

Science & Research *

**Plus Science and Research Supplement Questions (end of document)*

Cluster 1 Physical Science

Surface Currents Connect South Florida and the Keys (Winter 2002)
Ice Age Forest Discovered in Sanctuary Waters (Winter 2002)

Cluster 2 Sanctuary Zone and Water Quality Monitoring and Research

Water Quality Clearly Important to Marine Communities (Winter 2000)
Scientists Issue Sanctuary Report Card & Symposium Results (Spring 2002)
Water Quality, Seagrass & Coral Reef Monitoring Projects (Spring 2002)
Spiny Lobsters Thrive in the Ecological Reserve (Summer 2002)

Cluster 3 Research Projects in the Sanctuary

REEF Research --Grassroots Style (Spring 1998)
Queen Conch Stocking --Timing is Everything (Spring 1998)
Florida Bay Bottom-dwellers--Worth a Second Look (Fall 1998)
Divers Record Information on Fish Populations (Fall 2000)
Dolphin Ecology Project Describes Unique Behavior (Spring 2002)
Spotlight on Spoonbills in Florida Bay & Spoonbill Facts (Fall 2002)
Bonefish and Tarpon Tagging Research & Bonefish Life Cycle (Spring/Summer 2003)
TNC Keys Watch Volunteers Test Keys Canal Waters (Spring/Summer 2003)
Marine Events Reporting System Collects Observations of Events at Sea (Summer 2005)
Scientists Discover Red Tide Caused Deaths in Dolphins and Manatees (Summer 2005)
A Few Questions about a Keystone Herbivore (Winter 2006)

Cluster 4 Coral Reef Research

Volunteers Gather Baseline Data on Coral Reef Health (Fall 1998)
Coral Diseases in the Florida Keys (Summer/Fall 2001)
The Link between Coral Bleaching and Global Warming (Spring 2001)
Elkhorn Coral and White Pox: An Answer and More Questions (Fall 2002)

Cluster 5 Regional Restoration and Research

Changes in the South Florida Ecosystem (Spring/Summer 2004)
Florida Bay and Florida Keys Connections (Spring/Summer 2004)

Cluster 1 Physical Science

Surface Currents Connect South Florida and the Keys

1. What are the characteristics of the three subregions of South Florida's ecosystem?
2. How are these subregions interconnected?
3. What do the flow rate measurements show about the net flow of water from Florida Bay to the ocean side?
4. What is the nature of Florida Bay water flowing to the ocean side during some times of the year?
5. What has been learned from the surface drifter data?
6. How do the currents help make the shallow waters of the Keys and Florida Bay a nursery-ground for young marine organisms?

Ice Age Fossils in Sanctuary Waters

1. Why did scientists excavate a small sandy area in 45 feet of water?
2. What did they discover and what method was used to date the discovery?
3. Describe the conditions in Florida 8,400 years ago during the Pleistocene.
4. What do burnt fossils on the site indicate to scientists?
5. Where are PaleoIndian artifacts likely to be discovered within the Florida Keys National Marine Sanctuary? Explain your answer.

Discussion Questions

1. In general, what are the physical factors that define the marine environment of the Florida Keys?

Extension Ideas

1. Investigate the factors that contribute to the formation of ocean surface currents.
2. Investigate what is known about the earliest people who inhabited the Florida Peninsula.
3. Investigate what causes the sea-level to rise and fall over time.

Cluster 2 Zone and Water Quality Monitoring and Research

Water Quality Clearly Important to Marine Communities

1. What are the two main industries that are economically important to the Florida Keys? What do these industries depend upon for survival?
2. What two conditions are needed for a healthy marine ecosystem in the Keys?
3. What are two sources of nutrient enrichment in surface waters?
4. What ecosystem changes can result from nutrient enrichment?
5. What is outlined in the Water Quality Protection Program (WQPP) and Monroe County Comprehensive Plan?

Scientists Issue Sanctuary Report Card & Symposium Results

1. Why are the waters of the Florida Keys National Marine Sanctuary considered to be a living laboratory?
2. What research topics are being studied under the Water Quality Protection Program (WQPP) and why are these projects important?
3. Why are the baseline studies in the WQPP important as restoration of the Everglades to the north takes place?
4. Why are zone monitoring projects an important part of the science program in the Sanctuary?
5. What have four years of monitoring the fully protected zones indicated to scientists about the abundance and size of heavily exploited species such as the spiny lobster?
6. What events were associated with declines in coral cover and where does the highest coral cover occur today?
7. How did Geologist Gene Shinn demonstrate the porous nature of Key Largo limestone?

Water Quality, Seagrass, and Coral Projects

1. What is the goal of the Water Quality Monitoring Program?

2. Why is studying the seagrass community of the Sanctuary important?
3. What information is documented at each station studied in the Coral Reef Monitoring Project?

Spiny Lobsters Thrive in the Ecological Reserve

1. Where do adult lobsters reproduce and where do their larvae settle out after floating in the ocean currents for nine months?
2. What have scientists been doing to study lobsters in the 13 fully protected areas Sanctuary Preservation Areas (SPAs) and their corresponding unprotected reference zones?
3. What are scientists finding out about the size and number of spiny lobsters in the larger Western Sambo Ecological Reserve (WSER)? Do you think the Ecological Reserve might be serving as a refuge for spiny lobster? Why or why not?
4. Have similar trends toward increasing lobster size and number been observed in the smaller fully protected zones as compared with their corresponding unprotected areas? Why do you think smaller areas might make a smaller difference in terms of protecting lobsters? (Hint: Think about lobster movement).

Discussion Questions

1. What does pouring water through limestone rock demonstrate about the nature of the limestone rock that makes up the Keys islands?
2. What is needed on the part of the entire Keys community to solve water quality problems in the Florida Keys?
3. Why are the three main projects in the Water Quality Protection Program important to the Sanctuary ecosystem as Everglades restoration takes place?
4. What have four years of monitoring the fully protected zones of the Sanctuary indicated to scientists about the abundance and size of the spiny lobster?
5. How might fully protected zones aid populations of marine organisms that are harvested for commercial or recreational purposes?
6. What factors might influence the effectiveness of a fully protected zone in a marine area?

7. What events were associated with declines in coral cover and where does the highest coral cover occur today?

8. The Zone Monitoring Program (ZMP), nested within the Sanctuary's research program, includes studies that measure the effectiveness of zones as a management tool. Which of the studies discussed in the above articles fall into the ZMP category? Explain how each study meets the overall objective of the ZMP.

9. Describe how the sanctuary's research program addresses the management issues associated with the fully protected areas (SPAs, Ecological Reserves). Support your answer with examples.

Extension Ideas

1. Research the concept of Marine Protected Areas (MPAs)? Where did this concept originate and what countries are using MPAs to manage their marine resources? How do these MPAs differ from the SPAs or ERs in the Sanctuary?

2. Research how the National Park Service protects marine areas? What are the different designations for protected areas under the jurisdiction of the National Park Service?

Cluster 3 Research Projects in the Sanctuary

REEF Research --Grassroots Style

1. Why did marine life photographer Paul Humann envision the need for an organization such as REEF?

2. What becomes of the data collected by REEF fish-counters?

3. What are some of the questions about fish populations that data collected by REEF volunteers can help answer?

Queen Conch Stocking --Timing is Everything

1. What contributed to the decline in the Queen Conch population in the Keys?

2. What actions were taken to protect this species after noting the drastic population drop?

3. When might resource managers use hatchery-raised young to replenish a wild population of organisms?

4. What factors affect the survival rate of conch in the wild?
5. What habitat characteristics have been considered when deciding upon where to release hatchery-raised conch?
6. What did Researcher Bob Glazer hypothesize about the best time to release hatchery-raised conch into the wild?
7. How did Glazer test his hypotheses about the best season and lunar phase for out-planting conchs?
8. What did the results show for the best season? What was Glazer's explanation for this result?
9. What did the results show for the best lunar phase? What was Glazer's explanation for this result?

Florida Bay Bottom-dwellers--Worth a Second Look

1. What are macrobenthic organisms and why are they being studied?
2. What will the baseline data collected about macrobenthic organisms allow scientists to determine in the future?
3. What is done with the sediment collected in the Macrobenthic Community Assessment study?
4. What environmental information is being collected at the same time that a sediment sample is taken?
5. How many different groups of animals were found living in the four areas of Florida Bay being studied in the Macrobenthic Community Assessment study? To what animal group did most of these species belong?
6. Which area being studied had the greatest diversity of species (number of different kinds and abundance)?
7. What is the value in studying mollusks in Florida Bay?

Divers Record Information on Fish Populations

1. What organization involves volunteers in identifying and counting fish for scientific purposes?

2. What are the objectives of the Great American Fish Count?
(Note: Since the time of this publication, the Great American Fish Count has been changed to Great Annual Fish Count to reflect the fact that the program is being established and conducted around the world, not just in the U.S.)
3. What is involved in the "roving diver technique" for counting fish?
4. How is abundance estimated and recorded for each species of fish counted?
5. In terms of number of species, were differences noted in terms of the kinds of fish observed and the abundance of fish between the fully protected Molasses Reef Sanctuary Preservation Area (SPA) and the fished area known as Pickles Reef? Explain.
6. What will REEF's Advanced Assessment Team be monitoring on a regular basis?

Dolphin Ecology Project Describes Unique Behavior

1. What is mission of the Dolphin Ecology Project?
2. What results when the dolphins engage in mud-ring behavior?
3. How are dolphins identified in the field?
4. What does a database of individual dolphins allow scientists to study?
5. What will be studied in the future about dolphins?

Spotlight on Spoonbills in Florida Bay

1. Why were the spoonbills nearly hunted to extinction?
2. Why are brackish shallow waters important for spoonbills?
3. Describe the threats facing spoonbills today.

Bonefish and Tarpon Tagging Research & Bonefish Life Cycle

1. Describe the new tagging technique being used to track bonefish.
2. Why is it important to know more about where tarpon and bonefish spawn and spend their lives?
3. What is one important advantage of acoustic telemetry in tracking bonefish?

4. What is site fidelity and do all bonefish exhibit this behavior?
5. Describe how a PAT (Pop-off Archival Transmitter) operates.
6. What are the advantages of PATs over conventional metal tags?
7. What are some of the challenges associated with the new tag technologies AT and PAT?
8. Where is spawning in bonefish believed to take place?
9. During what phase of development do bonefish drift in the currents?

TNC's Florida Keys Watch Tests Canal Waters

1. What do high levels of enterococcus bacteria in Keys canal waters indicate?
2. What agency has set a recommended guideline for levels of this bacterium and why was this guideline set?
3. How did heavy rains appear to affect the level of enterococcus in canals?
4. The six sites with high bacterial levels are being screened further for viral pathogens. What will scientists learn from the results of this screening?

MEERA Collects Observations of Events at Sea

1. What does MEERA stand for?
2. What kind of events does the program track and record and who is responsible for making the observations?
3. What is the value to scientists of having a reporting system such as this one?

Scientists Discover Red Tide Caused Death of Dolphins and Manatees

1. What is thought to have caused dolphin and manatee deaths even after the bloom has disappeared?
2. Who was involved in conducting the research (agencies/organizations)?
3. What kind of analysis was conducted to determine the cause of death?

4. What is the red tide and how does it affect organisms like manatees?
5. How were the plant-eating (herbivorous) manatees exposed to the toxin found in red tide organisms?
6. When does red tide affect plankton-eating (plantivorous) fish?
7. What organisms eaten by humans can accumulate the red tide toxin?
8. How long ago was red tide recorded in the Gulf of Mexico?

A Few Questions about a Keystone Herbivore

1. What is the name of the keystone herbivore and what kind of organism is it?
2. What happened to this organism to cause its decline?
3. Why does the author believe this organism is important for the ecology of the Keys and Caribbean?
4. What two things are being done to restore urchin populations in the Keys and who is involved in this effort?

Discussion Questions

1. What do resource managers need to know about managing and protecting a species or group of organisms?
2. Explain how the study of an organism or group of organisms contributes to the information that resource managers need to know.
3. Give examples of how technological advancements in research are related to the knowledge gained by scientists studying the ocean and its inhabitants.
4. Why is it important to know the environmental factors as they relate to the kinds and numbers of organisms found in that environment?

Extension Ideas

1. Describe how the Roseate Spoonbill is being used as an indicator species in the restoration of the South Florida Ecosystem.

2. Investigate the current practices concerning Queen Conch population replenishment. Are the scientists studying conch populations using the methods described in the article to replenish wild populations? Why or why not?

Volunteers Gather Baseline Data on Coral Reef Health

1. Why is establishing a baseline inside and outside the Sanctuary's zones necessary?
2. Why is it important that Reefcheck volunteers gather information inside the newly formed Sanctuary Preservation Areas and other zones?
3. What was the highest percentage of algal cover in the Florida Keys? (This is important because when algal cover is high, living coral tends to be low and vice versa.) What kind of organism grows over old dead coral?
4. What was used as a measure of an individual reef's health?
5. What was the percent cover of living coral for the coral reefs in the Keys? How did this number compare with reefs around the world? How did this number compare with other reefs in the Caribbean?
6. What are some of the indicator species (or groups) being studied to better understand how the interrelationships between organisms at the reef are changing?

Cluster 4 Coral Reef Research

Coral Diseases in the Florida Keys

1. What was the first documented reef epizootic event and what caused it?
2. What has been the result of losing the urchins?
3. What is bleaching and what environmental conditions are associated with bleaching?
4. Define the broadest definition of "disease" and explain the difference between abiotic and biotic pathogens (causative agents).
5. Why is it difficult to identify the specific pathogens causing a particular disease?
6. Which area in the Florida Keys showed the highest disease incidence and which showed the lowest?
7. What might account for the lower disease incidence since 1998?
8. What weather phenomenon is associated with warm years and coral bleaching?

The Link Between Coral Bleaching and Global Warming*

*Note: The term climate change is now preferred to the term global warming.

1. Describe the process of bleaching in corals.
2. What result can bleaching have in corals?
3. What environmental conditions preceded the massive coral bleaching event of 1983?
4. What other organisms also suffered massive die-offs prior to the first widespread bleaching event in the Florida Keys?
5. What evidence suggests that coral reefs of the world are responding to global climate change, specifically global warming?
6. What do the meteorological data show about the rate of temperature change over the last century?
7. What might contribute to a rise in temperatures in the 21st century?
8. What can be done to curtail coral bleaching on a global scale?
9. What can be done to curtail coral bleaching on a regional scale?
10. What can be done to curtail coral bleaching on a local scale?

Elkhorn Coral and White Pox: An Answer and More Questions

1. In your own words how do you think a syndrome differs from a disease? (Use the context of the paragraph to answer this question.)
2. What has been noted in terms of the incidence of coral disease in the Florida Keys National Marine Sanctuary in the past five years?
3. What causes “white pox” in elkhorn corals and what kind of pathogen (disease-causing agent) is it?
4. Why is elkhorn coral a candidate for listing under the Endangered Species Act?
5. Why is the explanation that white pox is caused by human sewage an incomplete one?
6. What is not known about pathogen causing white pox?

7. Why is a non-human or “natural” cause of white pox still a reason to be concerned about white pox disease?
8. What other disease has also affected elkhorn coral in the Florida Keys? Has the pathogen of this disease been identified?
9. What other factors contribute to decline of elkhorn corals in the Florida Keys National Marine Sanctuary? In your explanation, identify the factors that are natural and those caused by humans.
10. Why is still important to have wastewater treatment in the Florida Keys even though by itself treatment will not solve the problem of elkhorn coral loss?
11. Describe one of the accomplishments of the Water Quality Protection Program?

Discussion Questions

1. Why are coral reefs important to people economically and ecologically?
2. Why is bleaching an undesirable thing for corals?
3. Why is it an oversimplification to attribute the decline in elkhorn coral with the bacterium *Serratia marcescens*?
4. What information is needed to further our understanding of the factors that affect the health of elkhorn and other corals? What studies would you conduct if you were studying this topic?
5. What is the value in having the levels of bacteria and viruses monitored in Keys canals?

Extension Ideas

1. Research the economic and ecological value of coral reefs to peoples of the world. Justify why scientific research should be focused (and money should be spent) to study and monitor the problem of bleaching and disease in corals.
2. Research the types of sewage treatment that, if used, would eliminate contamination of groundwater in the Keys.
3. Choose a known coral disease and describe how the disease first became known and the kind of research is being conducted to further understand its effects on corals.

Cluster 5 Regional Restoration and Research

Changes in the South Florida Ecosystem

1. Where are the Keys located and what is the length of this chain of islands?
2. How does drinking water enter the Keys?
3. What is the name of the watershed to which the Florida Keys belongs? In your own words, what is a watershed?
4. Briefly describe the 300-mile journey that water makes through the KOE watershed.
5. What was the first major change caused by humans to the South Florida ecosystem?
6. Why was the canal system built?
7. How do canals alter the natural sheet flow of water through the system?
8. What can be affected by changes in the variation of flows to the natural system?
9. What is the role of the South Florida Ecosystem Task Force in ecosystem restoration?
10. What is the Comprehensive Ecosystem Restoration Plan?
11. What is adaptive management and how will it be used in managing the restoration?

Florida Bay and Florida Keys Connections

1. What are the two initiatives designed to address the effects of altered flows on the mainland on the Florida Keys and Florida Bay?
2. Describe the primary goal of the Florida Keys Feasibility Study. What is involved in conducting this study?
3. If the predictions of the effects of altered water flows are undesirable, what will the study attempt to identify?
4. Describe the primary goal of the Florida Keys Tidal Restoration Study. What is planned to reach this goal?

Discussion Questions

1. Discuss the ways in which the restoration of the Everglades might affect the Florida Keys in both positive and negative ways.

2. Discuss the changes that took place because of altered flows on the mainland. How did these changes affect Florida Bay?

Extension Ideas

1. Investigate the status of current restoration projects that might affect the Florida Keys. Has progress been made regarding the restoration of tidal flows in some areas? Why or Why not?

2. Investigate and describe the goals and current status of the C1-11 spreader canal and the Biscayne Bay Coastal Wetlands Project.

Science and Research Supplement

Read any one of the following articles and complete the questions below:

Spiny Lobsters Thrive in the Ecological Reserve (Summer 2002)

Bonefish and Tarpon Tagging Research & Bonefish Life Cycle (Spring/Summer 2003)

Divers Record Information on Fish Populations (Fall 2000)

REEF Research --Grassroots Style (Spring 1998)

Queen Conch Stocking --Timing is Everything (Spring 1998)

Florida Bay Bottom-dwellers--Worth a Second Look (Fall 1998)

Keys Watch Volunteers Test Keys Canal Waters (Spring/Summer 2003)

Elkhorn Coral and White Pox: An Answer and More Questions (Fall 2002)

Volunteers Gather Baseline Data on Coral Reef Health (Fall 1998)

Dolphin Ecology Project Describes Unique Behavior (Spring 2002)

1. What are the objectives of the research project?
2. In what specific ways is the project designed to meet these objectives?
3. What are the results obtained from the project at the time of the article was written?
4. What questions (if any) have surfaced since the project results have been formulated?
5. What are the steps involved in planning and conducting a research project?