

## A POPULATION IN TROUBLE

TEACHER



### Activity Overview

In the delicate ecosystem of the Channel Islands, a series of small changes can have devastating results. The Channel Islands once had a large population of island fox, one of the smallest fox species in the world. However, the population of island fox began to fall in the mid-1990s. A series of changes to the ecology, including the introduction of golden eagles, may have been the cause of this devastating decrease in the island fox population.

Scientists monitor changes in population size that occur over time and look for relationships between species. In this activity, students will examine the relationship between island fox and golden eagle populations on Santa Cruz Island. Table 1 shows the number of island fox and golden eagles over a twelve-year period. Students will examine the data and use the TI-73 Explorer™ to graph and analyze the values.

Conclusions: Island fox are prey for the golden eagle. The increase in the golden eagle population is causing the decrease of the island fox on the Channel Islands. The data shows that the population size of each species reached equilibrium at the end of the period studied.

**Table 1 — Population of Island Fox and Golden Eagles on Santa Cruz Island**

Year	Number of Island Fox	Number of Golden Eagles
1990	1225	2
1991	1150	3
1992	900	5
1993	720	8
1994	520	12
1995	400	17
1996	280	20
1997	240	23
1998	200	24
1999	180	25
2000	160	25
2001	150	25
2002	150	25

Data Adapted

### Activity at a Glance

Grade: 6–9  
Subject: Science  
Category: Life Science, Earth Science  
Topic: Ecology, Animals, Living Things

### Time Required

- Two 45-minute periods

### Level of Complexity

- Medium

### Materials\*

- TI-73 Explorer™



TI-73 Explorer™



# Island Fox

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### Concept Background

- Bald eagles were once the top predators of the Channel Islands. Bald eagles do not harm fox populations, because they eat mostly fish and carrion (dead animals). Bald eagles have disappeared from the Channel Islands because of DDT in the environment.
- Golden eagles moved into the niche vacated by bald eagles. Unlike bald eagles, golden eagles catch live birds and mammals. Because they are diurnal, island fox are easy prey for golden eagles.
- Invasive plant species, such as fennel and alien annual grasses, have replaced the native chaparral and woody plants. As a result of this replacement, there is less plant cover in which island fox can hide.
- The increase in the population of feral pigs on the Channel Islands has attracted even more golden eagles. Park managers are working to remove feral pigs to make the area less attractive to golden eagles.
- The island fox is an example of dwarfism. In order to adapt to the island environment, the island fox gradually evolved into the small size found today. The small size of the island fox, about the size of a small house cat, makes it an attractive prey for golden eagles.

### Preparation and Classroom Management Tips

- You may consider having a discussion about population growth curves with your students before you begin the activity.
- You have the option of inputting data manually into the TI-73 Explorer™ or importing the data using the TI Data Editor. The instructions for inputting the data manually are in the procedure of the activity. If you wish to import the data using the TI Data Editor, use the following steps:
  - 1. Download and install TI Connect™ to your computer**
    - a. Go to <http://education.ti.com/us/product/accessory/connectivity/download/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™.
  - 2. Transfer the island fox and golden eagle data (fox\_eagle.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 island fox and golden eagle data file (fox\_eagle.73g) and drop it on the TI Connect icon which is installed on your desktop.
  - 3. Transfer the island fox and golden eagle data to your TI-73 Explorer™.**
    - a. Turn on the TI-73 Explorer™ without the island fox and golden eagle data.
    - b. Use the link cable to connect the TI-73 Explorer™ without the island fox and golden eagle data to the TI-73 Explorer™ with the island fox and golden eagle data.
    - c. Make sure both graphing devices are turned on.

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### National Education Standards

*Science Standard C: Life Science*  
Students should develop an understanding about the structure and function of living systems, reproduction and heredity, regulation and behavior, populations and ecosystems, and the diversity and adaptations of organisms.

*Science Standard F: Science in Personal and Social Perspectives*  
Students should develop an understanding of populations, resources, environments, natural hazards, risks and benefits, and science and technology in society.

*Math Standard: Data Analysis and Probability*

Students should develop an understanding about how to collect, organize, display, and interpret data.

*Math Standard: Problem Solving*  
Students should develop an understanding of mathematical concepts by working through problems that allow applications of mathematics to other concepts.

*Geography Standard 14: Environment and Society*

Students should understand how human actions modify the physical environment.

*Geography Standards 17 and 18: The Uses of Geography*

Students should understand how to apply geography to interpret the past and present and to plan for the future.



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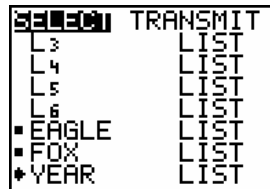
### TI-73 Explorer™ without island fox and golden eagle data

- d. Press [APPS] to display the **APPLICATIONS** menu.
- e. Select **1:Link** and press [▶] to display the **Link RECEIVE** menu.
- f. Select **1:Receive**. The message **Waiting...** and the busy indicator are displayed. The receiving unit is ready to receive the island fox and golden eagle data.



### TI-73 Explorer™ with island fox and golden eagle data

- g. Press [APPS] to display the **APPLICATIONS** menu.
- h. Select **1:Link** to display the Link SEND menu.
- i. Select **4:List** to display all the data items (see Key below). Press the [▲] and [▼] to move the selection cursor (E) to each data item for island fox and golden eagle data (**YEAR**, **FOX**, and **EAGLE**) and press [ENTER] to select each item. Once selected the items will be marked with a black box (■).
- j. Press [▶] to display the **TRANSMIT** menu.
- k. 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.



**Note: If you use the TIDataEditor to import data automatically, omit Step 1 and Step 2 in the procedure of Part A – Island Fox Population. Step 1 in the procedure of Part B – Golden Eagle Population must also be omitted.**

- Students can work in pairs to compare the population growth curves of the two species using two handhelds. Display the graph of the island fox on one handheld and the golden eagle 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.

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### Vocabulary

**Alien (Invasive Species)** A species that enters an area and occupies an ecological niche, succeeding within it so well that it replaces other species in the niche.

**Biodiversity** The variety of plant and animal species in a given area.

**Captive Breeding** Capturing and mating animals to produce offspring that can eventually be released into the wild. Captive breeding's goal is to restore a depleted population.

**Diurnal** Active during the day rather than the night.

**Dwarfism** An evolutionary adaptation in which a species develops a smaller-than-usual size in order to fill a niche or adapt to a specific, isolated environment.

**Feral** Having returned to the wild after being domesticated.

**Gigantism** An evolutionary adaptation in which a species develops a larger-than-usual size in order to fill a niche or adapt to a specific, isolated environment.

**Marine reserve** A "no take" zone in which fishing or harvesting of any marine resources is prohibited.

**Marine sanctuary** An area in which fishing and harvesting of resources are regulated but not prohibited, and certain activities are restricted.

**Stakeholders** People, or groups, who have a particular interest, or "stake," in a process or outcome.

**Sustainable** Able to be maintained over a long period of time

**Terrestrial** Living or growing on land.

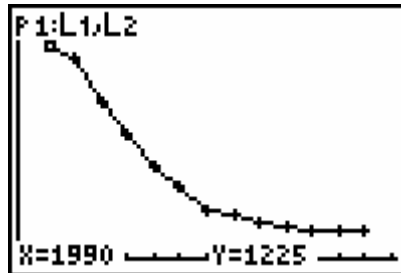
**Viable population** A number of individuals that allows for successful mating and reproduction, so that a particular plant or animal species can continue to survive.



## A POPULATION IN TROUBLE

### Part A — Island Fox Population

#### Data Analysis



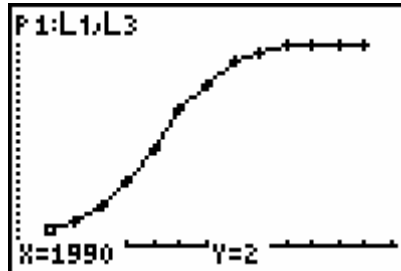
- 1** Q. Describe how the island fox population changed between 1990 and 2002?  
A. *The island fox population decreased between 1990 and 1999. It reached equilibrium after 1999.*
- 2** Q. Between which years did the initial slow-change phase, the middle rapid-change phase, and the final equilibrium phase occur?  
A. *From 1990 to 1991, the island fox population was going through the initial slow-change phase. From 1991 to 1999, the population was going through the middle rapid-change phase. From 2000 to 2002, the population was going through the final equilibrium phase.*
- 3** Q. What is the population size of the island fox at equilibrium?  
A. *The population size of island fox at equilibrium was 150.*
- 4** Q. By observing the trend in the data, what do you think the island fox population was in 2003? Explain.  
A. *By observing the trend in the data the population of island fox in 2003 was about 150. It is likely that the island fox population was in equilibrium in 2003.*
- 5** Q. On an island such as Santa Cruz, island fox are unable to migrate. Therefore, changes in population size are determined by the balance between the number of births and deaths. How do the numbers of births and deaths compare between 2001 and 2002? Explain.  
A. *The number of births and deaths between 2001 and 2002 were equal because during that period the island fox population was in equilibrium.*



## A POPULATION IN TROUBLE

### Part B — Golden Eagle Population

#### Data Analysis



- 1 Q. Describe how the golden eagle population changed between 1990 and 2002?
  - A. *The population increased between 1990 and 1998. It reached equilibrium after 1998.*
  
- 2 Q. Between which years did the initial slow-change phase, the middle rapid-change phase, and the final equilibrium phase occur?
  - A. *The golden eagle population was going through the initial slow-change phase from 1990 to 1992. The middle rapid-change phase occurred from 1992 to 1998. The final equilibrium phase occurred from 1999 to 2002.*
  
- 3 Q. Using the information provided in the research article and your graphs, describe the factors that may have caused an increase in the golden eagle population.
  - A. *Two main factors caused an increase in the golden eagle population. Golden eagles were able to move into a niche vacated by bald eagles. Bald eagles were eliminated from the Channel Islands due to DDT in the environment. Once on the Channel Islands, the golden eagles found large populations of island fox that were easy prey. As the graphs show, the large initial population of island fox supported golden eagle population growth.*
  
- 4 Q. What is the population of the golden eagle at equilibrium?
  - A. *The population size of golden eagle at equilibrium was 25.*
  
- 5 Q. By observing the trend in the data, what do you think the golden eagle population was in 2003? Explain.
  - A. *By observing the trend in the data, the population of golden eagle in 2003 was about 25. It is likely that the golden eagle population was in equilibrium in 2003.*
  
- 6 Q. Compare the population size of island fox and golden eagles. During the time period the population size of island fox decreased did the golden eagle population size increase or decrease?
  - A. *As the population size of island fox decreased the golden eagle population size increased.*



## Island Fox

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TEACHER

- 7** Q. Compare the population size of island fox and golden eagles. During the golden eagle equilibrium phase how did the island fox population size change?
- A. *The population of island fox reached equilibrium a short period after the golden eagle population was in equilibrium. At the beginning of the golden eagle equilibrium phase the population of island fox decreased slightly. When the island fox reached equilibrium in 2000 its population did not change significantly.*
- 8** Q. Using the information provided in the research article and your graphs, describe the relationship between golden eagles and island fox.
- A. *Golden eagles are predators that prey on island fox. As golden eagle prey on island fox, the number of island fox decreases. The number of golden eagle increases at the same time. By the end of the twelve-year period the two populations were in equilibrium.*
- 9** Q. How would the absence of golden eagles affect island fox populations?
- A. *If there were no golden eagles, the population of island fox would rise.*
- 10** Q. If island fox were the only prey for golden eagles, what do you think would happen to the population of golden eagles on Santa Cruz Island if the population of island fox became extinct after 2002?
- A. *If the population of island fox became extinct after 2002, the population of golden eagles would most likely become extinct on the island.*

