



LAND CRABS

RESEARCH SUMMARY
2008-2010

**ECOLOGY AND POPULATION OF COASTAL
LAND CRABS AT THE HACIENDA LA
ESPERANZA NATURE RESERVE**

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Volunteer Leaders: William Burgos Domínguez, Julio Calderón Díaz, Víctor Centeno Torres, Víctor Centeno Sierra, Nitzal Lugo Ríos



Concepción Rodríguez Fourquet earned her bachelor's degree in Biology from the University of Puerto Rico (UPR), Río Piedras campus, and a master's in Marine Sciences from the University of Puerto Rico, Mayagüez campus. She pursued her doctorate in Biology at UPR, Río Piedras campus. Rodríguez Fourquet is a renowned expert on the coastal land crab, *Cardisoma guanhumi*. She has led previous research studies on its population dynamics and demographics in Puerto Rico, in order to gain a better understanding of its population density, migratory patterns, and survival status. She has offered several conferences on the subject in international forums, including the Ecological Society of America's annual meeting held in Montreal, Canada, in 2005, as well as the British Ecological Society and Association for Tropical Biology Joint Symposium, held in Aberdeen, Scotland, in 2003.

Her investigative work has been published in numerous sources, including the international, Netherlands-based journal *Aquatic Botany*. She currently works as a professor in the Biology Department of the UPR, Bayamón campus.

IT IS IMPERATIVE THAT WE BEGIN TO VALUE THIS SPECIES AS A NECESSARY PLAYER IN THE ORCHESTRA OF GEOLOGIC TIME: FROM THE SEDIMENT THAT WILL MAKE UP OUR FUTURE EOLIANITES, TO THE WHITENESS OF OUR SANDY BEACHES, OR THE SOUND OF SHIFTING SAND UNDER THE ROLLING OF THE WAVES; ALL IS INTRICATELY INTERTWINED, GRAIN BY GRAIN, WITH THE CHORDS LAND CRABS PLAY.

INTRODUCTION

The oldest evidence of human presence at the Hacienda La Esperanza Nature Reserve (HLENR) dates back to the pre-Hispanic culture known as the Igneri, and studies have shown that land crabs were part of their diet. More than 2,000 years later, we still savor many dishes prepared with crab meat, even when excessive fishing and habitat loss of this species have caused its population to dwindle almost to the point of extinction. In fact, humans prey on the common land crab (*Cardisoma guanhumi*), without taking into account where and how this species lives, and how it ends up at our table, whether in the form of stewed crab meat or any other dishes that we currently savor.

Taxonomically, the species *ganhumi* belongs to the genus *Cardisoma*, which in turn belongs to the family of land crabs known as *Gecarcinidae*. Even though it developed specialized gills that allow it to extract oxygen from the air, this species requires moist conditions to avoid dehydration. To prevent this, land crabs dig burrows or caves that reach the water table, which fills the space with 1 to 2 liters of groundwater. Depending on the cave's location, it may be filled with fresh or saltwater, and serves as habitat for other organisms, including certain insects. Some crabs, especially females, share their caves with younger individuals that are smaller in size and unable to dig on their own caves. Wetlands, coastal grasslands, and riverbanks in HLENR offer an ideal water table setting for land crabs to dig their caves, even in lands found further away from the river or the sea.

To protect themselves from dehydration due to sun exposure, land crabs prefer shady areas. They see through cone-shaped eyes composed of ommatidia, and their vision is extremely sensitive to polarized light, so they tend to be more active during periods of less sunlight. Even though they are omnivores, they tend to prefer vegetable matter, especially red and white mangrove leaves. From inside their caves, they sense vibrations in the soil substrate, helping them to detect when fruit drop nearby. They can also feed from insects and even smaller crabs, which are sometimes devoured as a result of antagonism between individuals, especially males, who compete ferociously for the best territories and caves closest to the beach (which are very important to optimize their reproductive cycle).

All crabs are classified under the infraorder *Brachyura*, which implies a hidden or short tail. Because they possess ten legs, they belong to the order *Decapoda* (literally “ten legs”), and because of

their body structures, they belong to the class *Malacostraca*, which, in turn, belongs to the subphylum *Crustacea*, with whom they share a similar reproductive cycle. Contrary to sea crabs, however, land crabs mate on land, usually during the rainy season, which causes migrations to the sea, where females carry hundreds of thousands of eggs, as evidenced during the study. Land crabs emerge from the eggs as larvae, and they go through 5 stages as zoeas, and through a post-larval stage known as *megalopa*, before finally becoming young crabs and moving inland to compete with other land crabs.

In areas more densely populated by land crabs, approximately two caves per square surface meter may be detected, which suggests that this species may, in certain types of soil, contribute to substrate oxygenation and, therefore, to the carbon cycle. Like bats, land crabs that feed from fruit with seeds too large to be swallowed may contribute to seed dispersal. They also clean organic matter from vegetation, which is part of their basic diet. Further studies must be conducted in order to understand the effects of land crabs on their natural environment, considering that most of our current knowledge has been derived from preliminary observations.

Finally, because of its exoskeleton, the land crab is classified under the phylum *Arthropoda* of the kingdom *Animalia*. Before becoming an adult capable of producing hundreds of thousands of eggs, the land crab uses biomineralization to incorporate digested matter into its exoskeleton, which must be renewed more than 60 times in order to accommodate its growing body. Land crabs withdraw into their caves during these cycles.

Its feeding and reproductive habits, as well as the biomineralization of its exoskeleton, prove that land crabs transfer energy between land and marine ecosystems. Depending on the effects of natural

phenomena, fragments of their shells eventually make up part of rocks or beach sand. Because it may disrupt land crab activity within their ecosystems, some human activity, such as excessive fishing, significantly impacts these natural processes.

We must begin to value this species as a necessary component of our geological time frame, from the sediment that makes up our future eolianite rocks and our white sandy beaches, to the sound of shifting sand as the waves crash against it. All of these elements are intricately linked to the land crab's presence or demise. We must contribute to the protection of this species by supporting the closed fishing season that is in effect from July 15 to October 15 of every year, and by avoiding crabmeat consumption during that period. In doing so, we would help to ensure that future generations will benefit from this resource for years to come.

DESCRIPTION

BACKGROUND AND LEARNING ENVIRONMENT: COASTAL LAND CRABS ON THE RESERVE

From 202 invertebrate species identified at the HLENR, crustaceans have been the most widely studied group, especially the land crab *Cardisoma guanhumi*. This species is currently classified as a critical element on the Reserve, together with 4 other crab species. Previous studies have shown that land crab populations at the HLENR have remained fairly high and stable over the past 40 years, as compared to other locations in Puerto Rico, where land crab population and distribution have declined.

The first findings regarding the common land crab have shown that cave densities ranged approximately 2.1 ± 2.2 crabs per square meter in studied areas, and that the approximate size of their shells ranged in the vicinity of 65.5 ± 21 mm. Certain factors in the Reserve may contribute to these particularities. For instance, its lands are protected and they contain many ecosystems with ideal conditions, such as a high water table. The study of the relationship between land crab size and population and fishing practices surrounding this species still requires further attention.

OBJECTIVES AND QUESTIONS

This study seeks to provide an estimate of land crab population at the HLENR by studying population sizes and the physical characteristics of captured individuals at 8 locations within the Reserve. Studying the relationship between this species' life and reproductive cycles in relation to the seasons is necessary in order to understand its population dynamics. This knowledge, in turn, will contribute to drafting management plans that aim to protect and preserve the land crab, in a manner that fosters a sustainable use of the species and minimizes the impact of excessive fishing.

METHODOLOGY AND ACTIVITIES

Even though all Citizen Science Program research projects have sought to play an essential role in informal science education, this particular study placed special emphasis on volunteers gaining specific knowledge in regards to the species under research, particularly as related to its physical characteristics and reproductive habits. Distinguishing between sexes and knowing their reproductive cycles were of utmost importance, since capturing egg-bearing females is banned and there is a closed fishing season in effect between July 15 and October 15. Therefore, as part of the study, a test was administered to volunteers before and after their participation in order to assess their knowledge.

Groups were convened at 3 pm, and the activities could extend beyond 11 at night, with some activities requiring that volunteers spend the night at the HLENR in order to observe land crab feeding habits. Due to the strenuous nature of physical activities performed during the study, it was required that participants be older than 12 and that they be able to carry out the necessary tasks, which

included building, maintaining and managing traps to capture land crabs; identifying specific geographical areas for the study, and conducting a census of captured land crabs. The census consisted of identifying the sex of each individual, weighing it, measuring its shell and its larger chelicerae, and marking those individuals with a shell larger than 50mm. This information was recorded before releasing individuals into the same area where they were captured.

Aside from entering and analyzing data after each field visit, volunteers also randomly studied areas not specified for the study, in order to search for new land crab caves and to observe the vegetation surrounding them. Because there was a waiting period of 4 hours between the time that traps were set to when they were checked, the lead scientist used this time to discuss certain aspects of land crabs with the volunteers, such as the development stages of the crabs and how they relate to their habitats.

MATERIALS AND EQUIPMENT

Eight sampling areas were selected in order to facilitate marking and capture activities. In these areas, volunteers placed traps that had been fabricated using PVC piping of different diameters so that they would fit into different caves. Different wooden traps were also used to capture land crabs of varying sizes and in different soil conditions. The techniques and tools used to guarantee higher capture levels were perfected as the study progressed, and even more so after new volunteers who had previous experience in land crab fishing became part of the study. This also provided a unique opportunity to educate the land crab fishing community about the conservation of this species.

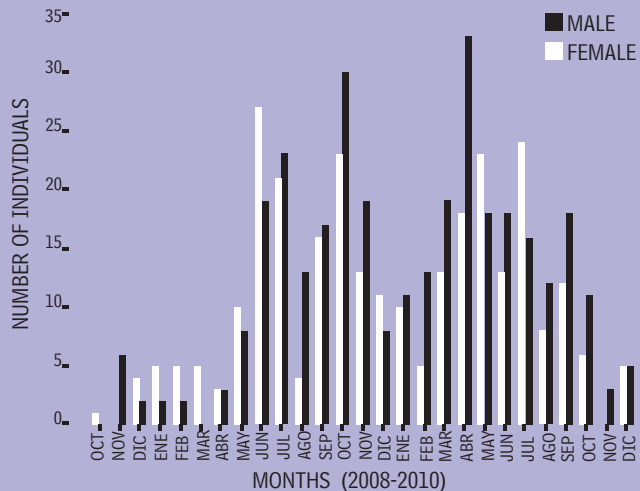
The width and length of captured individuals' shells were measured

using a Vernier caliper. Measuring weights were used to record their weight. Their sex was determined, and qualified candidates were marked using a pit-tag with a unique identification number, in hopes of recapturing them in the future. As previously mentioned, all data were recorded into field notebooks, entered into a computer, and analyzed. Apart from a few exceptions, each sampling area was visited once a month over the 24 months spanning the research.

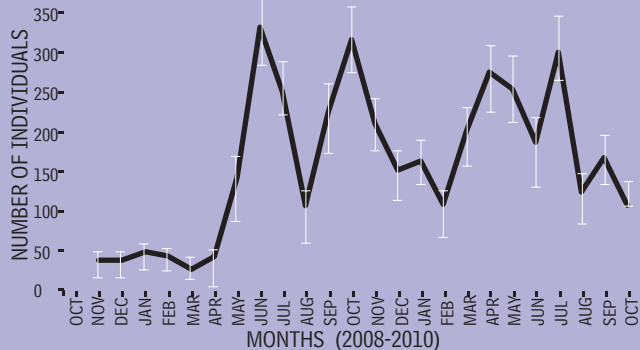
CITIZEN SCIENTISTS

Among the volunteers who became leaders, the contributions of William Burgos Domínguez, Nitza Lugo, and Julio Calderón were particularly noteworthy since, aside from participating dozens of times they even accompanied the lead scientist to the American Ecological Society annual conference, where they presented a poster with information about the study. The lead scientist also emphasized the participation of the Centeno Torres family, whose members contributed their ample experience in the practice of fishing land crabs and other species. The family's oldest son, Alexis, had played a considerable role during the final seven months of the research.

The lead scientist also acknowledged the participation of student groups and the effect that the activities had on them: From direct contact with land crabs for the first time, to enjoying the Reserve's night sky, these students undoubtedly benefited from the experience, which serves as evidence of the immense potential that informal science education holds for research. In many cases, the volunteers' observations confirmed or verified data that had otherwise only been available through literature on land crabs.

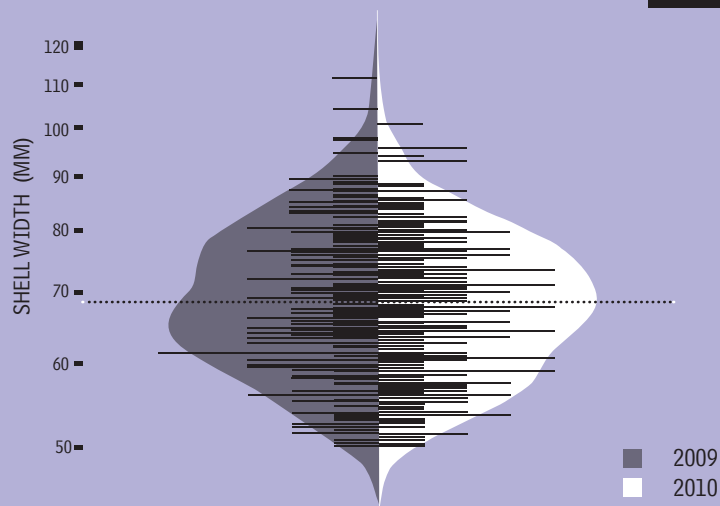


MALE AND FEMALE CAPTURES - CARDISOMA GUANHUMI



ABUNDANCE ESTIMATE - CARDISOMA GUANHUMI
ACCORDING TO MODEL (ERROR BARS = STANDARD ERROR)

+ las GRAFICAS no se incluyeron en las correcciones



SIZES OF SHELL WIDTH - CARDISOMA GUANHUMI

POINTS	CAPTURES	RECAPTURES	% RECAPTURE
Huerto	106	27	25%
River 1	74	14	18%
Jueyada 2	70	10	14%
Boquilla	67	10	15%
Jueyada 1	60	17	28%
Mirador	29	8	27%
River2	32	5	15%
Locks	19	10	52%

RECAPTURE STATS

RESEARCH SUMMARY

Outstanding Results

During the two years spanning the research, a total of 804 land crabs were captured, and 614 of them were deemed qualified for marking (328 males and 286 females). The average size of land crabs at the HLENR was determined to be 64.5 mm (2.5 inches) in shell size. Males were larger, with an average size of 66.4 mm (2.6 inches), as compared to the females, whose shells averaged 64.1 mm (2.5 inches). In 2009, the largest land crabs were found in the areas denominated Garden and River 1. In 2010, the width of shells in those land crabs captured in River 1 appeared to be decreasing, but not in those from the Garden area. This may have occurred due to an increase in land crab fishing in the River 1 area, as compared to the Garden area, where shell sizes remained roughly the same and where fishing was either rare or nonexistent.

Regarding their abundance, land crabs appeared to follow a marked seasonal pattern, with a larger amount of individuals observed between May and October 2009, and April and October 2010. Both periods coincide with this species' reproductive season as well as Puerto Rico's rainy season. During both years, the month of August showed a decrease in abundance. This may be related to land crab behavior patterns, such as females traveling to sea to deposit their eggs. This behavior may have affected the capture rates, thus causing a decrease in the abundance observed.

Illegal fishing during the months of July may also be responsible for decreased abundance during the month of August, since there is a lot of activity at the beach during the month of July and crabmeat

consumption is associated with beach activity. Females traveling out to sea present the ideal opportunity for their illegal capture, which may also account for decreased abundance.

Summary of Results

The land crab population at the HLENR shows seasonal abundance, with a decrease during the month of August. Land crab sizes were recorded in the range of 65 mm (2.6 inches) in shell width, which makes them unsuitable for catching. Land crab fishing practices are not allowed within the Reserve. Nonetheless, such practices continue to take place regularly, which warrants taking additional steps to propose and implement alternative management practices, such as allowing sustainable or controlled land crab fishing. A pilot project could include granting a special permit to catch land crabs in areas where their average shell width exceeds 65mm, and rotating the capture areas every year. Statistics should be kept to record the quantity, size and sex of captured land crabs.

REMAINING QUESTIONS AND FUTURE APPLICABILITY

The success of any changes made to the management plan may be supported by the findings of this scientific research. An experimental model may be implemented at the HLENR to carry out a controlled capture of land crabs, in order to observe possible application to other land crab habitats in Puerto Rico. Other possibilities include performing studies concerning *C. guanhumi* reproduction under capture, in order to establish a sustainable fishing program under

applicable laws. Both scenarios highlight the importance of the HLENR for scientific research and the possible influence of these research projects on the islands of Puerto Rico in general.

In any event, land crab populations must be closely monitored to study the effectiveness of management and protection plans for this species. The success of these plans, in turn, will depend on the active participation of citizen scientists and fishermen in land crab conservation efforts.



POINTS OF INVESTIGATION

Jueyada I	18° 28' 09.7"	66° 30' 37.8"
Locks	18° 28' 12.7"	66° 30' 52.7"
Corta Fuego	18° 28' 20.4"	66° 30' 44.9"
Jueyada II	18° 28' 22.1"	66° 30' 30.3"
Boquilla Stream	18° 28' 35.6"	66° 30' 36.4"
River I	18° 28' 41.93"	66° 31' 55.76"
River II	18° 28' 41.72"	66° 32' 00.67"
Garden	18° 28' 04.66"	66° 31' 34.25"



LIST OF PARTICIPATING CITIZEN SCIENTISTS

Abby Burgos
Abiana Echevarría Declét
Abigail Declét
Abimael Ortiz Alvarez
Abner L. Pérez
Achlee González
Acner Rodríguez
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Elí Sánchez Urbina
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Elio Ramos Colon
Elizabeth Concepción
Elizabeth Lozada
Elizabeth Mangual
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Elmer Caldero Torres
Elvin Méndez
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Emely Figueroa
Enid Mata

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Valerie Rodríguez
Valerie Sanabria
Vanessa Villanueva Mateo
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The Conservation Trust of Puerto Rico is a private, nonprofit organization whose mission is to secure functional and healthy ecosystems on the islands of Puerto Rico, and to instill in their inhabitants a sense of responsibility toward the conservation of our natural resources, so that we may have ecosystem services that will help us achieve our social, economic and quality-of-life goals.

The Conservation Trust of Puerto Rico believes that we can achieve our full potential, both individually and collectively, if we can sustain the ecosystem services on the islands of Puerto Rico and respect all forms of life with which we share our natural environment.

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