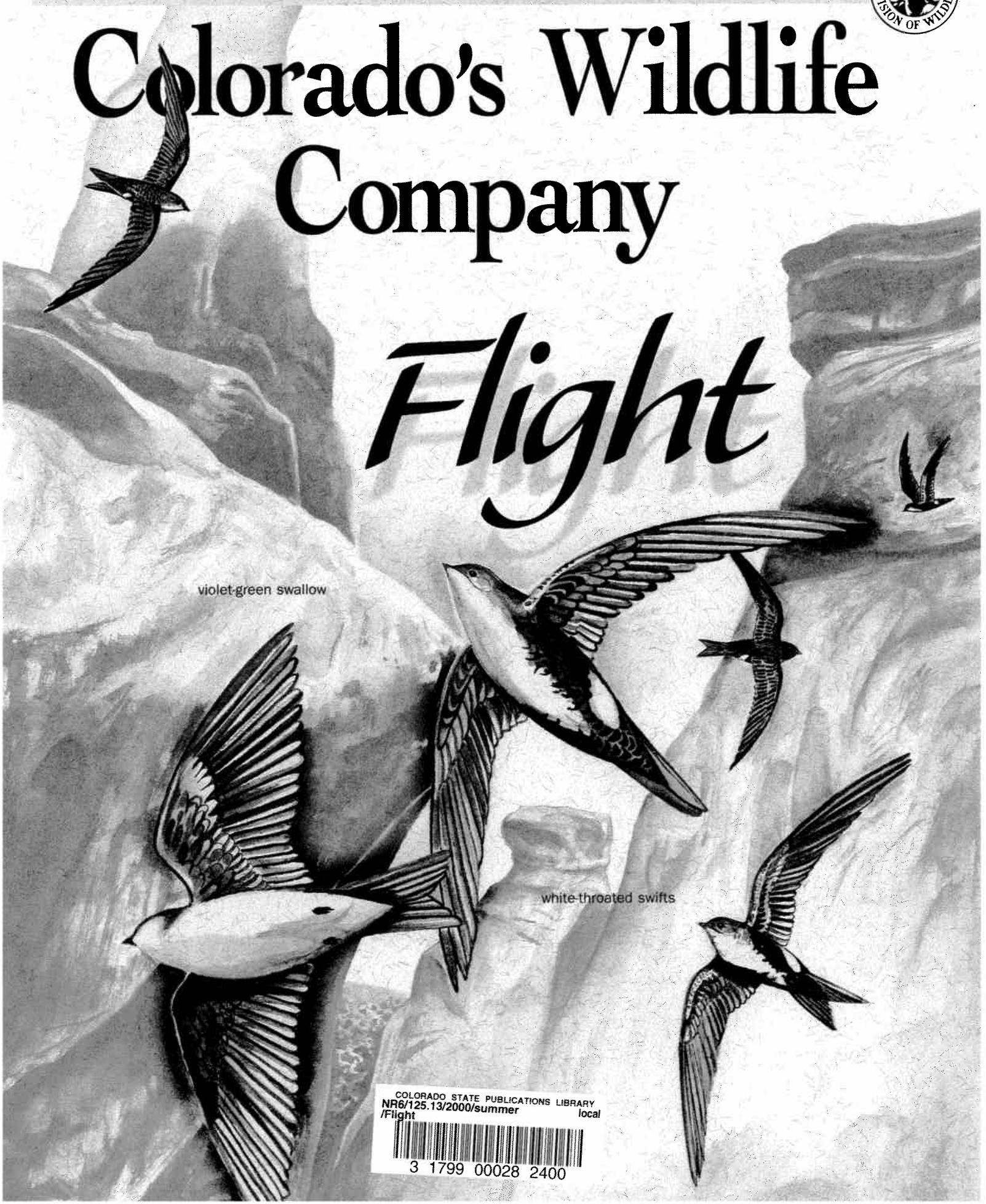
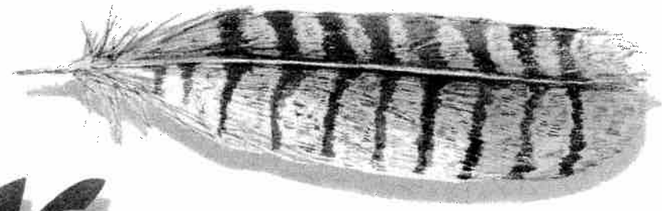
2000 SUMMER COMPENDIUM OF WILDLIFE APPRECIATION

Colorado's Wildlife Company

Flight





Air BORNE

by Mary Taylor Young

For countless millennia, humans have stood, earth-bound, and watched the flight of birds. What is this magical ability, this power of flight? It fills us with fascination and envy. How do they do it?

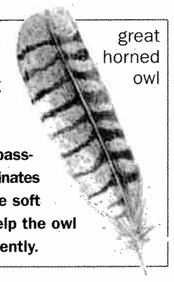
BUILT TO FLY

Birds have committed themselves to flight through great physical adaptations. Any pilot knows weight is an important consideration in flying. Birds have jettisoned extra weight from their design. Their slender bones are hollow and filled with air, but rigid and strong too. Some of the bones, like those of the pelvis, have fused to strengthen and simplify the skeleton. The breastbone has a deep keel that allows the attachment of large flight muscles.

Feathers are finely engineered tools, designed to meet the flight needs of each species' lifestyle—stiff ones for rapid flight and maneuverability, soft ones for silent hunting. Even the respiratory system of birds has evolved to be much more efficient than ours. Flying is strenuous, with a high oxygen demand. Birds have a complex respiratory tract, involving air sacs as well as lungs, that allows more air to pass through the system than the simple in-and-out breathing of humans.

We might think of a bird as a flying craft with a two-part wing. The "upper arm" moves at the shoulder joint, providing lift through flapping. Seen in cross-section, the upper surface of the wing is rounded and the bottom surface flat. Air flowing up and over the curved top moves faster than the air flowing under the wing (you might think of it as having to "catch up" with the air underneath). This difference in air speed causes lower air pressure on the upper side of the wing, which in turn creates lift. The angle of the wing controls the amount of lift, thus a bird coming in to land slows down by tilting its wings to reduce lift and create drag. A few inches from the ground, the bird tilts its wings into a stall, then lands gently (hopefully).

The outer half of the wing, the "hand," is flexible and acts like a propeller. A bird is able to spread those outer flight feathers, called primaries, like spreading the fingers of its hand. The primaries' flexibility allows the bird great control during flight. Watch a bird flying or hovering in the wind. You can see the many adjustments of individual feathers it makes to control its flight.



great horned owl

You won't hear the whir of wings from a flying great horned owl. The leading edge of the owl's primary feather has a "saw-tooth" design that breaks up air passing over the wing and eliminates noise. Wide and rounded, the soft secondary feathers also help the owl to move through the air silently.

It was long thought that birds rowed the air with their wings, pushing back and down as they flapped. But a French scientist discovered in the 1860s—by sticking white paper on the wingtips of crows, then photographing them in flight—that on the powerful downbeat, birds sweep their wings down and forward. At the bottom of the stroke, the wrist flexes up, the "fingers" spread and the wing beats upward with the primaries vertical to reduce drag. Thus it is the downstroke that powers flight and propels the bird forward.

The power behind bird flight comes from two major pectoral muscles. Like lumberjacks on either end of a giant saw, the strong depressor muscle and the weaker elevator muscle work in concert to move the wing up and down. Anchored at the breastbone and the upper arm bone, the depressor muscle contracts and pulls the wing down. When it relaxes, the elevator muscle pulls the wing back up.

Hummingbirds are the odd bird in this arrangement. Their wings are "all hand," and the wing moves entirely from the shoulder, providing them exceptional maneuverability. Watch a hummingbird alighting at a feeder. It lays its stiff wings on its back in one motion, without the folding and tucking done by other birds. This also allows hummingbirds to take off in a flash since they only need to lift their wings and begin flapping without unfolding them first. Of course hummingbirds are unique in their flying capabilities. They can fly backward—intentionally and under control—hover, and even fly upside down briefly. To achieve this aerobatic excellence, hummingbirds flap their wings 50 to 60 times a second.

FLIGHT DYNAMICS

The ability to fly offers tremendous advantages, but if its delicate dynamics are changed, things can get tricky for the bird. A hunting osprey flies over a lake, spots a fish, plunges to the water's surface and grabs the fish with its talons. In retrieving its prey, the osprey compromises its flight dynamic. Now it is at a complete stop with part of its body in the water. To become airborne again, the osprey must expend a great amount of energy. Only through vigorous flapping can it gain enough lift to break away both from gravity and the drag of the water. The bird also carries the added weight of the fish. With no surface to push off from and little help from wind or air movement, the osprey relies on muscle strength to essentially pull itself from the water into the air.

The heavier a bird is, the faster it must fly to stay airborne. Have you noticed how ducks flying overhead flap their wings very fast? Compare that to the lazy soar of a turkey vulture. The heavy-bodied ducks have a small wing surface for their weight. By contrast, the vulture has large, broad wings for its body size. Its weight is distributed over a greater wing surface area, meaning it has light wing loading. If a duck stopped flapping and tried to soar, it would fall out of the air like a lead weight. British scientist Sir D'Arcy Thompson calculated that the flightless ostrich, weighing 250 pounds, would need to fly at 100 miles per hour or more to stay in the air.

American kestrel

The pointed, stiff flight feathers of the American kestrel cut the air, allowing it to fly swiftly and change direction quickly. These small falcons often hover while hunting, a maneuver that would be difficult or impossible for a soft-winged owl.

HOW FAST, HOW HIGH?

So how fast can birds fly? Peregrine falcons are the Olympic sprinters of birds, capable of 40 to 60 miles per hour during ordinary flight, but able to plummet during their predatory stoop at up to 200 miles per hour. This is not a freefall but a controlled drop (headfirst), with the partially folded wings held out. After striking (or missing) its prey, the peregrine immediately pulls out of the stoop and flies off either to retrieve its dinner or to try again. Racing pigeons, which are often the prey of falcons, have been clocked at speeds of from 28 to 82 miles per hour. A California man, who clocked the speeds of birds in his car as they flew alongside a highway, reported a flicker flying at 44 mph, a Savannah sparrow at 37 mph, and a cinnamon teal at 32 mph, which sped up to 59 mph when he pressed it. It's not reported whether the teal got a ticket.

Have you ever watched a turkey vulture soar on summer thermals, higher and higher until it was no larger than a speck of pepper? Or seen the sparkle of white shapes in the clouds and realized they were a platoon of high-flying pelicans? While the small birds in your back yard seldom fly higher than 50 to 100 feet, vultures and pelicans may soar to 5,000 feet. The super high altitude records for bird flight come from mountain ranges like the Himalayas and Alps—obstacles migrating birds must fly up and over. Bar-headed geese were recorded migrating over the Himalayas at more than 27,000 feet and a Rüppell's griffon, a species of vulture, was struck by a commercial airliner over West Africa at 37,000 feet. In North America, the highest flying record is of a mallard that hit a plane at 21,000 feet.

FANCY FLYING

Why do Canada geese fly in a "V"? It has nothing to do with their ability to spell. As a bird flies, some of the lift produced is lost over the tips of the wings. The moving air tumbles off the wingtips, creating an up-spiraling vortex. By flying just off the wing of the bird in front, a goose can make use of its neighbors lost lift and save energy. Researchers estimate that birds in formation can fly 71 percent further on the same amount of invested energy than a goose flying alone.

What image of the West is complete without a red-tailed hawk soaring lazily on summer thermals? Soaring birds make use of rising columns of warm air to gain lift without flapping. They can maintain altitude or ride the columns higher and higher. To soar, a bird must have large, wide wings that give it light wing loading. Small birds can't soar very well because they are too easily tossed around by air turbulence. The classic soaring birds are the vultures, condors and buteo hawks, such as the red-tailed, Swainson's, ferruginous and rough-legged. To keep within these patterns of rising air, or to take advantage of shifting conditions, soarers must be able to make tight turns, change direction quickly or drop down to capture an air current.

The Gambel's quail has stiff feathers to power its explosive flight as it flushes from hiding. The sudden noise and whirring made by the feathers also aid the quail's escape by startling and confusing predators.

Gambel's quail

Like soaring, gliding flight occurs without flapping. A gliding bird is in a descending trajectory, coasting downward against the air resistance. To regain altitude, it must begin flapping or find a rising thermal. Some birds ride the air for hours, soaring up and around, then gliding down to soar once again upward. To tell whether a bird is gliding or soaring, check its wing profile. Primary feathers are held out and slightly forward during soaring, cocked backward when gliding.

ON THE WING

Courtship flight brings out some of the fanciest flying in the bird world. Courting bald eagles fly close together, then the male flips onto his back beneath the female, the two clasp talons, and tumble through the air. A male harrier performs a sky dance for the perched female, flying straight up in the air, then plummeting toward the ground before pulling up in a steep "U." Nighthawks do a similar dive, controlling the passage of air through their wing feathers to produce a loud *whoomp* at the bottom of the dive. The lark bunting flies up high, then floats downward in a spiral on stiff wings like a butterfly.

Swifts are true masters of the wing, eating, drinking, sleeping, bathing and even mating while in flight. Only nesting requires them to come to earth, and even then they choose high ledges and crevices. A swift's feet and legs are so small and weak they would have difficulty taking off if they did land on the ground. Their family name, *Apodidae*, appropriately means "footless." The swift's long, slender wings curve backwards and are designed for high speed flight. The pointed wing shape and stiff feathers allow the wing to cut the air during sharp turns and maneuvers.

Watch for Mary Taylor Young's new book entitled, *On the Trail of Colorado Critters: Wildlife Watching for Kids.*

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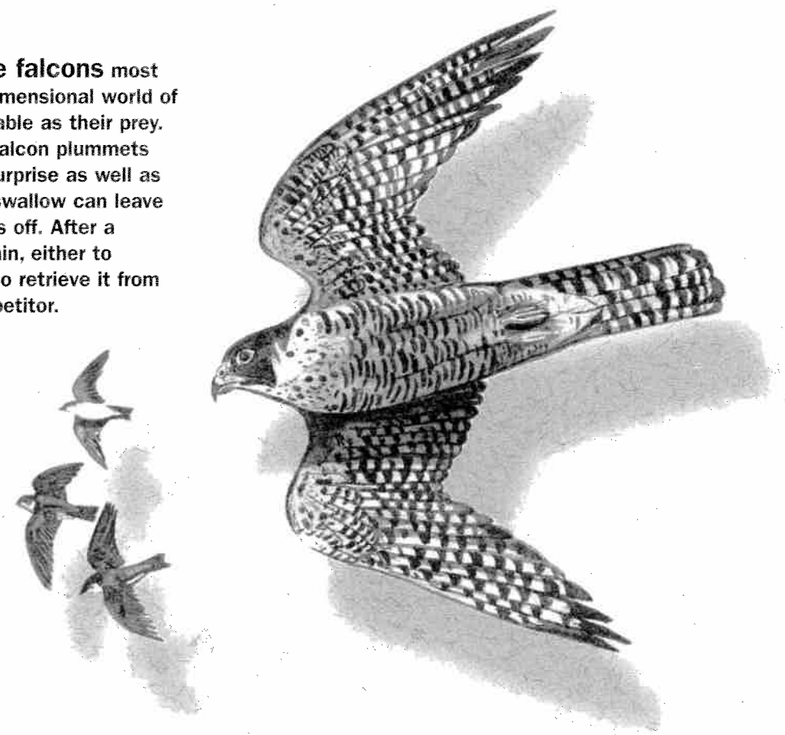
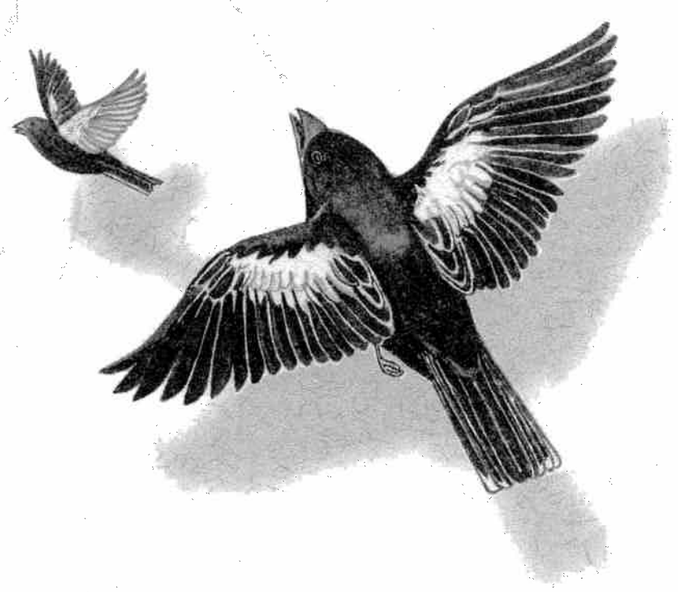
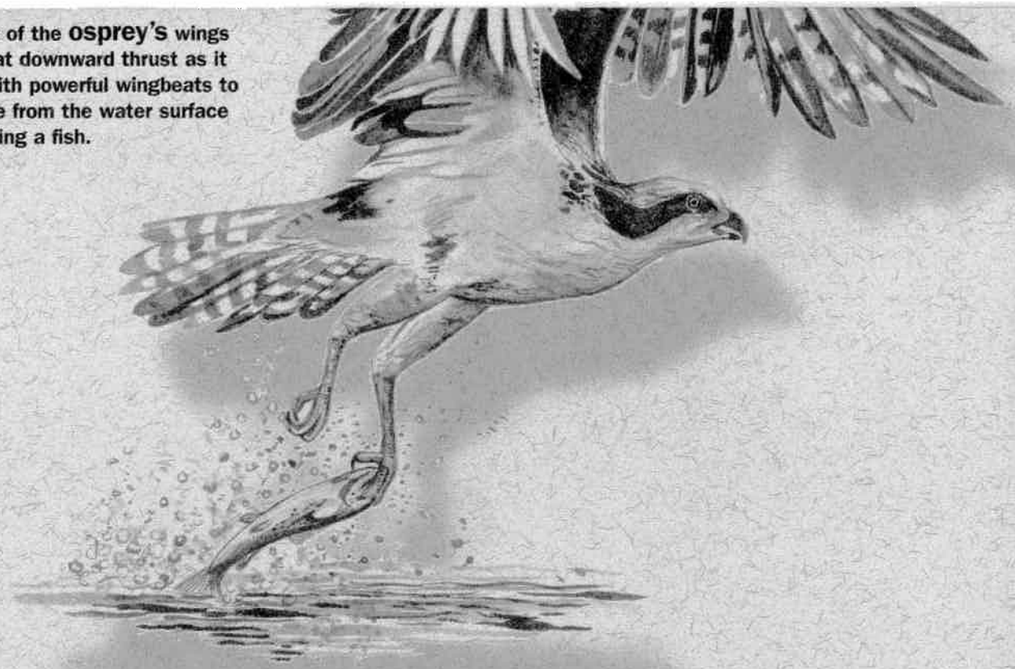
Soaring **turkey vultures** ride high like gliders on very broad, extended wings. By riding thermals, a vulture may not need to flap its wings for hours. In a downward glide, the wings are cocked slightly backward.

In Colorado, canyon-nesting **peregrine falcons** most often hunt birds in flight. In the three-dimensional world of air, they must be as fast and maneuverable as their prey. Spotting prey like these swallows, the falcon plummets down on them from above, employing surprise as well as speed. A last minute maneuver by the swallow can leave the falcon striking air as its prey speeds off. After a successful strike, the falcon stoops again, either to pluck the tumbling bird from the air or to retrieve it from the ground before it is stolen by a competitor.

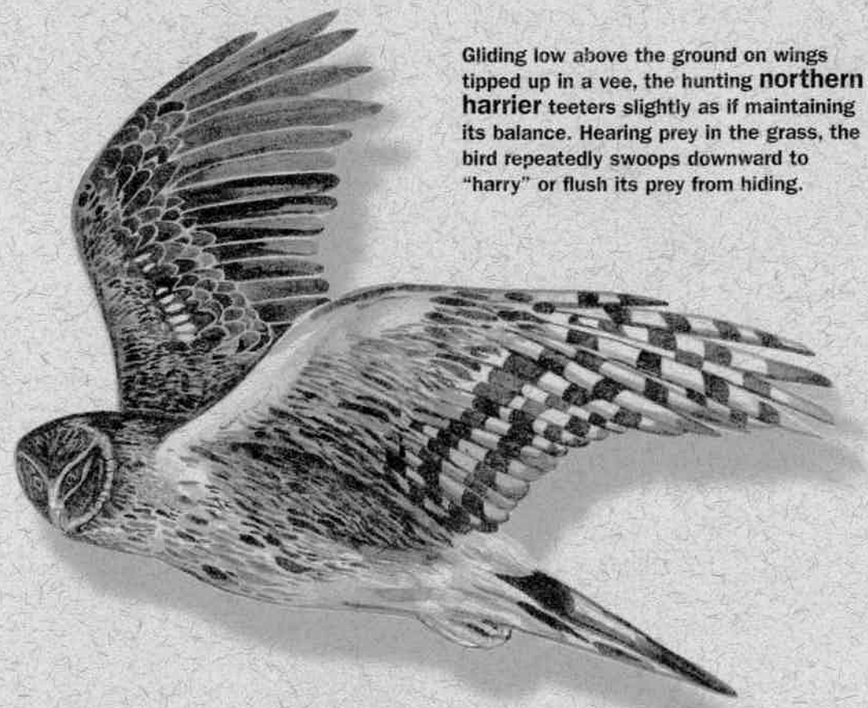


Lacking trees from which to sing during spring courtship, prairie birds like the **lark bunting** perform a song flight. The male shoots skyward, then drifts down to the ground on extended wings, teetering slightly like a gliding butterfly and singing loudly.



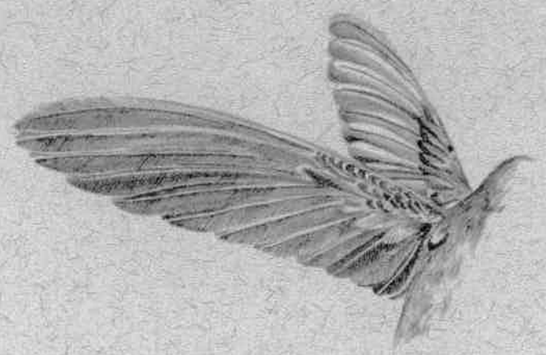


The high lift of the **osprey's** wings gives it great downward thrust as it struggles with powerful wingbeats to gain altitude from the water surface after capturing a fish.



Gliding low above the ground on wings tipped up in a vee, the hunting **northern harrier** teeters slightly as if maintaining its balance. Hearing prey in the grass, the bird repeatedly swoops downward to "harry" or flush its prey from hiding.

Winging it



Notice how the wings of the **broad-tailed hummingbird** lack the wrist joint visible as a bend in the wings of other birds? The hummingbird's stiff, knife-like wings are "all hand," allowing it to cut the air for high-speed flapping and complex aerobatics.

The wide, soft wings of the **barn owl** allow it to fly softly and silently, an important strategy for a night hunter. Owls lack speed and maneuverability, using instead stealth and surprise to descend on their prey.

More at home in the air than any other land bird, swifts, like this **white-throated swift**, have long, slender, stiff wings for rapid flight and pinpoint maneuverability, handy skills for pursuing flying insects.

Very large, broad wings, and a wingspan of nine feet, allow **American white pelicans** to soar high in the sky and travel long distances. They may fly as much as 50 miles one way in a day to find food.

California myotis

Like birds, bats can magically break the bonds of gravity to flutter in a three-dimensional world of air. They are the only mammals in the world capable of true flight. The physics of lift are the same for bats as birds, but the wing design and manner of bat flight are very different. The bat's entire body is a flying sail. Its leathery wings are formed of a membrane stretched across its outstretched fingers and arms, and fastened to its sides, heels and tail. Light and delicately built, the bat's arm and finger bones are impossibly long and slender, looking more like twigs than bones. The camber, or curve we see in cross-section, of a bird wing is fixed, but the bat wing is extremely flexible, like soft leather stretched across fingers. Bats can wiggle their fingers as easily as humans, allowing them incredible maneuverability as they adjust the trim of their wings in infinite variations. The flying bat manipulates the air with finely-tuned fingers like a harpist, its nimble flight an intricate song plucked by a master.

Here's how it works. Bat pursues Moth. Moth executes a series of rolls and evasions. By "wiggling" its fingers, Bat follows Moth's maneuvers, cutting, swerving, dipping in hot pursuit of its nimble prey. Bats turn much like a paddler maneuvers a canoe, by "rowing" or flapping one wing faster to turn in the opposite direction. They roll from side to side by changing the angle of their wings. The tail with its attached flight membrane acts as a stabilizer and as a rudder for sudden turns.

Dangling legs would be a hindrance to flight so the bat's hind legs are rotated at the pelvis so the knees aim out and back. Its body posture is naturally spread-eagled. Since bats are mammals, they are furry not feathered, but their wings are naked. As with birds, a keeled sternum offers a large surface for attachment of flight muscles. Unlike birds, both the downstroke and upstroke of the wings come into play in flying. The chest muscles power the downstroke that keeps the bat airborne. The back muscles pull the wings back up, propelling the bat forward.

This summer, watch at dusk for the fluttering shapes of hunting bats, mammals that are magically capable of flight.

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