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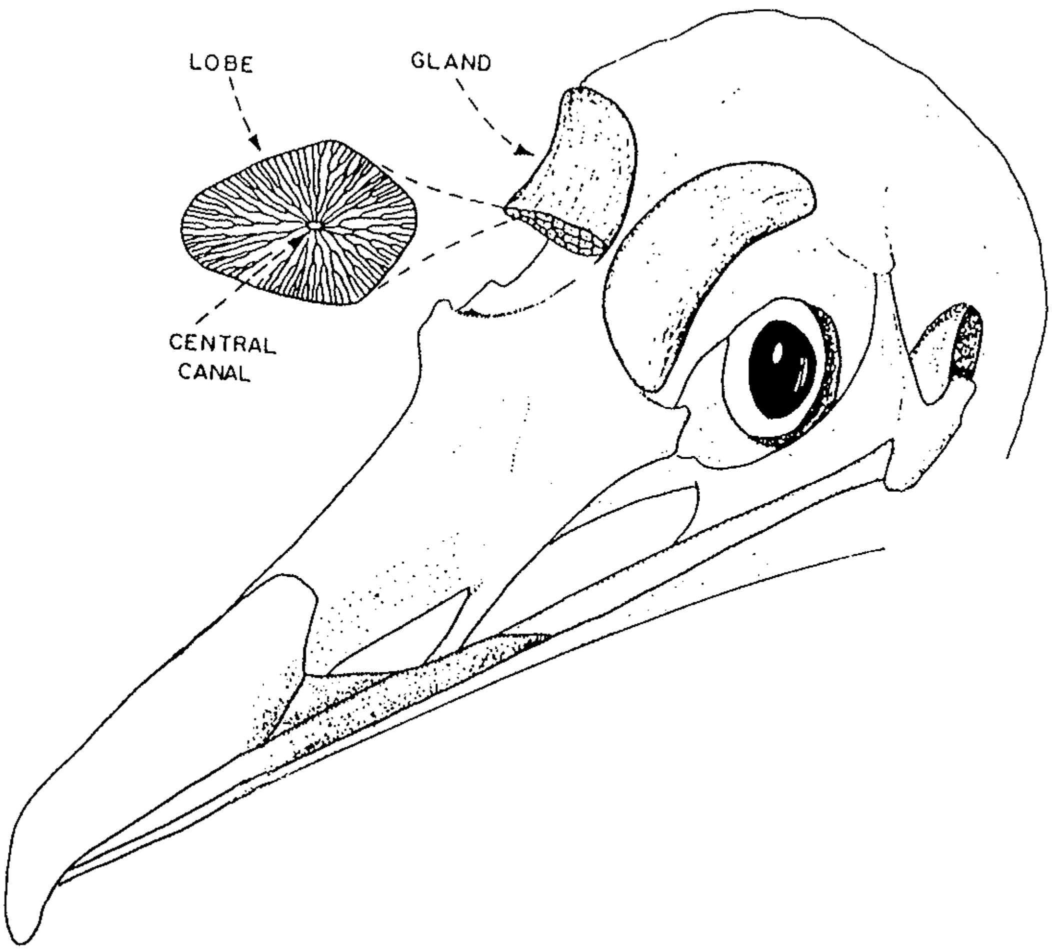

Nasal gland of a Herring Gull used to excrete salt from sea water.

Special Topics Issue: Water and Seabird Rehabilitation

Guidelines for Authors

The *Journal of Wildlife Rehabilitation* is designed to provide useful information to wildlife rehabilitators and others involved in the care and treatment of native wild species with the purpose of returning them to the wild. All feature articles are subject to a review process, and our staff and reviewers work with authors to produce the most accurate information possible in our ever-changing field.

The *Journal of Wildlife Rehabilitation* has various feature categories. We solicit submissions in the form of feature articles, rehabilitation notes, book reviews, news articles related to major events in the field, and selected case studies. Articles on veterinary medicine as it relates to wildlife rehabilitation are also welcome. We would like to expand the *Journal of Wildlife Rehabilitation* to include wildlife rehabilitation articles from countries outside the United States and welcome inquiries regarding such articles. We also have two short features we use for basic information: "For The New Rehabber" and "Simple Things That Make a Difference." They are intended for basic information or new ideas that are easily demonstrated with a short text and photos. All authors receive a $25 honorarium for each article accepted for publication or provide a one year membership or renewal.

Submission Instructions

1. An original and two copies of the manuscript should be submitted to the Editor, IWRC, 4437 Central Place, Suite B-4, Suisun, California 94585, USA. The manuscript should include references, photo legends, and footnotes, and should be typewritten, double-spaced, if possible. The author's name, address, and phone number should be placed on at least the first page of the article so it can be readily identified and the author contacted. Please note that each article should be accompanied by an abstract and a set of key words. If tradenames are used for products mentioned the author must indicate whether the product is ™ or ®. A product table at the end of the article should give readers the name and address of the companies involved and generic name or category of product.

2. The *Journal of Wildlife Rehabilitation* is prepared on a Macintosh personal computer with desktop publishing software. If papers are already on a personal computer disk, the submission cover letter should include that information, as well as what type of hardware and software systems were used. Obviously, being able to use the author's disk directly or translate it by machine to Macintosh format prevents input errors and speeds up the process. We are able to translate many IBM files provided that the software (including version) are written on the disk.

3. Manuscripts are received with the understanding that they have not been accepted for publication elsewhere. **It is the author's obligation to obtain permission or reprint rights if the submitted copy has been published elsewhere.** All accepted manuscripts are subject to editing. Unused manuscripts will be returned.

4. A separate page should be submitted with a short synopsis of information on the background of the author. Included should be the name, address, rehabilitation organization, phone number of the author and a biographical paragraph. Where appropriate, please list any academic degrees, special training, or experience that is relevant to the article (i.e., physical therapy—RPT, etc.) Articles pertaining to areas of veterinary medicine that involve tasks or decisions requiring a licensed veterinarian (e.g., soft tissue or orthopedic surgery) require a veterinarian as either the author or a co-author.

5. Black and white photographs are preferred for use in the *Journal of Wildlife Rehabilitation*. When no other option is available, color prints can be converted but this is costly and to be avoided when possible. Photo credits should be listed with the photographs.

6. Acknowledgments are limited to people who have contributed to the article in a major way.

7. References should be noted in the text with the last name of the author and the year published (i.e., Leighton, 1983) and listed at the end of the manuscript in alphabetical order in the following style:

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Editorial . . .

Seabird Conservation Can't Wait!

As you have probably noticed, this issue of the journal has a focus on seabirds and waterfowl. While most of these types of birds are not high profile as are California Condors or Peregrine Falcons, some populations of these birds are in decline and deserve special efforts. I recently looked at the 1996 Watch List from the American Bird Conservatory, a list designed to help focus attention on species in significant difficulty, and I noticed that a variety of water-related species had made the list. Birds listed with the highest priorities include the Black-capped Petrel, Steller's Eider, Black Rail, Mountain Plover and Limpkin. Those with high priority include the Black-vented Shearwater, Ashy Storm-Petrel, Reddish Egret, Black Oystercatcher, Long-billed Curlew, Buff-breasted Sandpiper, Hudsonian Godwit, Red Knot, Franklin's Gull, and Xantus' Murrelet. Only three water birds made it down to the level on moderate priority, the American Bittern, Emperor Goose, and the Black Tern.

Wildlife rehabilitators see many of these birds and we too can play a role in their conservation. Keeping records on the birds can help biologists document impacts. What kinds of impacts? Well, besides the obvious problem of oil spills, some of these species present with injuries related to fishing, other toxins such as pesticides, or predation by introduced species. Additionally, we have natural phenomenon such as the periodic El Niño episodes that often result in many starving birds brought in for care. Starvation is a result in a shift in food availability due to the warming of the waters. This year we have seen one of the largest El Niño currents brewing ever and when natural events are complicated by man-made threats such as a recent oil spill, life becomes even worse for seabirds.

Seabirds have other problems at their breeding colonies. In the last hundred years, human activities have introduced predators such as rats (from ships), feral pigs and foxes (old fur trade releases)—all of which can and do create havoc on islands where seabirds breed. And then there are the more subtle changes from human habitation. Increases in garbage and dumps are an example of how people can inadvertently create conditions which favor one species (gulls) over others (Atlantic Puffins). I won't even bring up the issue of feral pets such as cats and dogs which also can and do hunt mainland birds.

While rehabilitators can't do much about the breeding colony problems, we can learn as much as possible about the captive care and medical needs of these birds. If the need arises for captive breeding and we have done our 'homework' (i.e., learned how to provide captive care and medical support) and if we have published what we have learned, our work may serve as the foundation for conservation programs. While we don't generally impact large populations with rehabilitation efforts, we may impact small ones and if you think about it, those are the ones most in need.

It is through publications such as the journal that IWRC can assist species in decline. In this journal we offer readings on natural history and anatomy of seabirds, rehabilitation of goslings, a care tip on housing water birds and a book review on a recent book on captive care of waterfowl. We hope that you will find the information helpful. Incidently, special topics issues are usually done annually and this is the time of year we do the planning. If you have an idea for a special topic issue, drop us a line or email us at iwrc@inreach.com.

-Jan White-

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Life on the Ocean Wave: Anatomical Adaptations of Seabirds To Their Environment

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ABSTRACT

Seabirds constitute a group of birds that have adapted to a highly specialized pelagic lifestyle. This article reviews the anatomical adaptations of seabirds and provides insight into rehabilitation by understanding form (anatomy), function (physiology) and natural history.

KEY WORDS: pelagic birds, natural history, olfaction, propatagium, subcutaneous emphysema, salt or nasal gland, powder down, anemometer, Herbst corpuscles.

Introduction

Seventy one percent of our planet's surface is covered by water, approximately 140 million square miles of it. That translates into approximately two and a half square miles of water for every square mile of land.

Pelagic (ocean-going) birds have the freedom of the seas and wander them in numbers that stun the imagination. Storm-Petrels may be the most common bird in the world with estimates going into tens of millions. Albatrosses spend most of their lives soaring the stormy latitudes of the roaring forties, circling the entire Antarctic continent. The Arctic Tern manages to live a life of endless summer by criss-crossing the globe and avoiding the problems of winter.

This is a world that is not easily accessible for a lot of us and far remote from our environment. Pelagic birds live a secret life only allowing us once in a while a brief glimpse at them as they disappear behind a wave. We are largely ignorant of what most seabirds do out there. It takes detailed attention and highly skilled and patient observers. These sea travelers, masters of the air, allow us to observe them more closely and for a longer period of time when they come ashore to breed. In this environment they appear clumsy and are at a disadvantage on their breeding cliffs, because they are not in their element.

The biological success of seabirds is directly related to their mastery of the air and water. Millions of pelagic birds make a living on the ocean waves and must learn to cope with a vast open ocean with extraordinary adaptation. They tend to be nomadic, traveling great distances in search for food. Seabirds feed either from the surface or in the top 50 m of water and must find areas where this thin layer contains plenty of food. There is no where to perch but on the heaving wave, maybe a piece of driftwood or occasionally a ship. They must bear both calms and violent storms. Pelagic birds also endure climactic extremes during migration and live comfortably in polar cold or in tropical heat due to their feathers. Birds are, however, larger the further they live in the Arctic or Antarctic regions, since larger size reduces the ratio of body area to mass and so reduces heat loss. Most of them spend their entire lives at sea except for the breeding period on some remote island. They needed to adjust to a demanding environment in their evolution to meet these requirements. There are vast quantities of food in the sea, but it is a hard place to live and birds must be superbly adapted to an unusual lifestyle.

Out of more than 9,000 different bird species there are 390 species of birds in nine orders that swim habitually, and approximately 300 of them can be called seabirds. We differentiate "deep-sea sailors" like albatrosses and shearwaters (albatrosses are also scavengers like storm-petrels), "coastal fisherman" like cormorants and gulls, "divers" that spend only part of the year at sea like loons and grebes, and sea-ducks that specialize in shallow water diving. Pelagic fish-eating birds that take their prey by lengthy underwater pursuit in the Northern Hemisphere are murres and auks (Alcidae) while in the Southern Hemisphere they are penguins, (Sphenisciformes) and diving petrels (Pelecanoididae).

Food competition between murres (Alcidae) and other birds at the same trophic level (surface-feeding) like kittiwakes, fulmars, guillemot and the Arctic Tern is limited, because murres have an advantage—they can dive much deeper and have an advantage utilizing a larger variety of food.

One group of seabirds makes a living as "general-purpose opportunists." Many of them are confirmed ship-followers and are keen on galley waste. Fishing boats can provide a significant source of high caloric food and the wasteful habit of dumping is a blessing for them.

There is also a group of "thieves and pirates" specializing in kleptoparasitism. They threaten and steal food from others. Fish dangling from the bill of a puffin is very tempting to other birds. The most common thieves are Arctic and Great Skuas (jaegers), gulls, kittiwakes, Razorbills, terns, and frigatebirds. They use threatening movements, long-distance chases and often successfully attack birds midair in flight. They force them to regurgitate their catch or drop the fish they are carrying so they can harvest their prey. Skuas also take young puffins and kittiwakes when they get the chance and frigatebirds take tern and shearwater chicks.

Food

The food available to sustain sea-going birds relates in quantity indirectly to the concentration of nutrients in upwelling waters. Together with the power of the sun's light and warmth, and the minerals the sea has to offer, the Phytoplankton can flourish in the continuous daylight of the Antarctic summer. These "meadows" of plant plankton are "grazed" by animal plankton or Zooplankton, which in turn feeds the krill, swarms of small shrimp like organisms whose numbers can exceed 30,000 in a cubic yard of water. These tiny morsels are hunted by larger invertebrates and by fish. Arctic Cod is of major importance in the diet of murres and this fish plays a pivotal role in the marine food web. Krill can sustain all the larger marine life of the region, from small fish to huge whales, and every sort of seabird, whether they feed directly on the krill or on the abundant fish species higher in the food chain. Those crustaceans, mollusks and small fish are hunted by larger fish, and by birds, seals, whales and man.

Tropical oceans maintain the lowest level of food production and the fish are usually larger in warm water. A greater variety of seabird species may be recorded there. Plunge-diving is usually the best technique to make a living at these latitudes together with surface feeding. Seabirds of tropical and sub-tropical latitudes tend to be more sedentary, because there are seasonal differences in weather.

If one wants to observe sheer numbers of birds, one has to go to the polars region. There are fewer species, which have been able to adapt to the demanding conditions in high latitudes. Between 40° and 60° South the sea abounds with krill. They multiply to staggering numbers and are carried north by the currents to be eaten by equally staggering numbers of birds: penguins, prions, shearwaters and petrels—to say nothing of whales. In the northern polar region the majority of fish are smaller, feeding directly on the plankton community. Little auks and some of the murrelets developed gular pouches for carrying large quantities of plankton. Cassin's Auklet can carry more weight in plankton than a puffin can carry in fish, yet it is only about one third the size.

Availability of food can vary unpredictably during the course of the seasons due to wind directions, currents and weather conditions in general.

Feeding Techniques

Seabirds live more or less exclusively on animal matter from Zooplankton to fish and therefore have developed a broad arsenal of hunting techniques. Albatrosses and shearwaters may duck under the surface and peck, or pluck from the surface in flight. Diving petrels plunge into the waves after shrimps and small fish from very low altitudes. Storm-petrels feed on the wing, feet dangling and "walking" on the water, picking food from the surface.

Double-crested Cormorants fish cooperatively, driving schools of fish into shallow water to concentrate them. White Pelicans also do so, working in a side-by-side formation advancing on a shoal with their great beaks scooping in the water. Brown Pelicans have a more spectacular technique, diving from a height in active chase of individual fish. The seemingly clumsy impact of pelicans serves the useful purpose of temporarily disorienting the prey which is promptly gathered into the bag. The pelican's pouch is a trapping device, a scoop rather than a dip-net, attached to their massive bill. The maxillary portion of the beak acts as a lid closing the lower mandible which is an elastic pouch and can hold several gallons of water. The water is drained off and the catch is swallowed whole—head first.

Plunge-diving is characteristic also for gannets and boobies (Sulidae). Boobies spend much of their time gliding purposefully over the water, bill angled downward, watching the water surface for signs of fish. They can dive from varying heights of up to 33 m (100 feet) streaking downward at great speed. Boobies hit the water, folding their wings just before they go through the surface, like a stone with barely a splash. They do not penetrate deep into the water, resurfacing several meters away with their catch. Their buoyant plumage would make it difficult for them to dive very far down, but it is the speed of entry into the water which gives the required impetus for a brief underwater chase. The large webbed feet work like rudders for underwater maneuvering. A tapering, pointed bill with serrated edges is ideal for grasping a slippery fish for gannets, boobies and mergansers. The Blue-footed Booby will also catch fish by diving below the water from a swimming position on the surface.

Typically boobies spread out over the sea so they can just see one another at a distance. If one plunges into the sea, the splash alerts distant colleagues to the action and in no time that first bird is joined by many others. Boobies will cooperate as a flock a by whistling a rallying call to indicate when fish are found. The rest of the group follows the first diver, synchronized in their movements. Boobies prefer early morning and late afternoon for hunting to avoid the attention of the frigatebirds. The lighter, more maneuverable male booby specializes in catching small fish and the heavier female catches larger fish further offshore in deeper water. Between them they exploit a wide variety of prey.

To absorb the shock of impact while diving for food, Pelecanidae and Sulidae have a system of air pockets under the skin (physiological subcutaneous emphysema) that forms a spongy protective mattress. It is an extension of the airsac system to cushion initial impact. It extends into the legs, which also makes it challenging to get into a vein when drawing blood.

Another anatomical adaptation to this life style is the nostril system. To avoid water forcing itself into the nasal cavity and oropharynx when diving into the water the nostril system is either modified—reduced to a narrow slit or sheltered by a horny flap—or completely closed.

Birds that plunge into water do not have external nares—they are occluded so they must breathe through their mouths. The nares are entirely absent in adult gannets (Sulidae), frigatebirds (Fregatidae), adult cormorants (Phalacrocoracidae), and Anhingas (Anhingidae). pelicans (Pelecanidae) are partially blocked: Brown Pelicans have a narrow slit while White Pelicans have a more generous slit opening. Oral respiration means special modifications of the structure at the angle of the mouth. When handling these birds do not keep their beak closed for a long period of time to control the head for they will suffocate. Keep the beak open by putting a pencil in between the maxillary and mandibulary portion of their beak so they can breathe while you are holding them.

Puffins do not have an extensive crop area in which to collect the small fish they then feed to their chick. Thus they carry mainly sandeels, herring, sprats, and capelin locked between the hornae papillae on the upper palate and the cornified fleshy tongue. Additional grooves on the oversized bill help to hold these fish in their beaks as they continue to dive for more. As they mature the number grooves on the massive beak increases and the skill level improves. However simple the mechanism for holding the fish, it is still remarkable that a bird can carry several fish, and chase, catch and hold another at the same time. Most seabirds carry just a single item back to their chick, but puffins can carry an average of 22 small fish at one time with their fish-heads locked in the beak grooves and with dangling bodies outside. What a remarkable sight for a little bird and quite an invitation for kleptoparasitism. The record is held by a puffin which had 61 sandeels and a rockling clamped in its beak (Harris 1984). Puffin have an intermediate tongue between the larger, slender, rigid tongue of the guillemot and the fleshy tongue of plankton eaters (Little auk) which allows the puffin to eat both fish and invertebrates (mainly in winter).

In tropical waters the main food source is squid and flying fish, which are chased both in the sea and over it. Tropicbirds are most active at dusk, plunge-diving for squid which rise to the surface during that time. Terns also plunge for their food, but from a lesser height, and they hover like kestrels before they commit themselves to the descent. They pick or scoop small fish from the surface with their straight, sharply pointed bills, without getting their feathers or even their feet wet. They do not rest on the water but perch on a piece of driftwood or may stay in flight for months without difficulty. These terns or' sea-swallows' enjoy a life of perpetual summer, always where the feeding is at its seasonal best, breeding in one hemisphere and "wintering" in another.

Skimmers fly above the water surface, with the lower mandible held down, knifing through the surface water. When it touches something, the shorter maxillary portion of the beak closes with a snap holding on to its prey.

Phalaropes are the only shorebirds that spend much of their time at sea. They stir up aquatic larvae by paddling "on-the-spot" in furious circles spinning on their own axis to create a very local upwelling of food items.

Coastal species tend to come ashore by day or night, depending on their feeding preferences. Gulls have a sort of general-purpose shape combined with an opportunistic mind—true survivors.

The body of a typical flying bird is streamlined, broad and blunt in front, tapering to a slender tail. The typical diver's body on the other hand is long and cylindrical, and its center of gravity is placed toward the rear. For paddling in water, legs should be located near the rear, where the leg muscles interfere the least with the streamlining of the body, and where they can best control steering. Surface ducks tip their bodies head down and tail up to reach for food in shallow water.

Diving ducks submerge completely with quick, arching dives from the water's surface, and feed at various depths in the water. They hold their legs extended back, propel themselves with their feet and hold their wings tightly against the body. Both feet stroke simultaneously, while coots paddle alternately. Penguins, loons, grebes, cormorants, and auks all have relatively solid and heavy bones.

Penguins, shearwaters, diving petrels, cormorants, auks, and guillemots use their wings to swim underwater. Large wings are a handicap underwater because their friction with the water slows the bird down. Better divers have small, thin, muscular wings, which means poor flying ability. Gentoo Penguins were timed by Murphy (1936) swimming underwater at 36 km/hour—a respectable flying speed for some birds.

The majority of dives are under 5m in depth and diving birds rarely stay underwater more than a minute. Loons have been known to stay submerged for 15 minutes and Emperor Penguins over 18 minutes. Most of the oxygen comes from oxymyoglobin of the muscles and oxyhemoglobin of the blood, and both of these substances are more concentrated in diving birds. During prolonged dives these birds can reduce their total metabolism by more than 90%. Emperor Penguins achieved dives whose maximum depth was 265 meters (875ft.) observed from underwater chambers. Loons have been taken in nets set 60 m (198 ft.) deep, cormorants at 40 m (132ft.), gannets at 26m (86 ft.), and grebes at 30 m (99 ft.) (Welty 1975). Murres were observed at oil drill stations by TV surveillance cameras at 200 m (660 ft.) depth. The trunk skeleton of a guillemot shows dorsoventral compression of the body, which is characteristic of diving birds. Protection against water pressure in deep dives is provided by the unusually long overlapping rib projections, or uncinate processes.

Structural anatomical changes for swimming and diving fulfill important functional adaptations. In diving birds the legs are moved to the caudal end of the body leading to an upright, slow gait as in murres and penguins. Loons and grebes cannot walk at all and are awkward on land. Do not, however, conclude that these species have a hip injury. Loons also have wing loading that requires them to bring their wings below the surface of the water in order to take off. Young inexperienced birds sometimes make a crash-landing on black, wet pavement , because it looks like water leaving them stranded.

The knee joint and proximal portion of the tibiotarsus show the most drastic changes in diving birds. The cnemial crest on the proximal tibia head is well developed in loons. It extends proximally far beyond the surface area with the distal femur to enlarge the attachment area of the powerful extensor muscles of the leg. The muscles are proximal at the upper and lower thigh continuing as tendons to the distal end of the leg. This enables us to find the medial metatarsal vein very easily, which is the best location to draw blood in birds.

Olfaction

At sea a good sense of smell can be lifesaving because of the vast territory utilized in search of food. Tube-nosed birds are guided by their sense of smell to a good meal (like a whale carcass) from quite a distance away and flock to the feast. Giant Petrels especially excel at this useful task, which tidies the ocean.

In most birds the nostrils open into the nasal cavities at the base of the bill. Several specializations occur in different bird species according to their lifestyle. In the Procellariiformes (Tubinares) the nares are located in forwardly directed tubes formed from separate elements of the rhamphoteca, the keratinized sheath covering the upper beak. The nostrils extend as tubes along the bill with rostral openings.

Birds, with rare exceptions (gannets, frigatebirds, pelicans, cormorants, and Anhingas), breate through their nostrils and the funneled air is forced to pass over complex and convoluted surfaces of the nasal passage.

The Procellariiformes have unusual large olfactory lobes. These birds apparently use their sense of smell to track down food and seem to be able to smell meat, blood, and ground-up squid and fish oil floating on the sea surface. Some seabirds like the prions and White-chinned Petrels behave like bloodhounds in the Antarctic territory. These birds may locate Zooplankton, by following

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Rehabilitation Notes: Canada Geese (*Branta canadensis*) Part 1. Goslings: Hatchling to Flight Stage and Release

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ABSTRACT

Canada geese (*Branta canadensis*) fly migration routes through the four major flyways in North America, and successfully nest in a wide range of habitats. Canada geese are remarkably good parents; however, orphaned goslings are often the product of the negative impact of humans on traditional Canada goose nesting areas. Successfully rearing non-imprinted or habituated Canada goose goslings to flight stage and reintroduction to wild habitat requires a working knowledge of their natural history and conscientious attention to diet, housing, and socialization.

KEY WORDS: Canada geese, Canada goose goslings, monomorphic, gander, gosling husbandry, release criteria.

Introduction

The Canada Goose (*Branta canadensis*) is indigenous to North America. Canada Goose habitat extends south from their Arctic breeding grounds to wintering habitat in northern Mexico (Bellrose, 1980). Wildlife biologists currently recognize eleven subspecies or races, with a morphological range from 1.4 kg for the Cackling Canada Goose (*Branta canadensis minima*) to 9.1 kg for the giant Canada Goose (*Branta canadensis maxima*). There is much mixing between races; therefore, wildlife biologists often identify Canada geese by their geographic fidelity, or by their size, such as small, medium, and large. Canada geese have adapted reasonably well to the encroachment of humans on their ancestral habitat, and the species has greatly benefited from waterfowl refuges and commercial grain production. Conversely, environmental contaminants and negative interactions with humans in urban areas jeopardize these animals. Canada geese may require rehabilitation for a variety of reasons. In urban areas goslings may become separated from their parents on treks from the nest site to habitat more appropriate for raising young. Both adults and young may be injured from attacks by raccoons, dogs, Snapping Turtles, or other predators. Injuries may also result from fishing line entanglement, encountering motor vehicles, lead toxicity from ingesting lead shot or fishing weights, or improper restraint by humans.

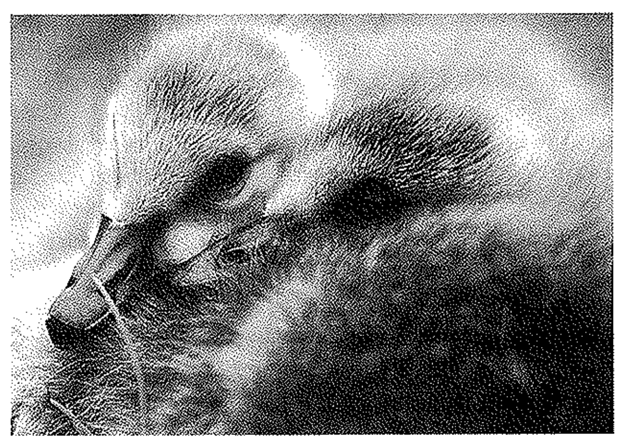


Photo courtesy of Kit Howard Breen.

Adult Description

Canada geese of all races have black legs and feet, and a black bill; black neck and head with a white cheek patch; dark brown to gray-brown wings, back, sides, and breast; white belly, flank, and undertail coverts; and black tail feathers separated from the rump by a white V-bar. Canada geese are sexually monomorphic. There is no eclipse phase.

Juvenile Description

Canada geese less than one year of age exhibit an indistinct color division between the neck and breast, and the tips of their tail feathers are notched, rather than rounded. At 1.5 years of age, geese have replaced most of their body feathers with adult feathers except for the primary wing feathers that are pointed, rather than rounded on juveniles (Moser, Craven, and Miller, 1991).

Natural Diet

Canada geese are herbivorous and eat grasses, grains, and aquatic vegetation. Preferred grasses include wheat (*Triticum*), ryegrass (*Lolium perenne*), clover (*Trifolium*), and common landscape grasses such as bluegrass (*Poa pratensis*), and fescue (*Festuca*). Food preferences during fall and winter vary relative to geographic availability, and include grain crops such as corn (*Zea mays*), millet (*Panicum*), buckwheat (*Fagopyrum*), milo (*Sorghum*), and soybeans (*Glycine max*). Along the Atlantic and Pacific flyways, and on interior lakes and ponds, geese may forage for aquatic plants such as pondweed (*Potamogeton* ssp.) and cordgrass (*Spartina* spp.) (Martin, Zim, and Nelson, 1951). Captive Canada geese, however, have difficulty maintaining adequate body weight on high fiber diets (Owen, 1985), and should be offered, ad libitum, a commercial waterfowl diet such as Purina Duck Diet™ or Purina Mazuri Waterfowl Diet™ (Purina Mills, St. Louis, MO 63144). This food is formulated to meet the specific nutritional requirements of young waterfowl (Purina Duck Starter™ or Purina Mazuri Waterfowl Starter™), breeding adults (Purina Duck Breeder™ or Purina Mazuri Waterfowl Breeder™), or non-breeding juveniles or adults (Purina Duck Grower™ or Purina Mazuri Waterfowl Maintenance™). Do not substitute commercial foods formulated specifically for gamebirds, turkeys, chickens, or other avian species.

Nesting, Egg-laying, and Incubation

Canada geese may establish loose pair bonds, and attempt breeding, at two years of age. Successful breeding seldom occurs before the age of three (Bellrose, 1980). Geese mate for life and pairs forage, rest, swim, and fly together. Families remain in close proximity and fledgling offspring migrate with their parents to breeding grounds. There, they separate from their parents and join other non-breeders for the duration of the breeding season. In the fall, yearlings may rejoin their parents and the new fledglings for migration to their wintering grounds. If pairs are separated by death or distance, either sex may choose a new mate before the next breeding season.

Young Canada geese usually breed in the same area from which they initiated their first flight, and return to the same area each year to nest (Bellrose, 1980). Hand-raised, fully-fledged birds should, therefore, be released in areas suitable for nesting and raising young. Canada geese adapt to a wide variety of nesting conditions and sites, including islands, shorelines, artificial nests, cliffs, and tundra. Preferred habitat appropriate for release and breeding offers clean, open lakes or ponds surrounded with grass areas for grazing, aquatic vegetation for both food and cover, and nest sites with excellent visibility.

The goose rounds out a depression and lines the rim with vegetation pulled from the nest site. Egg laying is initiated before nest construction is completed. The nest bowl is lined with down pulled from the breast of the goose. Clutch size varies from one to twelve eggs, but averages five or six eggs (Bellrose, 1980). The goose incubates the eggs and the gander defends the goose and the nest from predators. A goose injured during the process of egg-laying should be fed a commercial waterfowl breeder diet to insure adequate calcium and protein levels. The incubation period varies with race from 24 days for the Cackling Canada goose to 30 days for the Giant Canada Goose (Bellrose, 1980).

GOSLING HUSBANDRY

Diet

Protein levels must be consciously managed in young waterfowl. High protein diets in waterfowl may result in death from renal failure or in leg and wing deformities (Ritchie and Harrison, 1994). From hatching to the end of the third week, offer goslings commercial waterfowl starter, with 20% protein, ad libitum, and access to spring growth of grasses such as ryegrass, clover, and bluegrass for grazing. Make every effort to provide goslings with grazing areas of spring growth grasses in protected pens during the critical period of growth to flight stage. From the beginning of week four to flight stage, protein levels should be reduced to 16-17%. Offer ad libitum a commercial waterfowl grower or maintenance diet, with 16% protein. At eight weeks add scratch grains (typically a mix of cracked corn, wheat, and milo) mixed 1:1 with the grower diet (Ritchie and Harrison, 1994, and author's experience). Provide grit, such as small cherrystone gravel separately. Waterfowl must have grit to process grain foods.

Oarwing

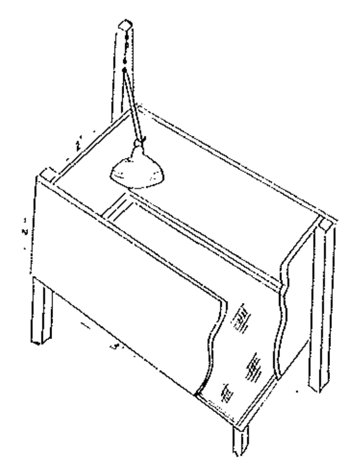
Wing abnormalities, particularly oarwing, or angel wing, are considered to be related to excessive protein in fast-growing birds (Ritchie, Harrison, and Harrison, 1994 and Robbins, 1993). Developing oarwing may be observed in goslings from approximately 3-5 weeks of age. The primary feathers, or lower section of the wing, appear to be growing outward and perpendicular to the body of the gosling. The primary feathers do not tuck under the secondary feathers of the upper wing as they do in normal development. The carpal joint is actually twisting under the weight of the primary feathers, and the goose will be permanently flightless if the condition is not corrected.

Oarwing generally can be corrected during the initial stages of primary feather growth by folding the wing in normal position, with the primary flight feathers under the secondary flight feathers and, with non-stick tape, tape the wing to itself. (Ritchie, Harrison, and Harrison, 1994). The wing should be so wrapped if oarwing is even suspected to insure proper development. After 3-5 days, remove the wrap, observe the wing feathers for normal positioning, and rewrap for another 3-5 day period if necessary. Generous access to green grass for grazing, spacious areas for exercise, and swimming opportunities are factors that may reduce the incidence of oarwing (Ritchie, Harrison and Harrison, 1994).

HOUSING

Hatchlings can be housed in brooders, such as commercial poultry brooders with a thermostatically controlled heating element, waterers, and food trays. A brooder box can be constructed to meet the housing needs of goslings from 1-14 days of age. Construct the brooder box of untreated plywood, 2' X 3' X 2', with removable, plastic-coated hardware cloth floors, and a corner post from which a heat lamp can be suspended. Construct one floor using 1/4 inch mesh for hatchlings 1-2 days old, and one with 1/2 inch mesh for goslings 3-14 days of age. All wood surfaces can be finished with epoxy which preserves the wood and makes the surface much easier to clean and effectively disinfect. Otherwise, use new flooring for each new group of goslings, and clean and disinfect all surfaces of the brooder box.

A 250 watt heat lamp bulb, 24-26 inches above the bottom screen, usually provides sufficient heat. Be absolutely certain the birds cannot come into physical contact with the lamp. Ambient temperature should be in the range of 90-95°F for newly hatched goslings. Place a thermometer on the lower portion of one of the walls and closely monitor temperatures. The behavior of the goslings is a good indicator of whether the lamp height should be adjusted. Goslings will move away from the lamp if the temperature is too high. If temperatures are too cold, they will huddle together, or pile up as close to the source of heat as is possible. With ideal brooder temperatures, the goslings will be evenly distributed over the floor or will form a circle around the perimeter of the lamp light when sleeping. If the brooder box is in a cool room, covering the wire mesh with brooder paper, or smooth woven cloth and paper towels, will result in higher temperatures. Brooder paper, or cloth materials, must be replaced often during the day to maintain a clean environment. A poultry waterer should be placed in close proximity to the feed tray and away from the heat lamp, as warm water is a media for bacteria. Water must be replaced at minimum twice daily, and the waterer washed in hot, soapy water every other day - more often in warm weather.



Brooder Box: Canada Goose Goslings

with access to an enclosed shelter with provisions for supplemental heat. A thermal gradient range of 70°F to 95°F inside the shelter will provide optimal choices for goslings up to three weeks of age. Housing should be lighted at night to allow goslings the opportunity to feed. The shelter should have a smooth, epoxy treated floor, covered with clean, dry wood shavings. All bedding must be kept dry because wet bedding and wet food are media for fungi growth, such as aspergillosis, a fatal disease. Remove wet material and dry the flooring before replacing bedding. The housing must be thoroughly cleaned and disinfected as often as necessary to maintain a healthy captive environment. Goslings should be housed in the shelter during periods of inclement weather, and at night to protect them from predation. Shallow pool(s), 4-6 inches deep, are beneficial for maintaining feather condition and for exercise. Step-ups made of untreated lumber from 1 to 4 inches thick will aid entrance and exit from the pool. Pools must be kept very clean to minimize disease transmission.

Fostering Canada Goslings

Canada geese adopt, or acquire, offspring from other Canada goose parents. Interior and large races accept orphaned goslings, so single goslings should be fostered with an adult pair and their similar-aged goslings. However, attempts to foster some of the small Canada species, such as the dusky (*Branta canadensis occidentalis*) and Aleutian (*Branta canadensis leucopareia*) races, are usually not successful. Canada geese have a well established dominance hierarchy and the single, hand-raised gosling will be at the bottom of the order, and will not have access to preferred foraging, swimming, or safe resting areas (Raveling, 1970). Hierarchy status is determined, in part, by the number of birds in a family (Raveling, 1970). Goslings of Canada goose races that do not readily adopt orphaned chicks should be raised with other Canada goslings, if that option exists. Artificially created families, such as a group of orphaned goslings, have a better chance of successfully competing for food and loafing areas.

Interior and large races usually accept orphaned goslings if the recommended protocol is followed. Fostering goslings provides the young with a much better opportunity for developing survival skills, and for appropriate species identification and sexual imprinting.

The foster family should have goslings of similar age and size, or slightly smaller, than the orphaned chick. Attempt the fostering on a day when the weather is warm and clear, and lake waters are calm. As a precaution, take catching nets (and a boat, if possible) to rescue the gosling if necessary. Transport the gosling to the lake site, and hold it in hand and in sight of the Canada Goose family, as you walk along the shore toward the family group. The gosling will usually peep loudly as you walk and its call will attract the attention of the adult pair. Walk slowly toward the goose family, and gently toss the gosling in the water as close to the adults as the geese will tolerate. If the parents will accept the chick, one of the adults will immediately swim toward the gosling and will take it back to join the family. Observe the behavior of the birds until you are assured the adoption is successful.

Fostering should be attempted only with healthy, self-feeding, and hydrated goslings. It cannot be human imprinted. Imprinting is the species-specific process by which species and sexual identity are established in waterfowl hatchlings. Initial imprinting begins prior to hatching with vocalizations from the incubating goose to her goslings at the time the eggs pip. The hatchlings recognize the unique vocal qualities of their mother and respond to her familiar voice by following her. This imprinting is critical to the survival of young waterfowl. In rehabilitation, however, a conscientious effort must be made to insure the goslings do not establish a bond or attachment to humans, or to any species other than Canada geese. A gosling unable to recognize other Canada geese as its species has a very poor chance to mate, to establish fidelity to a flock of other geese, and, in fact, to survive in the wild. From the first day the gosling is captive until it is fostered, the gosling(s) should be held in housing with a mirror along one side wall, natural feather dusters, and surrogate stuffed animals for comfort. Handling must be kept to an absolute minimum.

Feather Development and Age Determination

Normal growth weights for the various Canada Goose races vary widely (Sedinger 1988, and Yokum and Harris 1966). Therefore, plumage development is a more reliable indicator of determining gosling age, and monitoring normal growth, than is weight. The plumage development description in Table I applies to all races.

Table I

Plumage Development of Canada Goose Goslings

Age	Feather Description
1 week	Entire body bright yellow down, with a scattering of gray. Black, shiny bill, black feet.
2 weeks	Yellow fluff darkens to gray from top of body downward.
2 - 3 1/2weeks	Body dark colored except for yellow on the flank, breast, and head. First traces of wing and tail feathers. Legs and feet appear too large for the size of the gosling.
3 1/2- 5 weeks	Noticeable feathers on flanks, tail, and shoulders. Primary and secondary feather development appears —feathers are in sheaths.
5 - 6 weeks	No down on underside. Breast feathers apparent. White tail coverts and black neck color appear under down. Head is light-colored down. Back is dark down except for shoulders. Primary and secondary feathers erupt from sheaths.
6 - 7 weeks	Goslings vocalize a honking sound. White cheek patch appears. Feathers cover body except under folded wings, rump, head and neck. A band of white upper tail coverts contrasts sharply with black tail feathers.
7 - 8 weeks	Folded wings cover the entire back. Primaries are at 75% of their growth. Down still shows on head and black neck.
8 - 10 weeks	Primary wing feathers cross at base of tail. Goose completely feathered with the possible exception of traces of down on head and neck. White upper-tail coverts covered by folded wing. Flies well.

Release Criteria

Hand-raised juveniles should be released when healthy, waterproof, and fully feathered. Primary feather growth should be complete and feathers should be at the hard pen stage. Choose a release date after hunting season has closed, or in an area closed to hunting, during an expected three-day window of warm, clear weather. Transporting the birds in airline kennels will protect the feathers, bills and feet from injury. Choose a large, clean lake or pond, rimmed in part with aquatic vegetation, and surrounded by meadows or grain fields. Such an area would be suitable for nesting and raising young. Rehabilitators should be aware that release sites should be chosen where food supplies, safe resting areas, and open water are widely available to allow that single reintroduced goose access to food, swimming areas, and shelter without continually having to engage in agonistic encounters with more dominant Canada geese. Release Canada geese in close proximity to other Canada geese. However, allow a comfortable space, such as 25 yards, between the free-ranging geese and the reintroduced bird(s). Provide drinking water for geese if the distance to the release site requires more than an hour's drive. Reduce speaking to a minimum and do not make sudden movements. Carry the kennel to the shore and open the door to allow the goose an opportunity to assess its new environment. Do not force the bird to leave the kennel. Back away and observe from a hidden area, or from a distance. Allow the goose to exit the kennel when it wishes. Be certain the bird is interacting positively with the new flock and is a reasonable distance away before you remove the kennel.

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Continued from page 6

the odor of dimethyl sulfide (DMS), which is released when Zooplankton graze on phytoplankton (single-celled plants). Bernice M. Wenzel, of the University of California, Los Angeles, estimates that these birds can detect normal ambient concentrations of DMS from up to 4 kilometers away. Ornithologists have only recently accepted the idea that birds can smell at all. Most birds may rely more on visual cues but the significance of olfaction has been underestimated for a long time.

The most rostral portion of the nasal cavity regulates air flow and warms and moistens the incoming air. Inspired air is progressively warmed and humidified in this highly vascularized area and water is absorbed from the mucous carpet. On exhalation, the reverse process occurs. This process prevents undue loss of body heat and fluid imbalance.

The primary function of the middle area is to provide extra surface area to trap debris, with its ciliated epithelium enriched with large numbers of mucous glands. The ciliary action sweeps trapped debris and mucous though the choanal slit into the oropharynx, where it can be swallowed. This removal mechanism is a critical part of the respiratory defense system. The nasolacrimal duct empties into the lateral wall of the nasal cavity below the middle concha. The salt content of the tear secretion has bactericidal effects.

The caudal portion of the nasal cavity consists of the caudal dome-shaped concha, covered by a specialized secretory and olfactory epithelium. The endings of the neurons of the olfactory nerves are embedded in the membrane covering the small posterior concha. Nasal conchae are most often cartilaginous, but may be bony.

The Nasal Gland

The nasal gland (salt gland) is a highly efficient salt excretion gland that opens into the rostral portion (vestibular region) of the nasal cavity. This gland is of great importance to pelagic birds for osmoregulation. They can only drink seawater (3% salt solution—three times saltier than a bird's body fluid) and their kidneys are not efficient enough to extract enough salt from the blood stream. Usually more salt is excreted through the nasal gland than via the kidneys. There is also a positive correlation between the size of the salt gland and their excretory capacity. Mallards and godwits that live on seawater have larger salt glands than their relatives living on fresh water (Staaland, 1967).

Most pelagic birds can adjust abruptly to drinking fresh water but the salt gland needs to be reactivated before release. This is done by gradually increasing the amount of salt to a 3% solution, administered by gavage over a few days. This process is detailed by Holcomb (1987).

Although excessive salt amounts may be lethal to some birds, it is necessary to the diet in moderate amounts for various metabolic processes such as nerve-impulse transmission, blood clotting and bone formation.

Most of the time the gland lies within the orbit, beneath the supraorbital crest and therefore Heinroth called it supraorbital gland. The salt is removed in a liquid form (5% sodium chloride) by the nasal gland and drains via a duct along the lacrimal bone across the hinge of the upper beak. Salt drops can be observed running down the

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Simple Things That Make A Difference:

Portable Net-bottom Caging for the Bird on the Go!

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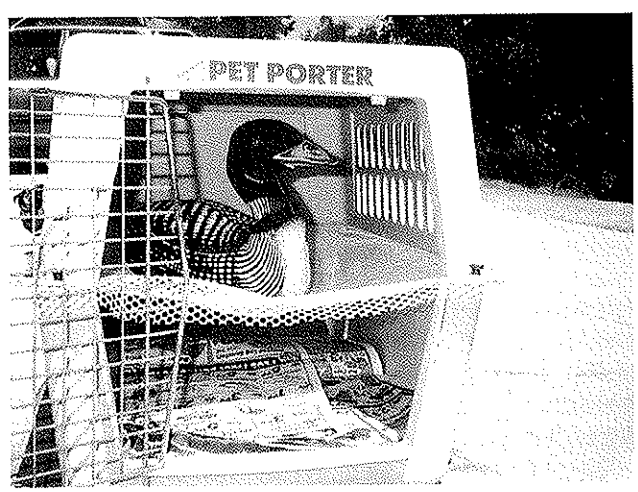
The benefits of net-bottomed caging for oiled seabirds has been known for some time (Holcomb, 1988). The give of the net distributes the weight of the bird more evenly, preventing keel sores. The net also allows feces to fall away, which prevents urate burns on the feathers. We have adapted the system for use where portability or isolation are necessary for seabirds and waterfowl. This housing was also used for two days with a crow that could not stand well due to a head injury. Its feet were wrapped to prevent the toes from catching in the net and as soon as it demonstrated some stability it was returned to normal caging.

Select a portable kennel at least two sizes larger than you would normally use for the size of the bird to be put in the carrier. There must be allowance for adequate headroom, as the bird is suspended almost at the midline of carrier height. The netting used must be knitted, having no abrasive knots at the joints of the mesh. Nylon 1/4" mesh is preferred due to its elasticity, washability, and soft texture. Larger mesh will allow feet and legs to get caught and finer mesh will not allow feces to drop through adequately.

Remove the top and door of the carrier. Place a piece of netting over the bottom of the carrier with at least one inch overlap all around. Use clothespins or tape to keep it in place while you set the door back in place then put the top onto the base. Put the bolts in on one side then grasp the excess net on the opposite side and pull to remove slack in the net before replacing the bolts in that side and the back. Put newspaper or paper towels in the bottom of the cage. Insert bird. To secure the netting at the front of the cage you may



either pull a bit of the net through the door in at least two places and put a piece of dowel through the mesh to hold it, or, my preference, use a small bungee cord to hold it.

Because seabirds eject feces in a jet, we use a light sheet to cover the side vents as well as the door to prevent wide distribution of the substance. This covering also prevents visual stress but care must be taken to maintain good ventilation.

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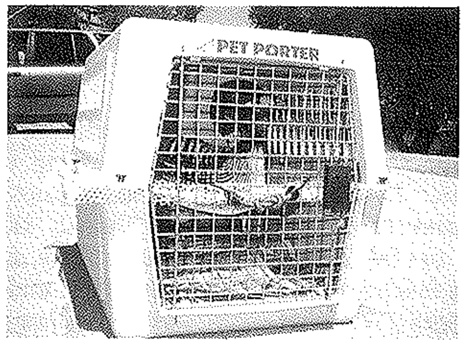
Author Profile

Susan Patton is the chair of the Oiled Seabird Project for the Pacific Wildlife Care in San Luis Obispo, California. A veteran worker of many oil spills and years of working with seabirds, she draws on her experience to share information with other wildlife rehabilitators.



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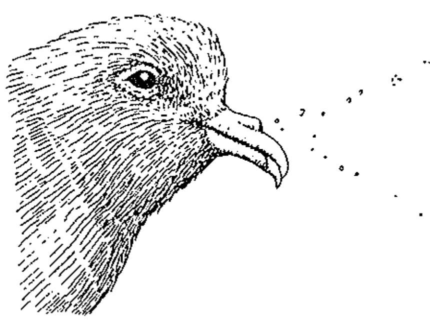
seabird's beak, dripping off the end of the bill, or being shaken from the bill by the bird, or being forcibly ejected through the nostrils as small salt droplets (see below). Birds usually cannot sneeze, so instead, they shake their heads from side to side. In the case of diving birds with no external nostrils, the liquid trickles from the internal nostrils to the roof of the mouth to be expelled.



Currents and wind

In contrast to deep ocean currents, surface currents are greatly influenced by prevailing winds. Seabird colonies abound in areas where the cold water of ocean currents meets warmer water to produce upwellings rich in food. These regions are also visited extensively by migrating seabirds.

Currents and wind influence food availability, and can either support a large number of birds or have a devastating effect on their survival rate. Contrary wind can temporarily reverse the flow and replace cold rich water with warm lean water. When the Humboldt Current fails to bring its mineral riches to the coast of South America, disaster threatens the vast congregation of seabirds off the coast of Chile and Peru, which produces the precious guano. When the warm El Niño current penetrates too far south it displaces the plankton-rich cold Humboldt Current from the coast. Vast shoals of anchovies come inshore to feed on the plankton, and move away as well. Cormorants, pelicans, boobies, fulmars and scoters suffer catastrophic losses. The result is bad news for both fishermen and fish-eating birds denied their food source. Food shortage is a very effective control on numbers. During El Niño years when warm lean water pushes tropical fish too far north up the west coast of the United States, west coast wildlife care centers have influxes of starving bird,s and are confronted with the dilemma of deciding whether to return them to an environment with severe food shortages. This year we have the same problem with hundreds of seabirds starving to death and washing ashore.

Penguins and diving petrels are confined to the Southern Hemisphere because the tropical warm-water belt of the equator offers no food to sustain them. There are no auks in the Southern Hemisphere occupying a similar ecological niche as in the Northern Hemisphere. The resemblance of the larger auks to penguins and the smaller auks to diving petrels can be explained by similar environmental pressures, that molded them to a similar appearance. Albatrosses are confined to the hemisphere they were born in because the calm air of the doldrums offers no lift for them to glide across.

Flight

The seabird is the perfect union of form and function. The bird's body must be compact yet light. The streamline form allows minimal air resistance and the bird's weight is close to the center of gravity—below the wings when in flight.

For diving birds the most economical way usually is to ride the up-draft created as the wind presses against waves. Seabirds drift with the wind currents. In times of violent weather seabirds will avoid the worst winds by getting out of a hurricane's way.

Pressure Measure: Anemometer

Gliders in the seabird community possess a highly specialized paired organ along the nasal septum in the middle chamber of the nasal cavity. These small forward-opening pockets detect variable pressures produced by different external air-stream velocities and weather conditions. This highly specialized valvular structure offers an explanation as to as to why seabirds can avoid storms and get away from them if the bad weather system is not too extensive. They can pick up pressure differences like a barometer to recognize weather changes.

In times of violent weather, seabirds will avoid the worst by getting out of a hurricanes way. Despite its small wing the puffin can make headway against gales of 100 km/hr but will give up the struggle at 150 km/hr (Harris 1984). If a storm cannot be avoided, smaller and lighter species (phalaropes) will attempt to ride it out on the surface and may die in huge numbers. Occasionally, little auks and storm-petrels may be "wrecked" ashore in great numbers by huge waves. Luckily the sea is a relatively safe place to be—most of the time. There are no foxes and only few people. Tagged albatrosses have demonstrated that they can travel around the world logging 30,500 km (19,000 mi.) in 80 days by soaring—just extending their wings and going with the wind (Welty 1975).

Sense of Hearing and Equilibrium

The ear fulfills two very important functions: as an instrument for hearing and also as an organ of equilibrium. Birds are sensitive to a wide range of sound frequencies and even more sensitive to different intensities and possibly frequencies, too.

As an organ of balance and motion-perception, the ear reached a high state of perfection very early on in the phylogenetic tree and was progressively refined in birds. This organ works closely together with another sensory organ, the filoplumes. *Filoplumes* are long, hairlike feathers with a long fine shaft and a tuft of short barbs or barbules at the free end that monitor the position of feathers. Their follicles have many free nerve endings and several encapsulated nerve endings (Herbst corpuscles) lie nearby, especially at the base of the wing remiges. These sensory corpuscles at the base of each filoplum detect fine movements of the shaft and can monitor the position of movement during flight. In many birds filoplumes are also evenly distributed among the outer contour feathers to warn the bird when wind disrupts the smooth outer surface of the plumage. Wind that hits the filoplum sends the signal for correction from the sensory corpuscles and reports immediately to the central nervous system to counterbalance a sudden change in wind conditions to be able to keep the feathers in optimum position.

Feathers

Feathers have allowed birds to spread and thrive all over the planet. They keep them warm, insulate them from heat, allow them to escape from enemies, and explore food sources and breeding opportunities wherever they may be.

As in all birds, seabirds have the usual categories of feathers including contour, flight, and down. They also have powder feathers or powder down which are special feathers with barbs that disintegrate into a fine powder and are thought to aid the bird in grooming. They are the only feathers that grow continuously and are never molted. Herons and bitterns have dense, yellowish prominent patches of powder feathers on their breast at the apertura thoracica and the belly area. These feathers contribute considerably to waterproofing. Feathers can also be a source of camouflage that allows birds to blend with their habitat. The dark back and light belly and breast area allows diving sea birds to blend in with their surrounding.

Feathers are subject to wear and tear and to the aging and fading effect of UV rays. Feathers are composed of keratin, the same protein substance that forms the hair and fingernails of mammals. A program of maintenance and periodic replacement needs to be installed and planned carefully. Preening is essential to a bird's survival.

The bird simply draws the feather through its beak until the web is restored. With acrobatic skills this also can be accomplished during flight. Flight and tail feathers need to be kept in peak condition, for damage will diminish their aerodynamic capacity. Birds are constantly replacing their feathers. Mature worn feathers are shed through a process called molting. During this time, the bird may be less insulated and may not be able to fly as easily. Members of several unrelated groups of birds become flightless when they are replacing their primaries. These include auks, diving petrels, divers, grebes, ducks, swans, geese and rails. Puffins' main molt occurs in late winter just before the birds return to the breeding colonies.

Most waterbirds have large oil glands (uropygial glands) which secrete a fluid containing fatty acids, fat and wax. The uropygial gland is a bilobed holocrine gland located at the base of the pygostyle. It serves several different functions: it is bactericial and produces a precurser of Vitamin D. The oil gland maintains the conditioning of the skin, feathers, beak and claws.

Insulation and waterproofing are spoiled if plumage becomes messed. Therefore a generous portion of the day is dedicated to preening. Powder feathers are thought to aid the bird in grooming its plumage, acting like a talcum powder, while the beak rearranges the barbs and barbules in the proper order. Only a combined action of mechanical preening that rearranges feathers and aligns them together with an application of oil gland secretion and functional powder feathers assure waterproofing of the plumage. Surface swimmers have feather pockets of waterproof flank feathers, which stick up on the side of the body to keep elbows and wrists of the wing dry while the bird paddles on the surface.

In cormorants part of the plumage is not waterproof but it is not as bad as in Anhinghas. The contour feathers are modified to allow air out and water in, when underwater—an adaptation well suited to diving birds. After a fishing session they need to dry the large flight feathers of their wings and tail while their dense body plumage keeps their skins dry inside the suit of feathers.

Grebes seem to swallow quite a few of their feathers while preening. This can develop into a problem if the patient is dehydrated at the same time, because they have a tendency to develop a featherball in their gizzard. A firm, dilated ventriculus can be palpated on the left side of the abdominal cavity, caudal from the sternum. Most of the time this is a normal occurrence and is not something that requires treatment.

Wings

Wings are modified forelimbs and one of the most incredible structures ever to evolve. The major parts of the wing muscles lie close to the body and rely on long tendons to transmit their power to the extremities of the limb. Light, yet amazingly strong, the wiry tendons can sustain great loads in flight without breaking. The muscles are fueled almost exclusively by glycogen, a carbohydrate that furnishes instant energy for quick takeoffs and short spurts of flight. For birds that fly for sustained periods of time, fat is burned as the energy source.

Regardless if glycogen or fat is burned to operate the muscles, an inevitable by-product of the system is heat. Blood is circulated through the muscles and the heat is transferred elsewhere, much the way an engine passes water through a radiator to keep from overheating.

While in motion, a bird's wing is the shape of an airfoil. The wing is rigid and rounded in the leading edge, while feathers in the trailing edge taper to a point. This curve acts to deflect air downward, so that air flowing over the wing moves at a faster speed than the air flowing underneath it. The fast-moving air above the wing has a lower pressure than the slow-moving air beneath it. This difference in air pressure pushes the wing upward, creating a force that is called lift.

In addition to lift, other forces act on a bird's wing during flight. The air itself provides resistance to things moving through it. This force, called drag, slows the wings down. The amount of drag and lift a bird experiences as it flies depends upon its angel of attack—the angle at which the bird's wing encounters the flow of air. The bird adjusts the angle of attack while traveling at different speeds to ensure that the force of the lift is always greater than the force of the drag.

Gliding is the simplest way a bird flies requiring no complicated methods of flapping the wings, nor does it consume muscle power. A gliding bird will generally lose height continually. Many gliding birds are able to exploit natural air currents, thermals and up-drafts to keep themselves aloft.

Flapping flight requires more energy for a bird than gliding. In addition to lift, the bird must also produce thrust, the force that propels it forward. Lift and thrust are achieved by a flapping motion of the wing, which can be divided into a downstroke (propeller) and an upstroke (airfoil). The largest flight muscles are the pectoral muscles; when they are flexed, the powerstroke, or downstroke occurs when they are relaxed, an upstroke is achieved by a pulley action of tendons over the joints of the shoulder. A smaller set of breast muscles, called the musculus supracoracoideus, is attached to the carina of the sternum, or breast bone at the lower end. The tendons at the top are connected to the humeri, by looping over them. When the m. supracoracoideus contracts, up go the wings.

When taking off, a bird must be able to secure sufficient lift to get its weight off the ground. When enough speed is accomplished, the wings no longer need to work as hard, and they revert to their normal, less arduous pattern of movement. The tail is extremely helpful as a steering device during flight. Large tails provide steadiness and flexibility. Birds can also accomplish steering by tilting the body and deflecting air flow to one side or the other.

A broad soaring wing enables pelicans to soar at low speed. This type of wing is fairly long and broad with a medium aspect ratio (i.e., wing span divided by average width) and moderate wing loading (i.e., the body weight divided by the surface area of the wing).

The long soaring wing is restricted to oceanic species. The shape is long, slender and pointed, with a high aspect ratio and high wing loading. Such wings allow gliding at high speed, but also satisfy the competing needs of flapping flight. However their relative fragility and clumsiness demand a habitat that is free from obstacles. The wing beat is rapid and the amplitude of each stroke is small.

Long and narrow wings are designed for effortless soaring. The true gliders of the pelagic birds are the fulmars and albatrosses. They make use of thermals or they lift from wave winds. The Wandering Albatross has the longest wingspan of any flying bird, exceeding 3.5 m (11ft.). Albatrosses find flapping flight extremely tiring and during calm conditions they are forced to settle on the sea and wait for the wind to pick up again. Shearwaters "fly" under water to a certain extent.

Frigatebirds are masters of soaring flight, with long narrow wings, using their deeply forked tails as rudders, they catch flying fish in flight or just at the surface. They cannot swim or dive and their wettable plumage would quickly become waterlogged. They tend to return to land at night to roost for they traded an almost total lack of land mobility (they can perch at the nesting tree) and swimming capacity in exchange for superb flight capability.

Long, pointed wings are built for speed and long distance use. The champion long-distance migrant is probably the Arctic Tern, which may travel as far as 36,000 km (22,500 mi) each year in migration flights.

The propatagium is a triangular fold of skin on the leading edge of the brachium and antebrachium which increases the surface area of the wing. It is supported internally by a number of muscles and tendons. A specimen of a wing from a Sooty Shearwater shows that the tensor propatagialis complex seems to be very well developed in these soaring birds with a special process from the distal humerus to support the structure. The tensor propatagialis and the accessory tendons of insertion are closely associated with the propatagium or patagial skin fold. There are two primary tendons of insertion: the pars brevis tendon which inserts onto a bony process (processus propatagius)—a distal bony structure of the humerus which inserts onto the tendon of origin of the extensor metacarpi radialis, as well as onto a fascial attachment running dorsally on the ulna and connecting all the extensors. The pars longus tendon inserts onto the extensor process of the metacarpus. This propatagialis complex is rather extraordinary and functions like a rubber band holding the wing in position and helping the bird to keep the wing extended and locked into an open position without muscle strain. This phenomenon is similar to the perching mechanism in passerines. When the bird bends its leg while perching, this shortens a tendon in the rear toe so that it is locked into a closed position around the perch. This extraordinary structure could explain why pelagic birds can stay in the air for weeks at a time and sleep while soaring without straining the muscles to keep the wings extended.

Rehabilitation centers close to shorelines quite often have to treat patagium injuries that are caused by fishing line entanglement cuts into the delicate membrane or fish hook injuries perforating the patagium. Careful evaluation of the extent of the injury of this highly specialized skin fold will be necessary in regard to releaseability. Soaring seabirds will be susceptible to permanent damage to their locking mechanism than diving seabirds.

Auks have short narrow wings and fly in air with difficulty but underwater with great skill. Puffins have a usual frantic beat of 300-400 beats per minute to compensate for their inadequate-looking small wings. Despite its small wing the puffin commonly flies at 80 km/hr (Harris1984). Wings are used for propulsion underwater and feet serve as rudders. Large wings are a disadvantage underwater for they offer much resistance. A compromise between the needs of flight (large area required) and swimming (small paddles required) has to be found.

Penguins are master submarines with even shorter wing. They cannot fly at all. They seem so wonderfully efficient at catching fish as pursuit divers that they do not need to fly anymore. Apart from the penguin family only one other seabird has taken this irrevocable step and that is the Flightless Cormorant of the Galapagos Islands, with its vestigial wings.

Feet

The pelvic girdle in seabirds is reduced to the absolute minimum. Penguins can travel on land or ice only by walking slowly and stiffly upright on their short legs and tail prop, or by tobogganing on their belly.

Seabirds in general have webbed feet with no hallux or only a ruudimentary first toe. Only the second, third and fourth toe are developed and the claws are useful in rock-climbing. In the totipalmate foot, all four digits are included within the webbing and are found in gannets, boobies, cormoants and pelicans. Phalaropes have only slightly webbed feet and broad toes similar to coots, because they are pelagic waders and shorebirds that spend much of their time at sea. Their legs are oval-shaped to reduce water resistance yet retain strength.

Grebes have lobate-webbed feet that can fold during the forward movement to reduce the resistance in the water to a thin silhouette of the shank and foot, which offers little more resistance to the water than a knife-edge. During the backward movement the skin fold on the digits expands and allows pushing action.

Storm-petrels walk on the sea with their webbed feet. Cormorants use them as propulsion units in diving and active pursuit of prey. Webbed feet are useful in waterborne take-offs, assist as brakes in landings, and control surfaces in seemingly difficult aerial maneuvers.

The tarsi are usually laterally flattened in seabirds, which does not help with mobility. Puffins walk and dig more than the other auks and have no flattened tarsi. The toenails are strongly developed and the inner nail is very large markedly curved and twisted sideways (for digging).

Buoyancy

The bones of diving birds are less pneumatic and they have no subcutaneous emphysema (extra extensions of their air sac system), which makes gannets, boobies and pelicans so buoyant. Cormorants and penguins swallow pebbles for ballast, possibly to adjust their weight.

Phalaropes have extra dense breast and belly plumage to provide enhanced buoyancy and waterproofing—they float like corks. They are usually seen in sociable gatherings on the water, swimming most of the time.

Grebes seem to be able to squeeze air not only from their plumage, but also from the air sacs of the body, and slowly sink into the water as their specific gravity increases.

Vision

The importance of a bird's eye is shown by their size. Birds are intensely visual animals. The eye sockets take up a substantial portion of the skull. Bird's sight, the sense upon which they depend more than any other, is keen. The shape of the retina resembles a parabolic reflector and lies near the point of focus for all directions of light. Their vision ensures that they can assimilate lots of information in a small amount of time.

Pelagic birds have to be able to work with two different breaking indexes of two media that they are working in: air and water. They need to allow correction for deviation at the same time which is essential for their hunting success and seems to be a learning process.

Cormorants can locate prey without difficulty even in murky water with poor visibility. Forward-facing eyes give binocular vision so that diving birds can judge distances accurately to capture herrings, mackerel or flying fish with their powerful dagger-shaped bill.

The UV sensitivity of avian eyes allows them to see colors differently and probably makes gender recognition easier for them (Korbel 1997).

Enemies and Threats

Leopard Seals eat penguins but usually food shortage is the main killer in seabirds. Egg-snatching gulls and bird-snatching jaegers and skuas are natural enemies to breeding colonies.

Multinational fisheries compete with seabirds for their prey on unequal terms. Two million tons of fish are hauled out of the Bering Sea alone annually (Dunkel 1997). Fishing activities pose a real threat to pelagic birds. Besides food competition a huge amount of seabirds drown in trammel nets. For example, twenty thousand auks drown in Galway Bay alone each year.

Puffins and other seabirds eat sandeels, herring, sprats, capelin and other small fish. During 1975-1980 an average of 1.5 million tons of small fish was taken per annum from the North Sea (Bailey 1983) and processed into fish meal by industrial fishing fleets. These escalalating huge amounts taken on a regular basis have serious consequences for seabirds in this area.

With their ships, man introduced rats to remote islands. Rodents prey on eggs and chicks in breeding colonies and as a consequence some birds are declining in numbers. Arctic foxes raid nests or wait around breeding cliffs for crash-landings, when chicks learn how to fly. Human impact has threatened populations for centuries. Many species are clumsy on land and are easy prey for man. The flightless Great Auk was persecuted to extinction in 1840 (Harris 1984). Eggs and adult seabirds have been exploited mercilessly and only recently have we begun to give them the consideration they so rightly deserve in the form of protection by law.

Seabirds usually do not fight back, but one group have a deterrent. The tube-noses (albatrosses, shearwaters, fulmars, petrels and storm-petrels), a highly successful sea-going group of birds, carry with them a powerful musky odor caused by the stomach oil which they will so freely spout at an intruder if alarmed. It seems to be a defense mechanism and disturbs waterproofing considerably when sprayed on feathers.

Oil pollution claims many lives each year. Manmade debris and pollution litters the oceans, fishing nets trap auks, fishing net fragments strangle gannets, birds get entangled in invisible fishing equipment and plastic debris, and fish hooks perforate the digestive tract of birds that come too close to the by- products of our civilization. Contamination by Cadmium, Selenium, and Strontium has been documented in the Bering Sea (Dunkel, 1997). Increased garbage and waste products are a threat to the marine ecosystem and shoreline environments. Lead contamination is a contributing factor in the breeding failure of eiders. Females weakened by ingested lead are thought to be more apt to abandon their nests, and males become infertile. Lead pellets in the sediment where birds feed are gobbled up to be used as grit to grind up food. For eons the Yukon-Kuskokwin Delta has been a preferred hunting area for eiders and other birds and the Yukon Delta would now need to be vacuumed to get rid of yesterday's ammunition. Warning today's hunters to use only non-lead ammunition is a half-solution because the damage is done already and the poison remains in their environment.

Tourism and erosion from human development continue to place many seabirds at risk. Providing safe habitats for feeding and breeding will help to ensure the continued survival of these unique birds.

Closing Remarks

Rehabilitation of seabirds is very demanding on time and resources and takes some knowledge to be able to do a satisfactory job. The window of opportunity is rather small in which to accomplish your goal. Pools with excellent water quality need to be available all times. In a triage situation priority treatment has to be given to species with declining numbers, which are of special concern to us (see editoral, this issue). Feel free to contact experts that are experienced and willing to share their knowledge with you or transfer the patient as fast as possible to the center that is best equipped for a particular species. It is the quality of work that will give you satisfaction and we are all working towards the same goal: releasing healthy wildlife in the shortest possible time.

We are just at the beginning of our understanding of this very special and fascinating world out there. These birds indicate environmental changes on the broadest scale and we owe it to future generations to enjoy this truly remarkable phenomenon in its natural and undisturbed form.

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Waterfowl: Care, Breeding and Conservation

Simon Tarsnane
Hancock House Publishers
1431 Harrison Avenue
Blaine, Washington 98230-2262
1996
277 pages
$24.95 USA

Although, this book was written by experienced captive care providers for those working with waterfowl in zoos or private settings, it can provide wildlife rehabilitators with valuable insights. Topics exceed those common to the wildlife rehabilitation literature with coverage of incubation, nesting, and pinioning, however, many other topics (e.g., facility set-up, diet, nutrition, rearing, diseases, predator control) are of interest to wildlife rehabilitators. Additionally, the book has 13 chapters on specific groups of ducks with much information on individual species. All major groups of waterfowl are included.

Wildlife rehabilitators are accustomed to reading information that makes very specific recommendations for them. Sometimes this book does and sometimes it does not. The chapter on facilities gives the reader a general sense of what is advisable and is geared for the private collector—a corollary to the home rehabilitator. I was charmed to find a book that addressed the issues of water filtration of biomass from ducks! The author talks about what works and just as importantly, what fails! Additionally, the book deals with not only the enclosure, but choosing what plants will work the best.

This is not a scientific text and citations are lacking. However, the intended audience may not care as long as the information they get is generally good. The nutrition section covers the common deficiencies and gives good general information on the nutritional content of many common diets or food items. They also refer the reader to manufacturers for specific information on feeds mentioned and provide addresses.

The disease and treatment section attributes 90% of mortality directly or indirectly to stress. Sound familiar? The book emphasizes prevention of disease rather than treatment (another familiar refrain). The author offers up to the reader that he is not a veterinarian but does wish to provide a brief overview of the common waterfowl diseases. For further reading, he refers to the Ritchie, Harrison and Harrison text on avian medicine. I do wish he had a veterinarian read through the medical section which could have been made more 'reader proof'. For example, he prefers to give dosages in amounts without reference to the strength of the drug. This can be especially dangerous with levamisole hydrochlorite, which if overdosed, can and has killed animals. However, if you just need a general overview of how medical problems in waterfowl are approached, this book will provide it.

The book has numerous color photographs by Frank S. Todd, a renowned aviculturist and author in his own right (*Natural History of Waterfowl*). While the photos include the usual subjects (birds), there is a collection of photos of various enclosures, rearing units and waterfowl ponds.

The individual chapters vary in depth because they are based on the experience of the author and read like notes. Each section does try to provide specific information on usual clutch size and incubation period.

For the waterfowl rehabilitator or center that handles a significant number of these birds, this book will make a welcome addition to the library. For the purchase price, it is a good value and shares a wealth of experience.

-Jan White, DVM-

PLAN NOW FOR THE 1998 IWRC ANNUAL CONFERENCE

The 21st Annual Conference of the International Wildlife Rehabilitation Council will be held in Fort Worth, Texas, October 15-18, 1998 at the Radisson Plaza Hotel, Fort Worth, Texas. Start planning now to join us for this exciting and informative meeting. Our host is Lee Watt of Wildcare in Fort Worth, who will be working with other local groups and rehabilitators to bring us an unforgettable conference! The "Call for Papers" will be available by mid-winter for potential speakers and presenters. We are very excited about going to the "Lone Star" state and hope you can all join us there!

Upcoming Meetings/Training:

Fifth International Conference - "Effects of Oil on Wildlife", November 3-6, 1997, Doubletree Inn, Monterey, California. Hosted by the Oiled Wildlife Care Network, a joint program of the California Dept. of Fish & Game, Office of Oil Spill Prevention and Response, and the University of CA, Davis Wildlife Health Center. For information contact: Nancy Ottum, Oiled Wildlife Care Network, ITEH, U of Ca, Davis, CA 95616, 916-752-3809, email: ndottum@ucdavis.edu.

Second Annual Conference - The Wildlife Center of Virginia, November 8-9, 1997, Ingleside Resort & Conference Center, Staunton, VA. For information contact Conference Chairperson at the Wildlife Center of VA, PO Box 1557, Waynesboro, VA 22980, 540-942-9453/Fax 540-943-9453.

16th Annual Pacific Coast Oil Show & Conference - November 11-12, 1997, Kern County Fairgrounds, Bakersfield, CA. For information contact Petro-Tech Expos, Ltd., 1988 University lane, Lisle, IL 60532-4182, 630-241-9873/Fax 630-241-9870.

NYSWRC Annual Seminar - November 14-16, 1997. For information contact NYSWRC, PO Box 515, Medina, NY 14103.

Introduction to Raptor Rehabilitation - Alaska Raptor Rehabilitation Center, January 14-19, 1998, Sitka, AK. For information contact ARRC, PO Box 2984, Sitka, AK 99835, 907-747-8662/Fax 907-747-8397, email: arrc@ptialaska.net. This course is available for credit through the IWRC. There are 42 units assigned for the successful completion of the course.

NWRA 1998 Conference - March 11-15, 1998, Seattle, WA. For information contact NWRA, 14 N. 7th. Ave., St. Cloud, MN 56303, 320-259-4086.

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