Benthic Species Update 2014

Toledo Institute for Development and Environment

Port Honduras Marine Reserve
Commercial Benthic Species UPDATE: 2009-2014

Conch, Lobster, Sea Cucumber

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ACRONYM KEY

AGRRA	Atlantic and Gulf Rapid Reef Assessment
BFD	Belize Fisheries Department
EDF	Environmental Defense Fund
GRMR	Glovers Reef Marine Reserve
GUZ	General Use Zone
LT	Conch lip thickness
OUT	Marine areas close to but outside PHMR
PCNP	Payne's Creek National Park
PHMR	Port Honduras Marine Reserve
PRZ	Preservation Zone
RZs	Replenishment Zones (previously NTZs)
SL	Conch shell length
TAC	Total Allowable Catch
TIDE	Toledo Institute for Development and Environment
WCS	Wildlife Conservation Society

1. INTRODUCTION

1.1 Fisheries Assessment Report 2009-2012:

In 2013, TIDE research and monitoring department conducted a comprehensive assessment of commercial benthic and finfish species in PHMR, comparing fisheries dependent data (boat and landing site surveys of catch) and fisheries independent data (underwater surveys) from 2009-2012. Mean size, population structure and population density or abundance were determined for each species, comparing different management zones in the reserve (RZs, GUZ and outside PHMR).

TIDE has also been consistently conducting underwater conch and lobster surveys of underwater populations since 2004 to the present, providing information on population density/abundance, size and maturity of the two most important commercial species – lobster and conch. Since 2011, Donkey Dung sea cucumber (*Holothuria mexicana*) has become a significant commercial species also, and thus underwater surveys have been conducted by TIDE for *H. mexicana* since September 2011.

1.2 2009-2013 Benthic Commercial Species Audit:

The aim of the 2009-2013 Benthic Commercial Species Audit was to inform adaptive management of Managed Access, currently in its third year of implementation in Port Honduras Marine Reserve. It is a comprehensive assessment of the health of commercially exploited benthic species in PHMR, by far the largest local fishery products in both income and weight. This is necessary to improve understanding of the complex relationships between commercial benthic species of PHMR, fishing and the environment, and is crucial for informing on the effectiveness and adaptive design of Managed Access. A long-term goal of TIDE's commercial species monitoring programs is to be able to assess stock levels of commercial benthic species and enable sustainable catch quotas to be determined for PHMR. Detailed background information on the program can be found in the 2009-2013 Benthic Commercial Species Audit Report, and is the precursor to this current report.

1.3 This report: Benthic species update 2009-2014

Results of TIDE's lobster, conch and sea cucumber underwater surveys, covering a six-year period between 2009 and 2014 (2011-2014 for sea cucumber), are presented and discussed here, with emphasis on informing the effectiveness to date of Managed Access as a fisheries management tool for Belize.

2. BACKGROUND

2.1 Port Honduras Marine Reserve:

Port Honduras Marine Reserve (PHMR) lies off the coast of Southern Belize, starting from the mouth of Monkey River it extends south to 8km north of Punta Gorda Town and 25 km east to include the Snake Cayes (Robinson et al. 2004). The Marine Reserve covers an area of 414 km^2, incorporating coastline, mangrove cayes, submerged banks and a number of ecosystems of critical importance to local coastal communities and to Southern Belize as a whole. Extensive seagrass meadows cover the shallow coastal areas and surround an intricate network of mangrove cayes. Thick mangroves cover nearly all of the 138 Cayes within the reserve and border the coastline and estuaries of PHMR. Fringing coral reefs encompass the offshore Snake Cayes and patch reefs are scattered throughout the reserve. These ecosystems are home to a myriad of flora and fauna, which live in delicate balance with one another and their surrounding environment. Some of these organisms are of considerable commercial benefit to the local communities and to the wider economy of Belize, such as the queen conch, sea cucumber and the Caribbean spiny lobster.

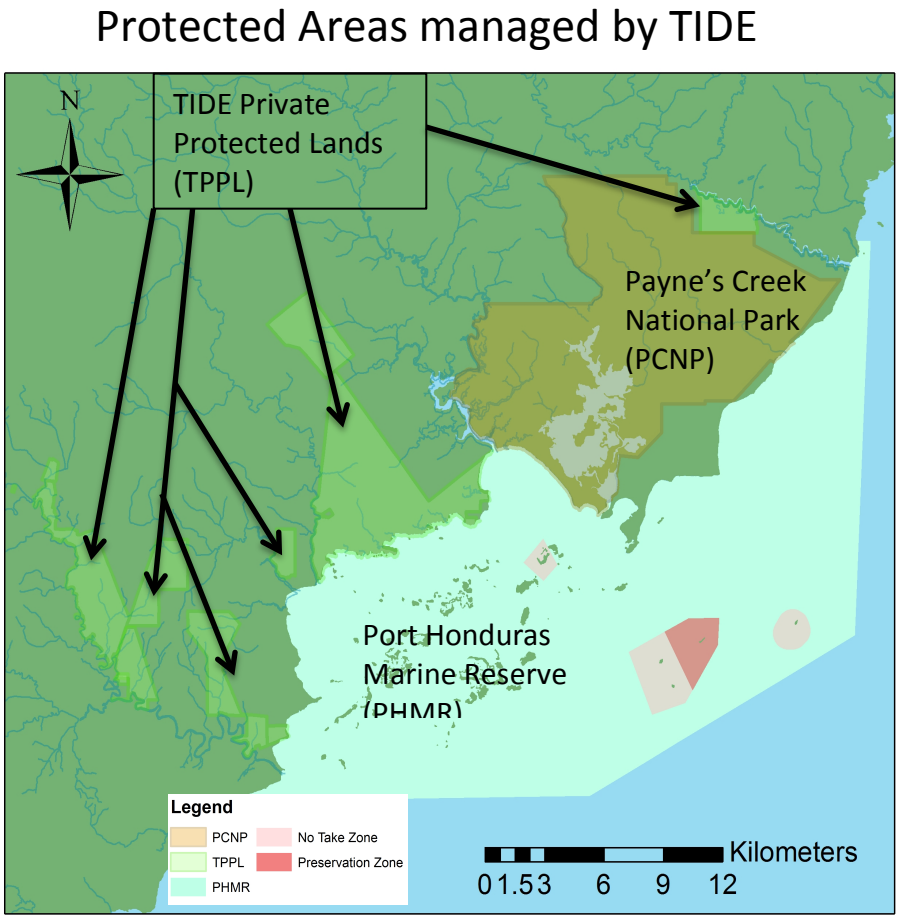


Fig. 1. Management zones of Port Honduras Marine Reserve (PHMR), showing proposed Replenishment Zones after 2013 stakeholder consultations. Also Payne's Creek National Park (PCNP) and TIDE Private Protected Lands (TPPL).

PHMR was established in 2000 and is co-managed by the Toledo Institute for Development and Environment (TIDE) and the Belize Fisheries Department (BFD). PHMR is composed of three zones (Fig. 2.1): 95% is a General Use Zone or GUZ (regulated extractive activities allowed), 4% is a Replenishment Zone or RZ (non-extractive activities only) and 1% is a Preservation Zone or PRZ (research activities only). As such, only 5% of the reserve is under full protection from extraction.

2.2 Buffer Communities:

Three communities depend on the marine resources of PHMR for commercial and subsistence purposes. Known as the "buffer communities", these are Punta Gorda, Punta Negra and Monkey River Village. Punta Gorda, located 2-3km south of PHMR is the largest of these, with approximately 6500 people. Punta Negra, on the central part of the mainland coast of the reserve between Punta Ycacos and Monkey River is the smallest, with approximately 20 residents. Monkey River Village is located at the northern end of the reserve on the southern bank of the mouth of the Monkey River. There is approximately 15-20km between each of these communities. Fishers from these communities fish for conch, lobster, sea cucumber and various finfish species in PHMR.

2.3 Replenishment Zones and Spill-over Effects:

It is well known among marine protected area specialists that at least 20% of a marine protected area needs to be "no-take" in order for there to be sufficient spillover into general use areas. This is a theory supported also by the BFD. After concern that RZs in PHMR were not meeting this threshold, public consultations were held by TIDE in 2013 with PHMR stakeholders from all three buffer communities. A small extension was agreed upon to encompass West, South and Middle Snake Cayes within one contiguous Replenishment Zone. However, this still falls short of the mandate from the BFD to increase RZs to 20% of territorial waters in the next few years. Further new zoning plans are in development (Foley & Baker 2014) and have been submitted to TNC in January 2014 for review prior to future consultations with communities to get build their support.

3. MONITORING METHODS

Data on population density, maturity and size frequency of Queen conch (*Strombus gigas*), Caribbean spiny lobster (*Panulirus argus*) and Donkey Dung sea cucumber (*Holothuria mexicana*) were collected and analysed. This involved comparison of morphometric data from underwater surveys of lobster, conch and sea cucumber.

3.1 Conch:

In the years 2009-2010, conch monitoring took place twice each year, just before the conch season closes in June, and shortly before it opens again in September. In 2011 and 2012, the first monitoring was moved to July, just after the conch season closed, in order to capture the impact of all open season extraction.

Queen conch populations were monitored at 12 sites strategically placed throughout PHMR from 2004 to 2008, incorporating local fishers' knowledge and habitat information. Since September 2011, 20 sites have been monitored; five in the RZs, 11 in the GUZ and four outside the reserve. At each site, where possible, five 50 x 2 metre belt transects were laid parallel to one another and at least five metres apart. At some sites, only three or four were possible due to habitat and depth constraints. The specific number of sites surveyed in each monitoring trip varied slightly due to weather, resources, and underwater visibility.

Shell length (cm) and lip thickness (mm) are recorded for all queen conch (*Strombus gigas*) encountered, and population density (conch per hectare or conch ha^{-1}) calculated later based on number of conch found in the area surveyed. Shell lengths and lip thicknesses are divided into standard size "**cohorts**" (groups of standard increments) to determine population structure via **size frequency distribution,** or **the proportion of the total sample in each size cohort**, allowing changes in stock maturity over time to be estimated between 2009 and 2013. This is important for predicting the general **fecundity** of the population, which likely decreases with diminishing average age/size.

Effectiveness of the shell length based size restriction of 17.8cm (7 inches) in protecting juvenile conch is also assessed by analysing trends in the proportion of the conch population throughout 2009-2013 that was of legal shell length but with lip thickness below Stoner's et al. (2012) lip thickness at maturity estimations of >9mm for males and >12mm for female conch.

3.2 Lobster:

Caribbean spiny lobster (*Panulirus argus*) populations are surveyed at 18 sites within and adjacent to PHMR twice a year, immediately after the closed season begins (15th February), and immediately before it opens (14th June). Sites are located in the RZs (8 sites), GUZ (7 sites), and outside the reserve (3 sites). At each site, where possible, either two diver pairs conduct two 30 minute timed swims simultaneously or a 60 minute timed swim is conducted by a single diver pair. For each lobster located, species, gender, maturity (tar spot, eggs) and carapace length are recorded. The number of sites surveyed in each zone

may vary between monitoring periods and years for a number of reasons (resources, weather, visibility). Abundance is calculated as number of lobsters encountered per hour during each timed swim. Carapace lengths were divided into standard size cohorts to determine population structure via size frequency distribution as with conch, enabling estimates of stock maturity and fecundity to be made.

3.3 Sea Cucumber:

Sampling is carried out as close as logistically possible to the start and end of the sea cucumber closed season (July 1 - December 31) at six sites in PHMR using a technique based on that of Amesbury and Kerr (1996). Different habitats in PHMR were stratified to determine habitats suitable for sea cucumbers and within those stratifications, monitoring sites were randomly determined. However it was ensured that there were monitoring sites within both the RZs and GUZ in order to have comparable data.

A 11.28 m line (*calculated as*: area of a circle = $\Pi r^2 \rightarrow 400m^2/\Pi = 127.32$; $\sqrt{127.32} = 11.28m$) is attached to a central pole, and two divers swim the line around the pole in a "radar sweep" trajectory covering $400m^2$ of habitat. When *H. mexicana* are found, length and width measurements are taken in situ, being careful not to touch the specimen as this might cause it to retract. Specimens are then brought up to the boat to be weighed before being returned to their original location. In order to gain population density estimates, the number of *H. mexicana* per hectare is calculated. Mean length and weight are also calculated to determine mean sizes in different management zones.

4. FINDINGS
Conch:

Observations:

- Conch densities have continued to decline in all zones, and are now at a critical low.
- The closed seasons of 2013 and 2014 failed to achieve their intended purpose of increasing abundance by protecting conch during their reproductive period.
- While mean shell length continues to remain stable, mean lip thickness has increased in 2014, coinciding with a major decrease in density, indicating lack of juveniles (those conch left are not reproducing as much, possibly having a harder time finding each other to successfully reproduce due to low population). See graphs (Fig 2,3,4).

Discussion:

- These observations point to a need for revising the legal framework for managing conch. It is known from studies in other areas that shell length is not the most accurate proxy indicator of maturity in conch. Other parameters, such as lip thickness, operculum dimensions or meat weight

may be better maturity indicators. TIDE's conch lip thickness study aims to inform this and make recommendations for incorporating lip thickness and/ or other parameters into existing legislation to protect immature conch from harvesting.

- While there are signs that existing management tools such as RZs, gear restrictions, fisher access limitations through Managed Access can have a positive effect on sustainability of the conch fishery, greater diligence, accuracy and honesty are needed with managed access reporting from fishers.

Recommendations:

- Take previous recommendations regarding incorporating lip thickness into legal framework seriously, and to work with fishers to better understand spawning locations and closely monitor them to substantiate suspected decrease in reproduction.

- Compel fishers to record conch catch diligently and honestly, by showing them the longer-term benefits through managed access data from understanding impact of fishing better.

- More outreach is required to ensure demand is only for mature conch, and that fishers understand the long term benefits of ensuring juvenile conch are protected.

Fig 2.

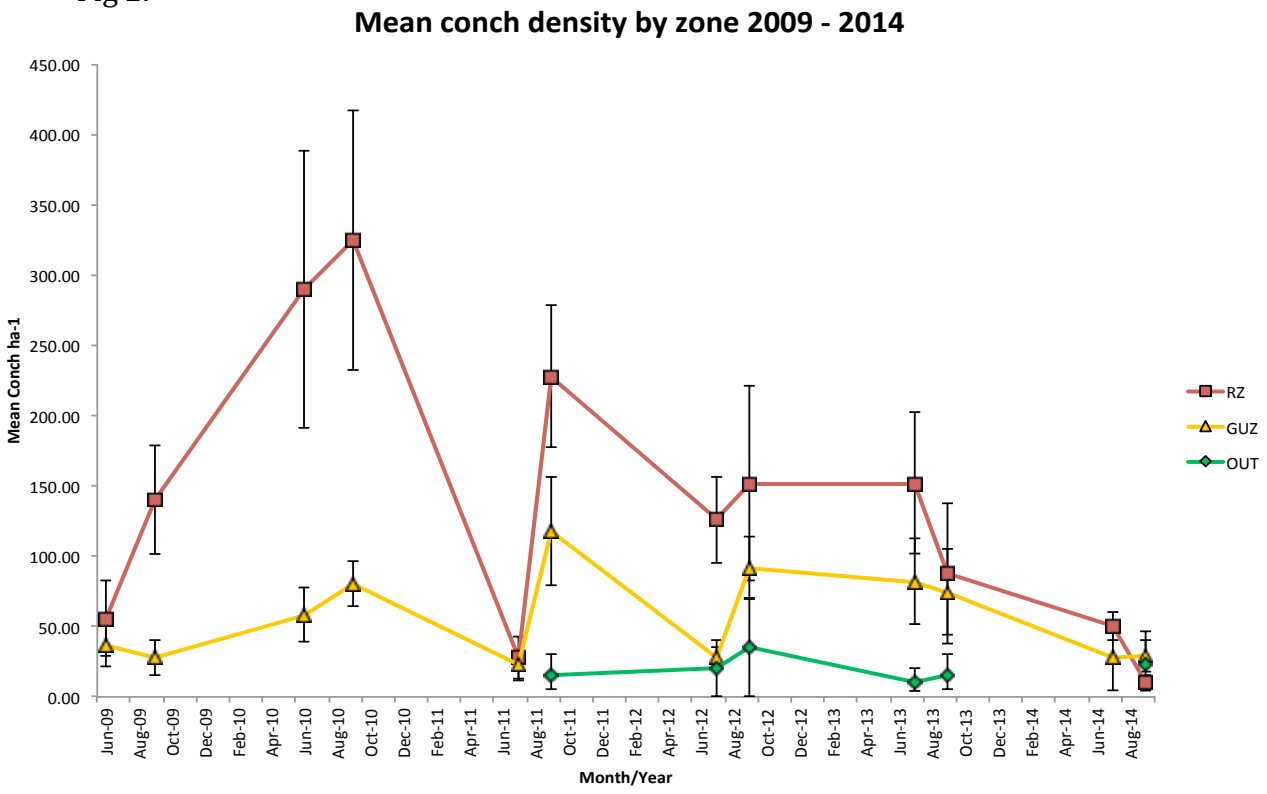


Fig 3.

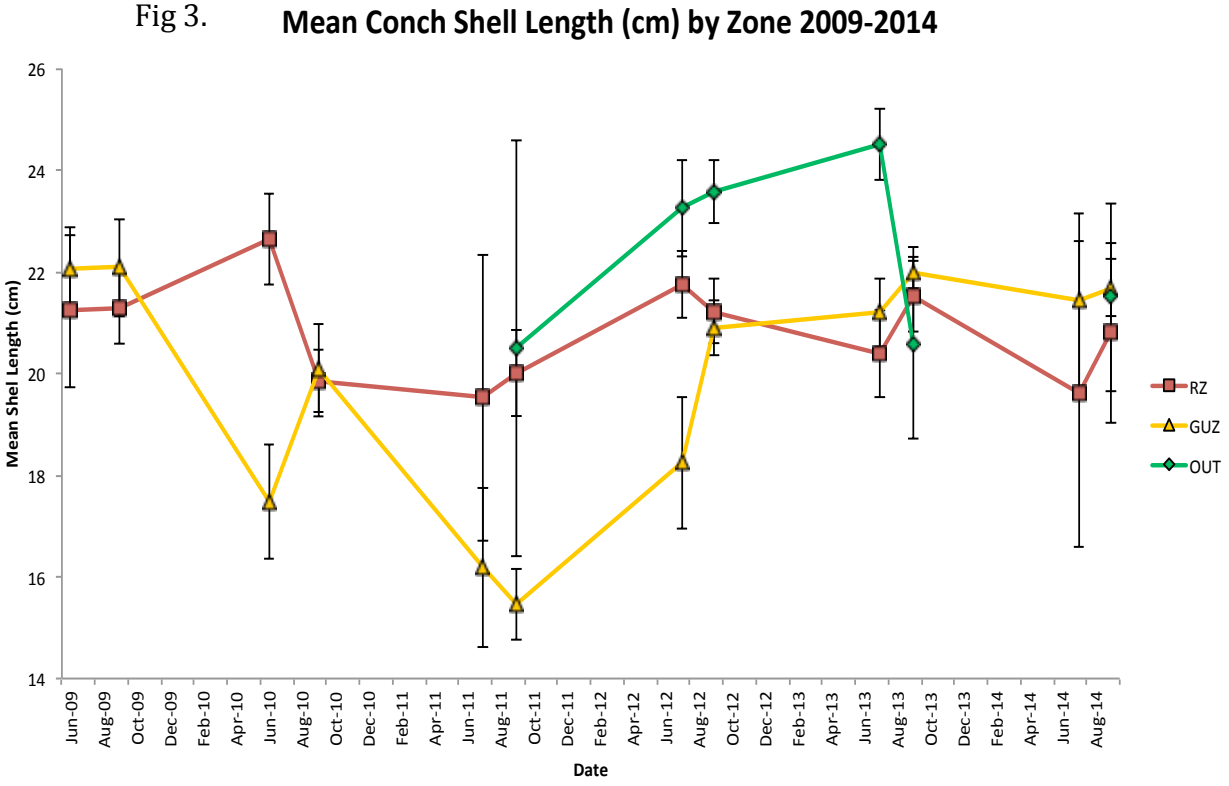
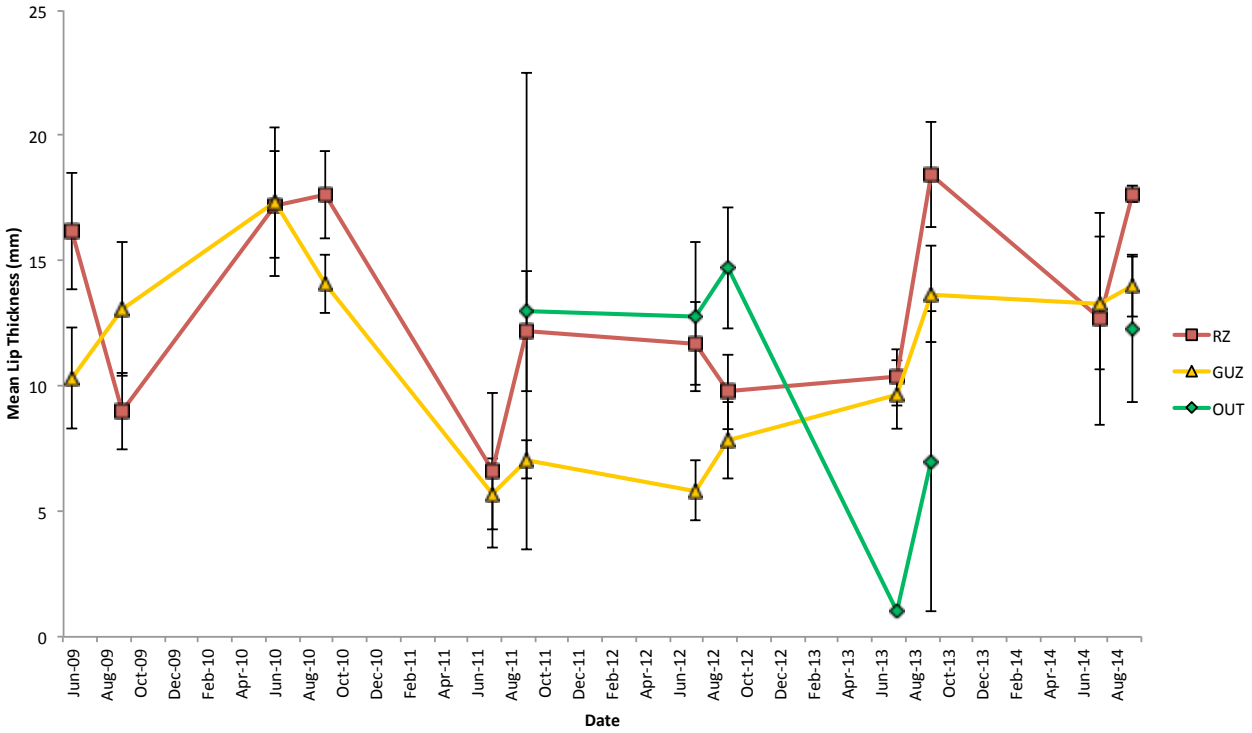

Mean Conch Shell Length (cm) by Zone 2009-2014
Mean Shel Length (cm)
26
24
22
20
18
16
14
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Date
RZ
GUZ
OUT

Fig 4.


Mean Conch Lip Thickness (mm) by Zone (2009-2014)
Mean Lip Thickness (mm)
25
20
15
10
5
0
Jun-09
Aug-09
Oct-09
Dec-09
Feb-10
Apr-10
Jun-10
Aug-10
Oct-10
Dec-10
Feb-11
Apr-11
Jun-11
Aug-11
Oct-11
Dec-11
Feb-12
Apr-12
Jun-12
Aug-12
Oct-12
Dec-12
Feb-13
Apr-13
Jun-13
Aug-13
Oct-13
Dec-13
Feb-14
Apr-14
Jun-14
Aug-14
Date
RZ
GUZ
OUT

Lobster:

Observations:

- Things have improved slightly from a bad situation in 2012-13 for lobster, although abundance is now higher in GUZ areas than in RZs in 2014.

- Mean carapace length has remained static in 2014 in the GUZ while mean abundance in the GUZ has increased, indicating good reproduction and good adherence to lobster fishery laws in GUZ areas.

- Mean carapace length in RZs has dropped significantly since 2013 while abundance has remained static, indicating reducing overall maturity in the RZs.

Discussion:

- In the GUZ, improved management and access restrictions due to Managed Access and improved enforcement seem to be promoting a slow increase in abundance in the GUZ.

- Reduced maturity in RZs indicates possible illegal harvesting of large mature lobsters in RZs, or migration of mature lobsters to other areas, possibly to adjacent lobster shades located just outside RZs. Weather is another possible contributing factor. This trend could lead to reduced spillover into GUZ areas if overall maturity of RZ lobsters is decreasing.

Recommendations:

- Continue working with compliant managed access fishers to show them positive effects on maturity from good management of GUZ, and to crack down on illegal fishing in RZs.

- Conduct study to determine whether lobster shades increase abundance or simply attract lobsters from natural habitats in RZs to lobster shades, which may be considered preferable habitat by lobsters.

- Increase size of RZs to increase distance between lobster natural reef habitat inside RZs and lobster shades just outside RZs. A sufficient distance is needed to ensure lobsters in shades are not simply being attracted away from RZs.

- Increase night time patrols in RZs, increase enforcement presence at mini station at West Snake Caye, and trial new surveillance technologies such as remote controlled cameras to protect RZs at night

Fig 5.

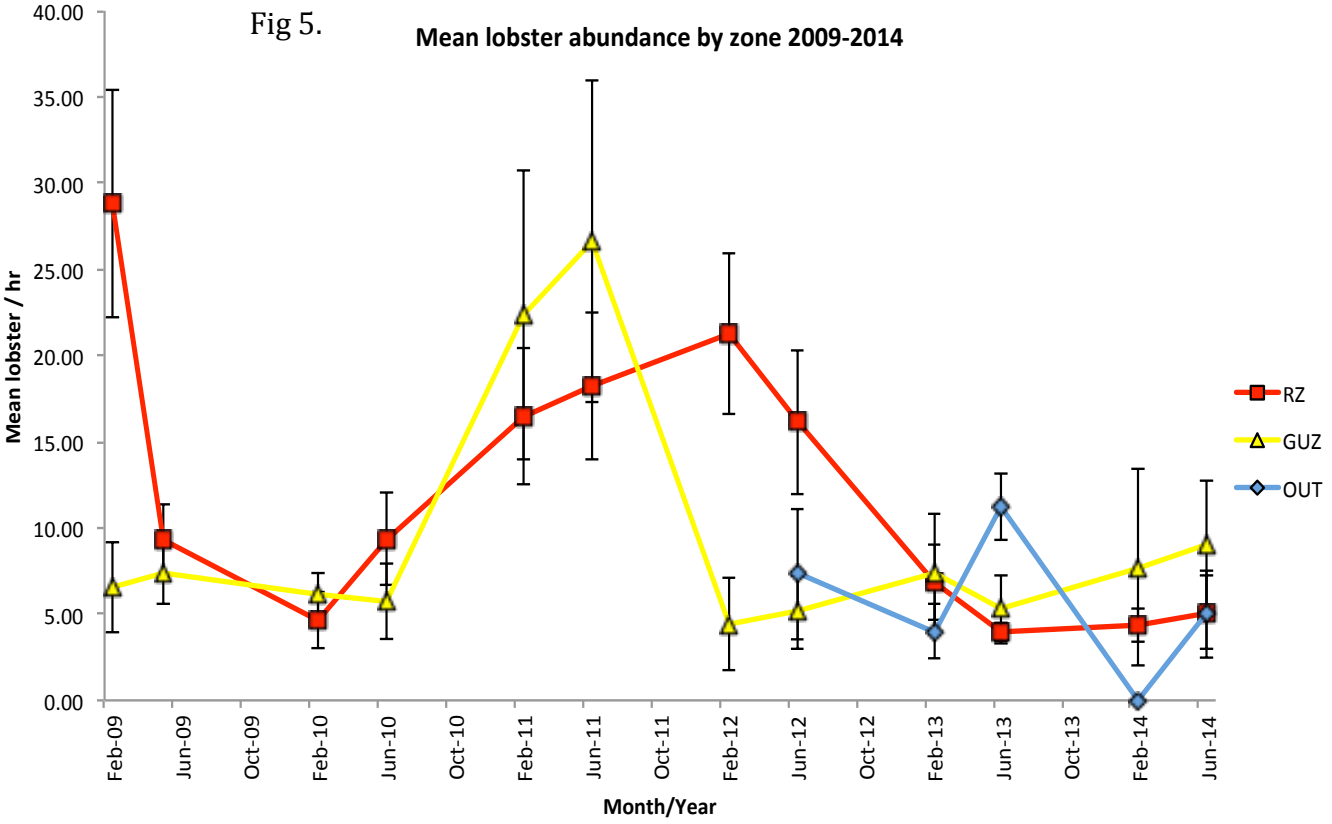
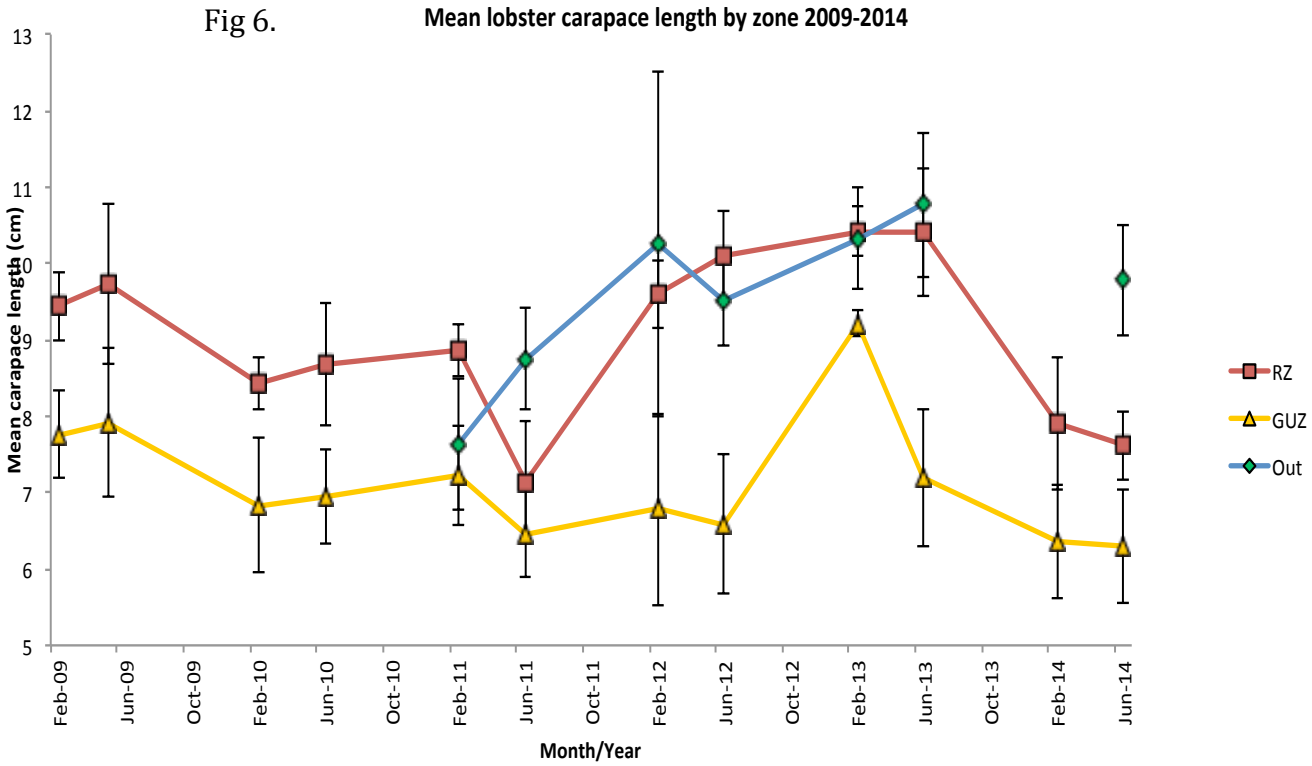

Mean lobster abundance by zone 2009-2014
Mean lobster / hr
40.00
35.00
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Feb-09
Jun-09
Oct-09
Feb-10
Jun-10
Oct-10
Feb-11
Jun-11
Oct-11
Feb-12
Jun-12
Oct-12
Feb-13
Jun-13
Oct-13
Feb-14
Jun-14
Month/Year
RZ
GUZ
OUT

Fig 6.


Mean lobster carapace length by zone 2009-2014
Mean carapace length (cm)
13
12
11
10
9
8
7
6
5
Feb-09
Jun-09
Oct-09
Feb-10
Jun-10
Oct-10
Feb-11
Jun-11
Oct-11
Feb-12
Jun-12
Oct-12
Feb-13
Jun-13
Oct-13
Feb-14
Jun-14
Month/Year
RZ
GUZ
Out

Sea Cucumber:

Observations:

- GUZ density has decreased significantly from ~50 per hectare in GUZ before 2012, to <10 per hectare since in GUZ, with no signs of recovery.

- RZ density has decreased from pre 2012 levels of >170 per hectare, and stabilised to ~30 per hectare, less than pre-fishery levels in the GUZ.

- Mean lengths have remained stable in RZs, indicating that they are primarily adult habitat for sea cucumber, while mean length in GUZs has had a net increase since 2011, indicating lack of juveniles from poor reproduction.

Discussion:

- These observations indicate possible illegal harvesting of sea cucumbers in RZs, and over harvesting in GUZ areas.

- Sea cucumbers favour habitats typical of GUZ areas more than in PHMR's RZs, such that existing RZs may not be suitable for protecting the life cycle of sea cucumbers (PHMR RZs were established long before there was a sea cucumber commercial fishery. There may as a result be poor spillover from GUZ back into RZs.

- Managed Access logbook data for 2014 indicated it was the most lucrative species in terms of CPUE, Sea cucumbers are detritus feeders so there is concern of reduced benthic water quality - i.e. if there is too much rotting matter at the sea floor, it will cause aerobic decomposition, sucking out the oxygen from thedemersal zone, increasing probability of benthic commercial species dieoffs and absence of reproduction during spawning season due to unfavourable mating conditions. Low densities may have difficulty recovering as likelihood of encountering other sea cucumbers to reproduce has decreased significantly.
- It could also drive down coral health with corals and seagrass struggling for light, in turn reducing oxygen concentrations at the sea floor from seagrass photosynthesis.

Recommendations:

- Investigate possibility that some fishers may be subcontracting sea cucumber extraction work to non-licensed fishers.

- Reduce quota by more than 50% with immediate effect with annual review based on uncaught stock maturity and density research, a

- Introduce a designated landing site, closely monitored and enforced to ensure catch data

collected comprehensively and annual quota being strictly adhered to.

- Introduce new replenishment zones that protect areas of prime sea cucumber habitat in the seagrass and mubflat areas of PHMR.

Fig 7. ***H. mexicana*** **- Mean density (sea cucumber ha-1) by zone: 2011-2014**

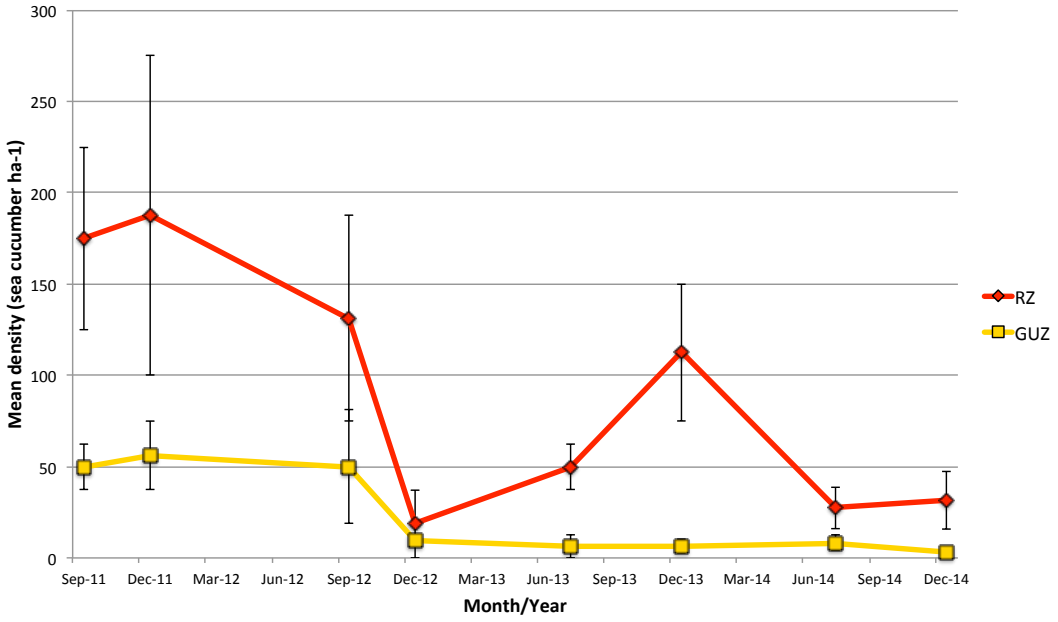
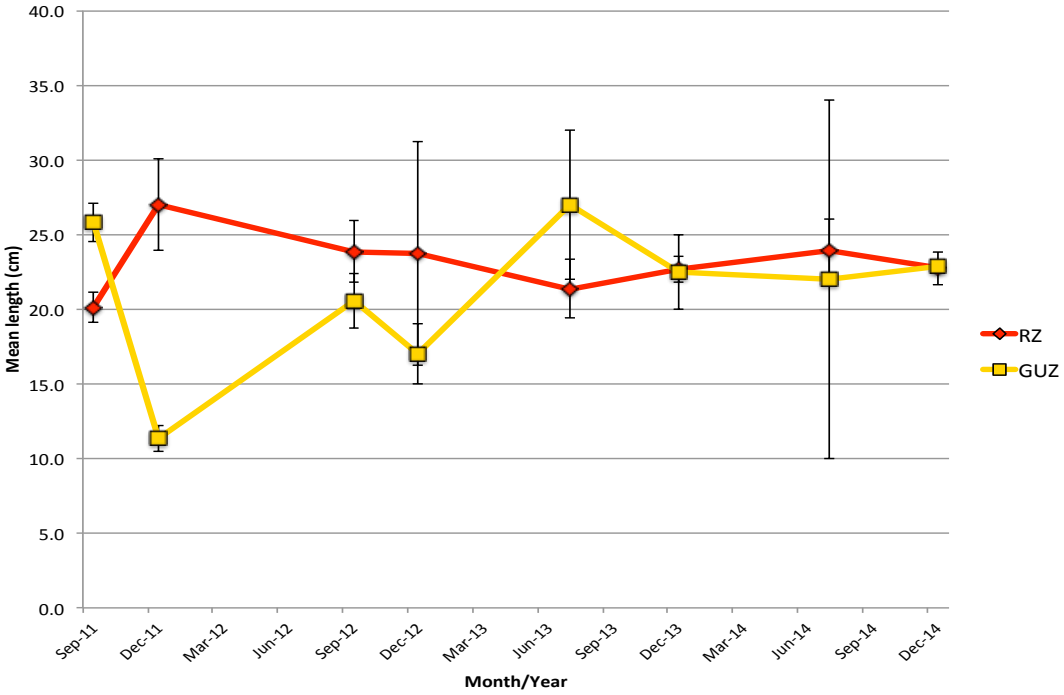
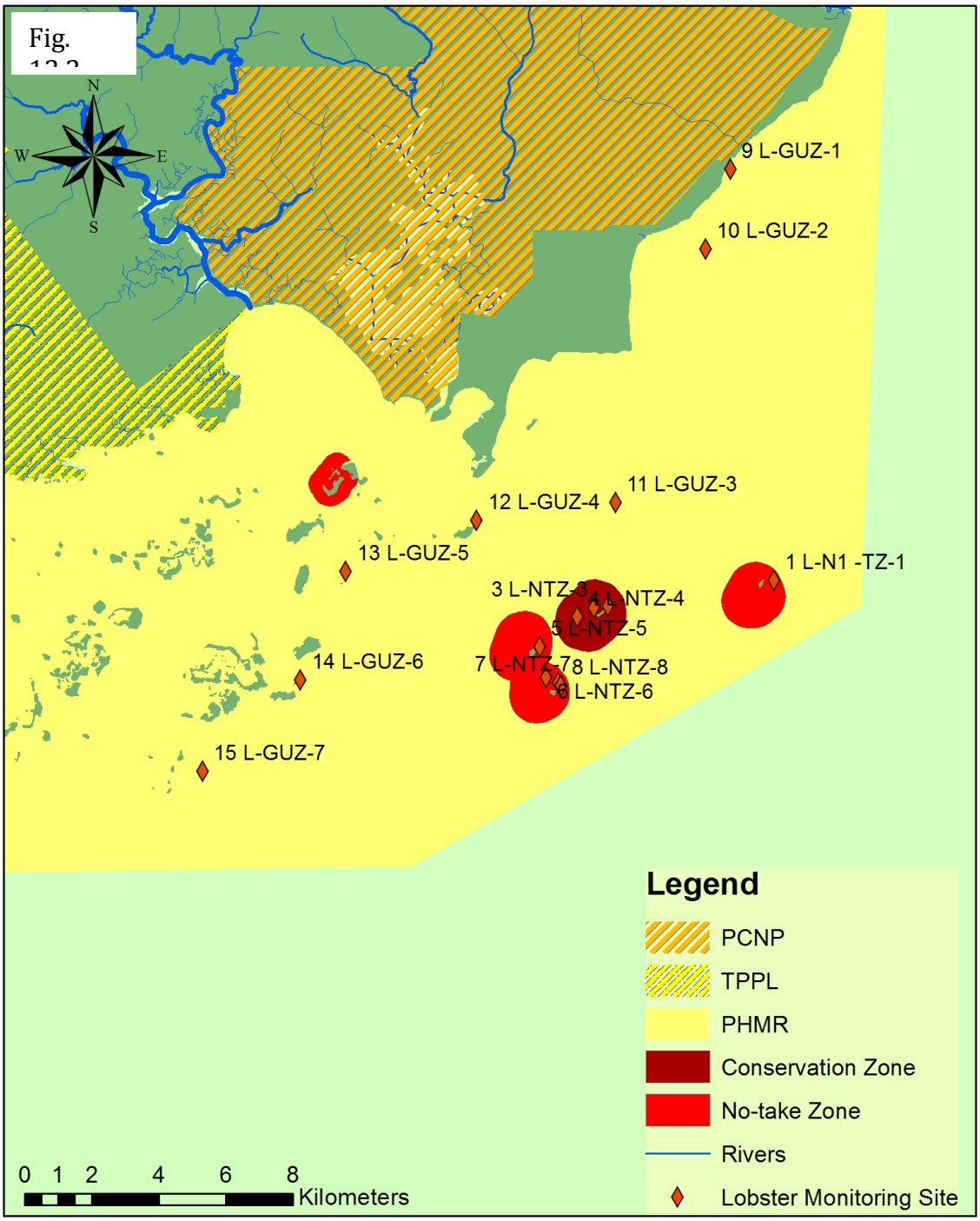


Fig 8. ***H. mexicana*** **- Mean length (cm) by zone: 2011-2014**



Conch Monitoring Sites in PHMR

Lobster Monitoring Sites in PHMR



Sea Cucumber Monitoring Sites PHMR