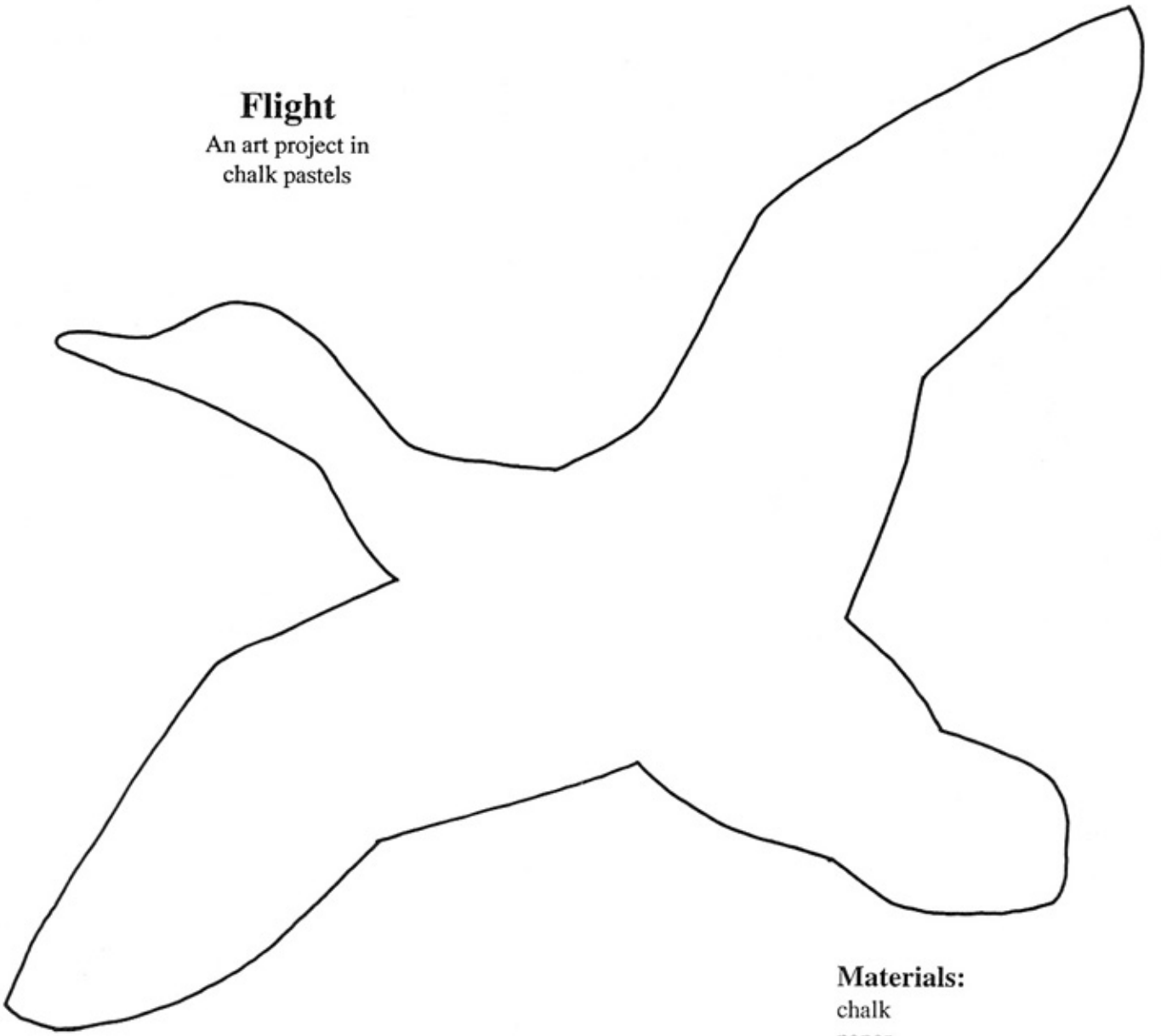
Flight

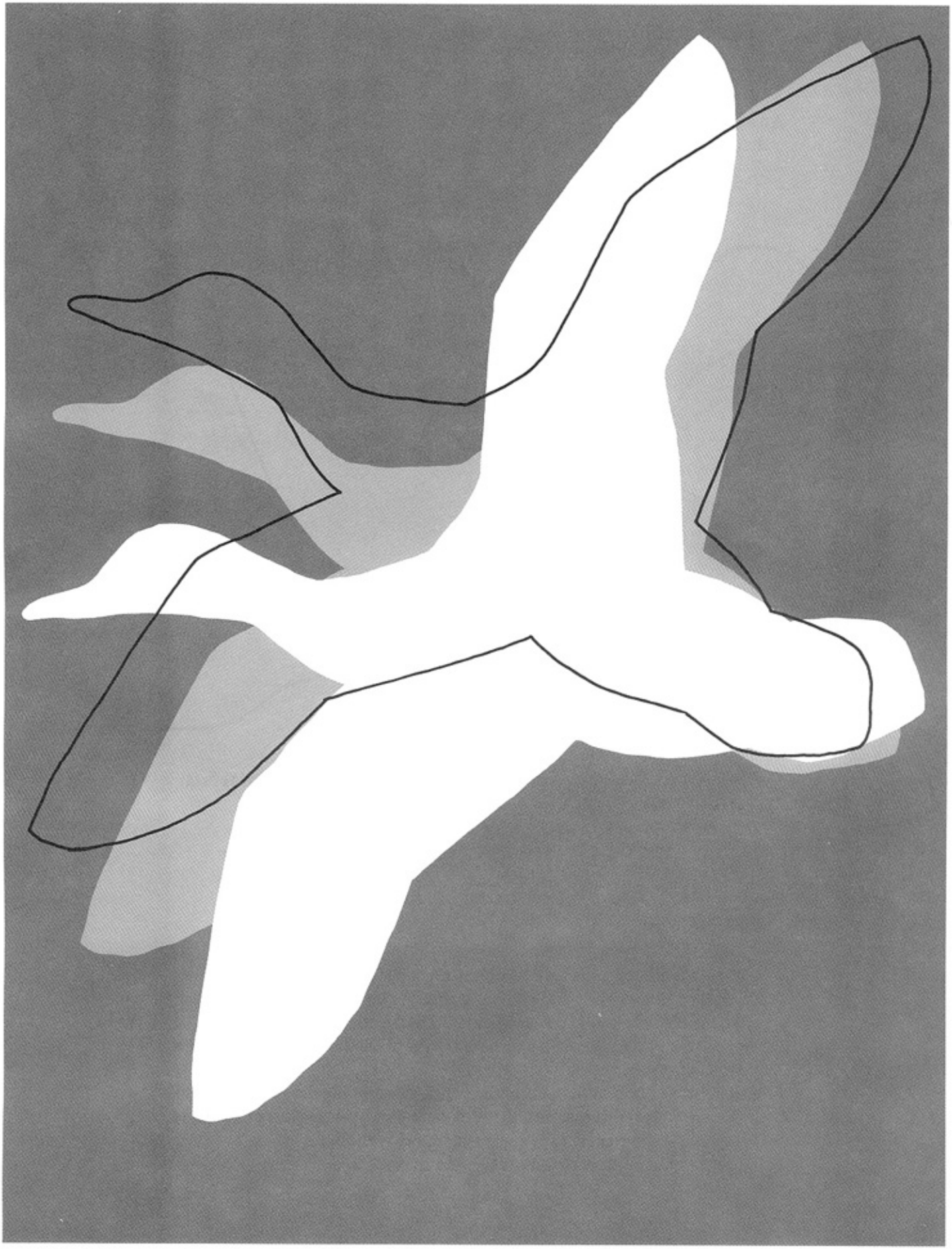
An art project in
chalk pastels



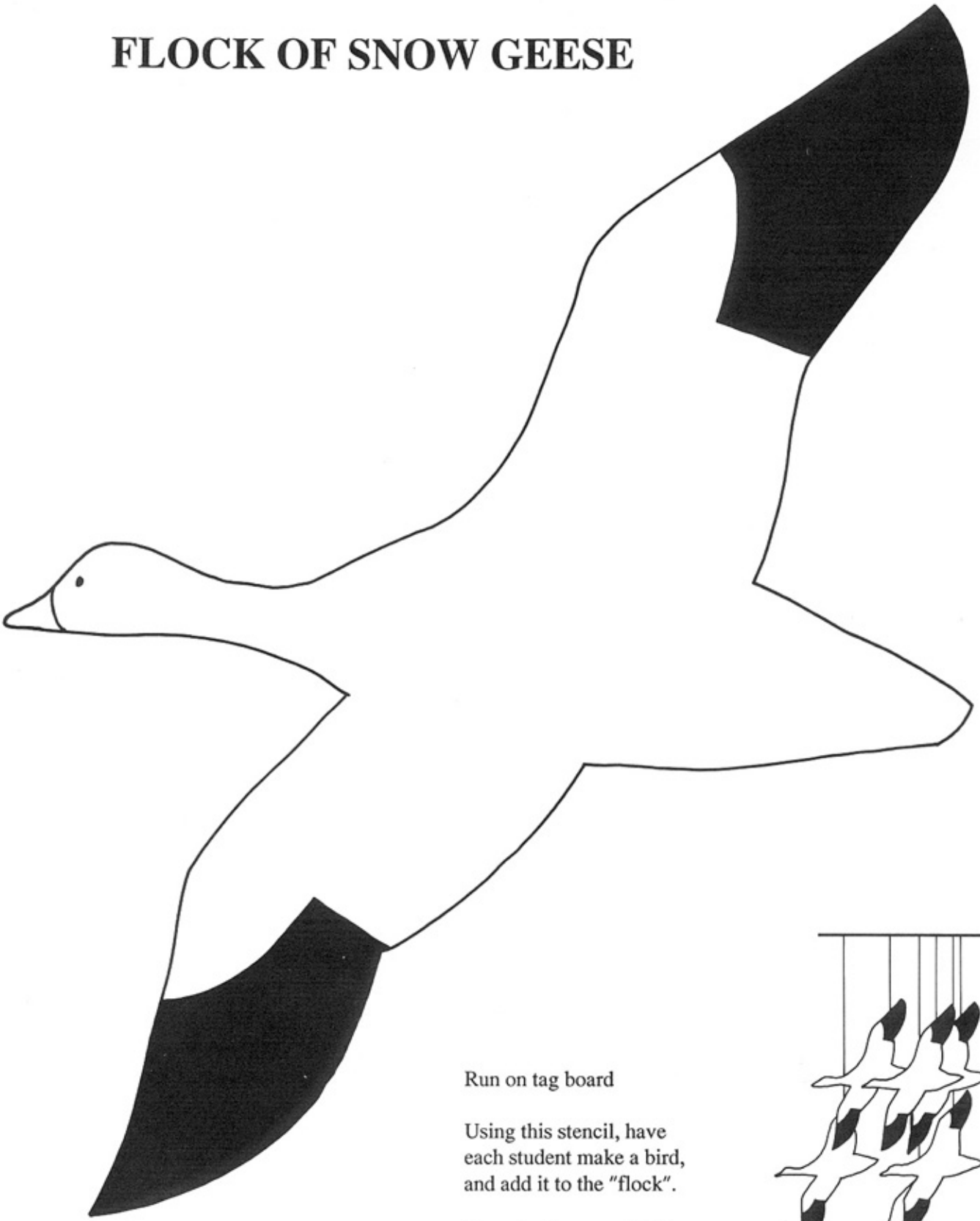
Materials:
chalk
paper
scissors
Kleenex

Run on tagboard

1. Cut out the stencil and chalk it heavily on one side.
2. Place it on clean paper, and holding it firmly with one hand, use the other hand to wipe the chalk from the center of the bird to the edges of the paper.
3. Prepare the bird again, with a different color of chalk. Watch out for smudges on your hands or the paper.
4. Place the bird on another part of the paper, overlapping the first outline that you made, and brush this color off the bird, onto the paper and out to the edges.
5. Repeat until desired effect is achieved. Spray with fixative.
6. Finally, you may want to outline the bird in black ink.



FLOCK OF SNOW GEESE



Run on tag board

Using this stencil, have each student make a bird, and add it to the "flock".

One wire hanger will take at least a flock of six.

FOLLOWING DIRECTIONS ...*An Origami Bird...Step by Step*

Demonstrate this with 5 students, and let them teach others in small groups.
Label points and corners as you go.

1. Place a square sheet of paper (included) on the table with one of the corners toward you. Label the top point A, the left point B, the bottom point C, and the right point D. See Figure 1.

2. Fold point B to point D, forming line AC. See Figure 2.

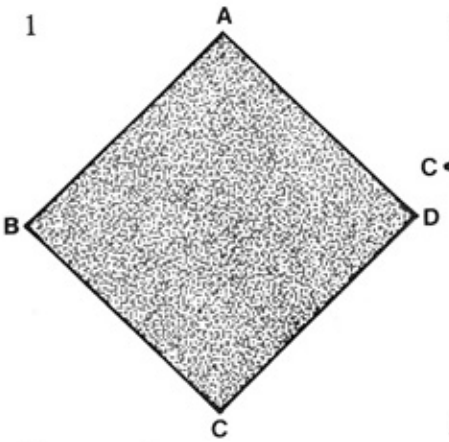
3. Open paper and fold line BC to AC. Repeat with line DC to AC. See Figure 3.

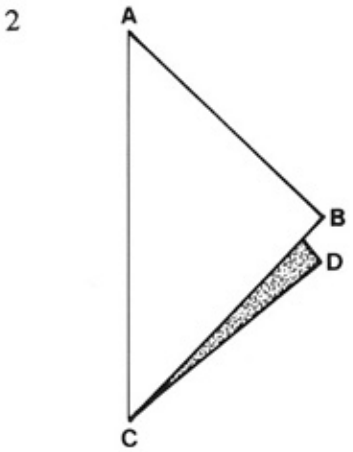
4. Put the paper down so C is on the left. Label the top corner E and the bottom corner F. Fold BE to meet CE. Repeat with DF to meet CF. See Figure 4.

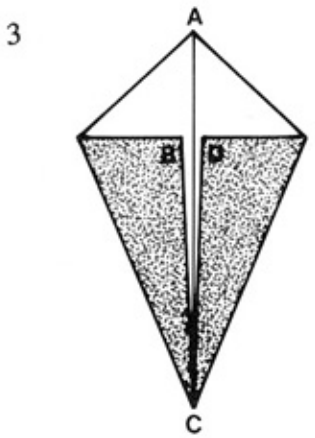
5. Fold so that E falls on F and crease the fold. Draw a line GH that is parallel to F as in Figure 5. Fold up on line GH. This forms the neck.

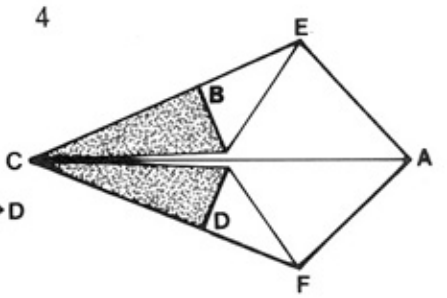
6. Unfold the neck. Open the shape at points E and F. Push the neck in <u>between</u> E and F and crease again on GH. Label a diagonal line IJ on the neck (forms head). See Figure 6.

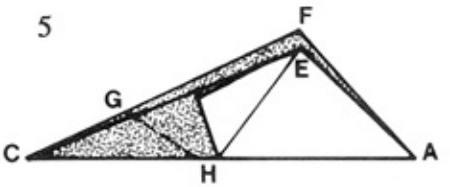
7. Fold the head down on IJ. Unfold the head and open the neck fold. Push the head down inside the neck fold so that the head is in the <u>center</u> of the neck. Crease at the top of the head as in Figure 7.

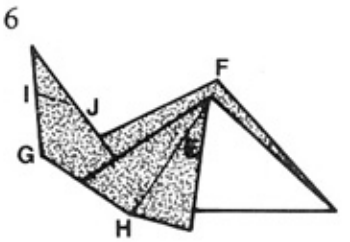


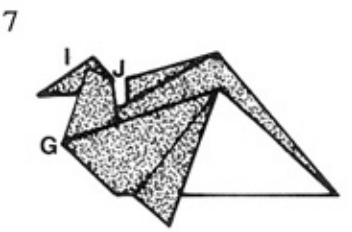










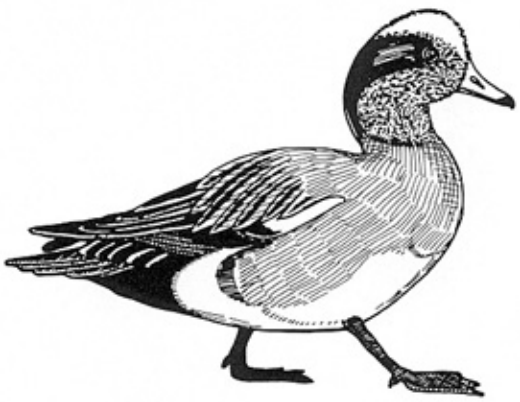


American Avocet
Black-necked Stilt

American Bittern

American Wigeon

Belted Kingfisher

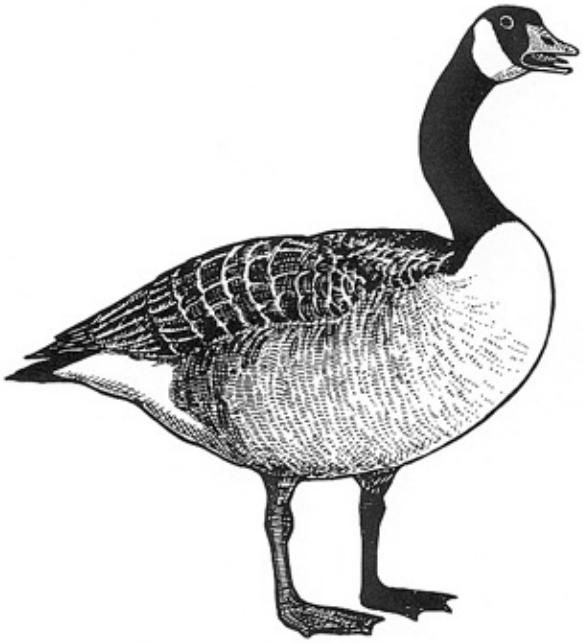


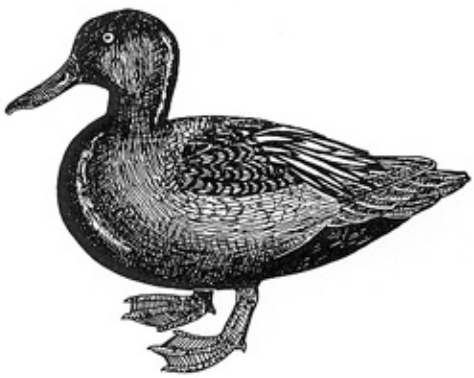
Canada Goose

California Quail

Cinnamon Teal

Canvasback



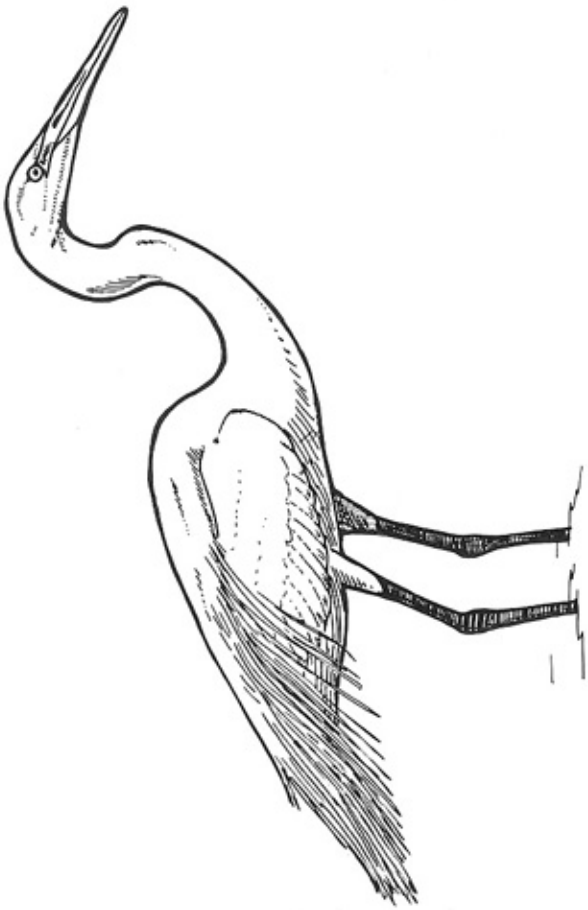


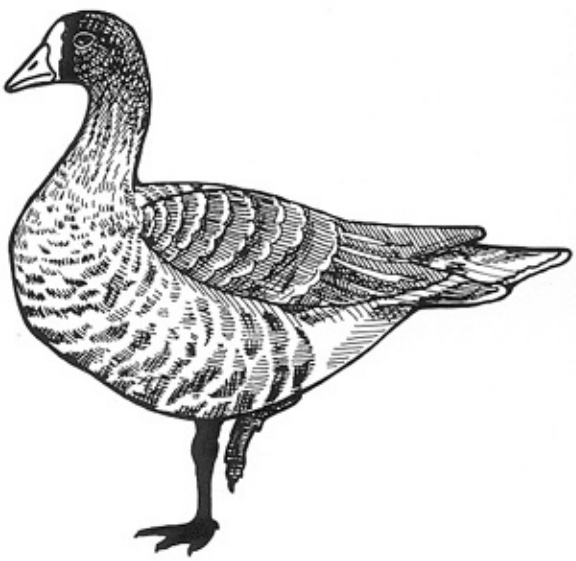
Great Blue Heron

Coot

Greater
White-Fronted
Goose

Great Egret



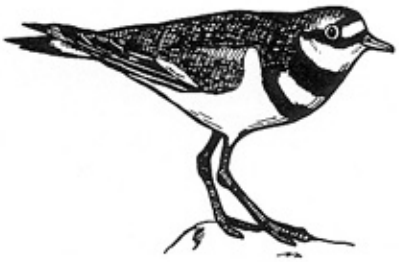


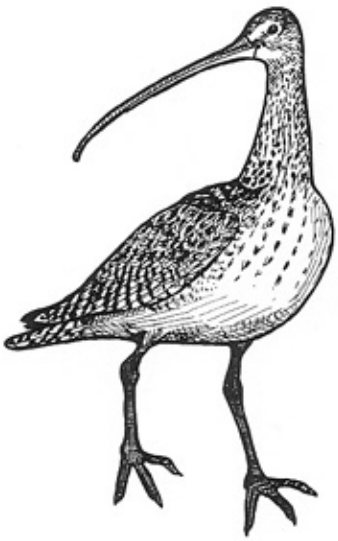
Long-billed Curlew

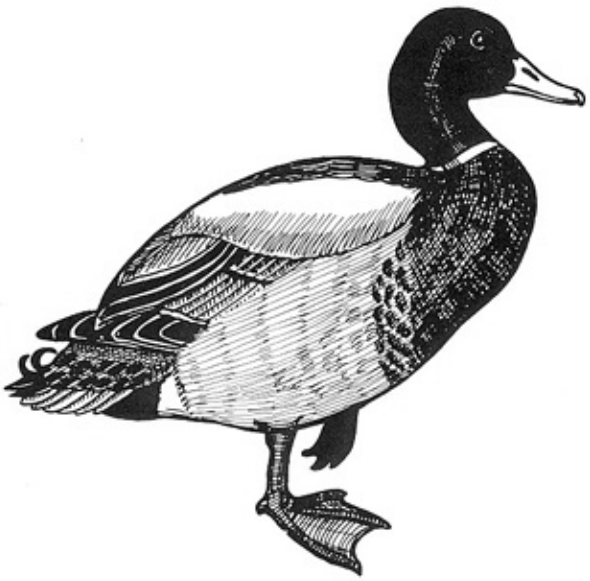
Killdeer

Northern Flicker

Mallard





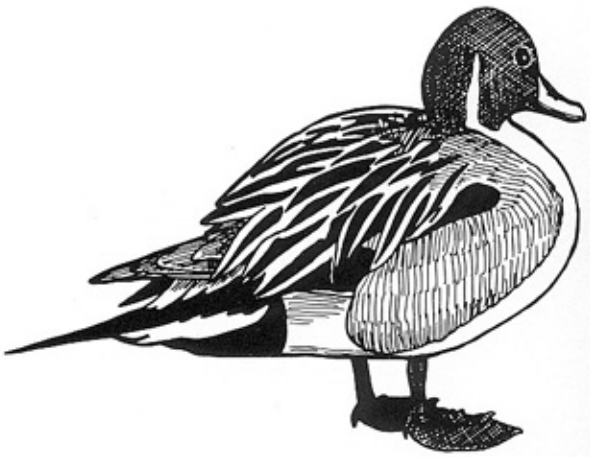


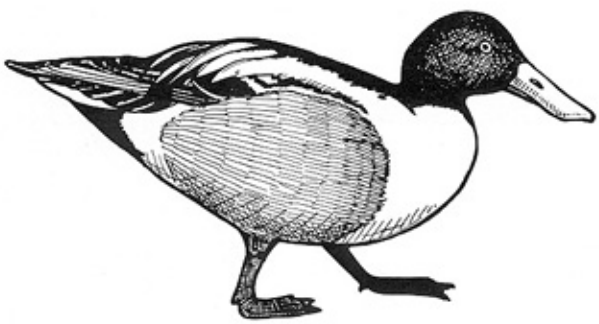
Northern Pintail

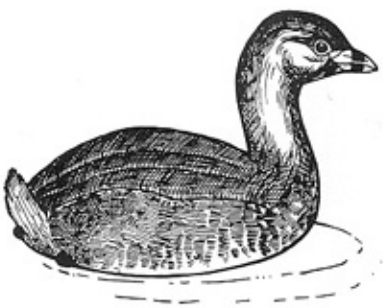
Northern Harrier

Pied-billed Grebe

Northern Shoveler







Ring-necked Pheasant

Red-winged Blackbird

Sandhill Crane

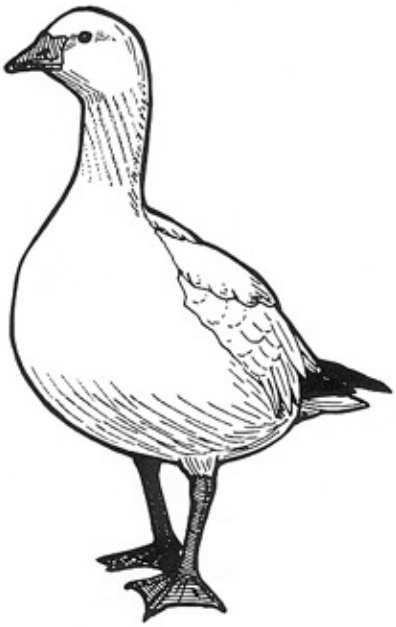
Ruddy Duck

Western Grebe

Snow Goose

Wood Duck

Western Meadowlark



Name

Migration Identification

When studying migratory birds, it is important to be able to identify them in flight. Here are the outlines of seven migratory birds from the Central Valley. Can you identify *any* of them? *Some* of them?

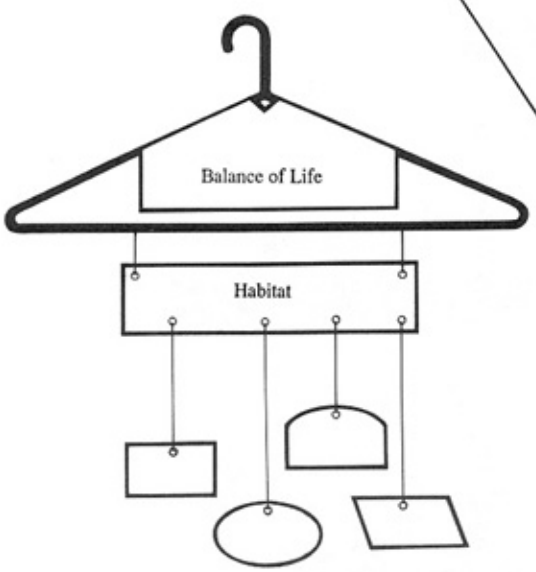
Answers below.

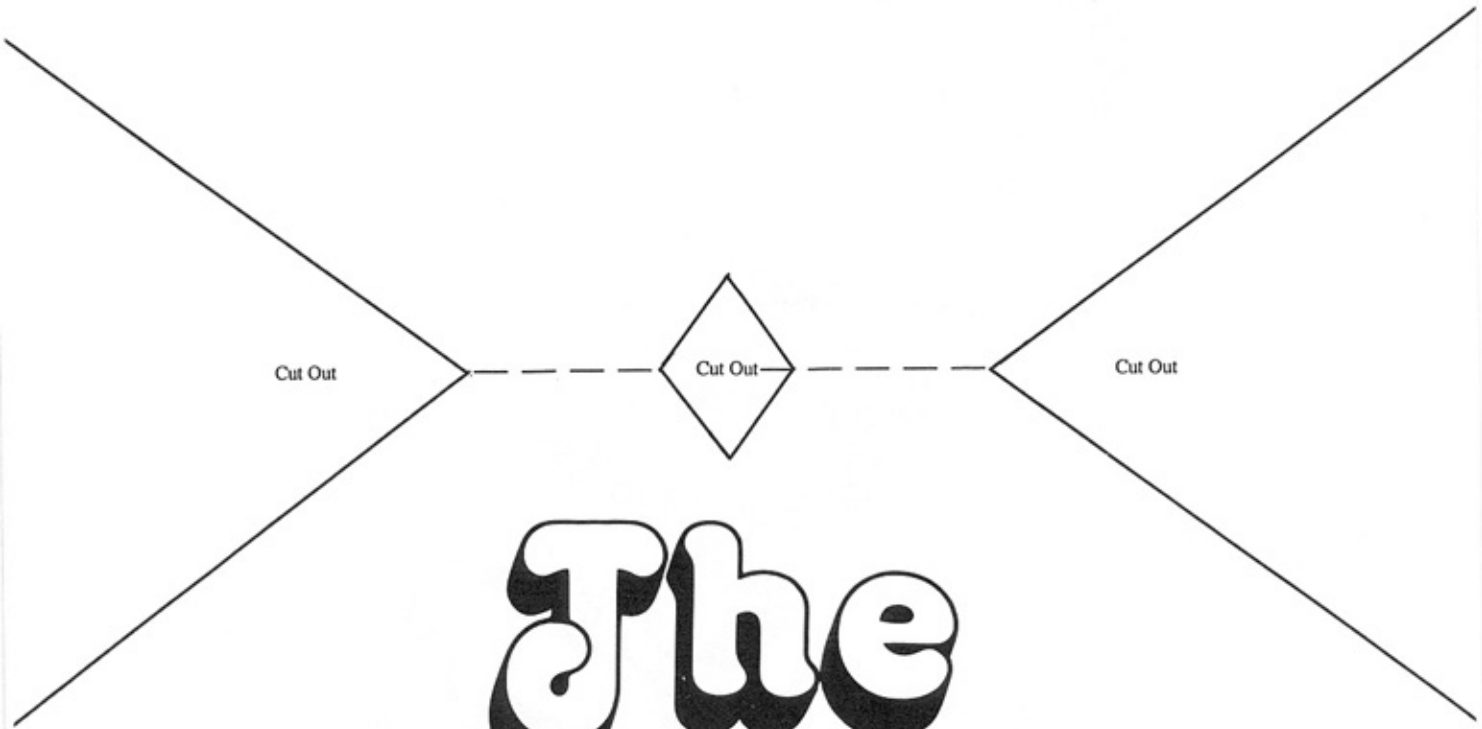
1. Northern Harrier Hawk
2. Northern Pintail
3. Northern Shoveler
4. Mallard
5. Canada Goose
6. Kingfisher
7. Sandhill Crane

HABITAT MOBILE

4 Requirements for Habitat

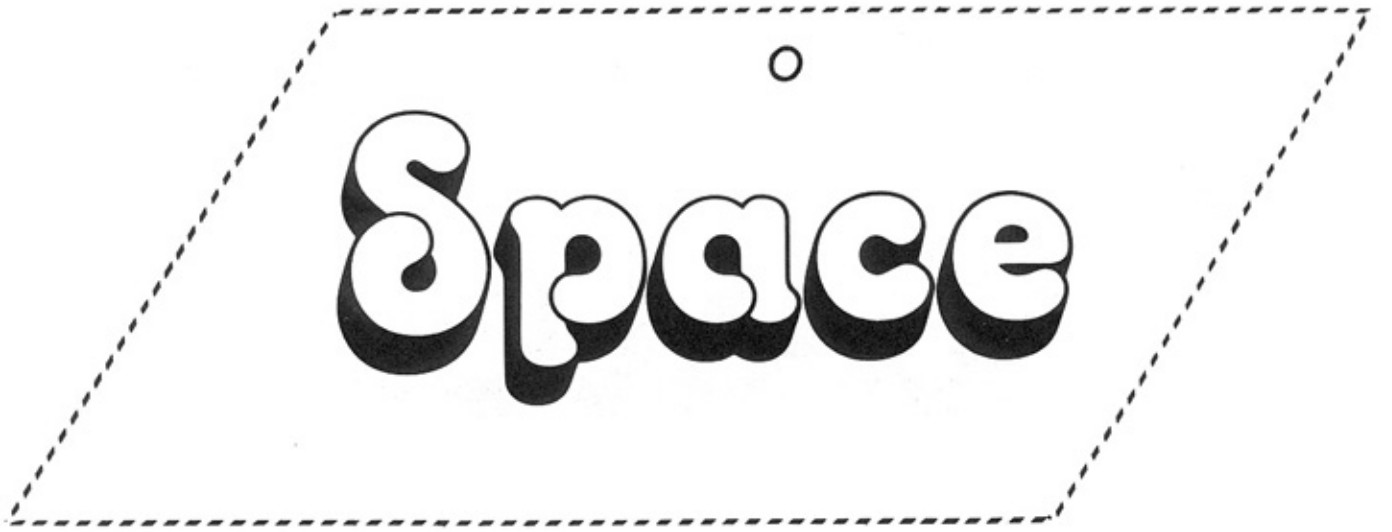
1. Run all sheets on tagboard.
2. Have students color letters and cut out pieces.
3. The "Balance of Life" jacket fits over the top of a hanger.
4. Arrange and hang the pieces as shown below.





The Balance of Life


Cover


Space


Food

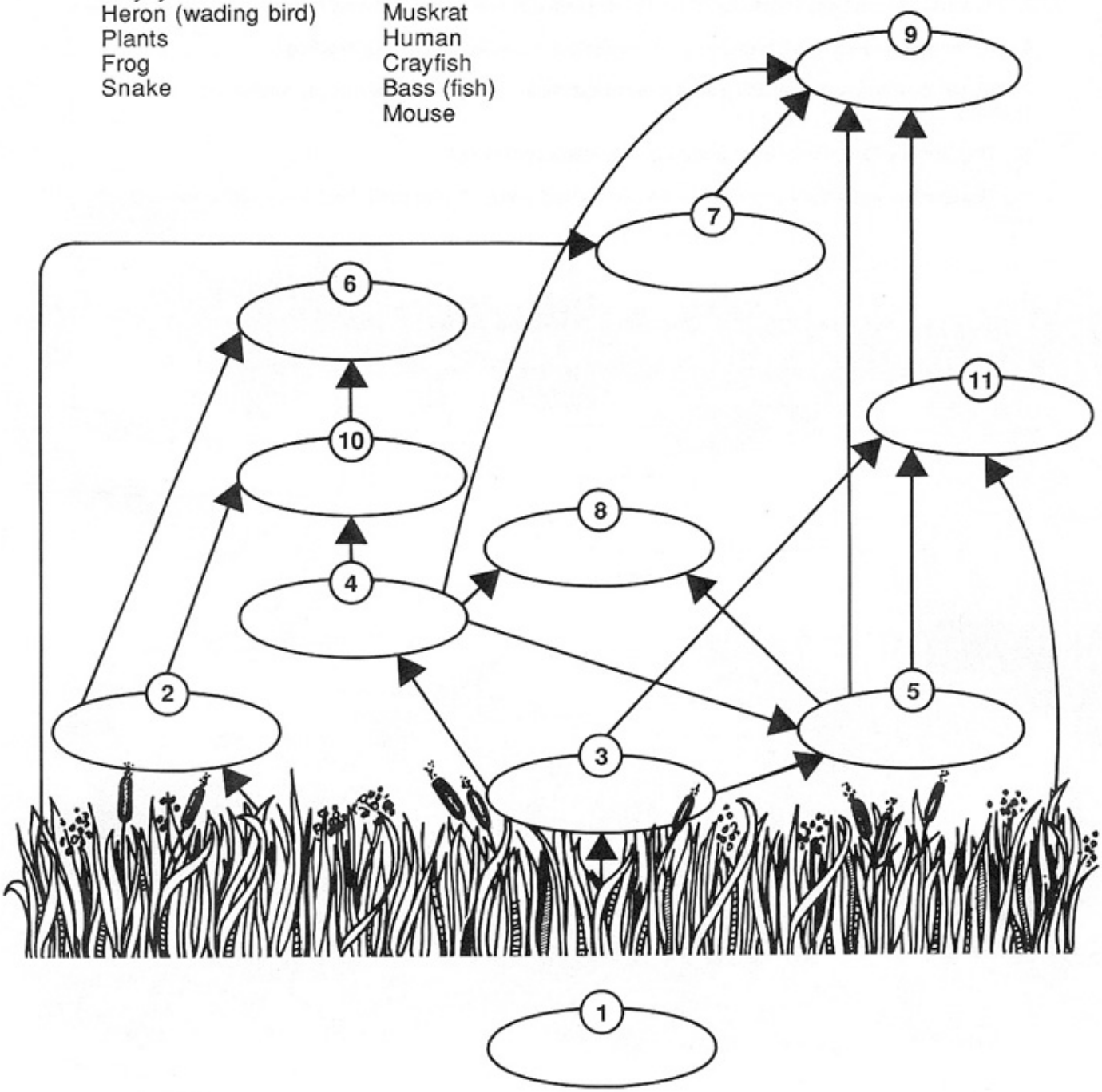

Water

Freshwater Marsh Food Web Puzzle

Every creature has to eat. Some food comes from plants and some from animals. Most creatures eat many different things. Plants and animals, including humans, are all linked in a "food web".

Here is a simplified food web from a freshwater marsh area where pioneers might have settled 200 years ago. Read the clues and see if you can work out the web. Use the words below to fill in the correct numbered places. (Note: The arrows point away from the "food" toward the creature that eats it.)

Mayfly
Heron (wading bird)
Plants
Frog
Snake
Owl
Muskrat
Human
Crayfish
Bass (fish)
Mouse



Clues

1. These living things use energy from the sun to make food. They provide the most food in the entire world.

2. This small marsh rodent eats plants and sometimes insects.

3. The larva of this flying insect feeds on plants.

4. This creature eats insects; it stays close to water but is sometimes found on land.

5. This animal lives all its life in the water and feeds on insects and frogs.

6. This bird hunts at night for snakes and mice.

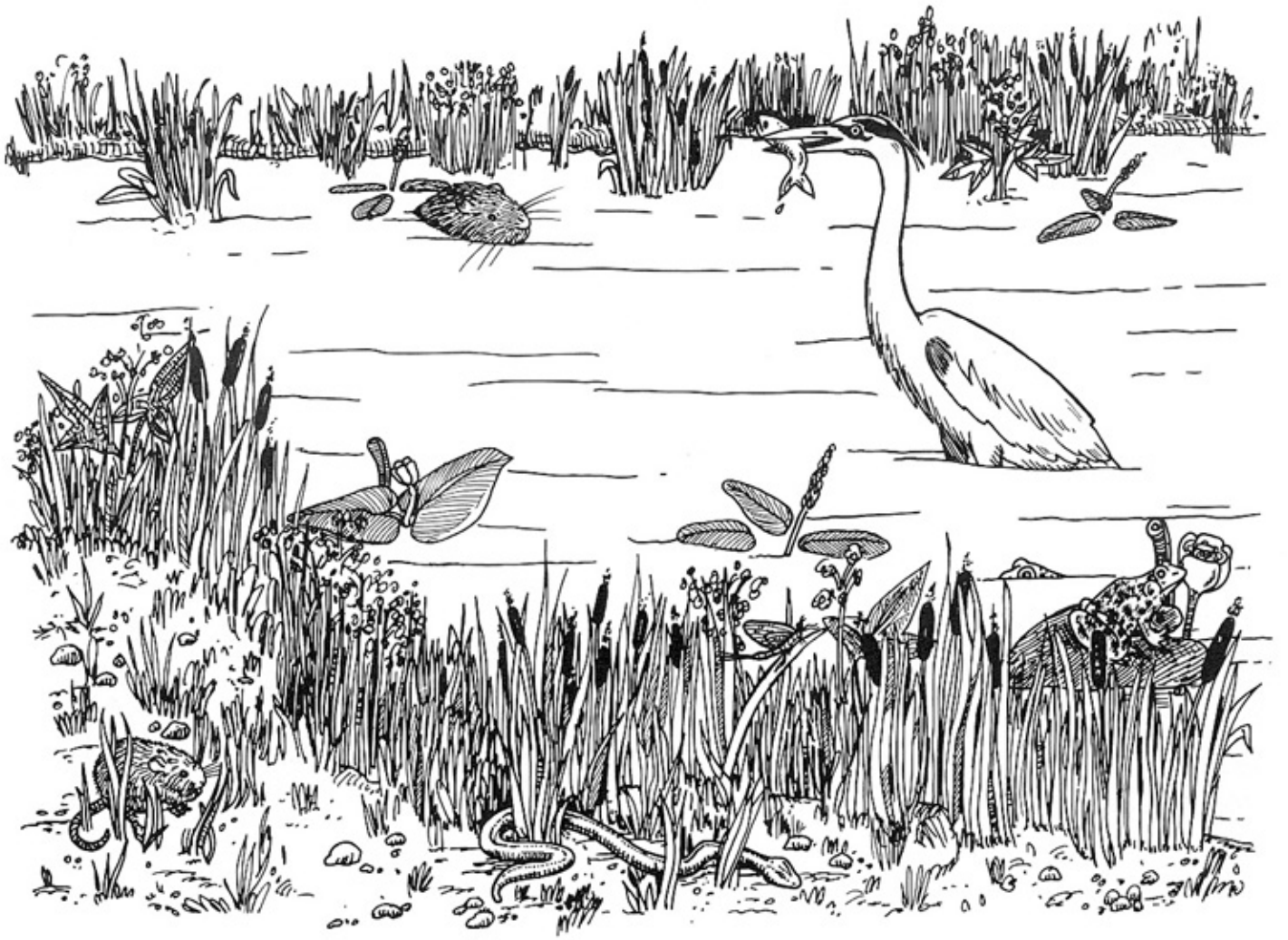
7. This small mammal was hunted for its fur; its meat was also eaten. It eats mostly plants.

8. This long-legged bird wades among plants in shallow water, looking for fish and frogs.

9. This creature can find many things to eat in the marsh, including plants, fish, frogs, crayfish and muskrats.

10. This long reptile hunts for frogs and mice. It swallows prey whole.

11. This creature looks like a small lobster and swims backwards. It eats small dead fish, insect larvae and plants.



Answers: 1. plants, 2. mouse, 3. mayfly, 4. frog, 5. bass, 6. owl, 7. muskrat, 8. heron, 9. human, 10. snake, 11. crayfish.

PUT ME IN MY PLACE!

Habitat Match 4 - 6

A Wildlife Refuge is a special place for birds and other animals. Government workers take care of the Refuge so that it will always be used by the wildlife. Different kinds of birds like to be in different parts of the Refuge. Read about the birds, cut them out, and put them where they like to be. Or, take the short cut - write the letter that is next to the bird in the part of the refuge where you would find that bird.

SNOW GOOSE **A**

Likes to feed in grasslands and grain-fields.

AMERICAN COOT **B**

Can be found in the water or wandering on the edges of the water. This bird can walk along on lily pads.

WESTERN GREBE **C**

Found on open water where it builds floating nests.

RUDDY DUCK **D**

The Ruddy Duck and the Canvasback are ***diving ducks***. The Ruddy Duck is found in marshes, lakes and ponds. Canvasbacks like open lakes and marshes.

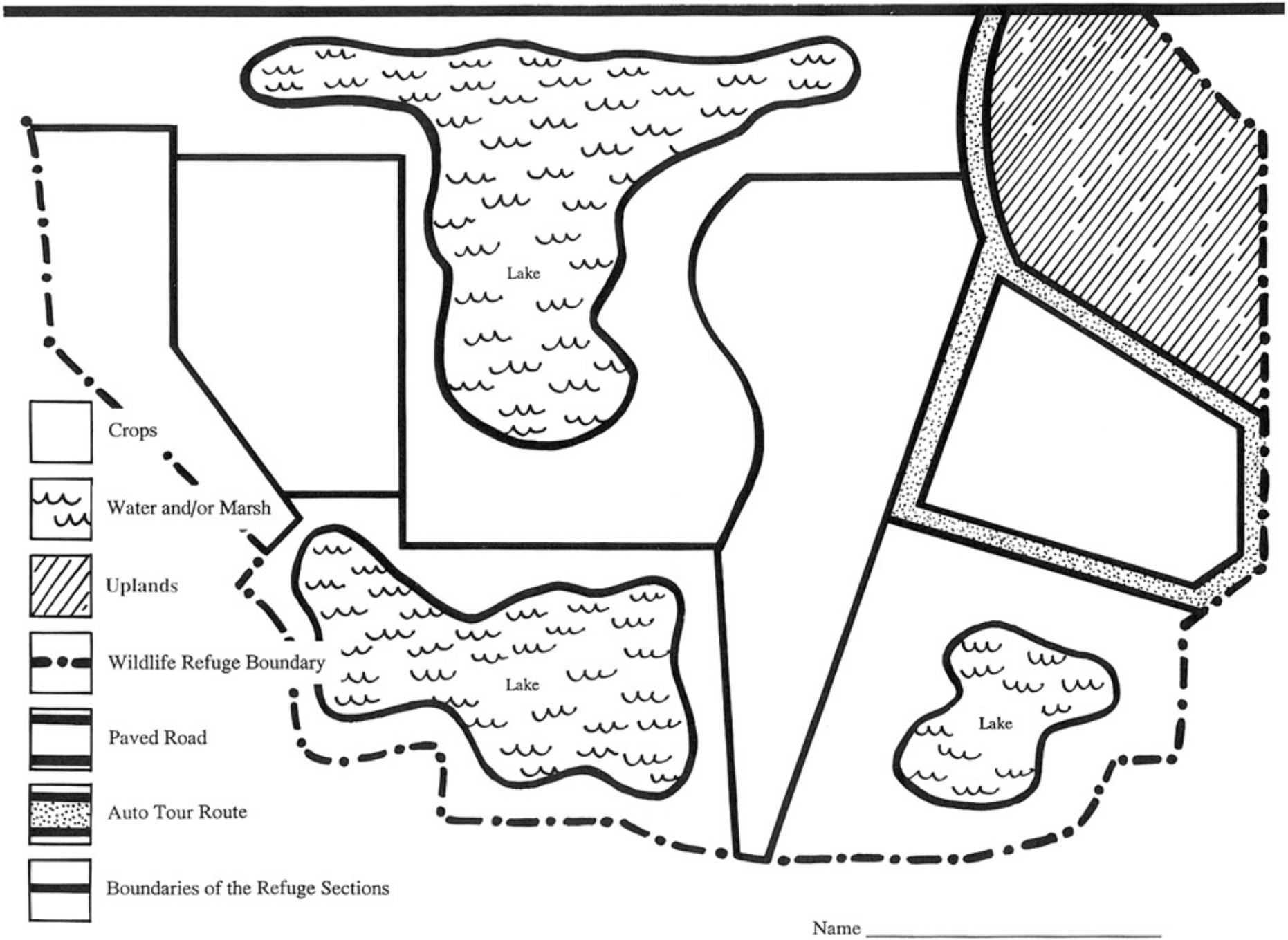
CANVASBACK **E**

CINNAMON TEAL **F**

The Cinnamon Teal, Pintail and Mallard are **dabbling ducks**. They feed by tipping tail up to reach aquatic plants, seeds, and snails. The Cinnamon Teal can be found on ponds and in lakes and marshes. The Pintail will be in marshes and open areas with ponds or lakes. The Mallard enjoys the water, but can be found in many places on the refuge, so you can put it where you like!

PINTAIL **G**

MALLARD **H**


Lake
Lake
Lake
Crops
Water and/or Marsh
Uplands
Wildlife Refuge Boundary
Paved Road
Auto Tour Route
Boundaries of the Refuge Sections

Name _____

Migratory Birds

In spring and autumn, the sky can become dark with countless birds flying between their **breeding grounds** and **wintering grounds.** This seasonal or periodic movement, called **migration,** is not unique to birds. Various wildlife species ranging in size from butterflies to whales are migratory.

Why Do Birds Migrate?

The reason birds migrate can be explained only partially at this time. Several theories for migration have been identified, and it is probably a combination of factors that stimulates birds to migrate. One theory suggests that changes in weather which affect the availability of food and water cause birds to migrate. Waterfowl obviously cannot feed in frozen lakes and many insect-eating birds leave the north to winter in Central America after feeding on the abundant Arctic insects all summer. A second theory links migration to genetic or inherited characteristics by suggesting that migration is an instinctive return to ancient habitat areas.

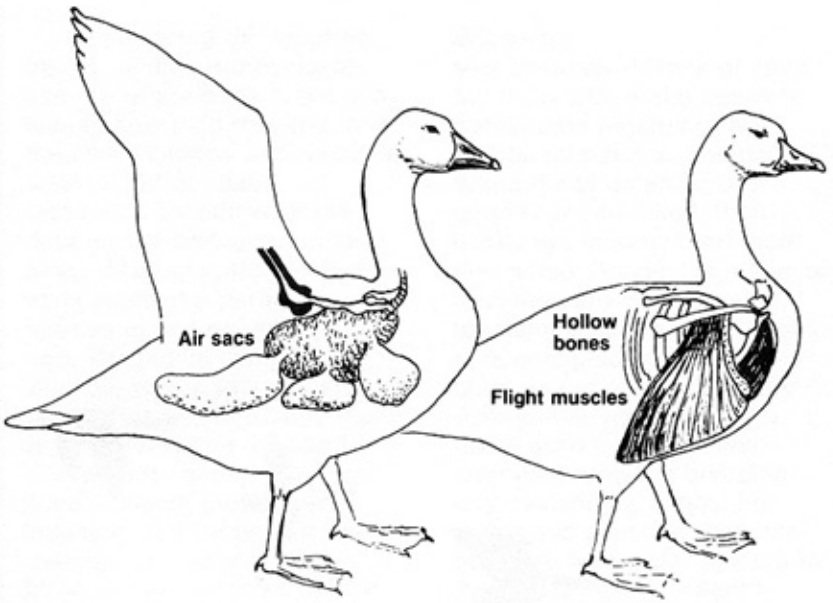
Migrating Canada geese

How Do Birds Migrate?

During migration, birds accomplish remarkable feats. For instance, a ruby-throated hummingbird can fly 500 miles in 25 hours, an average of 20 mph; mallards can fly as high as 21,000 feet; geese attain speeds of 50 mph; and greater shearwaters migrate 8,000 miles annually. The destinations of migratory birds are as amazing as their flights. After a journey of 3,000 miles, the Tennessee warbler has been known to return to the same tree in which it nested the preceding year.

Migratory methods are also varied and fascinating. In addition to the usual method of flying, some seabirds migrate by swimming; mountain quail migrate by walking down mountain slopes.

Several senses and adaptations enable birds to migrate. For a start, most migratory birds have very powerful flight muscles. They also have a highly developed respiratory system, hollow bones, internal air sacs, and specialized body shapes. All of these features



enable them to fly high, fast, and for long periods of time.

In addition, most birds have very sharp vision. This enables them to use distant landmarks and the sun or stars as directional cues. Other helpful aids include an ability to see ultraviolet light, hear low-frequency sounds (like the surf against a distant beach), detect the magnetic and gravitational fields of the earth, and sense weather frontal systems and changes in barometric pressure. One or several of these aids may be used depending upon the species and the route traveled.

When Do Birds Migrate?

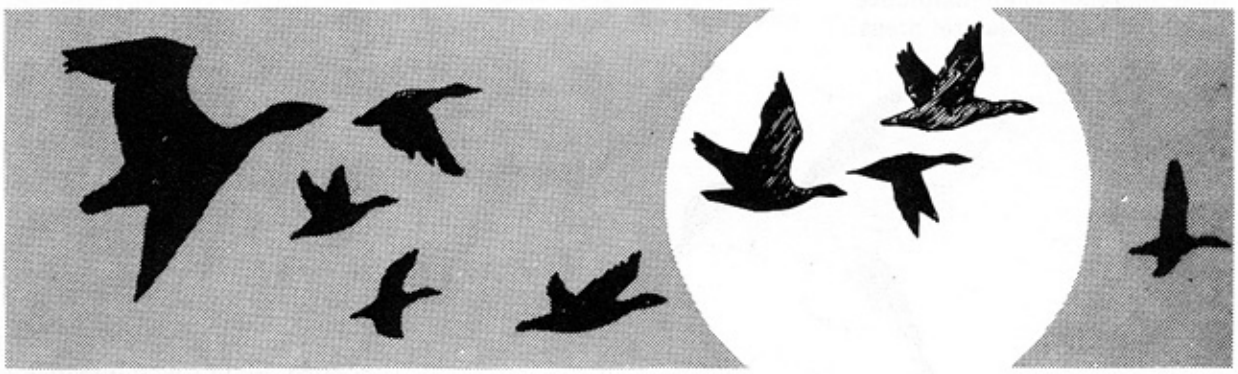
Times of annual migrations vary. For instance, while many shorebirds begin their fall migration in early July, other species, such as geese, do not begin until late fall. And while some birds have a leisurely migration schedule, others fly swiftly to their destinations. In general, however, migrations in the fall are less hurried than in the spring. It is believed that spring migrations are faster because of the stimulus to breed and nest.

The time of day when migration occurs also varies. In general, most small birds migrate by night. Ducks and geese may migrate both day and night. Observations made with telescopes focused on the full moon have shown birds migrating over one area at a rate of 9,000 birds per hour! Travel by night enables some of the small birds to avoid their enemies. In addition, by traveling at night, birds can spend the day feeding and resting. Day migrants include loons, cranes, gulls, hawks, and vultures. Soaring birds such as broad-winged hawks migrate only during the day because they are dependent upon updrafts created by the sun.

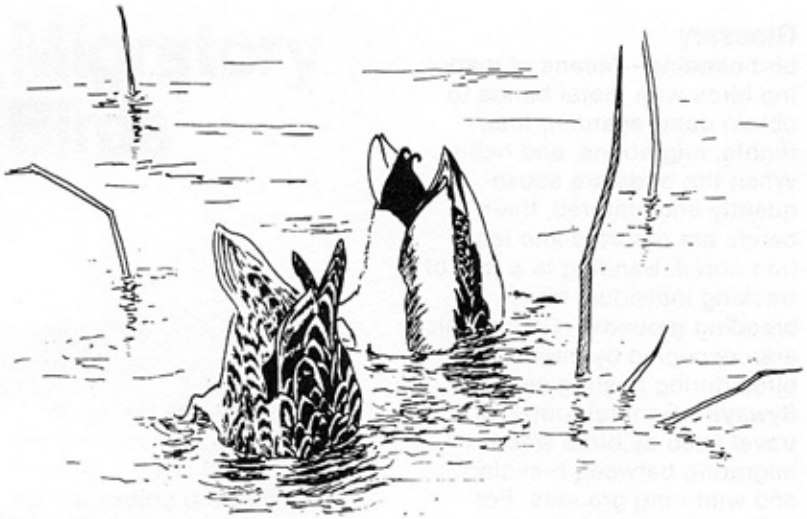
Where Do Birds Migrate?

Migration can take birds from the Arctic to Antarctica. While most species' journeys are not that long, many birds—even small songbirds—do travel impressive distances. This makes bird migration an international concern. Where birds migrate depends on a variety of elements, but the importance of food, water, and shelter must not be overlooked. Many species of birds will seemingly travel several thousand miles out of their way but actually take that route because of the availability of food sources.

While general directions of flight are consistently followed by migrating birds, it is important to remember that the term "migration route" does not mean an exact, specific route between wintering and breeding grounds. Routes tend to follow major habitat types, avoid crossing obstacles like mountain ranges, and provide the necessary food, water, and shelter. Migration routes tend to follow a north-south path, but routes can also include east-west movements.



Nocturnal migrants



Temporary migration stopover

There appear to be four broad migration routes in North America. For research and management purposes these routes are depicted as four distinct **flyways:** the Atlantic Flyway, the Mississippi Flyway, the Central Flyway, and the Pacific Flyway. Of these, the Mississippi route is used most.

Difficulties Along the Way

Despite the many benefits of seasonal movement, a number of problems can occur during migration. Migrating birds are under considerable stress and use up a great deal of energy in sustained flight. A sudden storm that blows them off course or unusually cold weather that reduces their food supply can have disastrous results. Stress also makes them more susceptible to disease, as does the fact that some birds migrate in large flocks where disease can spread easily. Another problem for migratory birds is collisions with skyscrapers, picture windows, radio towers, etc.

Alteration of habitat along the flyways offers potential benefits as well as problems for migrating birds. Many marshlands and other resting places for the traveling birds have been converted to farmland. The birds must feed and rest to survive, so they often take advantage of wheat or corn fields along the way. These crops are a good food source, but many birds have begun to delay their migrations, feeding for long periods in areas with prime supplies. This not only presents a problem for the farmer but also for the birds which may suffer a higher incidence of disease or face severe weather as the seasons change. The conversion of land for many other uses such as housing or commercial development reduces the amount of food available during migration.

Migratory bird populations can also be seriously affected by contact with pesticides. For many years DDT was used to kill insects. Through the food chain process, DDT accumulates in the bodies of birds and mammals. For birds, this can result in thin-shelled eggs, infertility, and sometimes death. While DDT is now banned in the United States, it is still used extensively in other parts of the world. Therefore, birds migrating to these areas are still exposed to it.

Research and Management

A variety of research is currently being conducted to increase our knowledge of bird migrations. Methods used to collect migration data include direct observation, recordings of calls, **bird banding,** radio tracking, radar observation, and laboratory studies involving orientation, navigation, and the physiology of migrating birds.

Of all these methods, however, bird banding has probably yielded the most information. Bird banders trap or net birds and place a metal band on each bird's leg. Each band has a different number on it. This number, along with a description of the species of bird, its age, sex, and date of banding, is sent to the U.S. Fish and Wildlife Service. After the banded bird is released, it may be caught again by banders, die of disease or other natural causes, or be shot by hunters. Information on the recapture, or the band from the dead bird, is then sent to the Fish and Wildlife Service.

By analyzing the reported bands, wildlife professionals can tell where birds breed and winter, how long they live, and the times, lengths, and routes of their migration. Band recoveries provide valuable data for the biologist to use when estimating the relative abundance of a particular species in an area or population. The public can play a valuable role in this research by sending any bird band found to the address on the band.

The information obtained from research provides valuable contributions to the management of migratory birds. Some examples of how research data are used by wildlife experts include how to: combat disease outbreaks, change feeding patterns that are damaging crops, and set harvest limits for migratory bird hunters. Much of the management of migratory birds consists of making sure that adequate habitat exists along the migration routes so birds can rest and feed. Hundreds of private, State, and Federal wildlife refuges have been established to help meet these needs. Similar efforts are also conducted in other countries. This international effort is crucial to the survival of migratory birds.

Research, habitat preservation and management, and international treaties insure that migratory birds will be here for future generations.

Glossary

bird banding—Means of marking birds with metal bands to obtain data regarding their flights, migrations, and habits. When the birds are subsequently encountered, their bands are reported and location noted. Banding is a way of tracking individual birds.

breeding grounds—Geographic area occupied by migratory birds during nesting season.

flyways—General routes of travel used by birds when migrating between breeding and wintering grounds. For ducks and geese in particular, there are four major flyways in the United States: Atlantic, Mississippi, Central, and Pacific. The actual migratory routes of individual bird species may vary from these general flyway patterns.

migration—Seasonal or periodic movement between breeding and wintering grounds. Bird migration varies among species in terms of destinations, time, and duration. Generally migration is accomplished to utilize better feeding grounds.

wintering grounds—Geographic area occupied by birds in the winter. Wintering grounds are usually the most southerly range at which North American migratory birds spend the winter.

Department of the Interior/U.S. Fish and Wildlife Service, 1982

Freshwater Marsh

Few people realize the importance of **freshwater marsh** resources to the early settling of America. Trappers in search of beavers and other furbearers that were abundant in marshes, mapped rivers and founded outposts. These outposts later grew into cities such as Chicago, Detroit, and New Orleans. Settlers utilized the freshwater marshes' natural resources. Fish and game harvested there filled many tables. Marshes provided reeds for caning and marginal grazing land for livestock.

Too often, though, marshes were viewed as mosquito-infested wastelands to be used for dumping grounds or to be "improved"—drained or filled for agriculture or construction. Drainage had begun by George Washington's time, and alterations of freshwater marshes and other wetlands have since been carried out on a massive scale. It is estimated that today the United States has already lost 45 percent of its original wetlands acreage.

During the past few decades, people have begun to realize the ecological values and benefits of freshwater marshes. These valuable functions were noticed when they were interrupted due to wetland destruction.

One of the first values observed was the marshes' importance as habitat for wildlife, particularly waterfowl. As wetlands were destroyed, populations of ducks and geese declined. By 1956, the U.S. Fish and Wildlife Service had developed a wetlands classification system based on their value to wildlife and instituted programs to protect wetlands. At first wetland preservation was focused in terms of wildlife habitat. Now people are discovering that wetland preservation can provide some alternative solutions to water supply problems (floodwater storage, **groundwater recharge,** wastewater filtering).

Ecology

A freshwater marsh is an open area, dominated by nonwoody, or herbaceous, plants. Often the vegetated areas are interspersed with patches of open shallow water. Marshes may be flooded for all or only part of the year. However, they must be flooded enough to sustain herbaceous vegetation that is adapted to living in water-saturated soils—plants like cattails and bulrushes.

The freshwater marsh is one of several kinds of wetlands. Other wetlands include bogs, swamps, and salt marshes. They are formed in low-lying areas on river flood plains and coastal plains and in depressions formed by glaciers. Wetlands are more than their name directly implies—

more than just soggy earth, a mere interface between land and water. They are unique ecosystems, different from either land or water.

Freshwater marsh communities include a variety of unique plants and animals. The exact species composition of any particular marsh depends on many things: geographic location, water chemistry, depth and duration of flooding, season, and climate. Most freshwater marshes are very productive habitats. They produce more plant matter per **hectare** (2.47 acres) each year than cropland; and marshes don't need the addition of supplemental fertilizer.

Marsh animals feed on the plants and on each other in what are biologically known as "food chains." Of course, few animals eat only one kind of food, so these simple "food chains" are woven together into a complex "food web." (See Student Page.)

Marsh Wildlife

Freshwater marshes are vital wildlife habitats. Their high productivity supports a variety of creatures. During the breeding season, marshes provide cover, food, and nesting areas. The myriad voices of the spring chorus of frogs and toads reflect

Leopard Frog

this abundance of creatures. Salamanders congregate briefly to lay eggs. The newly spawned fry of sunfish, bass, and bullheads hide among the plants. Birds—songbirds, shorebirds, and waterfowl—raise their broods in nests among the reeds and cattails. During migration and in the winter, birds use marshes for feeding and resting areas. Many mammals, such as deer, and furbearers like the muskrat, live on the marsh or visit it to feed.

Changing Marshes

Marshes are constantly changing, gradually filling in and becoming land. This takes place through the natural inflow of soil and organic matter from the surrounding area, and through the buildup of dead plant material. As the water becomes shallower, cattails will grow farther out into the open water of the marsh. As the edges of the marsh become drier, the marsh slowly turns into a sedge meadow and may eventually become a forest. This gradual process is known as **succession,** normally occurring over a period of hundreds or thousands of years.

Humans can accelerate the process of succession through carelessness. Marshes fill in by **sedimentation** when **erosion** results from construction or farming in the marsh's **watershed.** Fertilizer runoff from nearby farms and lawns can increase plant growth in the marsh. When the plants die, their decay robs the water of oxygen necessary for fish and other aquatic organisms to sustain life.

In some instances the process of succession is naturally reversed, and new marshes are slowly created or old ones renewed. Over long periods of time, changes in rainfall and the course of rivers, the movements of glaciers, and the geological lifting of the land create new places for wetlands to form. Old, grown-in marshes can be rejuvenated when localized fires burning through the vegetation reopen water pools. The fires release nutrients stored in the dead vegetation and thus contribute to the maintenance of the marsh.

Animals also change wetlands. Muskrats—cutting cattails and bulrushes for food and to

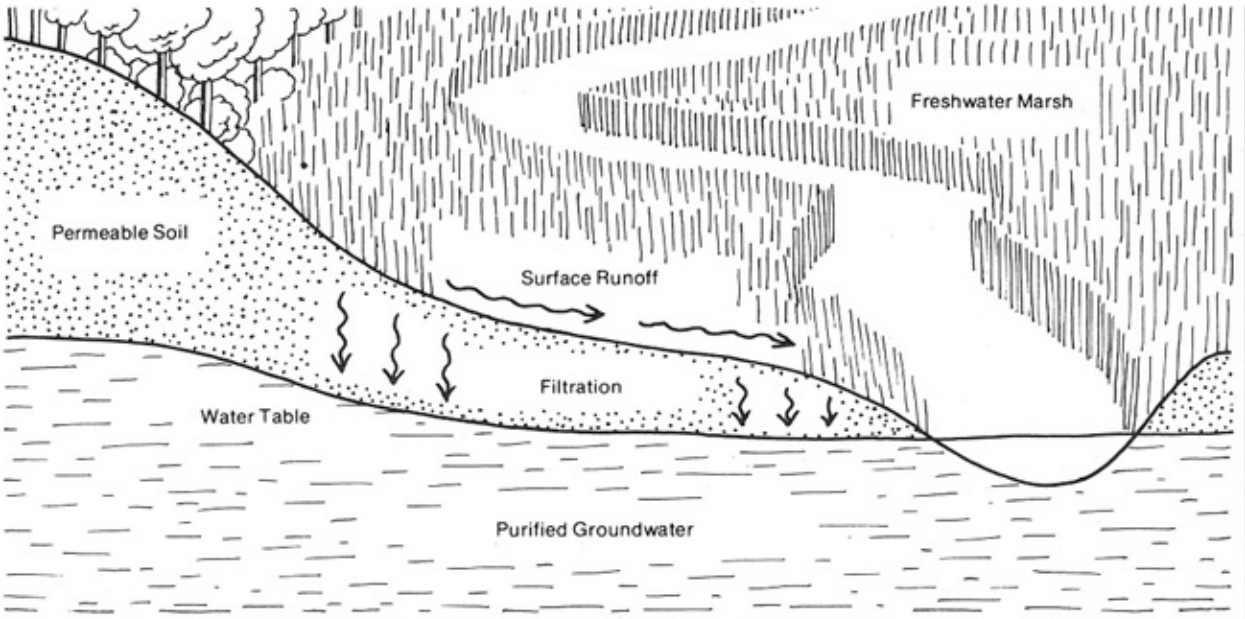
Giant Water Bugs

build their houses—can control the abundance of marsh vegetation. Muskrat "eat-outs" open up dense marshes, making more suitable habitat for ducks and fish that require some open water for swimming and feeding.

Beavers are best known for creating or changing marshes. Beaver dams, sometimes very large, cause flooding and create new wetlands. Forests are "opened up" as trees are killed by the standing water. In a few years the beavers move on to build a new dam elsewhere, leaving a moist meadow behind. This repetitive pattern was more common during the early settlement of this country when beaver populations were more widespread.

Water Resources

Freshwater marshes have important water resource values. Flood control is a natural function of marshes. Their soils and vegetation act as natural "sponges" that have a tremendous ability to absorb and retain excess water. This storage capacity can save the adjacent area from flood damage. During severe flooding in eastern Pennsylvania in 1955, the only two bridges surviving undamaged were located below a large cranberry bog. The presence of wetlands along shores and riverbanks also helps to



Groundwater Recharge from a Freshwater Marsh.

protect these areas from erosion. The dense root systems of the marsh plants hold soil that would otherwise be washed away.

Some of the water stored in marshes evaporates; some may be fed out slowly into streams. Still more of the water may seep underground to recharge the groundwater table. Whether this recharge occurs depends on the soil layers between the marsh and the groundwater. Where the soil is permeable, water will seep through. Recharge is important, especially where groundwater is being pumped out to supply human needs. When marshes are destroyed, rainwater, instead of being stored and seeping back to the water table, runs off and is no longer available for use in that area. Many areas now faced with groundwater depletion would have less serious problems if their wetlands were intact.

Wetlands also function as filters, removing pollution and sediments from water flowing through them. The slow rate of flow through marshes allows solid particles such as sand, silt, and clay to settle out. Nutrients in the water are broken down by bacteria and other microbes and absorbed by plants.

When wetland areas are developed—drained, **dredged**, filled, or channelized—wastes discharged there are no longer purified by normal biological processes. This results in pollution of the water supply. Wetlands can provide this purifying function only to a limited degree. Large amounts of pesticides or heavy metals, for instance, overload the system and threaten all marsh wildlife. Research is currently being conducted on the capacity of marshes to function as sewage treatment plants. Some marshes can process human waste with only minimal impact so long as nutrient loads are not excessive and the contents not too toxic.

Pumpkinseed Sunfish

Management

Most freshwater marsh management today is done by State and Federal agencies, private conservation organizations, and groups interested in hunting. Traditional management programs have been based more on "common sense" than on a real understanding of the functioning of wetland systems. Intensive research is being conducted on wetland ecology to provide a better basis for making management decisions.

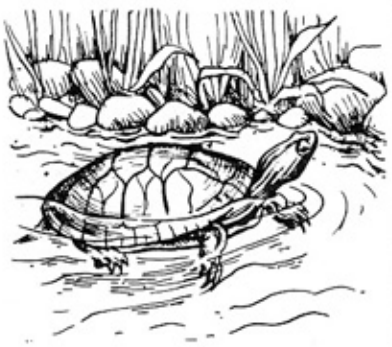
Specific management techniques can be used to improve freshwater marshes for wildlife. Building islands and sowing food plants provide nesting areas and food for marsh wildlife. Techniques can be used to increase natural marsh plant populations wherever water levels can be controlled. The water is "drawn down" in the spring, allowing plants to grow in areas where water was previously too deep. These areas are then reflooded in the fall to make the food available to migrating waterfowl.

Blasting, flooding, and plant cutting are used to create open water areas in very dense marshes. The feasibility of establishing marsh vegetation in normally

drier areas is also being researched with some success. In many cases, the only management a marsh needs is preservation.

Marsh Values

Freshwater marshes are too valuable to be unthinkingly destroyed. Before signing them over for development, people must consider the marshes' importance to the ecosystem. The marshes' connection to the groundwater and potential importance for flood control should be determined. A scattering of marshes is important, providing "habitat islands" for wildlife. Marsh plants help maintain the balance of gases in the air by taking in carbon dioxide and releasing oxygen. Freshwater marshes are valuable as open space, recreation and historic sites, scientific study areas, and for esthetic enjoyment.



Western Painted Turtle

Protecting Our Marshes

As people increasingly recognize the importance of wetlands, laws are being enacted to protect them. The Federal Clean Water Act (Section 404) now requires permits to be issued before dredging or filling of wetlands. Executive Order 11990 also provides for wetland conservation so that Americans will "protect against the cumulative effects of reducing our total wetlands acreage."

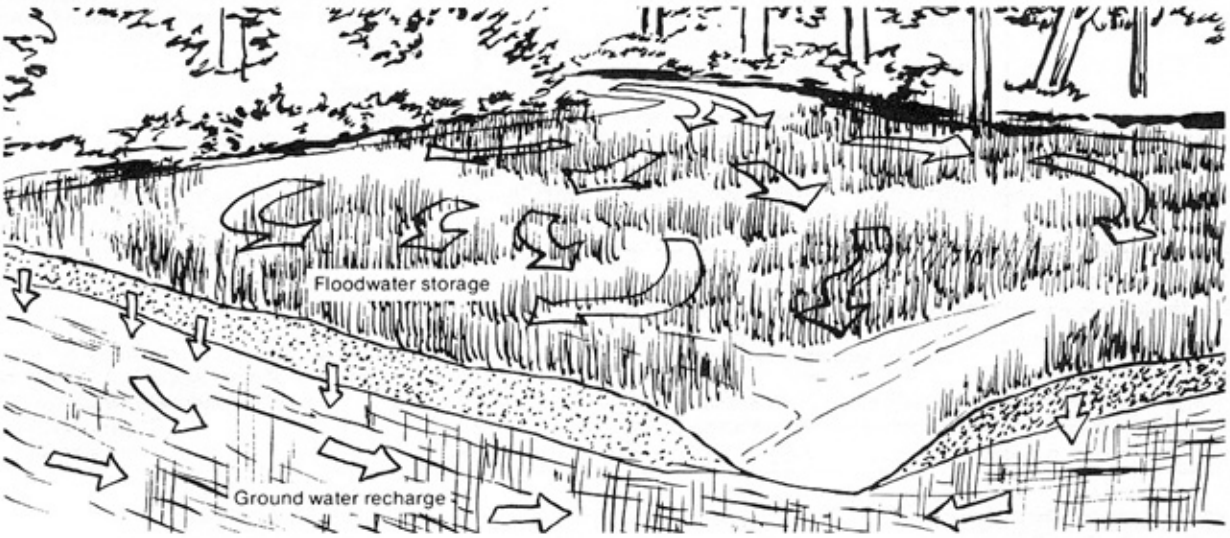
Despite these measures, the United States is still losing 300,000 acres of wetlands every year. More public support is still needed for programs encouraging conservation of freshwater marshes.

Glossary

dredging—Deepening a waterway by digging up the bottom.
erosion—The wearing away of soil by water or wind.
freshwater marsh—A wetland that contains freshwater and is dominated by herbaceous vegetation such as cattails and reeds.
groundwater recharge—Replenishment of the underground water supply.
hectare—Measurement of area in the metric system; 1 hectare (10,000 m^2) = 2.471 acres.
sedimentation—The process of suspended solid materials (e.g., sand, silt, plant matter) settling out of water.
succession—A gradual, natural sequence of changes in the plant and animal communities occupying a given area.
watershed—The area of land that drains into a particular body of water.

Department of the Interior/U.S. Fish and Wildlife Service, 1980

Wetlands Conservation and Use



Water purification

"A dawn wind stirs on the great marsh. With almost imperceptible slowness it rolls a bank of fog across the wide morass. Like the white ghost of a glacier the mists advance, riding over phalanxes of tamarack, sliding across bog meadows heavy with dew. A single silence hangs from horizon to horizon."

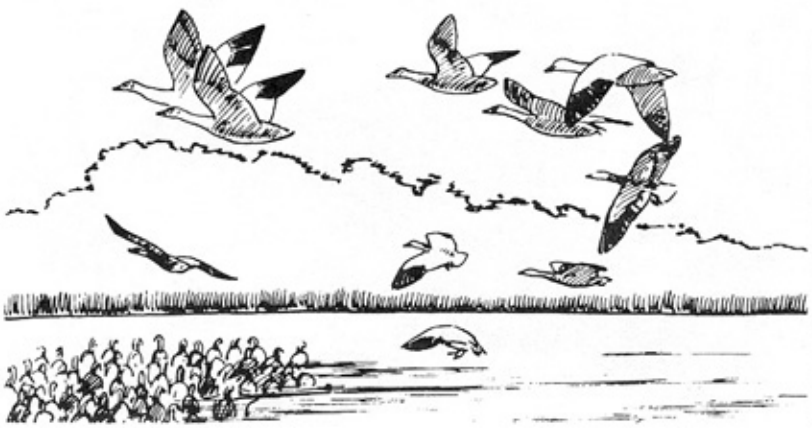
—Aldo Leopold
A Sand County Almanac

This peaceful beauty is only one of many wetland values.

Wetland Characteristics

Wetlands are places of interface between land and water. Though they may be flooded only occasionally during spring thaw or daily by the cycle of tides, water is the key feature controlling the life of the wetland ecosystem. Unique **hydric** soils and plants adapted to living in water-saturated conditions characterize wetland areas. Common names for different types of wetlands are swamps, bogs, freshwater or salt marshes, potholes, and sloughs.

These wetland systems have inherent natural values. They provide nursery and breeding grounds for fish, shellfish, waterfowl, and other wildlife. The highly productive wetland plants are the primary food source for these animals. Wetlands perform important **hydrologic** functions including water purification, **groundwater recharge,** and flood and erosion control. Unfortunately, these values went unnoticed for a long time while "worthless" wetlands were destroyed in efforts to "improve" them. The following table summarizes the benefits of natural wetlands to wildlife and people and the uses of developed wetlands.



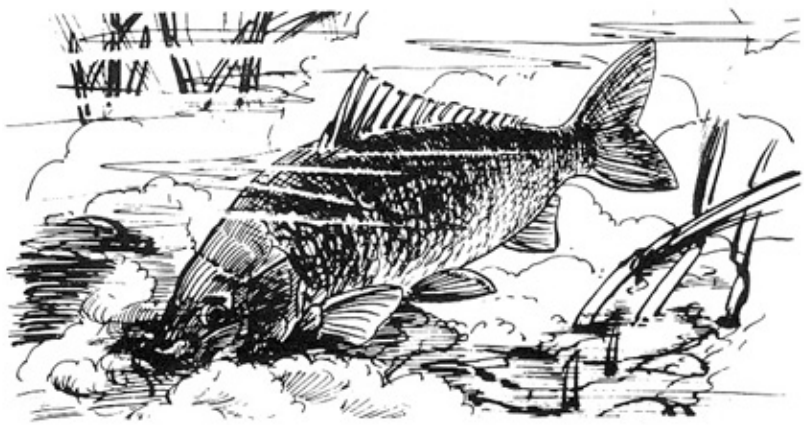
Functions/Uses	Natural Wetlands	Developed/Drained Wetlands
Wildlife Habitat	• Provide essential nesting, feeding, and wintering sites for waterfowl. • Provide food, water, and cover for many species of game and fur-bearing animals. • Provide breeding or nursery grounds for many species of fish and shellfish (including 2/3 of the commercial species).	• May support a different type of flora and fauna, but not generally wetland species. The problems of wetland destruction first became noticed due to a dramatic decline in populations of ducks and geese.
Water Resource Values	• Provide water purification because wetland plants and soil organisms absorb or break down many pollutants. Researchers are examining wetland use for wastewater treatment. • Recharge groundwater. Water held in wetlands may seep down to replenish the water table. • Provide flood and erosion control by temporarily storing excess water.	• Cause loss of water resource values after which deterioration of water quality or increased flooding may result. • Often requires construction of alternative solutions such as levees, dams, and treatment plants to replace formerly "free services."
Food Crops/ Productivity	• Provide food for people and other animals such as fish, shellfish, and waterfowl. Many wetlands are highly productive, with more plant growth per **hectare** than farmland. • Furnish areas for commercial crops such as cranberries, wild rice, and marsh hay.	• Usually easier to farm through small potholes than go around them. • Often result in soil destruction and loss of soil fertility; however, wheat, soybeans, and other crops may grow well in drained wetlands.

Indirect Human Impacts

In addition to the direct impacts of filling and draining, people have indirect impacts on wetlands. Industrial cooling water discharged into wetlands raises water temperature (heat pollution), sometimes killing animals or changing their life cycles. Wetlands are polluted by spills, discharges, or runoff of oil or chemicals.

The introduction of nonnative species, which have few natural enemies, also affects wetlands. For example, carp, a native fish of Asia, has thrived in many U.S. freshwaters. This fish "roots" in the bottom for food, raising clouds of sediment that can cause a variety of problems. For instance, this disturbance clouds the water, thus reducing light penetration. This in turn may cause a decrease in photosynthesis, which eventually reduces the amount of oxygen available to plants and animals.

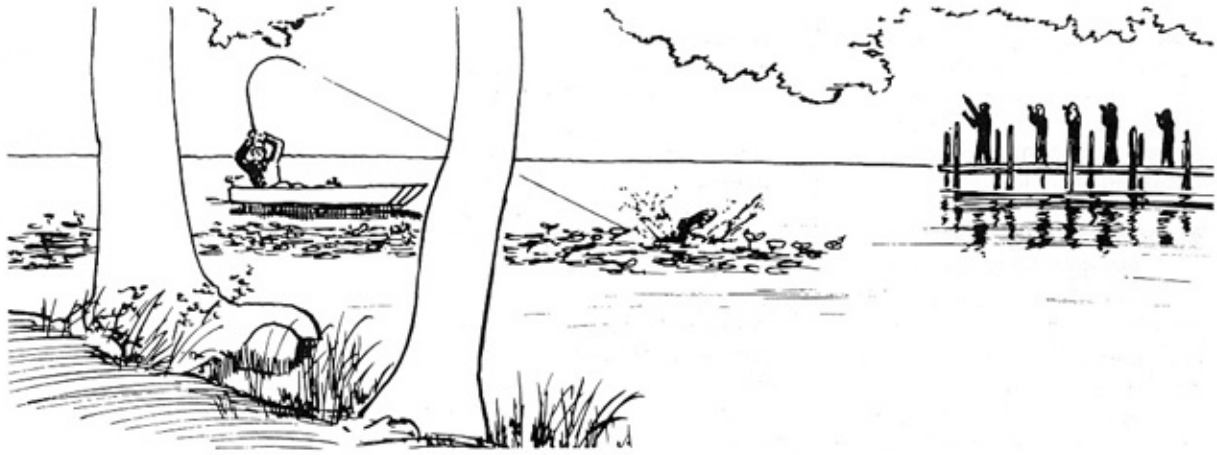
A second example of problems with introduced species is the purple loosestrife plant . It was brought into the United States in the early 1800's by a garden club and is taking over habitat once occupied by cattails. While some people consider purple loosestrife attractive, it is less nutritious than cattails. Ultimately, this affects food relationships in those wetlands dominated by purple loosestrife.



Choosing Priorities

Development of wetlands often impairs or destroys their natural functions. Before people became aware of these functions, filling, draining, or dumping on wetlands seemed the only way to make them useful. Now comes a need for careful balance. Does developing a wetland have more value than leaving it alone? The answer is not always simple.

Certainly different sites can be found for garbage dumps. But wetlands destruction is also spurred by the demand for jobs, food, and homes. Wetlands are drained for agriculture or filled for cheap, flat residential land or prime waterfront property. How are these values to be balanced?



Wetland Protection and Planning

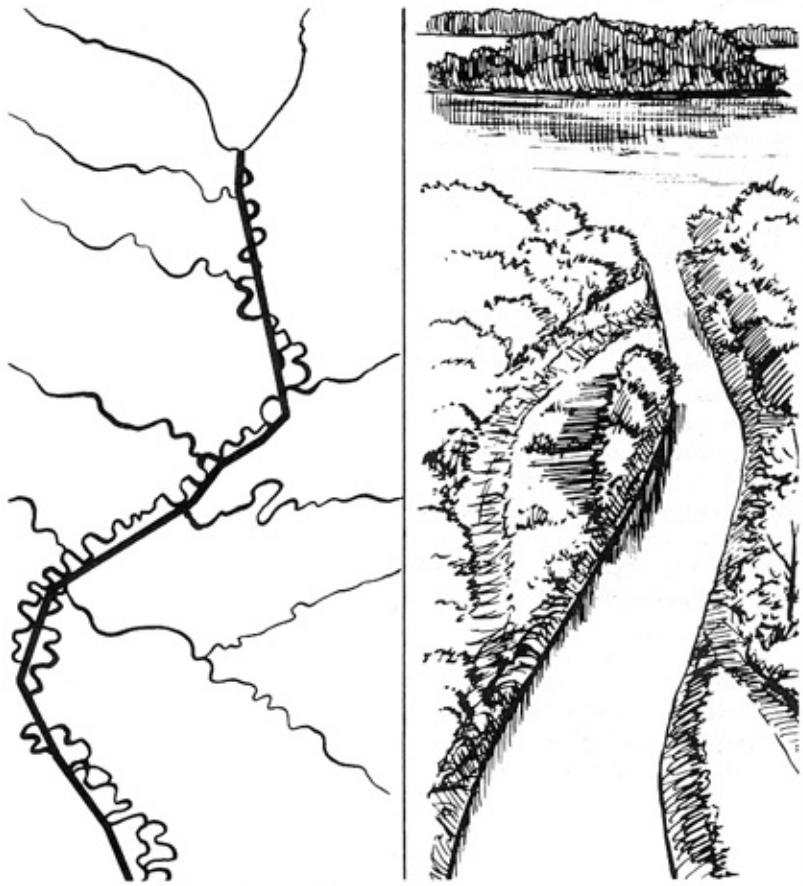
The first wetland protection programs were aimed at preserving wetlands important to wildlife, particularly to migrating birds. Federal and State agencies purchased wetlands or **easements** on them through the Waterbank or Migratory Bird Conservation Programs. Private agencies (such as The Nature Conservancy, Ducks Unlimited, and others) added to the conservation effort.

Increasing public realization of wetland values has led to broader programs for planning and preservation. The Clean Water Act requires permits for some wetland dredging or filling projects. The permit evaluation process ensures that public losses as well as benefits from proposed projects are considered. The Coastal Zone Management Act encourages States to consider development trade-offs in coastal wetlands. Many States have laws or public land management policies affecting wetlands; some offer tax relief programs for owners of wetlands.

Learning to Plan

Planning for wetland use and conservation requires knowledge of how wetland systems function. Research is now providing some needed information. Unfortunately, some lessons have been learned through hard experience. For example, some soils drained for agriculture were too acid or too salty for crops. Draining of prairie **potholes** has decreased waterfowl populations. Building sites located on former wetlands are often subject to recurring floods or storm damage.

A case in point is the **channelization** of the Kissimmee River, which flows into Lake Okeechobee in southern Florida. In the mid-1960's, this 100-mile-long meandering river was straightened into a 50-mile canal to drain and control floods on surrounding land. Soon water quality in Lake Okeechobee, the drinking water reservoir for the southern part of the State, began to deteriorate. What happened? Prior to channelization, the flowing water was slowed and filtered in the winding river and the adjacent wetlands. After channelization, runoff from adjacent farms and grazing land flowed quickly



Channelization of the Kissimmee River

and directly into Lake Okeechobee without benefit of the natural pollution removal. The river and marsh may now have to be restored to accomplish this important function.

Habitat Management

Planning for wetland uses is often an either/or trade-off decision because wetlands cannot be managed both for development and for natural values.

Preservation of wetlands is important to maintaining its wildlife values and, in most cases, proper management can enhance wetland habitat. **Moist soil management** can be used to control marsh plant populations wherever water levels can be manipulated. For example, water levels may be "drawn down" in spring, allowing plants to grow in areas that were formerly flooded. Reflooding these areas in the fall makes the food available to migrating waterfowl. Plantings and nesting boxes may be located where food or nest sites are insufficient.

Plans for development should not assume that wetland areas are useless. Wetlands are proving more and more to be invaluable resources. Their further loss would be both costly and sad, as so eloquently described by Aldo Leopold:

"Some day my marsh, dyked and pumped, will lie forgotten under the wheat, just as today and yesterday will lie forgotten under the years. Before the last mud-minnow makes his last wiggle in the last pool, the terns will scream goodbye. . . the swans will circle skyward in snowy dignity, and the cranes will blow their trumpets in farewell."

Our increased knowledge and appreciation of the wetlands' natural "work and worth" can help ensure their presence for future generations to enjoy.

Glossary

channelization—A process by which people modify the shape and course of a streambed to provide a more direct waterflow.
easement—Legal rights (for a nonowner) written into a real estate deed for a specific purpose—such as wetlands protection activities.
groundwater recharge—Replenishment of the underground water supply.
hectare—Measurement of area in the metric system; 1 hectare (10,000 sq m) = 2.47 acres.
hydric—A term used to describe particular types of soils formed under wet conditions.
hydrologic—A term pertaining to water—its properties, distribution, or circulation.
moist soil management—The process of controlling water levels in a marsh so that natural wild foods are abundantly produced for wildlife.
pothole—A shallow, water-filled depression of glacial origin found primarily in the northern Great Plains. Potholes characteristically have cattails, grasses, and abundant aquatic life.

Department of the Interior/U.S. Fish and Wildlife Service, 1982