

MAINTENANCE BEHAVIOR



Sleep



Head-droop-sleep/Doze: Eaglets spent considerable time sleeping with their heads resting on the nest, and it was not unusual to see the alert-eyed adult, supposedly protecting the eggs or young, slowly close one eye, then the other, and finally hang its golden head in slumber. The head usually, but not always, slumped forward. On a few occasions, the adult female Dozed off letting her head slowly creep backward until the bill was pointing approximately 40° above the horizon. The maximum recorded forward drooping resulted in the head oriented vertically downward.

When an adult Dozed, its lower lids crept gradually upward until the cornea was covered, then it periodically aroused, then Dozed again.

Head-tuck-sleep/Roost: When adults tucked their heads, the bill and usually the eyes were out of sight between the back and scapular feathers. As the head was rotated posteriorly, the lower lids were closed, and the head was rapidly quivered laterally as the bill parted the feathers. Roosting normally involves long bouts of Head-tuck-sleep.

Breathe

For terrestrial vertebrates, life is one long bout of Inhalation and Exhalation. High breathing rates are associated with overheating (evaporative cooling) and extreme exercise (low oxygen levels in the blood).

Cough and Sneeze

Adults and young forcefully expel air producing a sneezing sound. When performed, the mouth is open slightly and the head jerks. Sneeze is among those action patterns that are highly stereotyped. Sneezing probably clears the nasal passages. Falcons expel droplets of nasal salt secretion by Sneezing (Cade and Greenwald 1966:345). In eagles, this association seems less clear.

Just as for humans, Coughing probably expels occluding material in the upper trachea, but I have never seen an eagle Cough.

Care of Body Surface

Preen: Most feathered areas of the body are preened. Even the feet are Nibbled with the bill. Only the head, upper neck, bill, and throat are

Scratched. Eye-rub and Fluff often accompany the preen activity.

There are three major components of preening in the golden eagle. The Dig-in component is performed by rapidly shaking the head from side to side as the bill is pushed through the Fluffed feathers toward some underlying spot that is then Nibbled. Nibble is the rapid opening and closing of the bill in contact with the feathers or scales. The bill is held nearly closed

during Nibble. Often a feather is Nibbled from base to tip by slowly sliding the bill along the rachis. This is the eagle action pattern Comb-out (Fig. 9). Kruijt (1964:18) described a different preening component that he termed "combing" for the jungle fowl (*Gallus gallus*). When "combing," his birds swept their beaks across the surface of their feathers in high-amplitude strokes. The hooked tip of the eagle's bill would make this component difficult at best, and I



Fig. 9. Comb-out.

never observed eagles perform anything like Kruijt's "combing."

Preen serves several purposes. Occasionally, an eagle interrupts another activity, such as feeding, to preen a specific spot vigorously. At those times, preen probably serves to relieve discomfort due to a parasitic arthropod or mechanical irritation. Adults and young concentrate their preening efforts at emerging or unsheathing feathers. Preen also oils the feathers, rearranges barbs, and removes soil.

Eye-rub (Fig. 10): The eyelid and area immediately around the eye are wiped on the bend of the folded wing or, more often, on the anterior hump of the scapulars. The lower lid closes as the head swings toward the scapulars. Upon contacting the scapulars, the head both rotates rapidly about its axis and in its midsagittal plane. One to several strokes are performed in rapid succession during a bout.

Eye-rub often accompanies preen bouts. Eye-rub is sometimes preceded by exaggerated Blinking. At such times, it probably serves



Fig. 10. Eye-rub. Most of the time, the rub takes place on the compact ridge of the scapular feather bundle (and not, as seen here, on the bend of the wing/wrist).



Fig. 11. Scratch. The line of contact is the knife-like, medial edge of the talon of the middle toe.

to relieve eye irritation. At other times, it may also oil the feathers of the head.

Scratch (Fig. 11): Most of the head and throat cannot be preened and areas within 1 cm of the eye are Eye-rubbed. The rest of the head is Scratched with the feet. Scratch is performed in Stand and Sit postures while the wings are either folded or drooped to the nest for support. Scratch is accomplished by rapidly waving the foot through a series of low-amplitude oblong strokes so that the middle talon contacts the head from nearly the peak of the cycle through most of the downward stroke. While the talon is in contact with the head, the tarsus is horizontal or elevated distally; the shank is nearly vertical and the hallux is approximately perpendicular to the tarsus. Nearly fledged eaglets often use Scratch to initiate a One-leg-stand bout and vice versa.

An eagle's feet are specially equipped for grooming its head. The medial border between the unguis and subunguis of the claw of the middle toe forms a sharp edge that extends nearly the length of the talon. That edge is homologous to the pectinate claw of birds of other avian orders and is likewise used to groom the head. For this claw to contact the head, the middle toe is either crossed over the inner toe, or the middle talon is hyperextended so that it arches above the inner and outer talons and is thereby more available for contact with the head.

When Scratched, the head is lowered, deflected laterally, and rotated so that the contact area is near the raised foot. The lower lids of one or both eyes usually are closed when Scratching. The bill is slightly open because of lifting the upper mandible (movement around the naso-frontal hinge) or posterior retraction of the lower jaw, or both.

Bill-wipe: Bill-wipe (Fig. 12) is described in detail on page 50. Briefly, the bill is cleaned by wiping on the nest, on a tree, on a rock, or on another surface.



Fig. 12. Bill-wipe. Note the protruding tongue.

Rub-tomia: A subtle movement of the nearly-closed bill that probably moves food particles to the tongue surface. The upper and lower tomia (singular: tomium) are moved a few mm forward and backward, past each other via the naso-frontal hinge and the jaw joint. This action pattern is probably performed very often following eating bouts, but it involves such slight movements that it goes unnoticed except when watching a captive eagle from very close.

Bathe and Wing-flop-vent-dip: Captive eagles bathed in ponds and streams at depths of 10–25 cm. In a typical performance, the Standing bird rocked forward, dipped its breast, lowered one side into the water, then flopped the lowered wing outward into the water, and just as quickly retracted it. The eagle repeated this with the other side, then flopped both wings simultaneously as it dipped its vent into the water. The bird bathed for about 5 minutes. Fluffing accompanied the Bathing performance, and the eagle remained Fluffed, with its wings half spread, as it Stood in the sun after its bath. The air temperature was -1°C . The pond was covered with a thin layer of ice everywhere except at the bathing site, and about 7 cm of snow covered the ground. Wild golden eagles are known to seek places for bathing where they are far from cover, can view the surroundings, and have a declivity for an escape route (Charlet and Rust 1991).

I never observed wild eagles bathe (an activity), but nestlings performed Wing-flop-vent-dip that is the primary action pattern in Bathing. Large eaglets threw both folded wings dorsally at the same time that the vent area was swung downward and forward toward the feet. The wings and vent then returned to their former position. The raising of the wings and lowering of the vent occurred much faster than the return part of the cycle. All nestling performances



Fig. 13. Shade/Pant. Action patterns evident here also include Spread-dry and Spread-droop.

were in Sit posture. One to five cycles comprised each bout.

The context of the Wing-flop-vent-dip as well as its form suggested its association with bathing. Four of six performances occurred during rain showers; the fifth was immediately preceding a shower. Only the sixth observation was not on a stormy day. The action pattern probably indicated that the eaglet was stimulated to bathe, but in itself, Wing-flop-vent-dip served no discernible purpose. It is also likely that eagles Dust-bathe, although I have never seen such.

Spread-dry: After Bathing or after a rain shower, eagles very often three-quarters spread their wings and hold them drooped until the feathers dry. This is the same ethon as Spread-droop which is used to shade nestlings (Fig. 13).

Comfort Action Patterns¹

Head-shake: There are two forms of Head-shake. In the first, the bill is raised so the axes of the head and neck are roughly aligned, then the head is rotated quickly about those axes in several left-right cycles. This form (Long-head-shake), performed when an eagle is wet or after it Ruffle-shakes, dislodges unwanted substances (water or, more often, feather debris) from the long feathers of the head. The second form differs in that the axis of the head lies approximately perpendicular to the axis of the neck, so rapid side-to-side shaking results in the bill swinging through a wide arc. This form (Side-head-shake), associated with Cast, Vomit, Tear, and Bill-dig, dislodges unwanted debris from the bill or mouth, and, as Cade and Greenwald (1966:345) reported for a small falcon (*Falco* sp.), it dispels nasal salt secretions from the bill.

¹ Comfort action patterns are used for repositioning the body and plumage, including shaking and stretching.



Fig. 14. Fluff. Feathers are near maximum erection.

Tail-shake: The tail is rapidly rotated about the axis of the body in a series of left-right cycles. Tail-shake lasts approximately 1 second. Like Ruffle-shake, Tail-shake is initiated by a sudden explosion of movement that tapers slowly in speed. Unlike Ruffle-shake, Tail-shake is not preceded by conspicuous intention movements.

Tail-shake is the “punctuation mark” of eagle behavior. It very often follows such actions as alighting from Flight, Ruffle-shake, Two-wing-up-stretch, Wing-leg-tail-stretch, and Wing-fold, and it concludes preening and feeding bouts. Changes in posture are also punctuated with a Tail-shake.

Fluff (Fig. 14; Ellis 2013:133, 244): When an eagle Fluffs the feathers of one area, feathers in adjacent areas rise to a lesser extent. All action patterns that care for the body surface are associated with Fluffing. When an eagle performs such social displays as Mantle or Wing-spread-slap, its feathers are elevated, making it appear larger. An eagle increases the insulating

capacity of its plumage in hot and cold weather by Fluffing. Extreme performances are most often followed by Ruffle-shake.

Ruffle-shake (Fig. 15): Intention movements preceding Ruffle-shake include rotating the body axis so the tail is lifted off the substrate (the eagle, therefore, is in horizontal Perching posture) and simultaneously elevating the contour feathers (Fluff) for several seconds. At maximum Fluff, all contour feathers appear to be elevated. Likely exceptions are the small feathers of the tarsus and the greater primary coverts. The bill faces downward and forward, and the wings are lifted slightly away from the body. When all components of that posture are achieved, the bird vigorously churns its wings and body about the long axis for 1 to several seconds. The movement then slows, stops, and gradually the feathers are lowered.

When associated with preening, Ruffle-shake serves to remove down, shattered remnants of feather sheaths, and other debris. When performed following alighting from Flight, it probably repositions displaced feathers. Ruffle-shake

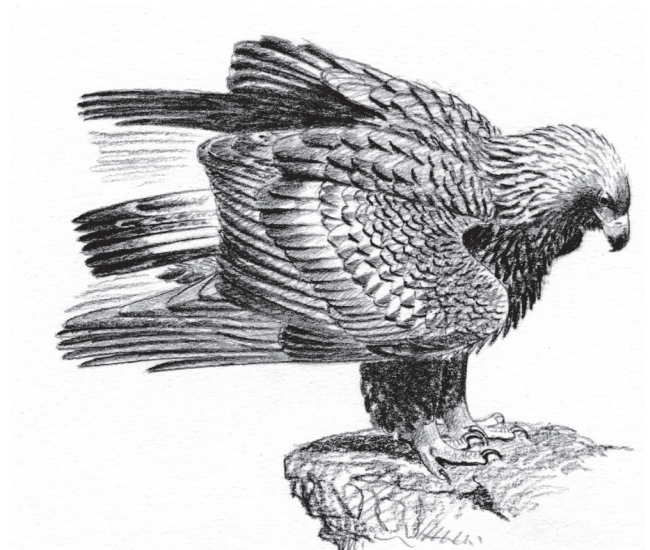


Fig. 15. Ruffle-shake. During the violent churning, the head is pointed downward.



Fig. 16. Gape. If Yawning, the head would have been pointed up and forward.

is often followed immediately by Head-shake, Tail-shake, and more preening.

Stretching

Most stretching action patterns are highly stereotyped and are only partly under voluntary control.

Mouth-stretch, Yawn, and Gape (Fig. 16): There are two, often indistinguishable, forms of Mouth-stretch. The Yawn includes the semi-voluntary opening of the mouth, the hyperextension of the mandible, and a few seconds of flexing of the muscles that open the mouth. The Gape is under voluntary control. When Yawning, the head is normally pointed upward or forward and the neck is likewise extended. When Gaping, the head was usually not pointed up. Yawning is often associated with arousal from sleep or another period of inactivity and, like other stretch ethons, may be associated with squeezing blood, high in carbon dioxide and low in oxygen, from the stretched muscles to allow reinfusion with oxygenated blood in preparation for activity.

In the golden eagle, the true Yawn is performed periodically throughout the day, often without identifiable external stimulation. Social facilitation, however, characterized some Yawn

performances, and Panting bouts are often accompanied by higher than normal Yawn performance rates. Voluntary Gaping, preceding Casting, probably helps move the pellet upward in the esophagus. Eaglets repeatedly Gaped when the adult females preened the crusty exudate (produced by maggots) from their auditory canals.² Gaping appears to involve more hyperextension of the bill (i.e., rotation about the naso-frontal hinge) than does Yawn.

Two-wing-up-stretch (Fig. 17): Eaglets Up-stretch in Lie, Sit, and Stand postures. When performing Two-wing-up-stretch in Stand posture, an eagle raises its folded wings over its back until they touch (or nearly touch) at a point somewhere between the midforearm and the elbow. The hand, during most performances, droops below the secondaries, and the tail remains folded. In falcons, by contrast, the hand and tail are normally fanned. Concurrent with the elevation of the wings, the eagle lowers its head and raises its rump. The tail usually droops slightly below the axis of the body. The eagle quivers 1 to several seconds as it strains to lift the wings and to rotate forward. Thereafter, the

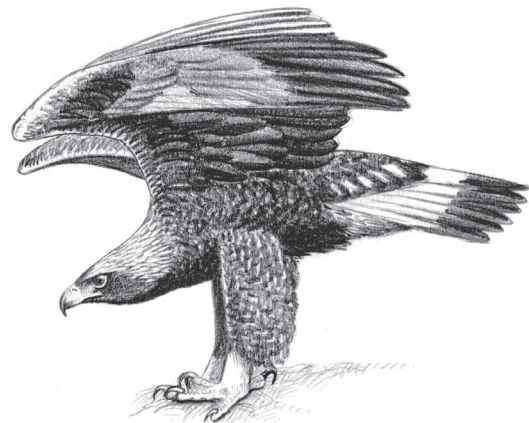


Fig. 17. Two-wing-stretch.

² Calliphorid larval infestations are common in many raptor populations (Philips and Dindal 1977). In some populations, 100 percent of nestlings are infested, but mortality is normally very low.

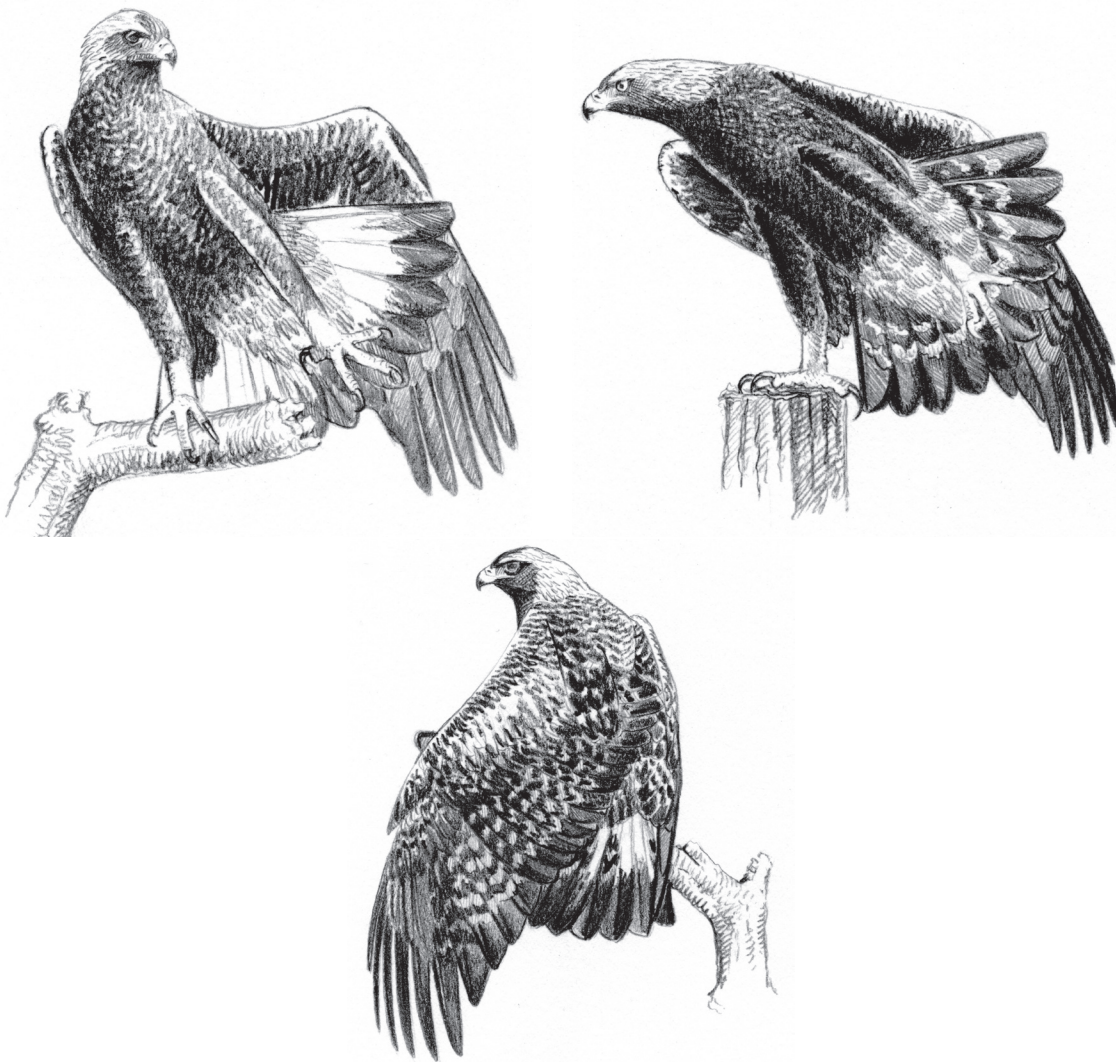


Fig. 18. Wing-leg-tail-stretch (various forms). When maximally performed, the head is held as for the right bird and a talon often passes through the wing feathers.

eagle relaxes, refolds its wings, and raises its foreparts.

No intention movements precede the Two-wing-up-stretch. Eagles, when Defecating, lift their wings, sometimes partially, sometimes fully, performing the Two-wing-up-stretch. This action pattern is temporally associated with the Wing-leg-tail-stretch and arousal (as from sleep or a prolonged Incubation bout). This action pattern often follows another eagle's performance (i.e., social facilitation).

Wing-leg-tail-stretch (Fig. 18): Eagles stretch unilaterally in Lie, Sit, and Stand postures. Sometimes eaglets extend only a leg or a wing when stretching unilaterally. Except where noted, the following description is based on adult performances, on a flat substrate, and in Stand posture.

Several body parts are extended when maximally performed. First, the tail is drawn toward one side and spread. Next, the near leg is lifted and moved toward the tail. Third, the near wing is extended downward and backward over the

tail. Simultaneously, the head is lowered and oriented pointing downward and slightly forward. Finally, the near leg is stretched backward against the fanned wing, and the toes are spread widely (i.e., hyperextended). A talon sometimes passes through the feathers so it appears on the dorsal surface of the primary feathers. The eagle strains (i.e., quivers), holds the posture for up to several seconds, then relaxes. Sometimes a Wing-leg-tail-stretch performance is terminated by lifting the head. As the bird relaxes, the wing slowly folds, the tail moves back toward the body axis, and the leg resumes its supporting position. A Lying eaglet commonly leaves its leg extended following a Wing-leg-tail-stretch. One eaglet left his leg extended for over 26 minutes after stretching unilaterally.

Two discrete types of wing extension were noted. Either the wing was fully extended so that the margin of the hand and the patagium formed a convex arc, or, more often, the hand was not fully extended and an angle of ca 120° was formed between the margin of the hand and the patagium.

At maximum extension, the antebrachium of the stretched wing was slightly past perpendicular with the body axis. When performed fully, the Wing-leg-tail-stretch is highly stereotyped. Variations in form appeared to result mostly from spatial factors that impeded performance. For example, the orientation of the stretched members is backward and sideward when performed on the nest, but when perched on a tree limb, the eagle orients its wing nearly vertically. In both situations, the positions of the body members relative to each other are much alike.

Wing-leg-tail-stretch is performed in company with Two-wing-up-stretch, after arousal from sleep or after rising from Incubation. No intention movements were observed. As for some other stretching ethons, the sight of an

eagle exhibiting Wing-leg-tail-stretch appears to stimulate other eagles to stretch (another example of social facilitation).

Thermoregulatory Behavior

Thermoregulatory behavior involves insolation and cooling. When an eagle is first exposed to solar rays, it is likely to Spread-droop until it becomes overheated. When eaglets first begin to Sit and Stand, their wings usually sag. Such sagging is similar to the wing position (Wing-droop) exhibited by overheated adults. Even in Lie posture, the wings are sometimes sprawled to the side so that the eaglet functionally is Wing-drooping. Sometimes sprawled nestlings also elevate (Fluff) their anterior scapular feathers, seemingly in an effort to expose underlying apterlae to facilitate convective and radiative cooling. Powers (2003:82, 102, 105–107) reported responses of nestling ferruginous hawks to overheating. These include: moving to the windward side of the nest, exposing feet and legs to the wind, panting, and extending the wings a bit to allow the breeze to flow around the underwing surfaces. These young hawks, like eaglets, also move about (even off the nest) seeking shade.

Eaglets, even when tiny, responded to overheating by moving toward cool objects (e.g., shaded portions of the nest) and moving into the adult's shadow. Bartholomew and Cade (1957) described wing- and leg-extension postures and eye bulging responses to overheated American kestrels. Nestling golden eagles, when overheated, sometimes do extend one wing or one leg when Lying, but I have never seen eye-bulging.

Pant (Figs. 13, 19): Panting appears as a presumed response to oxygen deficiency following vigorous exercise or to overheating due to lack of shade. It replenishes the oxygen supply and cools the bird by passing air over moist

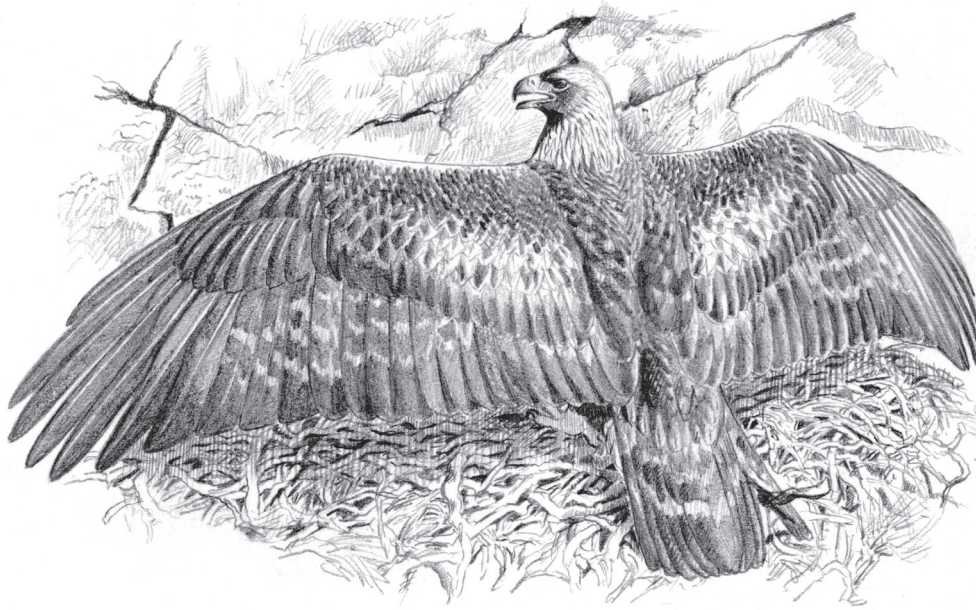


Fig. 19. Pant/Shade. The adult female Pants as she Shades her young.

evaporative surfaces. Eaglets are extremely vulnerable to overheating. When eaglets are Panting without shade, humans should not approach the nest. In some conditions, humans even 1 km distant will prevent the adults from returning to shade the young. Eaglets in unshaded nests sometimes die (Fyfe and Olendorff 1976).

When Panting, the mouth varies from slightly open to a maximum of 25° between the upper and lower jaws. The tongue is lifted from the floor of the mouth, extends forward, and is held in the gap between the tips of the upper and lower tomia. When the bird breathes, the tongue tip goes up and down in rhythm with the air movement. The whole body heaves with each breath. When maximally Panting, nasal salt secretion runs from the nostrils and drips from the tomi-um or hook of the bill. The maximum recorded nestling (age 39 days) respiration rate was 50 cycles in 25 seconds.

Some raptors, most notably the great horned owl, perform Gular-fluttering wherein the evaporative surfaces of the pharynx are fluttered so as to draw air in and out of the buccal cavity to promote more rapid evaporation. I have never seen this performed by eaglets or adults.

Each of the stress-related action patterns commonly accompanies Panting. Eaglets often Rattle-chirp or just Chirp when overheated. Eaglets also seem to Yawn more often during Panting bouts.

Spread-droop or Sun-spread (Figs. 13, 19): Kahl (1971) proposed several functions for the spread wing postures (sunning) in adult storks; they include wing drying, heat absorption, and shading the young. Many species of non-raptors perform Wing-full-spread when sunning (e.g., New World vultures; anis, *Crotophaga* sp.; anhingas, *Anhinga anhinga*; and cormorants, *Phalacrocorax* sp.), but the only eagle known to do so is the bateleur (*Terathopius ecaudatus*)

(Grier 1975). In other raptors, the wings are not fully spread and locked open (as in Soaring), but are three-quarters spread and most often drooped.

Kennedy (1968) listed vitamin D production and also insulating ectoparasites as important. Mueller (1972) concluded that wing spreading was stimulated more by an increase in light intensity than by change in heat level. Spread-droop, as used by a shading adult, is the same ethon as Spread-dry discussed under plumage maintenance.

In the eaglet, Spread-droop is seen in three contexts. In most cases, the eaglet spreads its wings immediately after becoming exposed to direct sunlight. In that context, the eaglet probably was attempting to absorb radiant energy. In three of thirteen bouts, eaglets Sun-spread after they were Panting. In those instances, the eaglets were either attempting to irradiate their plumage even though mildly overheated, or they were attempting to dissipate heat as described for the Wing-droop posture. In the third context, Sun-spreading served to dry the plumage.

Wing-droop: Kahl (1971:718) hypothesized that storks (Ciconiidae) droop their wings to facilitate heat loss by radiation and convection from the underwing surface. Like storks, eagles oriented back to sun when Panting; less so for Wing-drooping. Sometimes it appeared that the

scapulars were somewhat erected; if so, additional portions of the back and flank were made available for heat loss.

All thermoregulatory ethons and Wing-fold are closely associated with Wing-droop. Wing-droop is also a component of shading.

Wing-fold: Performed rapidly, the Wing-fold consists of bending the wing at elbow and wrist and lifting the humerus so that the wing lies close to the body, immediately below the scapulars.

Eagles perform Wing-fold after alighting from Flight and after all other ethons in which the wings are spread. It is also performed intermittently during Panting bouts wherein the wings droop for thermoregulatory purposes or because of fatigue. A resting eagle (juvenile or adult) will occasionally perform a slight lifting and pressing of the wing into its tightly folded position.

Shiver: Sometimes neonatal young flutter their wings (Wing-quiver, p. 53) at mealtimes as if Shivering, but I have not seen Shivering in the context of hypothermia. While eaglets are commonly seen moving into shade when overheated, moving into the sun to “warm up” is not normal. Moving to be Brooded by an adult is common. I suspect eagles do Shiver when hypothermic, but I have never seen it.





Subadult in Soaring Flight.