

## Part I: Puget Sound Introduction

### Review:

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The Puget Sound was formed about 20,000 years ago by the carving action of glaciers. During the retreat and re-formation of these glaciers a series of shallow **sills** (underwater valleys and ridges) were created, which recirculate water from the depths to the surface of the Sound.

Puget Sound is an **estuary**, where salt water from the ocean mixes with fresh water that falls as precipitation or drains from the surrounding land. More than 10,000 streams and rivers drain into Puget Sound. Made up of a series of underwater valleys and ridges, Puget Sound is deep, with an average depth of 450 feet and a maximum depth of 930.

In most Marine ecosystems, **nutrients**—in the form of dead, decomposing matter and fecal matter—sink. However, in the Puget

Sound, the **upwelling** created by the **sills** (see above) circulates nutrients and when combined with deep, cold, oxygen rich water, creates a unique and ideal environment for **phytoplankton** (free-floating photosynthetic plants)—which kick start an incredibly productive ecosystem and food web.

**Vocabulary:** Use this space to list new words or concepts that you would like us to review

## Estuarine Food Web:

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Puget Sound supports a very unique and delicate food web. Because estuaries can support both freshwater and salt-tolerant species, they are some of the most diverse habitats in the world! The arrows in this diagram illustrate the transfer of energy (food) between species.

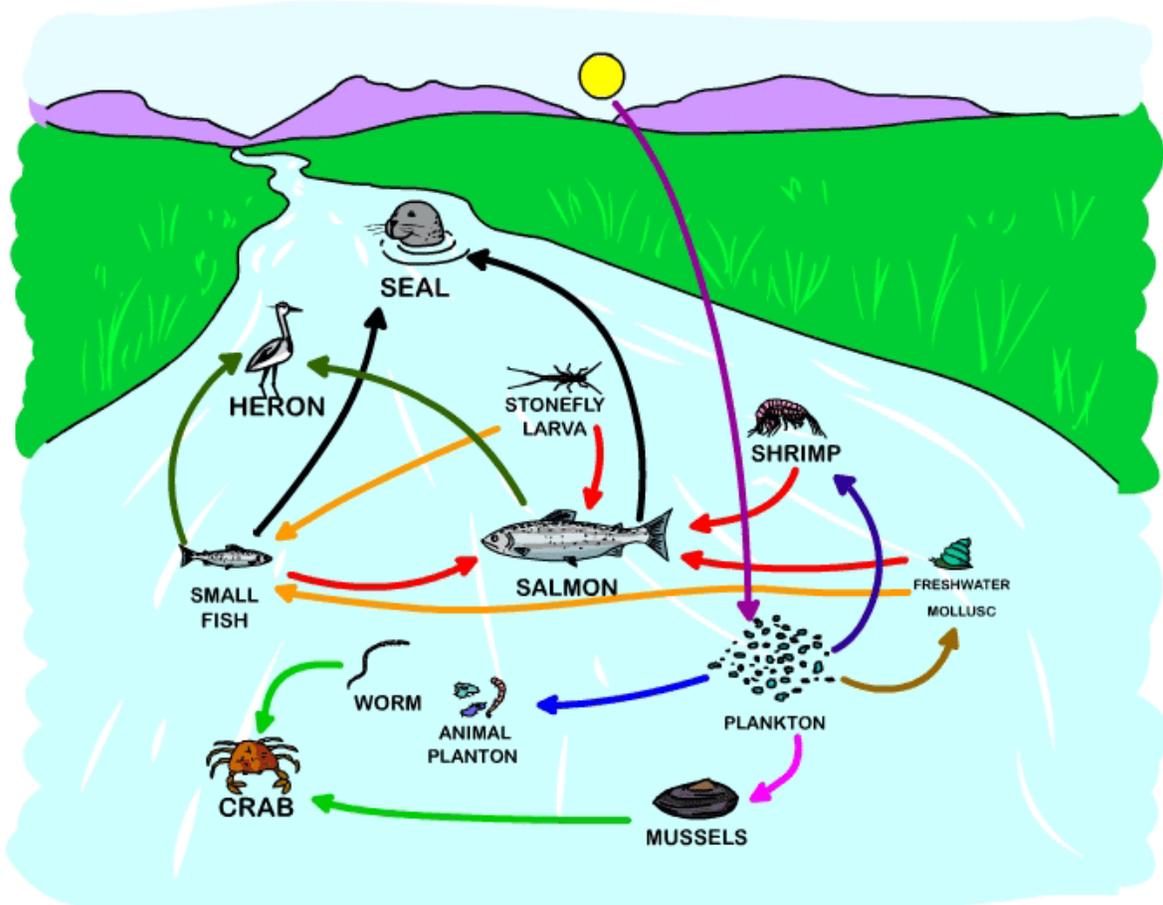


Image Source: [www.somethingfishy.ie](http://www.somethingfishy.ie)

1. Which species is linked to the most other species?
2. Where would humans fit in this food web? Draw yourself and the energy arrows needed to incorporate you into this food web.
3. Imagine that the plankton died – how would this affect the food web?

## Aquatic Life Cycle:

Image Source: [www.westbasin.org](http://www.westbasin.org)

### **Match the following**

\_\_\_\_\_ **Oxygen:** A gas upon which most life depends. Water contains dissolved oxygen. The amount of oxygen has a direct relationship between the size and number of animals found in a body of water.

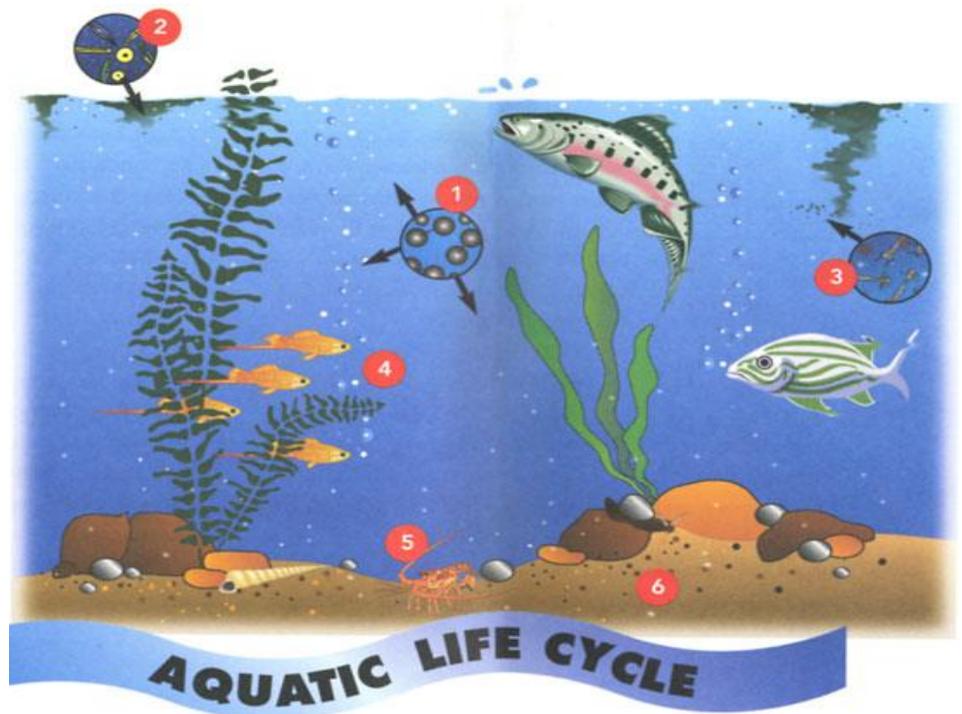
\_\_\_\_\_ **Phytoplankton:** Free-floating green plants. These small plants form the beginning of an aquatic food chain. Additionally, phytoplankton take in sunlight, convert the sunlight into food and release oxygen into the water to be used by another life. This process is called photosynthesis.

\_\_\_\_\_ **Zooplankton:** Free-floating animals. These animals eat phytoplankton and, in turn, are eaten by larger animals along the aquatic food chain.

\_\_\_\_\_ **Fish:** A vertebrate (animal with a spine) that lives in water. Healthy bodies of water have different kinds and sizes of fish.

\_\_\_\_\_ **Bottom Life:** Animals that live on the bottom of a healthy body of water. Bottom life includes worms, snails, crayfish, mussels, clams and insect larvae.

\_\_\_\_\_ **Sediment:** Mud, Sand, or Gravel which has settled to the bottom of a body of water. A healthy body of water has sediment that is free of chemical pollution that settle to the bottom and are harmful to fish and bottom life.



### **Review Questions:**

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1. Where does the water come from that feeds Puget Sound, and what makes it unique?
2. What factors contribute to the diversity of life within Puget Sound?
3. How do you think the depth of Puget Sound influences the food web and life cycle?

## Human Impact on the Puget Sound



Image Source: <http://islandhighwayproject.wordpress.com>

### What is a watershed?

*An area of land within which the surface water (rain, snowmelt, etc.) all drains to a common body of water.*

Watersheds are defined geographically because mountains and hills determine the direction of water flow and funnel small creeks into progressively larger bodies of water, such as rivers, Puget Sound, the Salish Sea, and eventually the Pacific Ocean. We all live in a watershed.

This image illustrates a watershed that has become developed. The river in this region is the common body of water and will collect rain and **storm water runoff** (surface water that is not absorbed into the ground) from both sides.

1. In what ways can you see that human behavior has an impact on watershed health? Circle your examples in the image.
2. How does rain water behave differently on both sides of the river?
3. Why do you think watershed health is important?
4. Circle the water quality parameters that we can test that are directly related to human activity:

Dissolved Oxygen	Nitrates	Zooplankton	pH	Salinity	Turbidity
Surfactants		Silica	Phosphates	Temperature	

## Puget Sound Processes: Eutrophication

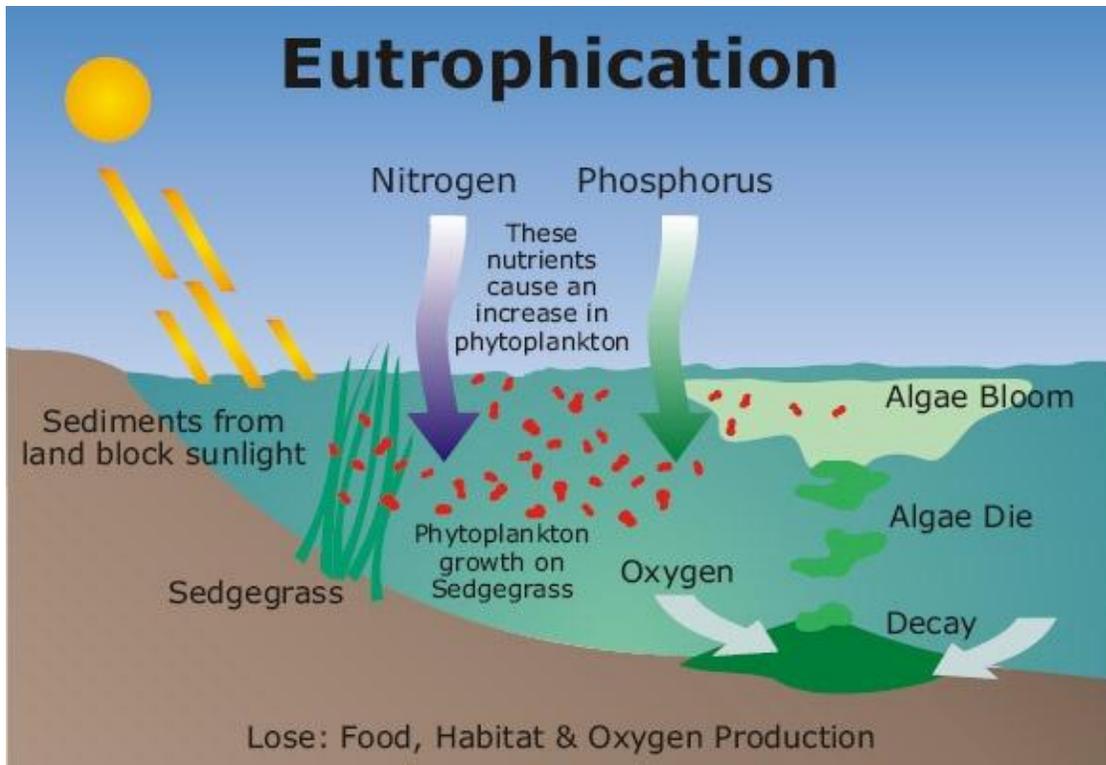


Image Source: <http://lincoln.ne.gov>

A process called **eutrophication** affects slow moving portions of the Sound where this excess of nutrients (**Nitrogen** and **Phosphorus** in this diagram) supports a dense growth of algae, **phytoplankton** and other organisms, which eventually die and fall to the bottom and decay thus depleting the waters of **dissolved oxygen**. Low oxygen levels (**hypoxia**) are of concern for all living things living in the Sound. Areas with low oxygen levels are often referred to as **Dead Zones**.

### Questions:

1. Where do you think these nutrients (**Nitrogen and Phosphorus**) come from and how do they get into the water?

2. Circle the correct words to complete the sentence:

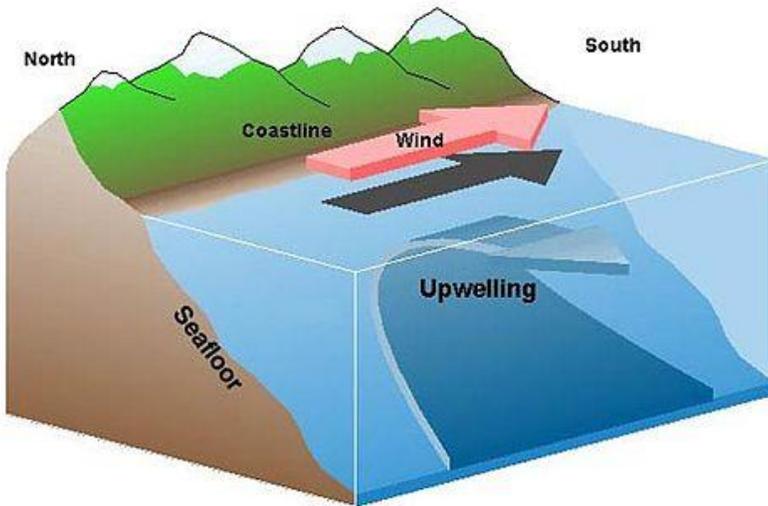
A dramatic (**increase / decrease**) of phytoplankton will eventually cause dissolved oxygen levels to (**increase / decrease**).

## Upwelling

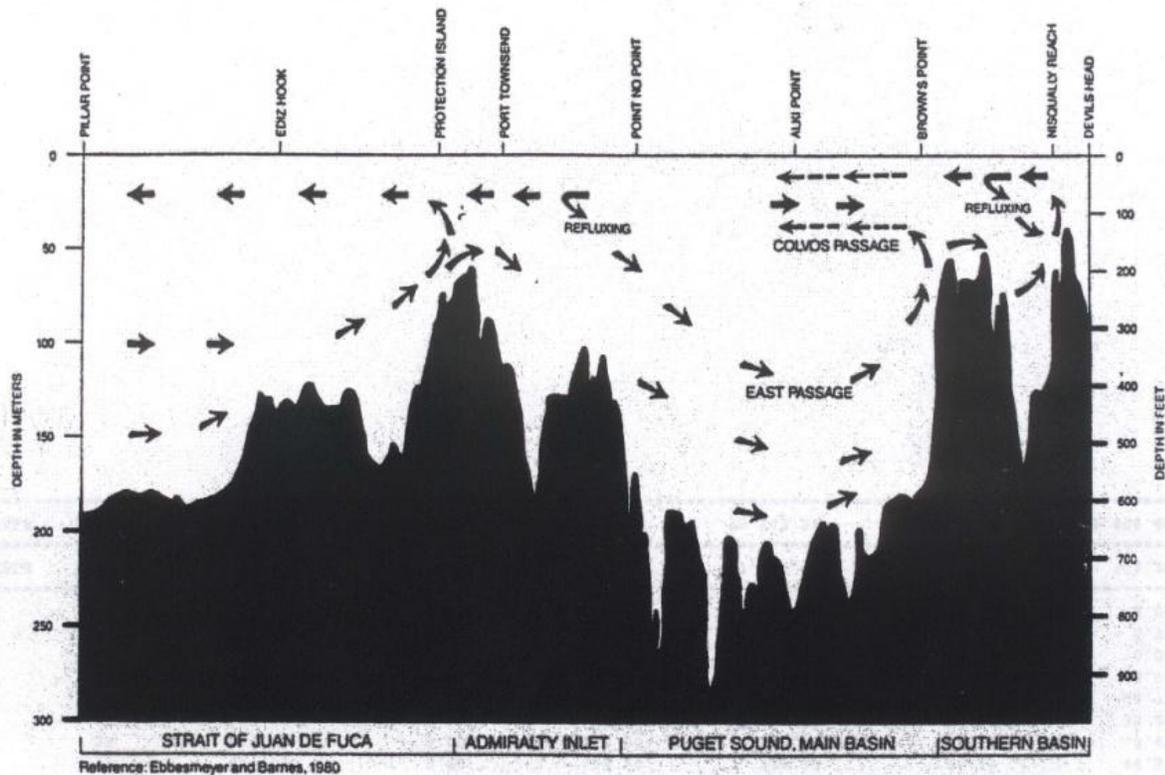
Upwelling is a process in which the colder, nutrient-rich waters are driven upwards to replace the warmer, often nutrient-depleted surface waters. Wind, currents, sills and other elements of the landscape can all affect upwelling.

### Question:

1. How might upwelling affect marine life?



Source: [www.greenseaupwelling.com](http://www.greenseaupwelling.com)



Circulation in Puget Sound - Source:

## Scientific Method

Number the steps of the scientific method in the correct order:



Source: [www.crsd.org](http://www.crsd.org)

**Question:** Are there any steps that you would include that aren't listed?

**Variables:** Match with the correct definition

A. Manipulated/Independent Variable

B. Responding/Dependent Variable

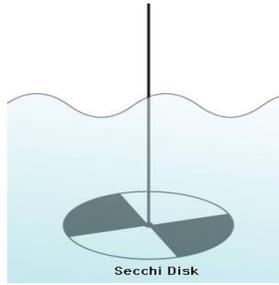
C. Controlled Variable

1. \_\_\_\_\_ The variable changed by the scientist.
2. \_\_\_\_\_ Quantities that the scientist wants to remain constant.
3. \_\_\_\_\_ Observed by the scientist and affected by changes to #1.

## Part II: Test Equipment and Water Quality

Image Sources: [my.opera.com](http://my.opera.com); [www.massaudubon.org](http://www.massaudubon.org)

Match the name of the equipment with its function:



Name of Equipment	Function
1. Niskin Bottle	____ Food for rabbits.
2. Phytoplankton Net	____ Collects animal plankton from the water column.
3. Zooplankton Net	____ Fine mesh material collects plant plankton.
4. DO Probe/Temp	____ Collects organisms in the air/water interface.
5. Refractometer	____ Measures the amount of salt in the water.
6. Secchi Disk	____ Collects sample from the bottom of the sound.
7. Carrot	____ Measure the clarity of the water.
8. Ponar Grab	____ Measures the temperature and dissolved oxygen in the water.
9. Neuston Net	____ Collects water at different depths

## Parameter Interrelationships:

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Image Source: [www.tomalesbaywatershed.org](http://www.tomalesbaywatershed.org)

Many of the parameters that we are able to test while on the Carlyn are very closely related to each other.

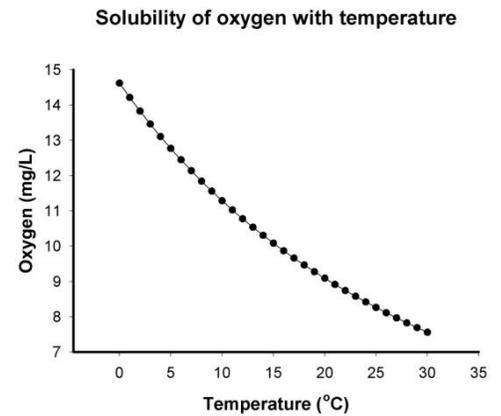
For example:

Levels of dissolved oxygen are limited by water temperature. Cold water can hold more dissolved oxygen than warmer water.

Circle the correct correlation:

When water temperature increases, dissolved oxygen levels will increase/decrease/stay the same.

What other parameters do you think are related? Which ones and why?



### Part III: Brainstorm

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#### Menu of Equipment and Parameters

Circle the equipment and variables you are most interested in investigating while aboard the Carlyn.

Equipment	Responding Variables (Parameters)	Manipulated/Independent Variables
Niskin Bottle	Dissolved Oxygen	Depth of Sample
Phytoplankton Net	Nitrates	Depth of Sound
Zooplankton Net	Phosphates	Nearshore/ Offshore
DO Probe	Surfactants	Proximity to freshwater
Refractometer	Silica	Developed/undeveloped
Secchi Disk	Temperature	<i>Others?</i>
Ponar Grab	Salinity	
Neuston Net	Phytoplankton/ Zooplankton	
Colorimeter	Turbidity	
	Sediment sample	

1. Narrow your choices to **two** pieces of equipment:
  
  
  
  
  
  
  
  
  
  
2. Which three parameters are you most interested in measuring? How do you predict they are related?