Young Naturalists

How Do Birds Fly?

Birds take to the sky and safely return to land or water in marvelously different ways.

By Carrol Henderson and Michael A. Kallok

For thousands of years, humans have watched with wonder and envy as birds fly. People first tried to fly like birds by imitating the flapping of wings. In the late 1400s, Leonardo da Vinci created a wing-flapping contraption called an *ornithopter* (from the Greek word *ornithos* for *bird* and *pteron* for wing). He thought flying was simply a matter of flapping wings up and down. The ornithopter didn't work because he did not understand how bird wings must generate lift and thrust to fly.

Today, airplanes with powerful engines can fly long distances. But human-made machines will probably never match the natural power and grace of birds on the wing. Birds have feathers and bones adapted for flight. With these adaptations, they can take off, hover, soar, glide, dive, and land in amazing ways.

RED-TAILED HAWK BY BILL MARCHEL

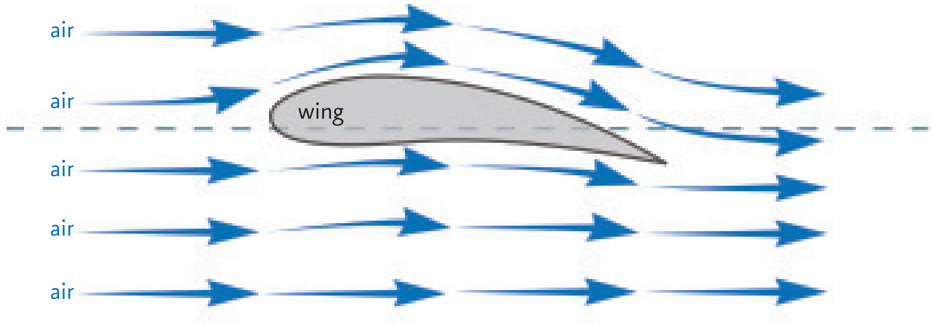


ILLUSTRATION BY STEVE ADAMS

Discovery of a force called lift

When a bird or airplane is moving through the air, the air splits its path at the front edge of the wing and meets again at the back of the wing. Because the top of the wing is curved, the distance from the front of the wing to the back of the wing is shorter for air passing under the wing. Air passing over the wing top moves more quickly than air under the bottom. The fast-moving air atop the wing creates less pressure than air underneath the wing. The higher air pressure under the wing lifts the bird upward. At the same time, wing flapping acts like a propeller to move, or thrust, the bird forward. Swiss mathematician Daniel Bernoulli first explained *lift* using an equation. This important discovery, known as Bernoulli's Principle, helped people learn how to achieve flight.

COMMON LOON BY RICHARD HAMILTON SMITH

Taking off

Leaping. A bank swallow drops from its nesting cavity on the side of a cliff or steep bank. Gravity pulls on the swallow, helping it reach the critical speed at which its spread wings generate enough lift to become airborne. Herons, egrets, hawks, and other birds leap upward as they push their wings downward to lift off.

Beating Wings. Many songbirds don't have very strong legs. Neither do grouse, pheasants, and puddle ducks, such as mallards and teal. These birds rise from the ground or water with a powerful downward thrust of their wings.

Like airplanes accelerating down a runway, many birds face the wind and run and flap their wings across a stretch of land or water to gain enough speed to lift off. To take off, sandhill cranes run into the wind across a field or grassland. A common loon has small wings compared with its body size and weight. To get airborne, a loon must run a long way across the surface of the water while flapping its wings fast.

Hovering. Hummingbirds never run, walk, or hop. They use their feet only for perching. Minnesota's ruby-throated hummingbird takes off from its perch by lifting its feet and beating its wings to hover up and away. Even if a hummingbird wants to move only two inches to the left on its perch, it must let go, hover up and to the left, then descend and perch again.

BANK SWALLOW BY CARROL HENDERSON, DNR

RING-NECKED PHEASANT BY BILL MARCHEL

RUBY-THROATED HUMMINGBIRD BY CARROL HENDERSON, DNR

TOP:

***Minnesota's state bird**, the common loon, faces into the wind during takeoff to increase lift. On calm days, loons must run and flap longer distances to take off.*

BOTTOM, LEFT:

***Like a hang glider**, the bank swallow leaps from high places and uses gravity to gain the speed necessary for lift.*

BOTTOM, MIDDLE:

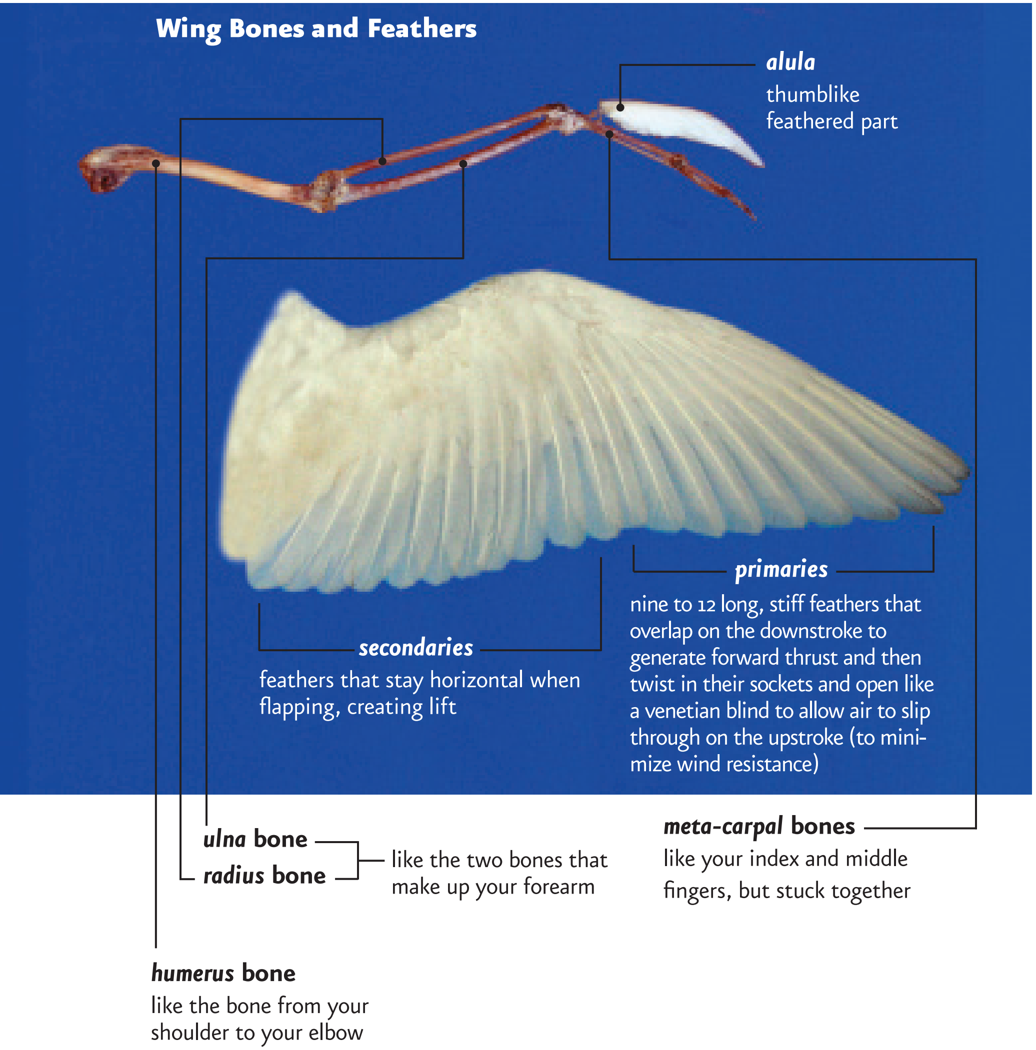
***The ring-necked pheasant**, like native fowl such as ruffed grouse and prairie chickens, has short, broad, cupped wings, which allow for explosive takeoffs and brief, fast flights.*

BOTTOM, RIGHT:

***Long, slender, oarlike wings** allow the ruby-throated hummingbird to hover, fly backwards, and even fly upside down.*

Flight gear

Birds make flying look easy. They seem to simply flap their wings and fly. Certain adaptations make birds perfectly suited to fly in certain ways and places. They have specialized feathers and use 50 different muscles that allow complicated movements.

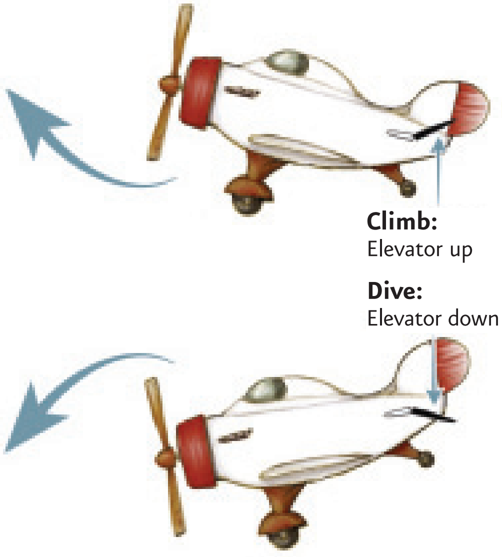


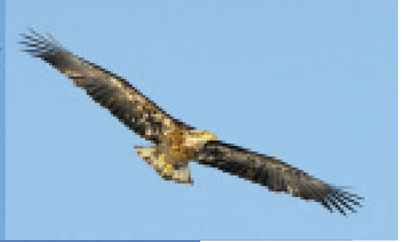
AIRPLANE ILLUSTRATION BY STEVE ADAMS

COMMON TERN BY CARROL HENDERSON, DNR

Tail. When a bird raises its tail, the tail helps the bird climb higher in the sky. To dive, a bird points its tail toward the ground.

The tail helps the bird slow down or stop flying and turn right or left. When a hummingbird approaches a flower, it lowers and spreads its tail feathers, so more air drags against the tail. This *drag* (wind resistance) helps the bird slow down and hover or stop. A common tern spreads its forked tail to slow its forward movement and stay stable while hovering on the wind as it looks for a fish below. A tern can also fold its tail straight back, so it is more streamlined and creates less drag during its long migratory flights between North and South America.





LEFT: TURKEY VULTURE BY CARROL HENDERSON, DNR; RIGHT: YOUNG BALD EAGLE BY BILL MARCHEL

Flight styles

A turkey vulture can't match the acrobatic flight of a barn swallow. Of course, a little barn swallow can't soar for miles without flapping like a big turkey vulture can. Why do different birds fly the way they do? There is certainly a difference in the size of birds, but how birds fly depends mostly on the shapes of their wings.

Soaring and Gliding. Using its long, broad wings, a turkey vulture can soar for hours in search of *carrion*, dead animals. A turkey vulture holds its wings at an upward angle, like a shallow letter *V*. This shape helps the bird stay stable in the air. If the wind tilts a vulture to one side, lift increases under the lower wing because it is extended horizontally a longer distance than the other wing. The lift brings the bird back to a horizontal position. When the Wright brothers were designing their first successful airplane, they studied soaring turkey vultures. Many airplanes have wings with a gentle upward angle to provide stable flight.

Pelicans, hawks, ospreys, and geese have long, broad wings too. Like turkey vultures, these birds fly with their primary feathers spread out like fingers on an open hand. These fingerlike wingtips give birds extra lift because each primary feather generates its own lift. Long primaries also give a bird plenty of thrust in forward flight and in diving for prey.

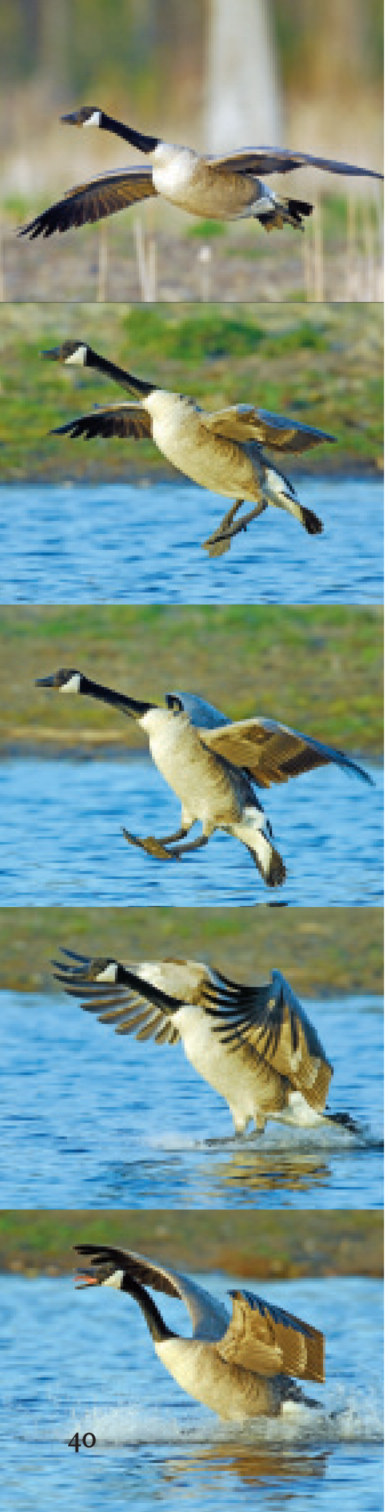
1. **Turkey vulture** (Long and broad wing for soaring)
2. **Common nighthawk** (Long, angular, and pointed wing for high speed)
3. **Greater prairie chicken** (short, broad, and cupped wing for quick takeoffs)
4. **Indigo bunting** (short and broad wing for quick takeoffs and flying long distances)
5. **Hummingbird** (long, slender, and straight oarlike wing for maneuverability)

Skydiving. Some birds, such as swallows and falcons, have long, angular wings with pointed tips. Pointed wingtips have less drag and allow a bird to perform dramatic aerial maneuvers in order to catch bugs or other prey on the wing. With its long, sleek, angular wings, a peregrine falcon can reach speeds of nearly 200 miles per hour as it dives toward other birds in flight.

This photo shows several postures of a peregrine falcon diving for prey. As the falcon's wings are drawn in and folded back, the drag decreases and the bird's airspeed can reach almost 200 miles per hour.

Short and Fast. Birds such as pheasants, turkey, and grouse have short, broad wings that allow them to fly very fast over short distances. The wings are shaped like an upside-down saucer. This curved design traps more air underneath the wings for a quick lift and noisy getaway from a fox, coyote, bobcat, or other predator.

Up, Down, Around. Rather than flapping, a hummingbird moves its straight, slender wings like the oars of a rowboat—but much faster. A ruby-throated hummingbird can make more than 50 wingbeats a second! A hummingbird cannot glide or soar, but it can flip its wings upside down at the shoulder joint to generate lift on both the forward and the backward strokes. By changing wing position, a hummingbird can fly up, down, forward, backward, and upside down. It is the only bird able to fly backward.



CANADA GOOSE BY BILL MARCHEL

Coming in for a landing

Landing is tricky—for birds (and airplane pilots). Different bird species have different methods of landing.

When a bird or airplane comes in for a landing, it must raise its body or nose upward to slow down. When a Canada goose comes in for a landing, it raises its body slightly, spreads its tail to create drag, and spreads out its wings to slow down. If a bird in the air slows down too much, it will lose all lift. Without lift, the bird, like an airplane, would "stall" and tumble from the sky. Geese and other birds use a cluster of feathers called the *alula* to help them land without stalling. Sticking out the thumblike alula forces air over the top of the wing, which helps maintain lift as it slows down to land.

Touch Down on Water. Geese, mallards, and many other birds circle into the wind to maintain lift as they slow down to land. Pilots do the same thing when landing airplanes.

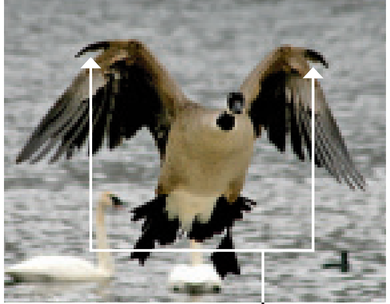
As a mallard approaches landing, it points its body upward and drops its feet. Next it raises its alulas and begins flapping its wings in a nearly upright body position. With wings held upright, the secondary feathers no longer provide lift but the flapping primary feathers give just enough lift for the bird to hover down slowly like a helicopter.

A trumpeter swan needs more room to land than a mallard does. It raises its head and body and extends its feet forward as it glides in for a landing. When its large, webbed feet touch the water, the swan gracefully water-skis to a stop.

Tree Landings. Some birds, such as egrets, perch on treetops. To land there, a flying egret raises its wings and beats only its primaries back and forth above its intended perch. It keeps its wings spread and stretches out its legs. As the egret drops gently from the air, its long legs reach out and its feet grasp a branch.

Songbirds use a slightly different technique to land on a perch. When a bird such as a robin comes in for a landing, it raises its body and wings into a nearly upright position to slow down. With feet outstretched, the robin has enough momentum to keep moving forward until its feet touch and grasp the perch.

Watch and Learn. The study of physics has helped humans achieve a better understanding of how birds fly, but much mystery remains. For example, how do migratory birds navigate so precisely to faraway places each year? People continue to look for answers to this and many other questions about birds' abilities. But you don't need to be a scientist to marvel at how birds fly. The next time you see birds taking off, flying, or landing, think about their remarkable adaptations and how each bird species is uniquely fit for survival and flight. V



CANADA GOOSE BY CARROL HENDERSON, DNR

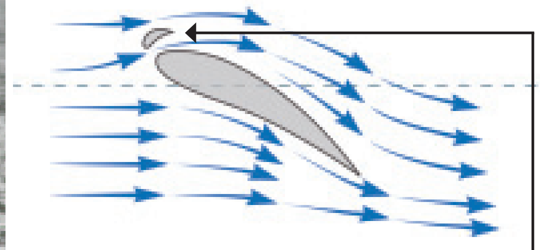


ILLUSTRATION BY STEVE ADAMS

The thumblike projections (alulas) on the wings of a Canada goose force air over the top of its wings to help maintain lift as it raises its body and wings to slow down and land. This illustration shows an airplane wing. Like a bird's wing, it has an alulalike part called the Handley Page slat to help an airplane maintain lift as a pilot raises the airplane's nose and slows down for a landing.

SNOWY EGRET BY CARROL HENDERSON, DNR

The large wings of the snowy egret serve as parachutes that allow the bird to descend gracefully to its treetop perch.

Note to Teachers

To learn more about how birds fly, see *Birds in Flight*, by Carrol Henderson, published by Voyageur Press.

Find links to teachers guides for this and other stories at www.mndnr.gov/young_naturalists.