Unit 2: Ornithology - Pre Reading Handout

Slide 1

Welcome to the unit on ornithology- the study of birds! This presentation will cover basic features of birds and how they have been influenced by flight. Then we will take a look at activities in the annual cycle of birds, ecosystem roles, and conservation challenges. Lastly, we will go over tips for bird observation and identifying birds. We will look at some of the common species of birds in this region of Maryland during class time.

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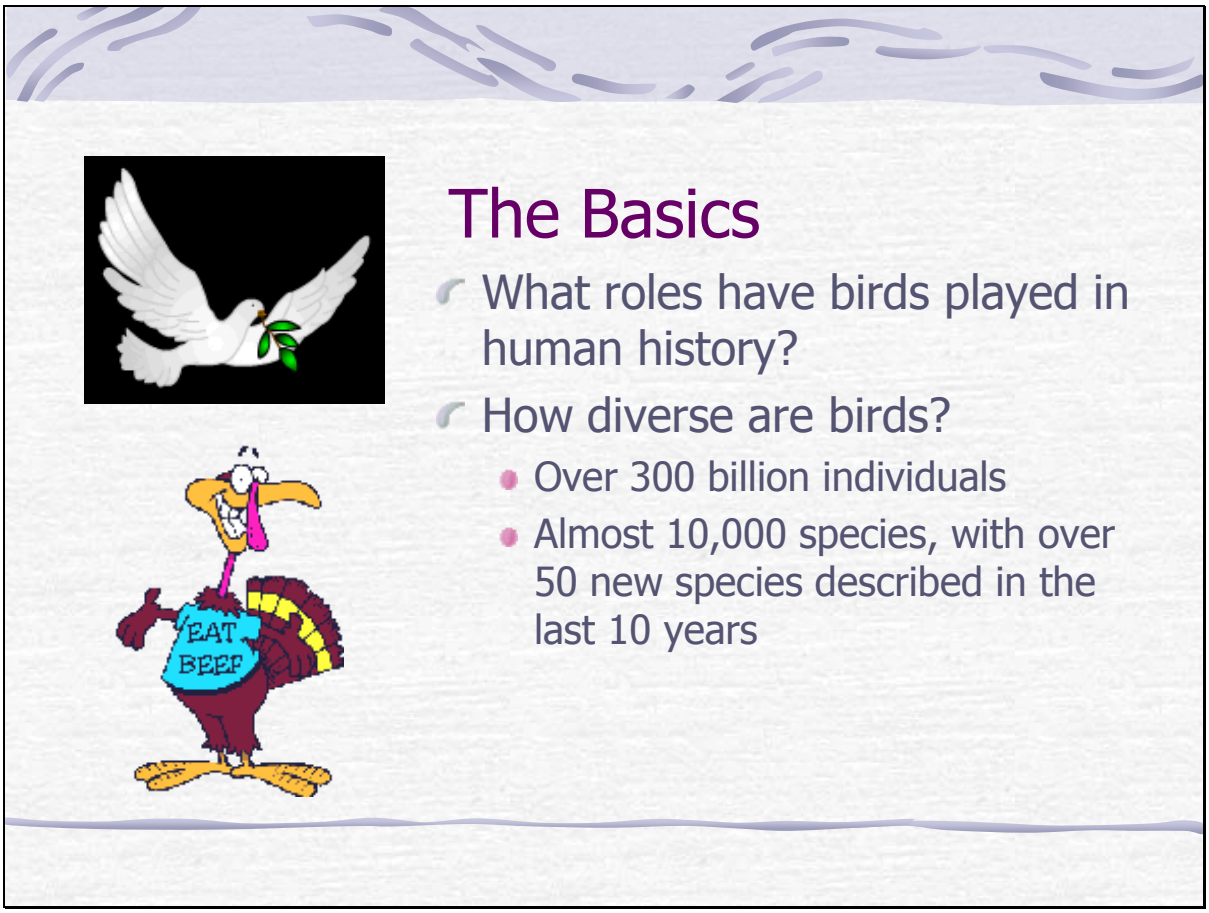
Slide 2



Birds are familiar animals due to their visibility and activity during the daytime. Birds have played many roles in human history- what examples can you think of? Here are a few: symbols, food, pets, objects of beauty, falconry- 2000 BC in China; communication- Romans using swallows to carry colors of chariot race winners, carrier pigeons; feathers- ornamentation and insulation, indicators to pollution including canaries in mines.

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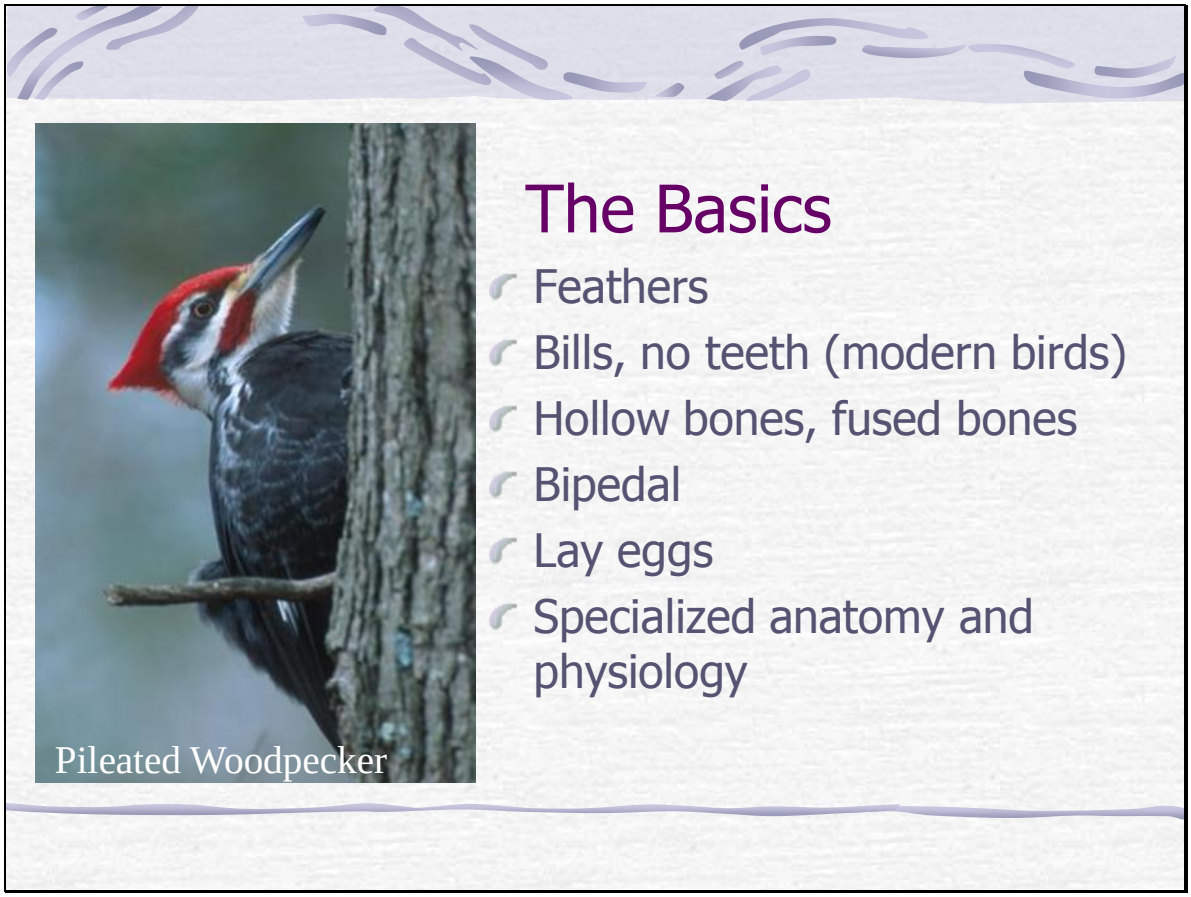

What makes a bird a bird? These characteristics are not unique to birds, although feathers were thought to be until recently. They describe important features. We will be taking a look at the specializations that birds possess in addition to other common features.

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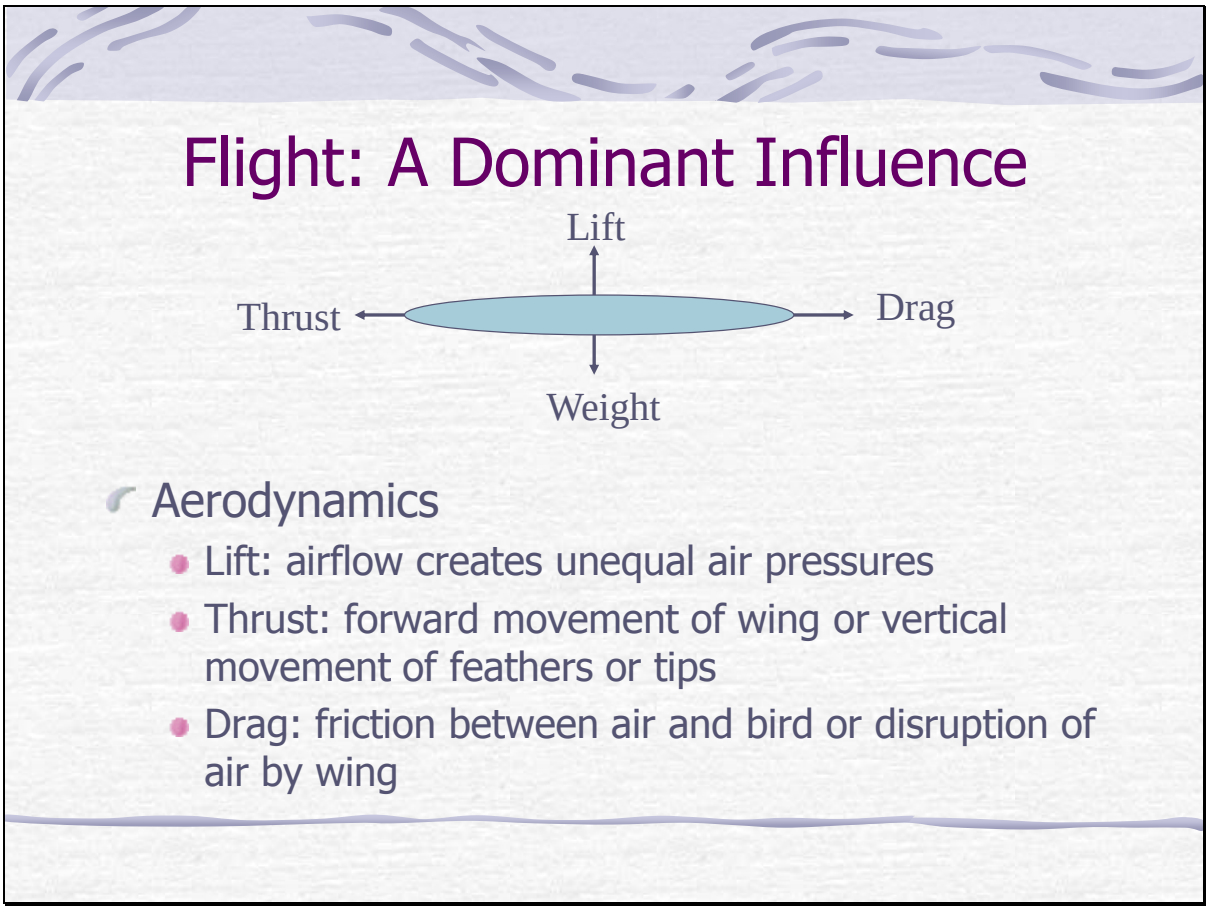

Flight has influenced many features of birds. First we will take a look at some basic concepts of flight, then we will look further into the specializations that birds possess. Even flightless birds were influenced by flight, since they evolved from flying ancestors.

There are four forces to consider in flight: lift, thrust, drag, and gravity (acting on the mass of the bird). The diagram shows the directions of these forces. In flight, lift is created as air flows faster over the top of the wing than the bottom. This creates lower pressure on top of the wing, and causes motion in an upwards direction. Think of what it feels like when you put a slightly curved hand out of a moving car window- you feel your hand lift up. The difference in air pressures is created by the shape or profile of the wing and also as the bird physically pushes down during flapping flight.

Thrust is created as the wing or wingtips are pushed forwards. Drag is created from two sources: friction between the air and the bird as the bird moves through the air, and by the disruption in the air created as the wing travels through the air. To fly and to move forward, the bird must overcome drag and gravity.

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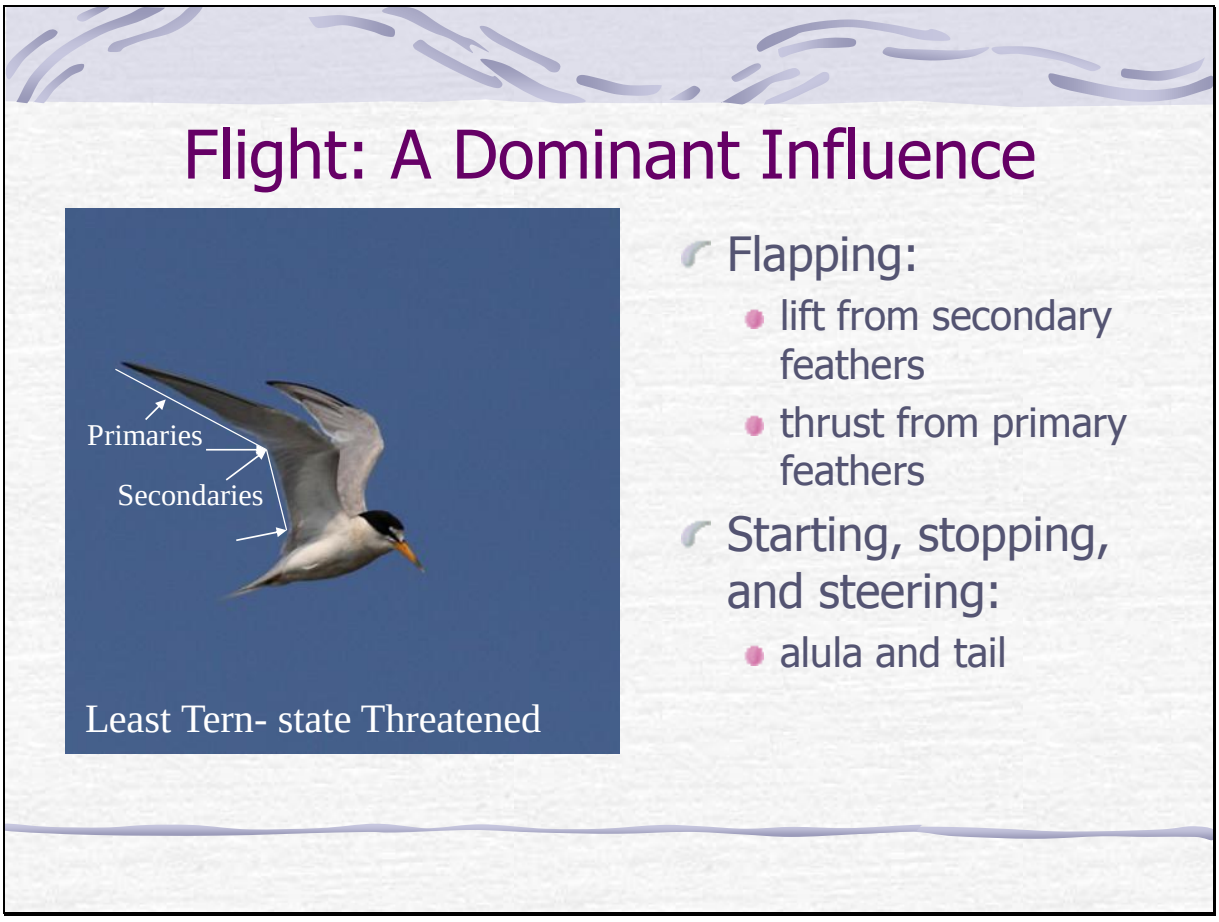

Birds fly by flapping flight, in which they actively move their wings, and by soaring or gliding, in which the position of the wings and tail are adjusted but not repeatedly moved up and down.

In flapping flight, the bird creates lift to overcome gravity primarily using the secondary feathers, pictured here. The secondary feathers are attached to the forearm bones. Drag is overcome by the thrust created by movement of the primary feathers. The primary feathers are attached to the elongated hand and finger bones. In addition, the alula, a small group of feathers attached to what is left of the thumb, can be controlled to assist in take-offs, landings, and steering. The tail feathers are also important in steering and landing.

During flapping flight, lift and thrust are mostly created during the downstroke of the wing. During the upstroke, birds bring their wings back and up. Depending on flight speed and the shape of the wing, some lift may be produced during the upstroke. An exception to this general rule is the production of lift in the upstroke by hummingbirds.

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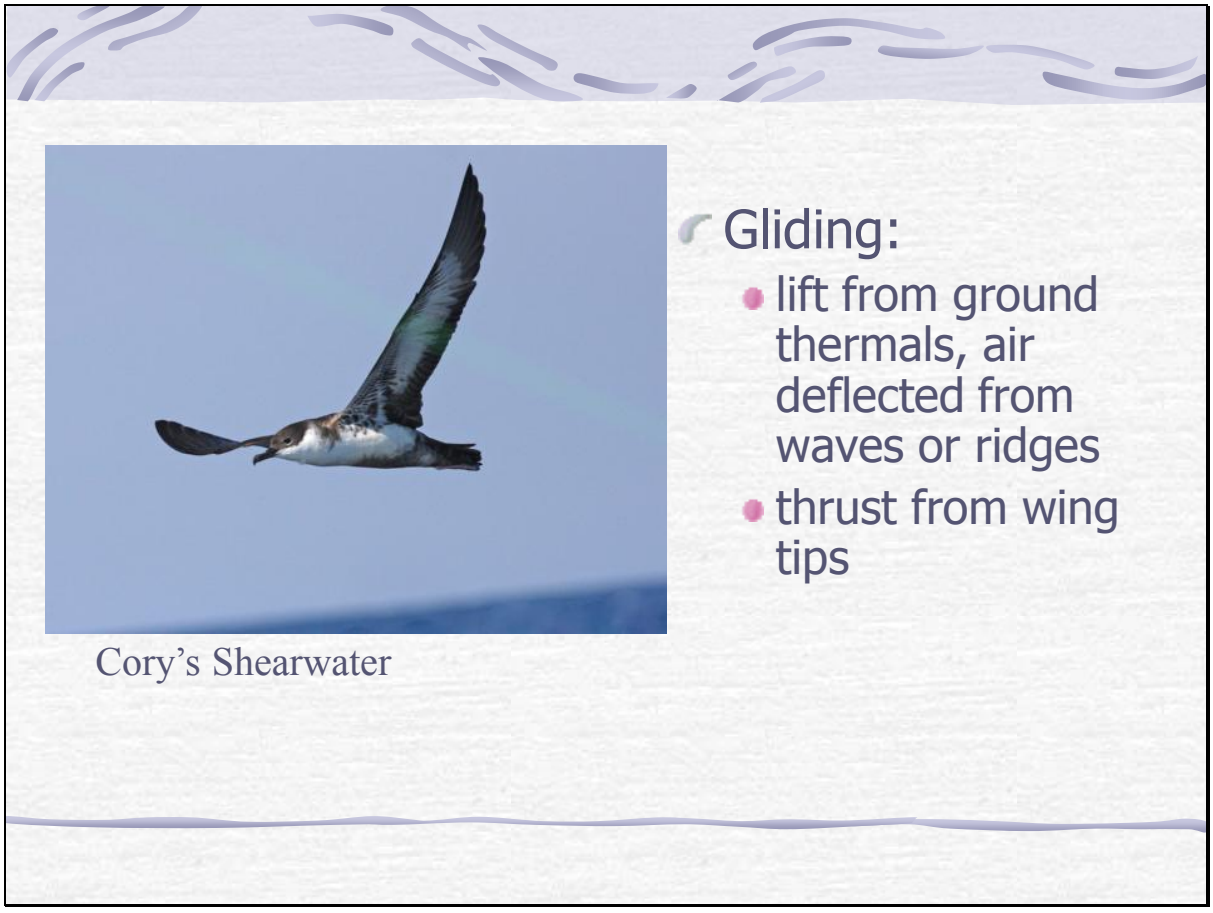

I am sure you have noticed that some birds rarely flap and get around quite well by gliding or soaring (examples?). In this situation, lift comes from thermals created by warming of the ground by the sun, deflection of air off of waves on the water, or deflection of air off of vertical cliffs or ridges. Thrust is created by subtly moving the primary feathers of the wing to catch air currents in a certain way. Some lift can be created from the tail as well as the wings, and the tail can also be used to steer the bird.

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Flight: A Dominant Influence

Great Blue Heron

Osprey

The Great Blue Heron on the left is creating a lot of lift from its outstretched wings, and will create thrust as the wing is brought forward. The Osprey on the right shows positions of feathers, wings, and tail important in landing. Some lift is still being created by placing the primary feathers sideways and by fanning the tail so that the bird does not come down too fast. On the other hand, the position of the secondary feathers has greatly reduced lift so that the bird is coming down. Notice the flexibility in the wing at the junction between the primaries and secondaries- the bird's wrist area.

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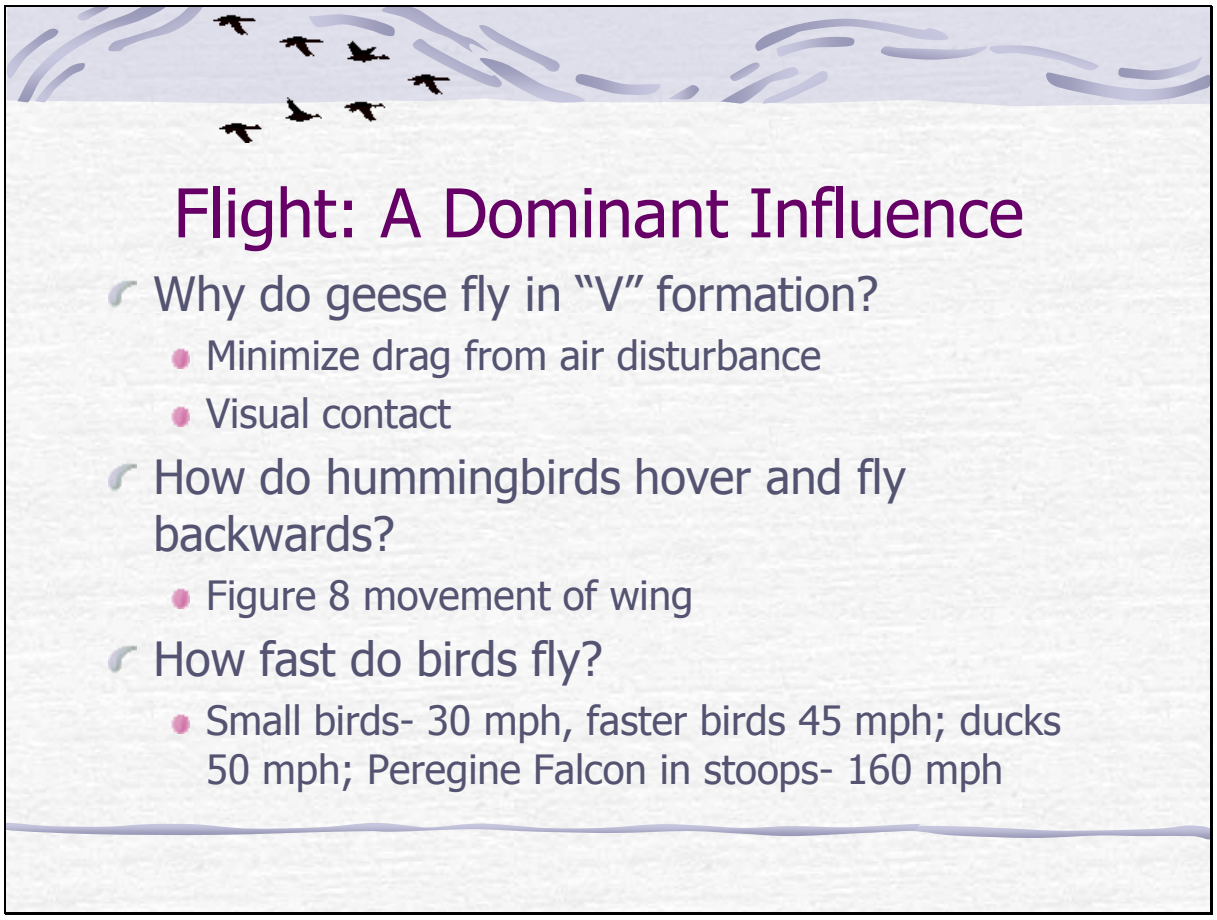

Here are a few "fun facts" about birds in flight. To increase speed, birds increase the amplitude but not the frequency of wing beats. Different wing shapes serve to provide better flapping or soaring flight, and different degrees of maneuverability.

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Flight: A Dominant Influence

- Anatomical and Physiological Adaptations
  - Weight-reducing
    - Feathers
    - Skeleton
    - Physiology
  - Power-increasing
    - Circulatory system
    - Respiratory system

Barn Owl

Let's take a closer look now at how a bird's physiology and anatomy allow it to fly efficiently. These adaptations can be put into two general categories: weight-reducing and power-increasing.

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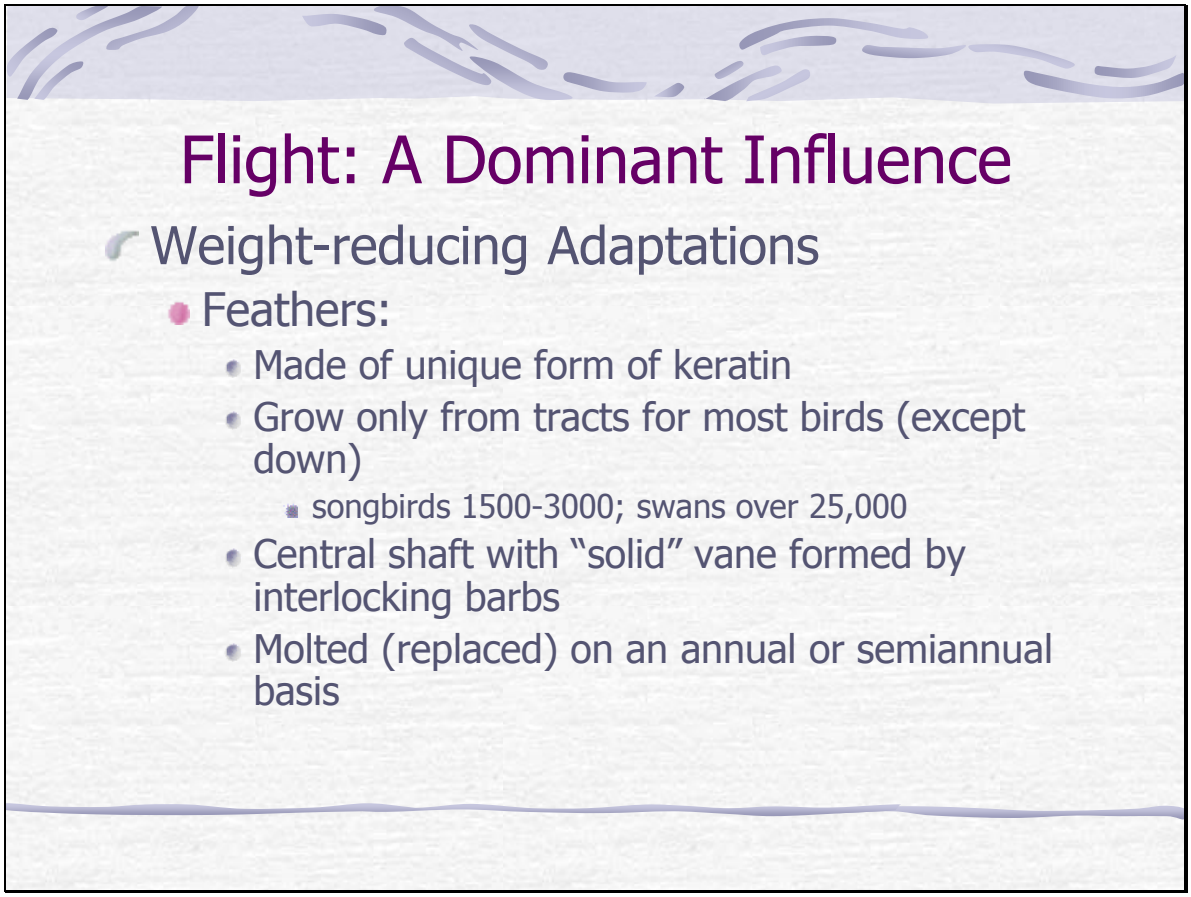

Feathers allow birds to have a large wing surface area that is lightweight and does not require bones for support. Feathers are made of a different form of keratin compared to reptile scales or even the keratin in bird bills or leg scales. For most birds, feathers (except those for insulation, like down) grow only from limited, linear tracts on the body. The large number of feathers in swans comes largely from the many small feathers covering the neck and head. Feathers have a central shaft with barbules coming off of it. These barbules have a system of hooks and notches or ridges that interlock and form a solid surface. As birds preen, they can "zip" these hooks and notches back together to maintain the solid surface.

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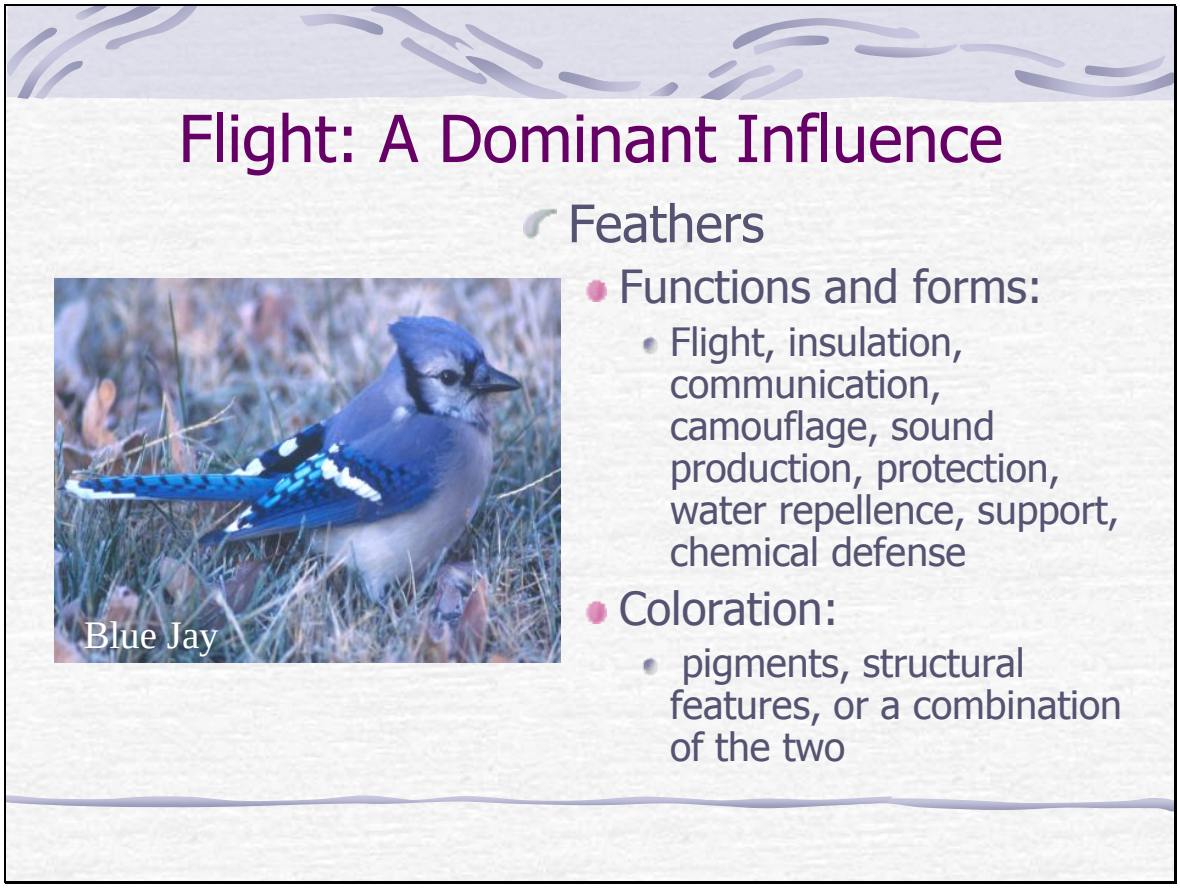

Feathers provide an amazing array of functions in addition to flight, as I have listed here. Can you think of examples of feathers with these functions? (insulation- down; communication- Red-winged Blackbird display; camouflage- female Mallard; sound production- American Woodcock, Ruffed Grouse; support- woodpecker tails; chemical defense- genus *Pitohui*, New Guinea, feathers and skin have same toxin as poison dart frogs, bright warning coloration)

The colors of feathers come from pigments, such as melanin (black, brown, reddish-brown) and carotenoids (red, yellow, and orange), the internal structure of the feather, or a combination of the two. For example the blue in a Blue Jay comes from melanin and the structure of the feather. If you hold a blue feather up to the light, you will see there is actually no blue pigment- just black/dark brown (melanin).

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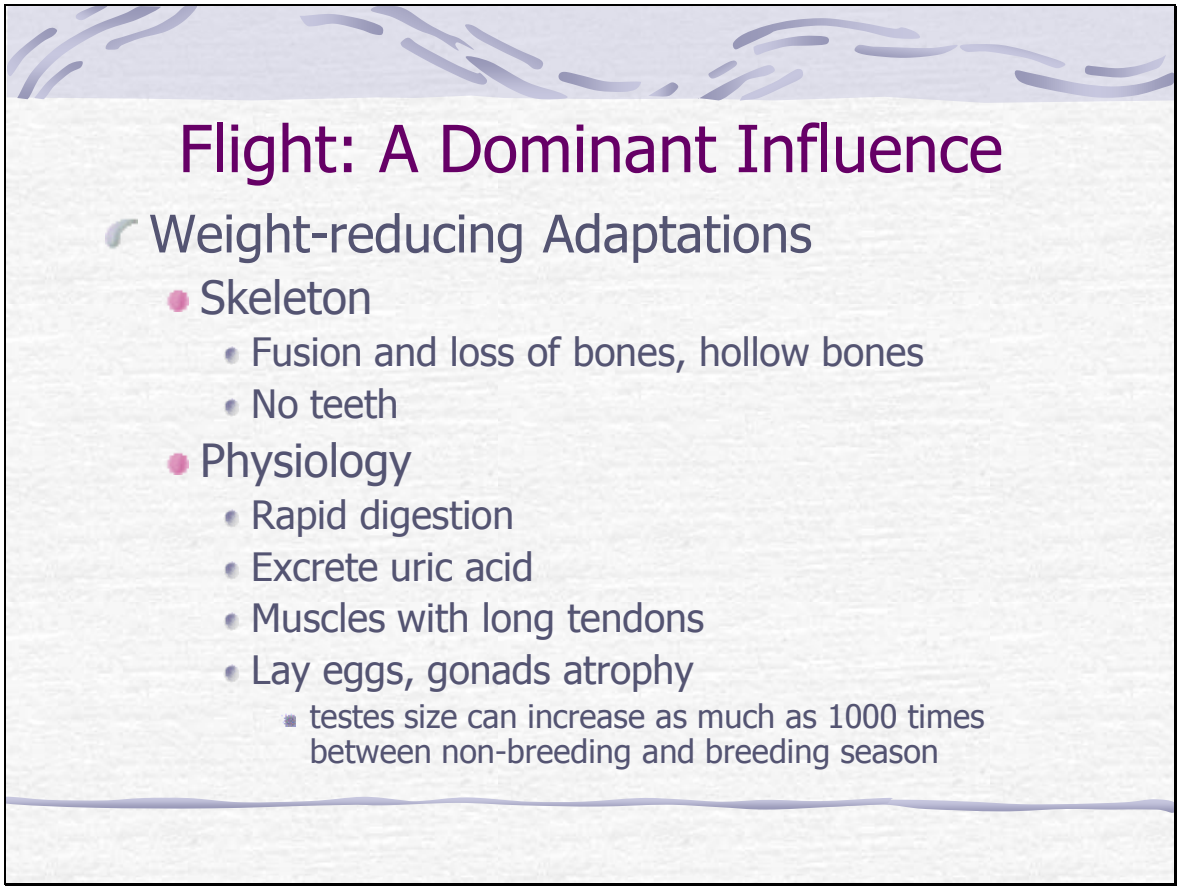

Weight reducing adaptations for flight come from the fusion and loss of bones, hollow bones, and lack of teeth. The physiology of birds reduces weight in several ways. Birds digest foods rapidly (as anyone who has a pet bird knows!). Birds excrete their nitrogen wastes as uric acid rather than urea, which requires much less water. Instead of large muscles in different parts of the body, birds concentrate their large flight muscles on the body and extend long tendons to the extremities. Egg-laying rather than carrying young reduces weight during reproduction and the gonads shrink markedly in size during the non-breeding season. The impressive example here is from Japanese Quail.

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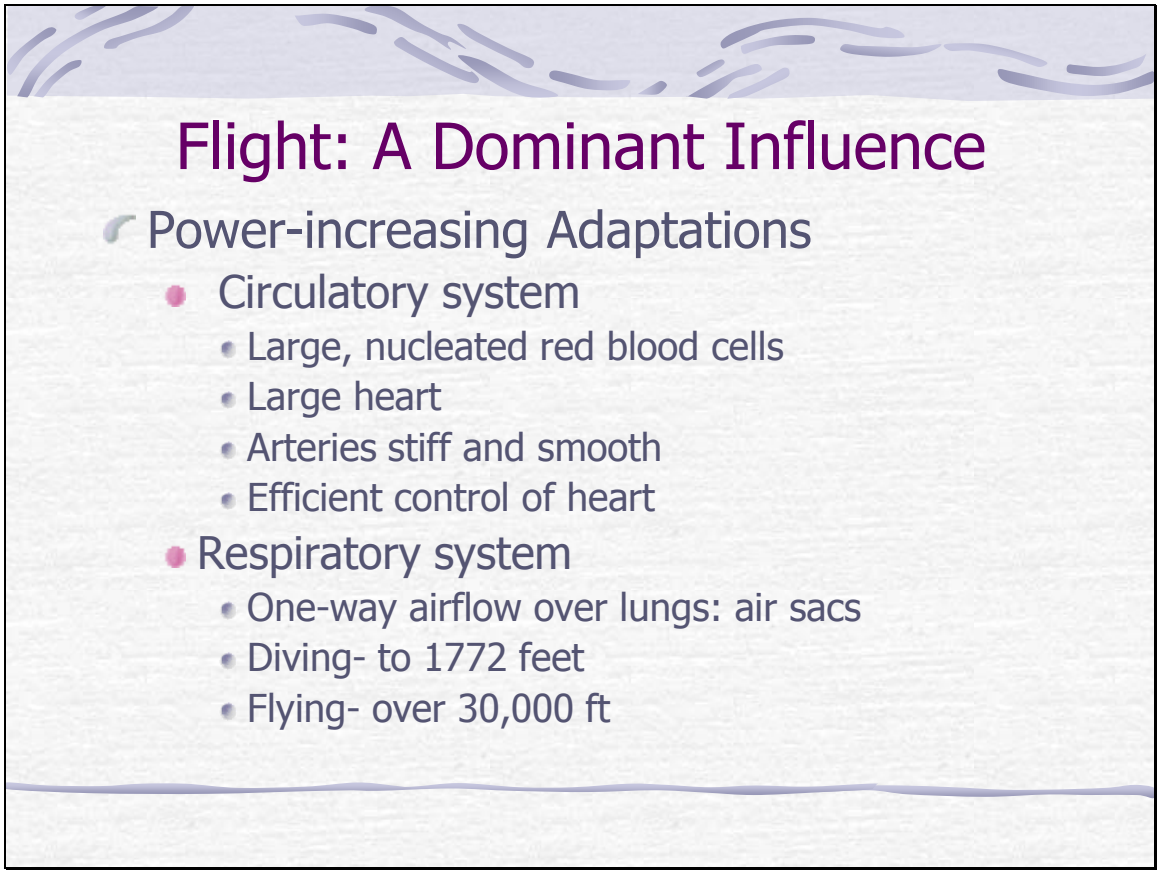

To increase power for flight, birds have very efficient circulatory and respiratory systems, including the features listed here.

We have a two-way air flow during respiration- oxygenated air passes over the lungs on the way in and carbon dioxide passes over the lungs on the way out. Birds have a series of air sacs inside of their body and even some bones in addition to lungs. These air sacs are set up so that only oxygenated air flows over the lungs in a one-way air flow system. The efficient respiratory system of birds allows them to dive to over 1700 feet (Emperor Penguin) and fly at over 30,000 ft (Bar-headed Geese migrating over the Himalayas). It also assists them in impressive long-distance flights.

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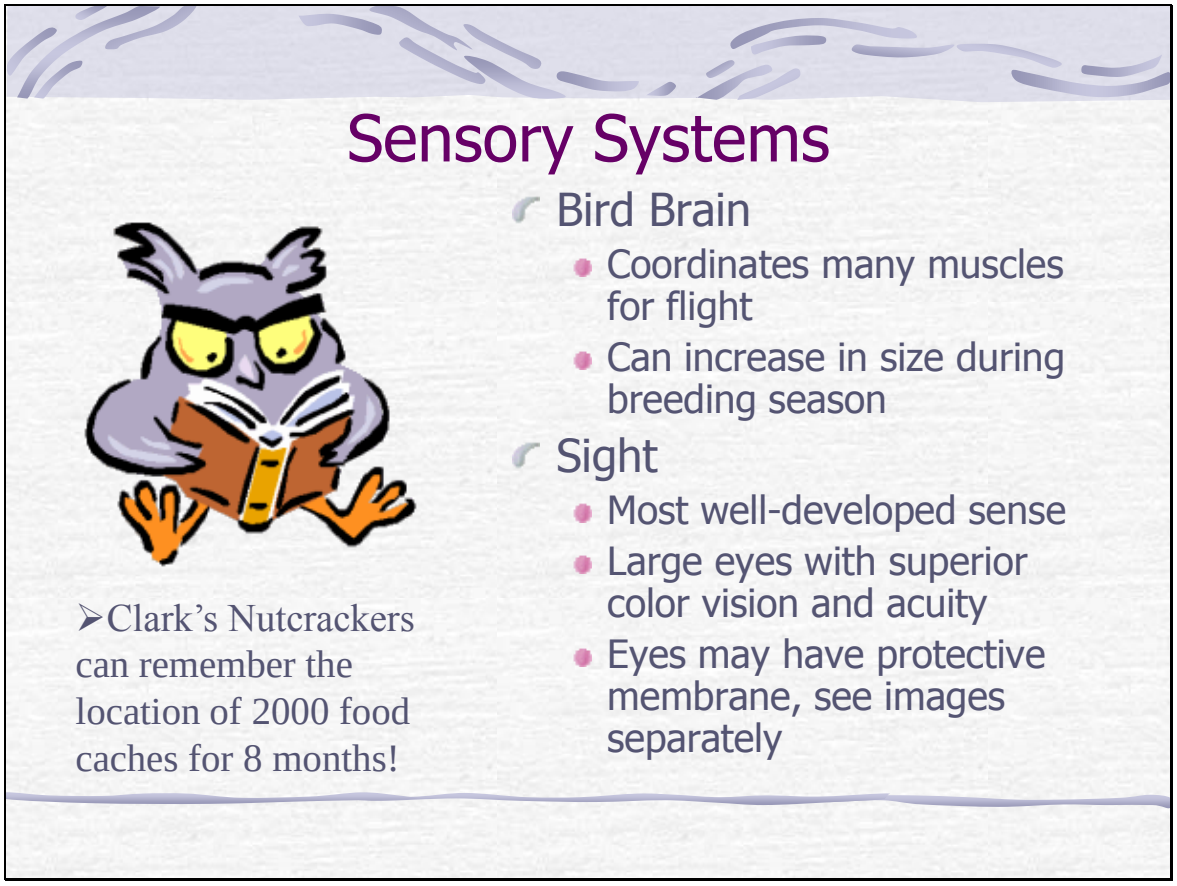

Let's take a brief look at the sensory systems of birds. Now, I hope that none of you have ever been called a "bird brain", but actually it should really not be thought of as a slur. Just look at this example and think of how many of us have trouble finding our keys! The brains of birds are really quite complex and some birds accomplish amazing feats. The brain coordinates the actions of over 50 muscles in flight, for example. Recent studies have shown that brain size can actually increase during the breeding season as males increase singing rates.

Sight is the most well-developed sense in birds, due to their large eyes and structures that provide excellent color vision and acuity (ability to distinguish objects at a distance). Some species that dive have a protective membrane that acts like goggles underwater, while other species, like pigeons, see an image on each side of the head. This lead to their "nystigmatic walk", bobbing the head back and forth to get more 3 dimensional vision from each side.

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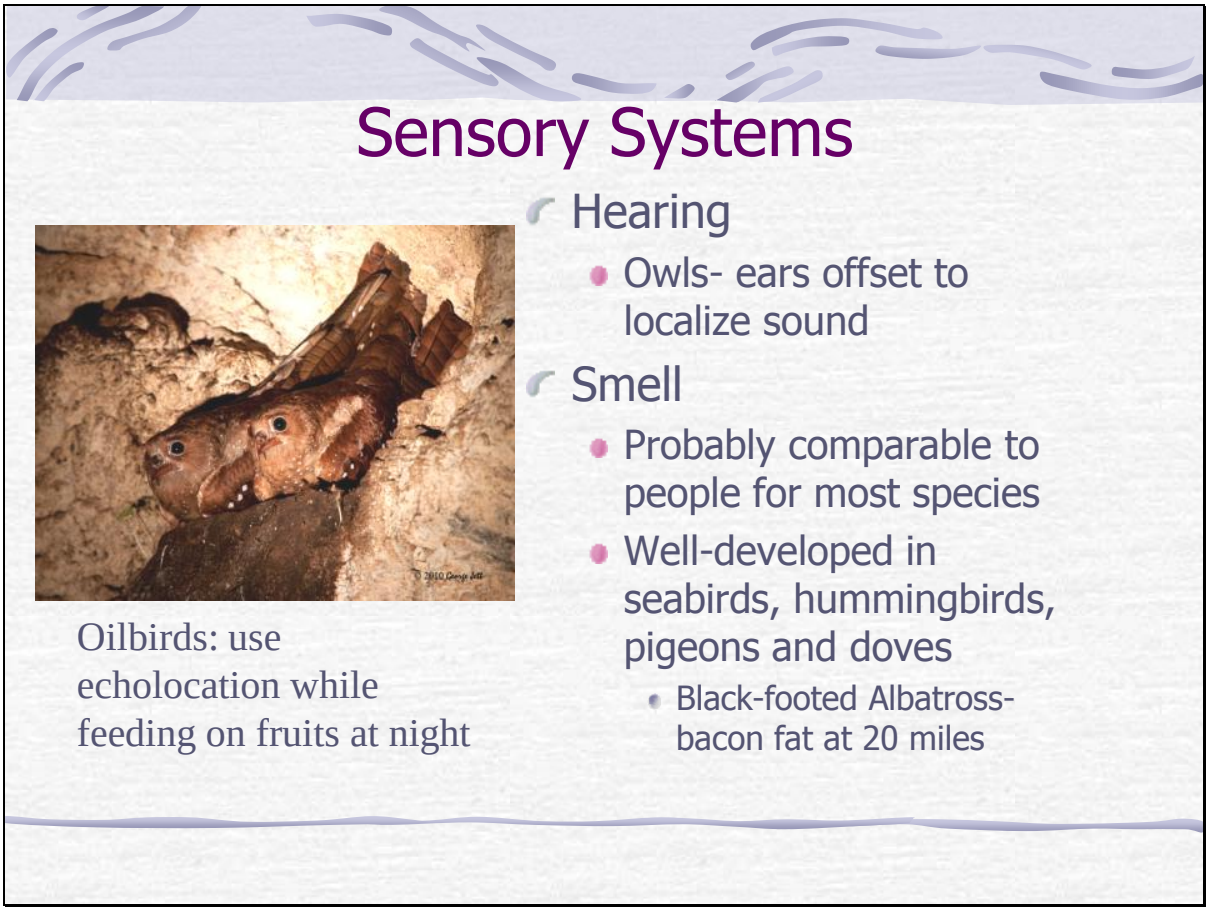

Owls have an especially good sense of hearing, with a Barn Owl able to catch a moving mouse in a dark room. Owl ears are placed asymmetrically on either side of the head to allow better localization of sounds. They also often have well-developed facial disks of feathers arranged to direct sound to the ears. An unusual specialization of Oilbirds is their ability to use a basic kind of echolocation, about equivalent to a person tapping a cane to sense proximity to objects. Oilbirds make a series of clicks and use the echo coming back to help locate the fruits that they feed on at night. This species is found in Trinidad and northern South America.

The sense of smell in birds is most developed for this group of species. One interesting example comes from an experiment with Black-footed Albatross, in which bacon fat was spread on the ocean. It attracted birds from about 20 miles away! In our area Turkey Vultures have a quite good sense of smell, which they use to find carrion. Black Vultures have a less well-developed sense of smell and tend to follow the lead of Turkey Vultures.

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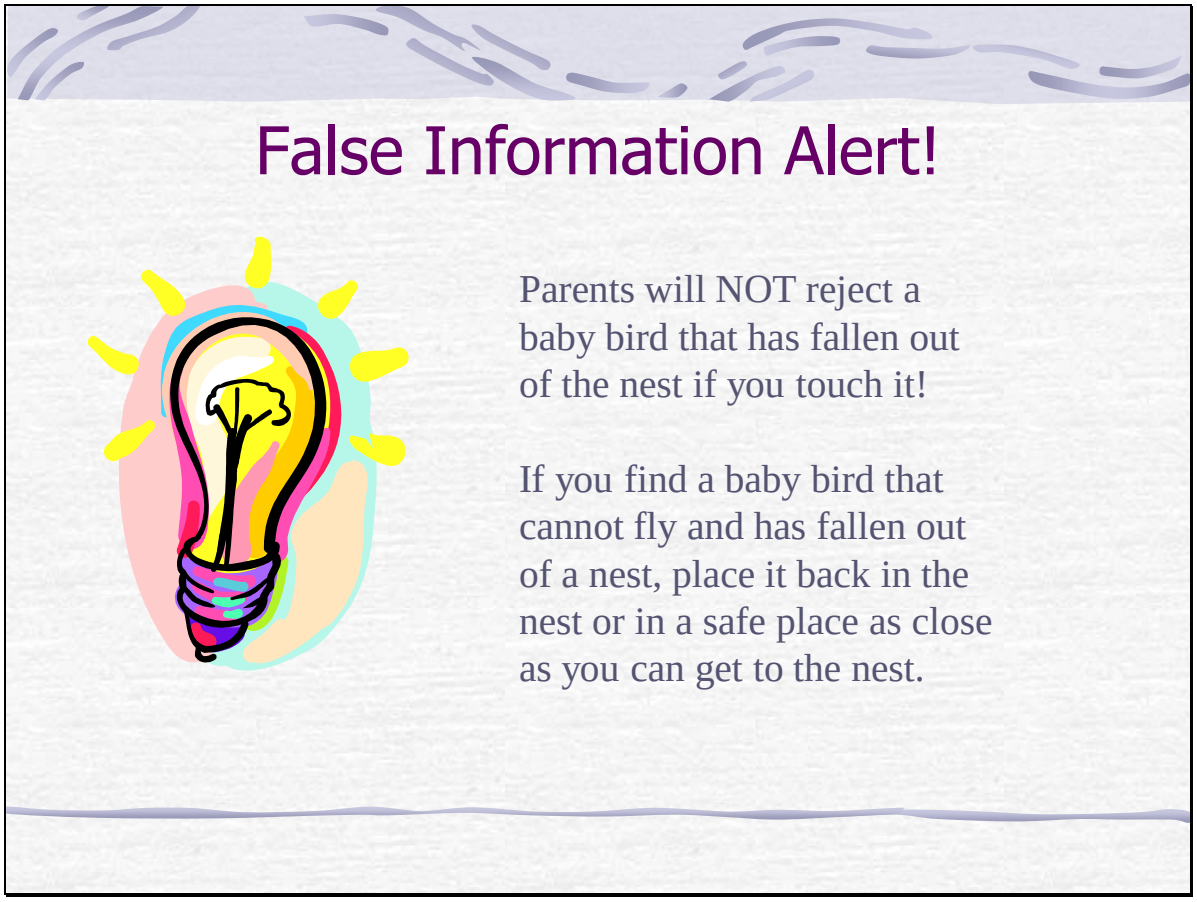

Because mammals in general have a very good sense of smell, and use it to identify their young, people falsely believe that birds do the same. It is not true that birds will smell "human" on their young and reject them as some mammals will. Please spread the word on this and help keep baby birds where they should be!

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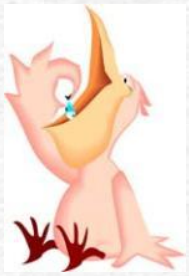
Feeding and Digestion

Young male Ruby-throated Hummingbird

- Foods Eaten
  - Most eat arthropods; nearly 1/5 of species take nectar

- Bill Types
  - Dip net, sifting/straining, spearing, grasping, probing, insect net, seed cracking, wood cutting



Next, we will go over some basic facts about feeding and digestion in birds. Birds eat a wide variety of foods. Surprisingly, many bird species will feed on nectar at some point. Bill shapes and sizes are often specialized to deal with certain kinds of foods. What are some examples of birds with these bill types? Dip net- pelicans; sifting/straining- flamingos; spearing- herons; grasping- kingfisher; probing- shorebirds, hummingbirds; insect net- nighthawk, swallows; seed cracking- cardinal, finches, sparrows; wood cutting- woodpeckers

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Seed-cracking bill:
Rose-breasted Grosbeak

Probing bill: Black-necked Stilt

Here are a few examples of specialized bill types.

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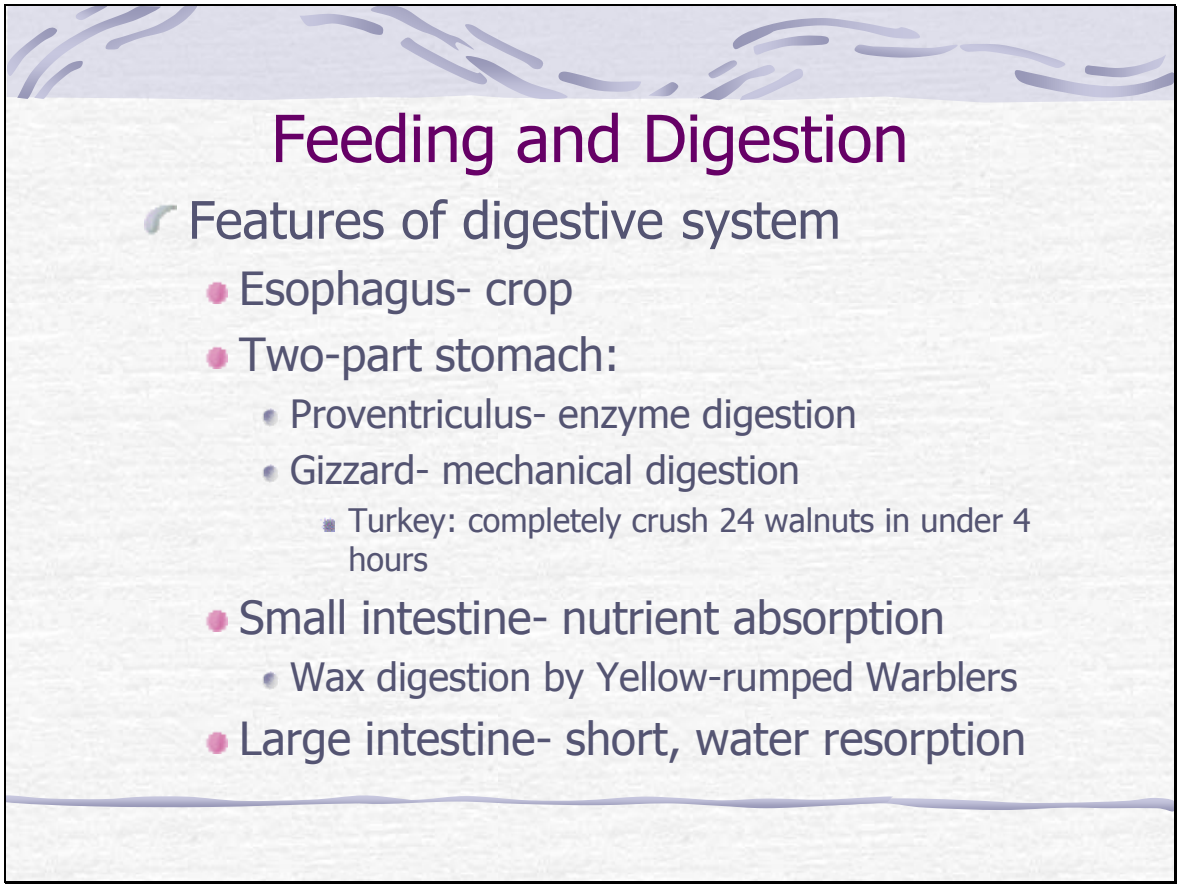

The digestive system of birds is similar to our own, but there are some important differences related to weight reduction for flight and other functions. Food first passes into the esophagus, which may have a well-developed pouch or crop where food is moistened or even temporarily stored. The stomach is divided into two parts. Enzymatic digestion of food takes place in the proventriculus and mechanical digestion (remember, no teeth!) takes place in the muscular gizzard. The gizzard may be lined with hard, ridged plates and frequently includes grit for grinding. An amazing example of gizzard function is this experiment with turkeys. The small intestine functions to absorb nutrients but an interesting specialization is that of Yellow-rumped Warblers. They can feed on wax myrtle and digest the waxy coating on the berries due to microorganisms that they house in their small intestine. The large intestine in birds is short and resorbs water.

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Some other interesting specializations of birds include this list. To get rid of undigestible materials, like fur, insect exoskeletons, claws, bones, etc., owls and also kingfishers cough up pellets. In fact, especially for owls, collecting and examining pellets from below roost areas is a good way to see what the owls are feeding on. Some examples of tool use in birds are the use of sticks to probe for grubs by the Woodpecker Finch (Galapagos Islands); Green Herons baiting fish to come to the surface by dropping pieces of vegetation; and Egyptian Vultures dropping stones on Ostrich eggs to crack them open. Some species hoard food, like the Clark's Nutcracker mentioned earlier, including making storage "granaries" (Acorn Woodpecker) or seed caches (Tufted Titmice), or spiking prey on thorns or barbed wire fences for later consumption (shrikes). In many habitats, birds are important seed dispersers because they will fly away from the plant to digest their food but pass seeds through quickly and often undamaged. The fruits of a number of plants in fact are providing an attraction "reward" to birds so that their seeds are dispersed away from the parent plant.

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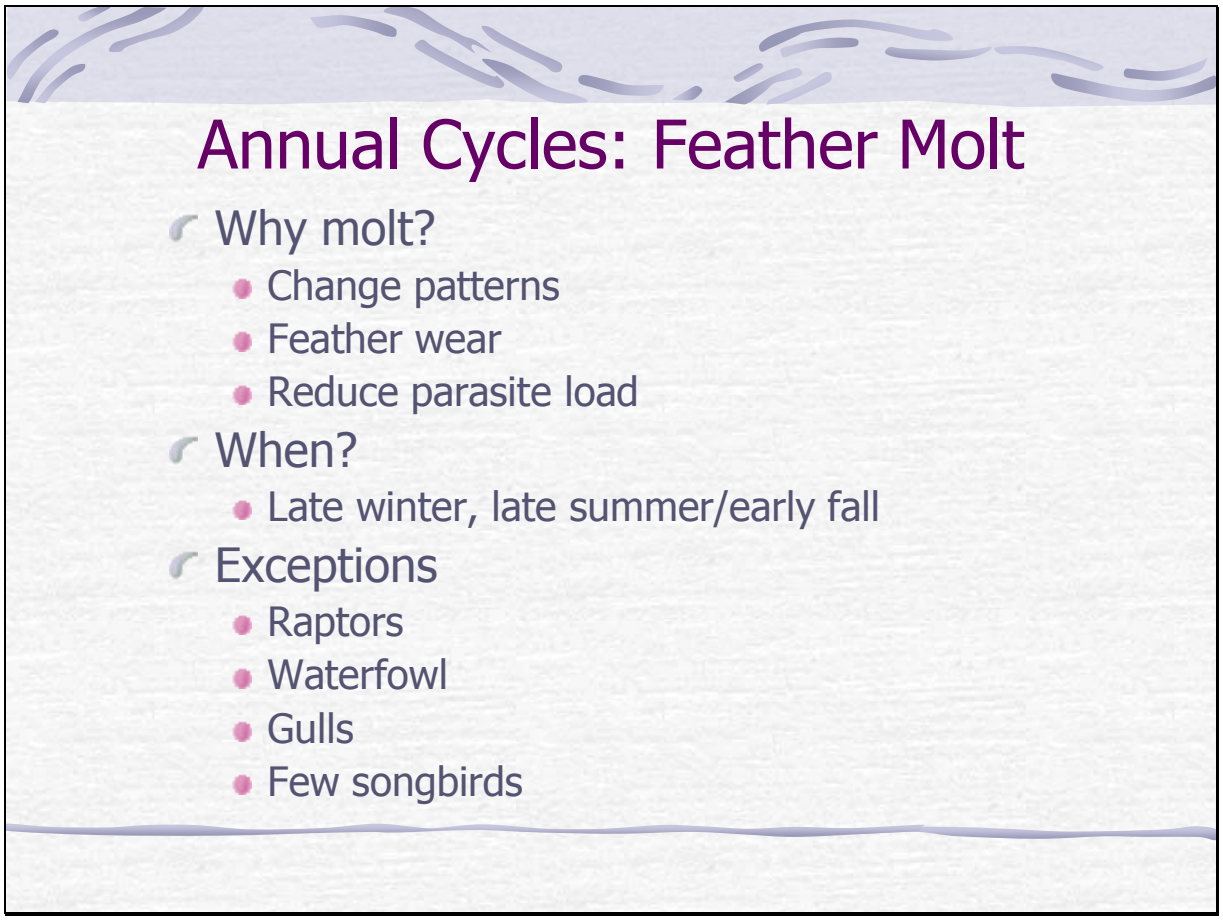

Birds replace their feathers by molting them- shedding the old and growing in new feathers. Feathers wear, build up parasites, or just need to be changed to change patterns for breeding. Most birds molt a few feathers at a time so that they can still fly, with the molt taking place before spring or before fall. An exception to this is waterfowl, who go through a flightless period. Birds may alternate between breeding and non-breeding plumage patterns or may take several years to obtain the typical "adult" pattern, like some raptors and gulls.

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Brown-headed Cowbird going into adult plumage

Scarlet Tanager in transition

Here two interesting examples of birds in transition between one plumage and the next. The male Brown-headed Cowbird is going from its juvenile plumage of all brown to the adult plumage of glossy black with dark brown head. The male Scarlet Tanager spends the non-breeding season in a more drab olive-green body (like female plumage) compared to the brilliant red of the breeding season. This may allow the male to be less conspicuous and better able to avoid predation.

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Annual Cycles: Migration

- East-west pattern: some Rufous Hummingbirds (above)
- Ruby-throated Hummingbird can fly over 600 miles nonstop in 26 hours

- Why migrate?
  - Exploit favorable opportunities
- Patterns- seasonal movement
  - North-south
    - Short distance: American Robin, Dark-eyed Junco
    - Long distance: Red Knot- 10,000 miles; warblers to Central and South America

Migration is an amazing feat. Although we don't usually think of it this way, it is actually more correct to think about birds migrating to take advantage of an opportunity, rather than to escape bad conditions. These seasonal movements are usually north-south in the U.S., but some Rufous Hummingbirds, for example, travel to the east in winter rather than south. Leave your hummingbird feeders out into December and you may get one of these rare visitors! The migration distances and flight times of species can be considerable- imagine flying 10,000 miles twice each year like the Red Knot and Arctic Tern. And imagine that the Ruby-throated Hummingbird can fly for 26 hours straight to cross the Gulf of Mexico!

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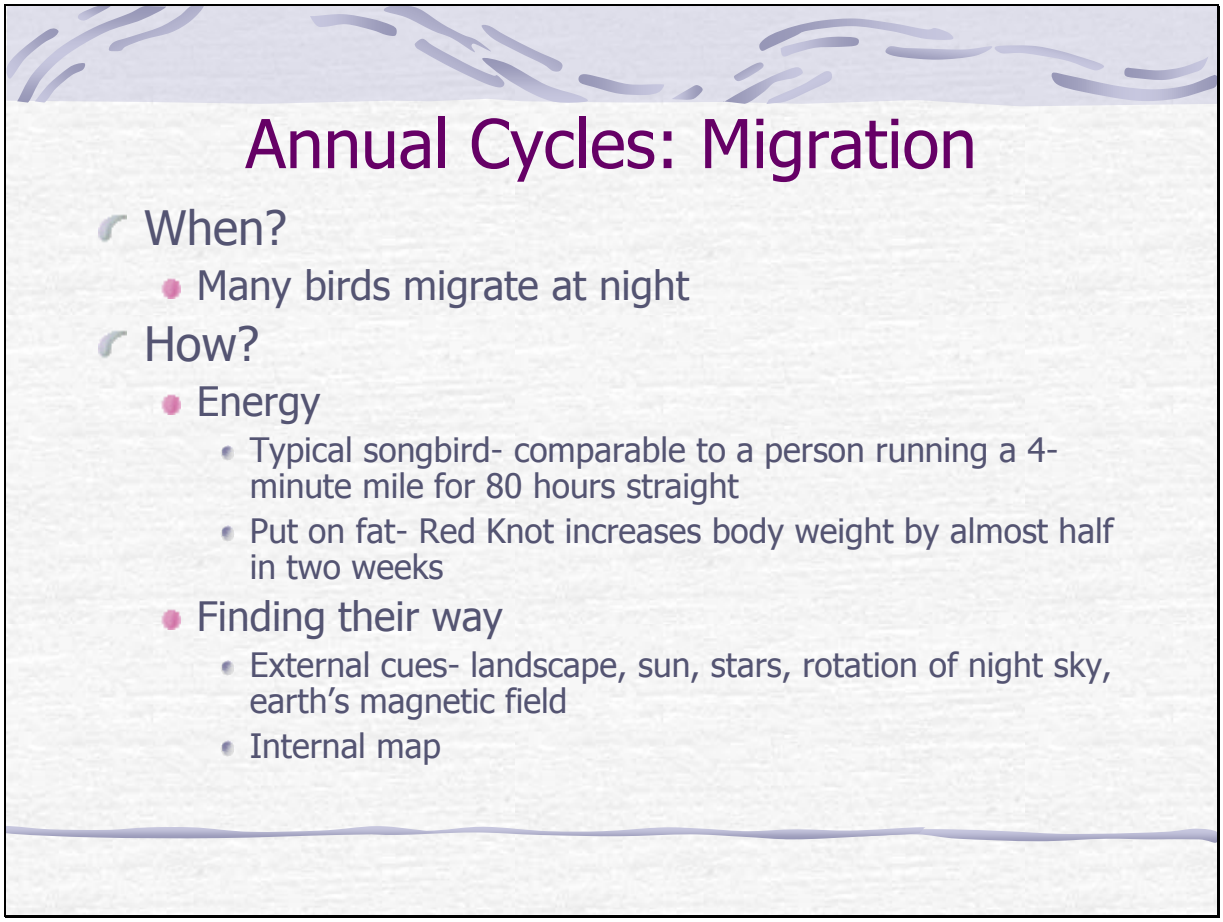

Many birds, such as our small songbirds, travel at night during migration. It is a time when they may use less energy because it is cooler, and they can avoid daytime predators. They can also then feed during the day. Birds that rely on or take advantage of thermals for longer movements migrate during the day, like raptors. The energy and physiology required to complete the long-distance migrations is impressive. The long-distance migratory feats of birds are said to be comparable to a person running a 4-minute mile for 80 hours! The fuel for birds is fat. In order to build up enough fuel, birds eat intensively- for example, the Red Knot puts on almost half of its body weight in fat in just two weeks.

Birds find their way to their distant destinations using a variety of cues. Especially for night migrants, the star around which the night sky rotates is an important orienting feature (north star). Birds also seem to have an internal map that guides them in terms of approximately what direction to fly and for how long.

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Another important event in the life cycle of birds in breeding. Many birds defend territories during the breeding season, while others nest in close proximity to one another (colonial waterbirds like Great Blue Herons, Royal Terns, and Brown Pelicans). Most bird species have a social system called monogamy- one male pairs with one female. That does not mean, however, that there aren't some offspring that are related to both parents!

Birds have a great variety of visual and vocal displays, and we enjoy many of these during the spring. You have probably seen examples of bird movements, often emphasized by special plumage features like bright colors or long plumes, in your backyard or on nature programs. What examples do you recall? Birds also make a wide variety of sounds, including songs and calls. Not all species produce "songs", but the study of those that do has provided interesting parallels between bird song learning and human language learning. Birds produce sounds as we do by passing air past vibrating membranes, but their sound production apparatus, called the syrinx, is located where the trachea splits into the two bronchi. In songbirds, two vibrating membranes are present and some species, like the Wood Thrush, control these separately- essentially singing with two voices at once!

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Annual Cycles: Breeding

- Eggs
  - Vary in shape from spherical to very pointed
  - Color, pattern, and size differ among species
  - Porous shell with yolk (food source) and albumin (insulation, water)
- Egg-laying
  - Each egg takes about 24 hours to form
  - Females lay from one to 23 eggs per clutch (nesting attempt)
  - May re-nest 2-4 times in a breeding season

Chuck-wills-widow egg

Bird eggs come in a variety of shapes, colors, and patterns. Sizes range from 0.2 g (hummingbirds) to 1600 g (ostrich). Cliff nesters have elongated eggs with very pointed ends, so that they role in a tight circle; owls and kingfishers that nest in cavities have very round eggs (use less shell, strong, lower heat loss). The porous shell allows gas exchange for the developing embryo. The calorie-filled yolk provides nutrients and the albumin (egg white) provides insulation and a water source. As the embryo develops inside of the egg, liquid waste products collect in an isolated section.

Female birds, the majority of which have only one ovary and associated structures, lay about one egg every 24 hours. Clutch size varies greatly and some species renest during a breeding season, raising more than one brood per year. In our area, for example, Eastern Bluebirds can have several broods in a season, depending on when they start and food resources.

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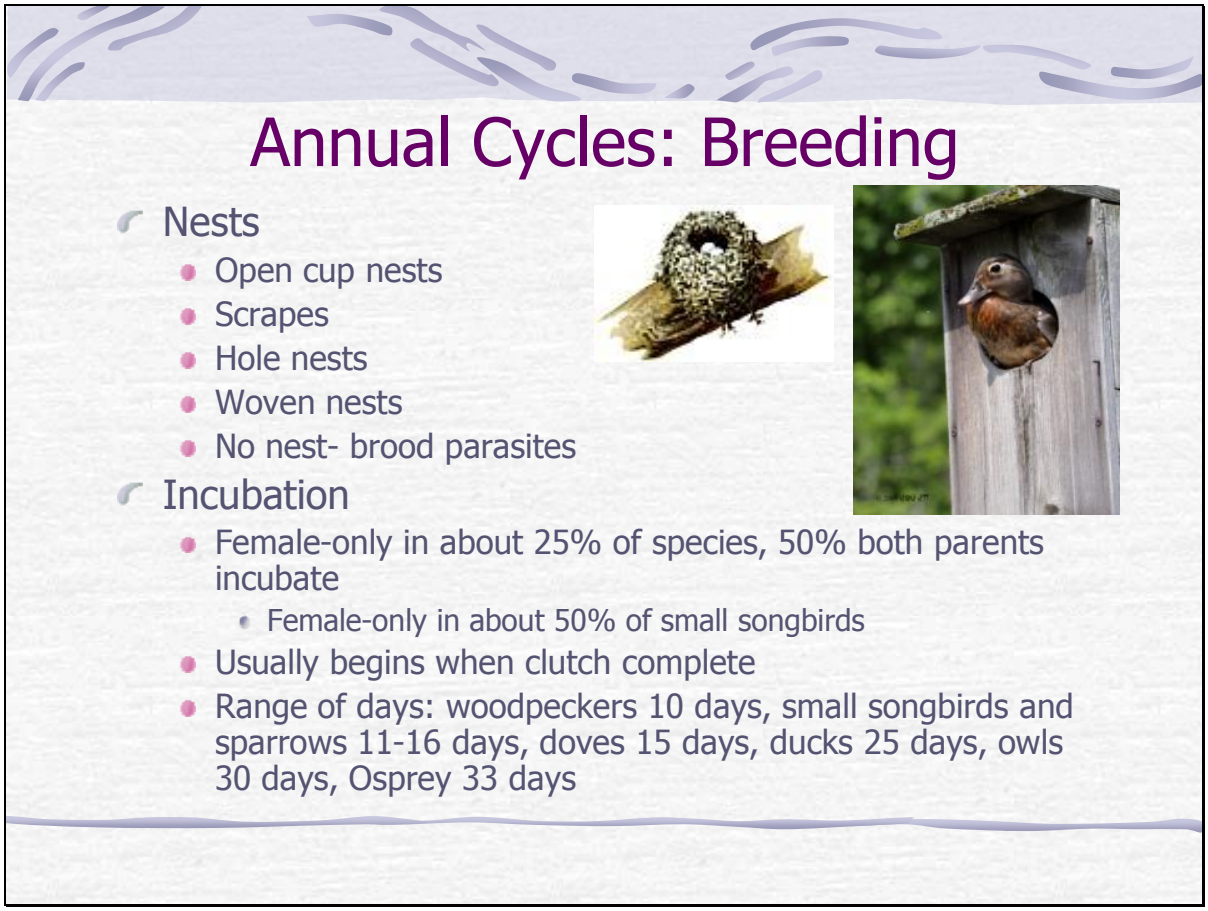

Nests show an equally dazzling array of shapes, sizes, and placement, from more simple open cup nests formed with a few twigs (Mourning Dove) to the woven nest of Baltimore Oriole. Nests are often lined with soft plant material or fibers and hummingbirds even camouflage their nests by attaching lichens to them with spider webs. Some species, like Wood Ducks, Hooded Mergansers, Eastern Bluebirds, and Barn Owls have benefitted from nest box programs. Brood parasites lay their eggs in the nests of other birds. In Maryland, Brown-headed Cowbirds do not build nests but only lay their eggs in the nests of other birds.

Incubation patterns vary across bird species in terms of who incubates and for how long. In general, incubation begins when the clutch is complete. Eggs are turned during the incubation period so that the membranes inside of the egg do not stick to the side of the shell. Larger birds and those with more developed young at hatching tend to have longer incubation periods.

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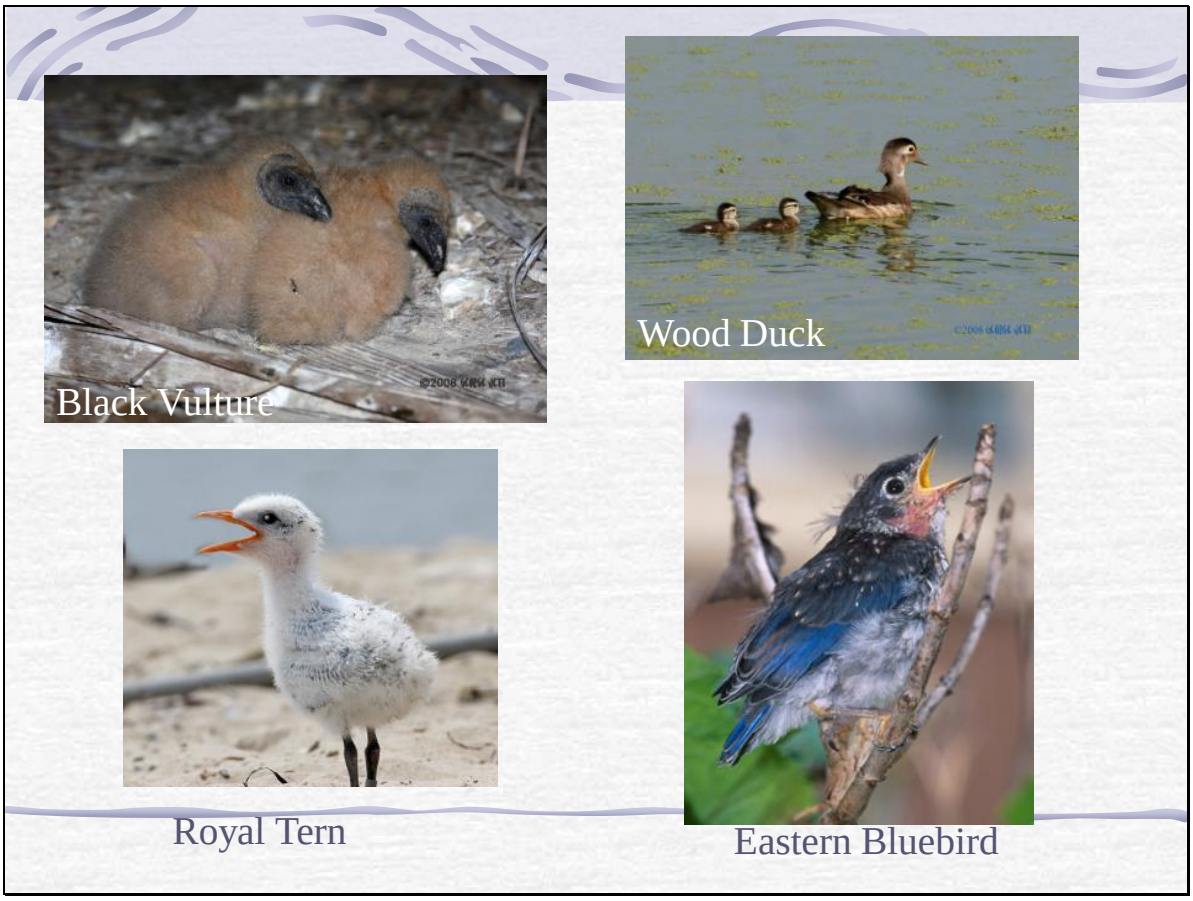

These young birds demonstrate a range of different states of development at hatching, from precocial (able to move, feed themselves- Royal Tern, Wood Duck) to altricial (unable to move, hatch out naked and with eyes closed- Black Vulture, Eastern Bluebird).

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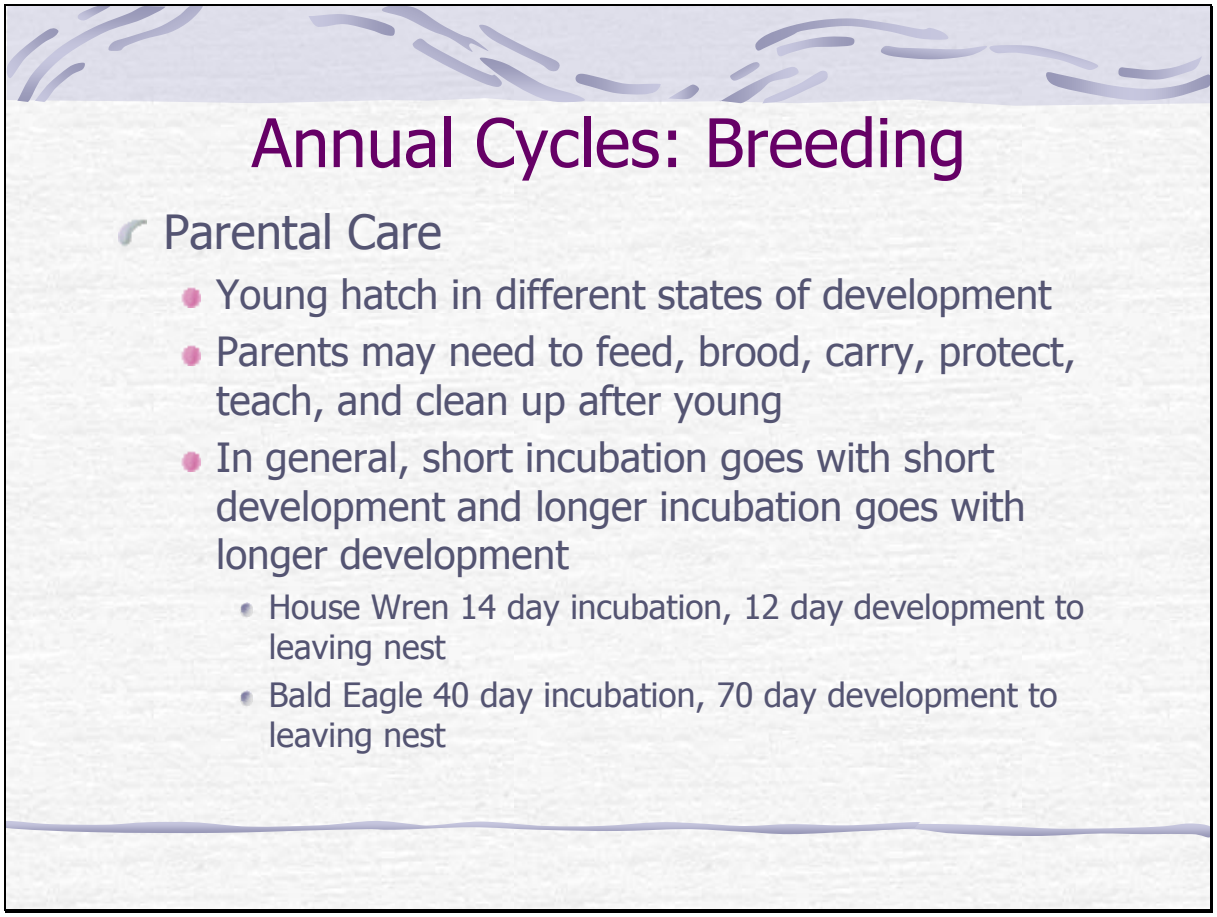

Young birds may be very undeveloped when they hatch, such as songbirds (altricial), or very developed when they hatch, such as waterfowl (precocial). Depending on the state of development at hatching, young birds may need certain kinds of care from their parents. The length of time that parents care for their young also varies greatly, as shown in the examples listed here. In some species, the young continue to be cared for even after they can fly, especially if they have specialized feeding habits like terns. Play can even be part of a young bird's development, allowing them to practice locomotory and social skills. Some examples are penguins sliding on ice flows and eider ducks riding on rapids.

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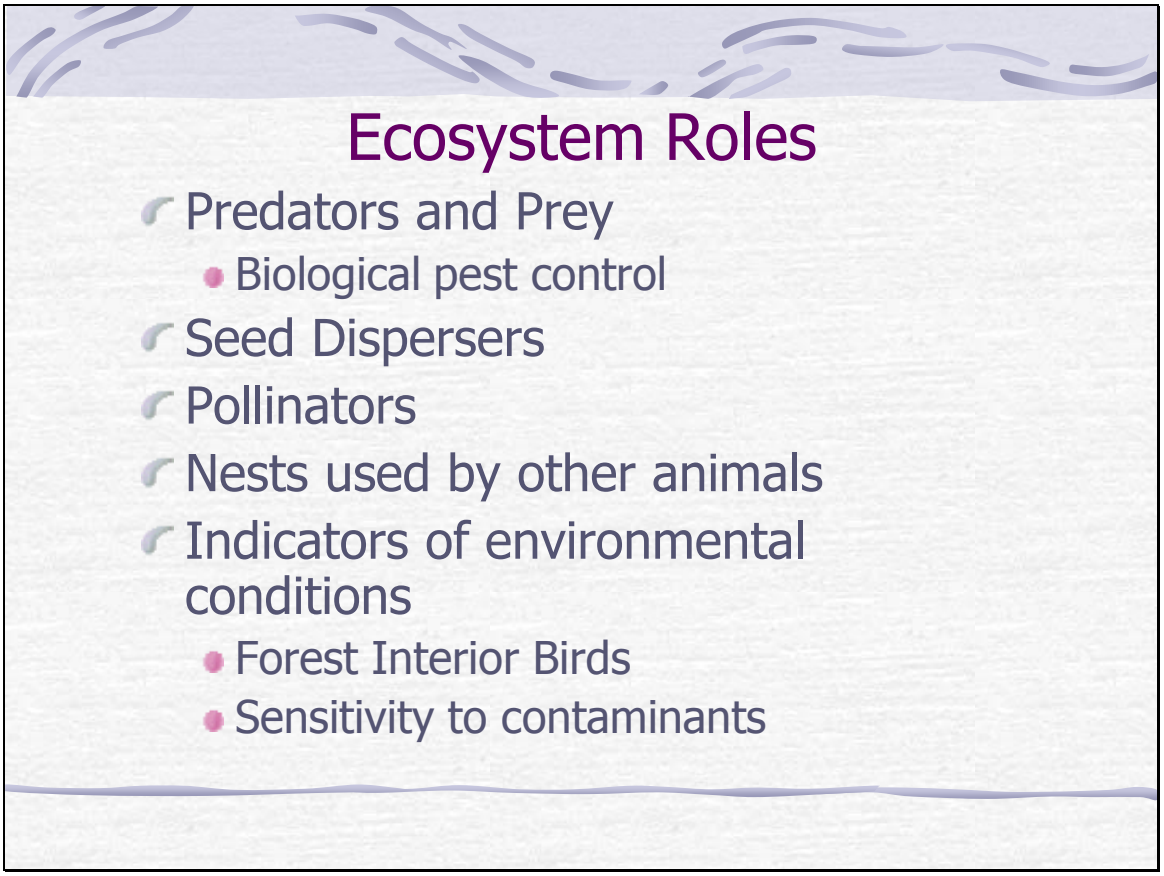

Now let's get to where birds fit into our natural systems. This slide lists what are probably the most important roles that birds play in ecosystems. Birds are an integral part of the "web of life" as both predators and prey. As I mentioned previously, they can be important seed dispersers and also pollinators. The nests that birds excavate, particularly tree cavity nests, provide homes for other animals that are unable to construct such nests themselves. The sensitivity of birds in general to contaminants has made them good indicators of ecosystem problems. In addition, species that we refer to as forest interior-dwelling species or FIDS are sensitive to forest fragmentation, and indicate a decline in habitat condition for a whole suite of species that are more difficult to study.

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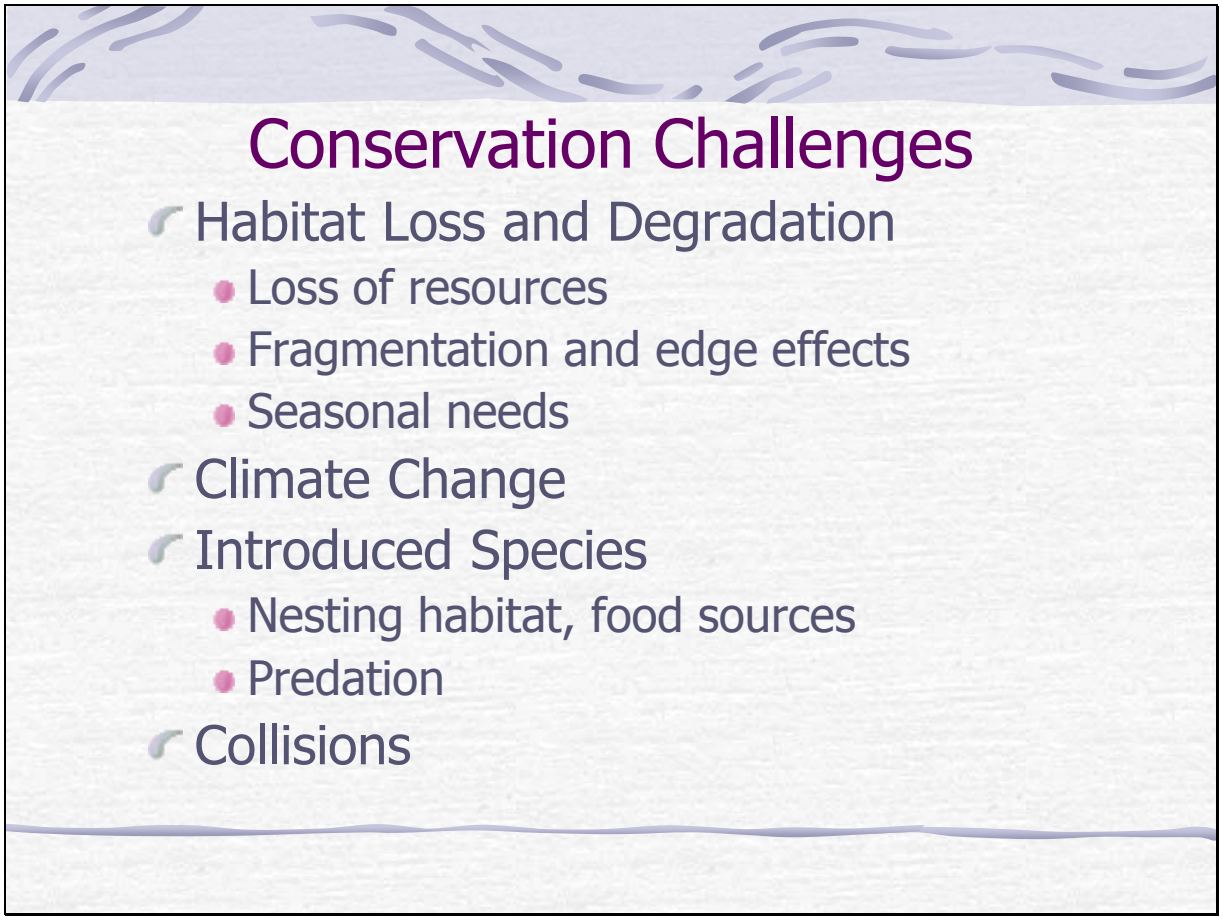

Given their ecosystem roles and sensitivities, what are some of the main conservation challenges that we face when it comes to bird populations? Habitat loss and degradation often have the greatest impacts on birds, as well as many other species, and this is an ongoing challenge for Maryland. When land uses change and the habitat is altered, resources needed to feed, breed, and carry out other activities can be lost directly or degraded due to fragmentation and edge effects. In addition, migratory birds need stopover sites and places to overwinter in addition to suitable habitat for breeding. Climate change impacts on birds are a relatively new area of inquiry, but one factor that could impact birds would be a shift in when and where critical insect food resources are available. Introduced plants do not always provide the same value in terms of nesting habitat and food, and introduced predators, or those that are out of balance, can have devastating impacts on bird populations, such as killing of birds by outdoor cats and vegetation impacts by overabundant deer. Collisions with cars, windows, towers, and powerlines are another source of bird mortality due to human activities.

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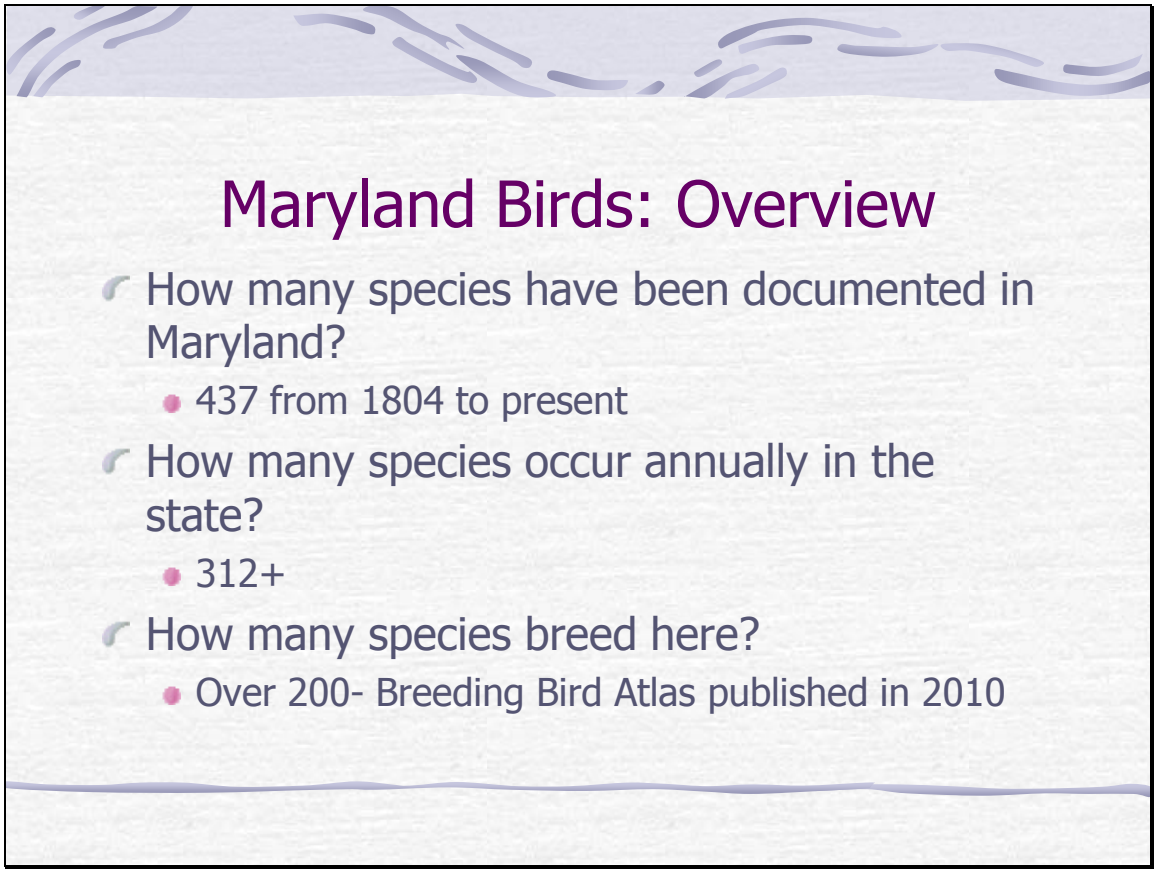

In preparation for identifying birds in the field, here are some introductory facts about Maryland birds. The most recent addition to the list of birds that have been documented in Maryland is Brown Booby, a large seabird that is related to Northern Gannett. This species is usually found in tropical waters, but occasionally shows up further north.

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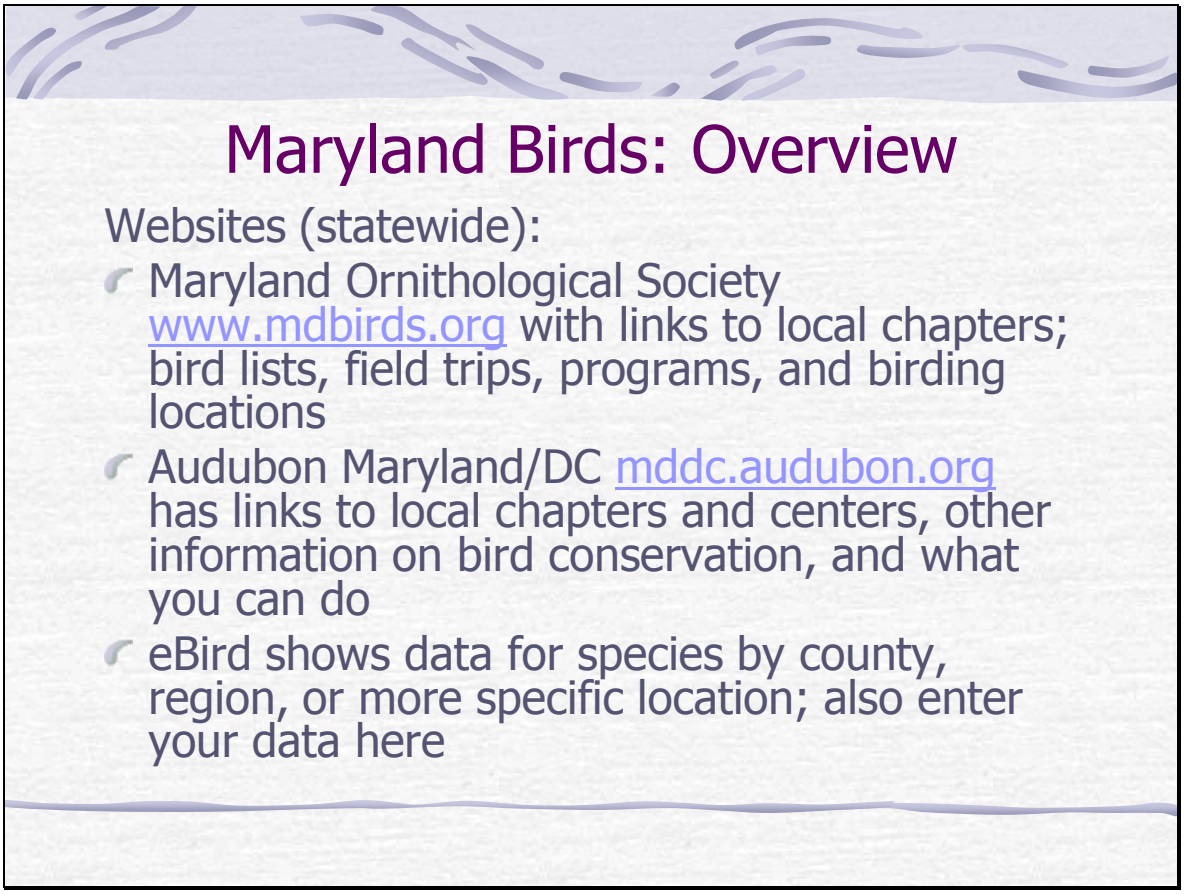

A place to start for bird lists, locations, and other information is local bird clubs. They can be accessed through the Maryland Ornithological Society website and through the Audubon Maryland/DC website. eBird can be a good resource as well for species location-specific information (select the counties, etc. you want to view) and time of year occurrence data. Ebird is also a great place to enter your data. You can help increase our knowledge of bird distributions, relative abundance, and timing of movements. We will also discuss how you might be able to contribute to our knowledge of nesting birds through the Cornell Lab of Ornithology NestWatch Program.

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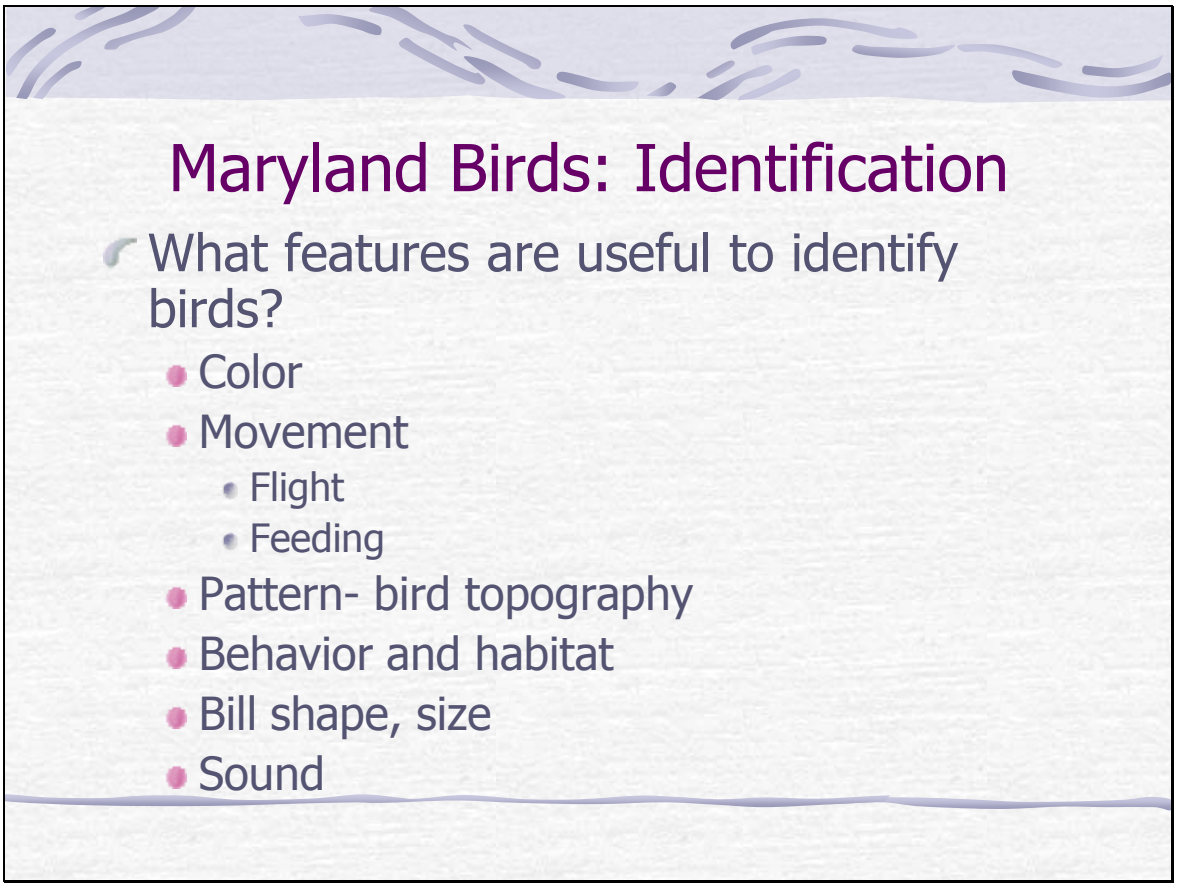

Identifying birds in the field can be challenging, but there are a few things that are helpful to focus on. Colors and patterns, including good attention to what is where on the bird, and bill shape and size are good external features to cue in on. Field guides typically have an illustration of "bird topography" to show what different regions of the body and head are called. Also notice how the bird moves, if there are any notable behaviors going on, and, if it is feeding, what movements are associated with that activity. Habitat and even time of year can also help to rule out more or less likely possibilities. Sound can be extremely useful, especially during the breeding season. There are many internet resources to help with identification of birds by sight and sound, and also bird quizzes to test your skills.

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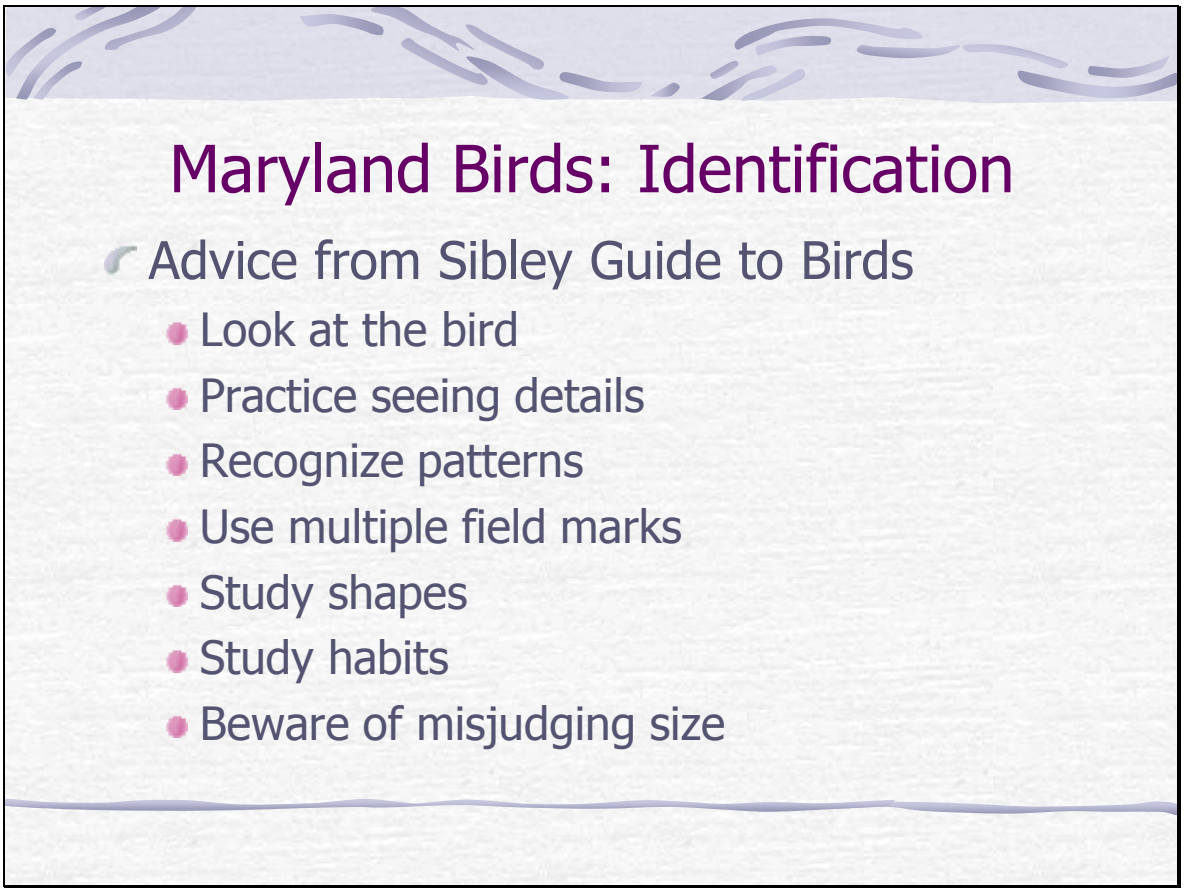

One of the best field guides is the Sibley Guide to Birds. These are some pointers from that guide that will serve you well in trying to figure out what bird you are looking at. The National Geographic Field Guide to the Birds of North America is also very good. Many people also use the Peterson Field Guide (Eastern Birds). The Crossley ID Guide: Eastern Birds uses a different approach to identification by showing birds in lifelike scenes and different views. Browse through the available guides and see what will work best for you.

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It can be a challenge to find a bird in binoculars and then get other folks with you to see the same bird you are looking at. The first step is to get yourself ready for the best view possible. To adjust binoculars for the distance between your eyes, fold or unfold the binoculars until you see one image. To adjust for differences between your eyes, look at a stationary object with your right eye close and focus the binoculars. Now open your right eye and adjust the lens closest to your eye until the object is in focus for both eyes. To find an object in the binoculars, practice keeping your head still and eyes on the object while bringing up the binoculars.

To help someone else see what you are looking at, these are some good tips. Phrases like "over there, up there, right there, in the tree", etc. are not usually very helpful!

We will practice using binoculars, finding birds, and describing where they are to others during class time.

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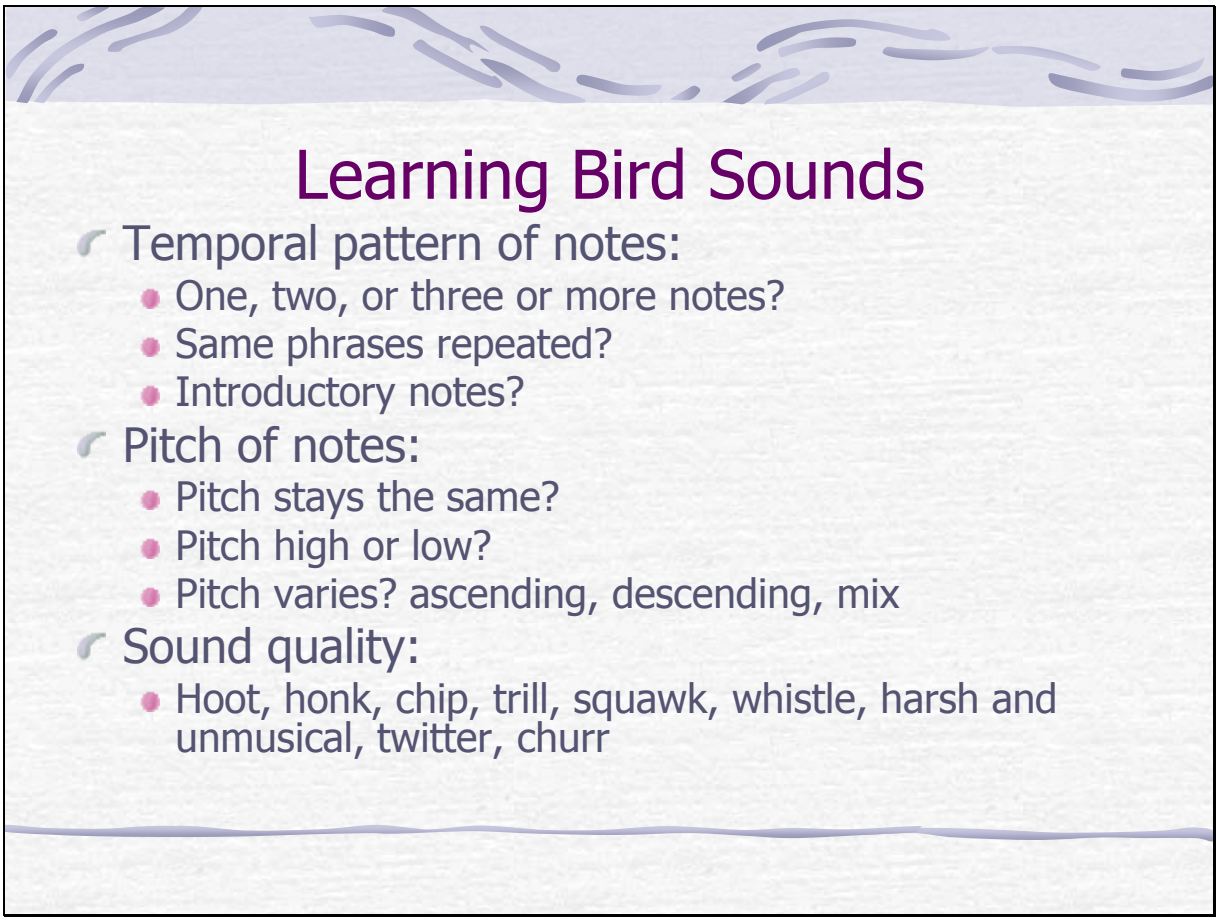

Learning bird songs can really open up a whole new world of knowing what species are present in an area, since it is often difficult to see all of the birds (especially in forests). Here are some features of the sound to listen for when you are learning bird songs and trying to identify what you are hearing. Pattern, pitch, and sound quality can all be very useful.

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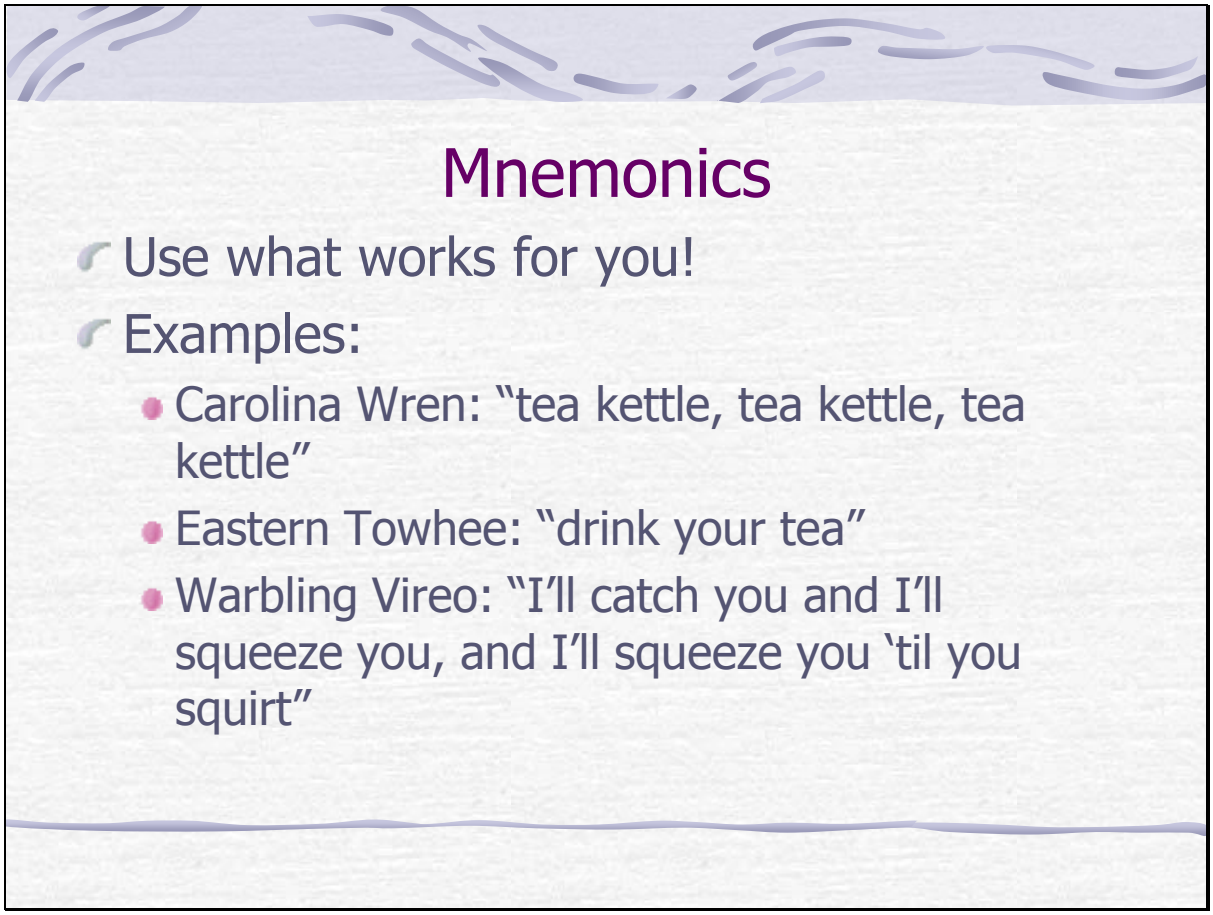

Well, there are a lot of bird sounds out there, and tricks for the memory can really help. You can make up your own or use the examples on the handout. Word phrases can be fitted to the sounds, like these examples, or you can use what the sound actually is saying, like fee-bee for Eastern Phoebe or jay for Blue Jay.

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So, now you need to get out and enjoy the birds! The American Birding Association has put together some very useful guidelines to ensure that in the act of observing birds, we do not interfere with them or cause them harm in any way. These guidelines can be especially helpful to keep in mind when you are leading a group of people.

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Following these guidelines helps the birds and also helps keep more areas open to birders.

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Many people provide food, water, and nest sites for birds- an excellent way to assist bird populations. However, we need to do it properly to have the desired effect. The Cornell Lab of Ornithology NestWatch program is a great source for more information on nest structures.

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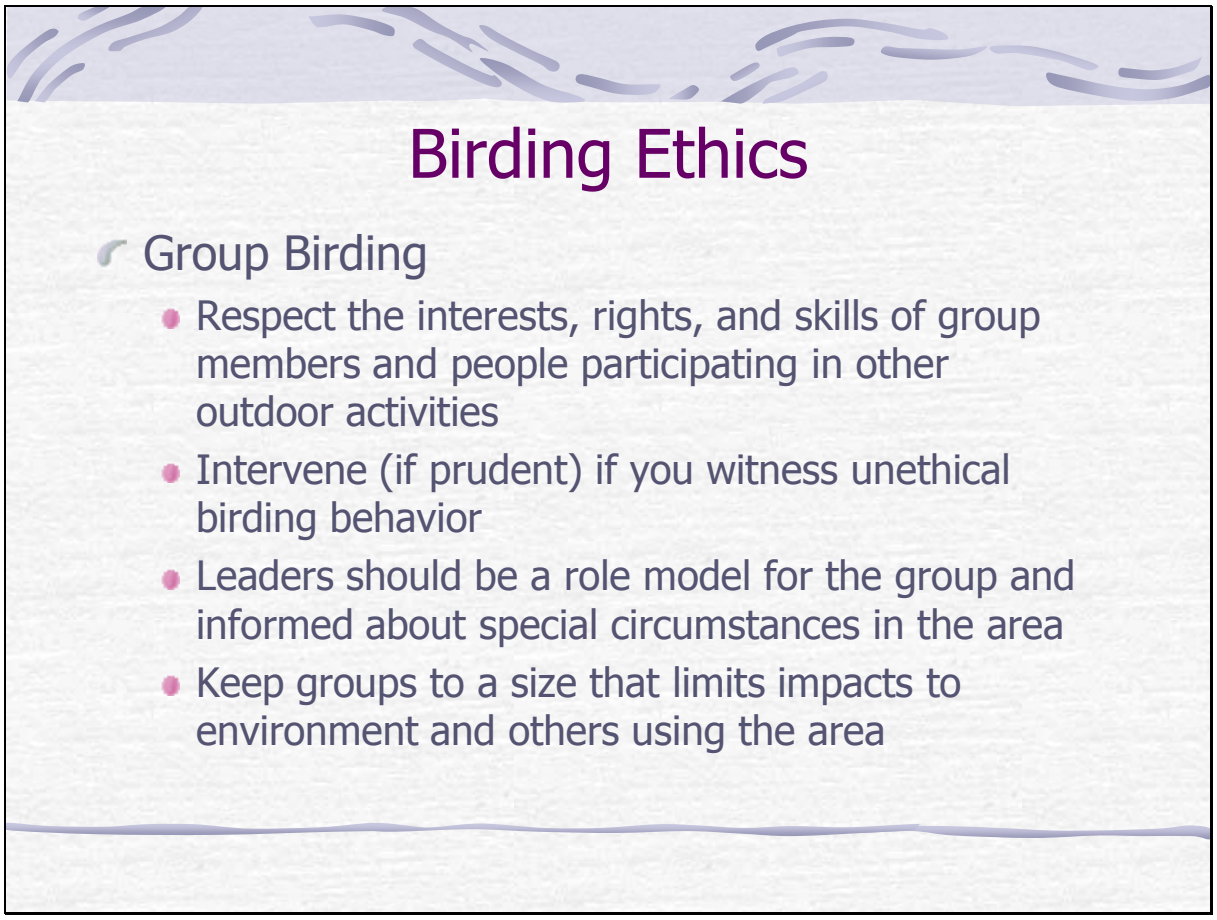

Groups can have a detrimental impact on the birds and it is important to be a good group leader (and participant).

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I would like to close with a few thoughts about challenges and protections for our Maryland birds. We have several kinds of legal protections and programs in the state for birds and their habitats, listed here. Critical Area Regulations protect habitat for rare species, colonial nesting waterbirds, and forest interior nesting birds. As of April 2010, the state list includes 15 endangered bird species (including one threatened at the federal level), 3 threatened, and 7 in need of conservation. The state list is revised about every two years and also includes species considered to be rare in the state. More information is available at http://www.dnr.maryland.gov/wildlife/Plants_Wildlife/rte/rteanimals.asp. Protection of wetlands by state law helps to protect bird habitats, as do a number of local regulations.

Most bird species in Maryland are protected under the federal Migratory Bird Treaty Act. This law protects not only live birds but also limits the possession of bird parts. The Piping Plover is listed as threatened under the federal Endangered Species Act.

The hunting of game birds in the state is also regulated by federal and state laws.

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Certainly our birds in Maryland face these general threats to birds mentioned earlier. Think about ways that you address these at home, at work, in your community, in your county, and in Maryland.

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Enjoy the birds!

- Thanks to George Jett for the use of his photos www.georgejett.net

Thank you to those that helped provide media for this presentation. Please do not extract, share, print, or otherwise use any of the bird photos.