it in the future. And as indicated previously, classification of marine (i.e. underwater) habitat is notoriously more difficult than classification of vegetation on the land surface because of the factors involved. For instance, the influence of sediment / turbidity also makes the identification of features in the water difficult. In any event, significant losses of seagrass cover would likely be due to activities such as dredging, which should be visible in satellite imagery, and which would therefore make such changes in seagrass cover easier to map.

Provided that TIDE is interested in going such a route, the suggested time scale for performing such an activity would be somewhere between annually to every five years. The recommended scale would be at least 1:100,000, and based off Landsat-7 and Landsat-8 imagery freely available from NASA, though the European Space Agency (ESA) will also be launching its SENTINEL-2

[8] Since the submission of this report at the end of February 2013, the data on Belize's national forest cover – including 'mangrove forest' – has been developed by CATHALAC and partners (see **Figure 8**).
[9] This is the approach being taken by the fellow southern Belize NGO, Ya'axche Conservation Trust, with regard to mapping of the changes in the 'Maya Golden Landscape' and Toledo on a whole.
[10] Notwithstanding, there are other techniques that could be utilized to generate such data – such as supervised image classification, unsupervised classification, or visual interpretation – but these would not ensure standardization with the existing product.

earth observation satellite sometime in 2014, which should be compatible for all intents and purposes to the Landsat series.

Extraction of data for PHMR from nationally available datasets

Also with regard to monitoring of the PHMR and surroundings, the other option available to TIDE would be to utilize existing national datasets such as forest cover, and extract from that data the information specific to the PHMR and surroundings. (In fact, all the data presented within this report have been estimates for the PHMR, extracted from datasets of national coverage.) This option would likewise ensure that the data presented have are comparable to national estimates, and the generation of the data would include no cost per se to TIDE, although the extraction of the data for the PHMR would require an investment of effort.

If TIDE already has some staff resources trained at the intermediate level in geographic information systems (GIS) and with the available hardware and software (e.g. ArcGIS) to perform such analyses, this option would be more cost effective than the previous option of TIDE developing its own mangrove and seagrass datasets for the PHMR from scratch. For instance, in 2010, CATHALAC in collaboration with the World Wildlife Fund (WWF), developed data on Belize's mangrove cover, and this was in turn integrated into the 2012 forest cover dataset developed by CATHALAC and partners in August 2012. As of the edition of this report, a 2013 national forest cover dataset has also been developed (see **Figure 8**), and which includes 'mangrove forest' as an individual class within the overall forest cover. Information for the PHMR can in turn be extracted from the 2013 dataset to examine changes in mangrove cover in the PHMR as of late March 2013.

The significant drawback of TIDE having to extract its data on mangrove cover in the PHMR from national datasets is that TIDE's ability to monitor such landscape level changes in mangrove cover will be tied to the availability of such forest cover datasets. Nevertheless, the tentative plan is for such datasets to be developed on an annual basis for Belize, although this will in turn depend on the availability of adequate quality (i.e. low cloud cover) imagery of the country. However, as regards seagrass datasets, it should be noted that there is no available time series of seagrass cover for Belize, so the principal option for generating such data may well be generation 'from scratch.'

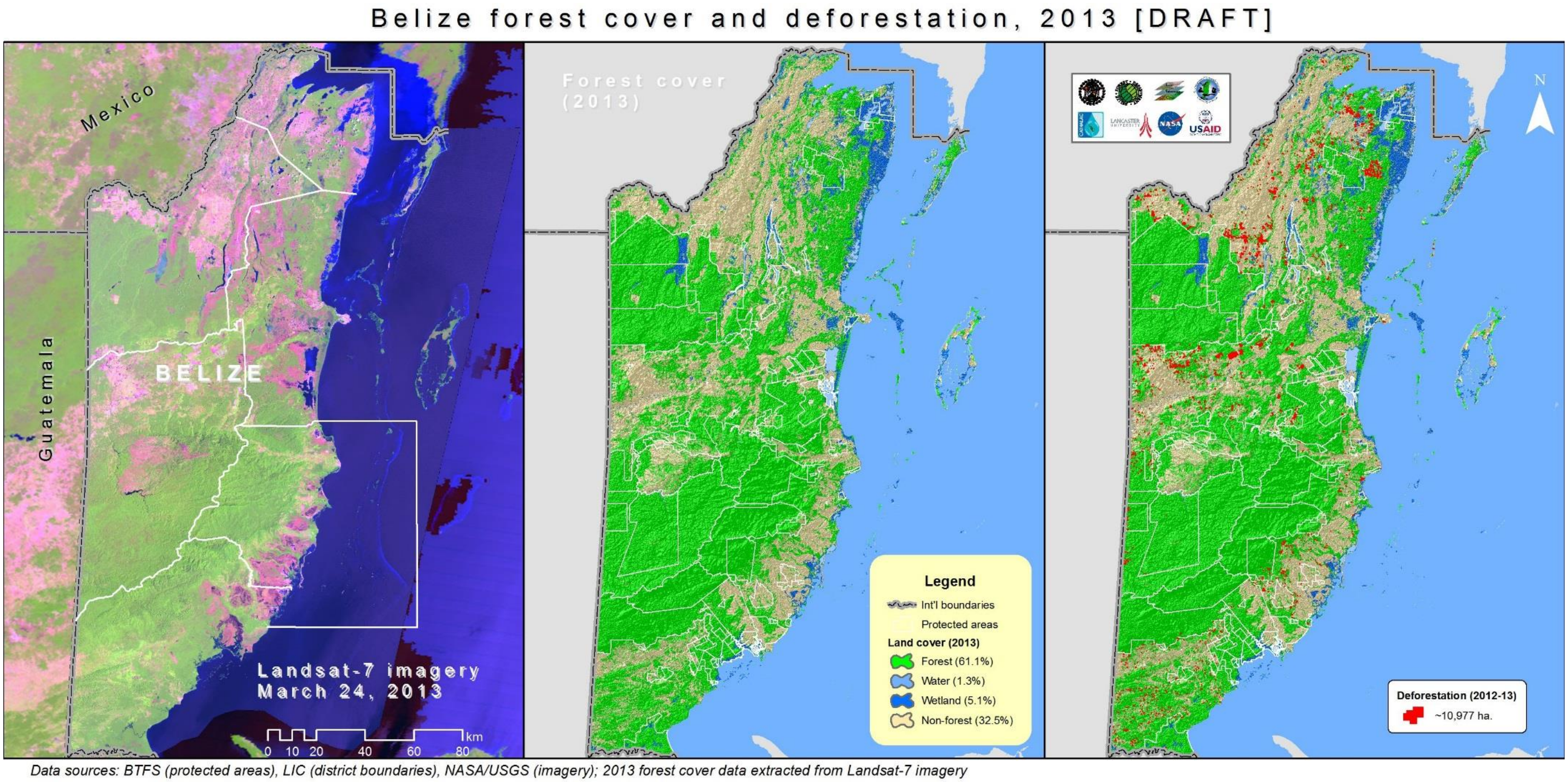

Figure 8: National-level forest cover data for Belize for 2013, including mangrove cover[11] within the forest class (source: *CATHALAC, 2013*)

[11] Based on their structural characteristics (i.e. height at or exceeding 3m), medium-height and tall mangroves were classified within the 'forest' class, while the other mangrove classes (i.e. dwarf mangroves and mangrove savannas) were included in the 'wetland' class.