

THE Caribbean Spiny Lobster

A Great Bahamian Tail

GUIDE FOR BAHAMIAN SCHOOLS



A Publication of The
**Bahamas Reef Environment
Educational Foundation**
www.breef.org

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The Bahamas Reef Environment Educational Foundation (BREEF) is a Bahamian non-profit foundation established in 1993. BREEF promotes the conservation of the Bahamian marine environment that sustains our way of life.

BREEF is committed to educating people about the marine environment and the role that it plays in our

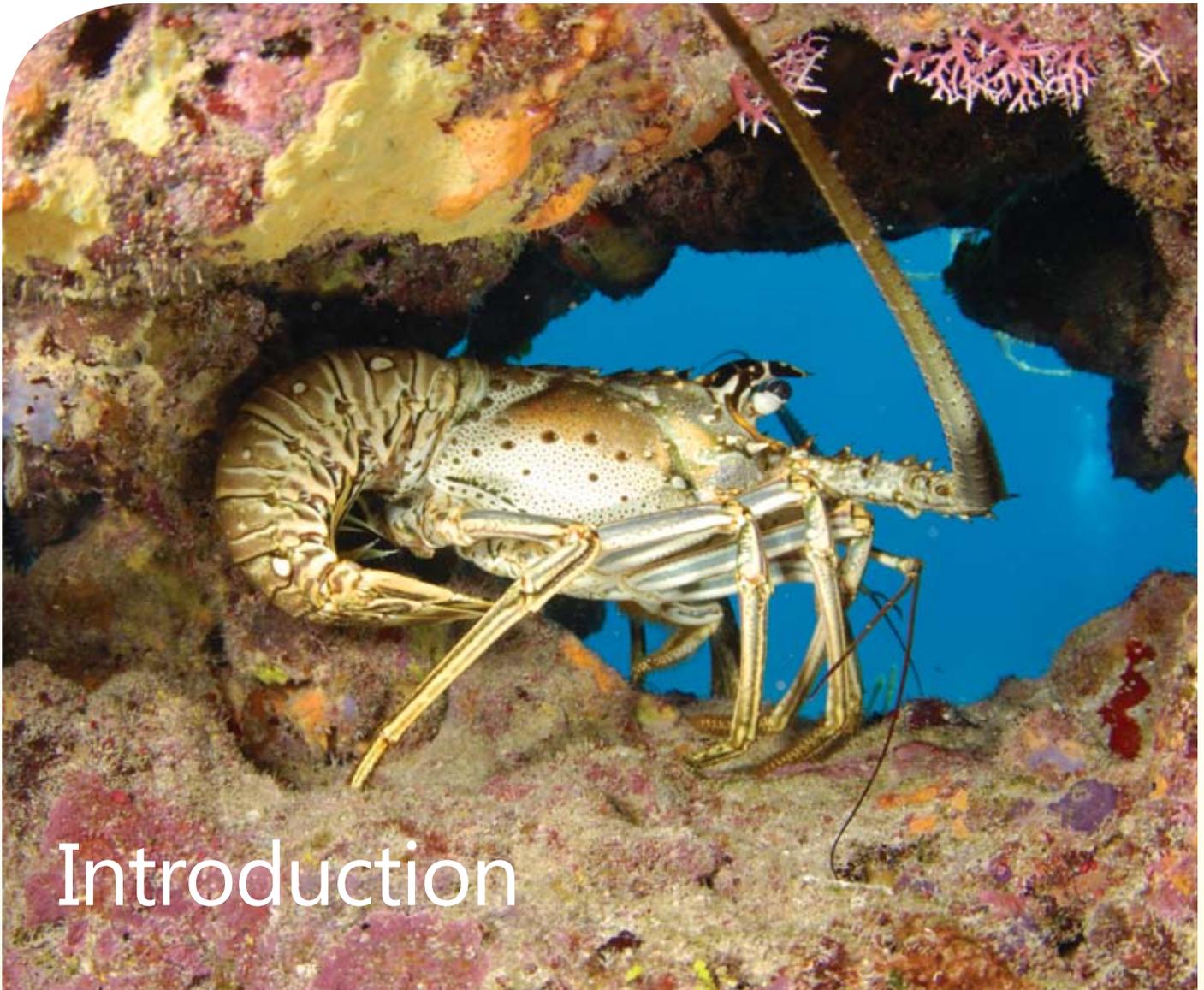
tourism and fishing industries, and in providing food, recreation and shoreline protection for us all. This important learning tool, developed by BREEF with funding from the Lyford Cay Foundation, is designed for use in Bahamian classrooms. It will help to provide enriching, engaging classroom experiences for science students throughout The Bahamas.

Note to Teachers



This booklet was developed by BREEF to support the learner outcomes of the Science and Social Science curricula in The Bahamas. The information can be utilized to teach Environmental Biology units such as Biodiversity, Interdependence between Species and the Environment, Endangered Species, Protected Areas, Conservation and Environmental Stewardship, Fisheries Management. Discussion questions denoted by  have been included throughout.

Visit our website www.breef.org for further information and resources. To schedule a classroom presentation or coastal field trips call 327-9000 or email breef@breef.org. We look forward to your feedback so that we can better serve your marine education needs and promote environmental stewardship to all.



Introduction

The Caribbean Spiny Lobster, commonly known to Bahamians as crawfish, is the largest fishery, and an important contributor to the economy. It provides many fishers, seafood vendors, processors and exporters with income, and is a popular delicacy for Bahamians and visitors alike.

As detritivores, crawfish are also important to the

environment. They help to maintain healthy coral reefs by feeding on dead and decaying organisms, such as fish and plant debris. Crawfish also feed on clams, worms, crabs, shrimp, urchins, sponges, and small fish. They are a food source (prey) for many marine organisms including octopuses, turtles, stingrays and nurse sharks. However, their most significant predators are human beings.

Classification

Kingdom	Animalia	multicellular organisms that ingest their food
Phylum	Arthropoda	jointed legs
Class	Crustacea	covered by a hard shell, have 2 pairs of antennae
Order	Decapoda	ten legs, head and thorax fused to form a carapace
Family	Palinuridae	can swim backwards using their tail for propulsion
Genus	<i>Panulirus</i>	
Species	<i>argus</i>	

The genus and species together make up the scientific name of an organism. This is referred to as the 'binomial system' of naming species because each organism has two names. The scientific name of an organism is universally recognized. The scientific name of the spiny lobster is ***Panulirus argus***, but it has many different common names including crawfish, Florida lobster, Caribbean spiny lobster, rock lobster, and bug.



Types of Lobsters

There are two main types of lobsters; clawless lobsters and clawed lobsters.



Clawless lobsters

Spiny lobsters lack claws and instead depend on sharp spines for protection. They have a pair of long conical antennae (whips) and a pair of shorter thin antennae which provide a sense of smell and touch.

The **slipper lobster**, also found in The Bahamas has two large, flat, rounded appendages instead of long antennae.



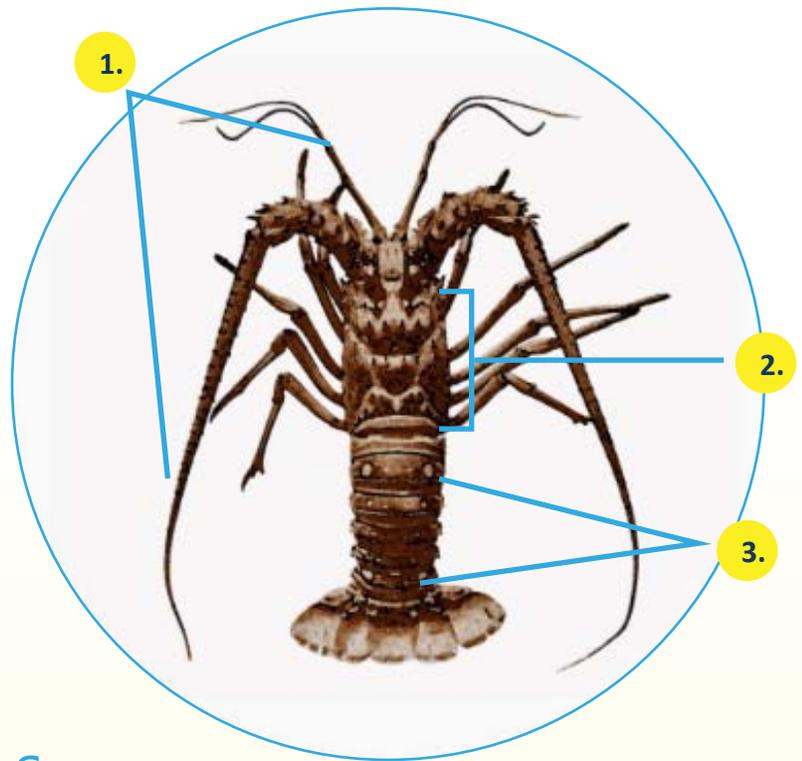
Clawed lobster

American (Maine) and European lobsters have a pair of large claws.

Distinguishing Features of the Spiny Lobster

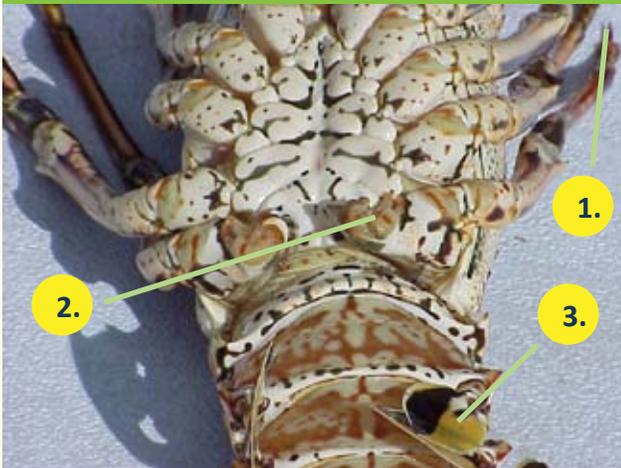
The body of the Caribbean spiny lobster is covered with a hard, reddish-brown exoskeleton which offers protection from physical damage.

1. Crawfish have two pairs of antennae, the longer whip-like ones bear sharp spines.
2. The spiny head and thorax are fused to form the carapace (cephalothorax).
3. The tail (abdomen) has four large cream-coloured spots, two each on the first and sixth abdominal segments.



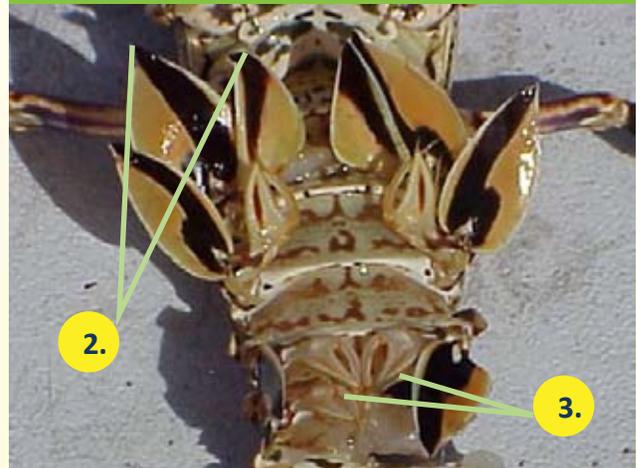
The Difference Between the Sexes

Male



1. The tip of each last leg is pointed
2. Males have a raised opening at the base of each last leg to pass the sperm packet to the female.
3. A set of single swimmerets along the edge of the tail aid in locomotion

Female



1. The tip of each last leg has a small claw which is used to transfer sperm from the tar spot to the eggs and to tend the eggs. (*not shown*)
2. Set of paired swimmerets along the edge of the tail
3. Set of forked claspers beneath the swimmerets with hairs for holding eggs.

Distribution and Habitat



The Caribbean spiny lobster inhabits the warm tropical and sub-tropical coastal waters of the Caribbean region.

Adult crawfish can usually be found under ledges and in crevices of the reef. They are nocturnal and come out to feed on invertebrates and detritus on shallow banks and in sea grass beds at night.

As juveniles, crawfish normally inhabit coastal wetlands and sea grass beds, which provide them with food and protection from predators. The eggs and early stage larvae are pelagic, drifting on currents in the open ocean.



Which habitats should be included within the boundaries of Marine Protected Areas (MPAs) in order to protect the spiny lobster fishery?

A- Including the following habitats: coastal wetlands, seagrass, coral reefs and open water within our MPAs will help to protect our marine ecosystems and our crawfish fishery .

Life Cycle of the Spiny Lobster

Adult - Breeding

The life cycle of crawfish begins with mating and spawning which takes place primarily during the warmer months of April through July. During mating, the male and female lie belly to belly. The male passes a sperm packet to the female through an opening called a genital pore located at the base of the fifth pair of legs. The packet attaches to the underside of the carapace of the female and hardens to form a black “tar spot”.

The female extrudes bright orange eggs through a genital pore at the base of third pair of legs. She transfers sperm from the “tar spot” to fertilize them.

The fertilized eggs are carried beneath the abdomen of the female attached to hairs called setae. A female with eggs is described as ‘berried’, named after the appearance of the eggs. The female carries the eggs until they are ready to hatch. Eggs that are removed from the female will not hatch. Females can lay eggs several times per season.



Illegally harvested crawfish with eggs



Fun Fact:

A crawfish with a 5” long carapace will lay three times as many eggs as a crawfish with a 3.5” carapace.

Larval Dispersal

In one to four weeks the eggs turn a brownish colour, indicating that they are ready to hatch. The eggs hatch, releasing microscopic **phyllosome** (leaf-bodied) **larvae** into the water column. The larvae are carried on ocean currents for 6-8 months until they metamorphose into transparent **puerulus post-larvae**. Larval lobsters have no defense and are preyed upon by plankton feeders. The post-larvae move from the open ocean into near-shore areas such as wetlands and sea grass beds, settling into algal habitats containing the red alga **Laurencia**.

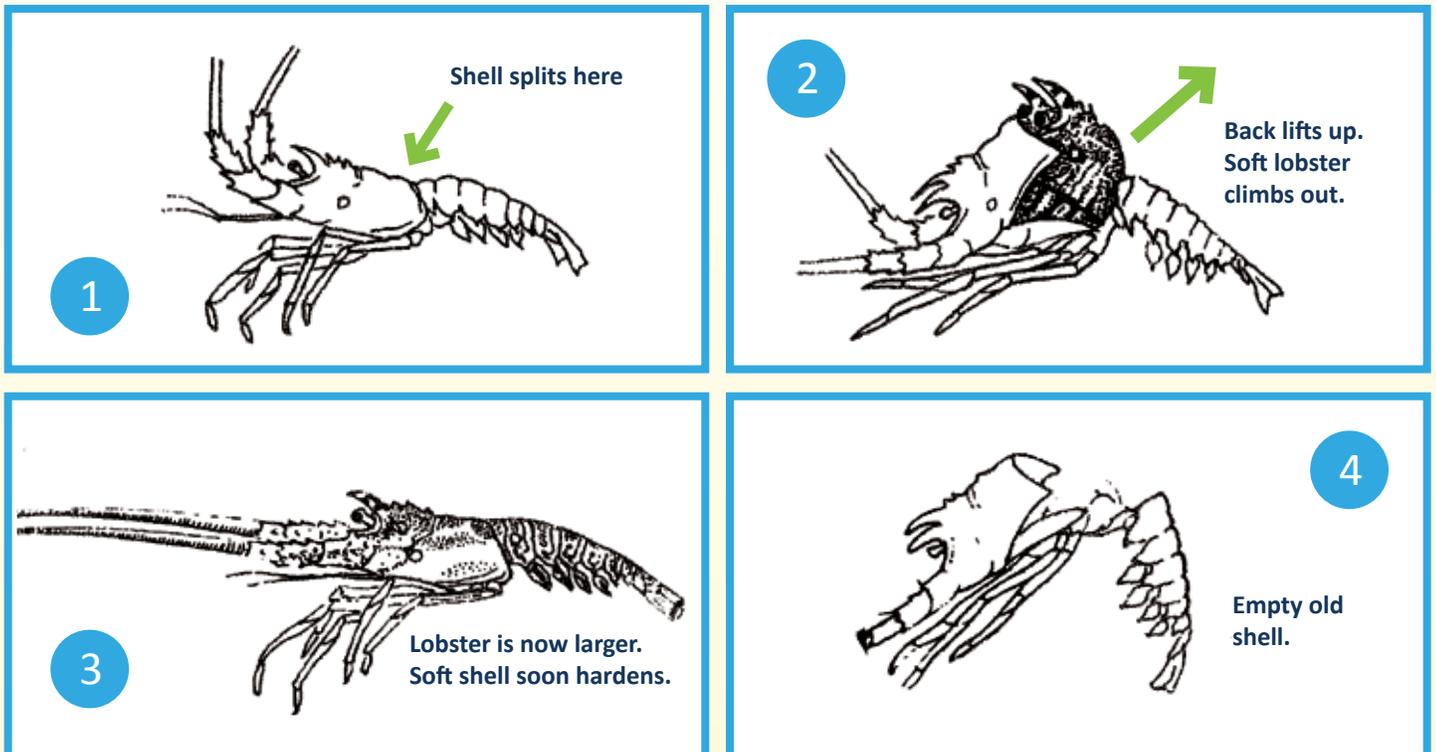
Juveniles

One week after settling, the post-larvae gain pigmentation to become coloured **juveniles**. At this point crawfish are approximately one year old. Juveniles live among **Laurencia** for camouflage, feeding and moulting as they grow.

Moulting

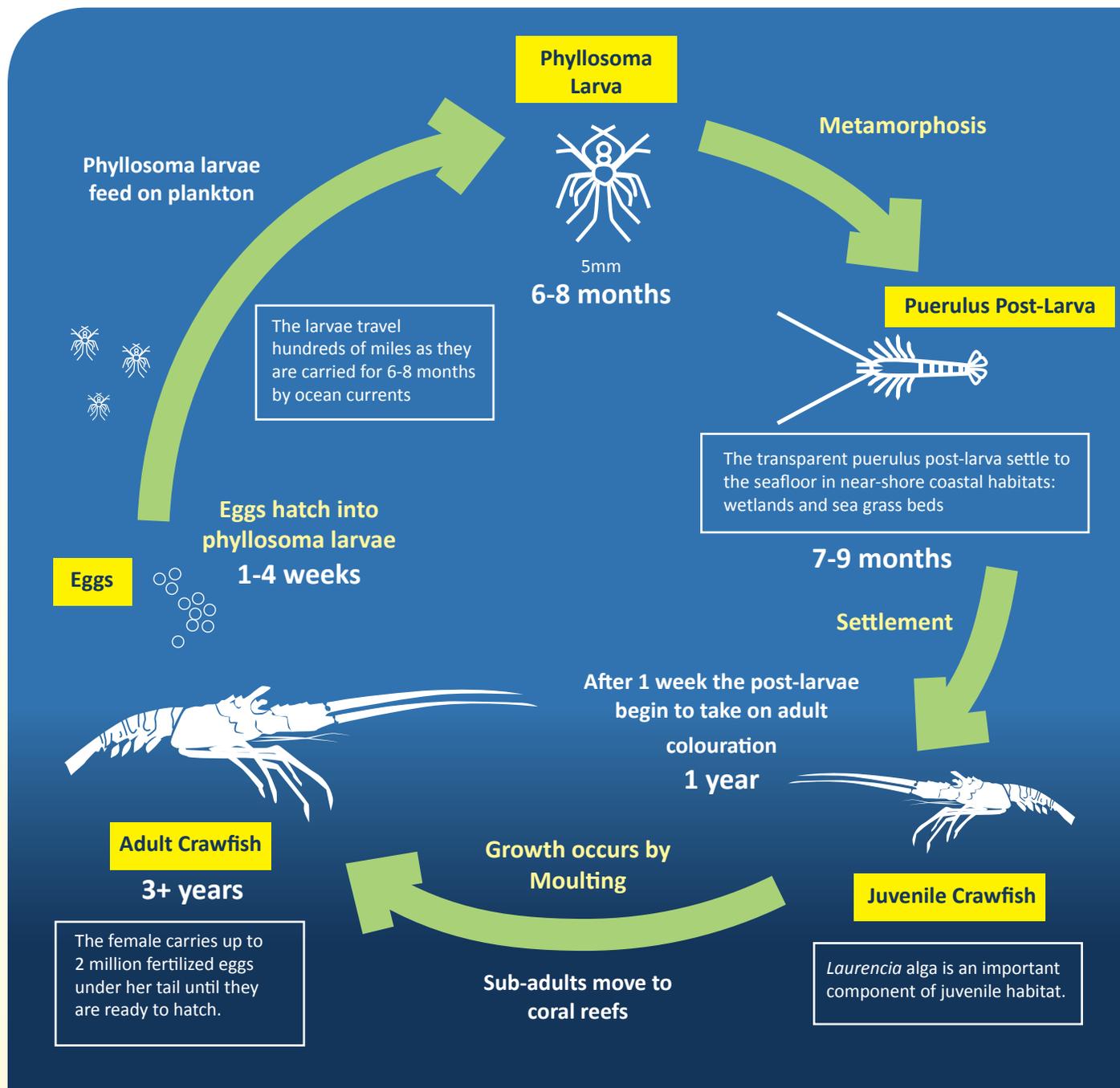
Before moulting, a crawfish grows a soft shell beneath its hard exoskeleton. To moult, the shell splits at the point where the carapace meets the abdomen. The crawfish slowly backs out of its shell through the opening. The now soft-shelled lobster expands to a larger size and the new shell hardens.

Larger sized immature crawfish called sub-adults migrate to coral reefs. They reach sexual maturity at three to five years with a tail length of approximately 5½”.



The Moulting Process

Life Cycle of the Spiny Lobster



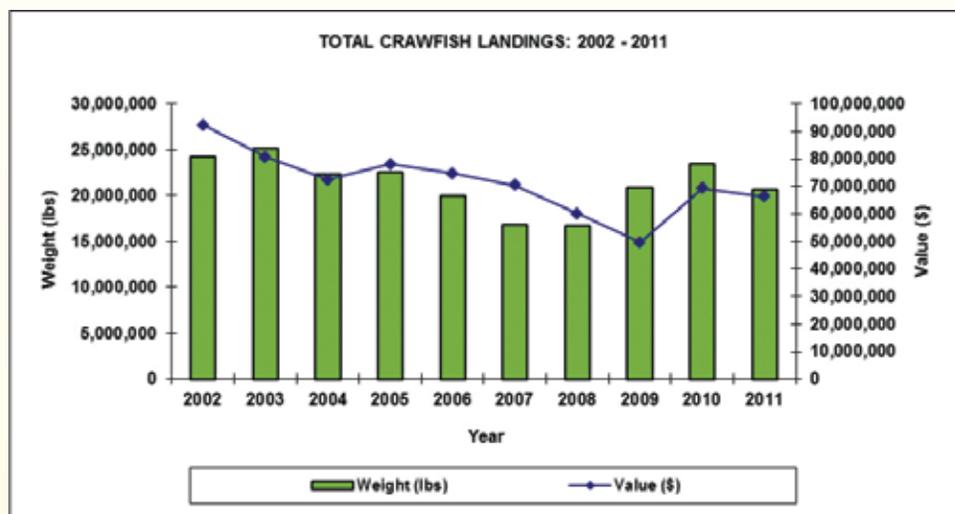
Fun Fact:

Lobsters grow throughout their lives and can live for up to 40 years, attaining a length of up to one meter.

The Bahamian Spiny Lobster Fishery

Crawfish makeup 60% of the total fishery product landed by fishers in The Bahamas and 85% of the value of landings on an annual basis. 80% of all fishery products and exports come from crawfish, making up 95% of the value of exports annually.

The lobster fishery in The Bahamas utilizes a range of fishing gear including spears, traps and condos (also referred to as casitas in other countries throughout the region). The use of condos is the main commercial method of fishing for spiny lobsters and has increased in popularity since the mid-1980s. Condos usually consist of a sheet of zinc-coated metal (e.g. corrugated roofing material) attached to treated lumber and/or concrete blocks under two sides. The condos function by providing an artificial habitat that attracts crawfish. The advantage of a condo is that fishers can use a lobster hook to capture crawfish alive, leaving



Crawfish Landings Data: 2002-2011

Source: Department of Marine Resources

behind the undersized individuals. Some concerns that have arisen from the use of condos include, the impact on bottom habitat, the movement of crawfish from natural reefs to condos, and marine debris arising from broken condos that are not removed from the ocean.

The Department of Marine Resources collects data on the fishery through fish buyers and processors. However, sales that go directly from fishers to restaurants, hotels,

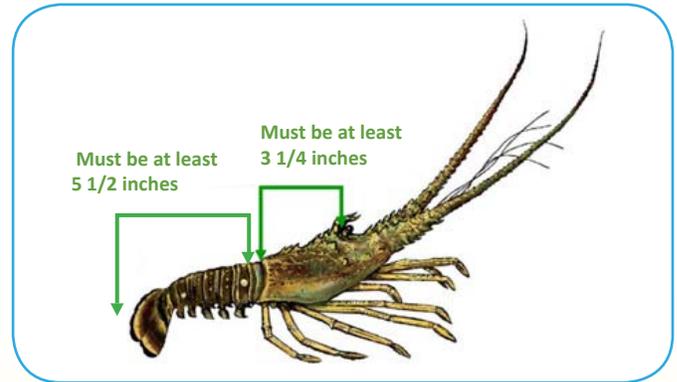
and individuals are generally unreported. The earliest records from the 1930's show that 1-2 million pounds of crawfish were harvested annually. From the 1940s-60s landings increased to approximately 3 million pounds/annum based on a six month open season. In 1966 the length of the open season was increased to eight months and the price doubled. As the price increased, so did the landings. Since 2000, reported landings of lobster have approximated 20 million pounds, generating an average \$65 million to the economy annually. Most crawfish are exported to the US, Canada and the European Union. Exports average 5 million pounds with an approximate worth of \$75 million per year.

BREEF is concerned about the health of the crawfish industry as there is evidence of decline in the catch per unit effort. This means that fishermen have to spend more time and go further off-shore to harvest sufficient crawfish to meet their needs.

Protection and Management of the Fishery

In an attempt to ensure the sustainability of the spiny lobster industry, legislation has been placed under the Fisheries Jurisdiction and Conservation Act to manage it. Fishery regulations pertaining to crawfish include:

- The minimum harvestable size is 3 ¼" carapace length or 5 ½" tail length.
- The harvest of crawfish is prohibited during the closed season: April 1st – July 31st
- A permit is required for all vessels trapping crawfish.
- Crawfish traps, unless otherwise approved, must be wooden slat traps no more than 3ft long, 2ft wide, and 2ft high, and the slats cannot be placed less than one inch apart.
- The possession of "berried" (egg bearing) crawfish is prohibited.
- Stripping or removing eggs from a female is prohibited.
- The use of noxious chemicals; poisonous barks, quicklime, household bleach or any other poisonous substance is prohibited.
- The use of SCUBA to capture crawfish is prohibited.
- Sportsfishers are limited to 10 crawfish per vessel at any time.



Threats

The main threat to the crawfish industry is **overfishing**. As technology advances it is becoming easier to harvest large amounts of wild animals from the sea. We must consider the impact of our actions if we want to ensure that our crawfish harvest is sustainable, and therefore available as a food source well into the future. **Other threats** include:



Harvest of Juveniles

The harvest of undersized crawfish (with tails less than 5 1/2" in length) removes animals from the population before they have had an opportunity to reproduce. This results in population declines over time.

Habitat loss

Traps and trap debris can impact corals by scraping or dislodging them, especially during deployment and retrieval, or when they are moved by storms. In seagrass beds, traps and condos can shade the seagrass reducing the numbers of shoots. Loss of habitat due to the impacts of coastal construction, coral bleaching due to climate change and pollution of wetlands, seagrass beds, coral reefs and the open ocean will impact crawfish populations.

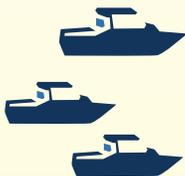


Use of Noxious Substances

Chemicals like chlorine bleach, detergent and gasoline drive crawfish from their hiding places making them an easy target for fishermen. These chemicals have devastating effects on coral reefs.

Harvest during the closed season

The closed season of April 1- July 31 corresponds to the peak breeding time for the species. Harvesting crawfish during this time reduces the reproductive capacity of the species.



Poaching

The vastness of The Bahamas makes it difficult to effectively monitor our waters to prevent illegal and unregulated fishing activity. The illegal harvest of crawfish by foreign poachers is fueled by the high demand and price of this commodity.

Invasive species

Invasive species are non-native species that can harm the environment by reducing native biodiversity. Lionfish are a threat to crawfish populations. Lionfish are carnivorous and have been known to prey on juvenile crawfish.



Conservation and Management of the Fishery

A well-managed spiny lobster fishery has measures to keep crawfish landings at a sustainable level, protect the species and the marine ecosystems on which they depend, ensure profitability and maintain employment levels in the industry. The following mechanisms are being employed in The Bahamas:

- **Improved mechanisms for data collection**

Data on the status of crawfish populations and on the harvest (size, location of harvest, and catch effort) should be regularly collected and managed to provide the information needed to effectively manage the fishery.

- **Establish a network of Marine Protected Areas (MPAs)**

MPAs should include areas that are still productive crawfish nurseries and breeding areas. By 2013, seventeen MPAs were established in The Bahamas, four of which were established as fishery reserves managed by the Dept. of Marine Resources to act primarily as fishery replenishment zones. MPA authorities are actively working to protect additional areas in order to meet The Bahamas' conservation goals.

- **Enforcement of fishery regulations**

- **Public education campaigns**

Such as the 'Size Matters' campaign led by Friends of the Environment in Abaco.

- **Marine Stewardship Council (MSC) Certification**

The Bahamas has embarked on an initiative to achieve MSC certification for the Bahamian spiny lobster fishery.



What can each of us do to protect the crawfish fishery?

A – Report illegal fishing activities, purchase legally harvested crawfish with a minimum tail length of 5 1/2 ", support vendors and fishermen who obey fishery regulations, support the establishment of MPAs, educate others.





Supporting Classroom Activities

Crawfish 101

Activity 1 - Life Cycles

A Comparative Conservation Study

ACTIVITY OVERVIEW

This activity compares the life cycles of ecologically or economically significant species in The Bahamas, i.e. The Caribbean spiny lobster, queen conch, and Nassau grouper. In preparation for this activity, students should have conducted research or have been provided with information for each species on the following areas: *life cycle stages, mode of reproduction, age of sexual maturity, number of offspring produced, frequency of reproduction, fishery regulations, habitat and threats.*

Organisms significant to The Bahamas are regulated by a number of strategies including: closed seasons, size restrictions, restriction on fishing methods or gear, fishing bans (sharks,

Extension Activities:

Science – compare the life cycles of other commercially important species.

Social Science / Family Life - Encourage students to share information with their friends and families.

Art/ Science: Develop posters or brochures to be displayed at school or in the community to increase awareness of the need to harvest mature crawfish with a minimum tail size of 5 ½”

Social Studies: Interview fishermen about crawfishing in the Bahamas to determine how the fishery has changed over time. Questions may be asked about where crawfish are caught (historically vs. today), the ease of finding legal sized crawfish now as compared to the past, methods used to harvest crawfish (traditional vs. current day), etc.

Language: Write a poem about the crawfish fishery in The Bahamas.

Music – compose a song to encourage people to harvest adult crawfish sustainably.

sea turtles), restriction on the sale of species (bonefish, sharks). These regulations have been developed based on scientific knowledge including organism life cycles. Through this activity, students should be able to link an organism's life cycle and its vulnerability to overexploitation. For example, organisms that produce fewer offspring, take longer to reach sexual maturity, reproduce infrequently and, are vulnerable to human impacts.

RESOURCES:

Life Cycle Posters, BREEF's Fish Rules App and marine organism booklet series: The Caribbean Spiny Lobster – A Great Bahamian Tail, The Nassau grouper – An Iconic Bahamian Species and The Queen Conch - True Bahamian Royalty www.breef.org

OBJECTIVES:

At the end of the lesson students will be able to:

1. Compare the life cycles of conch, grouper and crawfish.
2. Explain which of the life cycle stages of the conch, grouper and crawfish are most vulnerable to human activities.
3. Make inferences about the reason for existing regulations to protect conch, grouper and crawfish and/or their habitats.
4. Suggest additional strategies for the conservation of conch, grouper and crawfish based on their areas of vulnerability.

INSTRUCTIONS

1. Students should complete the worksheet provided to compare the Caribbean spiny lobster with another species as directed.
2. After the worksheets have been completed, lead a class discussion using the following questions as a guide in order to help students to understand that the biology of an organism impacts its vulnerability, and informs the regulations that are set to manage the fishery.
 - a. Give two similarities and two differences between the life cycles of crawfish and the other named species.
 - b. Based on your understanding of the life cycle of each species, why do the following regulations exist?
 - Closed seasons
 - Size restrictions
 - Fishing on SCUBA is prohibited
 - c. Which life cycle stage of each species do you think is most vulnerable to human activities? Give a reason for your answer.
 - d. Suggest additional strategies for the conservation of conch, grouper and crawfish based on their areas of vulnerability.

STUDENT WORKSHEET

Instructions: Use the findings of your research to complete the following table for the Caribbean spiny lobster and either conch, grouper or another species as assigned by the teacher.

Feature	Spiny lobster	
Mode of Reproduction i.e. <i>Asexual/sexual, Internal/external fertilization, egg laying/live birth</i>		
Mating season: <i>time of year & duration</i>		
Age and size/indication of sexual maturity		
Number of offspring per birth/ spawn		
Frequency of birth/spawning		
Life Cycle Stages: <i>Name, describe and give duration of life cycle stage, as applicable</i>		
Stage 1		
Stage 2		
Stage 3		
Stage 4		
Stage 5		
Habitat		
Threats		
Fishery Regulations		

Activity 2: How Many Crawfish are There?

Estimating Population Size

ACTIVITY OVERVIEW

In this activity students are introduced to a problem involving an environmental issue. Problem: Scientists have determined that the crawfish population has decreased. For this to be true, scientists must have counted the number of fish and noted the change. How did they count the crawfish?

Students are introduced to the capture-recapture method which involves capturing organisms, tagging them, returning them and recapturing another sample. In groups, students are given containers (the ocean) and an unknown number of beans to use in simulating the capture-recapture method. Students net the beans and substitute another type of bean to simulate tagged fish. Groups then take samples and record the number of tagged crawfish and the total number of crawfish captured. After several samples are taken, students apply their knowledge of ratio and proportion to arrive at the total crawfish population.

OBJECTIVE:

At the end of the lesson students will be able to:

1. Demonstrate the capture re-capture technique used to survey populations of marine organisms.
2. Estimate the size of a population by applying the concepts of ratio and proportion using the capture- recapture method.

MATERIALS (per group):

1 bowl, 300-350 kidney beans, 50 pinto beans (any type of bean can be used as long as they are similar in size), 1 small cup, 1 small canister – fishing net (e.g. 1-2oz disposable containers used to hold condiments), 1 plate.



Note: *Beads, counters, or macaroni can be used to represent tagged and untagged fish. Prior to the lesson, place 300 beans in each bowl. Do NOT disclose the number of beans that are in the bowl to the students beforehand. This number represents the actual crawfish population and will be calculated by the students by the end of the exercise. Prepare a cup containing 50 of the second type of bean for each group.*

PROCEDURE

1. Introduce the problem. Ask students what biologists need to know to determine that the crawfish population has decreased. *They must have determined the population at least twice beforehand.*
2. Place students into groups. Facilitate the groups while they discuss strategies for determining the number of fish in the bay. Allow the groups to share ideas with the entire class. (It is okay if students do not come up with the capture-recapture method during their discussions.)
3. After students have had a chance to share their ideas, identify the capture-recapture procedure as a statistical method often used to estimate large populations of animals in the wild. Connect the ideas presented by students during their discussion to the concepts that underlie the capture-recapture procedure. The capture-recapture method is based on the idea that if we measure a portion of a large population, count, tag, and release them, and then take another sample, we should be able to estimate the total population based on the proportion of tagged and untagged organisms recaptured. *(This method assumes that the population will be randomly distributed throughout the sample — like fish in an ocean.)*
4. Since it is unrealistic for your class to survey crawfish in the ocean, introduce the idea of a simulation. Explain to students that they are going to use a container to represent the ocean, and beans to represent the crawfish in the ocean.

CAPTURE

1. Capture a sample of crawfish from the ocean (bowl) by filling the small container to the rim. Place them on the plate, count and record (A).
2. Tag all of the captured crawfish by **replacing each** one with the second type of bean. *(Note: Since in this lesson we are tagging by replacing the captured crawfish with the second bean, the beans recorded as A can no longer count as part of the population and MUST be set aside.)*
3. Put the tagged crawfish (new beans) back into the bowl. *(Emphasize that the number in the population is unchanged.)*

RECAPTURE

1. Since crawfish move, mix the beans to distribute the tagged crawfish among the population.
2. Capture another sample from the ocean; ensure that you fill the container to the rim.
3. Record the number of tagged crawfish that were recaptured in the sample.
4. Record the total number of crawfish that were recaptured.
5. Return the entire sample to the ocean.
6. Repeat steps 1 - 5 as many times as time allows.
7. Calculate the average number of tagged crawfish that were recaptured (B) and the average number of recaptured crawfish in each sample (C).

Results Table:

	Initial capture/ tagged	Recapture 1	Recapture 2	Recapture 3	Recapture 4	Average
Number Tagged	A					B
Number Captured						C

Discussion Questions

After completing the capture portion of the capture-recapture method, ask the following:

1. **What information has been obtained from the capture?**

A- The number of tagged crawfish fish in each sample)

2. **Do you know how many crawfish are in your ocean?**

A - No.

Calculating Population Size

1. Instruct students to create a ratio to show how the number of tagged crawfish relates to the total number of crawfish in the ocean. Place students' ratios on the board and have the class reach a consensus on the one to use. It should be similar to the one below. **Note:** Remember that it is also correct to use the reciprocal, as long as there is consistency in the proportion.

$$\frac{\text{NUMBER TAGGED (A)}}{\text{TOTAL NUMBER IN OCEAN (unknown)}}$$

2. **Next, ask students: When the crawfish are recaptured, what could be found in the sample?**

A- All tagged, none tagged, some tagged and some not tagged.

3. **What do you expect to find?**

A- Some tagged and some not tagged.

4. **After the first recapture, what information will you obtain?**

A-How many total crawfish are in the recapture and how many of them are tagged.

5. Have students use a ratio to show how the number of tagged crawfish in the recapture relates to the number of crawfish in the recapture. Put ratio on the board next to the first one.

$$\frac{\text{AVERAGE NUMBER TAGGED IN RECAPTURE (B)}}{\text{AVERAGE NUMBER RECAPTURED (C)}}$$

The capture-recapture method is based on the assumption that these two ratios are equal; thus, the two ratios can be set up as a proportion.

$$\frac{\text{NUMBER TAGGED (A)}}{\text{TOTAL NUMBER IN OCEAN}} = \frac{\text{AVERAGE NUMBER TAGGED IN RECAPTURE (B)}}{\text{AVERAGE NUMBER IN RECAPTURE (C)}}$$

Mathematically the reciprocal is also true therefore,

$$\frac{\text{TOTAL NUMBER IN THE OCEAN}}{\text{NUMBER TAGGED (A)}} = \frac{\text{AVERAGE NUMBER IN RECAPTURE (C)}}{\text{AVERAGE TAGGED IN RECAPTURE (B)}}$$

The objective of the activity is to determine the population of crawfish in the ocean. Therefore if we make the '**Total Number in the Ocean**' the subject of the formula:

$$\text{TOTAL NUMBER IN THE OCEAN} = \frac{\text{AVERAGE NUMBER IN RECAPTURE (C)} \times \text{NUMBER TAGGED (A)}}{\text{AVERAGE NUMBER TAGGED IN RECAPTURE (B)}}$$

6. Each group should use the equation above to calculate the number of crawfish in the ocean.
7. Record the answers (estimates) for the total number in each ocean from each group. Have the class examine them to discuss the range of estimates and the probable number of crawfish in the ocean.
8. Finally, tell the students to count the number of beans that were placed in the ocean. (Each ocean should have had the same number of crawfish)
9. Students should then compare the actual number of crawfish to their results.

Discussion Questions

1. Did the capture-recapture method provide a reasonable estimate? Discuss.
2. Would estimates be closer to the actual population if a larger sample is used?
3. Would you get the same result by pooling the class data?
4. Why is the ongoing collection of population data important for the management of our fisheries?

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