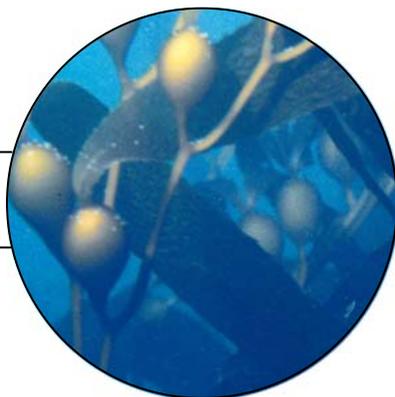


The Disappearing

KELP FOREST

ACTIVITY



Focus Question

What factors affect changes in kelp and sea urchin density?

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, you will examine the relationship between kelp plants and sea urchins, and the effects of severe El Niño events on their populations. You 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. You will examine the data and use the TI-73 Explorer™ to graph and analyze the values.

What is the relationship between kelp and sea urchins? What are the effects of severe El Niño events on kelp and sea urchin populations?

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



The Disappearing KELP FOREST

Part A — Kelp Density

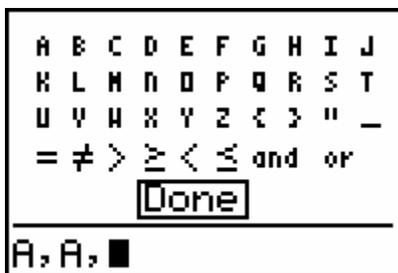
Procedure

1 Reset the TI-73 Explorer™ to the default settings.

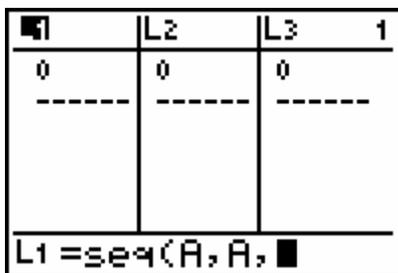
- Turn on the TI-73 Explorer™.
- Press $\boxed{2\text{nd}}$ $\boxed{[\text{MEM}]}$ $\boxed{7}$ $\boxed{2}$ $\boxed{2}$.
- Press $\boxed{2\text{nd}}$ $\boxed{[\text{MEM}]}$ $\boxed{6}$ $\boxed{[\text{ENTER}]}$.

2 Enter your data in the TI-73 Explorer™.

- Press $\boxed{[\text{LIST}]}$.
- You can enter the years from Table 1 in the TI-73 Explorer™ manually or automatically. If you want to enter the years manually, enter each number in L1. After entering each number, press $\boxed{[\text{ENTER}]}$. If you want to enter the numbers automatically, follow the steps below and then proceed with Step 2.c.
 - Use the arrow keys to move the cursor to the top of L1, highlighting L1.
 - Press $\boxed{2\text{nd}}$ $\boxed{[\text{STAT}]}$ $\boxed{\blacktriangleright}$ $\boxed{7}$ to select seq(. This function allows you to create a sequence of numbers.
 - Press $\boxed{2\text{nd}}$ $\boxed{[\text{TEXT}]}$
 - Select A by using the arrow keys and press $\boxed{[\text{ENTER}]}$.
 - Press $\boxed{.}$.
 - Select A by using the arrow keys and press $\boxed{[\text{ENTER}]}$.
 - Press $\boxed{.}$.



- Select DONE by using the arrow keys and press $\boxed{[\text{ENTER}]}$.



ACTIVITY

Materials*

TI-73 Explorer™



TI-73 Explorer™

* This activity has been written for the TI-73 Explorer™ but you can easily substitute the TI-83 or TI-83 Plus.

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- 3) Type 1983 \square , 2001 \square , 1. This will create a sequence of numbers that will represent the years starting at 1983 and ending at 2001, with an increment of one year.

L1	L2	L3	1
-----	-----	-----	
L1 =...1983, 2001, 1			

- 4) Press **ENTER**.

L1	L2	L3	1
1983	-----	-----	
1984			
1985			
1986			
1987			
1988			
1989			
L1(1)=1983			

- c. Enter the kelp density from Table 1 in L2. After entering each number, press **ENTER**.

L1	L2	L3	2
1983	.75	-----	
1984	.5		
1985	.18		
1986	0		
1987	.1		
1988	.93		
1989	.35		
L2(1) = .75			

3 Make a graph of kelp density and years.

- a. Press **2nd** **[PLOT]**
- b. Press **1** to define Plot1

STAT PLOTS			
1	Plot1...Off		
	↖ L1 L2	□	
2	Plot2...Off		
	↖ L1 L3	□	
3	Plot3...Off		
	↖ L1 L4	+	
4	PlotsOff		



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- Turn Plot1 On by pressing **ENTER**.
- Press **▾ ▸** **ENTER** to select line graph (↗).
- Set the Xlist. Press **▾** **2nd** **[STAT]** **1** to select L1 (year) for the X-axis.
Note: If you imported data using the TIDataEditor press **▾** **2nd** **[STAT]** and scroll down to YEAR using **▾** and then press **ENTER**.
- Set the Ylist. Press **▾** **2nd** **[STAT]** **2** to select L2 (kelp density) for the Y-axis. Note: If you imported data using the TIDataEditor press **▾** **2nd** **[STAT]** and scroll down to KELP using **▾** and then press **ENTER**.
- Press **▾ ▸ ▸** **ENTER**.

Manually Entered Data



Imported Data with TIDataEditor



- Press **GRAPH**.
 - Press **ZOOM** **7** to adjust the scale on your graph.
- 4** Complete the Data Analysis section. Answer the questions in your journal.

Data Analysis

While observing the graph, press **TRACE** and use the arrow keys (**▸** and **◀**) to move the cursor along a line. The X-coordinate and Y-coordinate of each data point are displayed below the graph.

Make a sketch of your graph in your journal and label it *Kelp Density*. Answer questions 1–4 in your journal by observing your graph.

- Which year(s) had the highest kelp density?
- Which year(s) had the lowest kelp density?
- Between which two consecutive years was the greatest increase in kelp density?
- Between which two consecutive years was the greatest decrease in kelp density?



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Part B — Sea Urchin Density

Procedure

- 1 Enter your sea urchin data in the TI-73 Explorer™.
 - a. Press **[LIST]**.
 - b. Enter the sea urchin density from Table 1 in L3. After entering each number, press **[ENTER]**.

L1	L2	L3	3
1983	.75		
1984	.5	11.23	
1985	.18	21.5	
1986	0	36.3	
1987	.1	10.6	
1988	.93	3.5	
1989	.35	11.3	
L3(1) = 7			

- 2 Make a graph of sea urchin density and years.

- a. Press **[2nd]** **[PLOT]**
- b. Press **[1]** to define Plot1

5	Plot1...Off	
↖	L1	L2
□		
2	Plot2...Off	
↖	L1	L3
□		
3	Plot3...Off	
↖	L1	L4
+		
4	PlotsOff	

- c. Turn Plot1 On by pressing **[ENTER]**
- d. Press **[↖]** **[↗]** **[ENTER]** to select line graph (↖↗).
- e. Set the Xlist. Press **[↖]** **[2nd]** **[STAT]** **[1]** to select L1 (year) for the X-axis. Note: If you imported data using the TIDataEditor press **[↖]** **[2nd]** **[STAT]** and scroll down to YEAR using **[↖]** and then press **[ENTER]**.
- f. Set the Ylist. Press **[↖]** **[2nd]** **[STAT]** **[3]** to select L3 (sea urchin density) for the Y-axis. Note: If you imported data using the TIDataEditor Press **[↖]** **[2nd]** **[STAT]** and scroll down to URCHN using **[↖]** and then press **[ENTER]**.
- g. Press **[↖]** **[↗]** **[↗]** **[ENTER]**.



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Part C — El Niño Events and Kelp Density

Read the information below and answer the question in your journal.

The density of kelp plants is an indication of the health status of the forest. Higher densities imply that more plants are present and the forest is doing well, while low densities show that the kelp forest is struggling. After a decline in kelp density, the forest can return if spores become established on the ocean floor and there are sufficient nutrients and sunlight to support their growth. However, it may take years for a forest to fully recover after a major decline.

El Niño events (which bring warmer-than-normal water to the Channel Islands) and increases in storm frequency can both affect the kelp forests. After El Niño events, large numbers of tiny sea urchins appear in the kelp forest, and in the following years, sea urchin densities rise significantly. Scientists believe that the increase in the sea urchin population is the result of a decline in sea stars (a predator of sea urchins) due to a disease brought by warm El Niño waters. High sea urchin densities contribute to kelp loss because urchins feed on kelp. In addition to destroying existing kelp plants, high sea urchin densities (more than 15 sea urchins per square meter) also prevent young sporophytes from anchoring their holdfasts to the bottom, and new kelp plants cannot grow to replace the ones destroyed by sea urchins.

- 1 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.

ACTIVITY

