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INTEGRATED WATERSHED RESOURCES MANAGEMENT

RESULT 2: PROTECTED AREAS MANAGED
REQUIREMENT 2.2: NATURAL RESOURCES IDENTIFIED, CHARACTERIZED AND MADE AVAILABLE

STANDARD 2.2.1: RAPID INVENTORY OF COMMON HERMIT CRABS IN ROATAN, MESOAMERICAN REEF

10 March 2006

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COVER PHOTO

Mesoamerican Reef, Roatan – Common Hermit Crab
By Stephen Dunbar

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International Resources Group
1211 Connecticut Avenue, NW, Suite 700
Washington, DC 20036
202-289-0100 Fax 202-289-7601
www.irgltd.com

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ACRONYMS AND ABBREVIATIONS

AFE	Administración Forestal del Estado
BICA	Bay Island Conservation Association
CBM	Corredor Biológico Mesoamericano
CCAD	Comisión Centroamericana de Ambiente y Desarrollo
CL	Carapace Length
COHDEFOR	Corporación Hondureña de Desarrollo Forestal
CURLA	Centro Universitario Regional de Litoral Atlantico
DAPVS	Departamento de Áreas Protegidas y Vida Silvestre
DIBIO	Dirección de Biodiversidad
DIGEPESCA	Direccion General de Pesca y Agricultura
GIS	Geographical Information System
GPS	Global Positioning System
IHT	Instituto Hondureño de Turismo
PMAIB	Proyecto de Manejo Ambiental de Islas de la Bahia
RRAP	Rapad Inventory Assessment
SAG	Secretaria de Agricultura y Ganadería
SCUBA	Self Contained Underwater Breathing Apparatus
SERNA	Secretaria de Recursos Naturales y Ambiente
SPSS	Statistical Package for the Social Sciences
TIN	Transect Identification Number
UNAH	Universidad Nacional Autónoma de Honduras
UTH	Universidad Tecnológica de Honduras
UTM	Universal Transverse Mercator

ACKNOWLEDGEMENTS

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The principal investigator that conducted all field work, analysis and generated the report for this invertory was Dr. Stephen G. Dunbar from Loma Linda University, California. For fieldwork activities the principal investigator was assisted by graduate students April D. Sjoboen and Veren J. Perumal from Loma Linda University.

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EXECUTIVE SUMMARY

Although rarely considered for biodiversity surveys, marine hermit crabs are widely recognized by scientists as important lower trophic invertebrates and by laypeople as common inhabitants of rocky shore and coral reef ecosystems. Hermit crabs have also been used as ecological indicators and may also be an important, easily used community monitoring tool. We have undertaken an initial survey to collect habitat, distribution and abundance data in the Mesoamerican Reef area of Roatan. This rapid inventory information will be valuable for improved management of marine protected areas such as the Sandy Bay West End Marine Park and other proposed protected areas in the Honduras Mesoamerican Reef.

INTRODUCTION

In general, many tropical marine invertebrates have received little attention with respect to understanding their ecology, behavior, physiology and distributions, not to mention the effects on them of rapid environmental change and degradation. Although rarely considered for biodiversity surveys, marine hermit crabs are widely recognized by scientists as important lower trophic invertebrates (Hazlett, 1981; Barnes, 2001; Mantelatto*, et al.*, 2004), and by laypeople as common inhabitants of rocky shore and coral reef ecosystems.

Hermit crabs are classified within the Subphylum Crustacea, Class Malacostraca, Order Decapoda, Infraorder Anomura, Superfamily Paguroidea. Families within the Paguroidea are the Coenobitidae, Diogenidae, Lithodidae, Paguridae, Parapaguridae and Pylochelidae (Martin and Davis, 2001). Hermit crabs are unique among the decapod crustaceans in that all species (except for the coconut robber crab, *Birgus latro*) require the use of gastropod shells (or some other, foreign structure) to protect the soft, uncalcified abdomen. Therefore, measurements of species diversity, distribution and abundance for hermit crabs can be related to the diversity, distribution and abundance of other marine and intertidal invertebrates that provide hermit crabs with protective resources. In addition, organisms and environments which provide food and space resources are also integral to hermit crab diversity, distribution and abundance.

Data for the hermit crabs of the Bay Islands are extremely limited with only a few studies carried out on the behaviors and diversity of hermit crabs species occurring along Bailey's Cay, Roatan and Barbareta, Honduras (Gilchrist, 2000, 2003; Fonseca*, et al.*, 2004). For instance, Gilchrist (2000) found that the types of shells used, population sizes and distributions of hermit crabs in the area of Bailey's Cay were consistent both before and after Hurricane Mitch. In other work by Gilchrist (2003), surveys for hermit crabs of two "background areas" around Bailey's Cay resulted in very low daily abundances of 8 species within 6 genera (see Table 1).

Table 1. Hermit crabs species and median number per day of hermit cabs found during surveys of "background areas" by Gilchrist (2003) during August, 2001.

Species	Abundance
Calcinus tibicen	2
Dardanus venosus	1
Paguristes cadenati	2
Paguirstes puncticeps	1
Pagurus brevidactylus	1
Pagurus criniticornis	2
Phimochirus holthuisi	1
Petrochirus diogenes	2

From a rapid marine biodiversity assessment around the island of Barbareta, Honduras, Fonseca, *et al.* (2004) reported the presence of 5 species of hermit crabs. Aside from these short-term studies, there have, to date, been no efforts to systematically collect information on the distribution, abundance and habitats of the hermit crabs of the Bay Islands of Honduras. Since hermit crabs can been used as ecological indicators (Dunbar, 2001; Dunbar*, et al.*, 2003) and may also be an important, yet easily used community monitoring tool, there is a real need to collect data that will fill the gaps in our knowledge regarding these species.

Our objective was to undertake a rapid, initial survey to collect habitat, distribution and abundance data for hermit crab species along the southern shore of Roatan, Honduras that could provide baseline data for more detailed, long-term studies in understanding these common species throughout the Bay Islands.

NATURAL HISTORY

Hermit crabs are crustaceans belonging to the Order Decapoda. As such, they have ten legs; two are claws or 'chelipeds', four are used for walking, and four are used to hold the shell from the inside. Most hermit crabs live in empty shells to protect their soft abdomens, although some occupy worm tubes and sponges. There are approximately 500 described hermit crab species and each species is specifically adapted to the type of shell that it inhabits. For example, those that occupy gastropod shells have curved abdomens to match the coil of the shell, while those living in straight tubes have straight abdomens.

While adult hermit crabs may be semi-terrestrial or aquatic, they all must return to the sea for reproduction. When competition is fierce, males will hold a female's shell with the smaller cheliped and drag her around with him, all the while using the larger cheliped to defend her against rival males until she molts and lays eggs. After hatching from eggs, the larvae float in the open ocean as plankton until they settle out near shore and find shells to inhabit. While many hermit crabs stay in the intertidal or subtidal zone, some species venture onto land or into the deep sea, as deep as 5000 meters. Some can even climb trees with their shells. Some hermit crabs in captivity have lived as long as 70 years, but undoubtedly they live shorter lives in the wild.

Hermit crabs must frequently exchange shells because the shell may become damaged over time or become too small as the crab grows. Intense battles can be observed between two hermit crabs fighting over the same desired shell. The shells they live in are often covered with marine life that settles on them and begins to grow, such as algae, coral, sponges, barnacles, and gastropods. Some hermit crabs will even pick up animals like sea anemones and place them on their shell for protection and camouflage.

As scavengers, they play an important role in curtailing algal growth, consuming dead animals and breaking up rotting material. Some of the larger hermit crabs will feed on live coral, clams, and other crustaceans. In a few species, only the young crabs live in shells, while older crabs no longer need them. A few species can grow as large as 16 inches in length. Hermit crabs use a variety of sensory organs to explore their environment, including compound eyes, bristles sensitive to touch and water current, and antennae to detect chemical stimuli. They utilize these specialized sensory organs to detect food, available shells, and mates.

METHODOLOGY

SUBTIDAL HERMIT CRAB SURVEY

Survey methods were the same as those reported in Dunbar and Perumal (2005) and Dunbar and Sjoboen (2005). Three zones along the south coast of Roatan were selected. Additionally, within each zone, two sites were chosen. In each site, 8 transects were laid in random orientation[1]. As much as possible, Universal Transverse Mercator (UTM) readings were taken for both the starting and ending points of the transect line by Global Positioning System (GPS). General weather, water temperature and salinity were also recorded for each transect. The dive team surveyed a 6 m wide swath along the 30 m transect for the presence and abundance of hermit crabs. All hermit crabs found were counted and individuals identified to species level in the water, if possible. Unidentified specimens were collected live in 'Zip-loc' bags and taken to a makeshift laboratory in which they were photographed for live-color (an important identification tool), then preserved in 70-90% Ethanol for further possible analyses.

INTERTIDAL HERMIT CRAB SURVEY

Rocky intertidal surveys for hermit crabs were done along the shore and parallel to the waters edge during low tide. All specimens found were identified on site (if possible) and counted. If identification was not possible in the field, specimens were collected in 'Zip-loc' bags and taken to a makeshift laboratory in which they were photographed for live-color, then preserved in 70 – 90 % Ethanol for further possible analyses. UTM's for locations of surveys were recorded with a handheld GPS.

Crabs collected from both subtidal and intertidal areas were identified using field guides by Debelius (1999), Humann and DeLoach (2002), Sprung (2001), by a key for Caribbean hermit crabs by Provenzano (1959) and in consultation with Dr. Christopher Tudge of the National Museum of Natural History (NMNH) and Dr. Rafael Lemaitre (NMNH).

Densities per hectare were calculated using the equation:

$$R(D_i) = D_f \qquad (1)$$

where R equals the area conversion factor, D_i equals the initial density of hermit crabs over the total area of surveys within a Zone and D_f equals the calculated density per hectare.

Sites and transects for both subtidal and intertidal surveys were carried out at the positions indicated in **Figure 1.** In **Table 2**, a list of transects surveyed is provided with corresponding details for each.

[1] In Zone 1, a total of only 8 transects were surveyed due to prohibitive weather conditions.

Figure 1. A map of Roatan showing the 4 Zones surveyed for hermit crabs along the south coast of the island between October 25 and November 2, 2005.

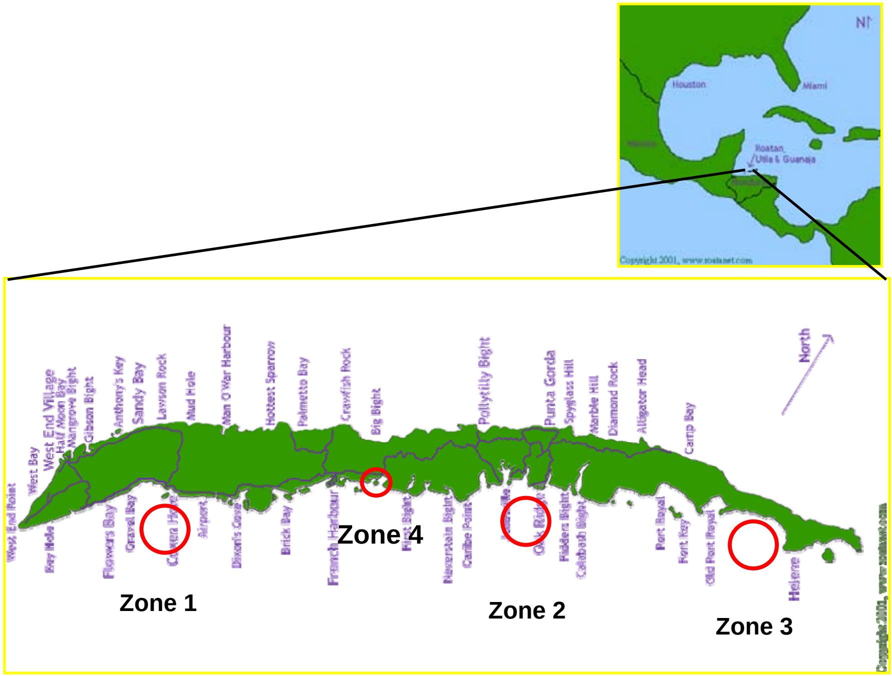


Table 2. Dates of survey transects with starting and ending Universal Transverse Mercator (UTM). The Transect Identification Number (TIN) and position of each transect is also provided. Note that some transects do not have UTM's. NA = no UTM.

Date (2005)	TIN	Subtidal/Intertidal	Start UTM	End UTM
Oct. 25	H-1A1-05	Subtidal	16 Q 0555241 1804877	30m NE
Oct. 26	H-1B1-05	Subtidal	16 Q 0548610 1802633	16 Q NA 180
Oct. 26	H-1B2-05	Subtidal	16 Q NA 180	16 Q NA 180
Oct. 26	H-1B3-05	Subtidal	16 Q 0548618 1802627	16 Q 0548586 1802620
Oct. 26	H-1B4-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 26	H-1B5-05	Subtidal	16 Q 0548559 1802606	16 Q 0548556 1802637
Oct. 26	H-1B6-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 26	H-1B7-05	Subtidal	16 Q 0548549 1802681	16 Q 0548572 1802699
Oct. 27	H-2A1-05	Subtidal	16 Q 0568055 1811602	16 Q 056055 1811646
Oct. 27	H-2A2-05	Subtidal	16 Q 0568055 1811646	16 Q 0568076 1811625
Oct. 27	H-2A3-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 27	H-2A4-05	Subtidal	16 Q 0568119 1811652	16 Q 0568102 1811624
Oct. 27	H-2A5-05	Subtidal	16 Q 0568085 1811655	16 Q 0568119 1811652

Date (2005)	TIN	Subtidal/Intertidal	Start UTM	End UTM
Oct. 27	H-2A6-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 27	H-2A7-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 27	H-2A8-05	Subtidal	16 Q 0568124 1811715	16 Q 0568098 1811677
Oct. 31	H-2B1-05	Subtidal	16 Q 0567749 1811555	16 Q 0567756 1811577
Oct. 31	H-2B2-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 31	H-2B3-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 31	H-2B4-05	Subtidal	16 Q 0567740 1811595	16 Q 0567731 181167
Oct. 31	H-2B5-05	Subtidal	16 Q 0567759 1811599	16 Q 0567724 1811597
Oct. 31	H-2B6-05	Subtidal	16 Q 0567452 1811365	16 Q 0567479 1811339
Oct. 31	H-2B7-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 31	H-2B8-05	Subtidal	16 Q 0567531 1811337	16 Q 0567551 1811368
Oct. 28	H-3A1-05	Subtidal	16 Q 0578797 1814331	16 Q 0578773 1814385
Oct. 28	H-3A2-05	Subtidal	16 Q 0578797 1814331	16 Q 0578762 1814374
Oct. 28	H-3A3-05	Subtidal	16 Q 0578797 1814331	16 Q 0578749 1814353
Oct. 28	H-3A4-05	Subtidal	16 Q 0578797 1814331	16 Q 0578272 1814308
Oct. 28	H-3A5-05	Subtidal	16 Q 0578771 1814322	16 Q 0578272 1814308
Oct. 28	H-3A6-05	Subtidal	16 Q 0578771 1814322	16 Q NA 181
Oct. 28	H-3A7-05	Subtidal	16 Q NA 181	16 Q NA 181
Oct. 28	H-3A8-05	Subtidal	16 Q 0578831 1814372	16 Q 0578856 1814345
Nov. 2	H-3B1-05	Subtidal	16 Q 0578438 1814294	16 Q 0578474 1814312
Nov. 2	H-3B2-05	Subtidal	16 Q NA 181	16 Q NA 181
Nov. 2	H-3B3-05	Subtidal	16 Q NA 181	16 Q NA 181
Nov. 2	H-3B4-05	Subtidal	16 Q NA 181	16 Q NA 181
Nov. 2	H-3B5-05	Subtidal	16 Q 0578503 1814266	16 Q 0578518 1814239
Nov. 2	H-3B6-05	Subtidal	16 Q 0578471 1814239	16 Q 0578482 1814205
Nov. 2	H-3B7-05	Subtidal	16 Q NA 181	16 Q NA 181
Nov. 2	H-3B8-05	Subtidal	16 Q 0578423 1814272	16 Q 0578402 1814255
Nov. 1	H-4A1-05	Intertidal	16 Q 0560304 1808457	16 Q 0560304 1808457

Date (2005)	TIN	Subtidal/Intertidal	Start UTM	End UTM
Nov. 1	H-4A2-05	Intertidal	16 Q 0560045 1808515	16 Q 0560045 1808515
Nov. 1	H-4B1-05	Intertidal (Paya Bay)	16 Q 181	16 Q 181

RESULTS

Over Surveys for hermit crabs were conducted over 43 transects along the southern coast of Roatan, Honduras between October 25 and November 2, 2005. These surveys resulted in a total count of 50 hermit crabs representing at least 9 species from 4 genera. Specimens were found in habitats varying from reef crests to rocky intertidal and on substrates from sand to coral rubble and rock.

In **Table 3**, the number of specimens found for each species collected is reported, along with the relative abundance of each species over the total number of specimens found during all surveys conducted in the study.

Table 3. The number and relative abundance of each species found over all surveys conducted.

Species	Abundance Found	Relative (%)
Calcinus tibicen	1	2.0
Clibanarius tricolor	7	14.0
Clibanarius antillensis	1	2.0
Paguristes cadenati	3	6.0
Paguristes punticeps	28	56.0
Paguristes totugae	1	2.0
Paguristes wassi	1	2.0
Pagurus annulipes	1	2.0
Pagurus miamensis	2	4.0
UnID'd	5	10.0
Total	**50**	**100.0**

It is clear that the species with the highest relative abundance during the present study was *Paguristes punticeps*. This species represented 56% of all hermit crabs collected, while *Clibanarius tricolor* had the second highest relative abundance at 14% of all hermit crabs found (**Table 3**).

In **Table 4** it can be seen that when data collected from the rapid inventory are compared with data on diversity and abundance of hermit crabs collected during the Gilchrist (2003) study, the total number of specimens found during the rapid inventory study was significantly greater ($\chi^2_{(1)} = 23.29$, $P<0.001$) than that found by Gilchrist. It must be emphasized here that the objective of the Gilchrist study was not to survey for general hermit crab diversity, but instead to provide estimates of diversity and abundance in "background areas" when compared with octopus dens and middens in the small area of Bailey's Cay (Gilchrist, 2003).

Furthermore, the rapid inventory of hermit crabs collected specimens of 6 species previously unreported in the peer-reviewed literature for the Bay Islands. These were *Clibanarius antillensis*, *Clibanarius tricolor*, *Paguristes tortugae*, *Paguristes wassi*, *Pagurus annulipes* and *Pagurus miamensis*. In a recent rapid assessment of biodiversity around Barbareta Island, Honduras, Fonseca, *et al.* (2004) did report the presence of *C. tibicen*, *C. antillensis*, *C. tricolor*, *P. cadenati* and *Petrochirus diogenes*. In addition, five species reported by Gilchrist (2003) were not found in the present study. These were *Dardanus venosus*, *Pagurus brevidactylus*, *Pagurus criniticornis*, *Petrochirus diogenes* and *Phimochirus holthusi*.

Table 4. A comparison of species diversity and abundance of hermit crabs found during both the rapid inventory assessment (RRAP) of hermit crabs and Gilchrist, 2003 studies.

Species	# RRAP	# Gilchrist
Calcinus tibicen	1	2
Clibanarius tricolor	7	0
Clibanarius antillensis	1	0
Dardanus venosus	0	1
Paguristes ccadenati	3	2
Paguristes punticeps	28	1
Paguristes tortugae	1	0
Paguristes wassi	1	0
Pagurus annulipes	1	0
Pagurus brevidactylus	0	1
Pagurus criniticornis	0	2
Pagurus miamensis	2	0
Petrochirus diogenes	0	2
Phimochirus holthuisi	0	1
UnID'd	5	0
Total	**50**	**12**

When species were plotted relative to the Zones in which they were found (**Figure 2**), results showed that abundance of hermit crabs varied among Zones with the highest abundance occurring in Zone 2. In this Zone, 22 *Paguristes punticeps*, 1 *Pagurus annulipes*, 1 *Pagurus miamensis* and 2, as yet, unidentified individuals were counted. Zone 1 had the lowest abundance with only 3 specimens found, 2 of which were *Paguristes punticeps*.

From **Table 5** it can be seen that when densities per hectare were calculated for each Zone, there were differences in densities among Zones. In order of increasing population densities for all hermit crab species combined, Zone 1 < Zone 3 < Zone 2 < Zone 4.

Comparisons of densities among the three zones in which *Paguristes punticeps* occurred demonstrated the highest estimated densities in Zone 2, and higher estimated densities in Zone 1 than in Zone 3.

Figure 2. The number of each species in relation to zones surveyed

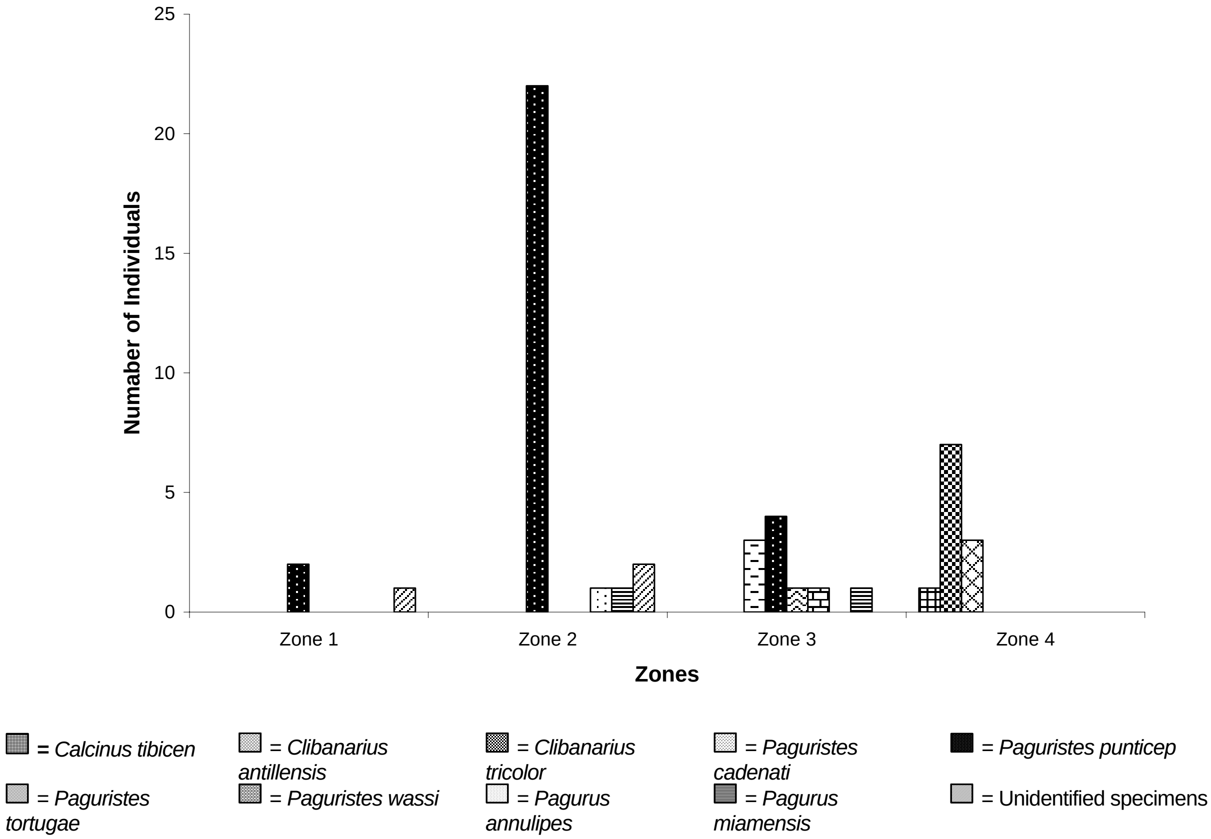


Table 5. Estimated densities per hectare for each species. Species present are listed within each Zone.

Zone	Species	Abund.	Est. Density/ha
1	*Paguristes punticeps*	2	13.9
1	UnID'd	1	6.9
2	*Paguristes punticeps*	22	68.0
2	*Pagurus annulipes*	1	3.1
2	*Pagurus miamensis*	1	3.1
2	UnID'd	2	6.2
3	*Paguristes punticeps*	4	12.4
3	*Paguristes cadenati*	3	9.3
3	*Paguristes tortugae*	1	3.1
3	*Paguristes wassi*	1	3.1
3	*Pagurus miamensis*	1	3.1
4	*Calcinus tibicen*	1	55.6
4	*Clibanarius tricolor*	7	389.2
4	*Clibanarius antillensis*	3	166.8

Although the highest counts took place in Zone 2, the greatest species diversity occurred in Zone 3 with 4 *Paguristes* species and 1 *Pagurus* species. However, the highest calculated density per hectare occurred among the intertidal, with *Clibanarius tricolor* having the highest density and *Calcinus tibicen* having the lowest of the three species found in this Zone.

SPECIES ACCOUNTS

PAGURUS MIAMENSIS. ID#: H-2A6-05-1. LLU.

Specimen collected in Zone 2, Site A, Transect 6, October 27, 2005.

Specimen details: Sex undetermined.

Color: Predominant color of markings may be green, rust-red, or purple. Ambulatory legs longitudinally striped on each segment and darker in region of faint transverse pigment band on each segment. Chelipeds faintly striped longitudinally, not solid brown with white fingers. Carapace with medial and lateral stripes on light background. Eyes pink with pinkish stripe on upper surface of eyestalks, dark on under surface. Antennules pigmented. Antennal acicles mottled; antennae with alternating dark and light bands(Provenzano, 1959).

Range: Known at present only from Bahamas and Miami, FL area (Provenzano, 1959).

PAGURUS MIAMENSIS ID#: H-3A6-05-1. LLU.

Specimen collected in Zone 3, Site A, Transect 6, October 28, 2005.

Specimen details: Ovigerous female.

Color: Predominant color of markings may be green, rust-red, or purple. Ambulatory legs longitudinally striped on each segment and darker in region of faint transverse pigment band on each segment. Chelipeds faintly striped longitudinally, not solid brown with white fingers. Carapace with medial and lateral stripes on light background. Eyes pink with pinkish stripe on upper surface of eyestalks, dark on under surface. Antennules pigmented. Antennal acicles mottled; antennae with alternating dark and light bands(Provenzano, 1959).

Range: Known at present only from Bahamas and Miami, FL area (Provenzano, 1959).

CLIBANARIUS ANTILLENSIS ID#: H-4A2-05-1. LLU.

Specimen collected in Zone 4, Site A, Transect 2, November 1, 2005.

Specimen details: Sex undetermined.

Color: In life, chelipeds olive to rusty brown with white spines, but white does not extend as far from the bases of the spines as in *C. tricolor* (Provenzano, 1959).

Range: Southern Florida through West Indies to Curacao and Brazil. Also reported from the Philippines (Provenzano, 1959).

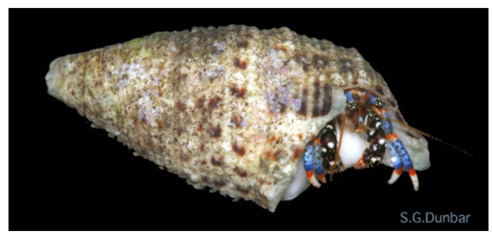
CLIBANARIUS TRICOLOR ID#: H-4A1-05-2, H-4A2-05-2. LLU.

Specimen collected in Zone 4, Site A, Transect 1, November 1, 2005 and Zone 4, Site A, Transect 2, November 1, 2005.

Specimen details: Sex undetermined.

Color: In fresh material chelipeds brownish to black, with white spines. Dactyls of ambulatory legs black-tipped, white or yellow most of their length, then orange at proximal end. Proximal ends of propodi also orange, segments otherwise pale to dark blue. Carapace and eyestalks blue, antennae orange (Provenzano, 1959).

Range: Bermuda, Florida from Miami through the keys, West Indies (Provenzano, 1959).



CALCINUS TIBICEN ID#: H-4A1-05-1. LLU.

Specimen collected in Zone 4, Site A, Transect 1, November 1, 2005.

Specimen details: Sex undetermined.

Color: Chelipeds red-brown to maroon, often tinged with purple, but fingers white-tipped. Dactyls of ambulatory legs white or yellow, banded with red. Distal ends of propodi also light. Eyestalks orange-red, becoming white before cornea. Carapace usually a rich red, often tinged with purple, more rarely with green, and bearing white punctae (Provenzano, 1959).

Range: Bermuda, West Indian region from south Florida to Brazil (Provenzano, 1959).

***PAGURUS ANNULIPES* ID#: H-2A6-05-1. LLU.**
Specimen collected in Zone 2, Site A, Transect 6, October 27, 2005.

Specimen details: Sex undetermined.

Color: White to gray with brown pigment band around each segment of ambulatory legs. Antennae with broad purple bands alternating with narrower white bands. Occasionally individuals may have very poorly defined longitudinal stripes on the leg segments (Provenzano, 1959).

Range: Massachusetts south to Florida Keys, around the tip of Florida and northward at least as far north as Alligator Harbor, probably westward. Cuba and Puerto Rico (Provenzano, 1959).

***PAGURISTES WASSI* ID#: H-3A6-05-1. LLU.**
Specimen collected in Zone 3, Site A, Transect 6, October 28, 2005.

Specimen details: Sex undetermined.

Color:

Range: Undetermined at present.

***PAGURISTES CADENATI* ID#: H-3B2-05-1, H-3B3-05-1. LLU.**
Specimens collected in Zone 3, Site B, Transect 2, November 2, 2005 and Zone 3, Site B, Transect 3, November 2, 2005.

Specimen details: Sex undetermined.

Color: Distinct by bright red carapace and legs, occasionally with some white spots. Eyes greenish on pale whitish or yellowish eyestalks (Debelius, 1999).

Range: South Florida, Bahamas and wider Caribbean (Debelisu, 1999); Barbareta, Honduras (Fonseca, *et al.*, 2004).

PAGURISTES PUNTICEPS ID#: H-1B4-05-1, H-3B6-05-1. LLU.

Specimens collected in Zone 1, Site B, Transect 4, October 26, 2005 and Zone 3, Site B, Transect 6, November 2, 2005.

Specimen details: Sexes undetermined. Two specimens noted and two collected among coral rubble in Zone 1. Twenty-two specimens noted among coral rubble, live coral and sand substrate within Zone 2. Four specimens noted and two collected among live coral and sand substrate in Zone 3.

Color: One specimen in life was rust-brown, covered with white spots, the cornea of the eye being blue (Provenzano, 1959).

Range: Has been found along northwestern Florida. Not uncommon in south Florida from Miami southward, and probably occurs in general in the West Indies (Provenzano, 1959).

PAGURISTES TORTUGAE ID#: H-3B4-05-1. LLU.

Specimens collected in Zone 3, Site B, Transect 4, November 2, 2005.

Specimen details: Sex undetermined.

Color: Usually whitish with the large spines on the inner margin of the manus and carpus red. Occasionally hard parts are lightly tinted with green or purple. Most striking is the banding on the eyestalks, of a sometimes broken, single ring of black (on white), and on the antennules similar rings on the ends of the segments (Provenzano, 1959).

Range: West coast of Florida, Florida Keys, (as far north as Miami), Dry Tortugas, and Puerto Rico. Probably in many other West Indian areas as well (Provenzano, 1959); from Florida, Lesser Antilles, Honduras to northern Brazil (McLaughlin and Provenzano, 1974); Ubatuba, São Paulo, Brazil (Negreiros-Fransozo*, et al.*, 1992; Hebling*, et al.*, 1994; Fransozo*, et al.*, 1998; Mantelatto and Sousa, 2000; Mantelatto*, et al.*, 2002); Laguna de Términos, Campeche, Mexico (Raz-Guzman*, et al.*, 2004).

DISCUSSION

CONSERVATION STATUS

Results of the rapid inventory of common hermit crabs demonstrate that the relative abundance of hermit crabs varied from Zone to Zone. Among all hermit crab species found, abundance was highest for *Paguristes punticeps* comprising 56% of all hermit crabs found in the survey. Although *P. punticeps* is here reported as present in all three marine Zones surveyed, the highest abundance of this species was found in Zone 2. Gilchrist (2003) also reported that *P. punticeps* was present in the "background area" of Bailey's Cay, Roatan, but recorded only one specimen. However, her study was limited to a relatively small area and was not specifically focused on issues of diversity and abundance except in relation to octopus behavior.

Clibanarius tricolor was the second most abundant species found during the survey, comprising 14% of all specimens found. *Clibanarius tricolor* is an abundant species on rocky shores of Roatan (pers. obs.) and the author has previously noted its presence on rocky shores at Alligator Head, near Paya Bay, at Henry's Cove, near Punta Gorda and on the intertidal area of Fantasy Island Resort (Zone 4 in the current study). One potential explanation for the low numbers of specimens found during the rapid inventory may be the harsh weather conditions occurring as a result of Hurricane Wilma and Hurricane Beta. Several species of intertidal anomurans are known to migrate between intertidal and subtidal zones (Fotheringham, 1975) and possibly during severe weather conditions (Rebach, 1974; Fotheringham, 1975)and this may be the case with *C. tricolor*.

Of special note was the conspicuous absence of any semi-terrestrial species of the family Coenobitidae. These are almost always present and common on most tropical shores and anecdotal information is consistent in noting the prevalence of Coenobitidae on Roatan. However, no specimens were seen during the intertidal surveys, or at anytime during the project. Again, a possible explanation for this may be the hurricane weather conditions persistent during the time of surveys.

When the estimated densities per hectare of all species combined were compared among Zones, densities in ascending order were Zone 1, Zone 3, Zone 2 and Zone 4. The low number of hermit crabs found in Zone 1 may be related to the lower number of transects surveyed in Zone 1 than in the other subtidal Zones due to adverse weather conditions. Despite the prevailing weather at the time, intertidal hermit crab populations were more abundant than subtidal, sand or coral reef populations. One reason why intertidal populations may be larger than subtidal populations is that intertidal abiotic conditions may assist in resource partitioning by enforcing upper limits to vertical distribution of sympatric species. Thus, direct competition for both food and shell resources may be reduced. By contrast, in coral reef systems, stable environmental conditions may increase both inter- and intraspecific resource competition (especially for shells), resulting in much more limited shell resources than occur on intertidal shores.

In addition, when general anthropogenic influences were compared among Zones by casual observations, the intensity of four main factors could be ranked. These were: 1) commercial boat traffic, 2) local fishing pressure, 3) human population density and 4) dive tourism pressure. When these factors were ranked among Zones 1-3, we found the following:

- **Zone 1** = high commercial boat traffic (ferries, commercial fishing vessels, cruise ships), moderate local fishing pressure, high human population density and high dive tourism pressure.
- **Zone 2** = moderate commercial boat traffic (commercial fishing vessels), low local fishing pressure, moderate human population density and low dive tourism pressure.
- **Zone 3** = low commercial boat traffic, high local fishing pressure, low human population density, moderate dive tourism pressure.

While uncorrelated with current environmental conditions and unsubstantiated by sufficient sampling, these observations do suggest that differences in anthropogenic stresses on ecosystem health may exist between Zones (although determination of such was not within the scope of this study), and that such stresses may influence the diversity, distribution and abundance of shallow, subtidal hermit crabs (as well as other marine organisms) along the inshore areas of Roatan.

The rapid inventory of common hermit crabs has also resulted in the collection and recording of 6 species previously unreported from the intertidal and/or marine habitats of Roatan, or from the Bay Islands. While some of the species currently reported have been reported from other areas of the wider Caribbean, results of this project (with further collection and identification) are likely to yield new location records and possibly new species.

EVALUATION OF THREATS AND MANAGEMENT RECOMMENDATIONS

In general, few reports on the marine invertebrate fauna of Honduras have been reported in the peer-reviewed literature. Hewitt (2002) has recognized that in many regions, the lack of inventories of marine fauna have resulted in a paucity of knowledge of rates of endemism and rates of invasion . Without large-scale inventories of marine fauna, it will not be possible to make determinations of distribution, abundance and diversity of many marine invertebrates in the area. *Therefore, it is recommended that large-scale, systematic inventories of marine invertebrates be carried out throughout the Bay Islands and that concentrated efforts be made to document and catalog species from this region.*

The recognition of changes in the status of marine organisms necessarily requires a systematic program of monitoring diversity, distribution and abundance at the community, guild and/or species levels. *Therefore, it is recommended that a program of monitoring invertebrate biodiversity (not only corals) be instigated and carried out over time throughout the Bay Islands and that field guides be produced from the resulting photographic materials.*

It is well recognized that environmental conditions such as temperature, salinity and water clarity can affect biodiversity on many levels (Sebens, 1994; Norse, 1995; Kramer*, et al*., 2000). Without an understanding of current trends in environmental conditions on a local scale, potential for modeling and predicting the affects of changing conditions on populations is severely limited. Through such linkages, Dunbar (2001) and Dunbar *et al* (2003) recognized the influence of fresh water inundation on hermit crab populations in Queensland, Australia. *Therefore, it is recommended that studies be conducted on links between environmental conditions (temperature, salinity, sedimentation) and hermit crab populations.*

Many organisms have been used as indicator species of environmental degradation and pollution (Filice, 1954; Reish, 1959, 1972; Stickle*, et al*., 1990; Al-Madfa*, et al*., 1998). An important recognition in any indicator system is that the indicator species is, at some level, a representative of its community or guild. By examining responses of the indicator species to changes in conditions, much can be learned of how the community the species represents may also be responding. Thus, it is important that the chosen indicator species have the potential to represent the community or guild in which it participates. *Therefore, it is recommended that studies be undertaken to investigate the potential for various hermit crab species to represent intertidal and shallow subtidal communities or guilds of which they are a part.*

In ecological studies there is a need for monitoring systems that are effective, economical and easily interpreted (Ward, 2000). In addition, several studies have found that the collection of significant and useful data may be undertaken by community groups, provided they have received sufficient training in methodology (Wells, 1995; Darwall and Dulvy, 1996; Kay and Coates, 2000); see also http://www.ozestuaries.org/indicators/In_hermit_crabs_f.html). Such community monitoring programs may serve not only for consistent collection of data year-round, but also to enhance environmental ownership by local communities and decision-makers, thus influencing the processes of policy-making along several levels. *Therefore, it is recommended that investigations be initiated into the potential for hermit crabs to be used as community monitoring tools among the Bay Islands and that training of key local stake-holders be undertaken using a "train the trainer" model.*

CONCLUSIONS

In conclusion, the rapid inventory of common hermit crabs of the Roatan region of the Mesoamerican Reef in Honduras has undertaken a rapid assessment of the diversity, distribution and abundance of the common hermit crabs of Roatan between October 25 and November 2, 2005. The project resulted in counts of hermit crabs along the southern coast of Roatan. It is recognized that hurricane weather conditions reduced the time available and limited the sites visited during the survey, and thus, counts are likely underestimates of diversity, distribution, abundance and density of hermit crabs around the island.

Despite prohibitive conditions, the rapid inventory has added 6 species of hermit crabs to the list of know species occurring on the island reported in the peer-reviewed literature and provided estimates of densities for each of the 9 species found. Findings for some species may represent new locality records. Furthermore, live-color photographs are provided here for each species, some of which no live-color photographs have previously been available.

In addition to the results reported here, recommendations for further research on the viability of the common hermit crabs of Roatan as environmental indicators and community monitoring tools have been provided. These recommendations provide a point from which long-term studies can be launched. The hermit crabs of Roatan afford many opportunities to further our understanding of important lower trophic invertebrates of the intertidal and coral reef environments of the Bay Islands, Honduras.

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