Project WILD Aquatic

Project WILD Aquatic K–12 Curriculum and Activity Guide Student Pages

Principal Sponsors

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Cover photos of large-mouth bass and swordfish courtesy of Bass Pro Shops.

Awards and Recognition

Project WILD, its sponsors, and many of its participants—including students and educators—have received a variety of awards and recognition. Project WILD was honored at the White House in 1991 as one of the first recipients of a Gold Medal for Education and Communications in the President's Environment and Conservation Challenge Award program. This award was bestowed "for excellence in developing innovative solutions to the nation's environmental challenges." Project WILD has also received the Conservation Education Award from The Wildlife Society. These materials have been endorsed by the National Council for the Social Studies and are consistent with recommendations of the National Science Teachers Association.

These materials have been developed through a cooperative agreement with the U.S. Fish and Wildlife Service. By this agreement, these materials can be made available to state fish and wildlife agencies through the U.S. Fish and Wildlife Service. Funding for the development of these materials has been provided with support from monies made possible through the Wallop-Breaux Amendment to the Sport Fish Restoration Act. This federal legislation provides support for aquatic resources education to increase public understanding of, and responsibility toward, the nation's water resources and aquatic life forms.

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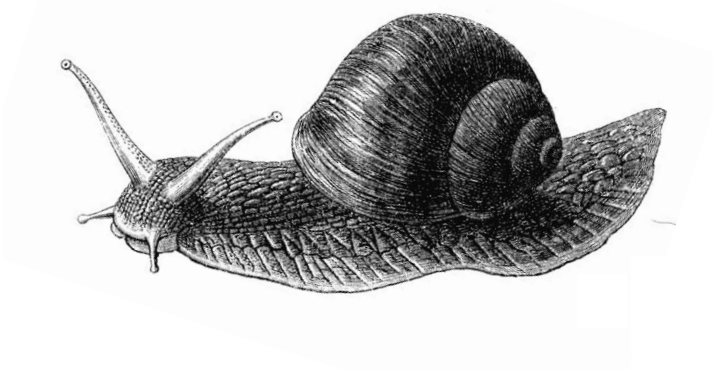
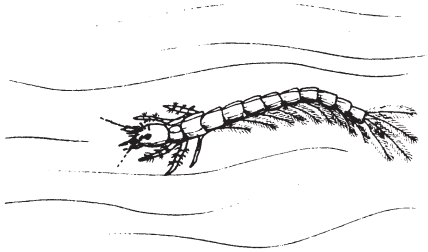


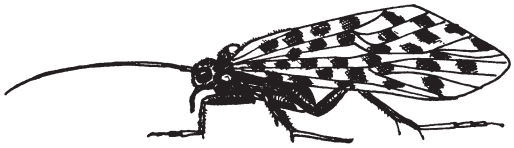
Alphabetical Listing

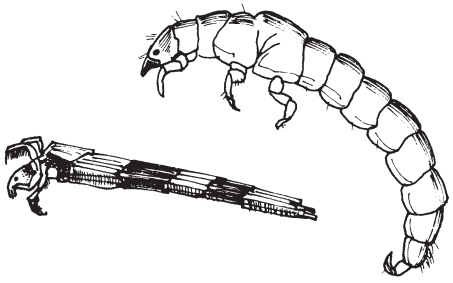
Whirling Beetle



Whirling Larva

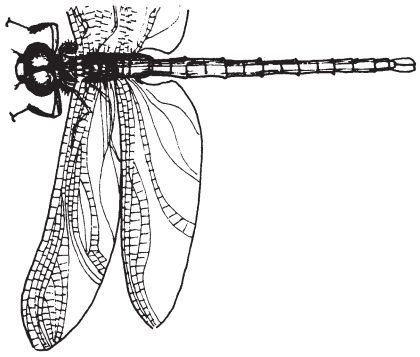
Caddisfly

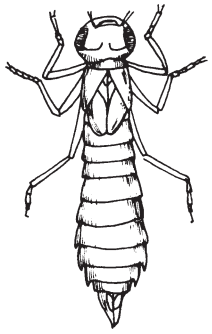




Caddisfly Larvae

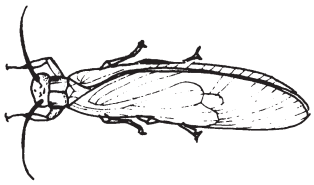
Dragonfly

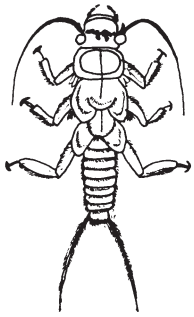




Dragonfly Nymph

Stonefly



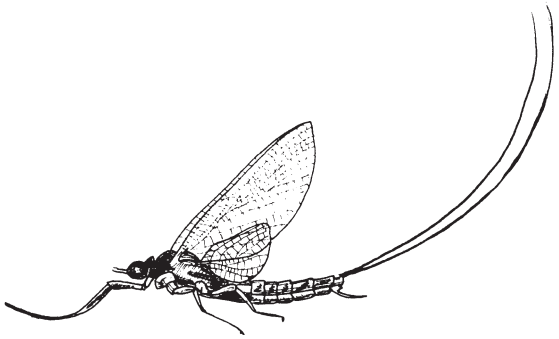


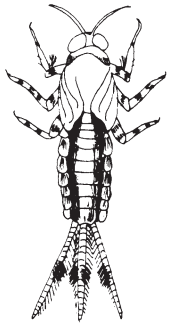
Stonefly Nymph

Osprey

Osprey Hatchlings

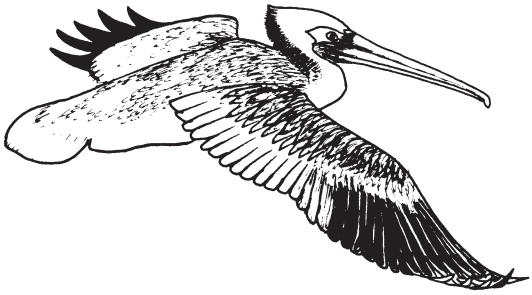
Mayfly





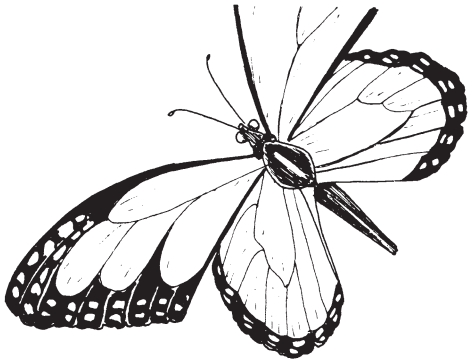
Mayfly Nymph

Pelican



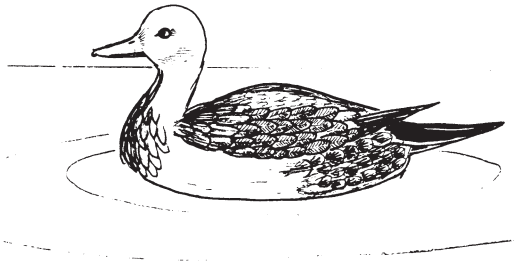
Pelican Nest and Eggs

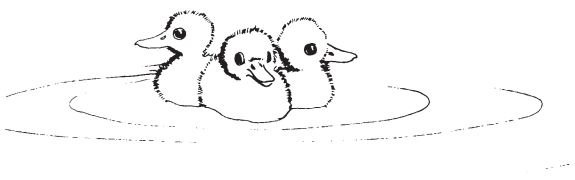
Butterfly



Butterfly Larvae

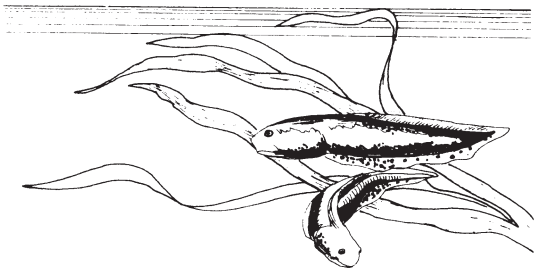
Duck





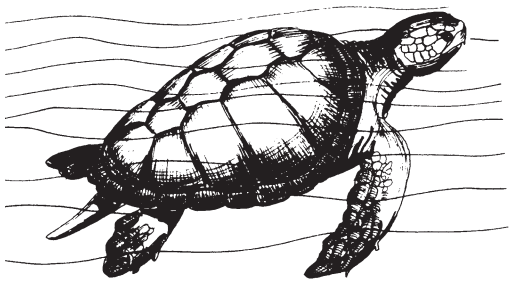
Ducklings

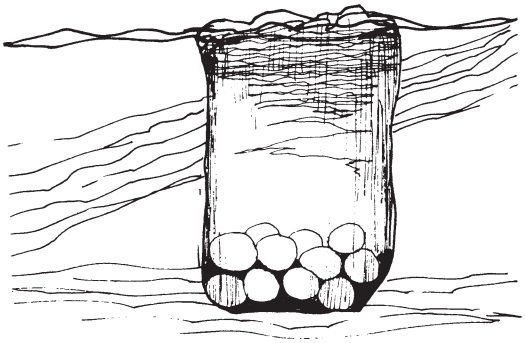
Frog



Tadpoles

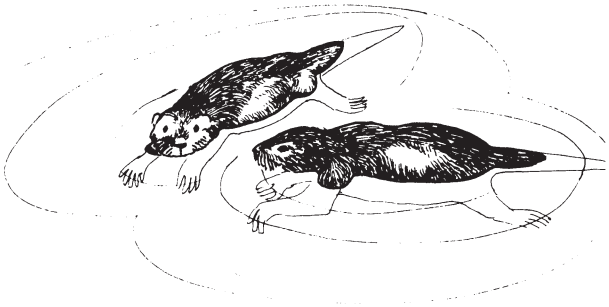
Sea Turtle





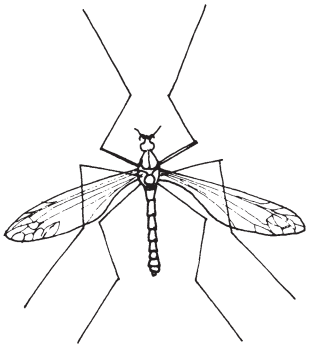
Sea Turtle Eggs

Sea Otter



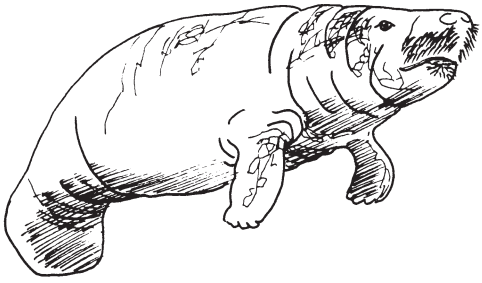
Young Sea Otters

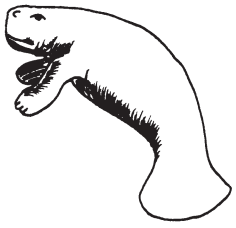
Cranefly



Cranefly Larva

Manatee



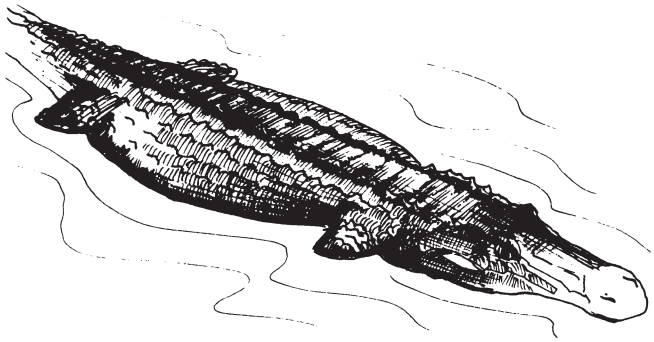


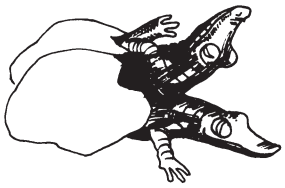
Young Manatee

Skate

Skate Egg Cases

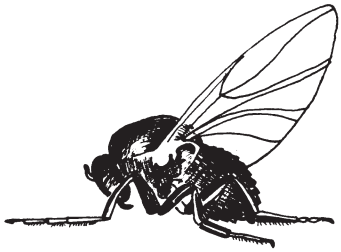
Alligator

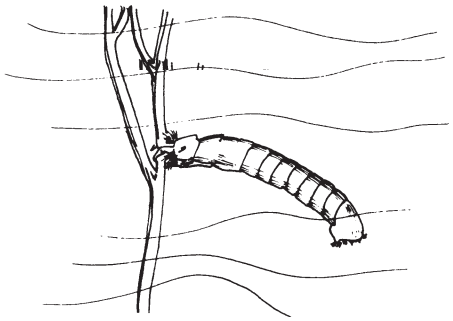




Alligator Hatchlings

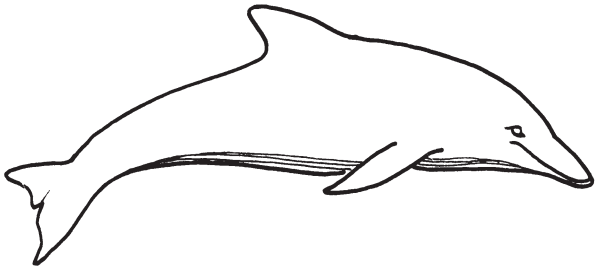
Black Fly





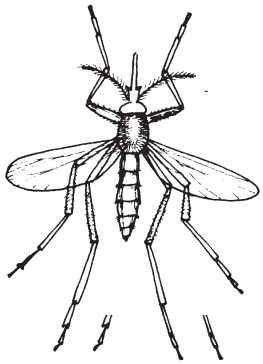
Black Fly Larva

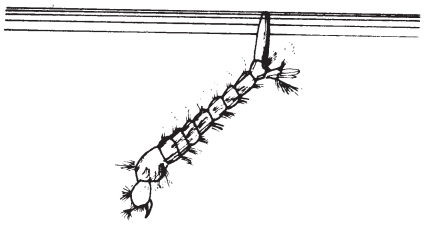
Porpoise



Young Porpoise

Mosquito





Mosquito Larva

Adult Beaver

Young Beavers

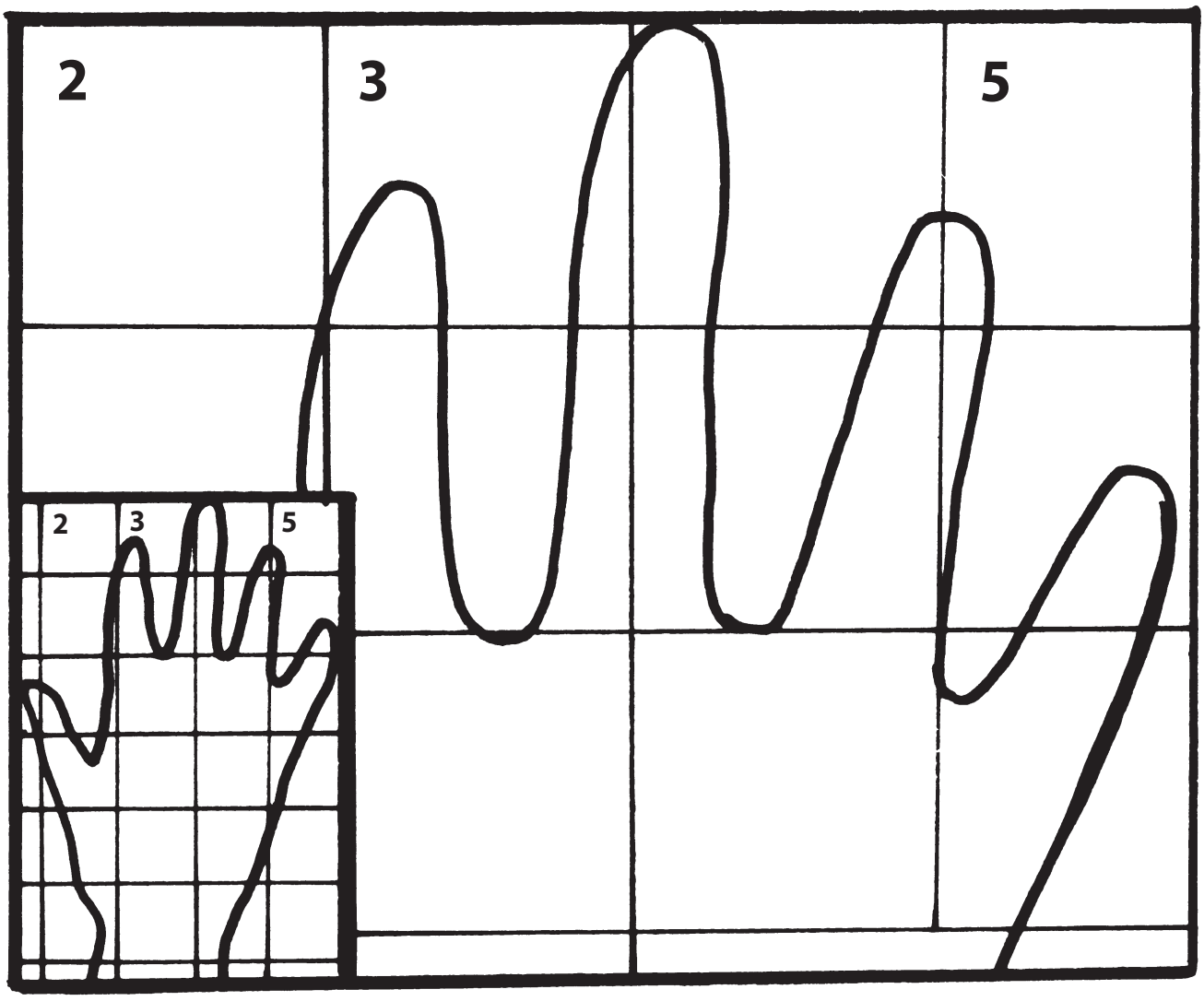


Diagram A

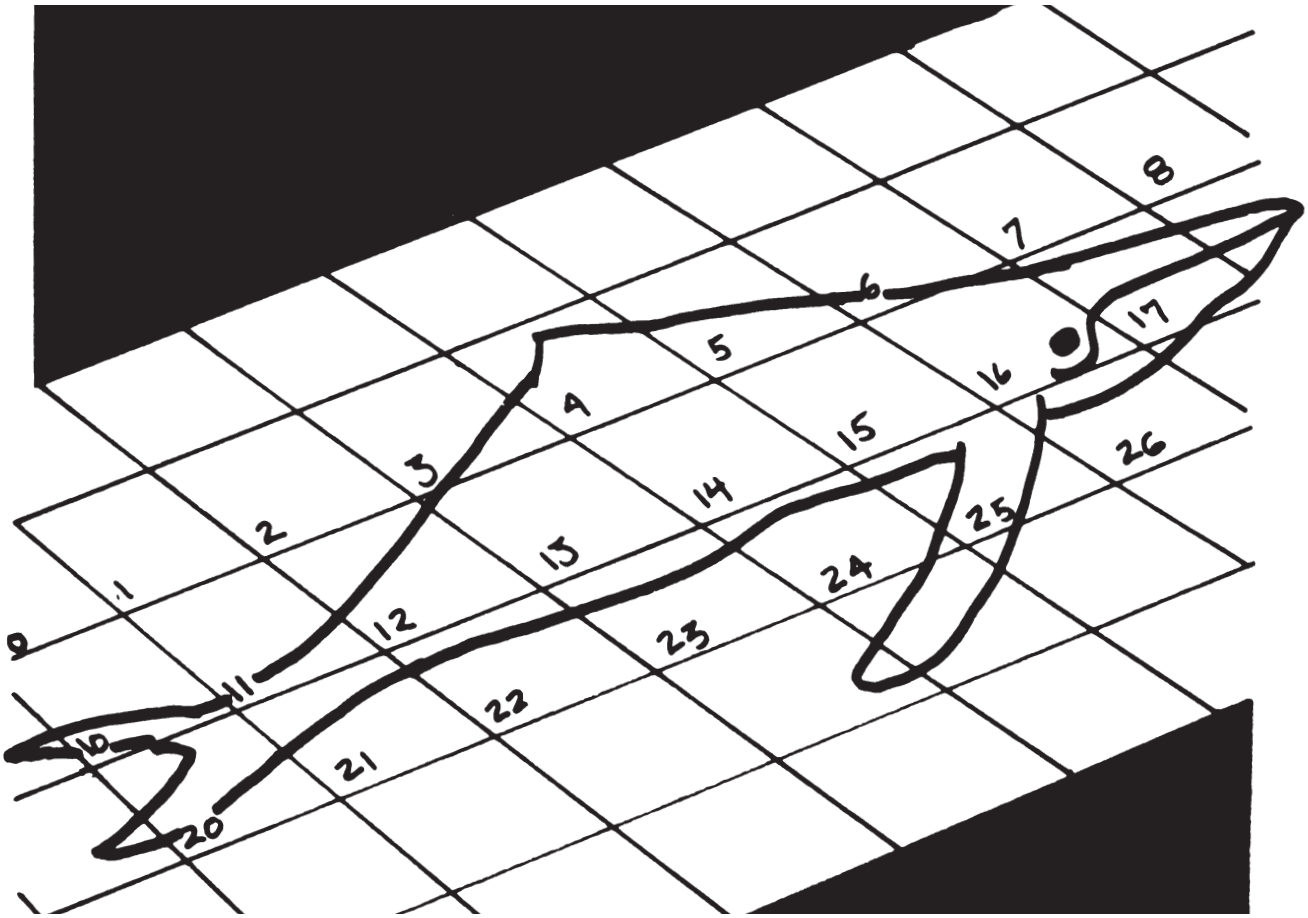


Diagram B

Pattern for Life-Size Whale

List of Materials

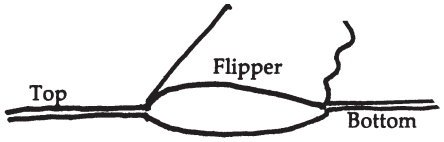
1. Black plastic, 4 mil, 24 feet (7.2 m) by 100 feet (30 m)
2. Clear/White plastic, 4 mil, 16 feet by 100 feet (4.8 m by 30 m)
3. Clear 2 inch (5 cm) wide plastic tape—20 rolls

Tools Needed

1. Tape measures, 100 feet (30 m) and 26 feet (8 m)
2. Scissors to cut the plastic and tape
3. High-speed fan

Steps

1. Lay plastic on 10-foot (1 m) grid.
2. Cut out all parts; cut out some of the flippers or tail flukes from the cutout sections of the whale body.
3. Tape together the flippers and tail flukes (remember the right and left sides for both), and tape together the top dorsal fin. Do not tape the body (straight side) connection.
4. After taping the "fins," turn inside out, placing the tape seam inside.
5. Tape together the cutout sections of the whale's top section as indicated on the plan.
6. Tape together the cutout sections of the whale's bottom section as indicated on the plan.
7. Place the tail flukes and flippers on the bottom section of the whale at their locations.

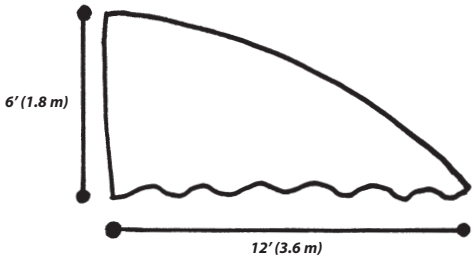


8. Start taping the top section to the bottom section, using the tail flukes as side walls where they connect to the body; start at the tail section on each side and work toward the mouth area.
9. Do not tape the end of the tail section together.
10. Mouth area—the clear/white plastic will have to be pleated to meet the side area taping; start in the center of the mouth and work out the sides—about 2 inches (5 m) for each pleat.
11. Once the whale is fully taped, place the fan in the tail opening and inflate the whale. One person will go into the whale to the nose section and pull the nose section out through the tail opening, inverting the seams and letting the flippers and tail flukes to the outside.
12. Mount the top dorsal fin on the black top section in the center of the tail section about 58 feet (17.4 m) from the front of the whale.
13. Place the-9 inch (22 cm) eye drawings on the top section, just in front of the flippers.

14. Inflate the model with the high-speed fan; step back and give it room.

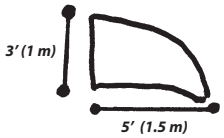
Tail Flukes

2 black and 2 clear/white pieces
(Will create right and left tail sections)



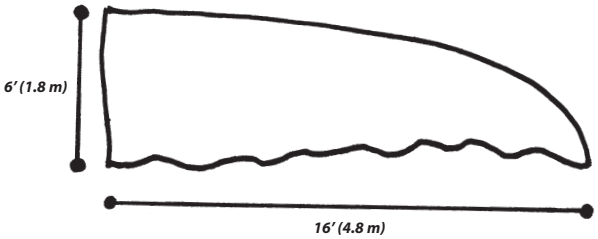
Top Dorsal Fin

2 black pieces

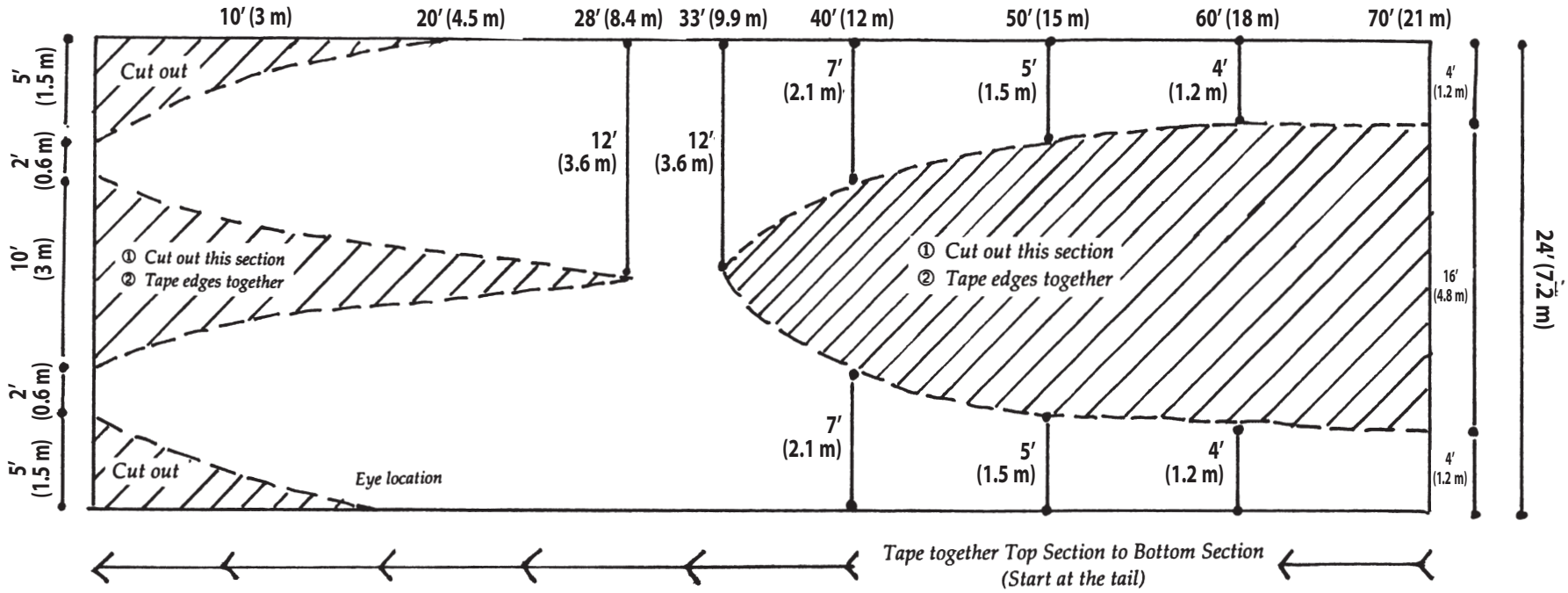


Flippers

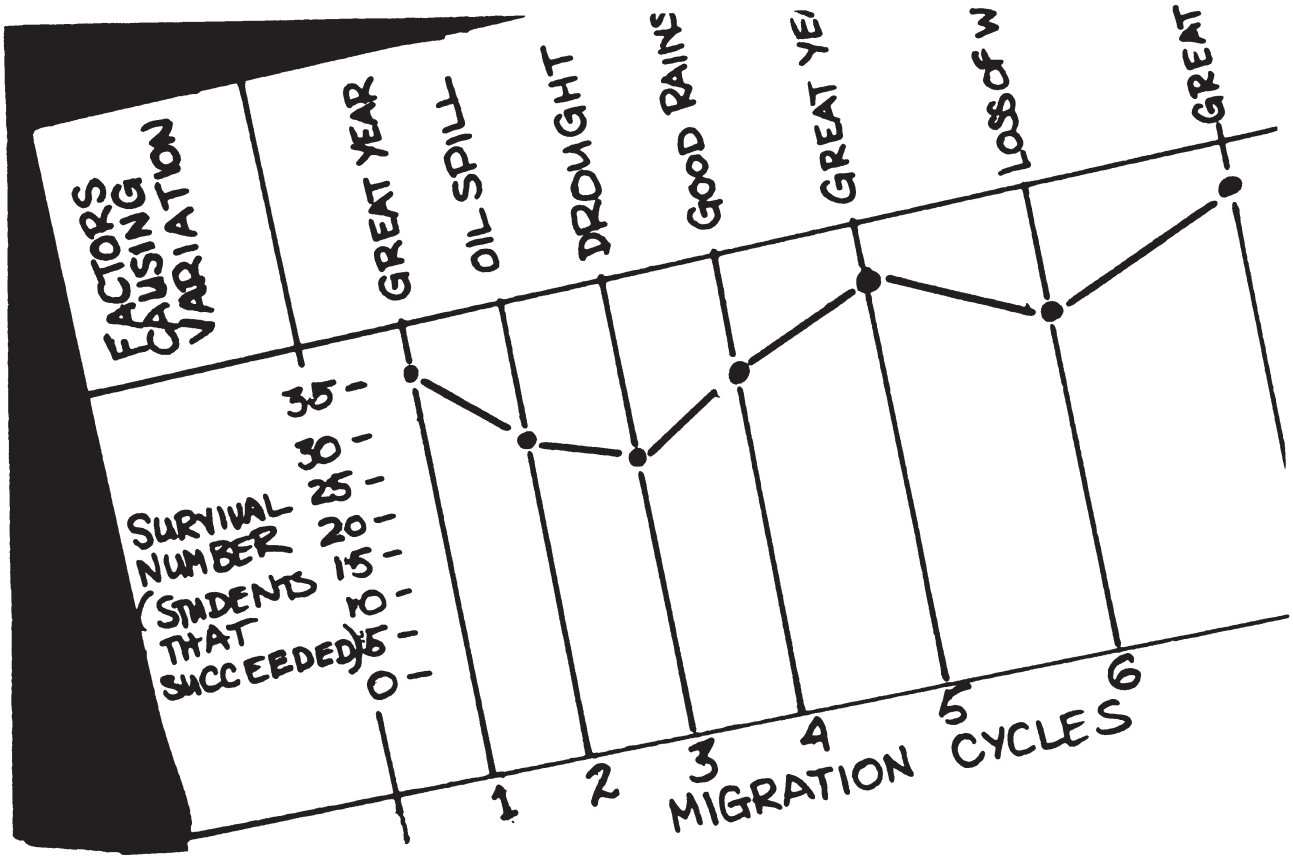
2 black and clear/white pieces
(Will create right and left flipper sections)



Top Section
24′ x 100′ (7.2 m x 30 m) 4 mil black plastic



Bottom Section
16′ x 100′ (4.8 m x 30 m) 4 mil clear/white plastic



The Water Cycle

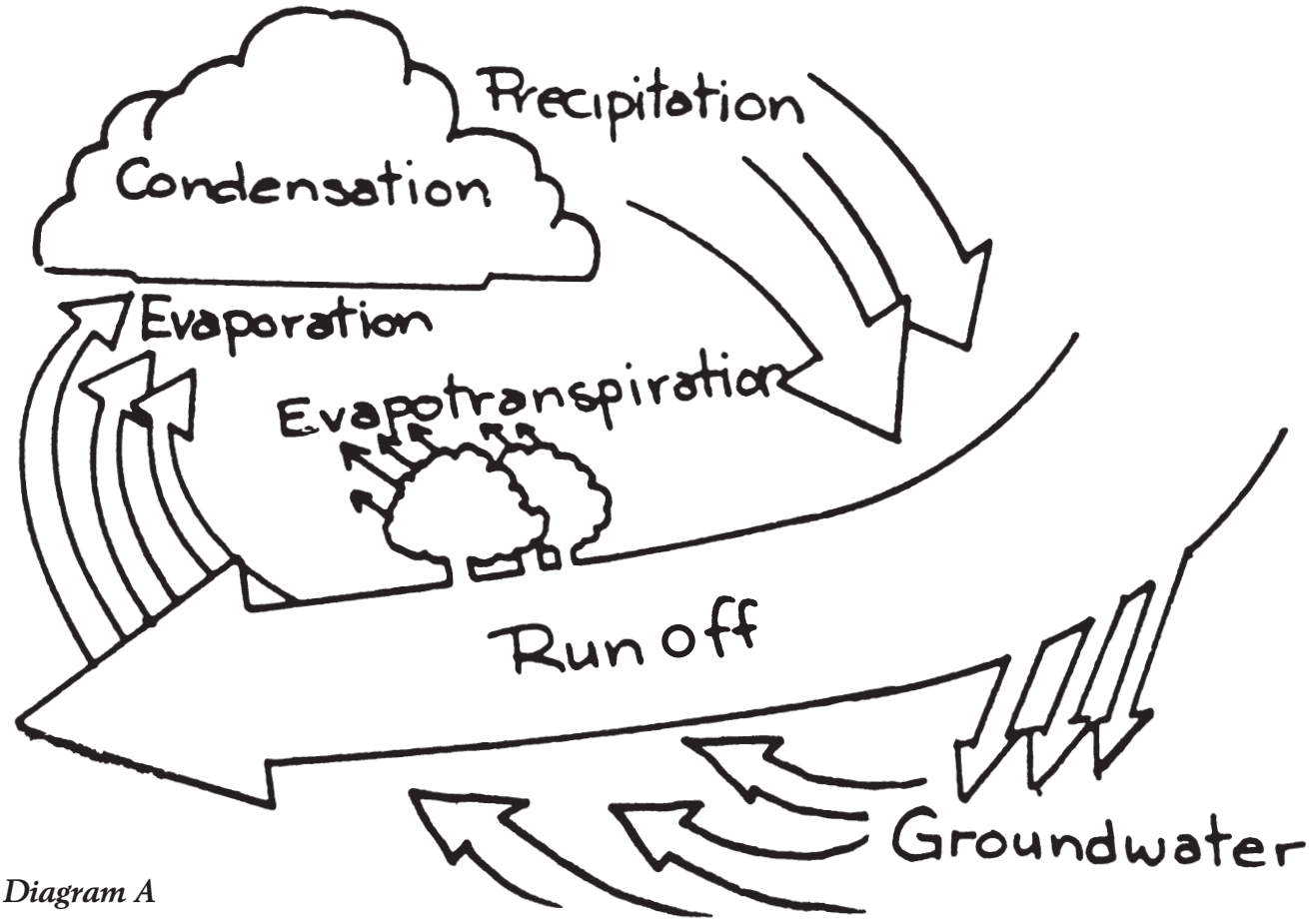
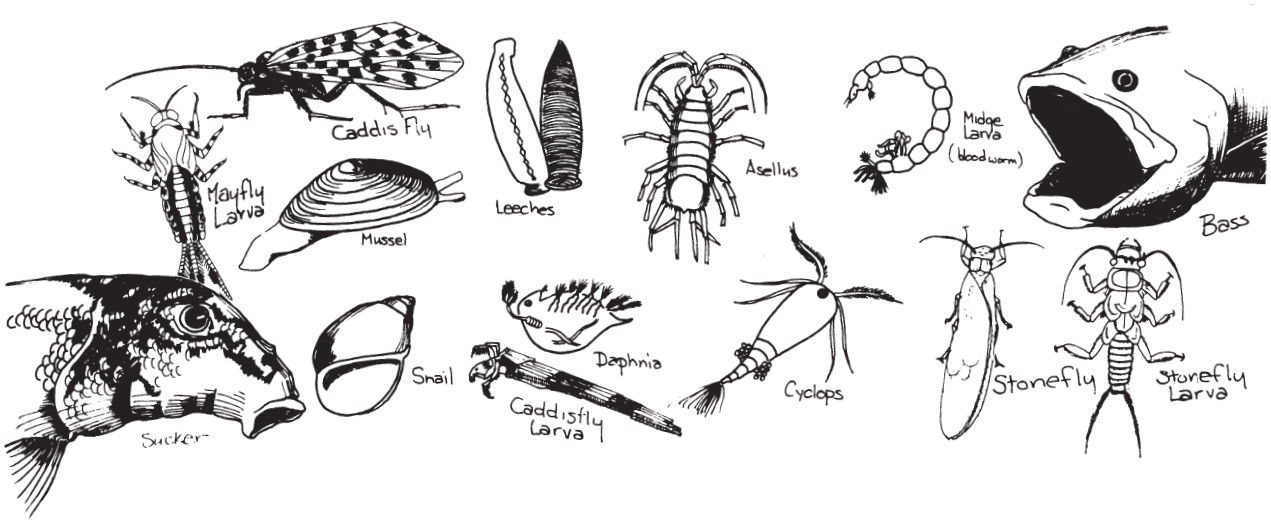
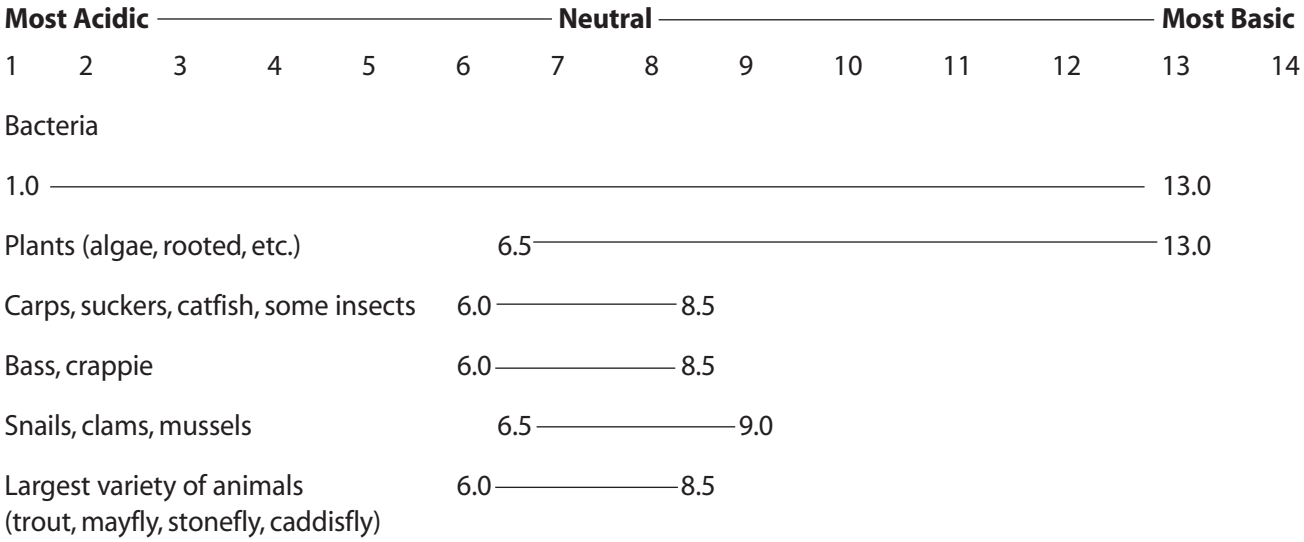


Diagram A



pH Ranges That Support Aquatic Life



Temperature Ranges (Approximate) Required for Certain Organisms

Temperature	
Greater than 68 °F (20 °C) = Warm water	Much plant life, many fish diseases Most bass, crappie, bluegill, carp, catfish, caddisfly, dragonfly, mayfly, mussels.
55 – 68 °F (12.8 – 20 °C) = Cool water	Plant life, some fish diseases Salmon, trout, stonefly, mayfly, caddisfly, water beetles, smallmouth and rock bass, various minnows and darters, mussels
Less than 55 °F (12.8 °C) = Cold water	Trout, caddisfly, stonefly, mayfly, various minnows, darters, sculpins

Dissolved Oxygen (DO) Requirements for Native Fish and Other Aquatic Life (DO in parts per million [ppm])

(Below 68 °F)	(Above 68 °F)
Cold-water organisms including salmon and trout	Warm-water organisms including fish such as bass, crappie, catfish, and carp
6 ppm	5 ppm

Student Worksheet I

Where Organism Was Found	Sketch of Organism	Number Found

Student Worksheet II

Observations	Predictions
Water Temperature _____ **Air Temperature** _____ **pH** _____ **Dissolved O_2** _____	

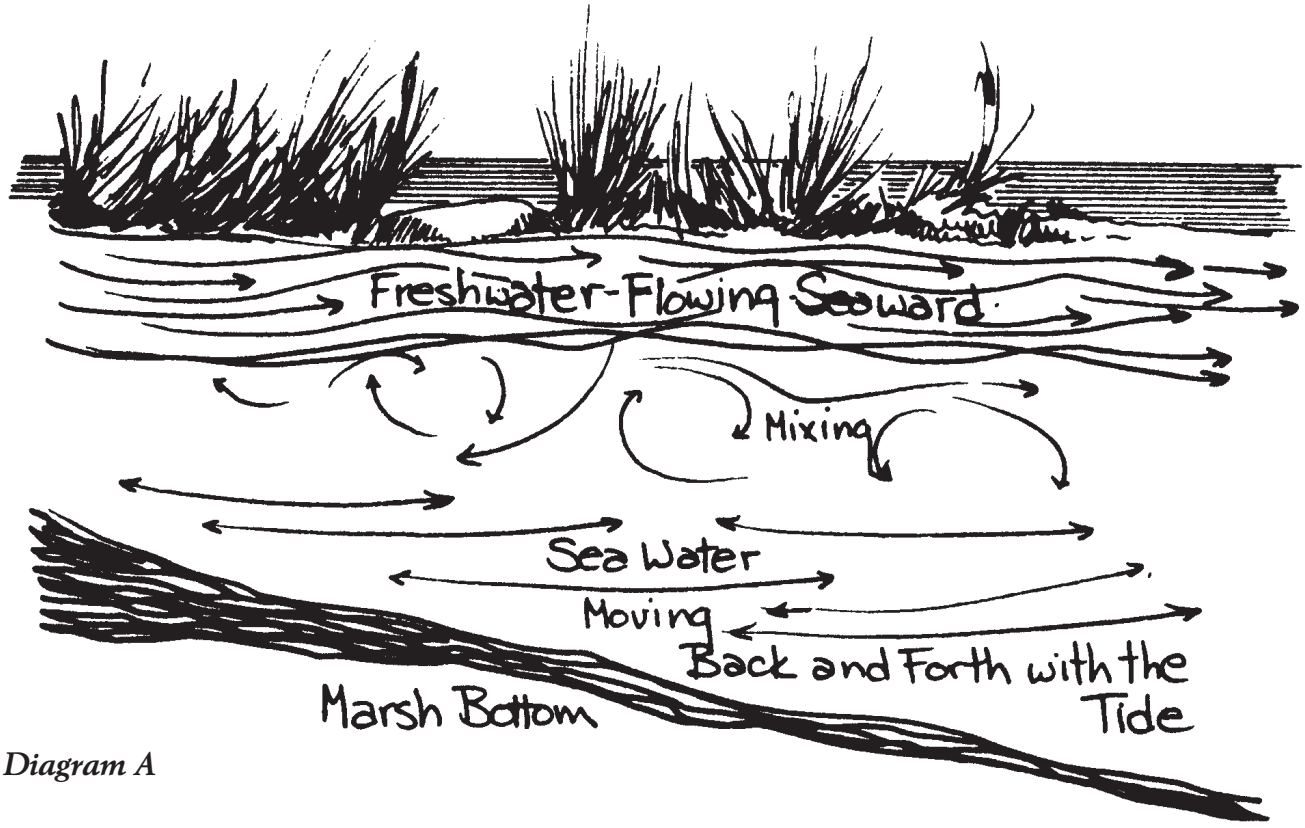
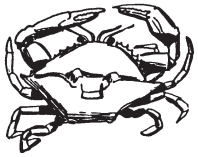

Freshwater-Flowing Seaward
Mixing
Sea Water
Moving
Back and Forth with the
Tide
Marsh Bottom

Diagram A

Master for Marsh Muncher

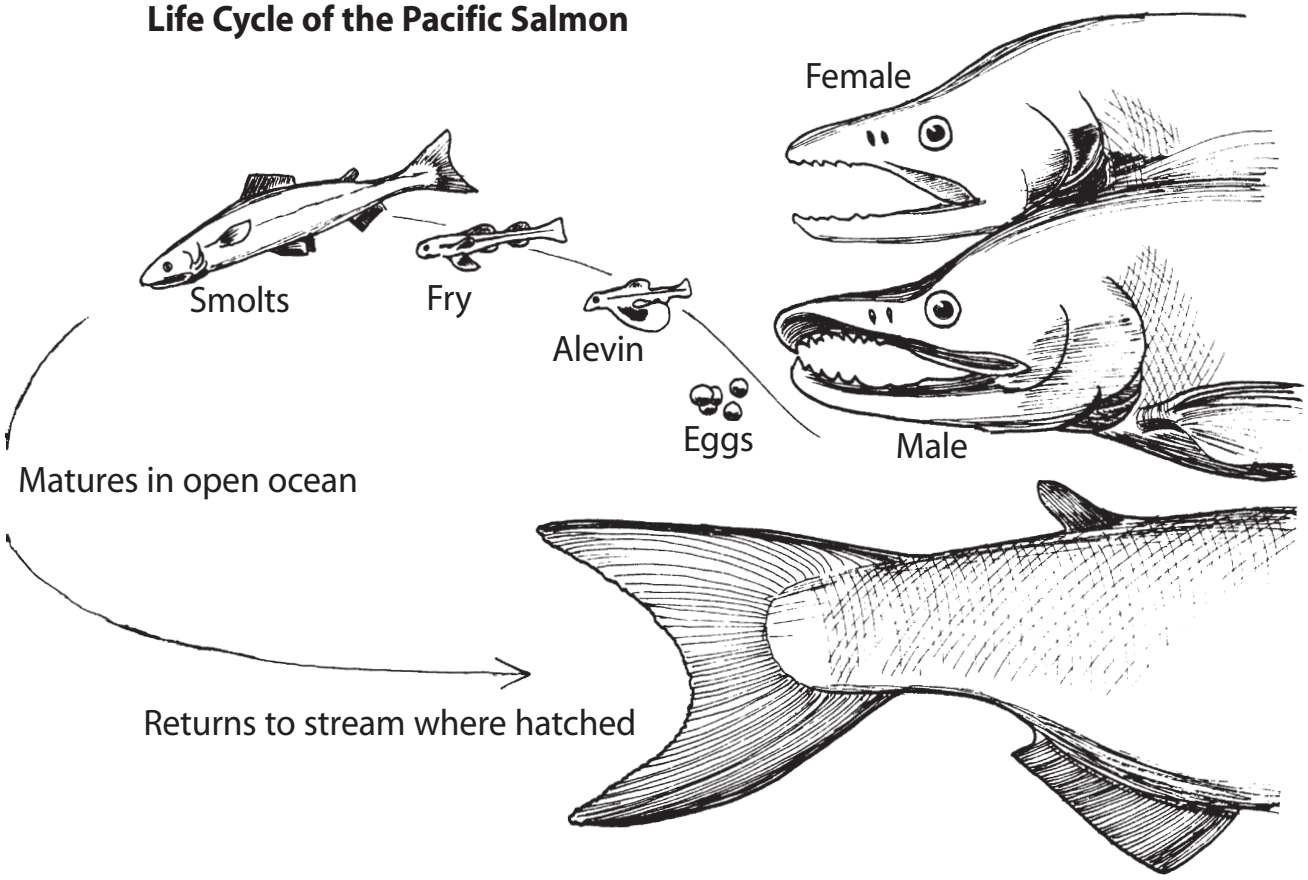
Predators

 **Person Fishing:** Student walks forward casting line, and tags prey by grasping on the shoulder.	 **Blue Crab:** Student walks sideways, waving arms like claws and grasps prey.	 **Raccoon:** Student walks forward washing hands and grasps prey.	 **Red Drum Fish:** Student walks with hands held forward like a mouth, and grasps prey.	 **Egret:** Student struts with hands on hips, so elbows are like wings. Nearing prey, arms become a beak to grasp prey.

Detritus-Eaters

 **Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	 **Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	 **Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)	 **Juvenile Fish**: Gulps down detritus particles in the water or on the bottom. (Student puckers lips and makes sucking noises while feeding.)
 **Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	 **Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	 **Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)	 **Shrimp:** Stirs up mud and detritus with walking legs that lift particles to mouth. (Student makes stirring motions with both arms.)
 **Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	 **Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	 **Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)	 **Snail:** Licks up detritus with specialized tongue called radula. (Student displays licking motion, using one hand as the radula.)
 **Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)	 **Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)	 **Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)	 **Oyster:** Filters detritus from water using gills. (Student waves arms back and forth in air.)
 **Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	 **Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	 **Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)	 **Fiddler Crab:** Picks detritus from sand with one or two claws. (Students pick objects from floor with thumbs and fingers acting as claws.)

Life Cycle of the Pacific Salmon



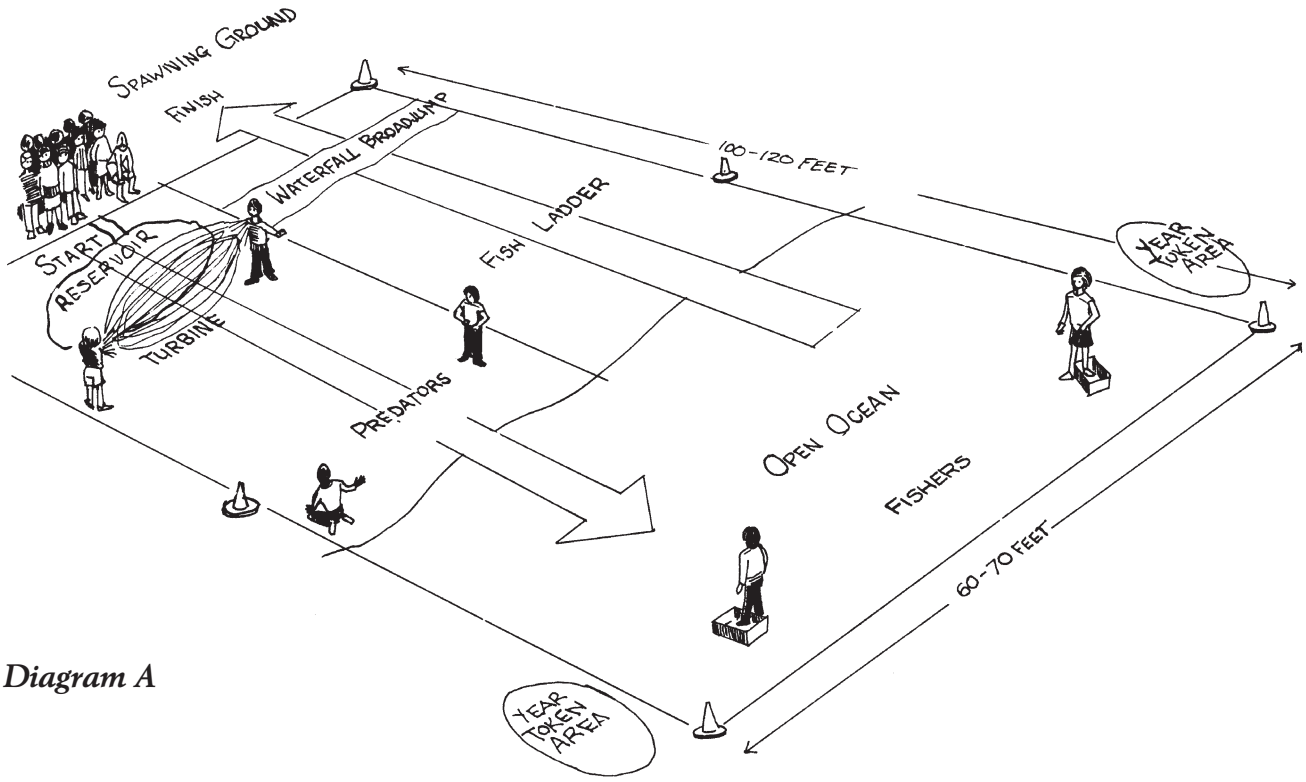

Spawning Ground
Finish
Waterfall Broadjump
100-120 feet
Start
Reservoir
Fish Ladder
Year Token Area
Turbine
Predators
Open Ocean
Fishers
60-70 feet
Year Token Area

Diagram A

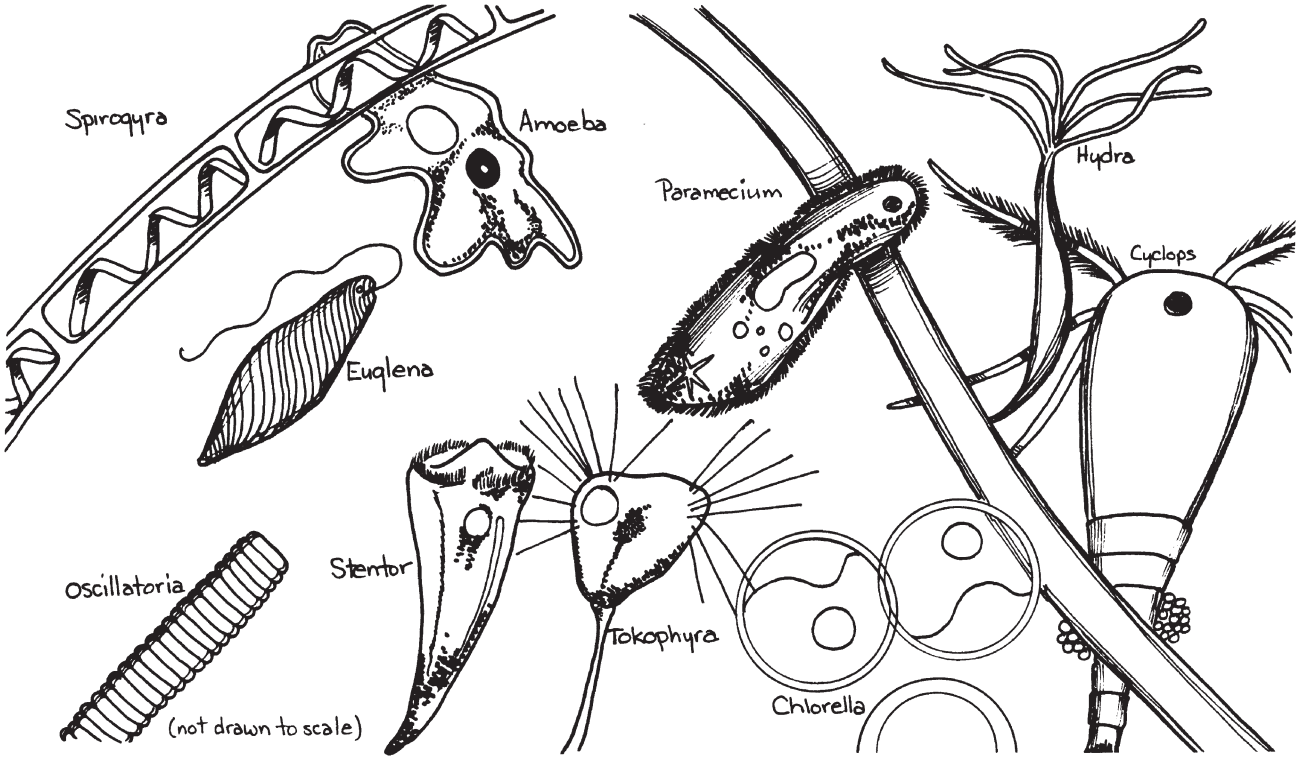

Spirogyra
Amoeba
Euglena
Paramecium
Hydra
Cyclops
Oscillatoria
Stentor
Tokophyra
Chlorella
(not drawn to scale)

Diagram A

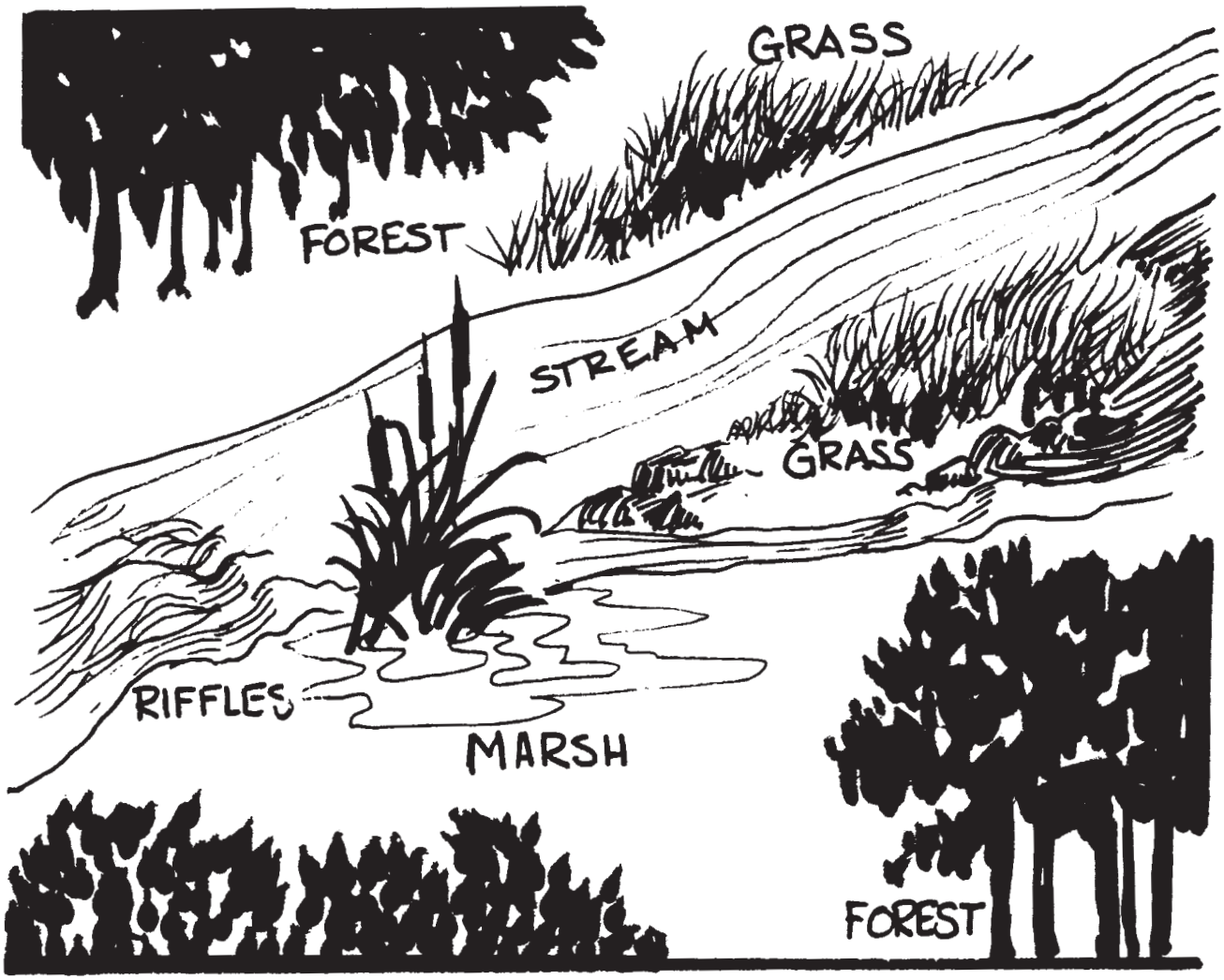
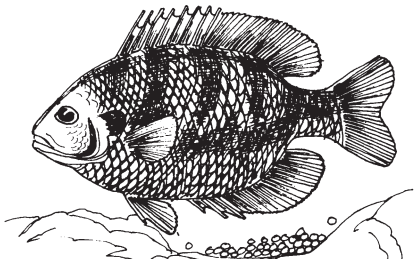
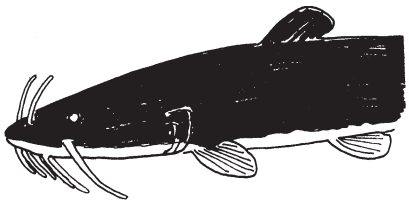
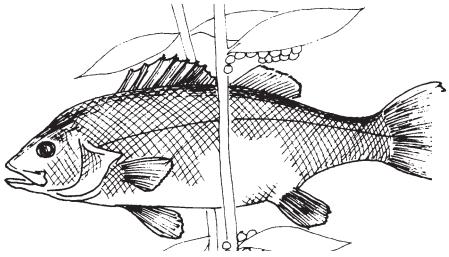
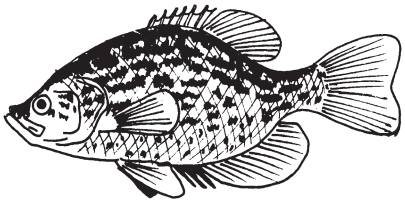
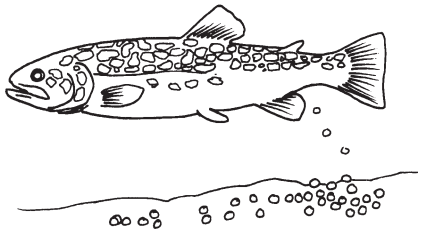
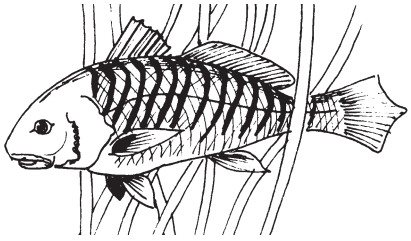
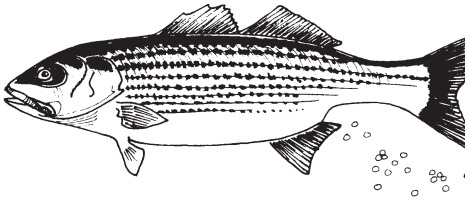
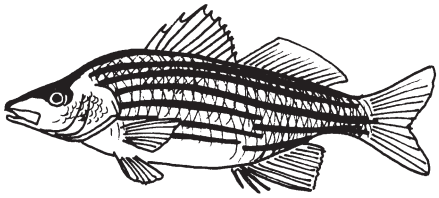
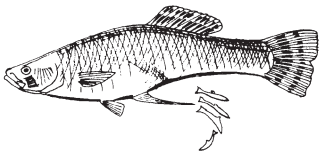
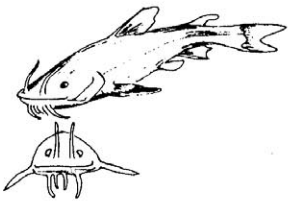
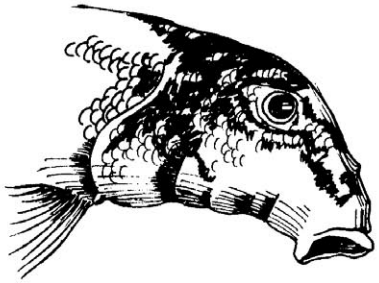
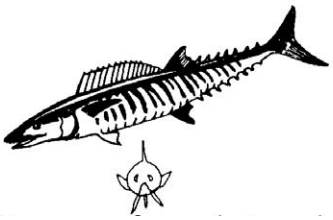
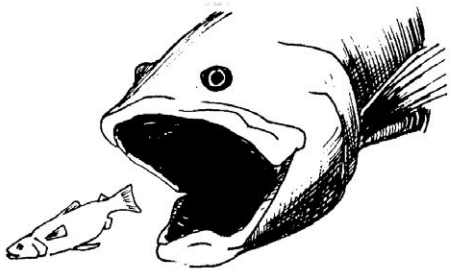
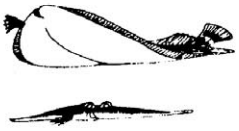
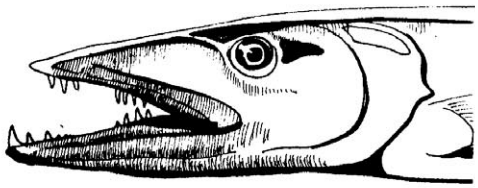
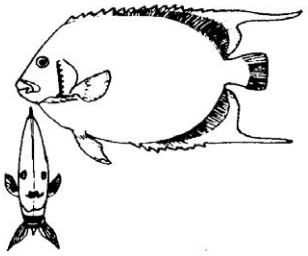
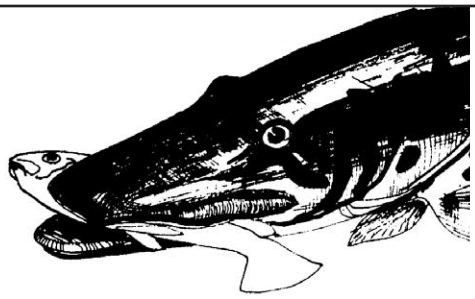
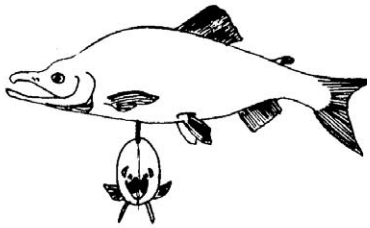
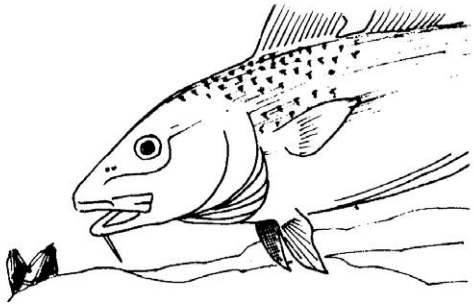
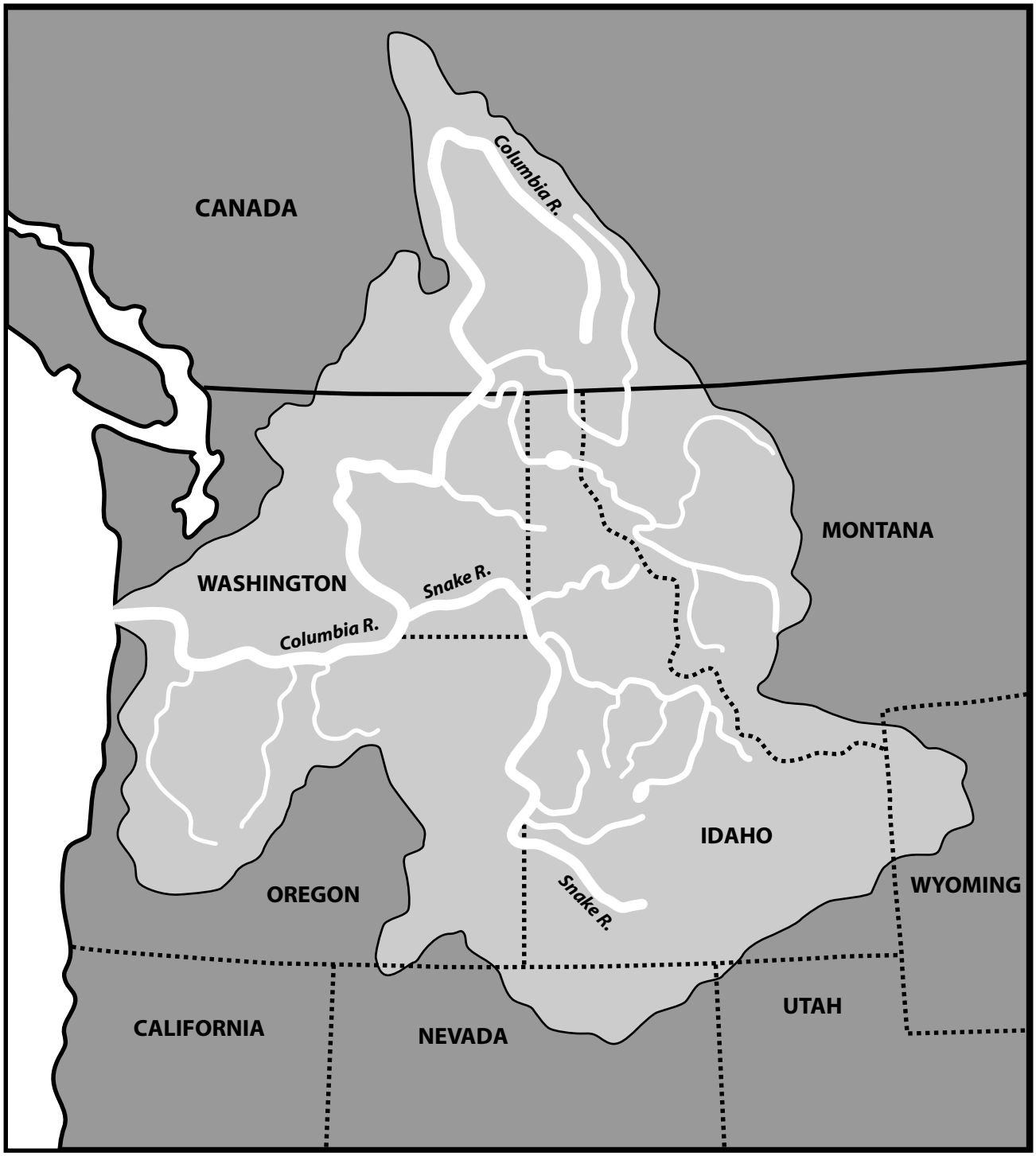


Diagram A

 Coloration Light Colored Belly (Albacore)	 Reproduction Eggs Deposited in Nests (Blue Gill)
 Coloration Dark Upper Side (Catfish)	 Reproduction Eggs Deposited on Vegetation (Yellow Perch)
 Coloration Mottled (Crappie)	 Reproduction Eggs Deposited on Bottom (Trout)
 Coloration Vertical Stripes (Croaker)	 Reproduction Free Floating Eggs (Striped Bass)
 Coloration Horizontal Stripes (Yellow Bass)	 Reproduction Live Birth (Gambusia)

Shape Flat Bellied (Catfish) 	Mouth/Feeding Sucker Shaped Jaw (Sucker) 
Shape Torpedo Shape (Wahoo) 	Mouth/Feeding Extremely Large Jaws (Grouper) 
Shape  Horizontal Disc (Halibut)	Mouth/Feeding Elongated Lower Jaw (Barracuda) 
Shape  Vertical Disc (Butterfish)	Mouth/Feeding  Duckbill Jaws (Muskellunge)
Shape  Humpbacked (Sockeye)	Mouth/Feeding  Elongated Upper Jaw (Cod)

Historic Salmon Range in the Columbia River Basin



Adapted from "Wild About Salmon, An Educators Guide", Idaho Department of Fish and Game, 1999.

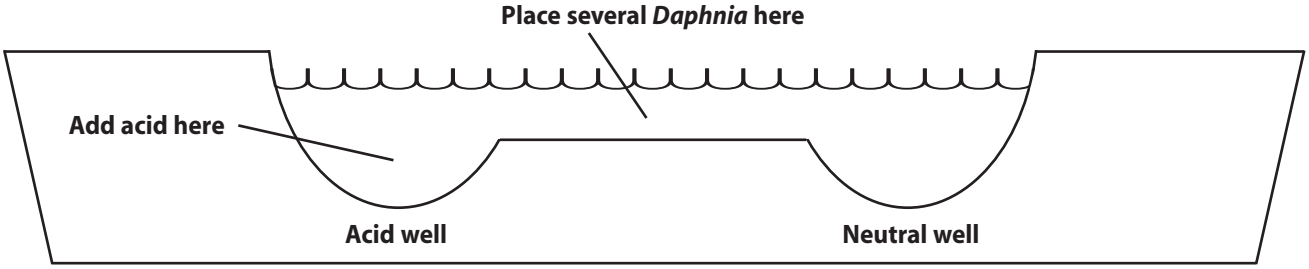

Place several *Daphnia* here
Add acid here
Acid well
Neutral well

Diagram A

Student Worksheet

	Room Light		UV Light	
	Moving	Not Moving	Glowing	Not Glowing (or glowing more faintly than controls)
Control Jar				
Treatment 1 (mildest)				
Treatment 2				
Treatment 3				
Treatment 4				
Treatment 5 (strongest)				

Netting

Species	Coarse Net		Fine Net		Comments
Number of Hands Used	1	2	1	2	
Lima lunker					
Pinto porgies					
Black bass					
Lentil moonbeans					
Rice wrasses					

COUNTRY BACKGROUND INFORMATION

Pargimo

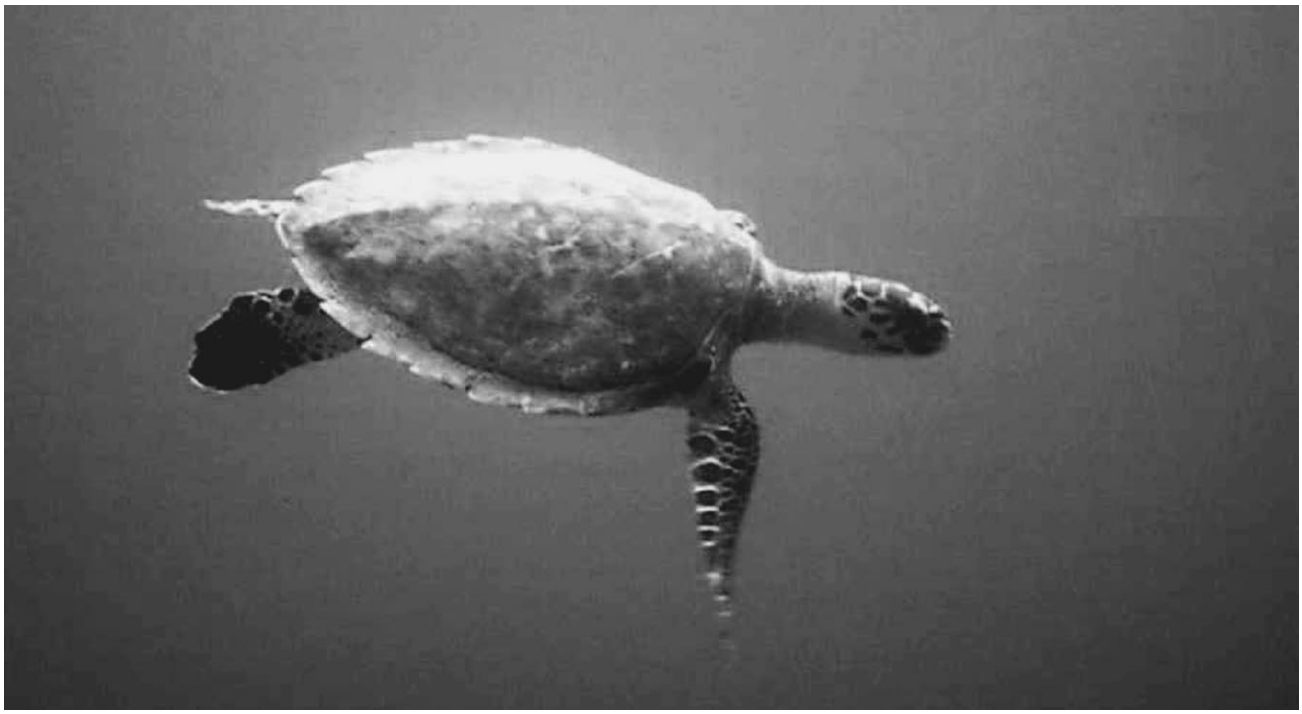
- Developing country.
- Some coastal land development.
- Coastal village income is based on fishing.
- Borders the Republic of United Peoples (RUP).
- Sea turtle and sea turtle eggs are a common food.
- Sea turtles, sea turtles eggs, and products made from sea turtles have been traded internationally for centuries and were an important part of the country's and individuals' incomes.
- Sea turtles migrate from the RUP coast to the Pargimo coast to spend their nonbreeding season.
- Some of the turtles migrate from the south of Pargimo to the north where they lay their eggs on the furthest northeast shores.
- A member of CITES, but lacking financial resources for enforcement.
- Ocean pollution by industrial sources is a concern.

The Republic of United Peoples (RUP)

- Developed country.
- A very active member of CITES with active enforcement.
- Borders Pargimo.
- Sea turtles migrate from the coast of Pargimo to the coast of RUP to lay eggs.
- Coastal lobster and shrimp fishery is a large source of income for many coastal communities.
- Extensive coastal land development.

Chumas

- Developed country.
- Landlocked, therefore, no sea turtles.
- Nonenforcing member of CITES.
- Culture encourages the use of sea turtles and sea turtle products as a food source, as a health aid, and for ceremonial uses.
- Black market for sea turtle products that goes unchecked by the government.



Scenario Cards

Country: Chumas

Sea turtle jewelry dealer
Because you know how valuable sea turtle jewelry is all over the world, you buy as much as you can, even though it is prohibited.

Wants:
Turtles
Money

Country: Chumas

Restaurant owner
The people of your community have been eating sea turtle eggs and sea turtles for thousands of years as a delicacy. You buy as many eggs and turtles as you can.

Wants:
Turtles
Turtle eggs
Money

Country: Chumas

Turtle trader
Middle class. You buy sea turtles from collectors in Pargimo to sell to companies in Chumas that make medicine, ceremonial products, and traditional food. Although your work has been respected and needed, it has now become illegal.

Wants:
Job

Country: Chumas

Ceremonial sea turtle buyer
You buy products made from sea turtles to sell for ceremonial uses. People in your community have been using sea turtle products for generations. Without them, the ceremonies would fail and harm would fall on the village.

Wants:
Turtles

Country: Chumas

Turtle egg trader
Middle class. You buy sea turtle eggs from collectors in Pargimo to sell to companies in Chumas that make medicine and traditional food. Although your work has been respected and needed, it has now become illegal.

Wants:
Job

Country: Pargimo

Government bureaucrat
You are interested in the agency operating efficiently. You have received a request for a special land development permit, but because of the new CITES regulations, must wait for judicial orders before you can fulfill this request.

Wants:
Judicial order (requiring beach habitat to be set aside) for coastal building permits

Country: Pargimo

Landowner
You have extensive coastal land holdings but are cash poor and need money to rejuvenate other businesses. You believe wild animals are property of landowner. You want poachers arrested.

Wants:
Capital investment funds

Country: Pargimo

Judge
You are frustrated by a lack of professional recognition for community efforts. You would like to further CITES by requiring developers to set aside beach natural areas for turtle habitat when applying for building permits. You hope that ecotourism will develop. You believe wildlife belongs to the public for protection.

Wants:
Professional recognition

Country: Pargimo

Collector of turtles (poacher)
You poach turtles from beach and ocean to sell to traders in Chumas in order to support large family. You believe wildlife should be available for public taking, but would prefer a legal job.

Wants:
Job

Country: Pargimo

Collector of turtle eggs (poacher)
You poach turtle eggs from beach to sell to traders in Chumas in order to support large family. You believe wildlife should be available for public taking, but would prefer a legal job.

Wants:
Job

Country: Pargimo

Wildlife biologist and manager
You are frustrated by poaching of turtles and by news of potential beach development. You would like to see the beaches protected and have a way to replenish the population of baby turtles. You believe wildlife belongs to the public.

Wants:
Beach in natural condition
Compliance by poacher
Turtle eggs

Country: Pargimo

Law officer
You are required to arrest poachers and traders of turtles or turtle products. Your position is difficult because you personally know the families that are trying to subsist through this illegal activity. You believe wildlife should be available for public taking, and you wish you did not have to arrest poachers.

Wants:
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

Country: The Republic of United Peoples

CITES organization head stationed in Pargimo
You are trying to ensure that the agreements of CITES are being enforced. You are well connected to government and environmental organizations in your country, and are willing to help anyone achieve recognition who facilitates compliance with CITES regulations.

Wants:
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

Country: The Republic of United Peoples

Sea turtle advocate
You are an advocate for the protection of endangered and threatened species. You would like to see the coastal areas left in a natural state and the citizens respecting the new laws to protect the turtles. You are well financed.

Wants:
Beach in natural condition
Compliance by poacher
Compliance by trader
Compliance by ceremonial sea turtle buyer

Country: The Republic of United Peoples

Wealthy developer
Because of increased demands for isolated vacation sites, your company plans to buy land on the southeast coast of Pargimo—natural areas that are prime sea turtle egg laying habitat. You plan to develop the area by building an elegant but rustic-looking hotel/lodge and to make a profit for the company and its investors.

Wants:
Money
Land
Land development permit

Country: The Republic of United Peoples

Entrepreneur
You would like to make a fresh start and move to Pargimo. The business you would like to develop is a turtle farm. Most of the turtles raised on the farm will be sold to local companies, although a set number of turtles can be donated to natural resource agencies each year if needed to maintain populations. You need a loan to begin the business.

Wants:
Start-up funds
Business operating license
Hotel

Country: The Republic of United Peoples

Tourist
You are looking for rare items (food and jewelry) to buy. You also need some experimental medicines not found in the RUP. On future trips, you would like to find a safe, comfortable hotel for your family to "get away from it all." You would also like to find out about local natural features for this next trip.

Wants:
Food
Jewelry
Medicine
Safety
Information on natural features

Country: The Republic of United Peoples

Owner of pharmaceutical company
Your company makes medicines, but the high cost of labor in the RUP is forcing you to move to Pargimo, where salaries are lower. It would also be closer to a source of turtle eggs, which contain chemicals that are ingredients in some medicines.

Wants:
Money
Turtle eggs
Business operating license

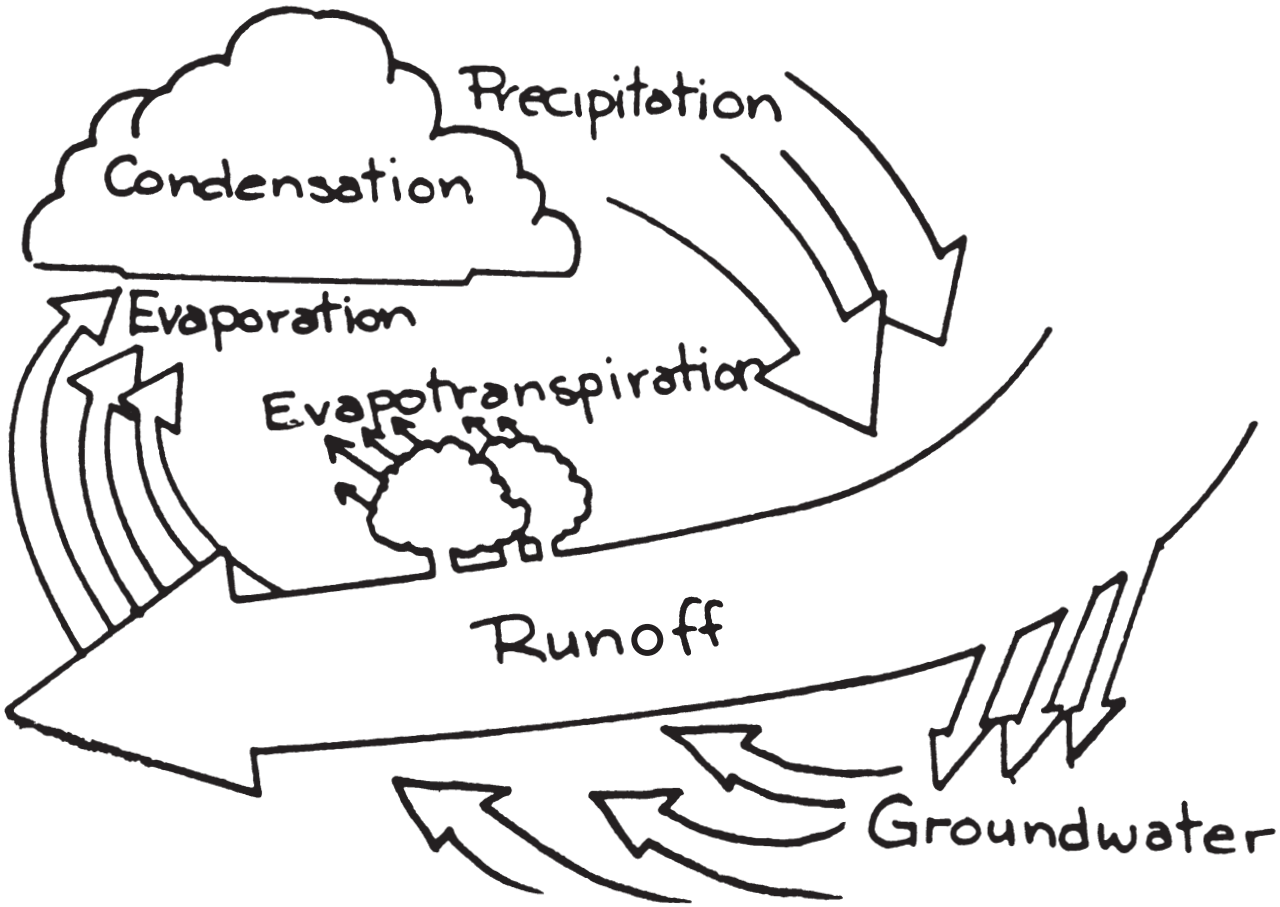
Haves Cards

Initially hand these cards out to the students representing the character typed in bold on the card. Most characters will get several cards. These cards will be traded to other characters during the activity. (Note trading conditions in *italics*.)

Country: Chumas **Sea turtle jewelry dealer** Jewelry *May not be sold until receives turtles.*	Country: Chumas **Restaurant owner** Food *May not be sold until receives turtles.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Ceremonial sea turtle buyer** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*	Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*
Country: Chumas **Turtle egg trader** Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Landowner** Beach in natural condition *Card may not be given away until judicial order is issued setting aside this land.*
Country: Pargimo **Landowner** Land *May not sell until notified that developer has received a land development permit.*	Country: Pargimo **Landowner** Beach in natural condition *Card may not be given away until judicial order is issued setting aside this land.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to Laws *May not be given until receives a job.*	Country: Pargimo **Judge** Judicial order (to set aside habitat) *Will not be issued until receives professional recognition from CITES.*

Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Collector of turtles** (poacher) Compliance to laws *May not be given until receives a job.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Wildlife biologist and manager** Information *May be given at any time.*	Country: Pargimo **Collector of turtle eggs** (poacher) Compliance to laws *May not be given until receives a job.*
Country: Pargimo **Government bureaucrat** Land Development Permit *Cannot be given until a judicial order is received.*	Country: Pargimo **Law enforcement officer** Safety *May be given at any time.*
Country: Pargimo **Government bureaucrat** Business operating license *May be given at any time.*	Country: Pargimo **Government bureaucrat** Business operating license *May be given at any time.*
The Republic of United Peoples **CITES organization head stationed in Pargimo** Professional recognition *May be given at any time.*	The Republic of United Peoples **Sea turtle advocate** Start-up funds *May be given at any time.*
The Republic of United Peoples **Wealthy developer** Capital investment funds *May be given at any time.*	The Republic of United Peoples **Entrepreneur** Job *May not be given until start-up funds and business operating license are received.*
The Republic of United Peoples **Wealthy developer** Hotel *May not be given until a land development permit is received.*	The Republic of United Peoples **Entrepreneur** Job *May not be given until start-up funds and business operating license are received.*

The Republic of United Peoples **Entrepreneur** Turtles *May not be given until start-up funds and business operating license are received.*	The Republic of United Peoples **Entrepreneur** Turtles *May not be given until start-up funds and business operating license are received.*
The Republic of United Peoples **Entrepreneur** Turtles *May not be given until start-up funds and business operating license are received.*	The Republic of United Peoples **Entrepreneur** Turtle Eggs *May not be given until start-up funds and business operating license are received.*
The Republic of United Peoples **Entrepreneur** Turtle eggs *May not be given until start-up funds and business operating license are received.*	The Republic of United Peoples **Entrepreneur** Turtle eggs *May not be given until start-up funds and business operating license are received.*
The Republic of United Peoples **Tourist** Money *To be exchanged directly for item on* "Wants" *list only.*	The Republic of United Peoples **Tourist** Money *To be exchanged directly for item on* "Wants" *list only.*
The Republic of United Peoples **Tourist** Money *To be exchanged directly for item on* "Wants" *list only.*	The Republic of United Peoples **Tourist** Money *To be exchanged directly for item on* "Wants" *list only.*
The Republic of United Peoples **Owner of pharmaceutical company** Job *May not be filled until business operating license and turtle eggs are received.*	The Republic of United Peoples **Owner of pharmaceutical company** Job *May not be filled until a business operating license and turtle eggs are received.*
The Republic of United Peoples **Owner of pharmaceutical company** Medicine *May not be filled until business operating license and turtle eggs are received.*	



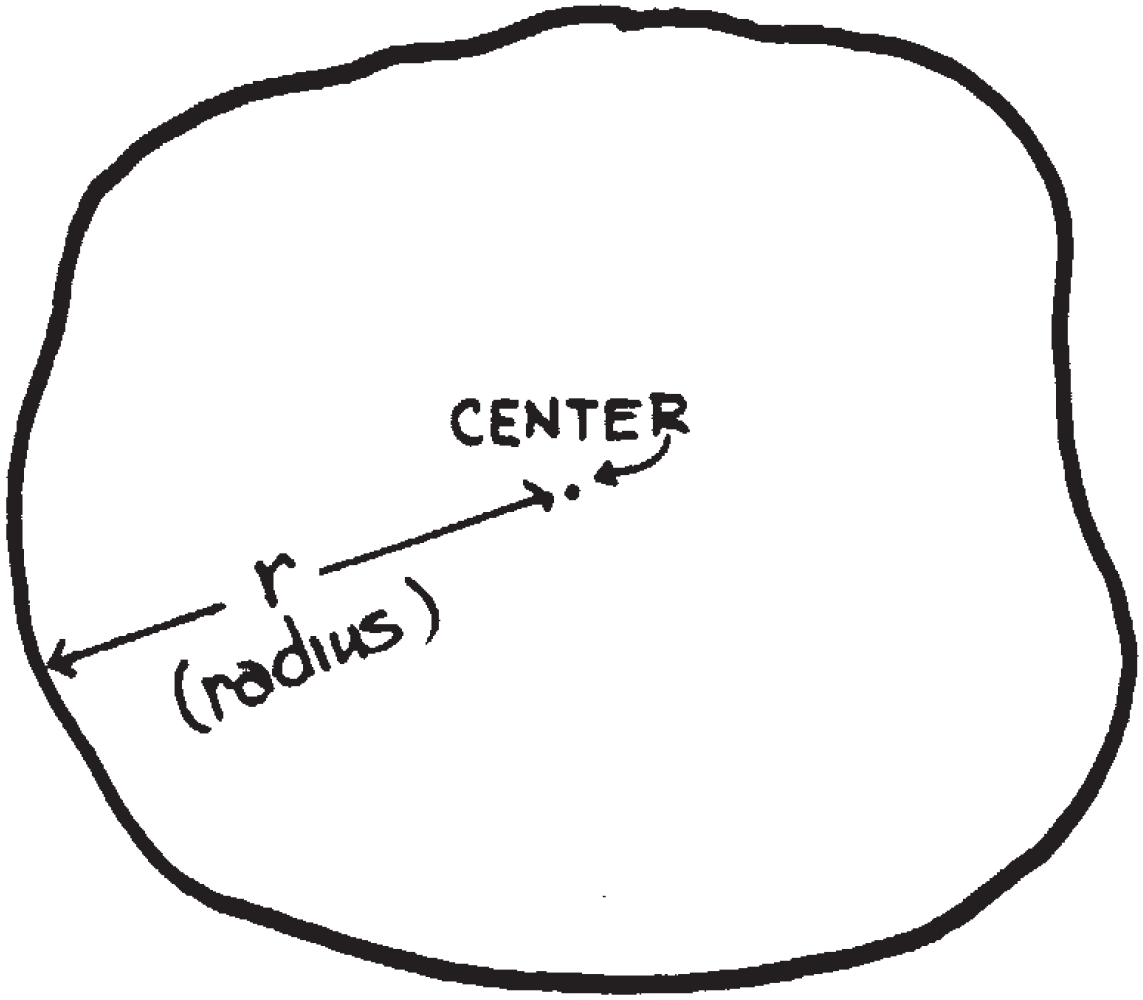


Diagram A

Round Puddles
Area = $\prod r^2$
($\prod$ = 3.14; it is a mathematical constant)
A = 3.14 x r x r =

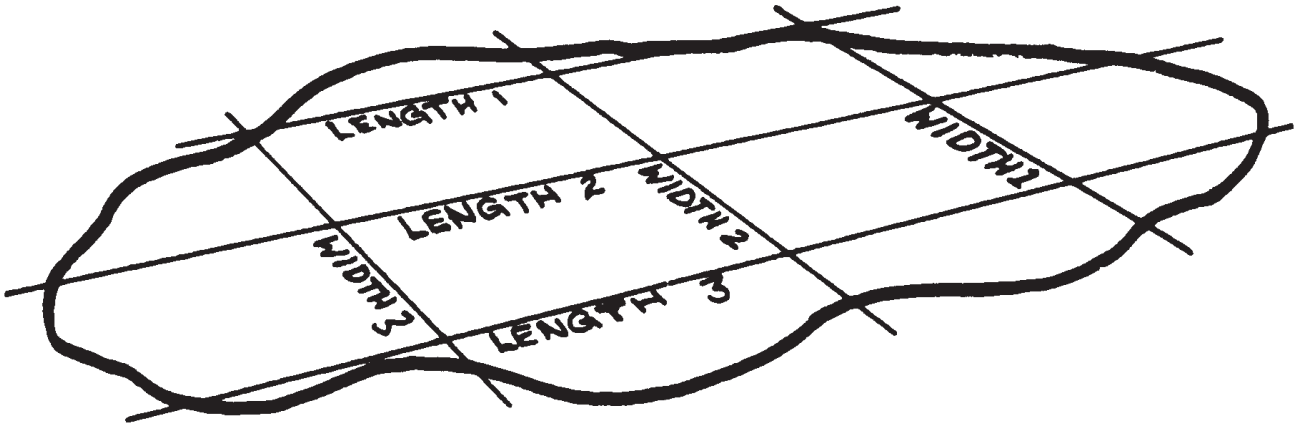


Diagram B

Area = Length (average) × Width (average)

Average Length (La) = $\frac{L1 + L2 + L3}{3}$

(3 is the number of measurements)

Average Width (Wa) = $\frac{W1 + W2 + W3}{3}$

A = La × Wa

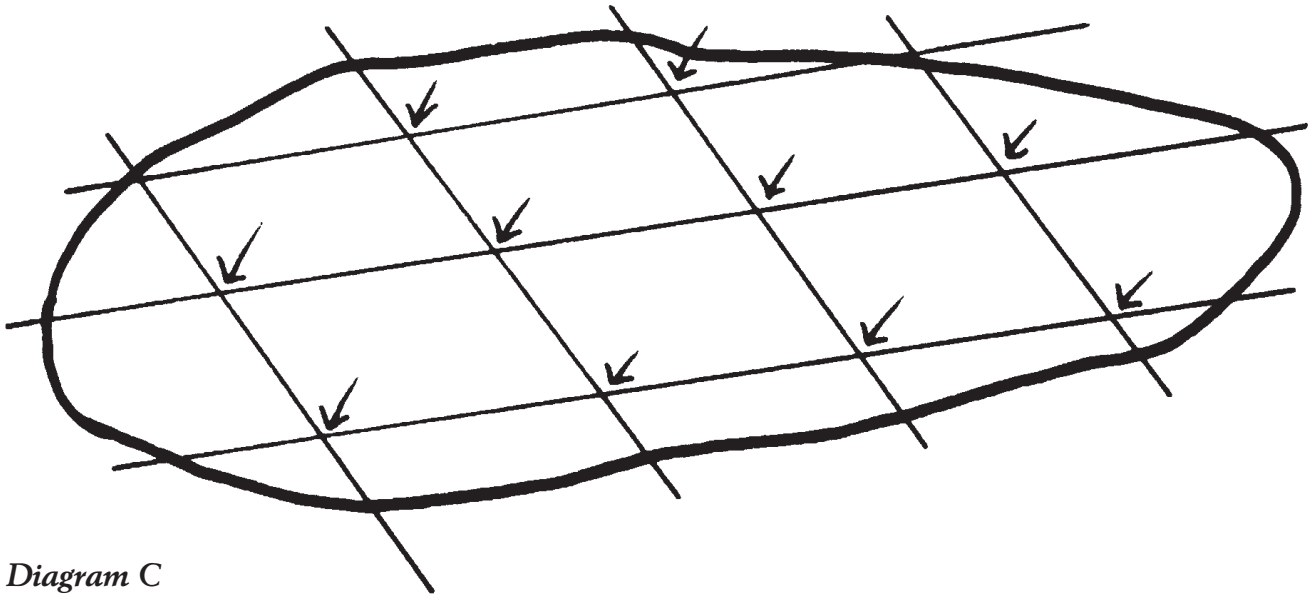


Diagram C

Use the following formula for average depth (Da). There are 10 measurements of depth shown in the example above.

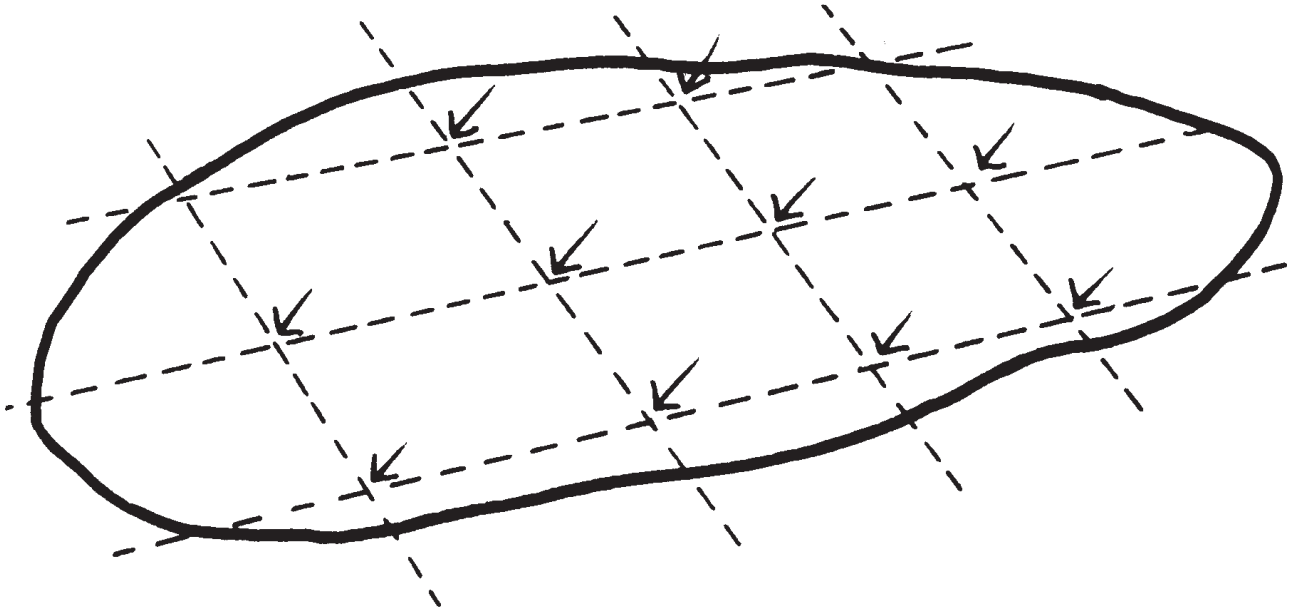


Diagram D

$$Da\ (average) = \frac{D1+D2+D3+D4+D5+D6+D7+D8+D9+D10}{10\ (\text{the number of measurements})}$$

Now the volume can be calculated:

$$Volume = La \times Wa \times Da$$

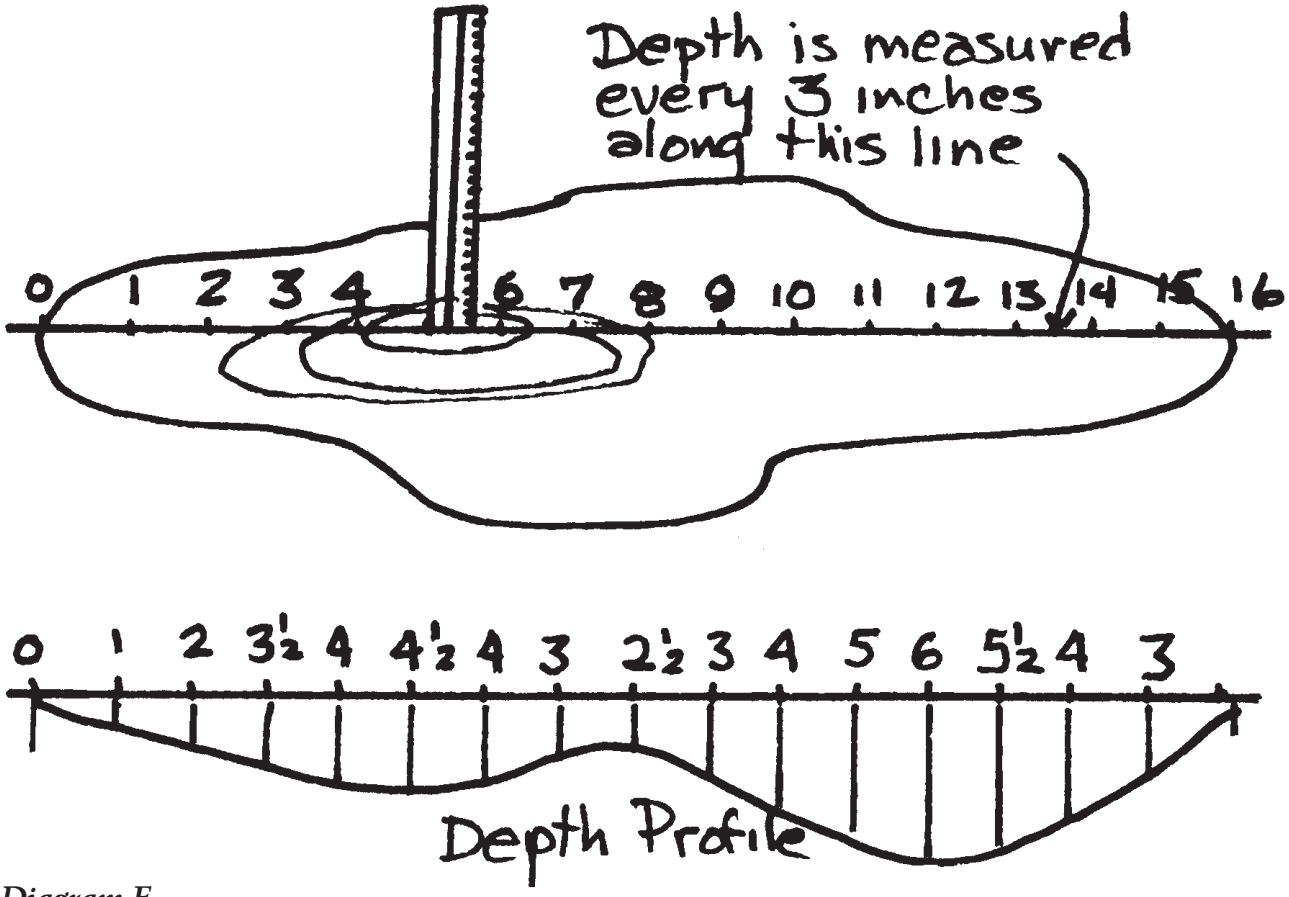

Depth is measured every 3 inches along this line
0 1 2 3 4 6 7 8 9 10 11 12 13 14 15 16
0 1 2 3½ 4 4½ 4 3 2½ 3 4 5 6 5½ 4 3
Depth Profile

Diagram E

Water on Earth

Source	Percentage of Total Water (%)
Oceans	96.5400
Ground water	
Saline/brackish ground water	0.9300
Fresh ground water	0.7600
Surface water	
Glacier/icecaps	1.7400
Freshwater lakes	0.0070
Saltwater lakes	0.0060
Rivers	0.0002
Other	
Ground ice, permafrost	0.0220
Atmospheric water vapor	0.0010
Marshes, wetlands (mix of fresh and saline)	0.0010
Soil moisture	0.0010
Incorporated in organisms	0.0001
Total	100.0000

NOTE: Total may not add up to 100 due to rounding

Source: Shiklomanov, I.A. 1993. "World Fresh Water Resources." In P.H. Gleick (ed.), Water in Crisis: A Guide to the World's Fresh Water Resources. Oxford University Press, New York.

Sample Class Chart

Teams

	1	2	3	4	5	6	7	8	9	10	
Color											**Totals**
Red											
Starting number											
Recovered number											
Blue											
Starting number											
Recovered number											
Clear											
Starting number											
Recovered number											
Green											
Starting number											
Recovered number											
Purple											
Starting number											
Recovered number											
Yellow											
Starting number											
Recovered number											

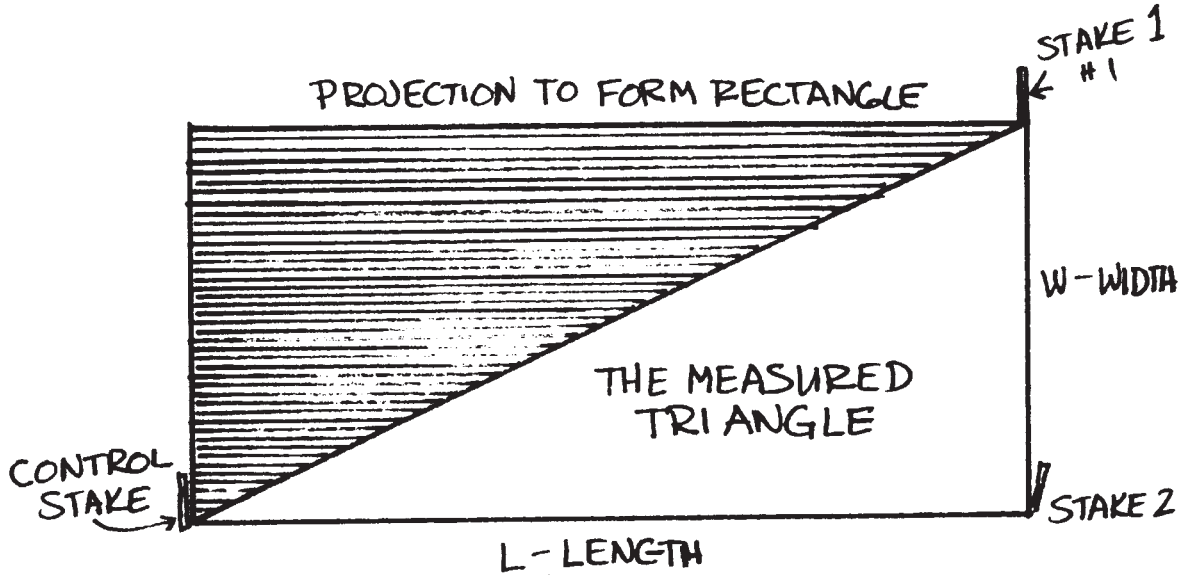


Diagram B

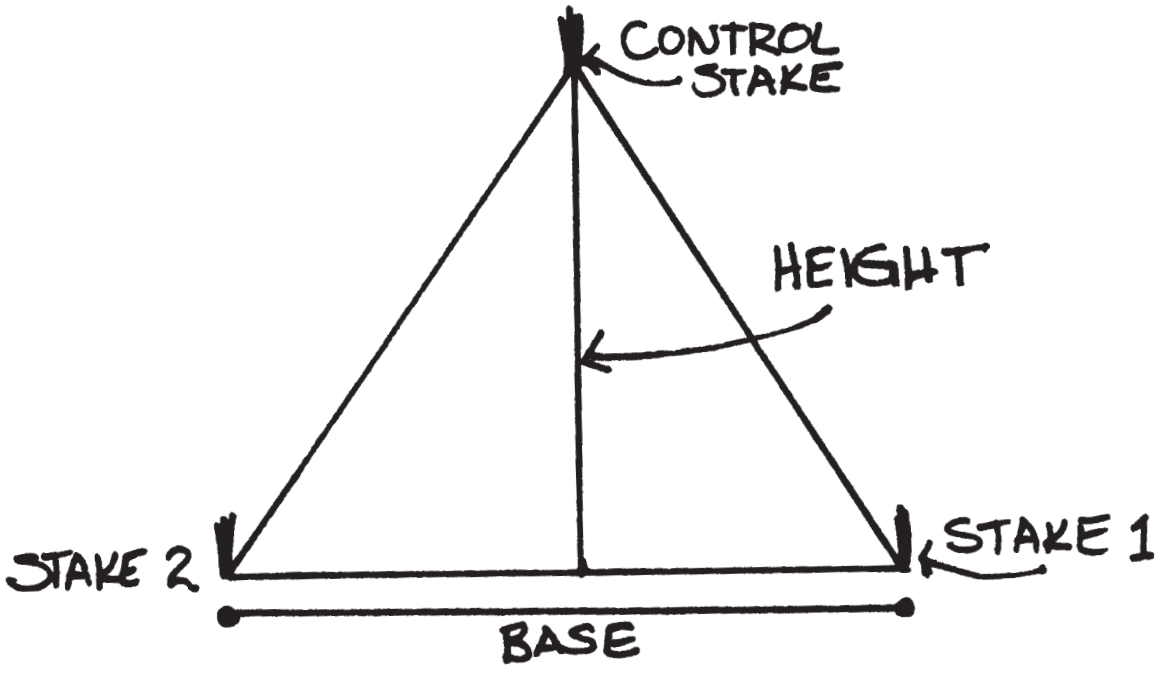


Diagram C

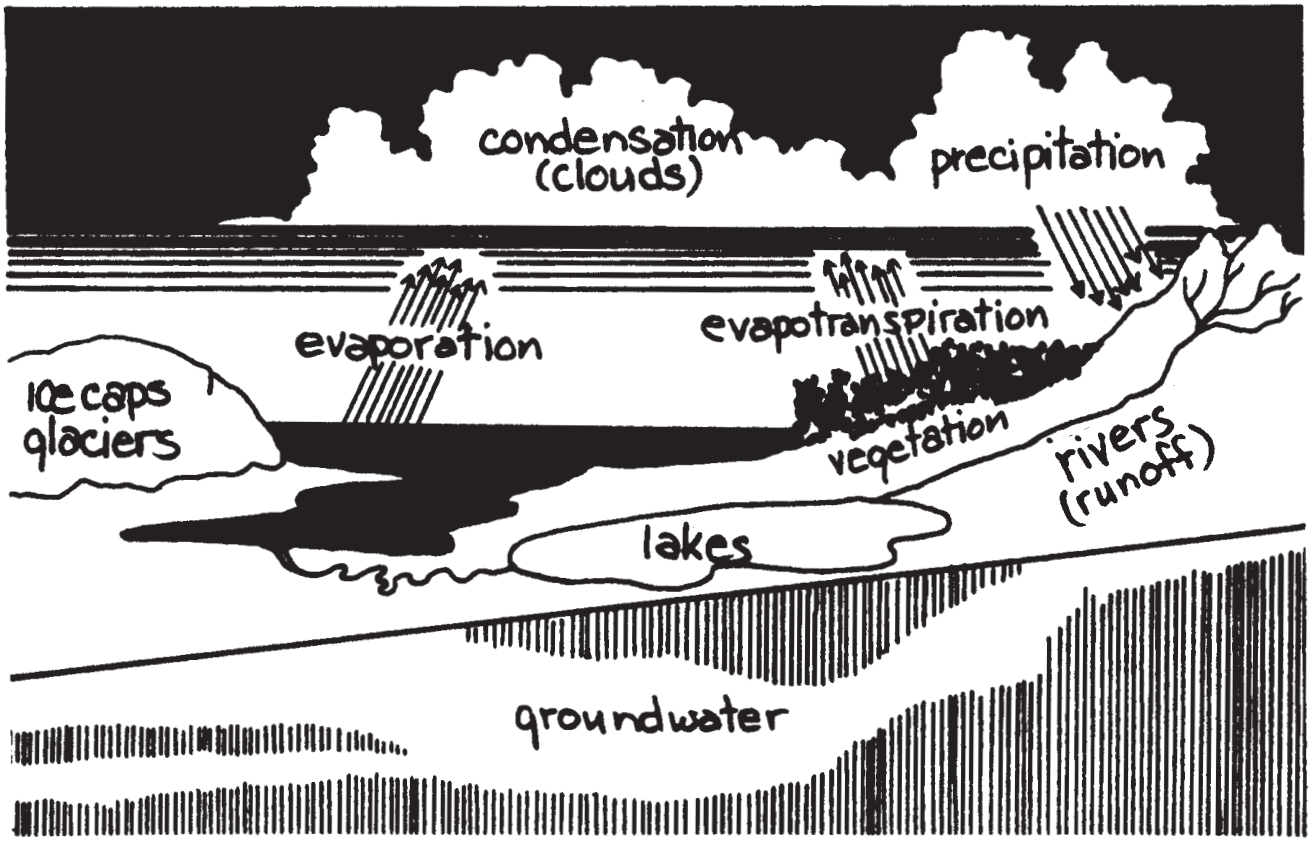

condensation
(clouds)
precipitation
evaporation
evapotranspiration
ice caps
glaciers
vegetation
rivers
(runoff)
lakes
groundwater

Diagram A

Water Consumption Chart

(all values are approximate)

3–5 gallons (12–20 liters)	Flushing a toilet
3 gallons (12 liters)	Shaving and letting the water run
5 gallons (20 liters)	Shower per minute
8 gallons (30 liters)	Cooking three meals
8 gallons (30 liters)	Cleaning house
10 gallons (40 liters)	Washing dishes (three meals)
20–30 gallons (75–115 liters)	Washing clothes
30–40 gallons (115–150 liters)	Watering a lawn
30–40 gallons (115–150 liters)	Taking a bath
30–40 gallons (115–150 liters)	Washing a car
_____	Miscellaneous use

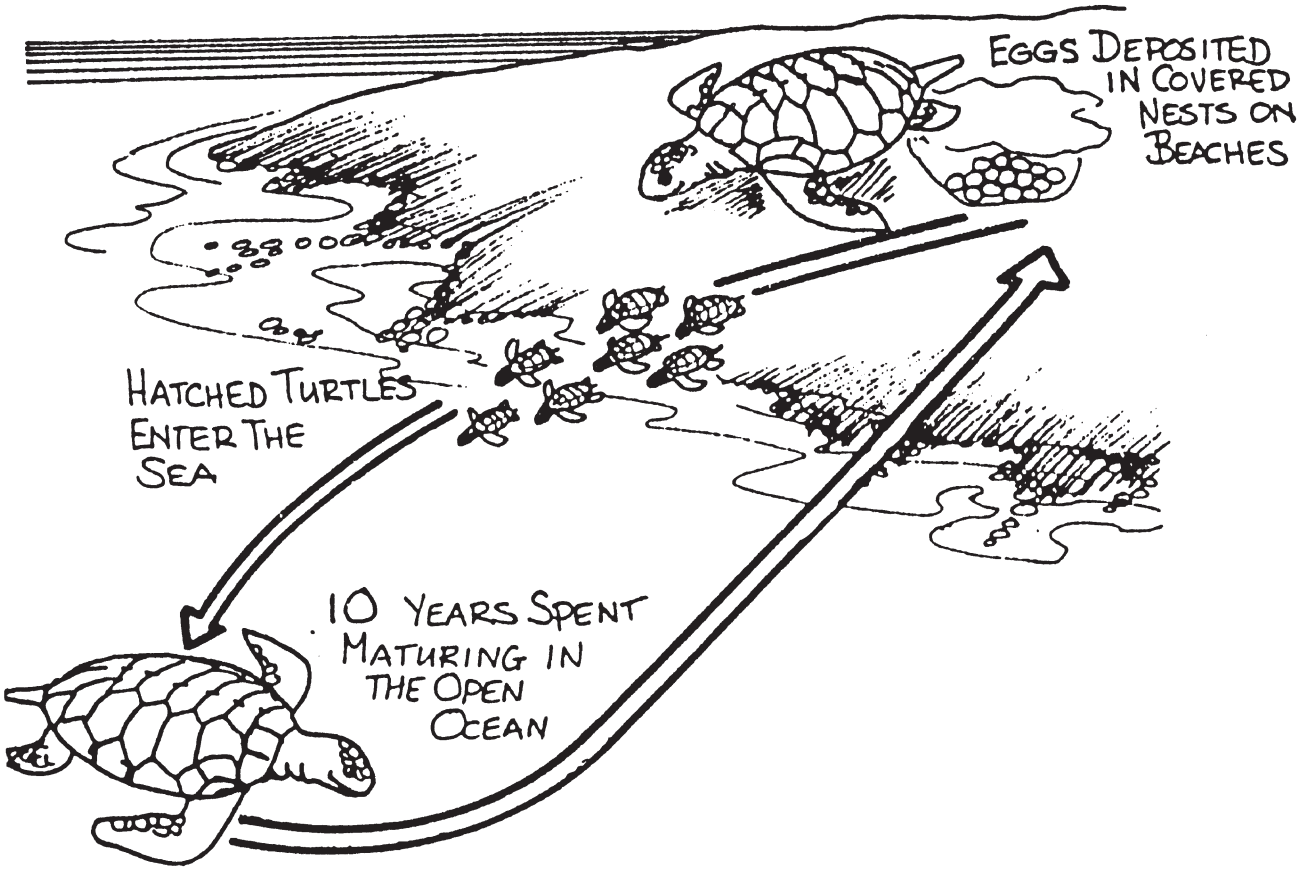

EGGS DEPOSITED IN COVERED NESTS ON BEACHES
HATCHED TURTLES ENTER THE SEA
10 YEARS SPENT MATURING IN THE OPEN OCEAN

Diagram A

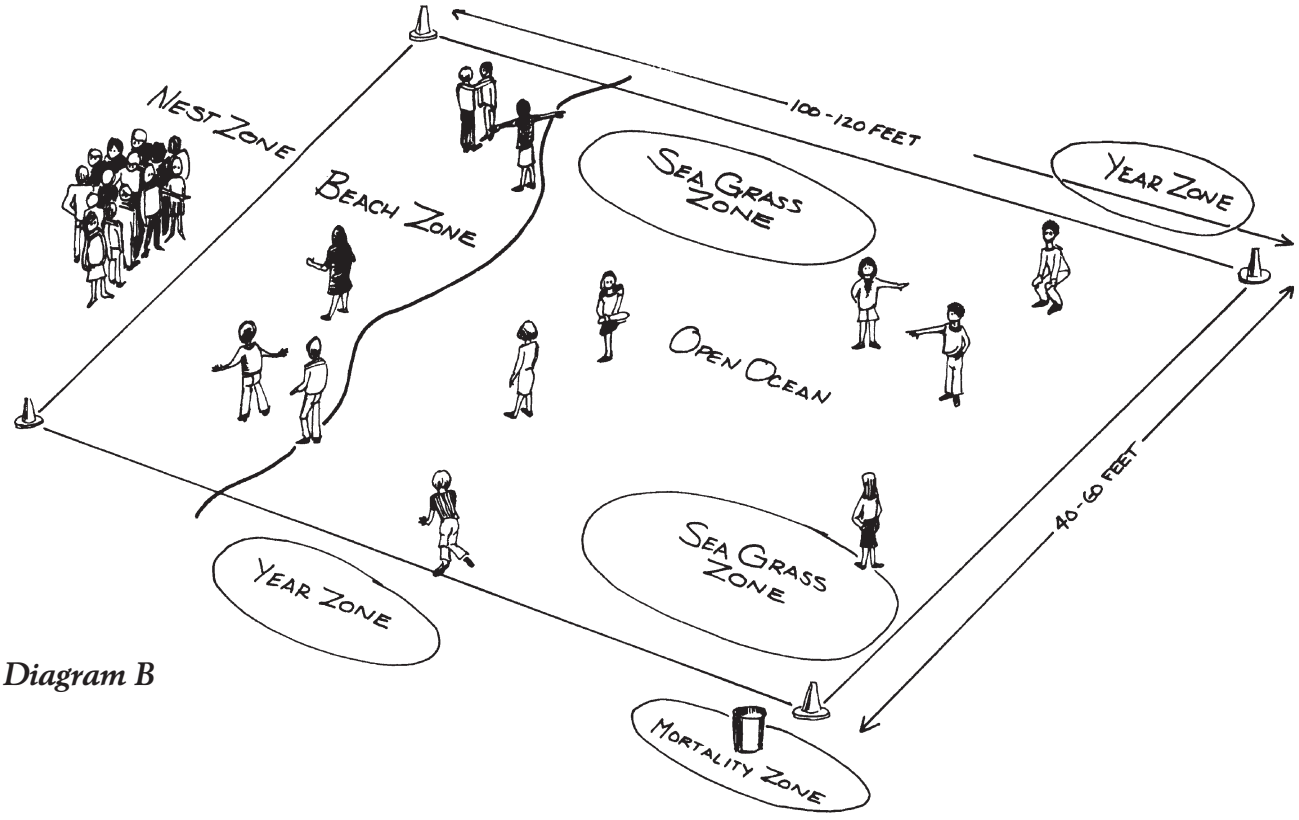


Diagram B

Student Page

Fish 1 (Chinook): These fish are considered to be the most abundant and valued fish species for catching. They migrate the entire length of the river and are the largest in individual size of all salmon.

Fish 2 (Coho): These fish are second to Fish 1 in popularity and economic value. They migrate only up to the lower middle part of the river system.

Fish 3 (Chum): Never popular, this fish species does not bite a hook well, is found only near the mouth of the river, and is usually caught with nets.

Fish 4 (Sockeye): Smallest fish in the group, they migrate to the uppermost part of the river. They require lakes for successful spawning and rearing. This fish species does not bite a hook well and is taken mostly with nets.

Fish 5 (Steelhead): These fish migrate throughout the river system. Habitat requirements are more restrictive than others.

The data below are taken from actual fish catches. The accompanying historical data provide an overview of human activity in the river, plus developing regulatory and management efforts over time.

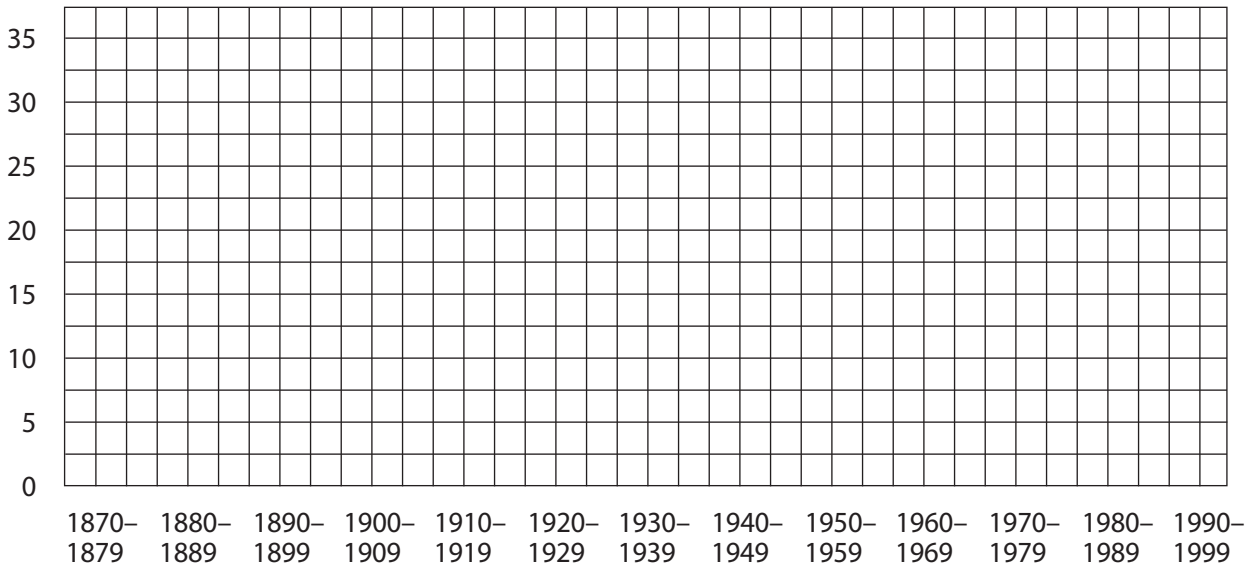
Fish Caught on the Columbia River*

Years	Fish 1	Fish 2	Fish 3	Fish 4	Fish 5
1870–79	22.7	—	—	—	—
1880–89	33.1	—	—	—	—
1890–99	24.1	3.2	0.8	2.4	3.0
1900–09	25.1	2.1	1.3	0.8	0.7
1910–19	28.1	4.3	3.6	0.9	1.9
1920–29	22.3	5.5	3.1	0.9	2.5
1930–39	17.2	3.2	1.2	0.3	1.9
1940–49	15.4	1.1	1.5	0.2	1.8
1950–59	7.4	0.6	0.2	0.3	1.1
1960–69	4.7	1.6	0.02	0.1	0.6
1970–79	5.9	1.9	0.01	0.2	0.4
1980–89	5.4	1.9	0.01	0.06	0.3
1990–99	0.05	0.019	0.001	0	0.18

*Figures are in millions of pounds. The 1990–1999 figures are from the Idaho Department of Fish and Game.

Diagram A

Fish Caught on the Columbia River



Adapted from an activity in "Water, Water Everywhere," Corvallis, OR; Oregon State University Extension Sea Grant Program, 1985. Used with permission.

Historical Data: Fish Caught on the Columbia River

1866	Opening of first fish cannery on the Columbia River.
1869–1883	Canning of Fish 1 jumped from 100,000 to 630,000 cases.
1877–1878	First efforts to regulate fisheries by state. Enforcement was limited but control of amount and type of fishing gear helped.
1880–1889	43 million pounds of Fish 1 taken from river by commercial fishers.
After 1883	Canneries begin to use other species of fish (2, 3, 4, 5).
1900–1909	30 million pounds of all fish taken.
1915–1920	40–44 million pounds of fish taken as World War I inspired intensive use.
1920	Approximately 1,000 commercial trollers operating in the Pacific Ocean. At least that many boats in the river with gill nets, seines, and traps.
1933–1938	Construction of first dam on lower part of the river.
After 1935	Only gill-netters allowed on the river. All other commercial fishing techniques banned.
1941	Second dam built in upper river. No fish ladders installed.
1930–1950s	Extensive logging in lowest part of river systems.
1940–1950	Four new dams built on the river between existing dams.
1950s	Six dams built on the major tributary of the river.
	Government launches a massive hatchery program for Fish 1, 2, and 5.
1953	Another dam built on main river.
1957	Another dam built.
1950–1960s	Ocean harvest rather than river harvest of Fish 1 and 2, increases greatly.
1968	Another dam built.
1968–1973	Extreme nitrogen supersaturation in river from dam spill of runoff water. Many small fish killed.
1960–1980	Fish hatchery techniques greatly improved on Fish 1, 2, and 5.
1970s	Commercial use of Fish 5 is banned.
1980s	Intensive regulation of ocean fishing on Fish 1 and 2.
1990s	One of the dams is removed.

Role-Playing Cards

A. G. "Rick" Ulture: a representative of the local farmers' coalition interested in the dam's potential for protecting crops from floods, as well as in its ability to provide water for irrigation.

Lotta Power: a lobbyist for the municipal electrical power company interested in developing the dam.

Rob or Marta Kanu: kayaker concerned with the loss of the whitewater stretch for canoeing and kayaking.

Sam N. Fish: a local sporting goods storeowner and avid fisherperson concerned with the loss of migration routes for the fish on the river.

Dan D. Lion: the president of the "Save Our Native Plants and Wild Animals" organization.

Pat "Pottery" Brusher: an archeology professor from the local university who has done extensive research on the archeological sites of American Indian fishing camps along the river.

Lynn Dripper: the director of the municipal water quality authority responsible for providing quality drinking water for the city. Believes in the dam's potential for providing a reservoir of high-quality water for the long, hot summers.

H. M. Owner: a representative of all homeowners in the river valley below the dam who would like to see more flood control.

Bobbie Lawkeeper: the local Rocksburg sheriff concerned about maintaining police protection, peace, health, and safety with only a one-person staff as the sole legal authority in the region.

T. M. Burr: the owner of a lumber company whose land would be inundated by the reservoir.

I. M. Floaten: an owner of a whitewater rafting company who uses the river for commercial rafting. Concerned about loss of the "best 7 miles of the river," I. M. argues that the lake would submerge the best rapids.

"Sky" Soarer: the president of the local bird club who has organized eagle-watching trips to the river every winter for the past 15 years.

Sam Slalom: an avid water skier who sees the new lake as a real boon to skiing interests.

Velma or Virgil Vigil: a local representative of the Gray Panthers, a group of retired people who are concerned about any rise in power bills.

"Boater" Cartop: an older fisherperson who enjoys throwing the boat on the top of the car and putting in at the closest float spot—especially lakes!

Marshal or May Flyfisher: a long-time resident who champions the purity of fly-fishing and insists on pristine habitat, noting the necessity of whitewater riffles.

Col. "Bull" Winkle: the president of "More Moose Now," who believes that the lake will provide more moose habitat.

Lap Larson: the president of W.O.W. (Watch Our Waves).

Cy or Sy N. Tist: a respected biologist who is prepared to testify about potential effects on wildlife from the building of the dam.

O. L. Slick: a salesperson for motor boats, water skis, and other recreational equipment.

Forest or Park Site: a trained forester who has worked in the woods in the area for more than 50 years.

Running Waters: a tribal leader who is concerned about loss of native heritage from flooding the region for the dam.

E. Conomy: a local businessperson who is concerned about the long-range business potential of the area.

C. D. Minium: a wealthy land developer who has architects working on designs for lakeside condominiums and resort homes.

Sample Observations Chart

Each group of students selects one difficulty level for each water type by placing a check in the appropriate box in its column. They may record additional observations in the boxes as well.

Difficulty Levels	Group 1	Group 2	Group 3	Group 4
Clean Water				
Easy to blow				
Less easy to blow				
Hard to blow				
Sand in Water				
Easy to blow				
Less easy to blow				
Hard to blow				
Silt in Water				
Easy to blow				
Less easy to blow				
Hard to blow				

Diagram A

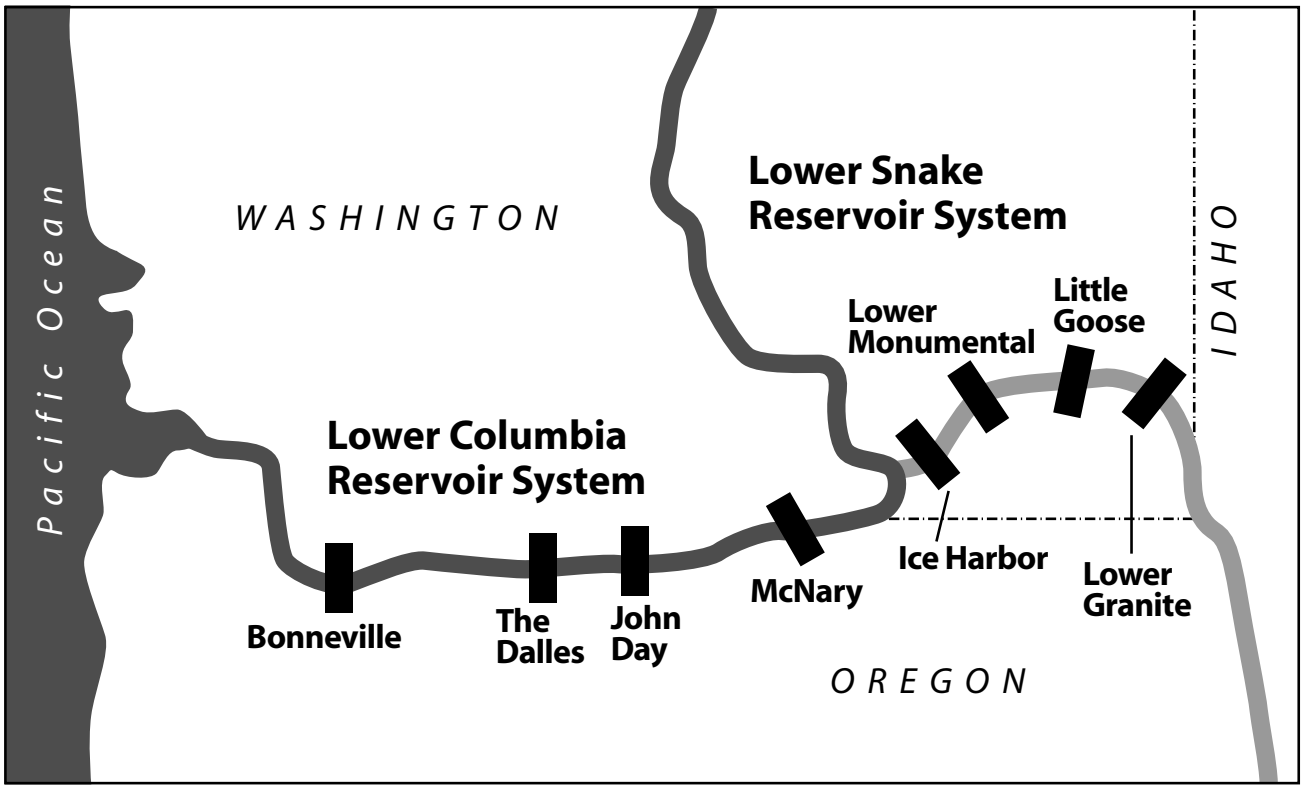


*Diagram A**

* Adapted from "Wild About Salmon, An Educators Guide," Idaho Department of Fish and Game, 1999.

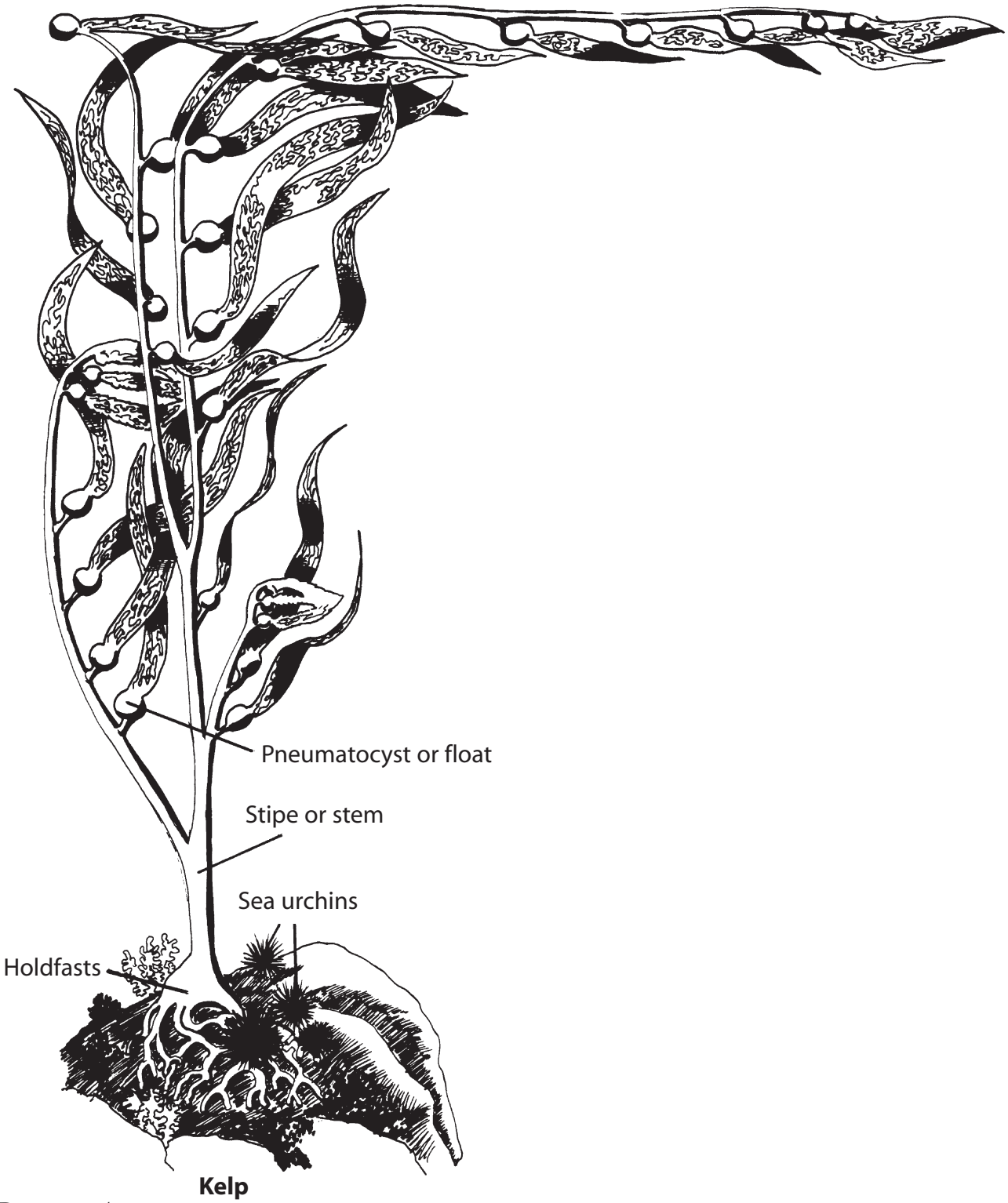


Diagram A

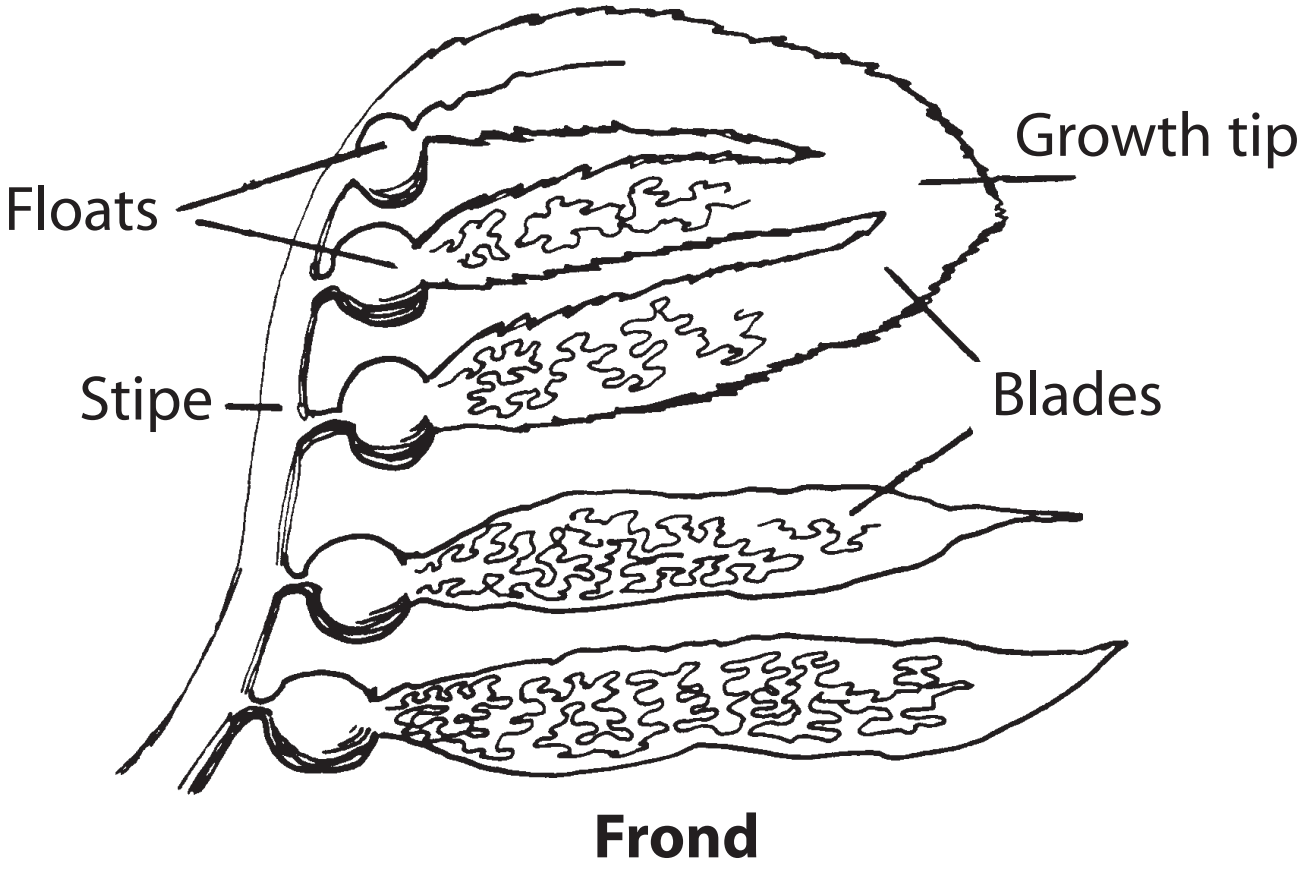


Diagram B

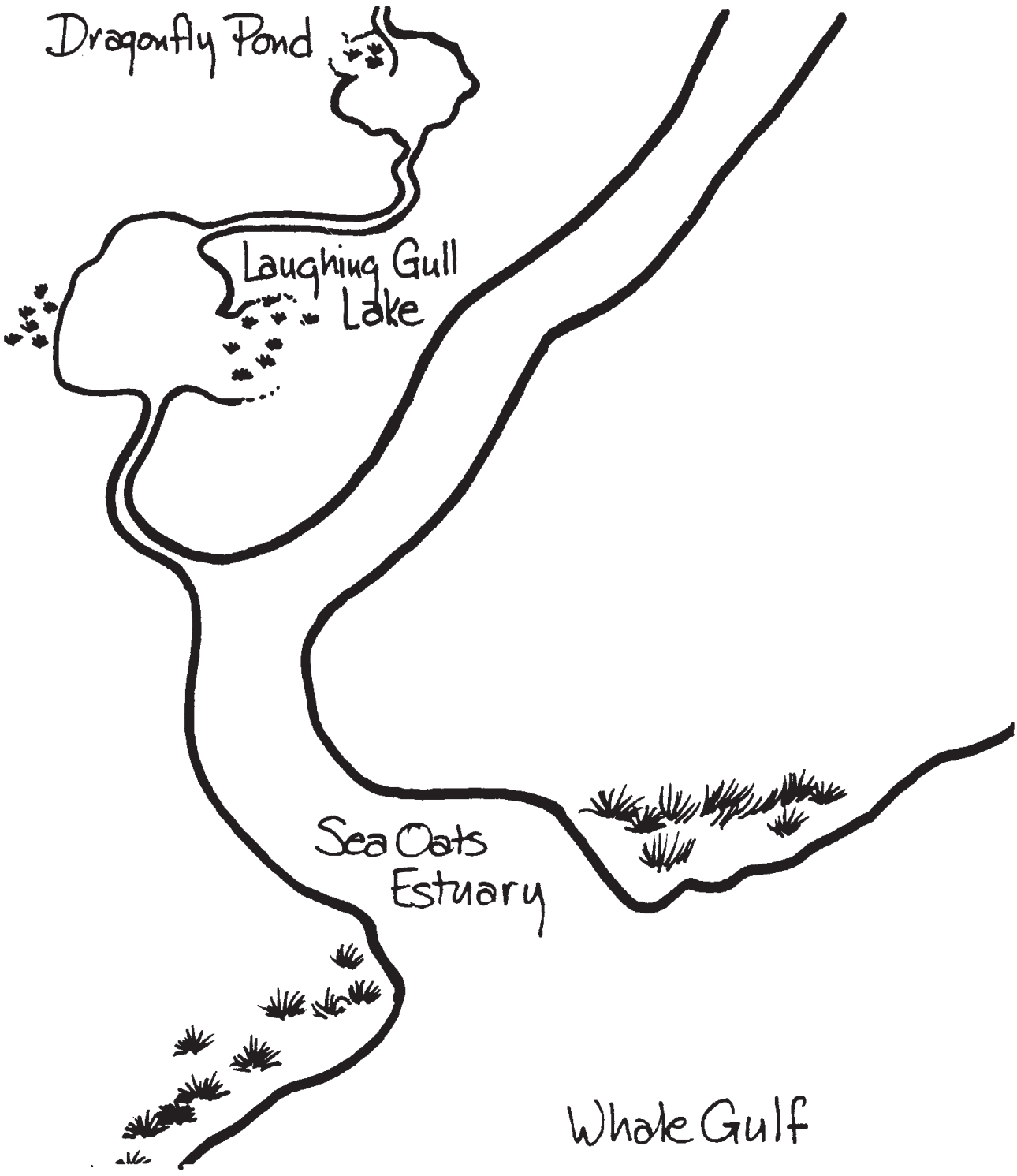
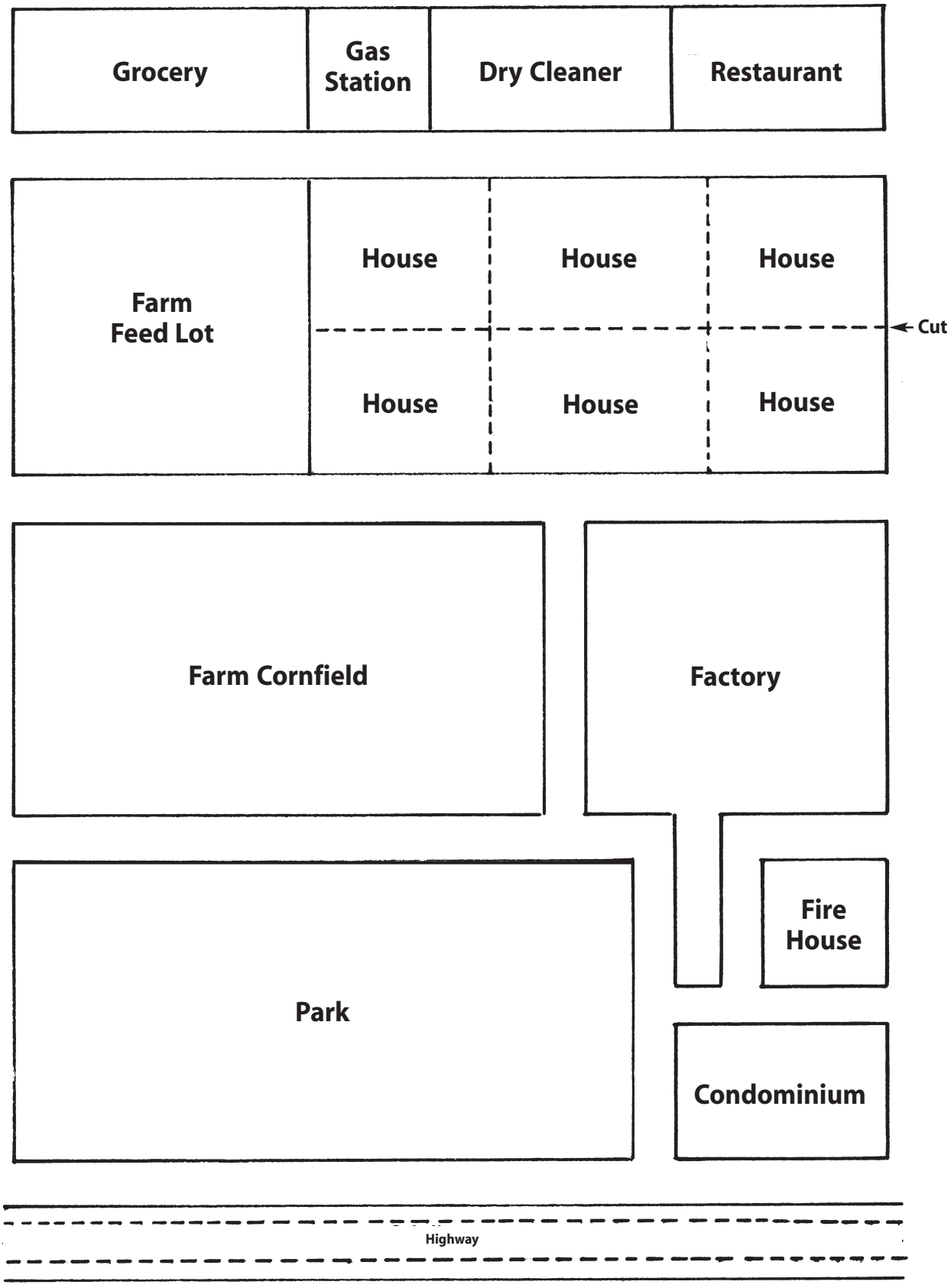

Dragonfly Pond
Laughing Gull Lake
Sea Oats Estuary
Whale Gulf

Diagram A

Land-Use Patterns



Map of Dragonfly Pond