SALINITY SLEUTHS (3-6)

Overview: In this activity, students will measure and compare the salinities of tap water, slough water, and salt pond water. They will then put together two food pyramid puzzles, one for the salt pond and one for the slough.

Content Standards Correlations: Science, p. 293

Grades: 3-6

Key Concepts: The water of the slough and salt pond have different physical characteristics. Salinity, one important physical characteristic, determines which life forms will live in the aquatic environment. Specific ranges of salinity are required to maintain the existing life forms. The aquatic life of the slough and salt pond support endangered species and migratory birds.

Objectives:
Students will be able to:
- use a hydrometer to measure salinity
- identify the salinity ranges necessary to support the existing life forms in the slough and salt pond
- describe food pyramids that exist in the slough and salt pond

Materials:
- 2 buckets, with ropes
- 3 hydrometers
- 3 graduated cylinders
- 1 tap water sample in 2 bottles
- 2 salinity models (fresh water and salt water)
- 2 wood food pyramid puzzles (20 pieces)
- 1 hydrometer poster
- 2 food pyramid posters

TIME FRAME FOR CONDUCTING THIS ACTIVITY

Recommended Time: 30 minutes

Introduction (8 minutes)
- discuss salinity as it relates to what can live in an aquatic habitat

Collecting Water Samples (7 minutes)
- collect a slough water sample
- collect a salt pond water sample

Measuring Salinity and Discussion (10 minutes)
- discuss how to measure salinity
- measure the salinity of tap water, slough water, and salt pond water

Constructing Food Pyramids and Closing Discussion (5 minutes)
- divide the students into two groups
- construct two food pyramid puzzles (one per group)
- discuss the food pyramids in the slough and salt pond
- discuss how salinity determines which life forms will live in an aquatic habitat

HOW THIS ACTIVITY RELATES TO THE REFUGE'S RESOURCES

What are the Refuge's resources?
- significant wildlife habitat
- endangered species
- migratory birds

What makes it necessary to manage the resources?
- Extreme, rapid changes in salinity will often result in the death of plants and animals. Water pollution control plants empty freshwater into sloughs, changing the habitat, and therefore, what lives in the habitat.

What can students do to help?

Refuge staff work with water pollution control plants to control the amount of freshwater being released into sloughs, but we need your help.
- The water you use at home ends up in the Bay; conserve your use of water
- Teach others what you have learned

SUPPORTING INFORMATION FOR THIS ACTIVITY

Salinity

- Salinity refers to the amount of dissolved salts in water.
- The physical factor of salinity directly relates to life in aquatic habitats.
  - Most plants and animals require a specific range of salinity in which to live.
  - Animals living in salty conditions tend to be more tolerant of a wider range of salinity than those adapted to fresh water environments.
  - However, sudden and/or great changes in salinity will often result in the death of plants and animals.
  - Humans can change the salinity of bodies of water as they develop and utilize nearby areas.
  - For example, in San Francisco Bay, the salinity in the south end of the bay has decreased due to fresh water outflow from Water Pollution Control Plants.

Measuring Salinity

- How well an object floats in water (its buoyancy) is related to salinity.
  - Dissolved salts make water denser. As the salinity increases so does the density. Therefore, the saltier the water is, the higher an object floats.
  - For example, it is easier for a person to float in the ocean (salt water) than a swimming pool (fresh water).
- A hydrometer is an instrument that measures the density of liquids.
  - As the salinity increases, the density increases and the hydrometer will float higher in the water.
  - The percentage of salt in distilled fresh water is 0%; the percentage of salt in ocean water is about 3%.

Slough and Mudflat Habitat

- If the palm of one's hand is used to represent San Francisco Bay, a tidal slough may be thought of as a "finger of the Bay".
  - Tidal sloughs are the main link between the salt marsh and San Francisco Bay.
  - Sloughs are natural waterways that carry water from the bay into the salt marsh as the tide comes in and return the water to the bay as the tide goes out.
  - Sloughs carry bay water into the marsh twice a day during the flood (incoming) tide and back to the bay during the ebb (outgoing) tide.
  - Mudflats appear in the slough channels at low tide.
- The water entering the slough from the bay is a combination of ocean water, which enters the bay through the Golden Gate, and fresh water, most of which enters the Bay through the Delta (the Sacramento and San Joaquin Rivers).
- Fresh water also enters some sloughs from creeks or Water Pollution Control Plants.

Slough and Mudflat Food Pyramid

- The slough and mudflats support many life forms. The diversity of plants and animals living in the slough and mudflats results in a dynamic food pyramid.
  - Producers have the ability to manufacture their own food (energy) and they make up the base of the food pyramid. In the slough and mudflats, the producers are phytoplankton (small, drifting plants) and detritus (decomposing marsh plants).
  - Consumers are all animals that cannot make their own food and are dependent on plant material (producers) as a source of food, either directly or indirectly by eating other animals that feed on producers.
  - Zooplankton (small, drifting animals, such as ostracods, copepods, and the eggs or larvae of larger aquatic animals) living the slough waters are the first level of consumers - they feed on the phytoplankton and detritus.
  - Small fish and mud creatures feed on zooplankton, phytoplankton, and detritus - they represent the second level of consumers.
  - Shorebirds, ducks, egrets, herons, and larger fish feed on mud creatures and small fish and make up the third level of consumers.
  - At the top level of the food pyramid are hawks, harbor seals, and humans.

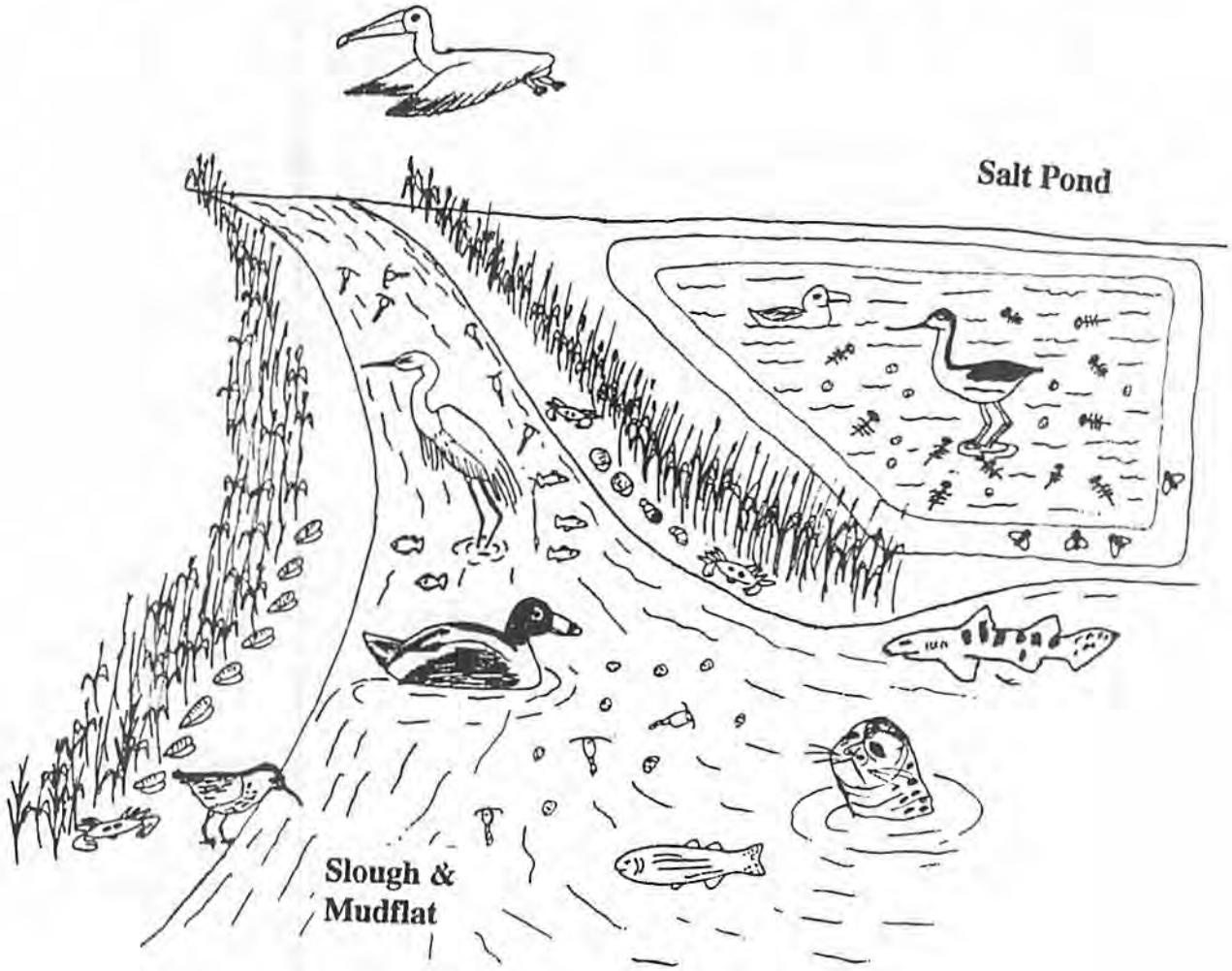
Salt Pond Habitat

- Salt Ponds are human-made habitats, created for the production of salt.
- Levees were built around the salt marshes, the natural habitat, and then the marshes were flooded with bay water. The flooding drowned the plants and resulted in salt ponds.

- The ponds that you can see from the refuge are part of a series of salt ponds that encompass South San Francisco Bay.
  - Water is pumped from the bay and is passed through the series of ponds.
  - Each pond has a unique salinity; the pond water becomes saltier as the sun evaporates the water.
  - After about 5 years, the salinity in the pond water is so high that salt crystals form and can be harvested, processed, and sold.
- In this very salty habitat, only certain plants and animals can survive.
  - The types of plants and animals found in a particular salt pond will be determined by the amount of dissolved salts in the water.
  - In ponds with lower salinity, algae, brine flies, brine shrimp, small fish, and water boatmen will be found. In mid-salinity salt ponds (such as salt pond N1 at the Visitor Center, Fremont Site), only algae, brine flies, and brine shrimp will still exist. In very high salinity salt ponds, only bacteria will be able to survive.
  - The colors of the salt ponds are determined by algae and bacteria, which make the water appear blue, green, yellow, orange, or red.

Salt Pond Food Pyramid

- Producers make up the base of any food pyramid, producing their own food (energy) and supporting the rest of the pyramid. In the salt ponds, single-celled algae are the producers.
- Brine shrimp and brine flies eat algae and make up the first level of consumers.
- Shorebirds and ducks feed on the brine shrimp and brine flies.
- Hawks and humans are the top level consumers, feeding on ducks and shorebirds.



How to Lead This Activity by Following the "Do, Read, Ask" Teaching Format

Introduction (8 minutes)

Do

Before the group arrives, take the hydrometers out of their cases and make the salinity models (cubes with marbles) accessible. When your group arrives, have them sit down at the picnic tables.

Read

"Welcome to Salinity Sleuths. You are going to become detectives and together we will solve the mystery of just how much salt is in these two aquatic (water) habitats, [POINT] the tidal slough and salt pond."

Ask

? **First we need to know what the tide is. Exactly what is the tide?** (The 'rising and falling' of the sea due to the gravitational force of the moon and sun, and the centrifugal force of the spinning earth. There are two high tides and two low tides each day. The ebb tide is the outgoing tide and the flood tide is the incoming tide.)

? **Who has heard of a tidal slough?** [POINT to the slough] **Can anyone tell me what a slough is?** (Discuss student responses and then read the following.)

Demonstrate and Read

"Let's pull out our Bay and slough model. Hold up *your left arm*. You now have a model of the San Francisco Bay."

Ask

? **What is a model?** (A model is a representation of something else; for example, a model airplane)

Read

[POINTING] "Use the pointer finger on your right hand to follow the along. In our model, your arm represents the Pacific Ocean and your wrist is the Golden Gate."

Ask

? **What is represented by the palm of your hand?** (San Francisco Bay)

Read

- "Wiggle your fingers. These are the sloughs around the Bay. As the tide comes in water moves from the ocean *(forearm)*, [FOLLOW THE PATH WITH YOUR FINGER] through the Golden Gate *(wrist)*, flooding the Bay *(palm)*.
- The water continues to move through the Bay into the sloughs *(fingers)* and then floods the salt marsh in places where there are no levees *(in between fingers)*.
- After high tide is reached, the water moves back through the sloughs *(fingers)*, to the Bay *(palm)*, and out the Golden Gate *(wrist)* into the ocean *(forearm)*.
- At low tide, when the slough water is carried all the way out to the ocean, the mudflat habitat beneath the water is revealed.
- Sloughs are filled with Bay water twice a day during the flood tides. Twice a day the water is carried back to the Bay and ocean as the tide goes out during the ebb tide.
- You may put down your arms. Now let's turn our attention to the other aquatic habitat."

Ask

? **Where is the salt pond?** (It's the large body of water surrounded by levees.) [POINT]

Read

- "Salt Ponds were created many years ago for the purpose of producing salt.
- This was accomplished by building low walls, called levees, around salt marshes. This created a number of huge, shallow, swimming pool-like structures that were flooded with water from the Bay.
- The flooding down the plants and resulted in the salt ponds.
- Today these salt ponds are still used to produce salt using solar evaporation. This process involves moving the saltwater through a series of salt ponds.
- As the water evaporates the solution (liquid) becomes saltier and saltier, and the water is moved from one pond to the next. After three to five years, the water is salty enough to crystallize.
- The salt is then harvested, processed, and sold."

Ask

? Are salt ponds natural or human-made habitats? (Salt ponds are human-made habitats.)

? Are the salt ponds affected by the tide? (No. The salt ponds are not connected to the Bay; they are surrounded on all sides by levees and not affected by the tide.)

? Where does the water in this salt pond come from? (Primarily from the adjacent salt pond which is about halfway through the evaporation process. During the rainy season some of the water comes from precipitation.)

Read

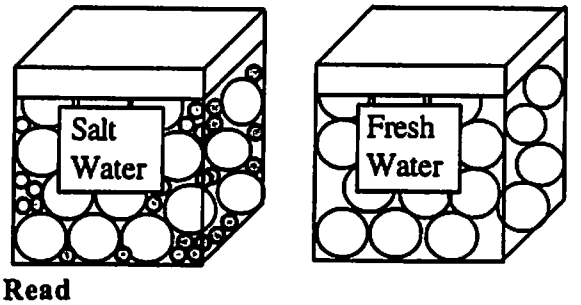
- "Now that we have some information about these two different habitats, we are going to do a scientific experiment to measure and compare the salinity of the tidal slough, salt pond, and tap water.
- We will be forming hypotheses (educated guesses) about the salinity of the water samples we actually test them.
- To measure the salinity of the water types we will be using an instrument called a hydrometer."
  [HOLD UP A HYDROMETER]

Ask

? First, what is salinity? (Salinity is the amount of dissolved solids in water)

Do

Show the salinity models one at a time. Point out that the marbles represent water molecules, and that there are the same number of water molecules in each.



Read

- "The marbles in these models represent water molecules. The cube with marbles only represents fresh water.
- When water molecules are surrounded by salt, represented here by styrofoam, the water is denser: there is more stuff (mass) in the same space (volume). The cube containing the 'salt' has a higher salinity."

Ask

? In nature, can we tell how much salt is in the water just by looking at it? (No. When salt is dissolved in water the resulting solution is clear.)

? How could we use buoyancy (how well an object floats in water) to measure salinity? [By floating something in water to see how high it floats; it will float higher as salinity (density of the solution) increases.]

Read

"This hydrometer measures the density of the solution, which in our case is the salinity. As salinity increases, the hydrometer floats higher in the water. The hydrometer has been colored to show four different ranges of salinity. Blue is fresh water; blue and red striped is brackish water (a mixture of fresh and salt water); red is ocean water; red and green striped is very salty water.

Ask

? Can humans drink salty water? (Not for very long.) Why? (The salt will dehydrate you.)

? In which color would we expect the hydrometer to float for our drinking water? (Blue)

? Would a house plant live if it was watered with salty water? (No. A house plant has no adaptation to excrete salt, unlike pickleweed which does.)?

? So, how does salinity effect what animals can live in the water? (Most plants and animals can only live in narrow ranges of salinity.)

Collecting Water Samples (7 minutes)

Read

"Let's collect water samples from the slough and from the salt pond, so that we can measure the salinity of these two habitats."

Do

Walk with the group to the bridge over the slough with a bucket that has a rope to collect the slough water sample.

Read

- "I need 4 students to collect the water sample.
- One student needs to tie the end of the rope to the bridge railing so that we do not lose the bucket.
- One student will carefully place the bucket over the railing and slowly lower it into the slough.
- One student will pull the sample back up.
- One student needs to carry the slough water sample back to the study area."

Do

Next, walk with the group to the salt pond to collect the salt pond water sample (take the second bucket with you).

Read

"I need two students to take the salt pond water sample. One student will collect the water and the other student will carry the bucket back to the study area."

Measuring Salinity and Discussion (10 minutes)

Do

Put the 3 samples you are going to test next to each other: the salt pond bucket, the slough bucket and the tap water sample.

Read

"Before we measure the salinity, we need to make our hypotheses. We will begin with water that came from the faucet inside the Center."

Ask

? **Which color on the hydrometer (salinity range) do you think the tap water will be?** (Let the students make hypotheses - educated guesses. Do not tell them the answers; let them measure the salinity with the hydrometer.)

Read

"I need two volunteers to measure the salinity of the tap water sample. One of you will pour the sample into the graduated cylinder and the other will place the hydrometer into the sample. Both of you will report the reading (color) back to the group."

Do

Select volunteers. Have one pour the water into the graduated cylinder.

Read

"Now, carefully place the hydrometer into the water sample until it is in the red and green striped area. Then, let go. Wait for the hydrometer to stop bouncing. Read the hydrometer by looking at the top of the water from the side at eye level."

Ask

? **What color does the water-line fall in?** (Blue)

? **Was your hypothesis accurate?**

Do

Repeat the process with the salt pond sample

Read

"We need to make our hypothesis about this sample of salt pond water.

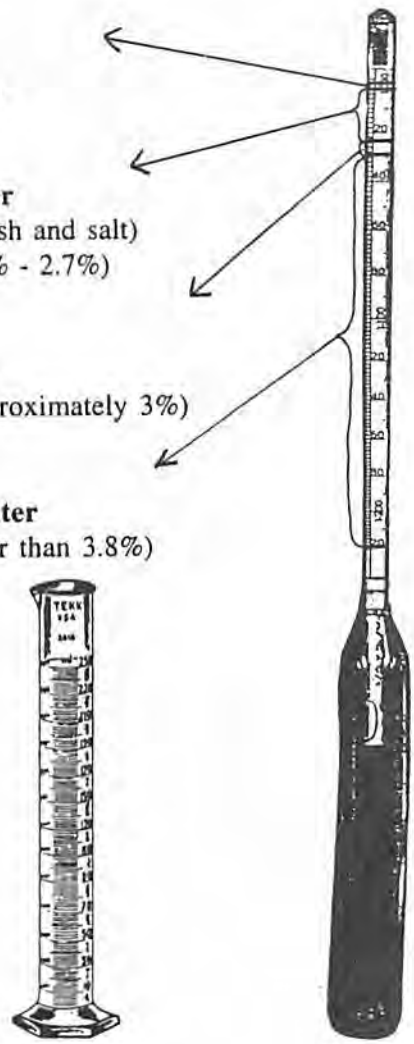
Reading the Hydrometer

Blue =
Fresh Water
(salinity = 0%)

Blue/Red =
Brackish water
(mixture of fresh and salt)
(salinity = 0.1% - 2.7%)

Red =
Ocean Water
(salinity is approximately 3%)

Red/Green =
Very Salty water
(salinity greater than 3.8%)



Ask

? **Which color on the hydrometer (salinity range) do you think the salt pond water will be?** (Let the students make hypotheses - educated guesses. Do not tell them the answers; let them measure the salinity with the hydrometer.)

Read

"I need another two volunteers to measure the salinity of the salt pond water sample. One of you will pour the sample into the graduated cylinder and the other will place the hydrometer into the sample. Both of you will report the reading(color) back to the group."

Do

Select volunteers. Have one pour the water into the graduated cylinder.

Read

"Now, carefully place the hydrometer into the water sample until it is in the red and green striped area. Then, let go. Wait for the hydrometer to stop bouncing. Read the hydrometer by looking at the top of the water from the side at eye level."

Ask

? **What color does the water-line fall in?** (Red and Green striped)

? **Was your hypothesis accurate?**

? **Why is the water so salty?** (Salt ponds are used to make salt using solar evaporation. The water in this pond is about half-way through the process — water has been evaporating for about two years — and is therefore very salty)

? **What do you think lives in the salt pond?** (Specially adapted fish, brine shrimp, brine flies)

Do

Repeat the process with the tidal slough sample.

Read

"Let's make our hypothesis."

Ask

? **Where does the water in the slough come from?** (Water comes in with the tide from the Bay.)

? **Which color on the hydrometer (salinity range) do you think the tidal slough water will be?** (Let the students make hypotheses - educated guesses. Do not tell them the answers; let them measure the salinity with the hydrometer.)

Read

"I need two volunteers to measure the salinity of the tidal slough sample. One of you will pour the sample into the graduated cylinder and the other will place the hydrometer into the sample. Both of you will report the reading(color) back to the group."

Do

Select volunteers. Have one pour the water into the graduated cylinder.

Read

"Now, carefully place the hydrometer into the water sample until it is in the red and green striped area. Then, let go. Wait for the hydrometer to stop bouncing. Read the hydrometer by looking at the top of the water from the side at eye level."

Ask

? **What color does the water-line fall in?** (Blue)

? **Was your hypothesis accurate?**

? **Could the animals that live in the slough also live in the salt pond?** (No. They need to live in water with a specific salinity.)

? **Could the animals that live in the Bay also live in the tidal slough?** (Yes.)

? **How would an extreme, rapid change in salinity affect organisms that live in the bay, tidal slough, and salt pond?** (Animals living in salty conditions tend to be more tolerant of a wider range of salinities than those adapted to fresh water environments. However, sudden and/or great changes in salinity will often result in the death of plants and animals. Even if the change happens over time, the habitat may become unsuitable to the plants and animals that live in it.)

? **What factors would cause a fluctuation (change) in the salinity levels of the slough water?** (Tide height, rainfall, and surrounding salty soil.)

?**Are the salinity levels in the salt pond and slough constant throughout the year?** (No. Due to a fluctuation in tide height, rainfall, and surrounding salty soil.)

Constructing Food Pyramids and Closing Discussion (5 minutes)

Read

"We are going to construct two food pyramids, one for the salt pond and one for the slough and mudflats."

Ask

? **What is a food pyramid?**

- (A food pyramid shows what eats what in an ecosystem.
- Plants are at the base of the food pyramid, producing their own food (energy).
- The first level consumers feed on plants, the second level consumers feed on the first level consumers, and so on until the top level consumers, which have no natural predators.
- The amount of organisms decreases as you go up the pyramid.)

Do

- Divide the students into two groups.
- Hand one group the salt pond food pyramid puzzle pieces and the other group the slough and mudflat food pyramid puzzle pieces.
- Instruct them to work as a group to put their puzzles together. **Note: there is one piece in each puzzle that does not fit.**
- During the assembly of the food pyramids, encourage the students to read the puzzle pieces to determine which one does not fit.

Ask

? **What lives in the slough and mudflat habitats?** (Take all reasonable answers.)

Do

Point out the slough and mudflat food pyramid puzzle as you discuss it.

Read

- "The slough and mudflats support a food pyramid.
- At the base of the food pyramid are plants, which produce their own food (energy) with sunlight.
- The plants in the slough are small, drifting plants (phytoplankton) and decomposing marsh plants (detritus).
- Zooplankton (small, drifting animals) feed on the phytoplankton. Zooplankton make up the first level of consumers.
- Feeding on the zooplankton and phytoplankton are small fish and mud creatures.
- The next level includes ducks, shorebirds, egrets, and larger fish.
- At the top of the food pyramid are harbor seals, humans, and hawks."

Ask

? **What lives in the salt pond habitat?** (Take all reasonable answers.)

Do

Point out the salt pond food pyramid puzzle as you discuss it.

Read

- "The salt pond, like the slough, supports a food pyramid.
- All food pyramids start with plants. In the salt pond, single-celled algae produce food (energy), supporting the rest of the pyramid.
- Brine shrimp and brine flies feed on the algae, making up the first level of consumers.
- Shorebirds and ducks feed on the brine shrimp and brine flies.
- At the top of the food pyramid are humans and hawks."

Ask

? **Why did one piece not fit in each puzzle?** (It was the wrong salinity for the plants and animals.)

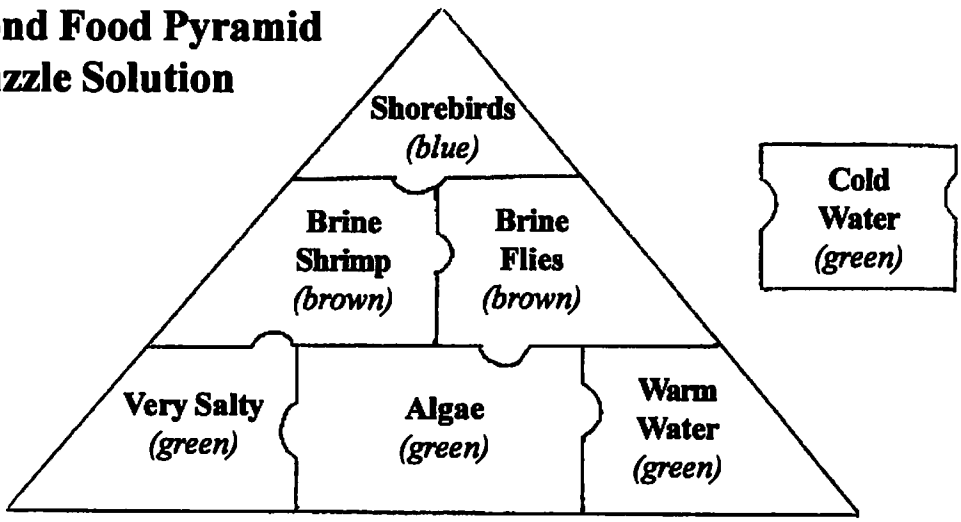
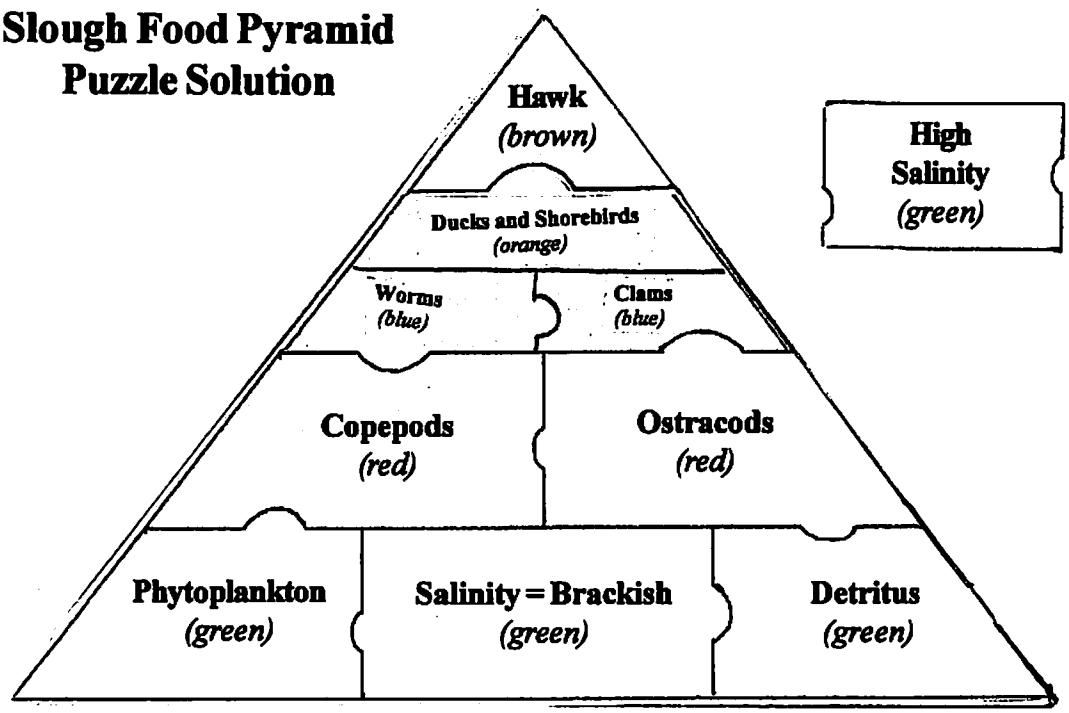
? **How would an extreme, rapid change in salinity affect organisms that live in the slough and salt pond?**

- (Animals living in salty conditions tend to be more tolerant of a wider range of salinities than those adapted to fresh water environments.
- However, sudden and/or great changes in salinity will often result in the death of plants and animals.)

? **People can change the salinity of the slough water by adding fresh water. How do people add fresh water to the slough?** (Water Pollution Control Plants empty fresh water into sloughs, changing the salinity of the slough habitat.)

? **How can people help maintain the salinity of sloughs?** (Water Pollution Control Plants can use reclaimed water for watering plants instead of dumping water into the bay. People can conserve their use of water in a variety of methods: using less, installing low-flow toilets, and saving and reusing water when possible.)

Salt Pond Food Pyramid Puzzle Solution



Slough Food Pyramid Puzzle Solution