Toledo Institute for Development and Environment

Port Honduras Marine Reserve

Commercial Benthic Species UPDATE: 2009-2015

Conch, Lobster, Sea Cucumber

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TIDE Research & Monitoring Department 2016

Benthic Species Update 2015

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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 also become a significant commercial species, 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, which is the precursor to this current report.

1.3 This report: Benthic species update 2009-2015

Results of TIDE's lobster, conch and sea cucumber underwater surveys, covering a seven-year period between 2009 and 2015 (2011-2015 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.

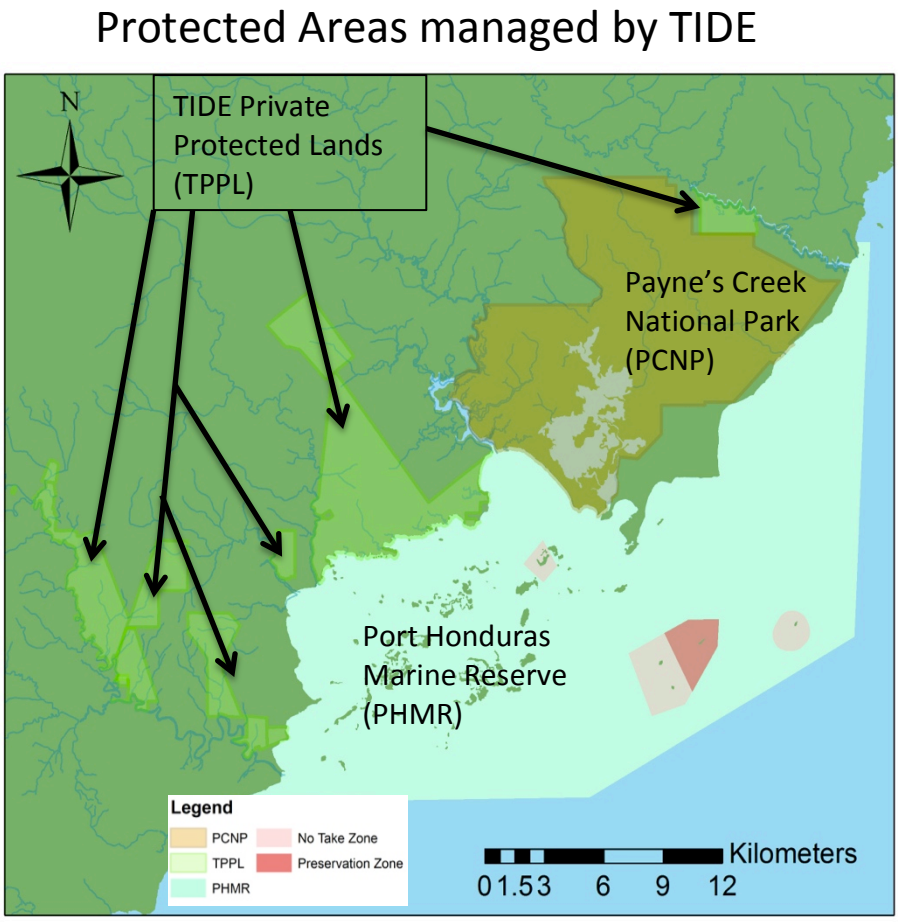


Fig. 1. Management zones of Port Honduras Marine Reserve (PHMR), showing proposed Replenishment Zones after 2013 stakeholder consultations. Also Payne's Creek National Park (PCNP) and TIDE Private Protected Lands (TPPL).

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. 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 main 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 6,500 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, with approximately 200 residents is located at the northern end of the reserve on the southern bank of the mouth of the Monkey River. There is approximately 10-15km 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 widely agreed 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 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. Starting in 2011, 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 RZs, 11 in the GUZ and four outside the reserve (OUT). 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 2015. 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 2009-2015 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 at 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:

Fig 2.

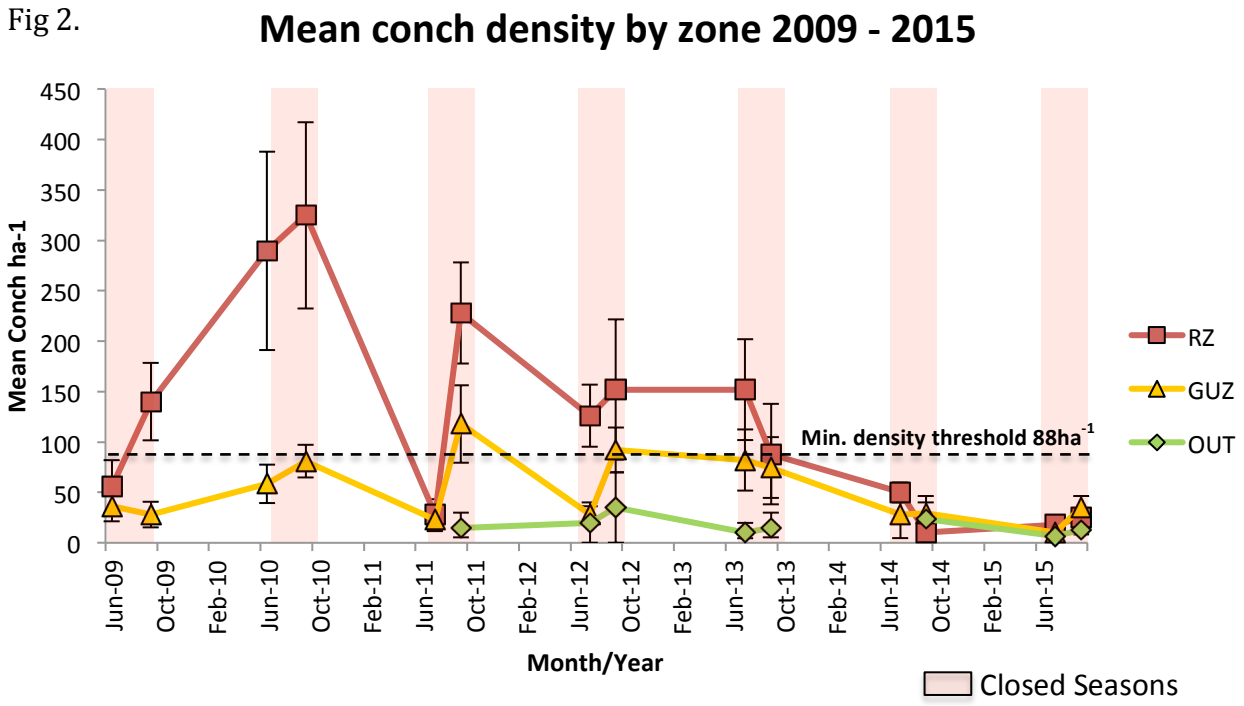
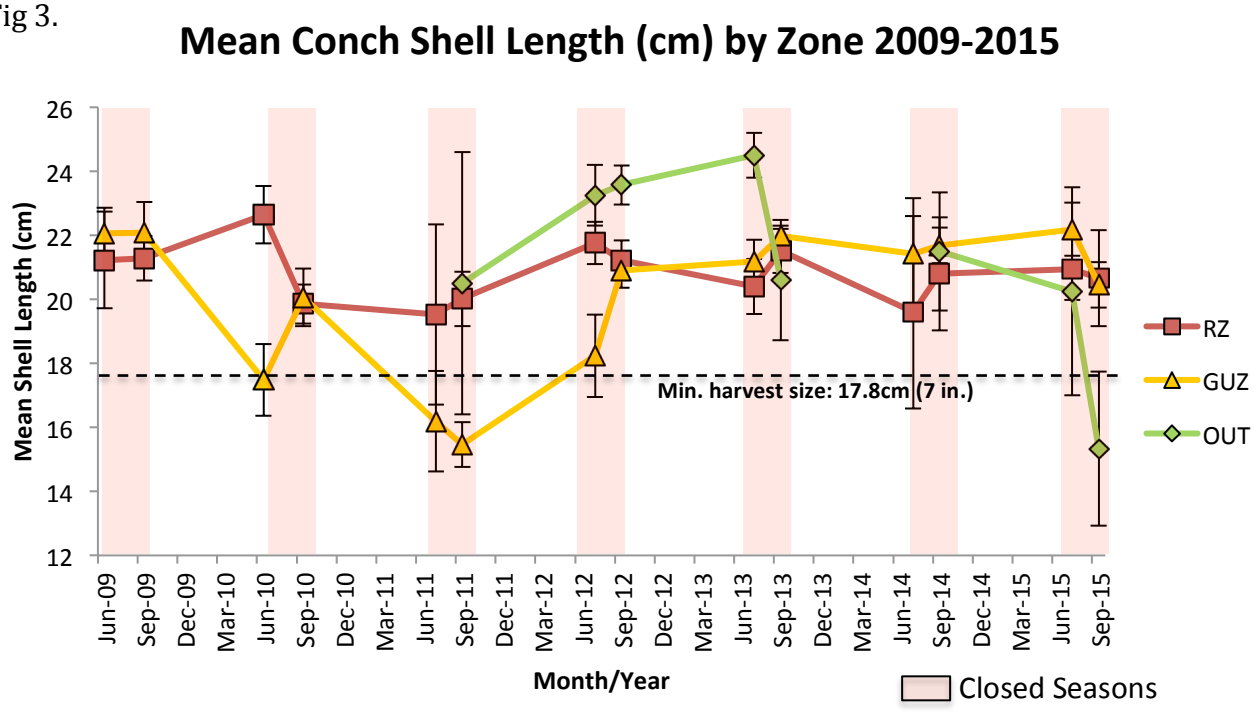


Fig 3.



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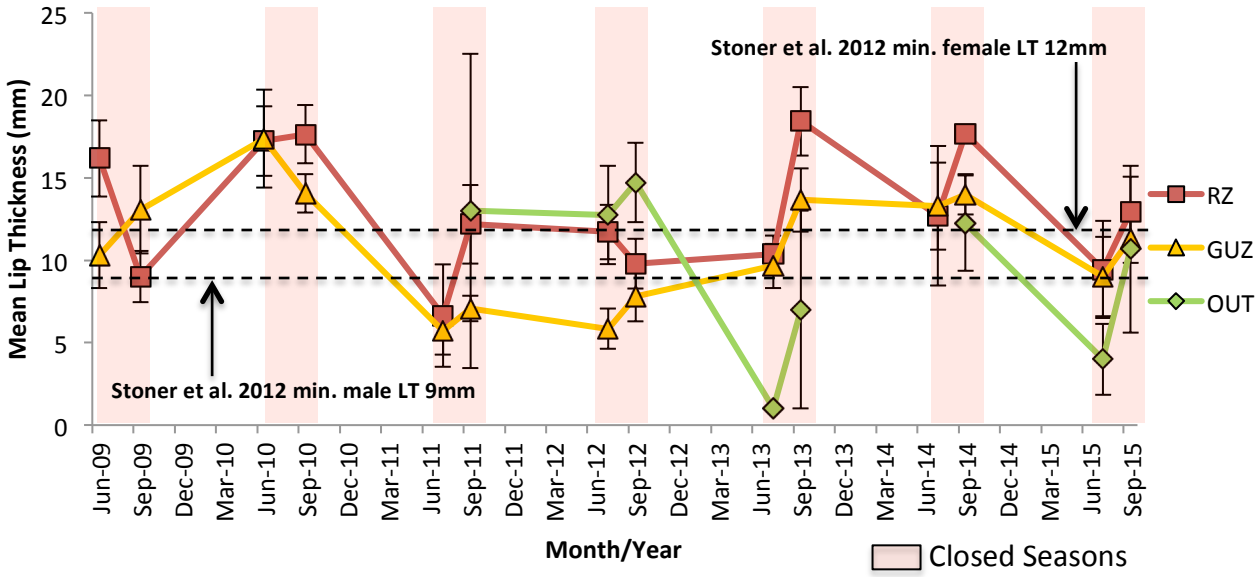


Observations:

- Conch densities have continued to decline in all zones into 2015, and are now at an even more critical low than 2014.

- The closed seasons of 2013, 2014 and 2015 failed to achieve their intended purpose of increasing abundance by protecting conch during their reproductive period.

- Mean shell length decreased in all zones during the 2015 closed season, while mean lip thickness increased in all zones during the same time period. This, combined with extremely low mean abundance in all zones, indicates poor recruitment via reproduction, with smaller adults being predominant, and few large adults or juveniles.

- Such low densities are likely to have an exponentially negative impact on reproductive success, as the likelihood of conch encountering reproductive mates at such low densities is low.

Discussion:

- These observations point to a need for revising the legal framework for managing conch. It is known from TIDE's 2015 conch maturity indicator study (Foley 2016) as well as other studies elsewhere in the Caribbean (e.g. Stoner et al. 2012) that shell lip thickness is a more accurate

proxy indicator of maturity in conch than shell length. TIDE's conch maturity indicator study makes recommendations for incorporating lip thickness into existing legislation to protect immature conch from harvest.

- While there are signs that existing management tools such as RZs, gear restrictions, and 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:

- Incorporate lip thickness into conch fishery size limit regulations.

- 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 of understanding impact of fishing better through Managed Access data.

- 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.

Lobster:

Fig 5.

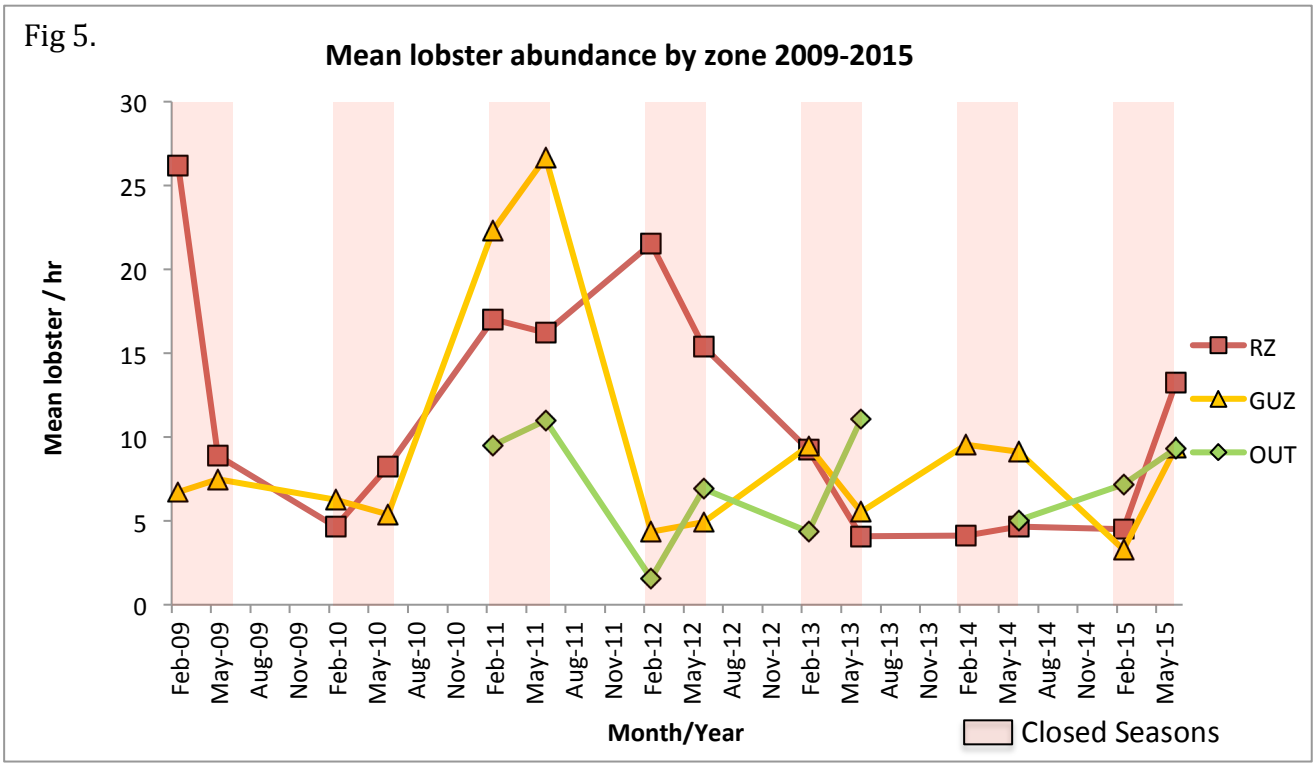


Fig 6.

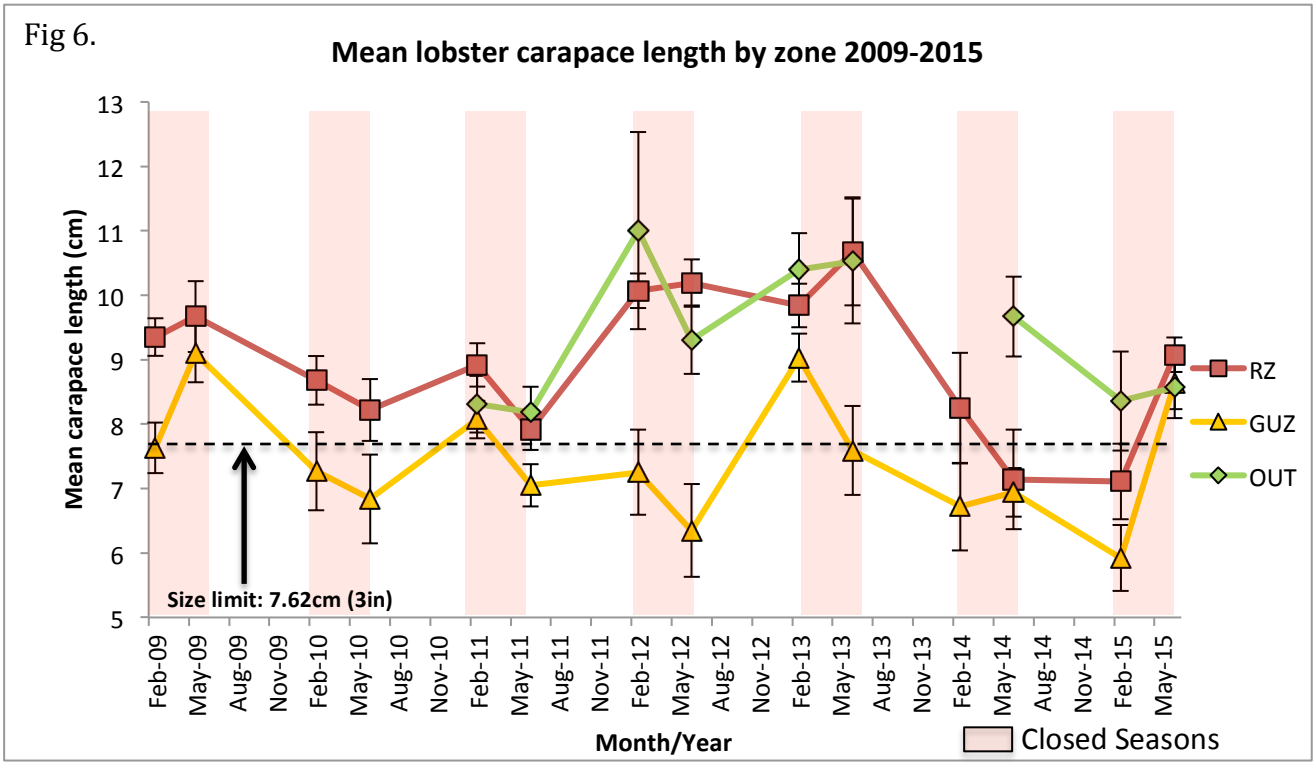
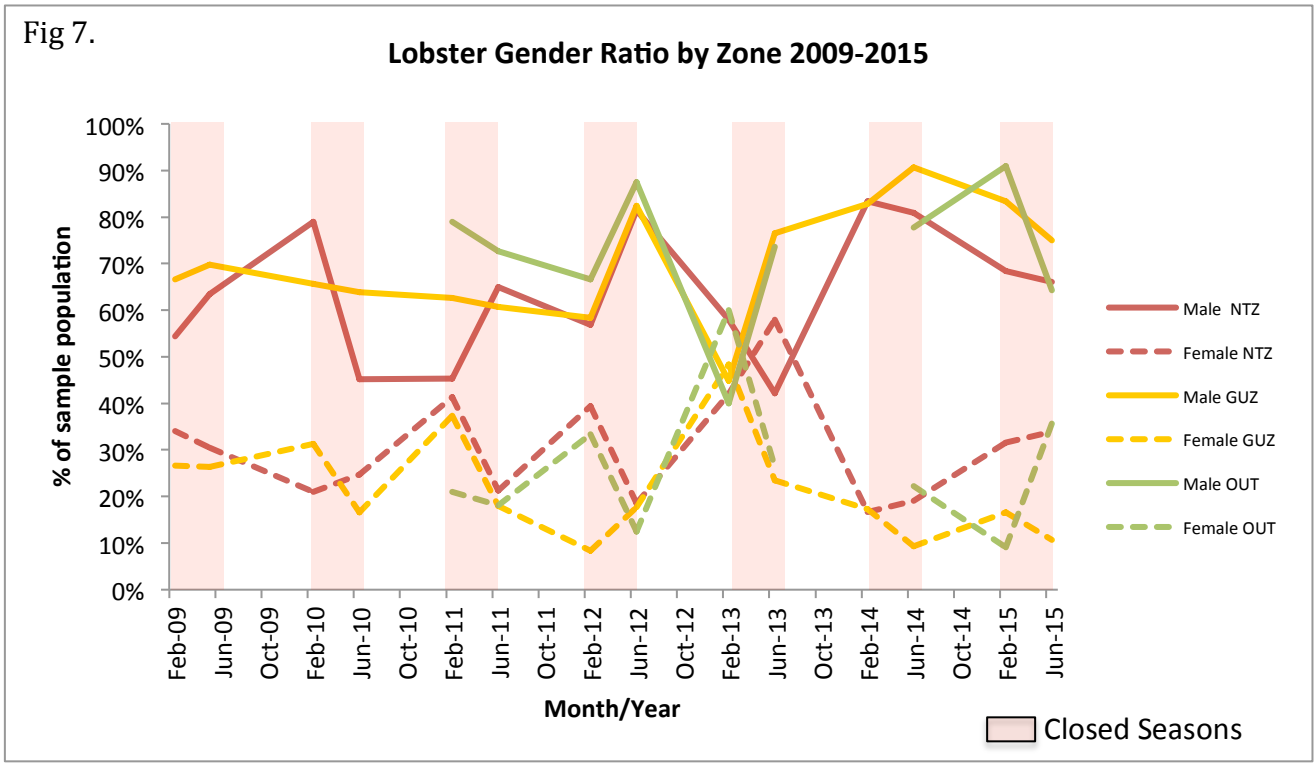


Fig 7.



Observations:

- Things have improved slightly from a bad situation in 2012-13 for lobster when abundance decreased substantially (Fig. 5). While abundance remained at ~5 lobsters per hour encountered in the RZ between 2013 and early 2015, and decreased from ~10 lobsters per hour in 2014 to <5 lobsters per hour in early 2015, an increase in abundance from <5 lobsters per hour to ~10 lobsters per hour was observed in both GUZ and RZs during the 2015 closed season.

- Mean carapace length has increased in both RZs and the GUZ during the 2014-2015 closed season. This, accompanied by increasing abundance in both zones over the same time period, is a good indication of sufficient adult spawning stock and healthy reproductive success, possibly attributable in part to good adherence to lobster fishery laws in GUZ areas. Similar trends have not been observed since 2011-12.

- Gender ratio has exhibited a relatively stable male bias (males ~60-70%; females ~20-40%), between 2009-2015 (Fig. 7). It appears that in general there are naturally more males than females in RZs, the GUZ and outside the reserve. 2013 was an exception, when the ratio was closer to 50:50. This was accompanied by a marked decline in abundance in all zones, possibly signaling male-biased mortality during that year. Since 2013, the male-dominated bias has increased to ~80% males, ~20% females in all zones.

Discussion:

- An increase in abundance in the 2015 closed season in both the GUZ and RZs coincided with an increase in mean carapace length over the same time period in both zones, indicating that the closed season resumed its function in 2015 of protecting reproductive activity. The relatively low mean carapace length in 2015 compared with 2012-2013, combined with an increase in abundance in 2015 provide an indication of good recruitment via reproduction in 2014-2015.

- In both the GUZ and RZs, there are signs of successful reproduction during the 2015 closed season, strengthening confidence in earlier 2014 signs of a reversal of the declining trends observed in previous years since 2011. The apparent improvement in stock health since 2013 coincides with improved management and access restrictions due to Managed Access and improved enforcement, which seem to be promoting a slow increase in abundance in the GUZ.

- While there was an overall trend of reducing maturity in RZs since 2013 based on carapace length, late 2014 and 2015 provide signs of a reversal of this trend. Close monitoring is necessary to determine if this trend will continue.

Recommendations:

- Continue working with compliant Managed Access fishers to show them positive effects on maturity, reproductive capacity and abundance from good management of GUZ, and garner stakeholder support and participation in reporting illegal extraction out of season or in RZs or under size limit.

- Conduct study to determine whether lobster shades located close to RZ boundaries increase abundance overall by creating artificial habitat 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.

Sea Cucumber:

Fig 8.

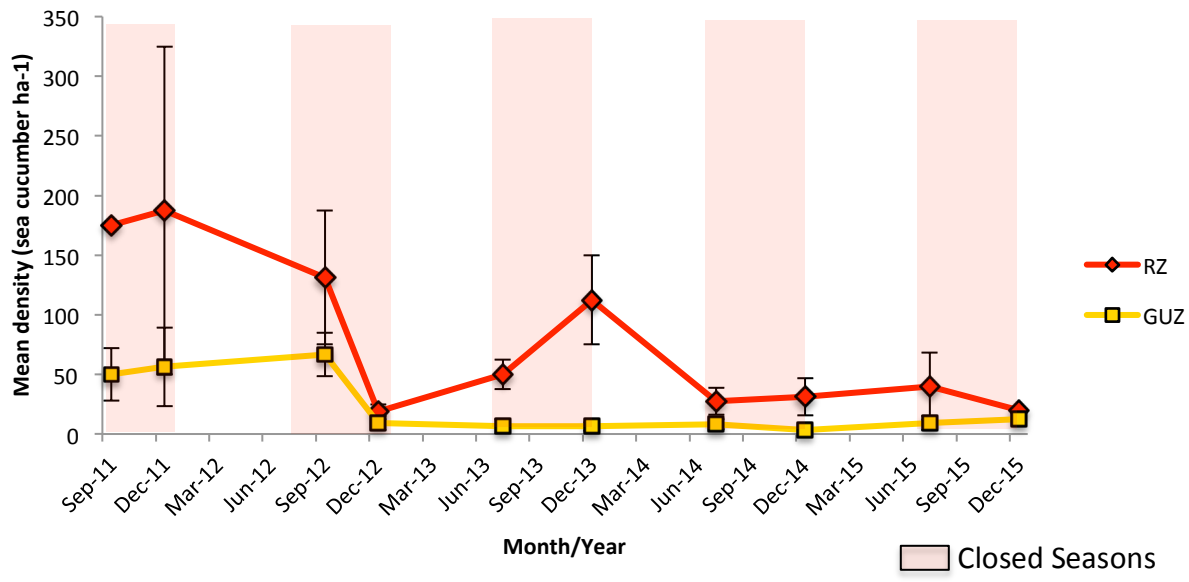


Fig 9.

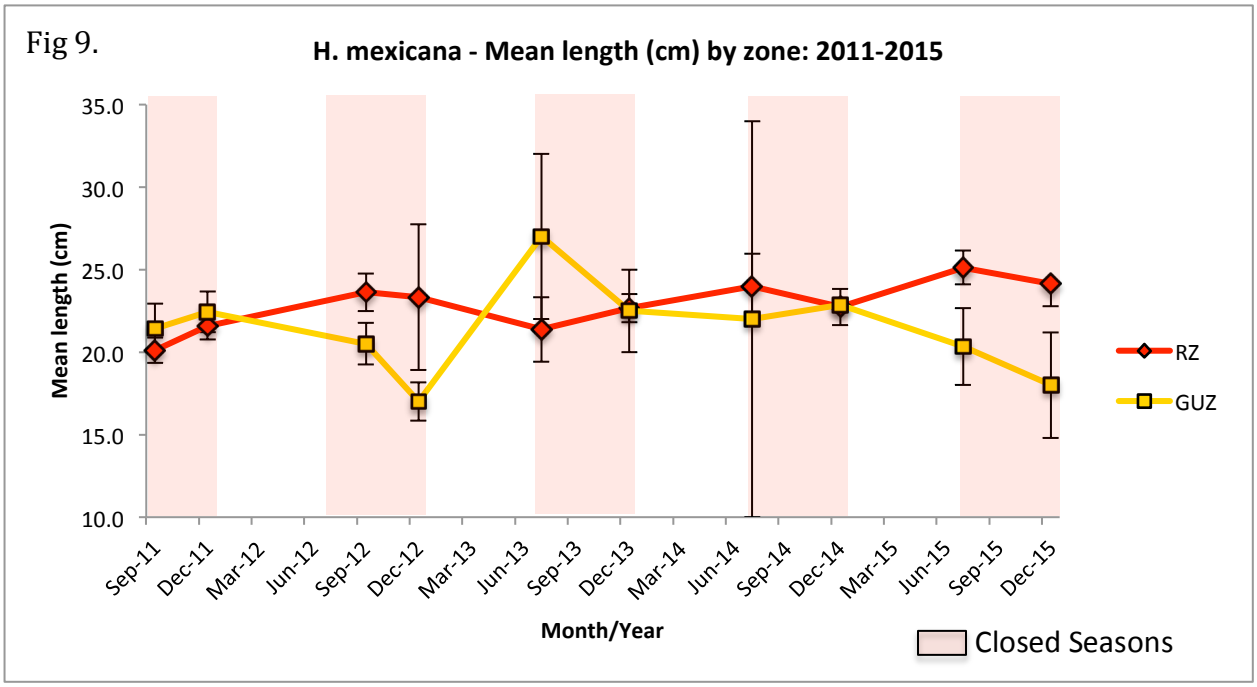
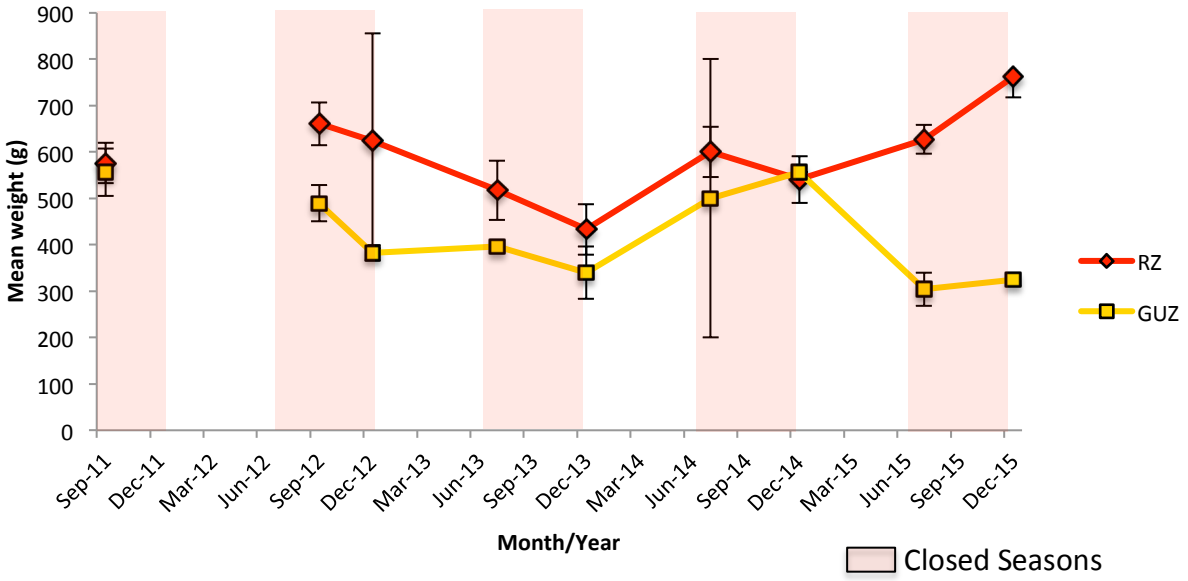


Fig 10. **H. mexicana - Mean weight (g) by zone: 2011-2015**



Observations:

- GUZ density has decreased significantly from ~50 per hectare in GUZ before 2012, to <10 per hectare in GUZ since, with no signs of recovery as of 2015.

- RZ density has decreased from pre 2012 levels of >170 per hectare, and had stabilised to ~30 per hectare in 2014, less than pre-fishery levels in the GUZ. RZ density increased marginally to ~40 per hectare at the start of the 2015 closed season, but decreased to ~20 per hectare by the end of the 2015 closed season, its lowest since records began.

- Mean lengths have remained close to mean values for all data since 2012 in RZs, indicating that they are primarily adult habitat for sea cucumber, while mean length in GUZs has had a net increase since 2011 accompanied by declining densities, indicating lack of juveniles from poor reproduction.

- Mean weight has increased continuously in RZs since 2014, and has increased overall since 2012. Meanwhile mean weight in the GUZ followed a similar trend to RZs between 2012 and late 2014, albeit smaller mean weights by 100-200g overall. After December 2014 mean weight in the GUZ has followed a declining trend in contrast to the continuing increase in RZs. This, accompanied by declining mean length in the GUZ and record low GUZ densities indicates that continuous overfishing accompanied by ongoing poor recruitment have combined to keep the GUZ population small in numbers and with very few large adults.

Discussion:

- Decreased RZ density during the 2015 closed season indicates the closed season is not performing its intended function of protecting sea cucumber reproduction. This could be due to low chance of mate encounter as a result of overfishing during the open season and possible illegal fishing during the closed season.

- 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 Catch Per Unit Effort (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 can cause aerobic decomposition, depleting dissolved oxygen levels in the demersal 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.

- These trends may be contributing to observed reduced coral health (Foley et al. 2016 TIDE MBRS report) 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.

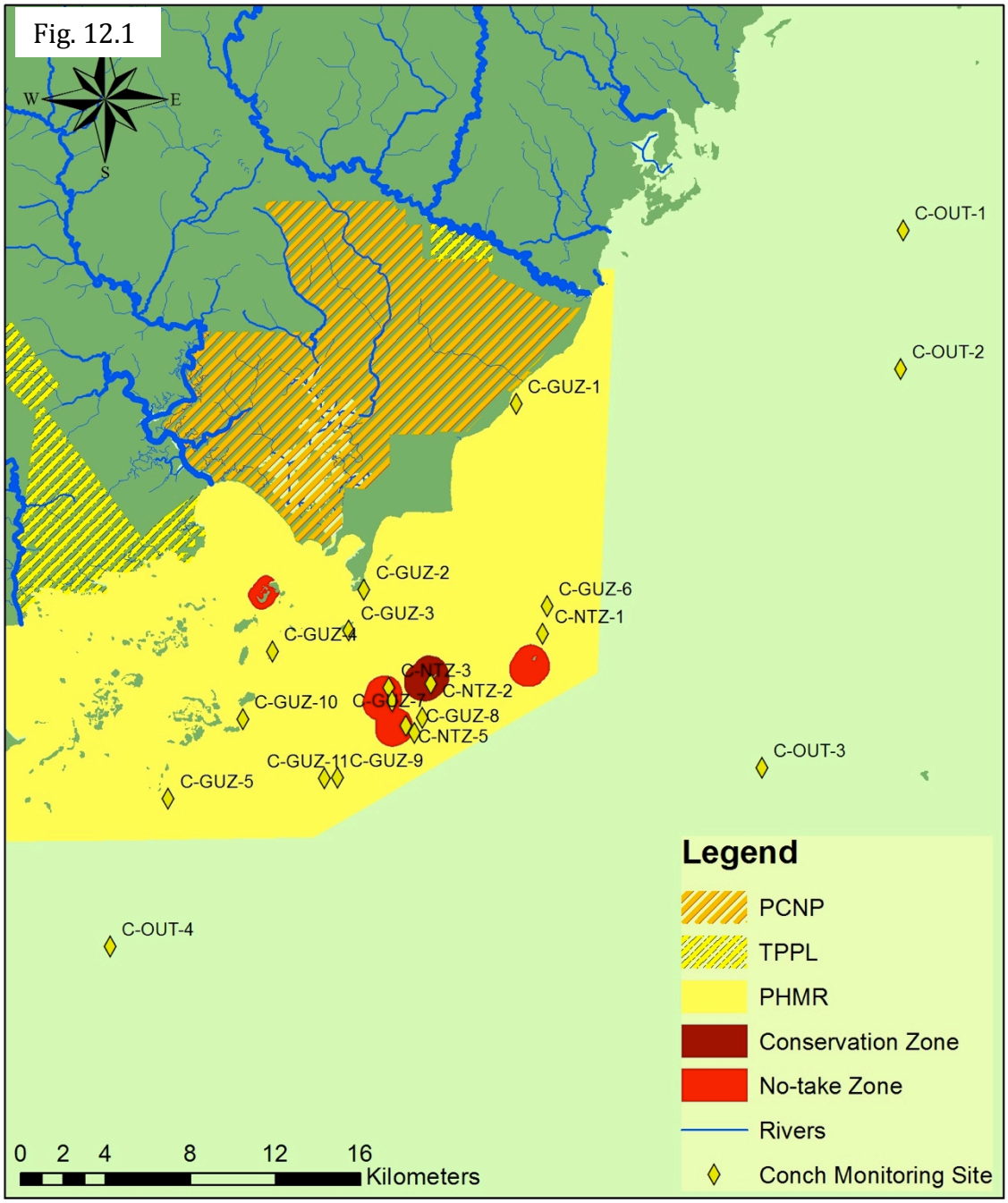
- Implement moratorium on sea cucumber extraction in PHMR, or at minimum reduce quota by >50% with immediate effect, with annual review based on uncaught stock maturity and density research.

- Introduce a designated landing site for sea cucumbers, closely monitored and enforced to ensure catch data is collected comprehensively and annual quota are being strictly adhered to.

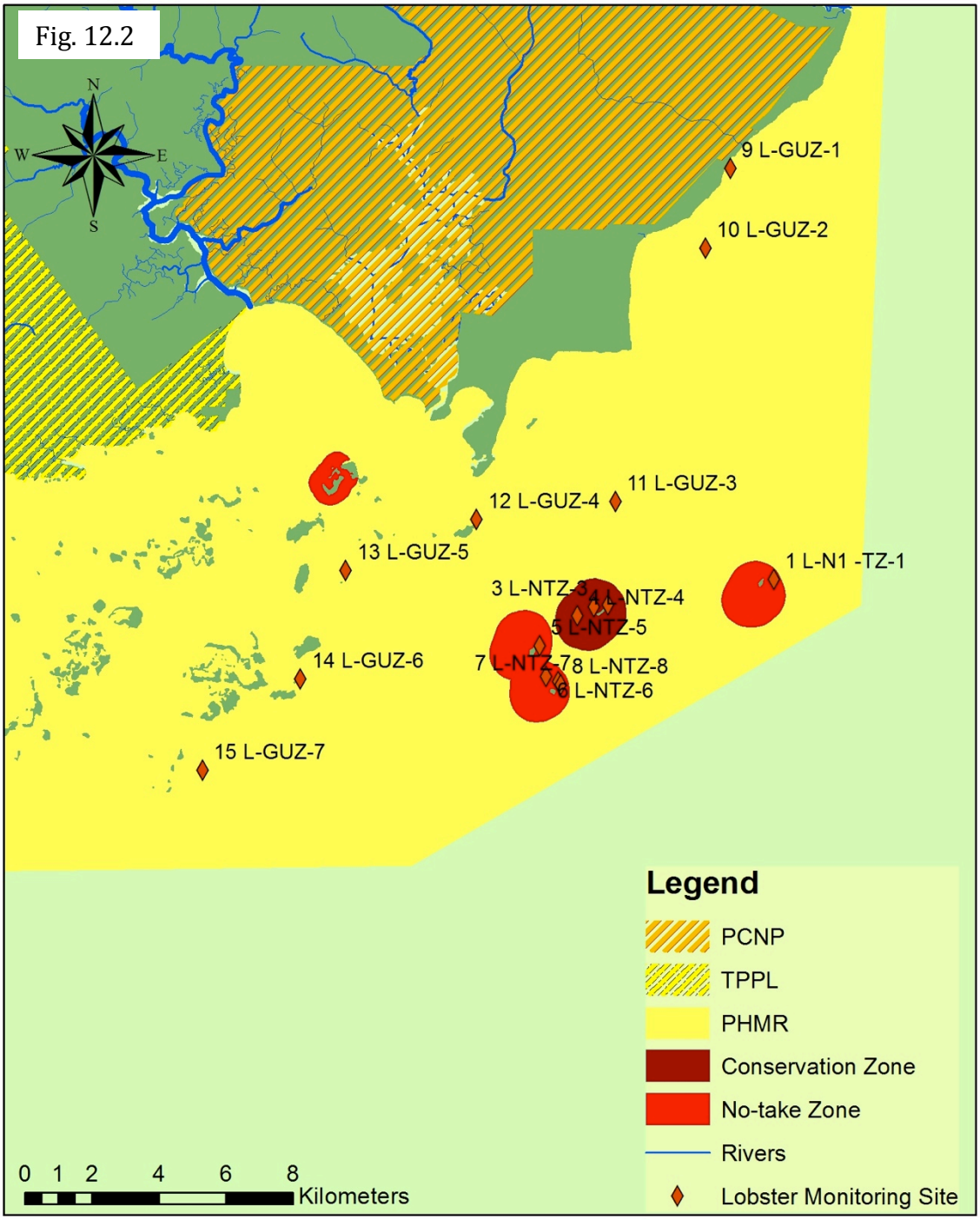
- Introduce new replenishment zones that protect areas of prime sea cucumber habitat in the seagrass and mudflat areas of PHMR.

- Increase number of monitoring sites from 6 to 20 to improve statistical robustness of data. Increase size of circle transects from 400m^2 to 800m^2 to capture sufficient density data in areas of severely reduced populations.

Conch Monitoring Sites in PHMR



Lobster Monitoring Sites in PHMR



Sea Cucumber Monitoring Sites PHMR