Alaskan Birds at Risk

Widespread Beak Deformities in Resident Species

The team creeps silently across a well-tended lawn, eyes drawn to a small wooden box perched several meters up a lone birch tree. The first biologist is armed with a broom in one hand and a bug net in the other. Her partner wields a lunchbox-sized plastic case and a tree-climbing ladder that looks like an oversized radio antenna. A neighbor peers out her window from across the street to watch the unusual spectacle.

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A small black-and-white bird zips toward the box's tiny, round opening and both women raise binoculars to their eyes in synchrony. A specific combination of metal and colored plastic bands on the bird's legs identify this Black-capped Chickadee, which was banded two years earlier as a nestling. "It's the female," Colleen Handel whispers, and Lisa Pajot nods as they duck behind the cover of a large spruce tree. The bird—named "Red-white-red", in reference to her color bands—appeared healthy in the nest as well as the following winter, when she was caught in a mist net set up nearby. The next summer, however, "Red-white-red" appeared at a residential nest box with a severely deformed beak. The overgrowth worsened, and, now, the upper mandible curves down and back toward her breast, while the lower extends up, crossing the upper at a nearly 90-degree angle. The effect is sobering. Even from a distance, this teacup-sized bird carries a conspicuous appendage that more closely resembles a pair of mangled scissors than any recognizable seed-cracking beak.

An alarming trend of strangely overgrown and crossed beaks among Black-capped Chickadees and other resident bird species has drawn attention from Alaskan scientists and birders alike. More than 1,500 chickadees have been observed with beak deformities in south-central Alaska—the highest concentration of such abnormalities ever recorded in a wild bird population. Biologists now estimate that approximately ten percent of adult chickadees in the area are affected—a staggering rate of deformity for any population. A normal, background level of beak deformities is less than one half of one percent (Pomeroy 1962), meaning that deformities in Alaskan chickadees appear to be at least twenty times higher than normal. Although the species is a year-round resident across forested regions of Canada and the northern two-thirds of the contiguous United States, fewer than 20 Black-capped Chickadees with beak deformities have been reported from outside of Alaska (Handel et al. 2006).

More recently, increasing numbers of other, mostly resident species with beak deformities have been reported in Alaska and the Pacific Northwest. The tally now includes a total of 30 species in Alaska and 22 in the rest of the Pacific Northwest, but the cause of this widespread problem remains a mystery. After Black-capped Chickadees, the most commonly reported species with beak deformities are Northwestern Crow, Black-billed Magpie, Downy Woodpecker, Steller's Jay, and Red-breasted Nuthatch, all of which are year-round residents in Alaska.

This cluster of Alaskan beak deformities was first brought to biologists' attention during late winter of 1999, and Colleen Handel and her team of scientists then began to investigate this startling phenomenon. They established a summer breeding study and, with help from volunteers, monitored nearly 500 nest boxes in south-central Alaska. Chickadees are cavity nesters and typically excavate holes in rotten trees or snags. They also willingly nest in bird boxes, a fact that Handel used to her advantage in this research. Of the more than 300 boxes occupied by Black-capped Chickadees, approximately one-tenth hosted a deformed adult. In one unusual case, both the male and the female of a single pair were deformed.

Handel and Pajot watch as the chickadee flits between the box opening and an adjacent branch. The bird holds a caterpillar in her beak, a seemingly impossible feat of balance and control given the beak's odd shape and large size. She pokes her head inside the hole once, and then again, but remains outside, perched on the birch

Biologists first observed large numbers of **Black-capped Chickadees** with beak deformities during the winter of 1999–2000. Since that time, more than 1,500 chickadees and lesser numbers of 30 other, mostly resident, species have been documented in Alaska with deformities. Although the problem is still under investigation, occurrence of deformities in a large number of species across a broad geographical area point to environmental factors as a possible cause. *Anchorage, Alaska; 10 January 2007.* *© John DeLapp.*

Birds with severe overgrowth of the upper and lower mandibles typically experience higher mortality than normal birds, especially during winter cold snaps. **Black-capped Chickadees** have important adaptations for surviving the short days and cold temperatures of Alaska's northern climate, including acquiring and metabolizing up to 10 percent of their body weight in fat every day. Deformed beaks affect birds' ability to feed normally, which can have severe consequences during periods of below-zero temperatures. *Anchorage, Alaska; 11 December 2004. © Robert Gill.*

branch. Begging cries of hungry chicks escape from the wooden nest box walls. A moment later, another black-capped head peeks out from the opening and the female makes a quick beeline toward it. She lands on the opening's edge, tilts her head, and in a highly coordinated effort, passes the caterpillar to her mate. He disappears back into the box, and the female flies out of sight. This form of cooperative feeding has not previously been reported among chickadees, and appears to be a strategy that allows deformed birds to provision chicks even if their deformities prevent them from feeding the nestlings directly.

Although many Black-capped Chickadees in the south-central Alaskan population successfully raise 6–8 young each year, nests with a deformed parent face greater challenges. For nests in which the female was deformed, Handel's team found that fewer eggs hatched on average. This lower success may have been due to a physical problem with the eggs, such as thinner eggshells, or problems during incubation. In several cases, deformed females behaved erratically, and eggs were scattered about the nest box haphazardly rather than arranged neatly in a nest cup. It is still unclear whether this behavior resulted from a physical limitation imposed by the beak deformity or a hormonal disruption of incubation behavior. Other studies have documented abnormal breeding activity associated with contamination by DDEs and PCBs (Haegele and Hudson 1977, Fox et al. 1978, McCarty and Secord 1999), a possibility Handel's team intends to investigate further.

Pajot studies the genetic relationships of south-central Alaskan Black-capped Chickadees. By examining DNA extracted from blood or feather samples, she can determine parentage and relatedness of local chickadees. Pajot recently discovered that deformed males have to cope with a surprising problem—being tricked into raising someone else's young! Her results showed that nests occupied by a deformed male contained a higher proportion of young from

Biologists captured this **Black-capped Chickadee** at a study site near Anchorage. Winter trapping sites and summer nest boxes provide information about the prevalence of beak deformities in local chickadee populations. Approximately 10 percent of adults in south-central Alaska are deformed—the highest level ever recorded in a wild bird population. *Anchorage, Alaska; 11 September 2003. © Colleen Handel.*

a different male or from different parents entirely. Although the reason for this pattern is not fully understood, it is likely that deformed males have difficulty foraging and spend long periods of time away from the nest. These absences would leave the birds with less time to defend their territories and mates, and provide better opportunities for other birds to sneak in unannounced. Deformed males were also less successful in rearing young, and a smaller proportion of nestlings survived to leave the nest. Handel suspects that the physical deformity hinders the male's ability to gather enough food for the nestlings.

At the nest box, the male has finished feeding the nestlings and flies toward a clump of spruce trees in the backyard, in search of more food for the fast-growing chicks. Parents have little time to rest during the approximately 16 days between hatching and fledging. Black-capped Chickadees, like most other songbirds, are altricial, meaning they emerge from their eggshells essentially featherless, with eyes closed. They transform from naked and helpless, resembling fingertip-sized plucked chickens, to nearly fully feathered and capable of flight in just over two weeks. For parents, this means round-the-clock foraging. The male has the added responsibility of provisioning the female during the first few days after hatch, when the nestlings are unable to stay warm on their own and must be brooded by the female.

Taking advantage of the chickadee parents' absence, Pajot assembles the tree-climbing ladder and places it against the base of the birch tree, securing straps as she climbs. The nest box sits just above a fork in the tree, and Pajot deftly wedges one foot in the crook and wraps her other leg around the trunk. With hands free, she picks up the nestlings and places them in a cotton-lined plastic container before returning carefully to the ground.

Handel and Pajot work quickly to measure and band the young birds. These chicks are 12 days old, covered in still-growing feathers that stand up at odd angles and give them a messy, disheveled appearance. They squirm and hop out of the container at any opportunity, and the researchers watch closely for any escapees. The smallest chick, likely the hungriest member of the brood, begs when the container lid is lifted, neck arched and mouth opened wide in hopeful anticipation of another caterpillar delivery. All five nestlings appear normal, with no unusual beak growth or obvious signs of poor health.

In some parts of Alaska, local residents and biologists have observed clusters of beak deformities and as many as 10 deformed birds have been observed at a single residence, among them these two **Black-capped Chickadees** feeding on suet balls. Deformed birds often rely heavily on feeder foods, including seeds, suet, and peanut butter. Biologists suspect that the high fat and low vitamin content of these foods could contribute to possible nutritional problems associated with beak deformities. *Anchorage, Alaska; 15 February 2006. © Sherry Shiesl.*

Birds with gross beak deformities have difficulty procuring natural foods and often appear messy and disheveled due to their inability to preen properly. In some cases, birds like the **Black-capped Chickadee** pictured here are unable to forage normally and may become desperate enough to eat out of the hand. *Bird, Alaska; 6 November 2006. © Susan Fenn.*

One of the most puzzling aspects of the beak deformities is their appearance almost exclusively in adults. Among nearly 2,000 nestlings examined, only one exhibited a slightly crossed beak. Clusters of beak deformities documented in other species outside of Alaska have been observed primarily in embryos or nestlings and rarely in adults. In addition, chicks in early developmental stages are typically more sensitive than adults to contaminants or other environmental stressors known to cause deformities.

Alaskan chickadees have not followed this pattern, and a high rate of deformities persists in the adult population, affecting additional birds each year. To further complicate matters, researchers have observed relatively frequent transitions between apparently normal and significantly deformed states. In more than 50 cases, birds displayed no beak overgrowth when first captured, and later exhibited a deformity. It is not clear if a change in environmental conditions prompts the development of the beak growth or if there is a delayed onset of a genetic or developmental problem. Thus, identifying "normal" versus "deformed" birds poses a significant challenge.

As Pajot returns the nestlings to their box, "Red-white-red" lands on a nearby branch. The bird flies to the box entrance, looks around, and then hops inside. Immediately, Handel picks up the broom and extends its length to cover the entrance to the hole. "Whew, she made that easy for us!" Pajot climbs the ladder again, this time equipped with a mosquito head-net, which she uses to cover the hole. After a several-minute wait that leaves the pair wondering if the bird escaped unnoticed, "Red-white-red" launches headfirst into the fine mesh. Pajot gently removes the bird from the net and places her in a small cotton bag for safe transport back down the ladder.

"Red-white-red" peers out from behind her absurdly large beak as Pajot examines the bird's plumage and measures the amount of body fat. Her feathers are darker than normal and look unkempt and ragged. "Red-white-red" and other similarly deformed chickadees struggle to perform basic daily activities, such as eating and preening. Handel explains that she has trimmed overgrown beaks in the past, but the deformities regenerate quickly and clipping provides only temporary relief. In Alaska's harsh winter climate, the ability to stay warm and well-fed is a bird's lifeline. Chickadees have several adaptations for survival at northern latitudes, all of which become compromised by a physical deformity. They store and metabolize approximately 10 percent of their body weight in fat each day and often enter a regulated state of hypothermia at night, aided by the insulation of well-preened feathers (Chaplin 1974, 1976; Sharbaugh 2001). Mortality rates of deformed birds are probably higher than those of normal birds, especially during the shortest, coldest days of winter. Several deformed chickadees with dirty, almost jet-black breast feathers have been found dead at residences in winter, most likely due to starvation or hypothermia.

Handel measures the length and amount of crossing of the beak, and draws a sketch on the data sheet for future reference. Pajot prepares a needle and a vial of preserving solution. The tiny blood sample, retrieved by lightly nicking the brachial vein along the bird's wing, will be used to assess potential DNA damage. Results indicate that deformed birds have more chromosome damage than normal

An important question remaining to be answered about beak deformities in crows, chickadees, and other species is whether an association exists with human communities. Deformed birds like this **Northwestern Crow** may be especially attracted to human food sources if they are unable to forage naturally. *Juneau, Alaska; 20 August 2006. © Ben Mitchell.*

birds, which can be caused by disease or exposure to contaminants (Custer et al. 1994). Laboratory tests have not identified any evidence of disease or parasites in this individual or other chickadees, however, and data on contaminants remain inconclusive (Handel et al. 2006).

Other large clusters of birds with beak deformities have been associated with exposure to contaminants, particularly PCBs, PCDDs, and PCDFs (Gilbertson et al. 1991, Ludwig et al. 1996). Although Alaska is considered a relatively pristine environment, with few toxic release sites, there is increasing evidence that long-distance atmospheric transport is a significant source of pollution in the Arctic and Pacific Northwest (Blais et al. 1998, Bailey et al. 2000). Chickadees and other Alaskan birds could be exposed to contaminants through natural or human-provided foods, by foraging on contaminated surfaces, during cavity excavation or nest building, or through inhalation of airborne contaminants.

Results from tests for contaminants offer some support for organochlorine compounds as a potential cause of beak deformities in Alaskan chickadees. Handel and colleagues (2006) found that PCBs were ubiquitous in chickadee eggs, nestlings, and adults, and were correlated with beak deformities and decreased hatchability. However, concentrations were below known toxicity levels and require further study. Due in part to chickadees' small body size, laboratory tests for PCDDs and PCDFs (the most toxic of the organochlorine compounds) were not sensitive enough to detect potential differences between normal and deformed birds and require further study (Handel et al. 2006).

Handel gently extends the bird's wing. A small patch of dark red blood stains the tiny cotton ball held against the needle prick, but the bleeding has stopped and the bird is ready for release. "Red-white-red" attempts to bite her captor, but the overgrown beak glances uselessly off Handel's thumb. Handel opens her hand, and the chickadee, startled by the sudden freedom, darts toward a feeder in the yard. "Red-white-red" perches on the wooden lip, attempting to smooth her ruffled feathers. Soon, she gives up this futile task and turns her attention instead to the feeder's ready supply of sunflower seeds and suet.

Researchers suspect that feeders, although critical resources for severely deformed birds, could be contributing to possible nutritional deficiencies that may affect beak

Along with Black-capped Chickadees, increasing numbers of other species have been documented with similar beak deformities in Alaska and the Pacific Northwest. Local birders have reported at least 150 deformed Northwestern and American Crows from more than 30 communities throughout this region. (The bird pictured here is from the zone of overlap between the two crow species and cannot be conclusively identified from this photograph.) *Edmonds, Washington; 8 August 2006. © Kevin Mack.*

Beak deformities examined in Alaskan birds appear to be a product of excessive keratin growth, and the upper mandible is often elongated and decurved, as with the **Northwestern Crow** pictured here. In some cases, the beak may also be crossed or have a pronounced gap, preventing the beak from closing normally. *Mukilteo, Washington; March 2003. © Judy Rowe Taylor.*

growth. Resident birds could develop nutritional deficiencies from incomplete diets, particularly if they are overly reliant on sunflower seeds at feeders or other human sources of food that are low in calcium and vitamin A and high in fat, which can interfere with calcium absorption. In addition, during short winter days, birds might not get adequate sources of vitamin D_3 from sunlight. Handel and others hypothesize that nutritional deficiencies might be compounded by other physiological problems, such as exposure to low levels of contaminants (Rice et al. 2003, Handel et al. 2006). For example, cormorants from Great Lakes colonies exposed to low PCB levels developed beak malformations only after being held in captivity for two weeks without natural daylight (Kuiken et al. 1999). Thus, there could be a synergistic condition involving low levels of PCBs or other contaminants and deficiencies of calcium and vitamin D_3.

"Red-white-red" probes inside the feeder unsuccessfully, unable to close her beak around a seed without bumping the tips of her elongated beak. Finally, she resorts to picking through shells beneath the feeder and occasionally finds an already-husked seed. Getting the seed from ground to mouth is no easy task, however, and involves a complex repertoire of motions. She bends over, turns her head sideways, and grasps the seed at the contact point between her upper and lower mandibles. As she raises her head, the seed drops from her mouth and she begins the laborious process once again. With another long winter just months away and a deformity that appears to be increasing in severity, this bird faces diminishing odds of survival. Alarmed residents call Handel's office frequently to ask what they can do to help "their" deformed birds, especially during winter cold snaps. Handel and Pajot provide recipes for "Birdie Corn Bread", which is nutritionally balanced and easy for deformed birds to eat, but can offer few other suggestions. Despite the concern of local birders, such calls are often followed by delivery to Handel's office of a tiny corpse, shrouded in paper towels or cloths.

Scientists and the public agree that this disturbing cluster of beak deformities demands further study. The growing number of species and broad geographic area affected suggests an ecosystem-wide problem with serious implications for wildlife. Handel and her team continue to investigate the cause of these deformities and recently expanded their research to include Northwestern Crows. Birders from communities across the Pacific Northwest have reported growing numbers of deformed crows, and the total number of documented observations for this species is second only to that of Black-capped Chickadees. Crows with beak deformities have been reported in south-central Alaska and along the coast to southeastern Alaska, British Columbia, and Puget Sound in Washington State. Unlike insect- and seed-eating chickadees, Northwestern Crows use a very different part of the ecosystem. They feed in the intertidal zone on mussels and other filter feeders (Verbeek and Butler 1999), and presence of deformities in this species indicates that both terrestrial and marine systems may be affected.

Crows pose different benefits and challenges for study than chickadees. Due to their larger body size, crows are better candidates for the testing of certain contaminants. In particular, Handel's team will focus on PCBs and dioxin-like compounds that have been implicated in other cases of beak- and keratin-specific abnormalities. Catching crows, however, is not for novices. Outsmarting wily corvids requires sophisticated techniques, junk food bait, and, most importantly, patience. Instead of sunflower seeds and peanut butter, crow traps are baited with whole hot dog buns, peanuts in the shell, and partially opened fast food bags.

At a waterfront site in Seward Alaska, where residents have reported several deformed birds at the supermarket parking lot and small boat harbor, two members of Handel's team set up a drop net trap. The biologists scouted the site on three previous occasions, and after a cold snap that presumably left local birds hungrier than usual, they decide to launch their initial trapping effort. Several hours of hiding behind a snowy dock on their bellies, however, bring them no closer to crows in the hand as they watch birds walk gingerly around the outside of the trap. A single deformed crow, feeding among a small flock of birds in the intertidal zone, also shows little interest in the trap's bait.

Just as the pair decides to pack up and admit defeat, a noisy scuffle breaks out among the flock and sends crows hopping and flapping on the beach. Distracted by the uproar, several birds unknowingly enter the target area of the hanging net. With little time to think, the biologists pull

the trigger and the net falls quickly over three birds. Nearly as startled by their unexpected success as the captured birds, they run toward the net and find the deformed bird among the captured trio. The method is far from perfect, but with a little luck, just might do the trick.

Although many questions remain, Handel and her team are hopeful that Northwestern Crows will provide important clues about the cause of Alaskan beak deformities. Updates on research efforts can be found online <alaska.usgs.gov/science/biology/landbirds/beak_deformity/index.html>. Reports of deformed birds in your area will help determine the extent of this problem, and photos are especially informative.

Data can be reported online <alaska.usgs.gov/science/biology/landbirds/beak_deformity/observerreport.html> or by contacting the author.

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