**Biogeography or What Happens to Fish Populations During El Niño**

**Overview**

Students look at images of fish caught by an otter trawl net off southern California. Using fish charts provided in this activity, they identify the fish and record their geographic range. The fish were collected in May 1997, shortly after the beginning of a major El Niño event. Students see what effects the El Niño had on fish population during its early stages.

**Concepts**

- In a given area fish populations can change as water conditions (e.g., temperature) change off-shore due to El Niño effects.
- Effects of an El Niño occur over time, so the U.S. west coast may not show significant effects for several months after an El Niño begins developing in equatorial waters.

**Materials**

- Movie of fish catch included with this activity (activity can be done without the movie)
- Fish Keys (included)
- “Catch of the Day” sheet (included)
- Paper and pencil to record results
- Atlas or map with geographical information about the U.S. west coast (if needed)

**Preparation**

Divide students into small groups.
Make copies of Fish Key and Catch of the Day sheets, one for each group.

**Procedure**

**Engagement**

An El Niño event is thought to be triggered when steady westward blowing trade winds weaken and even reverse direction. This change in the winds allows the large mass of warm water that is normally located near Australia to move eastward along the equator until it reaches the coast of South America. It then spreads out along the western coasts of the Americas, affecting water temperatures and weather patterns.

When El Niño effects reach the coastline of southern California, the surface water warms up, prompting changes in the types of the fish that live there. Many Zone (3) fish migrate to Zone (2), and Zone (2) fish move to Zone (1) [Zone map, Fig. 1]. By looking at fish populations, scientists can study El Niño’s effects over time.

The fish shown in this activity were caught in May 1997 [Fig. 2]. Satellite and surface water measurements indicated an El Niño had begun to affect the eastern Pacific Ocean at that time. Were its effects visible in the fish population off southern California?

In May 1997 an otter trawl was used by personnel on the research vessel Sea Explorer to collect fish...
Figure 1: Zone Map

Fish Biogeography

Map of Area Covered

Approximate Scale: 1/4 in. (6.35 mm) = 120 mi. (193 mm)
off Dana Point in southern California. An otter trawl net is used to collect fish by deploying it off a boat and trailing it in the water (it is not used to collect otters, but was named because of a Scandanavian word for “outer,” referring to the outer doors on the leading edge of the net).

Activity
1. Review *Sea Explorer* fish catch movie [Movie] and “Today’s Catch” sheet in this activity [Fig. 2].
2. Identify each fish in Figure 2. Then find out each of these fish’s geographic range using the Fish Key [Fig. 3]. (You may need a map or atlas of the U.S. west coast to match the geographic ranges listed in the Fish Key with the “Zone Map” in Fig. 1)
3. Assign each fish to its proper zone using the “Zone Map” [Fig. 1].
4. Had the fish population shifted from its normal position? Why or why not?

Explanation
Catch of the day fish in Figure 2 are (from top to bottom): Longfin Sandab, Tongue Fish, Bigmouth Sole, Horny Head Turbot, and Pink Perch. These are part of a typical Zone (2) fish population that we find in waters off of southern California during non-El Niño conditions. At the time these fish were caught (May 1997) surface water temperatures and sea levels in the equatorial Pacific showed that an El Niño had begun. However, at this early stage, fish populations in southern California waters had not yet shifted from normal.

Typically, as an El Niño progresses, scientists observe significant changes in fish population in several regions, including southern California. As water warms off the southern California coast, the migration of new species occurs stepwise. As the water temperature rises to 20°C, the first to arrive are the big game fish like Swordfish, Skipjack, Bigeye, Marlin, and Yellowfin Tuna. They venture north because they prefer warm water over the cold water that is normally found off of southern California.

Next, the number of *macroscopic* animal plankton (*zooplankton*) begins to decrease or disappear. This compromises the *food chain* and eventually affects many species. This can occur when warmer-than-normal waters “cap off” the normal *upwelling* of nutrients from deeper waters. (Under non-El Niño conditions, cold nutrient-rich waters normally upwell and stimulate the growth of *phytoplankton*, the bottom of the food chain.) Moreover, El Niño’s warm waters can directly affect the zooplankton population in the waters off of southern California. As masses of warm water shift from the south, upwelling of these relatively nutrient-poor warm waters may occur. The “shifted” water masses may have fewer zooplankton, which are another important part of the food chain.
Next, fish sensitive to water temperature begin to migrate out of southern California waters. We see a decrease in California Halibut and English Sole. But, it is the Longfin Sandab, Slender Sole, and Hornyhead Turbot that decrease the most dramatically. Their decrease could be because a “compromised” food chain affects their food source; it may also be caused by thermal stress. Those most affected by thermal stress are the Rockfish. Interestingly, sardines and anchovies increase in numbers because they seem to do better in such conditions.

As the El Niño condition persists, fish normally found far to the south appear in the southern California waters. The first to arrive are the Lumptail Searobin and Smooth Stargazer.

EXTENSION

Using what they have learned about El Niño-related migration and the Fish Key [Fig. 3], have students assemble a collection of fish types that would be expected during fully developed El Niño conditions off of southern California’s coast.

Consider the drastic changes in southern California fish types that El Niño conditions can bring; do the students expect that other forms of marine life--such as marine mammals and sea birds--are also affected? How? Find out by researching the impacts that the 1997-1998 El Niño had on these types of animals. (Some of this information is available from newspaper and magazine reports from 1997-1998, and the Internet.)

LINKS TO RELATED CD ACTIVITIES, IMAGES, AND MOVIES

Activity Ocean Variations During an El Niño

VOCABULARY

biogeography
macroscopic
zooplankton

El Niño
phytoplankton
upwelling

food chain

SOURCE

Today's Catch
### Fish Key

<table>
<thead>
<tr>
<th>Range</th>
<th>Fish Type</th>
<th>Range</th>
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<tbody>
<tr>
<td>Yaquina Bay, Or-Panama</td>
<td>California Tonguefish</td>
<td>Bering Sea-S. Baja, CA</td>
</tr>
<tr>
<td>S. Alaska-S. Baja, CA</td>
<td>Pacific Sanddab</td>
<td>Monterey, CA-Costa Rica</td>
</tr>
<tr>
<td>Monterey Bay-Gulf of CA</td>
<td>Longfin Sanddab</td>
<td>Monterey Bay-Gulf of CA</td>
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<tr>
<td></td>
<td>California Tonguefish</td>
<td>N. Washington-S. Baja</td>
</tr>
<tr>
<td></td>
<td>Bigmouth Sole</td>
<td></td>
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<td></td>
<td>Starry Flounder</td>
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<tr>
<td></td>
<td>California Halibut</td>
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</tbody>
</table>
Figure 3: Fish Key

R a n g e          F i s h T y p e          R a n g e

S. Alaska-S. Baja
Slender Sole
Bering Sea-N. Baja
Rex Sole

Bering Sea-British Columbia
Yellowfin Sole
Bering Sea-C. Baja

Bering Sea-N. Baja
Dover Sole

Bering Sea-N. Baja
Petrale Sole
Bering Sea-Pt. Reyes

Bering Sea-N. Baja
Flathead Sole

Bering Sea-Santa Rosa Is.
Greenland Halibut
Japan-Bering Sea-Oregon

Arrowtooth Flounder

Pacific Halibut
## Fish Key

### Range

<table>
<thead>
<tr>
<th>Range</th>
<th>Fish Type</th>
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<tbody>
<tr>
<td>N. California-S. Baja</td>
<td>Diamond Turbot</td>
<td>S. Alaska-N. Baja</td>
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<td>Pt. Reyes, CA-S. Baja</td>
<td>Hornyhead Turbot</td>
<td>Morro Bay, CA-S. Baja</td>
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<td>Bering Sea-C. Baja</td>
<td>English Sole</td>
<td>Prince Williams Sound, Alaska-C. Baja</td>
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<td>Bering Sea-S. California</td>
<td>Rock Sole</td>
<td>Bering Sea-San Francisco</td>
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<tr>
<td>Bering Sea-Ventura, CA</td>
<td>Hybrid Sole</td>
<td>Bering Sea-Redondo Bch., CA</td>
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<tr>
<td></td>
<td>Butter Sole</td>
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<td>Hybrid Sole</td>
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<td></td>
<td>Sand Sole</td>
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<tr>
<td>San Clemente &amp; Catalina Islands-Peru</td>
<td>Rainbow Scorpionfish</td>
<td>Pt. Conception-Gulf of California</td>
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<tr>
<td>San Francisco-C. Baja</td>
<td>Treefish</td>
<td>Bering Sea-N. Baja</td>
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<tr>
<td>S. Alaska-C. California</td>
<td>Shortspine Thornyhead</td>
<td>San Francisco-N. Baja</td>
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<td>S. Alaska-San Miguel, Is.</td>
<td>Tiger</td>
<td>S. Alaska-San Diego, CA</td>
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<td>Black</td>
<td>S. Alaska-San Miguel, Is.</td>
</tr>
<tr>
<td>Alaska-C. California</td>
<td>Blue</td>
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<td></td>
<td>Quillback</td>
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<td></td>
<td>China</td>
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</tbody>
</table>
Figure 3: Fish Key

Range  Fish Type  Range

S. California-Peru  Pacific Flagfin Mojarra  N. Baja-Sea of Cortez
Pt. Conception-S. Baja  Specklefin Midshipman  S. Alaska-Gulf of California
San Francisco-S. Baja  Opaleye  Monterey Bay-Gulf of California
Pt. Conception-Gulf of CA  Halfmoon  Zebraperch
Bering Sea-Monterey Bay, CA  Skilfish  Bering Sea-C. Baja

C. Baja-Peru  Smooth Stargazer
Figure 3: Fish Key

<table>
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<tbody>
<tr>
<td>S. BC-N. Baja</td>
<td>White</td>
<td>Alaska-N. Baja</td>
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<tr>
<td>N. California-C. Baja</td>
<td>Sharpnose</td>
<td>Oregon-C. Baja</td>
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<tr>
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<td>Walleye</td>
<td>S. BC-N. Baja</td>
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<tr>
<td>S. BC-Monterey Bay</td>
<td>Silver</td>
<td>Silver</td>
</tr>
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<td>Washington-N. Baja</td>
<td>Redtail</td>
<td>N. California-C. Baja</td>
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<td>Calico</td>
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