

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

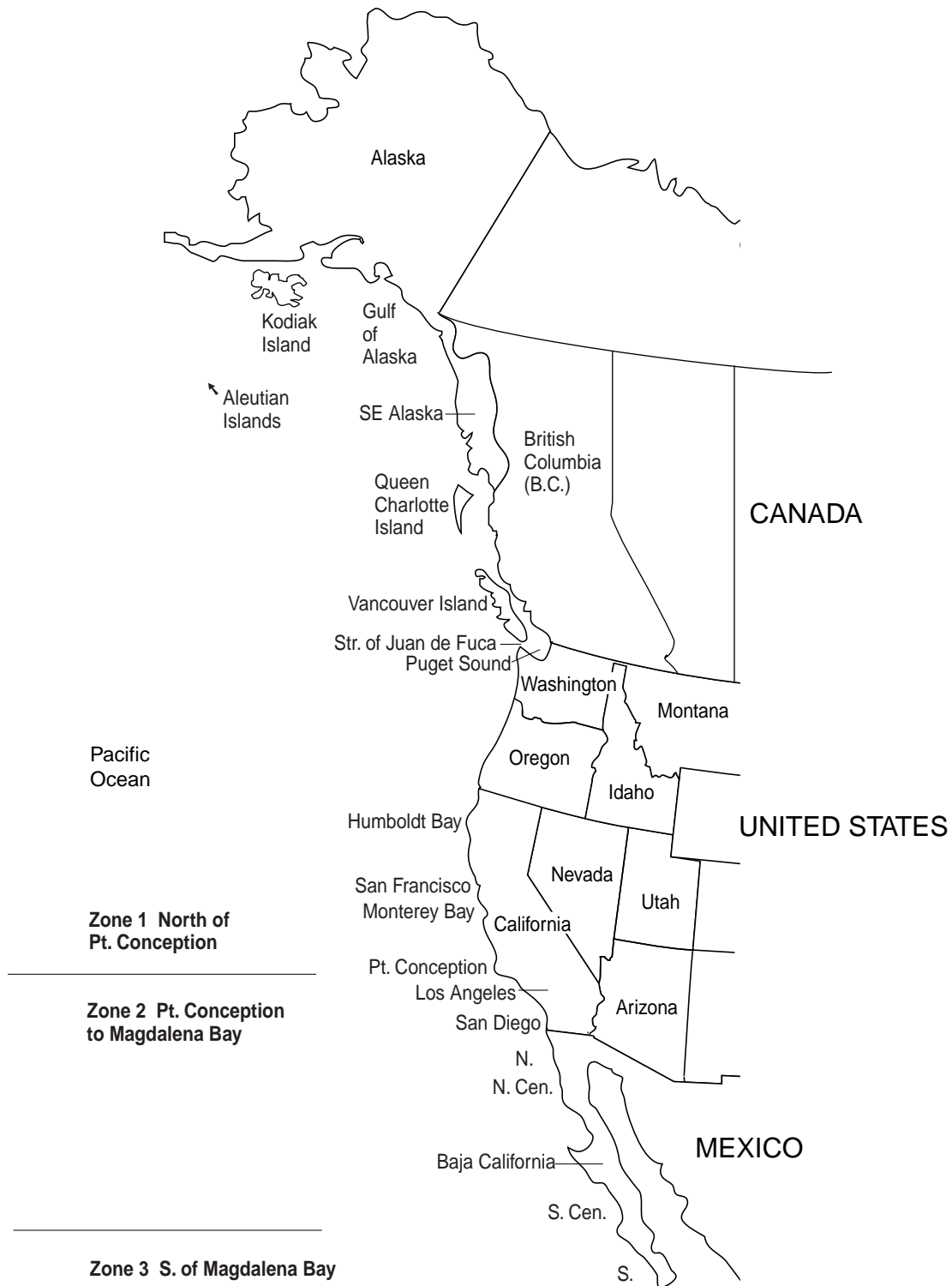
An El Niño event is thought to be triggered when steady westward blowing trade winds weaken and even reverse direction. This change in the winds allows the large mass of warm water that is normally located near Australia to move eastward along the equator until it reaches the coast of South America. 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.

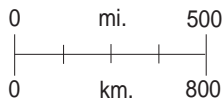
The fish shown in this activity were caught in May 1997 [Fig.2]. Satellite and surface water measurements indicated an El Niño had begun to affect the eastern Pacific Ocean at that time. Were its effects visible in the fish population off southern California?

In May 1997 an otter trawl was used by personnel on the research vessel *Sea Explorer* to collect fish

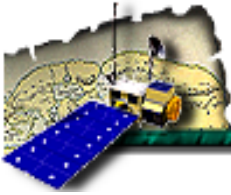
Figure 1: Zone Map Fish Biogeography



Map of Area Covered



Approximate Scale: 1/4 in. (6.35 mm) = 120 mi. (193 mm)



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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 Scandinavian 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?



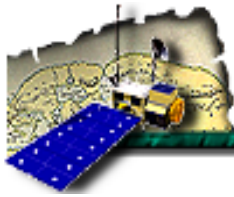
Movie. **Today’s catch**

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.



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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 effected 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

El Niño

food chain

macroscopic

phytoplankton

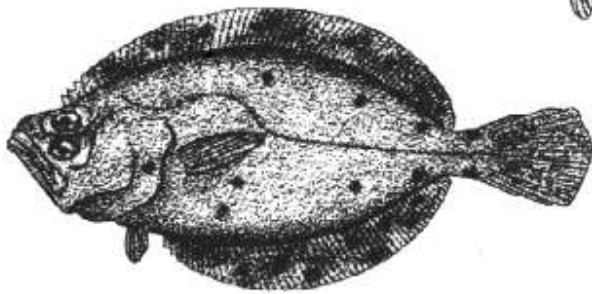
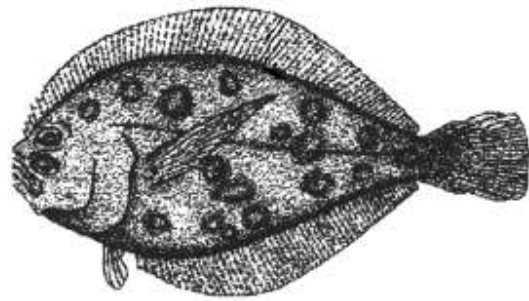
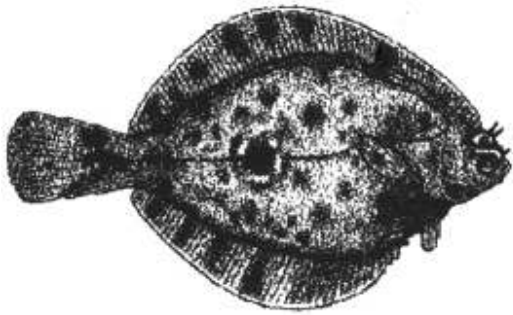
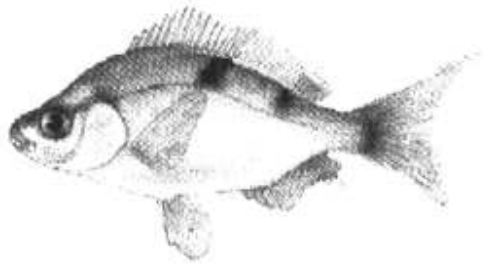
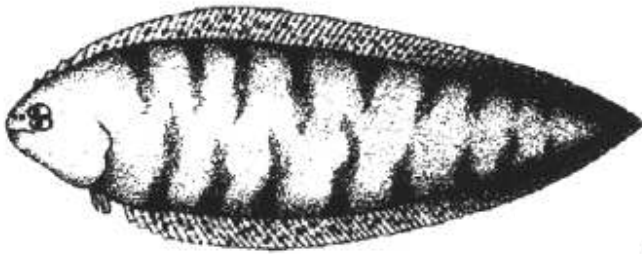
upwelling

zooplankton

SOURCE

Adapted from Orange County Marine Institute activity series. Original fish figures from: Eschmeyer, W. and Herald, E., *A Field Guide to Pacific Coast Fishes*, Houghton Mifflin Co., Boston.

Today's Catch



Fish Key

Range

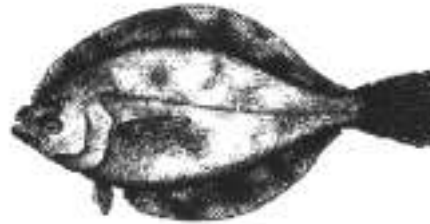
Fish Type

Range

Yaquina Bay, Or-
Panama



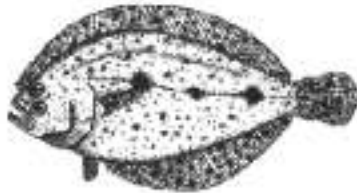
California Tonguefish



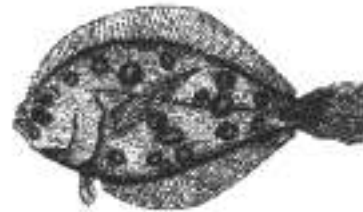
Bering Sea-
S. Baja, CA

Pacific Sanddab

S. Alaska-
S. Baja, CA



Speckled Sanddab



Monterey, CA-
Costa Rica

Longfin Sanddab

Monterey Bay-
Gulf of CA



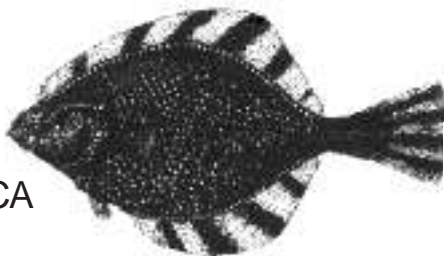
California Tonguefish



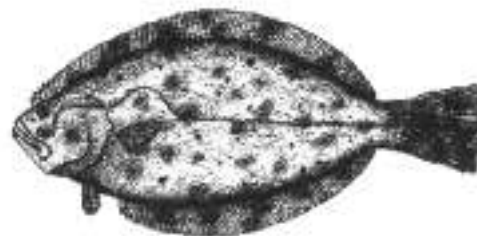
Monterey Bay-
Gulf of CA

Bigmouth Sole

N. Alaska-
Santa Barbara, CA



Starry Flounder



N. Washington-
S. Baja

California Halibut

Figure 3: Fish Key

Fish Key

Range

Fish Type

Range

S. Alaska-
S. Baja



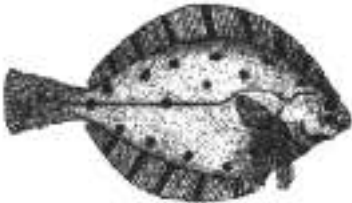
Slender Sole



Rex Sole

Bering Sea-
N. Baja

Bering Sea-
British
Columbia

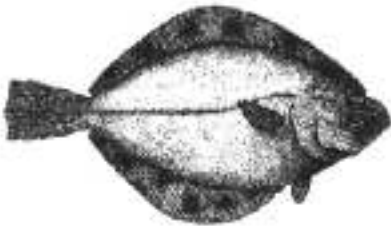


Yellowfin Sole



Bering Sea-
C. Baja

Bering Sea-
N. Baja



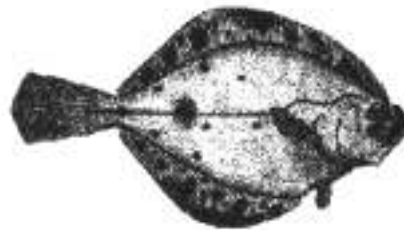
Petrale Sole

Dover Sole

Bering Sea-
N. Baja



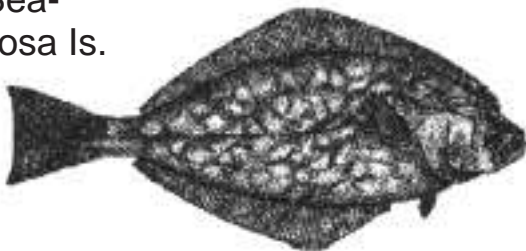
Greenland Halibut



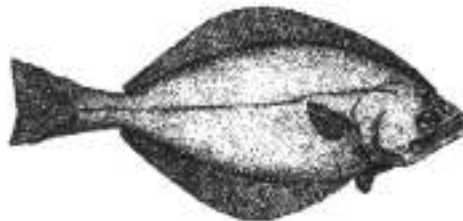
Flathead Sole

Bering Sea-
Pt. Reyes

Bering Sea-
Santa Rosa Is.



Pacific Halibut



Arrowtooth Flounder

Japan-
Bering Sea-
Oregon

Figure 3: Fish Key

Fish Key

Range

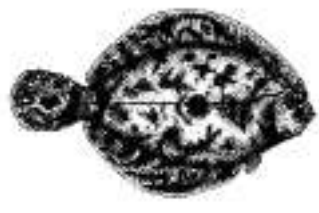
Fish Type

Range

N. California-
S. Baja



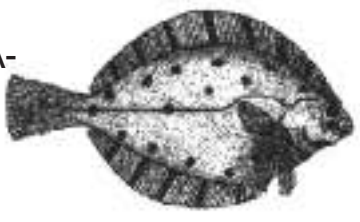
Diamond Turbot



C - O Turbot

S. Alaska-
N. Baja

Pt. Reyes, CA-
S. Baja



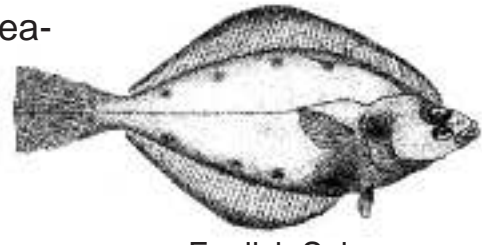
Hornyhead Turbot



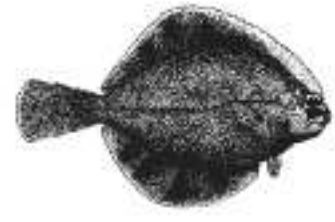
Spotted Turbot

Morro Bay, CA-
S. Baja

Bering Sea-
C. Baja



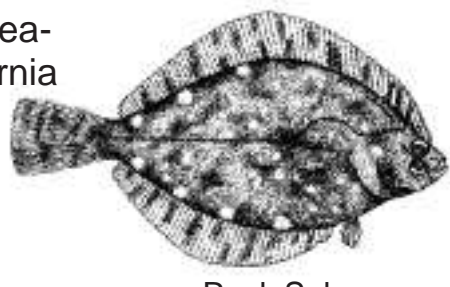
English Sole



Curlfin Turbot

Prince Williams Sound,
Alaska-
C. Baja

Bering Sea-
S. California



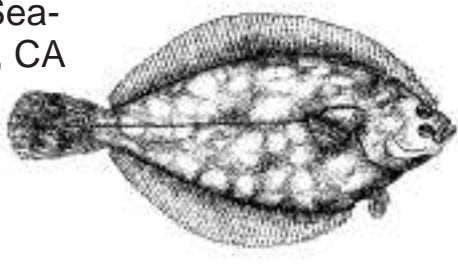
Rock Sole



Hybrid Sole

Bering Sea-
San Francisco

Bering Sea-
Ventura, CA



Butter Sole



Sand Sole

Bering Sea-
Redondo Bch., CA

Figure 3: Fish Key

Fish Key

Range

Fish Type
Rockfishes

Range

San Clemente &
Catalina Islands-
Peru



Rainbow Scorpionfish



California Scorpionfish

Pt. Conception-
Gulf of California

San Francisco-
C. Baja



Treefish



Bering Sea-
N. Baja

S. Alaska-
C. California



Tiger

Shortspine Thornyhead

S. Alaska-
San Miguel, Is.



Black



Flag

San Francisco-
N. Baja

S. Alaska-
N. Baja



Blue



Rebanded

S. Alaska-
San Diego, CA

Alaska-
C. California



Quillback



China

S. Alaska-
San Miguel, Is.

Figure 3: Fish Key

Fish Key

Range

Fish Type

Range

S. California-
Peru



Pacific Flagfin Mojarra



Lumptail Searobin

N. Baja-
Sea of Cortez

Pt. Conception-
S. Baja



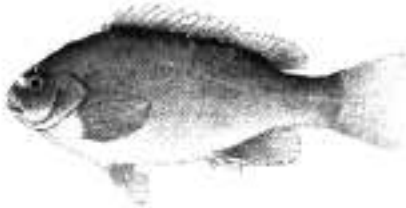
Specklefin Midshipman



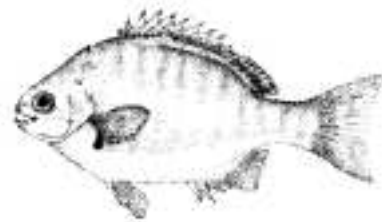
Plainfin Midshipman

S. Alaska-
Gulf of California

San Francisco-
S. Baja



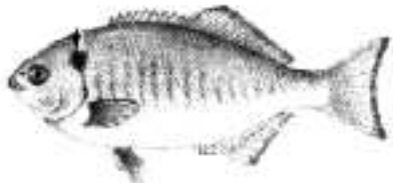
Opaleye



Zebraperch

Monterey Bay-
Gulf of California

Pt. Conception-
Gulf of CA



Halfmoon



Sablefish

Bering Sea-
C. Baja

Bering Sea-
Monterey Bay,
CA



Skilfish



Smooth Stargazer

C. Baja-
Peru

Figure 3: Fish Key

Fish Key

Range

Fish Type
surfperches

Range

S. BC-
N. Baja



White



Pile

Alaska-
N. Baja

N. California-
C. Baja



Sharpnose



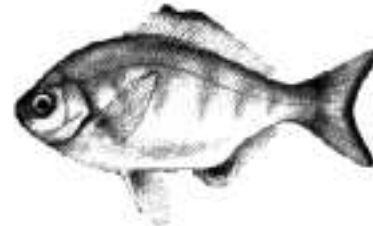
Spotfin

Oregon-
C. Baja

S. BC-
C. Baja



Walleye



Silver

S. BC-
N. Baja

S. BC-
Monterey Bay



Redtail



Pink

N. California-
C. Baja

Washington-
N. Baja



Calico