Student Workbook

California Education and the Environment Initiative

4

Science Standard 4.2.b.

The Flow of Energy Through Ecosystems

California Education and the Environment Initiative

Approved by the California State Board of Education, 2010

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California Environmental Protection Agency

California Natural Resources Agency

Office of the Secretary of Education

California State Board of Education

California Department of Education

California Integrated Waste Management Board

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Key Partners:

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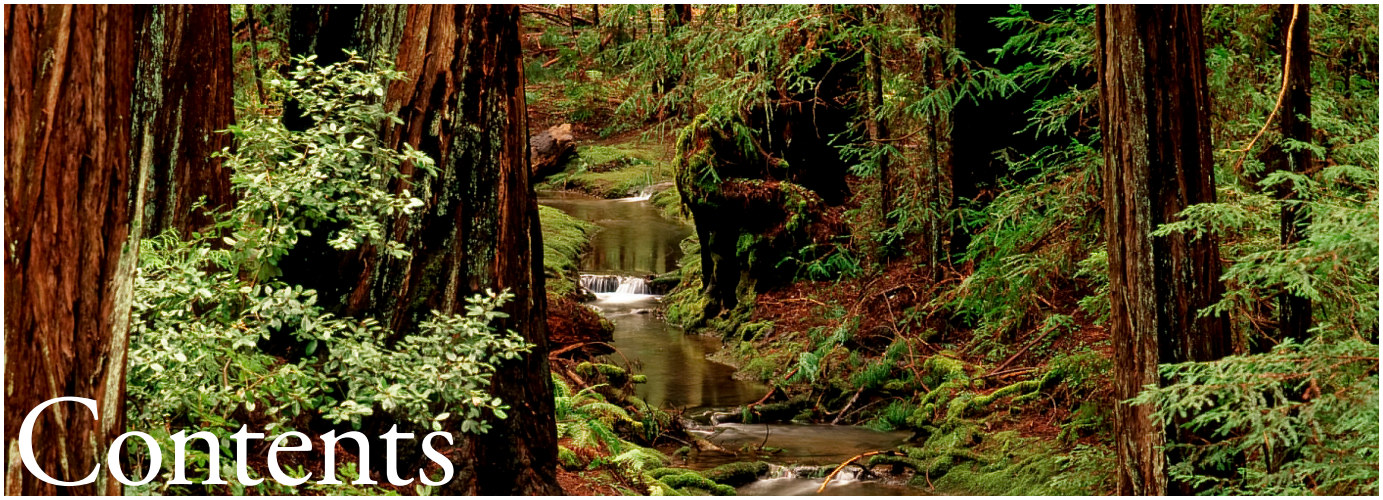

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Name: _____

Instructions: Reread the ***California Connections: The Mysterious Humboldt Squid***. Highlight (or underline) all consumers listed in the article in yellow. Then highlight (or underline) all producers listed in the article in green.

The Mysterious Humboldt Squid

Adam first heard about the Humboldt squid from a man who had a fishing boat in Mexico. The man told him that the squid were dangerous. He called them "diablo rojo" which is Spanish for "red devil." The name came from their glowing red skin. He said that Humboldt squid are difficult to catch. They fight hard when they are hooked on long fishing lines. When fishermen pull them onto their boats, the squid squirt them with water and an inky black liquid.

Adam was not sure if Humboldt squid were "devils" or not, but he was about to find out. He looked thoughtfully at the lights of Santa Rosalia in the distance. He wondered if the jumbo squid would attack him. Adam pulled on his wetsuit as the sun sank below the horizon. He watched the bright orange sky fade to blue-black. Soon, the boat captain would shine bright white lights on the dark water. That would attract the squid to the top.

Before his dive, Adam studied facts about Humboldt squid. He found out that these creatures are also known as jumbo flying squid. They get their name from the Humboldt Current. The current is like an underwater river found off the coast of South America. Many kinds of ocean creatures live in this area. This is where people first saw the Humboldt squid.

Coastal Baja California

Name: _____

The Life of a Squid

Squid are related to octopuses and cuttlefish. They are all cephalopods. Those are marine mollusks known for their big heads and arms, or tentacles. A Humboldt squid has huge eyes. It can grow up to six feet long and weigh over 100 pounds. Its body is soft and tubelike, with fins shaped like diamonds. The Humboldt squid has a total of ten arms. Two of its arms are longer tentacles used for feeding. The arms have barbed suckers on them. These barbs are very sharp, like teeth. The squid uses the barbs to grab its food and drag it into its mouth. Its mouth has a sharp beak that tears the food into tiny pieces.

Squid babies grow to adults in only one year. In order to grow so fast, they have to eat 10 percent of their weight in food every day. That is almost 10 pounds of fish a day! If humans ate in the same way as these squid, we would have to eat about 30 meals per day instead of three.

These amazing animals live for less than two years. During their short lives, the squid are very social. They swim with hundreds of other squid. They can swim up to 15 miles per hour. The squid have been known to travel 30 miles in a day, searching for food.

Humboldt squid

Name: _____

Ocean waves

When they find a school of fish, shrimp, or other food, there is a feeding frenzy. The jumbo squid spend their days together 800 feet or more beneath the ocean surface. That is deeper than any scuba diver can safely dive. They return to the surface at night to feed.

The Squid Food Web

The squid are part of a food web that includes producers, consumers, and decomposers.

Producers are organisms that can use the Sun's energy to make their own food. Some producers in the ocean are green algae, red algae, kelp and plants such as sea grasses. Producers also include some tiny floating organisms called phytoplankton.

Consumers are organisms that eat other organisms. Squid are consumers, as are fish, turtles, marine mammals, and other types of plankton called zooplankton. Humboldt squid are carnivores. They eat lanternfish, shrimp, mollusks, sardines, krill, Pacific hake, and anchovies. One Humboldt squid will even eat another Humboldt squid if it is hurt or hooked on a fishing line. Some marine animals, such as sea urchins, eat both algae and very small animals. Consumers that eat both plants and animals are known as omnivores.

Humboldt squid are eaten by other ocean carnivores, such as whales, seals, swordfish, sharks, porpoises, and marlin. Human beings eat squid, too. Fishermen also use squid as bait.

To avoid their predators, Humboldt squid can jump straight out of the water. The squid also have special cells that change the color of their skin. The cells allow the squid to blend into the background, so predators

Name: _____

cannot see them. The squid can also use their skin to flash light on and off. Marine scientists think that squid use light and color to communicate with each other.

Moving North

Humboldt squid have spread from Chile, Peru and the Gulf of California into more northern waters off the U.S. west coast. They are now found off the coasts of Central California, Oregon, Washington, and as far north as Alaska. Scientists do not know why they are moving north. Perhaps many of the squid predators, like swordfish and sharks, found farther north have been caught, so the ocean is now safer for the squid. Ocean water temperatures are rising. This may be causing the squid to move, too. For example, there was a five-year period during the 1930s when ocean temperatures were unusually warm. During that time, Humboldt squid were found in large numbers off California and Oregon. No one knows for sure why the Humboldt squid are moving.

What we do know is that now there are over 10 million squid in the waters of Baja California. People who fish there complain that a type of white fish called hake is starting to disappear. They make fish sticks out of hake, a popular food for many people. Jumbo flying squid eat hake, too. More squid means less hake, which is a problem for many people. The people who fish for hake do not like to see more squid in the water. The people and squid are competing for the same food.

Not everyone is upset about the rising population of Humboldt squid. The town of Santa Rosalia has grown because people eat the squid. The fishery in Santa Rosalia catches up to 100,000 tons of squid every year. More squid in the water means more business for the people who catch them.

Seal

Name: _____

Swimming with Squid

Adam was finally ready for his dive. The boat captain hit a switch. Light flooded the sea around the boat. Adam strapped an underwater camera around his waist. Then he fitted a vest of thick rubber over his chest to protect himself from the squid. He checked his diving gear and jumped into the water.

Soon, Adam saw hundreds of Humboldt squid rising to the surface all around him. Each squid was flashing like a light, off and on. Then they turned from white to red. At first, the squid stayed a few feet away. They moved quickly around him in many different directions. The way all the squid swam around in the water reminded Adam of a flock of birds flying through the air. In fact, the squid use their fins much like birds use their wings. Adam remembered that they are sometimes called jumbo flying squid. Now he understood how these squid can catch so many fish to eat.

Then, as quickly as they had come, the squid moved away. It was as if they realized Adam was not there to hurt them. One squid even reached out a long tentacle and touched Adam lightly on the shoulder.

Adam started taking pictures. He was amazed by the squids' beauty and strength. As his camera captured their colorful bodies on film, he knew that they were more than "red devils." Adam decided that he would learn all he could about Humboldt squid. He wanted to solve the mystery of why they had traveled so far from their South American home.

Diver near Humboldt squid

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore.** (18 points)

Organism	How I Get Energy	What Am I?
Alpine columbine	I grow in the shade in high meadows. I use the Sun's energy to make my own food.	
Alpine gold	I grow high in the mountains between 9,000 feet and 13,500 feet. I use the Sun's energy to make my own food.	
Clark's nutcracker	I mainly eat pine seeds. I also eat other types of seeds, nuts, berries, insects, and eggs of other birds. I sometimes eat dead animals.	
Gray-crowned rosy finch	In summer, I eat insects, especially cutworms. In winter, I eat seeds, especially those of Russian thistle, wild grass, mustard, and sunflowers.	
Human	I eat a wide variety of foods.	
Mountain yellow-legged frog	I eat a wide variety of land-based and water-based insects. I also eat tadpoles.	
Parnassian butterfly	When I am a caterpillar, I eat leaves from the stonecrop plant. When I become an adult butterfly, I eat the nectar of flowers.	
Pika	I usually eat flowers or grasses nearby my alpine rocky home. I need to look out for hawks that like to eat me.	
Yellow-bellied marmot	I eat the leaves and blossoms of many different plants and grasses. I also eat fruits, grains, and occasionally insects.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore**. (18 points)

Organism	How I Get Energy	What Am I?
Black-tailed jackrabbit	In the summer, I eat grasses and leafy plants. In the winter, I eat woody, dried plants. I don't need much water. I get most of my water from the plants I eat.	
Goldfields	I will grow in almost any soil. I use the Sun's energy to make my own food. Some people eat me as an herb.	
Human	I eat a wide variety of foods.	
Purple needle grass	Because my long roots can tap water deep underground, I do very well during times of drought. I use the Sun's energy to make my own food.	
San Joaquin kit fox	I mostly eat small rodents. I also like black-tailed jackrabbits. I will eat birds that nest on the ground and some insects.	
Tule elk	I forage on annual grasses. I will also eat small flowering plants. Mountain lions like to eat me.	
Western meadowlark	During the summer, I eat mostly insects. In fall and winter I eat more seeds and grain.	
Western spadefoot toad	As an adult, I eat beetles, moths, crickets, bugs, flies, ants, and earthworms. As a tadpole, I eat a variety of aquatic insects.	
Yellow-billed magpie	Most of my diet is made up of insects. I will even peck insects off the backs of mule deer. I will also eat natural and farmed fruits, grains, and berries. In the fall, I love to eat acorns.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore.** (18 points)

Organism	How I Get Energy	What Am I?
Beavertail cactus	I live on the floor of the desert and on dry, rocky slopes. I use the Sun's energy to make my own food.	
Desert bighorn sheep	I spend a lot of time grazing. I usually eat grasses and flowering plants. I also eat young twigs, leaves, and shoots. I use my horns and hooves to remove the spines of cactus pads. Then I eat their moist pulp.	
Desert tortoise	I eat grasses and shrubs. I will also eat the new growth of cacti and their flowers.	
Giant desert hairy scorpion	I mostly eat small desert insects. I will also eat small lizards.	
Human	I eat a wide variety of foods.	
Joshua tree	I am pollinated by a certain species of yucca moth. I use the Sun's energy to make my own food.	
Ladderback woodpecker	I eat insects, such as the yucca moth, that I find either beneath or on the bark of trees.	
Roadrunner	I eat lizards, snakes, grasshoppers, mice, and sometimes birds, by chasing and capturing them on the ground.	
Yucca moth	When I'm in my larval stage, I eat the seeds of yucca plants. When I am an adult, I do not eat. My life cycle at this point is very short.	

Names: _____

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Organism	How I Get Energy	What Am I?
Antelope ground squirrel	I forage on the ground and in shrubs and trees. I can carry food in pouches in my cheeks. I eat various plant parts, such as seeds, fruits, and green vegetation. I also eat insects.	
California leaf-nosed bat	I eat many types of insects. I prefer crickets, grasshoppers, moths, beetles, and caterpillars.	
Creosote brush	I handle droughts very well. My waxy leaves help me to conserve water. I use the Sun's energy to make my own food. I am eaten by ground squirrels and kangaroo rats.	
Desert pupfish	When the weather is cold, I become dormant. I burrow in the bottom of the pools where I live. When I need energy, I feed on brown and green algae.	
Human	I eat a wide variety of foods.	
Kit fox	I eat jackrabbits and rodents. I especially like kangaroo rats and ground squirrels.	
Lucy's warbler	I mostly eat caterpillars, beetles, and leafhoppers.	
Merriam's kangaroo rat	I mostly eat seeds, and plenty of those come from two main plants: creosote brush and ocotillo. I can hold seeds in my cheek pouches. I build small pits in the soil to store seeds for later.	
Ocotillo	Most of the year I do not have leaves. After a rain, I produce leaves for a short time. I have several spiny, spindly branches. I use the Sun's energy to make my own food.	

Names: _____

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Organism	How I Get Energy	What Am I?
Black oak	I am a deciduous tree; so I lose my leaves during the winter. Owls, woodpeckers, and tree squirrels use holes in my trunk as dens. I use the Sun's energy to make my own food.	
Black-tailed deer	I eat many different types of plants. I eat grasses, new growth on trees, and different types of shrubs. I even eat poison oak.	
Caddisfly	As an adult, I eat plant nectar or sap. I may also eat bits of plants. Occasionally, I eat other insects.	
Fisher	By looking at my name you might think I eat fish. I actually eat mice, porcupines, squirrels, snowshoe hares, birds, and shrews.	
Golden trout	I eat many types of insects, but my favorite food is caddisfly larvae. Humans like to eat me.	
Human	I eat a wide variety of foods.	
Lodgepole pine	I grow tall and straight in the forest. I use the Sun's energy to make my own food.	
Mountain bluebird	I eat both insects and berries.	
Pileated woodpecker	I eat insects that nest in standing and fallen trees. I will also eat wild berries and nuts.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore**. (18 points)

Organism	How I Get Energy	What Am I?
Banana slug	My favorite food is mushrooms, but I also graze on roots, fruit, seeds, lichen, algae, animal droppings, and dead animals.	
Coast redwood	As my name suggests, I grow best near the foggy coast. I use the Sun's energy to make my own food.	
Flying squirrel	I like to eat mushrooms. I also eat the seeds, nuts, leaves, sap, bulbs, bark, flowers, and roots of plants. Less often, I will eat insects, eggs, worms, small birds, and other mammals.	
Human	I eat a wide variety of foods.	
Pileated woodpecker	I eat insects that nest in standing and fallen trees. I will also eat wild berries and nuts. I play an important role in maintaining the population of wood-boring beetles.	
Spotted owl	One of my favorite meals is the flying squirrel. I also eat woodrats, voles, mice, rabbits, bats, and birds.	
Redwood sorrel	I grow close to the moist forest floor. I use the Sun's energy to make my own food.	
Mountain Lion	I am a predator and consume most animals with four legs that I find. I also eat insects.	
Wood-boring beetle	I feast on wood! In my larval stage I'm known as a woodworm. I eat wood then, too.	

Names: _____

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Organism	How I Get Energy	What Am I?
Acorn woodpecker	About half of my food is acorns. I store them in tree-trunk holes that I bore. These are very important in the winter. I also eat tree sap along with fruits, flowers, nectar, seeds, and even eat insects.	
Black-tailed deer	I eat many different types of plants. I eat grasses, new growth on trees, and different types of shrubs. I even eat poison oak.	
California dogface butterfly	When I am a caterpillar, I feed on the leaves of false indigo bush. When I am an adult, I feast on thistle nectar.	
Human	I eat a wide variety of foods.	
Indigo bush	I make pretty purple flowers. I use the Sun's energy to make my own food.	
Gray fox	I eat insects, rabbits, mice, and even the western skinks (lizards).	
Valley oak	The acorn woodpecker loves to eat my acorns. I use the Sun's energy to make my own food.	
Western bluebird	In summer, I normally eat insects. In winter, I eat more berries and small fruits.	
Western skink (lizard)	I am a reptile. I eat insects, spiders, and worms.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore**. (18 points)

Organism	How I Get Energy	What Am I?
Beaver	I eat cattail shoots, parts of pond lilies, and other aquatic plants. I also eat the bark of cottonwood, willow, and other trees.	
Black bear	I eat many different types of food. I eat small mammals, insects, berries and nuts, grasses, and even wood. I will also eat dead animals.	
Bobcat	I am a nocturnal animal, so I do my hunting at night. I like to eat rabbits, squirrels, ground birds, and small deer.	
Cattail	I live in wetlands and in damp areas near rivers, lakes, and ponds. Many of my parts are edible to humans and other animals. I use the Sun's energy to make my own food.	
Cottonwood tree	I grow very quickly in the wet ground along riverbanks. I survive flooding very well. I use the Sun's energy to make my own food.	
Crayfish	I look like a little lobster. I eat worms, insect larvae, and small fish. I am also a scavenger, so I will eat dead fish, other animals, and plants.	
Human	I eat a wide variety of foods.	
Red-shouldered hawk	I build nests in large trees that are often near water. I eat rodents, such as voles, mice, and chipmunks. I also eat small snakes and birds.	
Western yellow-billed cuckoo	I look for food in shrubs and trees. I eat insects, such as tent caterpillars, grasshoppers, moths, and cicadas. I also eat treefrogs and lizards, and some fruits and seeds.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore**. (18 points)

Organism	How I Get Energy	What Am I?
Big sagebrush	I live in dry plains, mesas, or rocky areas. I use the Sun's energy to make my own food. Pronghorn antelope, mule deer, and sage grouse depend on me for food during the winter.	
Coyote	I eat rabbits, squirrels, mice, and grouse. Fruits and vegetables are a big part of my diet in the fall and winter.	
Greater sage grouse	Most of my diet is sagebrush leaves and buds, especially in the winter. In other seasons, I will eat other small flowering plants and some insects. Unlike many other birds, I do not eat seeds.	
Human	I eat a wide variety of foods.	
Pinyon jay	I mostly eat seeds from the pinyon pine. I pry the cones open with my sharp bill. I store the seeds in the fall so I can eat them in the winter and early spring. I also eat some insects, nuts, and fruits.	
Pinyon mouse	I eat berries, seeds, nuts, and insects.	
Plain titmouse (a small bird)	I eat many creatures, such as caterpillars, beetles, ants, wasps, and grasshoppers. I also eat berries and seeds.	
Pronghorn antelope	I eat grasses, weeds, sagebrush, and cacti.	
Single-leaf pinyon pine	I grow to about 15-feet tall in rocky soil and rock crevices. Pinyon jays eat my seeds. I use the Sun's energy to make my own food.	

Names: _____

Instructions: Read how the following organisms get their energy. Decide whether each organism is a **producer** or **consumer,** and select your answer in the right-hand column. If it is a consumer, also select an "H" if the organism is an **herbivore**, an "O" if it is an **omnivore**, or a "C" if it is a **carnivore**. (18 points)

Organism	How I Get Energy	What Am I?
Blue mountain lilac	I grow bright blue flowers. I use the Sun's energy to make my own food.	
Ceanothus silkmoth	When I am a caterpillar, I eat a number of different plants, including the blue mountain lilac. When I am an adult, I do not eat. My life cycle at this point is very short.	
Chamise	I live on dry slopes. I use the Sun's energy to make my own food.	
Coast horned toad	I mostly eat ants, beetles, and spiders. If you want to find me, look near anthills.	
Gray fox	When I hunt, I hunt alone. I hunt birds, insects, rabbits, and other rodents.	
Human	I eat all different kinds of foods.	
Meadow mouse	I eat seeds, nuts, berries, and other parts of flowering plants.	
Pacific rattlesnake	I prey on lizards and rodents, such as small rabbits, rats, and mice.	
Wrentit	I eat insects, fruits, and seeds.	

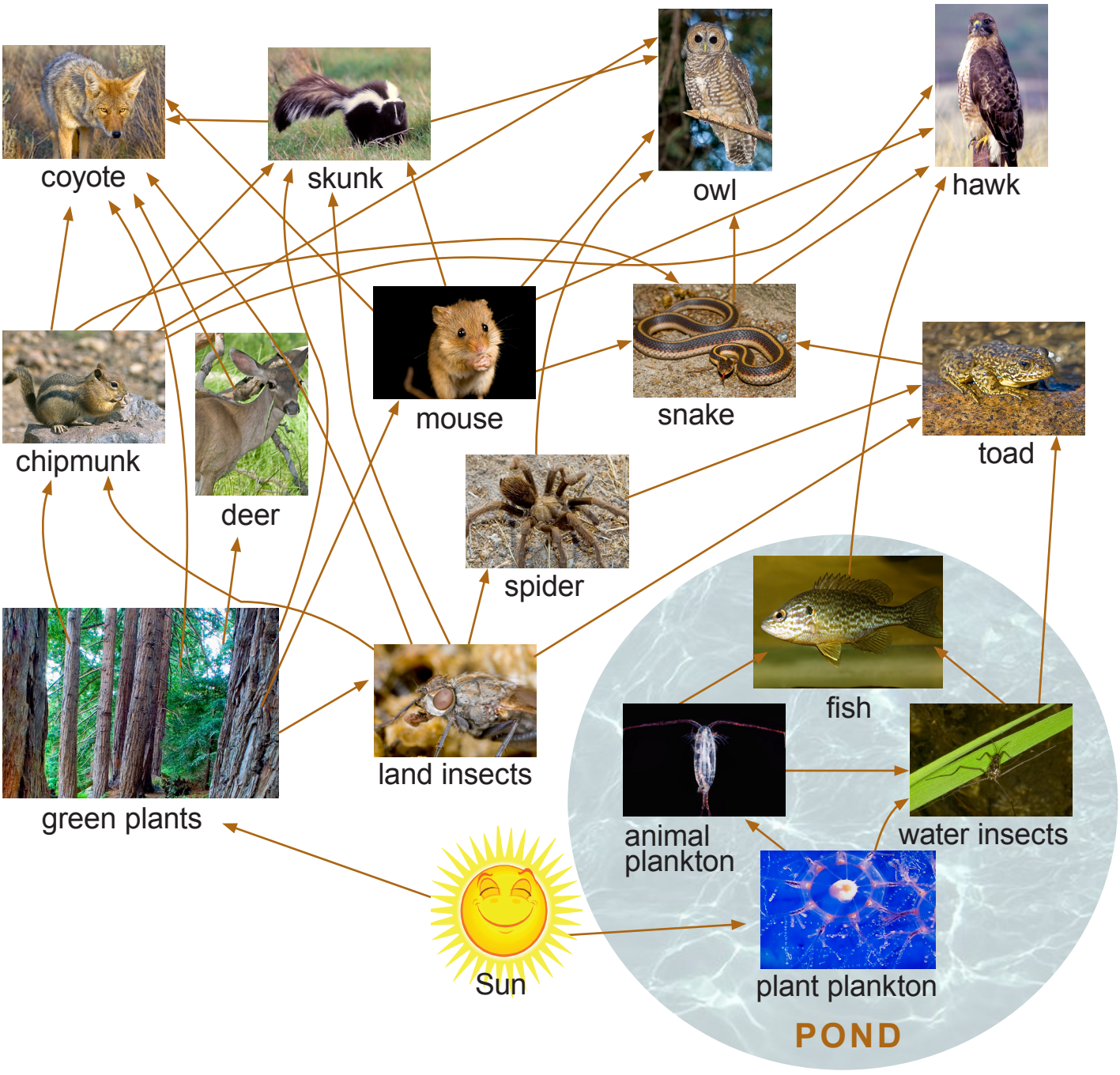
Name: _____

Instructions: Read about each of the organisms. Use this chart as a guide during the class "Where I Get Energy" discussion.

Organism	Where I Get Energy
Anchovy	plankton (plant and animals, such as krill)
Animal plankton	plankton (plant)
Humboldt squid	lanternfish, shrimp, mollusk, sardine, krill, Pacific hake, Humboldt squid, and anchovy
Krill	plankton (plant and animal)
Lanternfish	plankton (animal)
Marlin	Humboldt squid, sardine
Mollusk	plankton (plant and animal)
Orca (killer whale)	Humboldt squid, sardine, seal, filetail catshark
Pacific hake	sardine, shrimp
Pacific mackerel	anchovy
Plant plankton	Sun
Sardine	plankton (plant and animals, such as krill)
Seal	Humboldt squid, Pacific hake, sardine
Shrimp	mollusks, plankton (plant and animal)

Name: _____

Instructions: Use this food web to help you answer the following questions.



Name: _____

Think and Write:

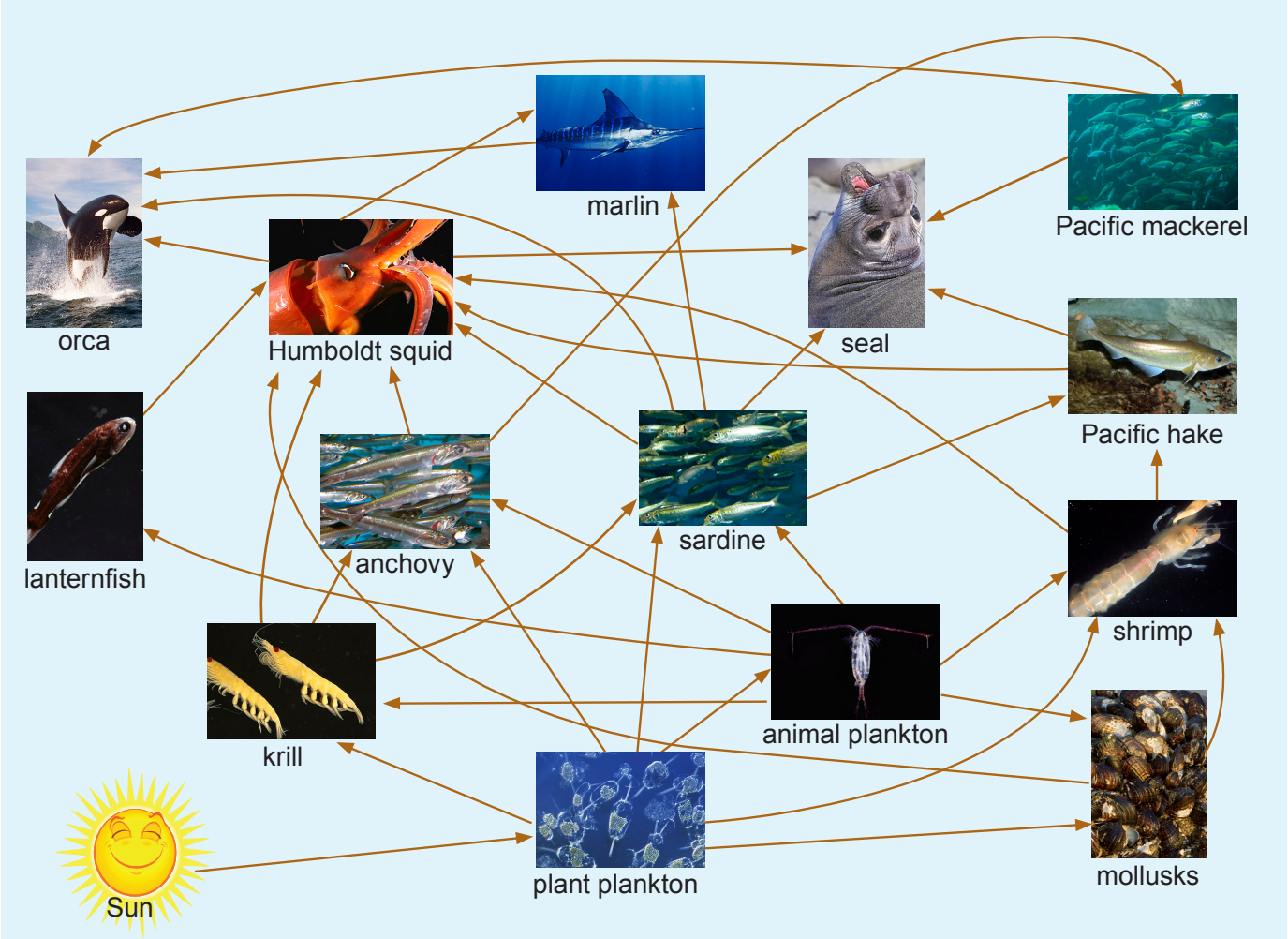
1. Which organisms in the food web above compete with one another for food?

2. Which food do you think consumers **competed** for most in this ecosystem?

3. What would happen if we added humans to this food web? What foods might humans eat and who would humans compete with for that food?

Name: _____

Instructions: Use this food web to help you answer the following questions.



Think and Write:

1. If the sardines were to disappear from this ecosystem, what would happen to the plankton? (3 points)

Name: _____

2. If the sardines were to disappear from this ecosystem, what would happen to the orca, marlin, seals, Humboldt squid and Pacific hake? (3 points)

3. If the sardines were to disappear, which organisms might compete more with each other? Explain which organisms might compete less with each other? Explain. (4 points)

Name: _____

Instructions: Read the top part of the page. Discuss the reading with your partner. Work together to answer the questions that follow the article.

Outbreak!

It was a summer day in the forest. Flea eggs hatched in the warm weather. The fleas carried a virus (or germ) that did not make insects sick, but could make small mammals very sick. The young fleas hopped around, looking for their first meal of blood.

A chipmunk ran over the ground near the fleas. A hungry flea jumped on the chipmunk. The chipmunk did not feel the flea bite, but when it did, the flea's virus went into the chipmunk through its blood. Later, the chipmunk went home to its nest in the pine tree. The same flea bit the other chipmunks there, getting energy from their blood. All of those chipmunks got the virus from the flea. Next, the flea laid eggs. When those eggs hatched, there were more fleas, with more of the virus. The fleas spread the virus to all the chipmunks in the tree.

One night, a hungry mouse came to the chipmunk's nest. It was looking for leftover food. The fleas with the virus bit the mouse, too, and it got sick just like the chipmunks did. Then the mouse carried some of the fleas back to its nest on the ground. Pretty soon, the rest of the mice in the forest had the virus, too.

In about a week, all the mice in the forest had died from the virus. Half the chipmunks in the forest had also died from the virus.

Think and Write:
Think of how the whole forest ecosystem would be affected by this change. Then answer the following questions:

1. Where do the mice and chipmunks get their energy? (2 points)

Name: _____

2. What organisms get energy from mice and chipmunks? (5 points)

3. How would the food web be affected if there were no mice and fewer chipmunks? Provide two examples. (4 points, 2 points each)

4. How would the deer be affected by the change in the food web? (2 points)

Name: _____

5. How would the snakes be affected by the change in the food web? (3 points)

6. How might the fish be affected by the change in the food web? (2 points)

7. How could the virus outbreak change the whole forest? (2 points)

Name: _____

Instructions: Read the top part of the page. Discuss the reading with your partner. Work together to answer the questions that follow the article.

Earthquake!

At one o'clock in the afternoon, the ground began to shake in the forest. A coyote sleeping in its den felt some sand and small rocks fall on its head. A hawk in a pine tree had to hold on to a branch to keep from falling.

The ground under the pond in the forest cracked during the earthquake. The water in the pond began to go underground. At first, the fish did not notice the water around them was disappearing. The plankton in the water near the top of the pond and the worms living in the water near the bottom of the pond were the first to feel that something was changing.

The next day, the pond only had half as much water in it. The coyote walked by in the afternoon and saw toads sitting in the wet dirt around the pond where the water used to be. They were watching the insects in the pond. There seemed to be a lot more insects in the water, but that was just because the pond was smaller. The hawk flew over the pond, hunting for fish. The fish were closer than ever to the top of the water.

Two days after the earthquake, the pond dried up. The fish were all eaten. The plankton, water insects, and algae had died without water.

Think and Write:
Think of how the whole forest ecosystem would be affected when the pond disappeared. Then answer the following questions:

1. List the organisms that lived in the lake. (5 points, 1 each)

Name: _____

2. What organisms ate the organisms that lived in the lake. (2 points)

3. How would the food web in the forest be affected by the pond's drying up? (2 points)

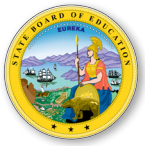
4. How might owls be affected by this change in the food web? (2 points)

Name: _____

5. How might snakes be affected by this change in the food web? (2 points)

6. How might mice be affected by this change in the food web? (2 points)

7. How might the earthquake change the whole forest? (5 points)



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