The Disappearing

KELP FOREST

T E A C H E R

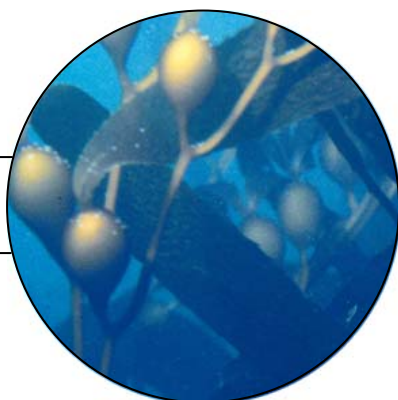**TI-73 Explorer™**

Activity Overview

If you were to dive into the cool coastal waters of the Channel Islands, you might find yourself swimming through a magnificent underwater forest of enormous alga called kelp. Kelp is a type of seaweed that can grow almost two thirds of a meter per day. Kelp forests provide a home for hundreds of species, like sea urchins, brittle stars, and sea slugs.

In this activity, students will examine the relationship between kelp plants and sea urchins, and the effects of severe El Niño events on their populations. They will use data collected by researchers at Johnson's Lee South on the island of Santa Rosa. Table 1 shows kelp density and sea urchin density over a nineteen-year period. Students will examine the data and use the TI-73 Explorer™ to graph and analyze the values.

Conclusions: Generally, an increase in sea urchin density at Johnson's Lee South is associated with a decrease in kelp density. However, other factors in the ecosystem such as disease outbreaks, pollution, and other human activities may alter this relationship.. After severe El Niño events, large numbers of sea urchins appear in the kelp forest, which reduce kelp density.

Table 1

Year	Kelp Density (Number of Adult Kelp Plants per Square Meter)	Sea Urchin Density (Individuals per Square Meter)
1983	0.75	7
1984	0.5	11.23
1985	0.18	21.5
1986	0	36.3
1987	0.1	10.6
1988	0.93	3.5
1989	0.35	11.3
1990	0.43	12.08
1991	0.23	2.23
1992	0.78	2.28
1993	0.68	1.48
1994	0.4	0.8
1995	1	2.05
1996	0.83	2.17
1997	0.29	1.25
1998	0.46	7.17
1999	0.42	10.67
2000	0.29	16
2001	0	20.25

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Concept Background

- Giant kelp is a type of seaweed that can reach lengths of over 30 meters (100 feet). Giant kelp can extend from the sea floor to the ocean surface creating a type of underwater forest ecosystem. This forest ecosystem is home for hundreds of species, like sea urchins, brittle stars, and sea slugs. Sea lions and seals feed on the fish and other organisms that gather in kelp forests.

- Sea urchins are herbivores (plant-eating animals) that rely on kelp as a source of food. If they become too numerous, they can eventually destroy an entire kelp forest leaving what is called a *sea urchin barren*. Under normal conditions, the sea urchin population is kept in check by predators, like California sheephead, spiny lobster, and sun stars.

- El Niño is a weather condition that affects the entire Pacific Ocean every 3 to 8 years and lasts for about a year once it starts. In an El Niño year, water temperatures are warmer than normal around the Channel Islands. This means there is a thicker layer of warm, nutrient-poor water over the cold, nutrient-rich water and it does not get pushed away by the wind as easily as in normal years. The warm, nutrient-poor water slows new giant kelp growth.

- Over the years, researchers have noticed that some kelp forests that were once thick and full of life have disappeared. Researchers don't know for sure why the kelp population is diminishing.

Preparation and Classroom Management Tips

- You may consider having a discussion about El Niño with your students before you begin the activity.

- Scientists believe that El Niño, water pollution, and hungry sea urchins are factors that contribute to the decline in kelp forests. After students have answered the data analysis questions, discuss the possible causes for the decline in kelp population.

- Although an increase in sea urchin density usually results in a decrease in kelp population, other factors such as nutrient level and water temperature may shift this relationship. For example, between 1990 and 1991 both populations decreased.

- Researchers measure kelp and sea urchin densities using a square measuring device called a quadrat. The device is 1 meter (3.2 feet) on each side. The data in Table 1 is presented as the number of kelp or sea urchin per square meter.

- You have the option of inputting data manually into the TI-73 Explorer™ or importing the data using the TIDataEditor. The instructions for inputting the data manually are in the procedure section of the activity. If you wish to import the data using the TIDataEditor, use the following steps:

  1. **Download and install TI Connect™ to your computer.**
     a. Go to
        http://education.ti.com/us/product/accessory/connectivity/down/download.html.
     b. Follow directions to download the software installer to your computer.
   c. Double-click the installer and follow the directions to set up TI Connect™.

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2. **Transfer the kelp and sea urchin data (kelp_sea_urchin.73g) from the computer to your TI-73 Explorer™.**
   a. Connect the computer and the TI-73 Explorer™ with the TI Graph Link cable.
   b. Drag the kelp and sea urchin data file (kelp_sea_urchin.73g) and drop it on the TI Connect icon which is installed on your desktop.

3. **Transfer the kelp and sea urchin data to your TI-73 Explorer™.**
   a. Turn on the TI-73 Explorer™ without the kelp and sea urchin data.
   b. Use the link cable to connect the TI-73 Explorer™ without the kelp and sea urchin data to the TI-73 Explorer™ with the kelp and sea urchin data.
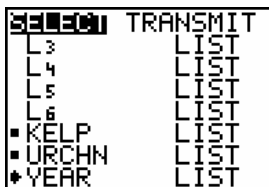   c. Make sure both graphing devices are turned on.

TI-73 Explorer™ without kelp and sea urchin data

a. Press APPS to display the **APPLICATIONS** menu.
b. Select **1:Link** and press ▶ to display the **LINK RECEIVE** menu.
c. Select **1:Receive**. The message "Waiting…" and the busy indicator are displayed. The receiving unit is ready to receive the kelp and sea urchin data.

```
SEND  RECEIVE
1█Receive
```
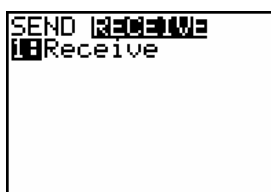
TI-73 Explorer™ with kelp and sea urchin data

a. Press APPS to display the **APPLICATIONS** menu.
b. Select **1:Link** to display the **Link SEND** menu.
c. Select **4:List** to display all the data items (see Key below). Press ▲ and ▼ to move the selection cursor (▣) to each data item for sea urchin and kelp data (**YEAR, KELP, and URCHN**) and press ENTER to select each item. Once selected the items will be marked with a black box (■).
d. Press ▶ to display the **TRANSMIT** menu.
e. Select **1:Transmit**. The name of each data item is displayed line by line on the sending unit as the item is sent, and on the receiving unit as each item is received.

```
SELECT  TRANSMIT
  L3        LIST
  L4        LIST
  L5        LIST
  L6        LIST
■ KELP      LIST
■ URCHN     LIST
♦ YEAR      LIST
```

Note: If you use the TIDataEditor to import data automatically, omit Step 1 and Step 2 in the procedure section of Part A — Kelp Density. Step 1 in the procedure section of Part B — Sea Urchin Density must also be omitted.

- Students can work in pairs to compare the graphs of the two densities using two handhelds. Display the graph of the Kelp Densities on one handheld and the Sea Urchin Densities on the other.

- This activity works well with students working in groups, or as a demonstration.

- Encourage students to answer the questions in Data Analysis in their journals.

- Create your own student questions for use on your students' TI graphing devices using the Texas Instruments StudyCard applications.
  .

Vocabulary

Alternation of generations The most common life cycle among marine plants, consisting of an alternation between a gametophyte generation and a sporophyte generation.

Blade The leaf-like part of kelp where most of the plant's photosynthesis takes place.

Density The number of individual plants or animals per unit area.

Gametophyte A microscopic kelp plant that forms when spores are released by specialized reproductive kelp blades.

Holdfast The root-like structure of kelp that anchors the kelp to rocks on the ocean floor.

Kelp A photosynthetic type of alga consisting of a holdfast, stipe, and blade(s).

Pneumatocysts Also known as gas bladders or floats, these gas-filled structures, located at the base of each blade, help push the blades of the giant kelp toward the sunlight at the surface of the water.

Quadrat A square frame used by divers to mark off distinct areas in which to monitor the number of selected species.

Species A group consisting of animals (or plants) that share many physical characteristics and can interbreed.

Sporophyte A kelp plant (often quite large) that forms when a gametophyte's egg is fertilized.

Stipe The section of kelp that connects the holdfast and the blades. A stipe looks like a land plant's stem.

Transect A line, marked at regular intervals, along which scientists align their quadrats to monitor species.
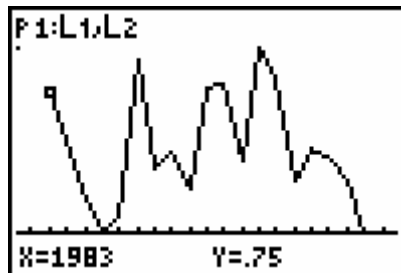
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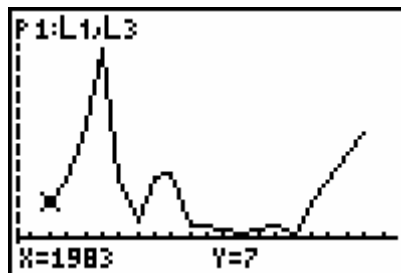
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Part A — Kelp Density

Data Analysis

1 Q. Which year(s) had the highest kelp density?

A. *The year with the highest kelp density was 1995.*

2 Q. Which year(s) had the lowest kelp density?

A. *The years with the lowest kelp density were 1986 and 2001.*

3 Q. Between which two consecutive years was the greatest increase in kelp density?

A. *The greatest increase in kelp density was between 1987 and 1988.*

4 Q. Between which two consecutive years was the greatest decrease in kelp density?

A. *The greatest decrease in kelp density was between 1988 and 1989.*

Part B — Sea Urchin Density

Data Analysis

1 Q. Which year had the highest sea urchin density?

A. *The year with the highest sea urchin density was 1986.*

2 Q. Which year had the lowest sea urchin density?

A. *The year with the lowest sea urchin density was 1994.*

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3 Q. Between which two consecutive years was the greatest increase in sea urchin density?

A. *The greatest increase in sea urchin density was between 1985 and 1986.*

4 Q. Between which two consecutive years was the greatest decrease in sea urchin density?

A. *The greatest decrease in sea urchin density was between 1986 and 1987.*

5 Q. Compare the densities of the two organisms. During the time period in which the kelp density had its greatest increase, did the sea urchin density increase or decrease?

A. *The sea urchin density decreased.*

6 Q. Compare the densities of the two organisms. During the time period in which the kelp density had its greatest decrease, did the sea urchin density increase or decrease?

A. *The sea urchin density increased.*

7 Q. Compare the changes in densities of kelp and sea urchin during other time periods on the graphs.

A. *From 1983 to 1988 and from 1997 to 2001, as sea urchin density increased kelp density decreased. During the same period, as sea urchin density decreased kelp density increased. However, the graphs show that this pattern was not true from 1989 to 1996.*

8 Q. Using the information provided in the research article and your answers to questions 5, 6, and 7, describe the relationship between kelp and sea urchin.

A. *According to the research article, an increase in sea urchin density may cause a decrease in kelp density. Factors in the ecosystem such as disease outbreaks, pollution, and other human activities may alter this relationship. During most time periods, the graphs show kelp density decreasing with increasing sea urchin density. However, this relationship was not true from 1989 to 1996, probably a result of disease outbreaks, pollution, and other human activities.*

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Part C — El Niño Events and Kelp Density

1   Q. During the period covered by the data provided, scientists recorded two severe El Niño events; 1982–1983 and 1997–1998. In the three-year periods following the El Niño events, does the data support scientists findings about kelp densities and El Niño events described above? Explain.

      A. *The data supports what scientists have found. Kelp densities decreased during the three-year period following the strong El Niño events primarily due to an increase in sea urchin density. The lowest kelp densities during the nineteen-year period occurred three years after the end of the strong El Niño events.*