CALIFORNIA NATURAL HISTORY GUIDES

RAPTORS OF CALIFORNIA

HANS PEETERS and PAM PEETERS

INTRODUCTION

RAPTORS ARE AN integral part of the California landscape. Not only do they play major roles in various ecosystems and act as indicators of the ecological health of the state, but they are also important aesthetic components of our land; it is very difficult to imagine a typical California savanna of stately oaks without a Red-tailed Hawk *(Buteo jamaicensis)* soaring above it in lazy circles, nor would the jagged cliffs of Big Sur have the same magic without the scream of the gulls or the arrow shape of a Peregrine Falcon *(Falco peregrinus)* flashing across the crags.

California surely is one of the finest hawk-viewing areas in the United States. Although Texas and Arizona boast more species because they attract a few more subtropical raptors, these are very local; you can drive vast distances and see nary a hawk. In California, you can count on catching glimpses of American Kestrels *(Falco sparverius)* and Red-tailed Hawks nearly everywhere, in part because our generally mild climate provides for a year-round abundance and diversity of food for both raptors and prey.

In addition, California has a greater variety of habitats and climatic zones than any other state, which invite both specialized raptors and generalists. Because of the close proximity of these varied regions to each other, many species can be found with rel-

Fig. 1. California savanna of chiefly nonnative grasses and valley oaks *(Quercus lobata).*

Fig. 2. Raptor food includes bobcats, crickets, lizards, other raptors, fish, dragonflies, centipedes, washed-up whales, worms, and maggots. A Turkey Vulture may eat pumpkins when better food is scarce.

atively little traveling. The high visibility of hawks in California also results from its position on the Pacific Flyway (and therefore from the influx and passage of winter migrants from the north), from its frequently open vistas, and from the presence of many hill ranges and mountains that encourage soaring.

The great Central Valley, with its wide-open expanses, is prime hawk-watching country; even on the densely forested heights of the Sierra one can locate raptors, although they are harder to find there. The coastal terraces, hills, and valleys in central and northern California, with their dense, low vegetation, harbor countless rodents, which make these areas magnets for wintering hawks; here, Rough-legged Hawks *(Buteo lagopus)* and Red-tailed Hawks of nearly all the color morphs join the resident Peregrine Falcons, hanging nearly motionless in the onshore wind. The white-water rivers of the north are fringed with conifers where the observer can easily spot the nest of an Osprey *(Pandion haliaeetus)* and, in some places, that of a Bald Eagle *(Haliaeetus leucocephalus)*. To the northeast and abutting against the eastern Sierra southward, the Great Basin spreads its sage plains into our state, along with isolated forest-covered ridges

Fig. 3. California habitats: northern coastal terraces are attractive to many raptors, especially in winter.

Fig. 4. California habitats: Great Basin and distant eastern Sierra Nevada.

and rolling hills, and here it is not difficult to watch Prairie Falcons *(Falco mexicanus)* and Golden Eagles *(Aquila chrysaetos)*. Even our cities have become virtual raptor sanctuaries, with for-

Fig. 5. California habitats: Mojave Desert, shown here with Joshua trees *(Yucca brevifolia),* which are among the few available nest sites for raptors.

merly rarely seen or shy species such as Peregrine Falcons and Cooper's Hawks *(Accipiter cooperii)* nesting on high-rises and above residential streets. A few hardy raptor species actually thrive in the driest land in California, the deserts.

What Is a Raptor?

In common usage, the word "hawk" is an imprecise term that has been used interchangeably with "raptor" or "bird of prey" for centuries. The term "raptor" conjures up an image of a bird that is powerful and swift, qualities much admired by humans. At rest, a raptor sits very upright and gazes about calmly, exuding an air of what we see as self-confidence and nobility. However, the term itself is nonspecific and applies to very small and delicate hawks as well.

Technically, most of California's diurnal (day-active) raptors are called "true" hawks, with the eagles being the largest species; falcons, however, are placed in a separate family, as are American vultures. They all, nevertheless, feed chiefly on meat and have a beak that is hooked to facilitate tearing apart this food. In most, the feet bear sharp, strongly curved claws for seizing prey. Most

are raptors, that is, they capture their own prey; but so are owls, which are not included in this book. Owls are considered nocturnal raptors, although some are active during the day.

The terms "hawk" and "raptor" have been used freely and interchangeably in this book to include all diurnal birds of prey, and although purists may object to such generalized usage, the alternatives are pointlessly cumbersome. Vultures, which are often lumped with the diurnal raptors, are included because they have many superficial characteristics similar to those of more typical raptors and, at a distance, often are difficult to tell apart from them.

The evolution of hawks is roughly comparable to that of motor vehicles. From a generalized ancestor, the motorized horse buggy, specialized vehicles of different shapes and sizes were developed for a variety of purposes. Although not all raptors may be derived from the same ancestor, most appear to be, and their diversification is similar. The Sharp-shinned Hawk *(Accipiter striatus)* is like a sports car: it is tiny and agile but has terrible fuel economy. The high metabolic rate demanded by its small size requires the intake of lots of food frequently, and a few days' bad luck in hunting can quickly lead to death. Its distant cousin, the Golden Eagle, is the 18-wheeler, ponderous and huge but very fuel efficient. In between these extremes lie the various hawks and falcons—the pickups, vans, sedans, and race cars of the auto world—which show variations in shape and size that adapt them to available habitats and prey.

All California vultures are members of the Cathartidae, the family of New World vultures. As raptors go, our vultures barely fall under the definition; they do so chiefly on the basis of their eaglelike appearance in flight, their hooked beaks, and to some extent their food.

Kites, hawks, harriers, ospreys, and eagles are raptors that have much in common, and although they may vary dramatically in size and shape, relating to their manner of foraging and the size and kind of their prey, all are usually pursuers of live quarry and are equipped with strong, grasping feet. All are in the family Accipitridae.

Falcons are the most streamlined birds of prey, with long, pointed wings and compact bodies; some are capable of attaining astonishing speeds. Falcons are members of the family Falconidae.

Raptor Names

The first English settlers on this continent were not well versed in natural history, which was not much in vogue then; they therefore tended to label organisms with the names of animals familiar to them from the old country, notwithstanding that the new birds and mammals they were seeing were in fact often not very similar to those of Merrie Olde England. To this day, Turkey Vultures *(Cathartes aura)* often are called "buzzards," wrongly, because to unobservant early settlers, they appeared similar to a true hawk, the Common Buzzard *(Buteo buteo),* of Europe and the British Isles.

In California, the first Europeans to see and write about the California Condor *(Gymnogyps californianus)* were Spanish missionaries, who called it variously the Royal Eagle or the Royal Vulture. It later became known as the California Vulture, a name that persisted into the twentieth century before being replaced by its present one.

Some of the more widespread raptors formerly were known by a variety of common names concurrently (at times depending on regional preferences), and sometimes the same common name was used for more than one species. Pigeon Hawk, for example, could refer to either the Sharp-shinned Hawk or the Merlin *(Falco columbarius),* both of which only rarely catch pigeons—unless they were named so because it was believed they looked like pigeons, which they do not. As recently as 1951 the Peregrine Falcon in North America was most often called the Duck Hawk because of its purported dietary preference (although many actually prefer rather smaller birds). All along, it was of course known to people taking more than a passing interest in birds that this species was actually the same as is found in Great Britain and elsewhere, where it has always been known as the Peregrine Falcon.

In order to make nomenclature more universally comprehensible and uniform, American ornithologists have in recent decades endeavored to bring North American common bird names in line with those used by the rest of the world. Thus, what formerly was called the Marsh Hawk here has now become the Northern Harrier *(Circus cyaneus),* another species represented both here and in the Old World. The American Kestrel, formerly known as Sparrowhawk (another case of mistaken identity be-

cause it preys mainly on insects and mice and only sometimes on sparrows) is very obviously a kind of kestrel, a falcon that is represented by a large number of similar species in the Old World. Conforming to general usage in ornithological books, the common names of the raptors in this volume are capitalized.

For greatest clarity in bird names, we have to turn to the scientific names used by the professional ornithological community. Ideally, the scientific name, or binomial (usually derived from Latin or Old Greek), should tell something about the animal—minimally, its affinities to other similar birds, or its color, or length of beak, and so forth. A binomial comprises two parts, the genus and the species. The Swainson's Hawk *(Buteo swainsoni)* and Red-tailed Hawk share the same genus name, indicating that they are close relatives, their differences being indicated by their species names. At their best, binomials describe the bird at hand: *Buteogallus anthracinus* literally means the coal black hawk-chicken, a quite descriptive name for the Common Black Hawk. But they can be exceedingly prosaic: the Golden Eagle is *Aquila chrysaetos,* which means "eagle golden-eagle."

Sometimes local varieties of a species are sufficiently distinct that they are given subspecific status, and a third scientific name is added, making it a trinomial—genus, species, and subspecies. The Peregrine Falcon has a distinctive Arctic race (subspecies) known as *Falco peregrinus tundrius,* and other Peregrine Falcons belong to one subspecies or another, although the population east of the Great Plains, once extinct, today consists of reintroduced captive-bred birds of mixed races and their offspring. A variety of races can be expected in any species that is very widely distributed.

Higher classification categories are more inclusive and indicate wider familial relationships. Caracaras are placed with the falcons in the family Falconidae because of their anatomical and genetic similarities. All diurnal raptor families, with the exception of New World vultures, are assigned to the order Falconiformes, the "falcon-shaped" birds. Officially, the New World vultures have been included with the Ciconiiformes, the "stork-shaped" birds, a placement based on anatomical and behavioral similarities and the results of DNA hybridization. However, more recent work indicates that these vultures are no closer to storks than to some other groups (J. Cracraft, pers. comm. 2002), and additional anatomical studies, supported by a reanalysis of the DNA data,

seem to place the New World vultures as a sister group to those of the hawks and falcons (Griffiths 1994). This problem of evolutionary affinity remains unresolved.

Ultimately, what matters most to the hawk-watcher is the species, and unfortunately this concept sometimes can be problematic. For example, the Harlan's Hawk was at one time considered a separate species. Today, it is considered one of several races of the Red-tailed Hawk *(Buteo jamaicencis harlani),* because it fits within the parameters of what constitutes a species: a group of organisms that share a common gene pool and that freely interbreed under natural conditions and produce fertile offspring. So, although Harlan's Hawks are exceptionally dark and lack a red tail, they nevertheless interbreed freely with "more typical" Red-tailed Hawks and produce all sorts of perfectly fertile intermediates. The White-tailed Kite *(Elanus leucurus),* on the other hand, was "lumped" with the very similar Black-shouldered Kite *(E. caeruleus)* of Eurasia and elsewhere some time ago; curiously, a moderately astute observer, watching both species in the wild, could readily pick out differences between the two (such as tail length and flight style), and more recent studies indicate that they are in fact different species, thereby restoring the original common and scientific names to our kite. The American Ornithologists' Union is the ultimate arbiter in assigning names for North American birds.

A Hawk s Body

Weight reduction and streamlining are the leading themes in the construction of a bird's body. The entire skeleton is extremely lightweight, with the long bones being hollow and strengthened with fine internal struts; and, as any eater of chickens knows, the biggest muscles are packed around the large and deeply keeled breastbone, the center of gravity in flight. These are the muscles that in birds power the wings and make up about 12 to 18 percent of the bird's weight. For aerodynamic reasons, the wings themselves contain only very small muscles that are used for altering the shape of the wing, for aid in keeping it folded, and for changing the position of the wing feathers.

A bird's neck and legs can be neatly tucked into and folded

against the body to retain the body's teardrop shape in flight. This shape is further enhanced by internal air sacs, numbering eight in most birds. These membranous bags smooth out the contour of the body beneath the skin and feathers, and some actually reach into the wing bones and the skull sinuses. They also act as reservoirs and bellows that feed air to the lungs during flight at a tidal volume four times greater than in mammals (which have no such sacs), over a one-way path that permits continuous gas exchange during both inhalation and exhalation, thereby supplying large amounts of oxygen for the bird's metabolic needs. In addition, air sacs provide a means for the elimination of the substantial heat generated by the friction of the muscles during flight. In some hawks, the sacs may house great numbers of roundworms, acquired from their food, which usually do not visibly affect the bird, although they may sometimes kill it.

A bird's rather small lungs are at least 10 times more efficient than those of mammals. Fixed in size, they lack the inflatable balloonlike alveoli of the lungs of a mammal; instead, fine tubes (air capillaries) lie parallel to the capillaries of the circulatory system, and air passes through them in the opposite direction from the blood flow (a countercurrent arrangement), thereby permitting much greater gas exchange while taking up much less space.

As with other birds, a hawk's internal organs are crammed into a compact, rigid airframe. Although the relatively long neck is highly flexible (raptors have 14 or more neck vertebrae; we have seven), the rest of the vertebral column is not, in contrast to that of other vertebrates; obviously, a body in which the posterior half can flop from side to side or up and down would not be very stable in midair. And so the vertebral bones of the back and of the pelvis are fused, except for a single one that connects these two regions. In falcons, extra bones accessory to the tailbone allow for the attachment of powerful muscles that manipulate the tail during braking and other maneuvers at very high speeds.

A diet of meat places no great demands on a digestive system, and that of raptors is generally simple and short. Because proteins are so easily digested, even in large chunks, there is no need to grind the food, and hence the gizzard does not have a thick muscular wall, as does that of a chicken, but is instead a simple sac. There is a crop, a second sac at the base of the neck where sub-

Fig. 6. Sharp-shinned Hawk with full crop.

stantial amounts of food can be stored and carried about, a sort of built-in lunch bag; as the stomach empties, the hawk moves more food down with jerky lateral contortions of the neck and by pushing down. Hawks drink only occasionally, most commonly in hot weather and just prior to bathing; their water needs are largely satisfied by their water-rich diet.

Like all birds and many other vertebrates, hawks have a single outlet for all systems whose products must leave the body—the digestive, urinary, and reproductive systems. They all terminate in the cloaca (Latin for sewer), a chamber that opens to the outside world by way of the vent. The ovaries (of which only one is active) and the internal testes shrink when not in use, thereby reducing body weight in flight, and eggs are laid one at a time at intervals.

Beak

Raptor beaks come in a variety of shapes and sizes. An eagle's beak is massive and powerful; a Golden Eagle easily takes apart a Beechey Ground Squirrel *(Spermophilus beecheyi)*, an animal that has an unbelievably tough hide. By contrast, the beaks of the majority of New World vultures appear weak and are relatively slender, hooked probes that can be inserted into small spaces of large carcasses. Oddly, the largely carrion-eating Crested Caracara *(Caracara cheriway)* has a heavy beak, rather like that of an eagle.

All falcons have a short but thick beak capable of delivering a powerful bite. Falcons have a special projection on the upper mandible just back of the tip, the tomial tooth, which can be slipped between the neck vertebrae of the prey to snip the spinal cord, bringing instant death; these birds have much smaller rear and inner talons than other raptors of comparable size.

The White-tailed Kite has a small beak but an enormous mouth. The gape is so large that the hawk can swallow an entire vole or large mouse with ease, perhaps an adaptation for bolting down prey as quickly as possible; this slow-flying species is frequently robbed of food by Prairie Falcons (which may actually, on occasion, eat the kite itself). Another hawk with a great gape is

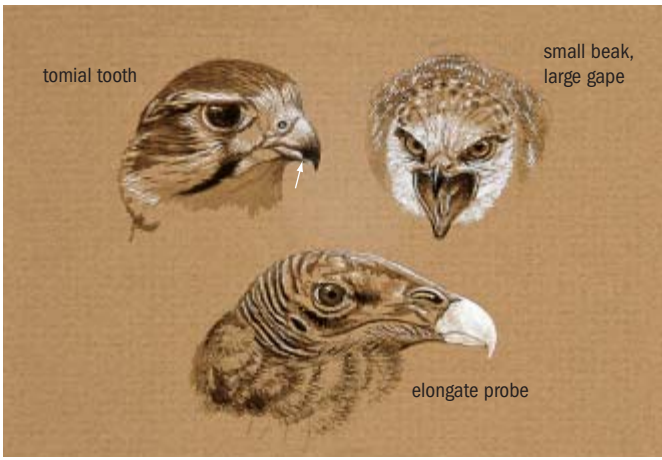

Fig. 7. Beak types: tomial tooth of a Prairie Falcon; small beak, large gape of a White-tailed Kite; elongate probe of a Turkey Vulture.

the Ferruginous Hawk *(Buteo regalis),* a large, open-country buteo, in which this feature is thought to facilitate cooling off by panting, particularly as a young bird in the nest, which is typically exposed to direct sun. The large gape of this species is bordered by highly visible yellow lips, which serve as a readily seen field mark.

The beak of a raptor grows continually and must be worn down by bones, dirt, and other abrasive materials to keep it from overgrowing, which could ultimately lead to starvation. Captive hawks have been observed to bite into sand. A bare, easily cleaned patch of skin at the base of the bill, called the cere, surrounds the nostrils and is continuous with the lips; it is frequently bright yellow in adults and pale or even bluish gray in juveniles, which is also true for the skin of the legs and feet.

Most hawks have an oval nostril (external naris), but in the majority of falcons, it is roughly circular and has a central tubercle that makes the structure distinctive. There has been much debate about the function of this tubercle; for example, it has been thought that it serves as a baffle during high-speed dives, but some decidedly low-speed relatives of falcons also have this feature. In Ospreys, which dive into the water to catch fish, the slitlike nostrils can be closed. In Turkey Vultures, the nostrils are perforate; there is no septum, and you can see in one nostril and out the other.

Legs and Feet

The flexor tendons that clench a bird's foot run from under the toes up the backs of the leg bones, so that when a bird squats, the tendons must travel a longer distance, thereby automatically pulling the toes inward. At the upper end, these tendons originate from thigh muscles, which, when contracted, also pull the toes inward. In addition, the ends of the tendons under the toes have grooves that can interlock, ratchet fashion, with grooves in the sheaths that envelop them; a raptor's foot can thereby remain locked in a clenched position without outlay of energy. The downside of all this grabbing versatility is that a raptor may be unable to disengage its feet from oversized aquatic prey and consequently drown, a not uncommon fate of Ospreys.

The legs and feet of raptors provide an excellent clue to their diet, and they come in a variety of models tailored to their use.

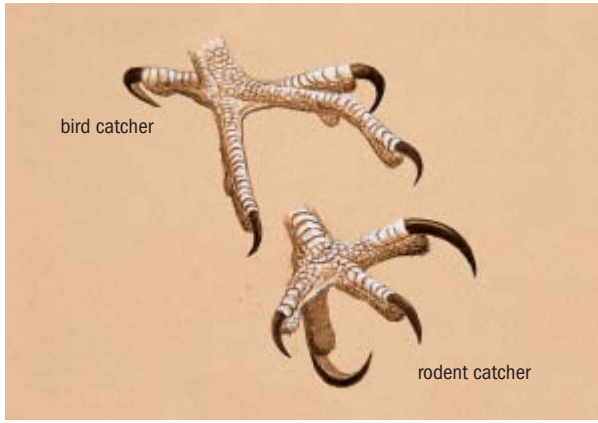

Fig. 8. Foot types of raptors.

Hawks that predominantly feed on rodents or insects usually have short, strong legs and short, stout toes. They have a powerful grip, and as in most raptors, the talons of the rear and inner toes are conspicuously larger (enormous in eagles) and are used as daggers in dispatching prey. The other talons of the foot are smaller and serve to hold the quarry. Most raptors' talons are needle sharp. In Peregrine Falcons and perhaps also in some other raptors, the talons inflict not merely puncture wounds but small cuts as well, useful in expediting the victim's demise. Like the beak, the talons grow continually.

Bird-catching hawks have two kinds of legs but very similar feet. Aerial hunters' legs are short, whereas the legs of hawks that snag birds in bushes are slender and long. In both, the toes are long and thin, and some of the toes have soft, nipplelike pads on their undersides that evidently help to anchor the foot in feathers. The pads of a rodent catcher are flatter and hemispherical.

Vultures have fairly long legs and long front toes, but because the hind toe (hallux) is extremely short, vulture feet, while suitable for walking and scratching, are useless for grasping; a vulture cannot use its foot to catch or carry something. In addition, its talons, though sharp, are unspecialized and not very long.

Ospreys have long and strongly curved sharp talons of equal length, and the outer toe is reversible so that the whole foot can

literally be wrapped around a fish; they have powerful legs for carrying sizable prey, and their toes bear tiny spikes to secure their slippery quarry.

Feathers

Feathers were long thought to be derived from the scales of the reptilian ancestors of birds. Recent work, however, convincingly demonstrates that feathers arose independently from tubelike skin outgrowths (Prum and Brush 2003). Numerous fossils of dinosaurs with feathers in various stages of evolution have been found, and the gradual elaborations of these structures are precisely echoed by the embryonic feather growth of modern birds. Feathered dinosaurs existed long before there were birds, and today's birds are now generally (though not universally) considered a group of theropod dinosaurs that developed powered flight.

Feathers are divided into distinct categories depending on their form and function. Like hair, they emerge from follicles and most, if not all, have small muscles attached to them and can be moved.

The overlapping contour feathers shape, protect, and insulate the body, and some (the long wing and tail feathers) also serve for flight; most can be raised and lowered, thereby varying the thickness of the heated air layer between the skin and the feathers. Specialized contour feathers known as coverts shape the airfoil of the wing; an upperwing covert arches up, whereas an underwing covert is flat. Whiplike filoplumes arise from follicles dense with tactile nerve endings and, being associated with flight feathers, may influence the movements of these. Fluffy down feathers provide added insulation. Semiplumes resemble both down and contour feathers: they have a long rachis, but their long barbs do not "zipper" together (see fig. 47, parts of a feather). Often found associated with the undertail coverts, they are sometimes used for display. Powderdown feathers crumble at their tips; they grow continually and are never shed. The powder they produce appears to aid in waterproofing feathers and causes the grayish bloom on some raptors' backs; a black velvet cloth wiped over the back of an adult Peregrine Falcon comes away gray. In some species, rictal bristles cover the nostrils and parts of the cere; these readily shed flakes of dried blood after feeding and keep dirt

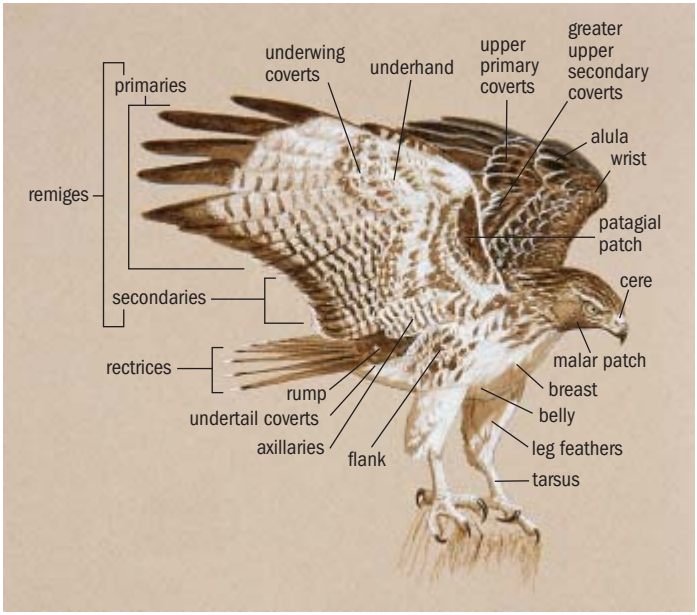

Fig. 9. Raptor topography (Red-tailed Hawk shown).

out of the nostrils, eyes, and so on. Gyrfalcons *(Falco rusticolus)* and Rough-legged Hawks, both Arctic raptors, have more feathers than hawks of comparable size from temperate zones. Ospreys have water repellent plumage and harder feathers on their breasts and legs, body areas that are first to strike the water in a dive, along with the beak and head.

As in other birds, the chief flight feathers of the wing (remiges) are divided into two groups, the primaries, which collectively arise from the outer, "hand" portion of the wing, and the secondaries, which are attached to the "arm." The secondaries are used chiefly to keep the bird airborne; the primaries are used for forward propulsion as well as for lift.

Whereas all birds' wings are modified to some degree, those of raptors are exceptionally finely tuned to serve special foraging methods. Raptors that frequently soar have outer primaries that

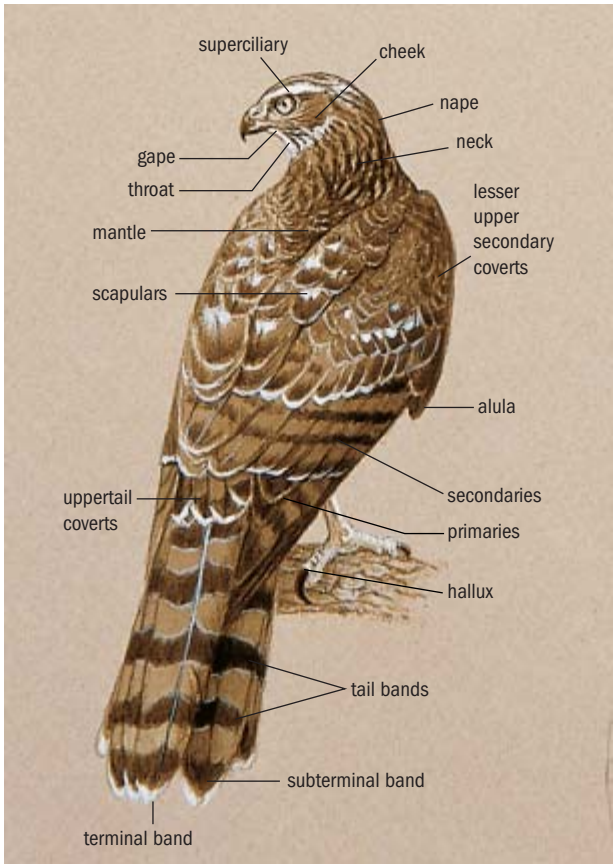

Fig. 10. Raptor topography (Northern Goshawk shown).

are deeply emarginated; that is, half or more of each primary is dramatically narrowed toward the tip (see fig. 46) so that when in flight overhead, the raptor appears to have widely spread "fingers" at the ends of its wings. These slotted remiges provide additional lift and are, in a sense, accessory "miniwings," or winglets, which, in effect, lengthen the wing. The added lift is derived from these

Fig. 11. Raptor topography (Peregrine Falcon shown).

winglets, reducing the drag caused by airflow toward the tips of the wings (Tucker 1993). Conversely, molting of some of the slotted primaries increases drag more than expected because of the resulting change of shape in the remaining slots (Tucker 1991). In raptors that pursue their prey by sprinting through dense vegetation, such as the Northern Goshawk *(Accipiter gentilis)*, the slotted outer primaries are extremely flexible and allow a deep and rapid wingbeat while providing powerful propulsion. Falcons, by contrast, which are less given to soaring, have long, narrow wings and minimal slotting mainly restricted to the outermost primaries.

A third group of somewhat less obvious flight feathers form the alula, attached to the "thumb" on the wing's leading edge. Alulae, when spread, furnish added lift during landing, and they can be extended during dives as stabilizers, like the fins of a rocket.

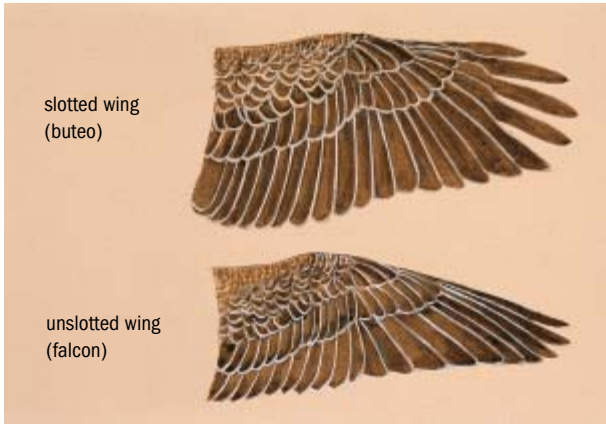

Fig. 12. Wing types of raptors.

Raptors normally have 12 tail feathers (rectrices) that can be spread widely or folded tightly. The extent to which a bird spreads its tail in flight is often correlated with the wingspread; in general, the more open the wings, the greater the tailspread, and with wings fully spread, the tail provides an estimated 10 percent of lift (Tucker 1992). The tail is also used for braking and for steering; a Golden Eagle, soaring in a wind, endlessly adjusts its tail's width and tilt. Various woodland hawks, not all closely related, have long tails to facilitate rapid changes in direction in tight quarters; highly aerial and soaring raptors' tails are often short because not much maneuverability is called for, and a long tail adds to drag.

Usually but not always, wing and tail feathers are longer in juvenile raptors than in adults; the reason for this difference is open to speculation. In very large raptors that do not molt all their remiges in one year, remaining first-year wing feathers can often be seen projecting beyond the newer, shorter ones in a second-year bird when the wings are spread. The central tail feathers of a captive juvenile male Peregrine Falcon, having been pulled out by a sibling, grew back with adult coloring and length, being nearly 3 cm (1.1 in.) shorter than the remaining rectrices.

The feathers of most raptors are pigmented, typically with shades of brown and black brown (melanins), and very often,

Fig. 13. Red-tailed Hawk attacking ground squirrels: the alulae are often deployed in fast glides, during stoops, and always during landing.

Fig. 14. Merlin with fully fanned tail to execute a tight turn as it mobs a Golden Eagle, whose tail is sharply angled as it maneuvers in a high wind.

Fig. 15. Differential damage to unpigmented parts of feathers. White bars damaged in secondary of Red-shouldered Hawk and rectrix of Prairie Falcon; white tip eroded from rectrix of male American Kestrel.

conspicuous bars adorn the flight feathers of the wings and the tail. The function of this barring is poorly understood, although dark pigment makes a feather stronger and more resistant to wear and, perhaps, to consumption by feather parasites. Thus, flight feathers are often tipped with black or dark brown.

Raptors that principally pursue birds in the air have fairly stiff flight feathers, whereas those of ground-game hunters are soft and pliable. This difference can be observed even in closely related species with quite similar foraging methods, such as Peregrine Falcons and Prairie Falcons, with the latter, as a partial ground hunter, having softer flight feathers. Likewise, the body plumage of aerial hunters is tighter and more compact compared to the fluffier covering of the ground hunters.

The plumages of juvenile (first-year) and adult birds are, with some exceptions, quite different, and some species also have subadult patterns (appearing after the first molt but before the full adult feathering is acquired, which in our eagles and condor takes several years). With Bald Eagles, second- and third-year

birds look strikingly different from juveniles and adults. It has been suggested that juvenal and subadult plumages suppress aggression by older subadults and adult birds, while at the same time earn an older subadult more respect from younger birds.

Hygiene

After feeding, raptors clean their beaks by vigorously rubbing them, first one side and then the other, on the ground or on their perch, and vultures may similarly wipe their heads after reaching deep into rotting bodies. Some also clean their feet by wiping them against the substrate, at times crossing their extended toes while doing so; a female Golden Eagle was observed to pull her talons through her beak, then inspect the results of her efforts much like a woman would after filing her nails.

Bathing is good for feather maintenance and is especially important in birds that make their living by the chase; most raptors bathe regularly, some doing so daily, given the opportunity. Captive raptors may even bathe at night, with only starlight for illumination. Ambient temperature appears to be of no concern even though wet feathers that subsequently freeze can be fatal. Hawks can be extremely vulnerable to attack by bigger raptors while bathing, and some bathe only very briefly and furtively; soaked wings can render them flightless, especially the larger species.

Water softens feathers and restores their shape, and as the hawk dries after a bath, it preens: it runs the long flight feathers through its beak to help straighten them and adjust their webs; loose down is removed; and oil from the uropygial gland just above the tail is transferred with the beak to the various feather tracts and rubbed on. Hawks preen daily, not only after a bath, and often interrupt a preening session by "rousing," the raising and vigorous shaking of the entire plumage, or by stretching legs and wings, usually one side and then the other.

Some raptors, such as Prairie Falcons, also dust bathe, which may clean feathers as well as kill ectoparasites, the dust particles acting as abrasives between the plates of the arthropods' exoskeletons. All raptors appear to enjoy sunning themselves, not only for warmth but also probably for additional therapeutic effects; they usually turn their backs to the sun, fan their tails, and partially or completely spread their wings.

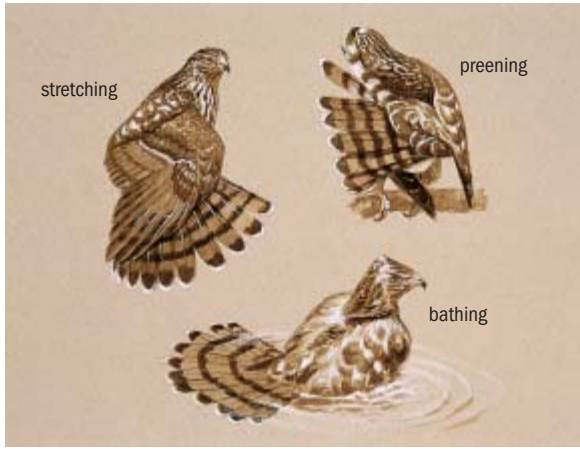

Fig. 16. Cooper's Hawk engaging in maintenance behavior.

Molt

Feathers become damaged and worn, and therefore all feathers must be replaced periodically, with the new ones pushing out the old. Molting is generally timed so that the absence of flight feathers does not interfere with migration or with the intensive hunting needed to raise young; however, built-in redundancy and various abilities compensate for such loss. Hawks can fly surprisingly well with damaged or even mostly missing tails. Broken and missing remiges, too, are usually not much of a handicap, although extensive damage here is more serious, particularly in the largest raptors.

New body feathers are usually in place by the time cold weather arrives. The Tundra form of the Peregrine Falcon begins to molt in summer in Alaska and northern Canada, interrupts the process during fall migration, and then resumes it on its Central and South American wintering grounds. Although both male and female raptors begin to molt their flight feathers during their breeding season at about the same time (at the onset of incubation), the female drops her flight feathers at much shorter intervals than the male, whose task it is to supply the female with food during much or all of the incubation period.

Fig. 17. Gaps in flight feathers caused by molting are often symmetrical, as in this Red-tailed Hawk.

In late spring and summer and into fall, it is very easy to spot molting activity—soaring raptors show conspicuous gaps in the flight feathers of both wings and tail. To grow a new flight feather takes about a month for a Redtail-sized raptor, less for a smaller hawk. In most birds, all feathers are replaced within a year, mostly during the summer, but in the largest raptors, the integrity of the wing is so critical that the wing molt is very slow and protracted and may last at least two years. In Golden Eagles, even some wing coverts may persist for three years before all are renewed, and the faded old feathers are easy to spot and facilitate the recognition of individuals. Raptors also molt the scales of their feet, much as they do their feathers.

Wings

The basic structure of a raptor's wing is the same as that of any other flying bird, that is, in cross section, the wing seen end-on forms an airfoil: the upper surface bulges near the leading edge of the wing and curves down toward the trailing edge, whereas the lower surface is flatter. As the bird moves forward through the air,

air molecules must pass over a longer distance crossing the upper surface than they must over the underside before reaching the wing's trailing edge simultaneously; the resulting pressure differential produces lift. Flapping increases this differential and, therefore, lift. Various other factors participate in the process that makes flight possible.

Three properties of the wing (camber, aspect ratio, and wing-loading) profoundly affect its function. The camber of the wing is the degree of the front-aft curvature; high-camber wings, with a conspicuous cross-sectional curvature, are very broad and suitable for prolonged, slow-speed soaring and provide much lift. Such wings are typical of vultures, eagles, and the various buteos (the latter are in fact commonly called broad-winged hawks). Low-camber wings, by contrast, are narrow and flat bottomed and enable the owner to travel at high speed while providing little lift at slow speeds. These wings are seen in falcons—and in jets. The shape of the airfoil creates drag at the wing's trailing edge, and birds can adjust the camber for various speeds to modify that drag; while landing, for example, large birds lift their upperwing coverts using small muscles, thus increasing the camber substantially to provide more lift and increased drag to slow down. Observant travelers can watch such changes in the camber of an airplane's wings during takeoff and landing.

The aspect ratio is the ratio of wing length (or wingspan) to wing width (the square of the wingspan divided by wing width). Wide wings, having a lower aspect ratio, provide much lift but also generate considerable drag; the long, narrow wings of falcons with their higher ratio cause less drag at the expense of reduced maneuverability.

The amount of weight that a unit area of wing must support (weight divided by wing area) determines what is called wing-loading. Raptors with a relatively low body weight and large, broad wings, such as Turkey Vultures, have low wing-loading. This is useful for prolonged, slow-speed soaring and is of course favorable to the conservation of energy. Heavy bodies supported by high-aspect-ratio wings (that is, a small surface area relative to the body weight they must keep aloft) indicate heavy wing-loading, suitable for high-speed pursuit in open spaces, as seen in many falcons; but these birds have to work harder at staying in the air. The forward thrust produced by flapping compensates for the additional drag.

Fig. 18. Cooper's Hawk flying upside down, with head right side up.

Fig. 19. Golden Eagle adult, about to land.

In active flight, the wingbeat of falcons is fast and snappy and often continuous, although these hawks also glide and soar. In a soar, a Peregrine Falcon looks like a toy bird kite; in a glide, its shape brings to mind a drawn bow. In a stoop, the wings are very nearly or completely folded so that the hawk looks like a missile. Thus, camber, aspect ratio, and wing-loading all can be changed to suit varying needs. Raptors can also fly at extremely slow speeds, pull in one wing at a time to pass between close trees, fly on their sides or upside-down, and rotate their wings into a vertical position as they " backpedal" to a soft landing on a branch.

Closely related raptors do not necessarily share all wing characteristics. The American Kestrel, a rather wimpy relative of the Peregrine Falcon, has much lower wing-loading; its less demanding prey does not require the large, powerful chest muscles needed for long-distance aerial chases. In the largest raptors, even extremely large wings do not always suffice: on windless days, California Condors, which are heavy bodied, have been seen to repeatedly hike up hills and launch themselves from the top in order to get enough air under their wings to stay airborne.

Flight

At takeoff, raptors jump into the air, run until airborne, or drop like a stone from their perch to gain speed. Humans have been thrilled since biblical times, and surely longer, by "the way of an eagle in the air."

Raptors in general are strong fliers; pragmatically, however, flight is mainly a matter of spending energy wisely. Gliding (point-to-point flight on set wings), the flight method most preferred by eagles and other raptors, is the most inexpensive, although no flight style is entirely free of energy costs.

A gliding hawk holds its wings out to the sides without flapping; the wings' surface area (and therefore lift) can be adjusted by partial folding. Because gliding usually results in a loss of altitude, a raptor wishing to stay aloft must find rising air that supplies sufficient lift to exceed the rate of drop. Updrafts along hill ranges and shorelines commonly support gliding without loss of altitude or provide a gain. The advantage of climbing in the air without a great outlay of energy also encourages raptors to make use of thermals, domed columns of warm air rising from heated

ground, including parking lots or even steam-heated air over nuclear reactors; they may rise a mile high.

A thermal can lift a hawk, soaring (gliding in circles or ellipses), with truly amazing speed. Movements of the tail and primaries direct its course. The air in the center (or core) of a thermal rises much faster than along its edges, a phenomenon exploited by Sharp-shinned Hawks, which have a much smaller turning radius than large raptors. The biggest are restricted to areas where the air rises less rapidly, away from the core. The use of thermals allows a long, usually descending glide from the top while the hawk scans the land below for prey, winding up perhaps in another thermal. Great distances can be traveled in this fashion with a minimal expenditure of energy. There is some evidence that at least some soaring birds can "lock" their wings into place to further reduce energy demands. Thermals facilitate migration and also courtship flights in some hawks.

Powered flight, by contrast, is very expensive; in the American Kestrel, it requires about four times as much energy as does gliding (Gessaman 1980). Few raptors fly very far with constantly beating wings; buteos and eagles frequently do so when driving off territorial intruders, and falcons and accipiters do so in pursuit of prey, but even then they may interject some gliding. Most commonly, hawks alternately flap and glide in point-to-point flight.

In a vertical stoop (a headlong dive), the falcon may pump its wings to accelerate, or the wings may be completely folded against the body so that the bird is shaped like a teardrop; in Peregrine Falcons the body becomes extremely elongated, and sometimes the wrist of one wing projects further forward than the other, presumably to optimize the aerodynamic configuration. The air stream ripples the body feathers, the tips of wings and tail vibrating. Although eagles and some other raptors also perform these dives, the trim shape of falcons suggests speed, and indeed, it has recently been established that Peregrine Falcons, which are the most aerial hunters, can exceed 240 miles per hour in a stoop. This velocity was determined by releasing trained falcons equipped with speed-recording devices from airplanes at 12,000 ft and having them follow skydivers who then recorded their dives with high-speed cameras and camcorders. The falcons, thrown from the plane, would catch up with the latter and land on its struts, waiting for the trainer to jump. They would then pass their plunging trainer or trail behind to adjust their speeds to draw level with him. Peregrines clearly do as they please in the air.

Senses

The quality of a raptor's senses is also a reflection of its lifestyle. Hawks that forage in or over dense cover have excellent hearing, finely attuned to sounds indicating the presence of prey. The sense of smell is poorly developed except in the Turkey Vulture and some Neotropical raptors. The Collared Forest Falcon *(Micrastur semitorquatus)* of Central and South America, a bird of very dense vegetation, has been known to enter mammal traps baited with sardines, indicating that it uses olfaction while foraging (A. Reuter, pers. comm. 1998). Captive hawks demonstrate a sense of taste, sometimes turning down food that appears perfectly suitable, and they are often very quick to reject a piece of meat in which medication is hidden.

All raptors have excellent eyesight, and their visual acuity is legendary. Whereas humans have only a small central area on their retina for high-definition color vision, the cones (color receptors) of nearly all diurnal birds are spread all over the retina. For good measure, they have four types of cones where we have only three kinds. Many raptors, and perhaps all birds, can perceive ultraviolet. For example, the Common Kestrel *(Falco tinnunculus)* of Eurasia and the holarctic Rough-legged Hawk detect the ultraviolet reflections of rodent urine and feces and thereby locate vole-rich meadows (Koivula and Viitala 1999). The American Kestrel and the White-tailed Kite likely do so as well.

Contrary to popular belief, a hawk does not see as if looking through binoculars, but rather, owing to far more receptors, it sees objects in much greater detail than does the human. A mouse at 50 yards appears to a person as an indistinct, brown, oblong object; the hawk, from the same distance, sees the mouse as the same size but also readily distinguishes its eyes, ears, other details, and most important, movement. Each eye of the hawk has two foveas, especially acute focal spots where receptors are very numerous: the central fovea detects movement, while the temporal (side) fovea makes out detail. Captive raptors tethered outdoors can often be seen cocking their heads as they use one of their central foveas, tracking something (likely another raptor) across the sky, far beyond human visual range. Raptors are especially keen at picking out defects in potential prey, at times from a great distance—defects that make capture easier. This is done with the temporal foveas of both eyes, because hawks have binocular vision.

Fig. 20. Many a fine hawk photo has been marred by the nictitating membrane sweeping across the hawk's eye just at the moment of exposure. Juvenile Red-tailed Hawk shown here.

Like other birds, they also see faster than we do, that is, they can separate two visual images in about half the time that it takes a human eye to do so. Such "speed-seeing" enables some hawks to pursue birds in twisting flight through dense twiggery at an

amazing pace. Many species bob their heads up and down or move them from side to side while looking at prey or potential enemies, presumably to gauge distance by triangulation.

Most diurnal birds of prey have a conspicuous brow ridge that gives them a fierce appearance; it may shade the eye from glare or protect it while diving into cover. As other birds, they have a nictitating membrane, a sort of semitransparent third eyelid that sweeps diagonally across the eye from the front and under the other two lids. It wipes the eye's surface and is probably also used in flight during rain and snow and perhaps in stoops.

Intelligence and Personality

A bird's brain lacks the mammalian brain's folds and wrinkles of the outer layer, the cortex, which we associate with intelligence; instead the brain's core, an area associated in birds with sensory perception and instinctive behavior, is highly developed and dominant. A falcon without cerebral hemispheres can grab a mouse but then is at a loss what to do with it (Welty 1975).

While much raptor behavior is stereotyped and instinctive, hawks are nevertheless clearly capable of rapid learning; they certainly learn very quickly when that process leads to a meal, which for a predator is nearly always an undertaking fraught with difficulties and sometimes danger unless the prey is grasshoppers or earthworms. The sport of falconry is based on this rapid learning ability. Raptors are always alert for clues that promise an easier meal—the limp of an injured rabbit, the distress call of a bird, or any physical irregularity in a potential prey bird, such as missing feathers. Oddly, the scream of a starling in the clutches of a Cooper's Hawk probably evolved not to put off the predator but rather to attract a second hawk that, while attempting to rob the first one, might permit the victim to escape. At many hunting clubs, hawks hurry to the sound of a gunshot and help themselves to a downed bird if it is small enough to carry off. A trained Cooper's Hawk, having once caught a pigeon in a barn, could not be carried within a hundred meters of the barn afterward without insisting on inspecting the building for another easily caught meal.

The practice of falconry has provided much opportunity to observe raptors' intelligence and personality, because captive hawks, and particularly those raised from chicks, soon become very tame and relaxed around their handlers (although they are

often less so around strangers; they tend to recognize individual humans and dogs). If taken at a very young age, they imprint on the falconer and, regarding the man or woman as a mate, demonstrate almost the full range of their species' behavioral repertoire, although some of these behaviors may become exaggerated in the absence of proper socializing with their own species.

Different species and species groups have distinct "typical" personalities. The three *Accipiter* species tend to be high strung and quick to panic when faced with unfamiliar environmental stimuli; Red-tailed Hawks are placid and deliberate by contrast, as are Harris's Hawks *(Parabuteo unicinctus),* which, being very social animals in the wild, quickly realize the advantages of being with a human (and sometimes with a dog). Among Merlins, the Prairie race tends to be more cantankerous, and the Taiga form the calmest. Peregrine Falcons are calm but reserved, whereas Prairie Falcons seem friendlier but are given to outbursts of rage when offended; and Gyrfalcons are known for their playfulness and enjoy toying with tennis balls as they grow up and beyond. Amiable in their attitude toward their handler, Golden Eagles are appropriately unflappable and noble in demeanor, although they are known to give warning squeezes with their mighty feet. One eagle, using its beak, removed its owner's hat time and again and tossed it to the ground, perhaps in play or as a form of preening its "mate." Turkey Vultures, not exactly a falconer's favorite species, and California Condors can be almost doglike in their tameness and seem to become affectionate. Needless to say, such interpretations of raptor behavior are anthropocentric.

Wild raptors at times appear to show little common sense. A female Golden Eagle on her nest, visibly agitated by the approach of a human, quickly relaxed when the latter moved to a point equally close, where a large limb hid the eagle's head but not her body, so that she could no longer see the observer. A Cooper's Hawk several times bashed into a cage safely holding three pigeons, each time failing and going off to try from a different direction or using different approaches, such as frontal assault or sneak attack. The problem here was obviously that the hawk failed to understand that a wire cage is not a tangle of branches from which prey can be evicted.

On the other hand, the quest for food can reveal what appears to be intelligent behavior. An adult female goshawk, having killed a Blue Grouse *(Dendragapus obscurus)* in a mountain

Fig. 21. Gyrfalcon in a playful mood.

meadow, laboriously carried her quarry into a small stand of lodgepole pines *(Pinus contorta)*, where she began to pluck her prize. Suddenly she stopped, sleeked down, and, after staring intently at the nearby forest's edge, dragged the grouse under a pile of dead branches, then perched about 6 m (20 ft) away on a low branch. At this point, an adult female Redtail arrived and began looking for the grouse on foot for several minutes. Having failed to locate it, the Redtail flew off again, whereupon the goshawk extracted the grouse and continued plucking and ultimately fed on it.

With a few exceptions, most wild raptors are shy, although there is considerable individual variation; perched Red-tailed Hawks often allow a close enough approach, especially in a car, to take pictures with a good lens, whereas most Northern Harriers do not. Some Golden Eagles are amazingly fearless; other individuals flee at a quarter of a mile. Shyness in some raptors may be learned, at least in part. In the American west, the Northern Goshawk vigorously defends its nest, attacking humans that climb its nest tree or, sometimes, as much as walk near it. In Germany, where the same species was relentlessly shot until fully protected in the 1970s, goshawks were notoriously shy and never seen near their nests. With the cessation of shooting, this avoidance behavior rapidly disappeared, and today the goshawk is a common breeding bird in some German cities; the city of Cologne alone has about 30 nesting pairs, the hawks feeding chiefly on city pigeons and calmly ignoring passersby below their nests in city parks.

In California, much the same has taken place with the Cooper's Hawk, a formerly secretive species that, in central California, used to be confined to nesting chiefly in riparian and oak woodlands. In recent years, Cooper's Hawks have set up households in California cities; the city of Berkeley (Alameda County), for instance, is home to at least 12 Cooper's Hawk nests, some on branches overhanging streets, the young decorating parked and passing cars with their droppings. As ever more suburbs have spread into the margins of wildlands, Cooper's Hawks have raised their young often in plain view of humans, and these young in turn have gone on to breed in towns and cities. Here, too, the behavioral change is a result in part of the decline of hawk shooting and the presence of large prey bases. It also demonstrates the ability of certain raptors to adjust to new conditions and exploit new food sources, and to live more or less in harmony with humans in California.

Hawk Identi cation

Many raptors, especially those flying at a distance or seen only briefly, are often difficult to identify, and lively arguments sometimes follow a sighting by a group of bird-watchers, even of experts. It may be helpful to begin a discussion on identification

with the numerous pitfalls that lead to bewilderment and misidentification.

Pitfalls of Identification

A lack of familiarity with raptor biology and the simple failure to note all of the field marks and flight traits are the most common causes of inaccurate raptor identification. Experienced hawk-watchers are amused by a novice's excited report of having spotted a white Gyrfalcon in oak savanna near Fresno, and carrying nesting material no less; that is because a beginner is unlikely to know that Gyrfalcons are exceedingly rare winter visitors, that no white one has ever been seen in this state, that they do not seek out oak savanna and do not nest here (ever), that they do not build their own nests, and that their bulk and flight style are very different from those of what the observer almost certainly saw: a White-tailed Kite.

A beginning hawk enthusiast observes a large brown hawk with a longish tail, flying by in a summer salt marsh, and decides it must be a juvenile goshawk. Juvenile Red-tailed Hawks, however, also have brown backs, and their tails are often considerably longer than those of adults and not red. But a Northern Goshawk has broad tail bands versus a Redtail's narrow ones; it has shorter, brownish primaries instead of long, dark-tipped ones, and a wide, conspicuous superciliary versus one that most often is inconspicuous. Add to that the habitat and time of year, and the goshawk identification is virtually certain to be erroneous (though there remains the very remote possibility that it is an escaped falconer's bird). In fact, the most likely candidate would be a juvenile or female Northern Harrier, provided it had the diagnostic white rump (see fig. 85).

However, experienced bird-watchers sometimes can be handicapped by their knowledge and fail to accurately identify a hawk because it is in an unexpected habitat or because they depend too much on color, an error which led expert birders to mistake dark morph Swainson's Hawks nesting in a Central Valley park for Golden Eagles. Obviously, size determination (which is often very difficult) was a problem, too.

Plumage variations in several species can be very confusing. The clear bib on the upper breast of a "typical" juvenile Red-tailed Hawk in California can be completely streaked in some

forms, though the bib can still be made out. Some adult color morphs of the Red-tailed Hawk often look like they have been dipped into extra red brown pigment, but the basic pattern of the species can still be discerned under it all; the dark waistcoat and the much lighter breast are rarely completely hidden. Some light morph adults with all-pale undersides and dark morph adults, which may appear totally dark brown or black, force the observer to focus on field marks other than color or pattern, such as flight outline, flight style, and so on.

Unusual flight styles can cause confusion. Ferruginous Hawks clipping along with angled wings a few feet above the ground look almost exactly like very large falcons rather than the plump buteos that they are. Sharp-shinned Hawks and Merlins occasionally use undulating (sometimes called "bounding") flight in which the bird's flight path alternately dips and rises, the dips caused by the hawk completely folding its wings against the body before the next set of wingbeats. This is the standard flight of jays, most woodpeckers, finches, and other small birds and may represent aggressive mimicry by these small raptors. Turkey Vultures, famous for their dihedral wings, at certain times soar on almost perfectly flat wings, whereas their mimic, the Zone-tailed Hawk *(Buteo albonotatus),* which is very rare in this state, rocks like a Turkey Vulture in flight on dihedral wings and joins this species in cruising the countryside, again to approach unsuspecting prey. Turkey Vultures often flex their wings while gliding, but so do California Condors, Red-tailed Hawks, and Golden Eagles, albeit more rarely and the hawks and eagles much less deeply. Because of their exceptionally broad wings (for a falcon), Gyrfalcons can fly at a snail's pace, more slowly even, it seems, than a buteo in no hurry, but they can accelerate to speeds higher than those of any other raptor in the straightaway.

Because the flight feathers in most hawks become shorter after the first molt, proportions perhaps previously familiar to the observer can change. The wings may become more pointed, as they do in goshawks, lending the bird a falconlike outline in flight. Because of its diminutive size and rusty breast, a male adult Sharp-shinned Hawk, when seen from afar and in poor light, might be mistaken for a robin! But female Sharp-shinned Hawks are frequently confused with the similar male Cooper's Hawks (which they also resemble in size), although when actually measured, there is no overlap between the two species.

Fig. 22. Nonraptors may be mistaken for raptors. The Common Raven *(Corvus corax)* is easily confused from afar with one of the dark raptors, but note the prominent beak and wedge-tipped tail; it is actually larger than a Red-tailed Hawk, although it does not appear so. On the Common Nighthawk *(Chordeiles minor),* slender, long wings with single, large white bars rule it out as a raptor.

We expect to see hawks perched in trees and on snags, telephone poles, fence posts, cliffs, and buildings, but most species at least sometimes sit on the ground (Prairie Falcons in the middle of a plowed field, Northern Harriers on levees, Ferruginous Hawks in a grassland, Golden Eagles on slopes), and so we fail to see them or dismiss them as inanimate objects or as species of less interest.

Whereas perched raptors are usually fairly easy to recognize as such, a variety of other flying birds are often mistaken for raptors. A lone gull (particularly a brown juvenile) or a pelican seen from afar can resemble a hawk, especially in a soar; Common Ravens *(Corvus corax)* soar also with set, flat wings and half-spread tail and appear quite hawklike except for the long, projecting head and beak. At a glance, even a pigeon or dove speeding by bears a resemblance to a small falcon. Nighthawks and swallows, too, can look like falcons at a distance. The usual hallmarks of most raptors normally clear up such errors—the large head, the tail length, the cadence of the wingbeat; all these help to set apart most birds of prey.

A report of a "kestrel" chasing shorebirds should be viewed with skepticism; "peeps" would be an extremely difficult quarry for a kestrel, but they are a very common prey of the similar-sized but much swifter Merlin. On the other hand, urban kestrels, especially males, do regularly catch songbirds, especially in winter, instead of the more traditional diet of insects and small rodents; they may also concentrate on songbird fledglings when they have young of their own to feed. Prey that is highly unusual for a raptor species should be cause to question an identification, but in itself should not nullify it; even the noble Peregrine Falcon has been observed to eat roadside carrion.

Hawks that have escaped from falconers could present real identification headaches to the hawk-watcher if such deserters were more common. Adherents of the sport sometimes use exotics, such as Lanner Falcons *(Falco biarmicus),* Sakers *(F. cherrug),* and Black Sparrowhawks *(Accipiter melanoleucus),* all of them birds of the Old World. They also train captive-bred hybrids (see figs. 58, 102), which combine traits from both parent species, such as Peregrine and Gyrfalcon, Gyrfalcon and Merlin, or even Cooper's Hawk and Harris's Hawk (raptors belonging to different genera!), and they backcross such mixes or breed them with a third species, producing "tribrids". These "mongrels" have a very high hunting drive, which explains their popularity. Peregrine and Prairie Falcons in the wild have produced hybrids at least once (Oliphant 1991). Usually, hybrids greatly resemble one or the other of their parents or whichever species contributed the most genes; an occasional individual, however, can be truly baffling.

Field Marks

Seen through binoculars, that compact, apparently crow-sized hawk seen in profile atop the high-tension tower has a black-capped head and conspicuous broad, black malar stripes; its back is gray, and the underside shows black bars on a pinkish white background. The wingtips seem to reach the tip of the tail. Presently, the raptor launches itself in the direction of the shoreline, flying with deep, fast beats of the narrow, pointed wings; shorebirds, rising and joining together into a swirling cloud, signal its arrival in their midst.

This Peregrine Falcon has obligingly presented its telltale field marks: size, shape, color, and pattern; it then revealed its flight

style, flight outline, and likely prey. Its perch and habitat, too, are typical for this species, although a Red-tailed Hawk, nearly the same size when perched, sometimes also sits on the same tower, making these clues less valuable.

Because not all of a raptor's field marks are equally useful, the dedicated hawk-watcher soon learns to look for all aspects of a raptor's persona, its "gestalt." The chief physical traits are obviously important, but so are flight style and the perches it uses, for example. Above all, the observer must keep an open mind and not jump to conclusions. It is embarrassing, having identified for fellow observers a Ferruginous Hawk by colors and size, to discover as soon as it takes wing that it is in fact a Redtail.

Size

Of all the observable traits, size is perhaps the most difficult to assess accurately. Distance and the absence of objects for comparison make size estimates highly unreliable. An enormous Golden Eagle soaring alone in the distant sky may seem no bigger than a Red-tailed Hawk. A hawk perched on a snag that projects above the crown of a leafy tree amidst the leaves often looks much bigger than it actually is, whereas a juvenile Red-tailed Hawk sitting in the top of a giant eucalyptus may strike the observer as no larger than a Merlin—especially when he or she really wants to see a Merlin. Also, various unrelated raptors are the same or nearly the same size, adding to the confusion.

Shape

Shape is very useful in sorting out a raptor's identity, whether the bird is perched or in flight. Most raptors can be assigned to one of three distinctive flight outlines; only a few do not fit easily into one of these categories. The silhouettes of raptors at rest also are sometimes very distinctive.

Raptors in Flight

"BUTEO" SHAPE: This shape is shared by vultures, most buteos, and eagles, all of which are frequently mistaken for eagles by the novice. The often-fanned tail may be short to moderately long; it always appears relatively short compared to the long, broad wings. In the Osprey, which also fits this pattern, the long wings are rather narrow. The buteo shape is perhaps the most familiar raptor shape.

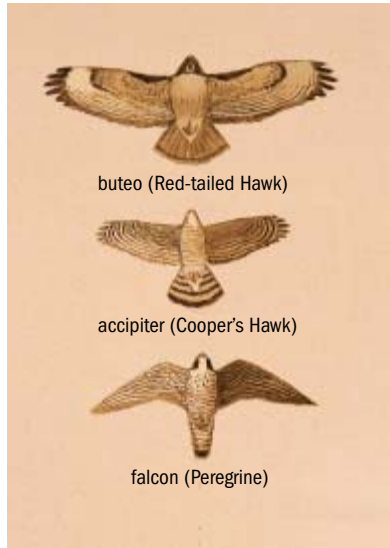

Fig. 23. Outlines of raptors in flight.

"ACCIPITER" SHAPE: Raptors that hunt in the woods have long tails and short, rounded wings. Although wings and tail may be spread while soaring (which most woodland hawks also do at times), these traits are still prominent. Besides the three accipiters (Sharp-shinned Hawk, Cooper's Hawk, and Northern Goshawk), the Red-shouldered Hawk *(Buteo lineatus)* also has this shape.

"FALCON" SHAPE: Long, pointed, usually narrow wings and long tails are characteristic of the falcons and the kites. Other kinds of raptors approximate this shape when they angle their wings sharply backward.

A hawk can dramatically alter its wings' shape for various purposes. The long, broad wings of a Red-tailed Hawk, when nearly folded in a stoop, resemble those of a falcon, whereas the falcon's pointed wings become distinctly rounder at the tips when it soars. Also, recently fledged falcons may appear somewhat round winged because the longest primaries that give the wings their distinctive pointed shape have not completely grown in. The loss of several primaries during the midsummer molt

lends an oddly pointed appearance to the wings of a Cooper's Hawk.

MISFITS: The Northern Harrier combines a long tail with long blunt wings and therefore does not neatly fit into any of these categories, and the rare Harris's Hawk, with its buteo wings and shape, has the long tail of an accipiter. In the even rarer Crested Caracara, all projecting body parts (neck, wings, and tail) are long, and the bird looks like a flying cross.

Raptors at Rest

Eagles not only are very large but also have conspicuously tall bodies from feet to shoulders when they sit upright. Perched with body horizontal, their legs appear too far forward, not at about the halfway mark of the body as they are in buteos.

Vultures often draw their heads down while at rest and from a distance may actually look larger headed than in flight because of a collar of feathers (ruff) that projects upward.

Buteos commonly look fat waisted because of their ample flank feathers that flare outward. Their heads are large and rounded.

Accipiters seem leggy, small headed, and long tailed. They have the habit of shaking their tails upon alighting and at intervals while at rest. Red-shouldered Hawks do so, also, but less frequently.

Falcons draw their large heads down, making the shoulders (actually bent wrists) appear to be hitched up very high. The wings are held tightly against the body, and the body appears less broad waisted than a buteo's. Falcons sometimes fold their tails to one feather's width, especially Prairie Falcons.

Windy conditions can alter the stance of any raptor as well as its outline. Facing into a high wind, a perched hawk's body is nearly horizontal. In wet or damp weather, many hawks partially open their wings, hanging them out to dry (wintering Red-tailed Hawks in the Central Valley show this behavior very frequently). In cool weather, the body feathers and those of the crown are puffed out for increased insulation, whereas heat causes the bird to flatten its feathers against the body. Overheated hawks are extremely sleek and pant rapidly. Young raptors often lie down to rest, not only in the nest but also elsewhere sometimes for a period after fledging, until the leg muscles fully develop.

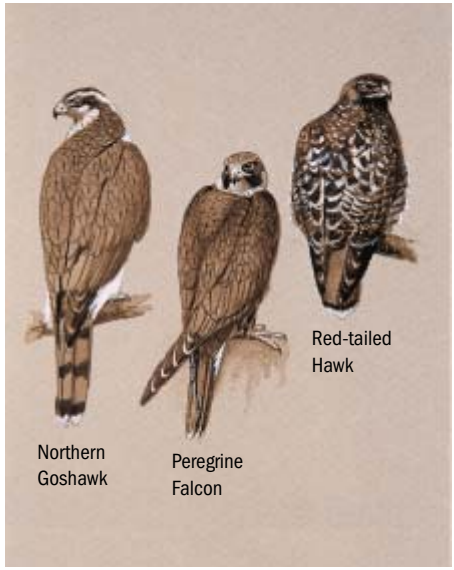

Fig. 24. Back views comparing shape.

Color and Pattern

Color would seem a reliable trait, but in poor light, it can be very difficult to determine. Moreover, several hawk species are polymorphic, that is, they come in a variety of colors, and, colorwise, may look nothing like the usual form. Colors also fade; in the course of a year, chocolate may be sun bleached to pale tan. Hawks sometimes forage in burned areas and pick up enough soot to make them appear entirely brown black. White, which is not really a color, is a useful field mark in a few raptors such as the White-tailed Kite and the Osprey. Both, however, are commonly mistaken for gulls.

If the sun is behind the observer, colors are bright and helpful; if behind the raptor, they are useless and appear black. Patterns, by comparison, reveal themselves over much greater distances than do colors, even in poor light, and they tend to be far more consistent, even if the actual colors stray from the norm. The dark patagium surrounded by lighter coverts on the underwing of a soaring buteo, for example, at once identifies the bird as a

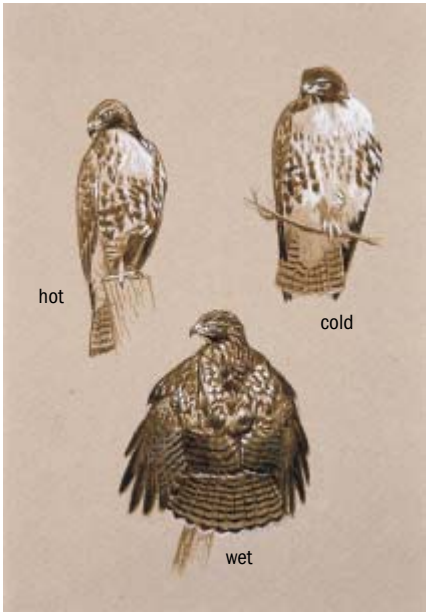

Fig. 25. Red-tailed Hawk.

Red-tailed Hawk, whereas the basal white half of the tail, sharply contrasting with the dark lower half, quickly tells the viewer that the very large raptor overhead is a juvenile Golden Eagle.

Voice

A few hawk species not only have very distinctive calls but are also highly vocal, particularly Red-shouldered Hawks during the nesting season; such calls can provide instant identifications, but the hawk-watcher also needs a good ear: Steller's Jays *(Cyanocitta stelleri)* habitually mimic the most common vocalizations of both Red-tailed and Red-shouldered Hawks, often quite convincingly. The rough alarm calls of nesting Prairie and Peregrine Falcons can frequently be heard at their nest cliffs before the birds themselves are seen. Golden Eagles are a rather quiet species, but during nesting season, adults call at sundown to proclaim their territory.

Fig. 26. Red-tailed Hawks are not always easy to recognize. This unusually pale juvenile Red-tailed Hawk might be mistaken for some other buteo were it not for the dark patagial patch.

Flight Style

A hawk's way of flying is an important clue to its identification. A long-tailed, short-winged hawk that glides between bursts of quick wingbeats is either one of the accipiters or a Red-shouldered Hawk. A few leisurely beats followed by gliding low over vegetation indicate a Northern Harrier. Coasting on long, pointed wings that curve down a bit is typical of a falcon; at speed, it moves its wings with a deep, rowing motion. A similarly shaped White-tailed Kite flies much more buoyantly with softer wingbeats, unless it is headed into a stiff wind. Unlike the Peregrine Falcon, it is also given to frequent hovering or kiting. When Turkey Vultures beat their wings, the process often looks labored, and the body is frequently moved up and down. Eagles, on the

other hand, have ponderous rowing, not laborious wingbeats, and their heavy bodies show no up-and-down motion.

Raptors soaring on a thermal can tell us a lot, too. Are the circles small or large? A Sharp-shinned Hawk usually makes much smaller ones than the similar Cooper's Hawk and is more likely to be tossed about than its more steadily riding cousin.

Interactions with other raptors also can provide clues; small hawks, diving at larger ones perched in trees or flying, are most commonly, but not always, American Kestrels, and during the nesting season, Red-tailed Hawks stoop spectacularly at Golden Eagles that enter their territory.

Perches

Raptors select perches either for temporary stopping points while foraging or for longer rests; a few use the same perch for both foraging and resting. However, it soon becomes obvious that many hawks prefer certain rest perches to others; Red-tailed Hawks are confirmed pole- or tree-sitters, and Rough-legged Hawks at times perch on extremely thin twigs. Accipiters like to conceal themselves inside tree crowns, although city Cooper's Hawks have an affinity for light standards. American Kestrels commonly sit on telephone lines, shunned generally by similar-sized Merlins, which usually sit either on treetops or in tree crowns but may also select other perches, such as fence posts. Bald Eagles like snags, whereas Golden Eagles relax on thick limbs in the crowns of big oaks. Large falcons can be found on high-tension towers (which are attractive to nearly all open-country raptors) and telephone poles, but also on cliffs and on the ground, and Turkey Vultures sit on snags and in eucalyptus trees. Although Swainson's and Ferruginous Hawks perch on poles, they are very comfortable on the ground as well.