

June 1975

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THE AVIAN ECOLOGY OF IZEMBEK LAGOON

Abstract

Izembek Lagoon, with the world's largest stand of eelgrass, supports a large mixed avian population. The lagoon is described in a biological sense. The birds are described in terms of feeding habits. Few exist without recourse to the lagoon. Some are carnivorous, feeding in the invertebrate community and the small fishes of the eelgrass beds. The waterfowl are divided between herbivores and carnivores, all directly or indirectly dependent on the eelgrass. Extremely abundant populations of shorebirds depend on the large invertebrate populations of the lagoon. The gulls (but for one omnivorous species), terns, and divers all feed on small fishes. The raptors, all open-country types, are discussed. Typical of northern areas, the number of species is not large, but several of the populations are large. The importance of the lagoon is emphasized.

THE AVIAN ECOLOGY OF IZEMBEK LAGOON

Introduction

Near the southwestern tip of the Alaska Peninsula lies the shallow embayment of Bering Sea known as Izembek Lagoon, a body of water which exhibits a unique ecosystem for the Aleutian region. This system, dominated by the world's largest stand of eelgrass *Zostera marina* L. (McRoy 1966), produces annually 166,000 metric tons of particulate carbon, 7,400 metric tons of nitrogen, 1660 metric tons of phosphorus, 3.45 metric tons of copper, and 386 metric tons of silica (Barsdate *et al.* 1974). Very little of this production is recycled within the lagoon, leaving a substantial balance that is exported to Bering Sea where it presumably enters the food web (Barsdate *et al.* 1974).

The lagoon is about 41 km long and from 3 to 12 km wide. Its surface area, about 218 km², is about 78% tide flats and 22% tide channels, with eelgrass beds covering roughly 68% of the tide flats or about 116 km² (McRoy 1966). The mean tidal range is 0.98 m, and the tide characteristics are those of a vanishing tide (Sverdrup *et al.* 1942). In spring and summer the low tides occur in daylight; in late fall and winter they occur at night. A complex system of channels drains the lagoon waters seaward on an ebbing tide through three openings in the barrier to Bering Sea. This barrier consists of the glacial promontory of Cape Glazenap plus a marine strand that forms two spits and two islands. The strand, typical of Aleutian island beaches, supports a vegetative community which is dominated

by five plants: *Elymus arenarius* L. *mollis* (Trin.) Hult., *Honckenya peploides* (L.) Ehrh. *major* (Hook.) Hult., *Mertensia maritima* (L.) S. F. Gray *maritima*, *Senecio pseudo-Arnica* Less. and *Lathyrus maritimus* L. *pubescens* (Hartm.) C. Regel.

The landward side of the lagoon presents a low, rolling profile with variable shoreline characteristics. At those points in the lagoon where the ancient shoreline coincides with the present one the shore is rocky and backed by low headlands. Along such shores solid sandy beaches occur in the straight stretches, but at every indentation these give way to instable organic deposits. Where the present and ancient shoreline are distinct, they are separated by a salt marsh. These overlie deposits of spongy peat derived from eelgrass, and the outer margin forms an instable shore. Sloughs lead back into these areas, sometimes to drain springs or sluggish streams, and all possess deposits of stinking organic ooze. In some of these the organic ooze has accumulated to nearly a meter in depth, forming treacherous mudbanks which even pintail ducks *Anas acuta* L. find insecure. Unwary humans who attempt to cross such mudbanks find themselves mired in a single step.

The vegetative cover at the shores edge varies much as do the shores themselves, but is dominated by an association of euryhaline grasses: *Elymus arenarius mollis*, *Poa eminens* Presl., and *Calamagrostis canadensis* (Michx.) Beauv. *Langsdorffii* (Link) Hult. Inland from the beaches a heath community dominates except along the streams and in the salt meadows. Grasses dominate the stream courses, and a community of crowberry *Empetrum nigrum* L. *nigrum*, Labrador tea *Ledum palustre* L. *decumbens* (Ait.) Hult., and dwarf birch *Betula nana* L. *exilis* (Sukatsch.) Hult. dominates the salt meadows. But it is the lagoon and the eelgrass that absorbs the biologist's

interest, for it is here that the food for a truly remarkable assemblage of birds is produced.

Eelgrass is a marine angiosperm, one of the group of plants known as "sea grasses." It produces long, ribbon-like leaves that float upright in the water, incline in the direction of any current, and lie on the bottom when the ebbing tide leaves them unsupported. In Izembek Lagoon the eelgrass occupies two zones, intertidal and subtidal. Those in the intertidal zone experience elevated temperatures during low tides in spring and summer, and produce seeds. Those in the subtidal zone are subjected to colder temperatures and have long periods of vegetative growth but produce no seeds. The temperature rise in the intertidal zone, which may send the thermometer to a reading of 20° C., results from entrapment of water in the dense eelgrass to form shallow tide pools. The dark-colored basaltic sediments absorb solar radiation and warm these tide pools.

At the end of the growing season in August a crop of eelgrass estimated to represent a production of 4.6×10^5 metric tons occupies Izembek Lagoon (Barsdate *et al.* 1974). In these circumstances the exposed tide flats present to the view an expanse of bright green extending to the level of mean high water all around the lagoon. With the advance of fall this fades perceptibly for many leaves are torn loose by feeding birds and rough water caused by storms, and more are sloughed by the plants. All these drift about the lagoon and eventually wash out to Bering Sea. Soon, winter temperatures freeze the lagoon, incorporating the leaves of intertidal eelgrass plants into the ice. When the ice moves, these leaves are torn loose, leaving roots and rhizomes in the substrate. Thus in spring the expanse of green has disappeared from the tide flats. In late April,

a month after the vernal equinox, low tides again occur in daylight. Increasing solar radiation warms the shallow tide pools, and the cycle of primary production begins again.

The tide pools formed by the eelgrass stands furnish suitable habitat for an extensive community of invertebrates and some fishes, and serve as a trap to retain organic matter. Subtidal stands offer the substrate to which colonies of diatoms are attached in certain seasons. Such colonies change the bright green color to a rust red. In both tidal and subtidal stands the small gastropods *Lacuna* and *Margarites*, the tiny pelecypod *Turtonia minuta* Fabricius, and rows of the skeleton shrimp *Caprella* occupy the leaves. Numerous free swimming crustaceans such as shrimps and amphipods occupy the water in the tide pools, and some burrow in the sediments. The helmet crab *Telmessus cheiragonus* (Tilesius) occurs abundantly in the lagoon, both within the eelgrass beds and on sand bars associated with drainage channels. Young specimens of the brooding starfish *Leptasterias*, measuring less than an inch across the rays, forage as an epiphyte on the eelgrass leaves as well as on the bottom. In the sediments and detritus accumulations dwell polychaetes, myriads of the tiny clam *Macoma inconspicua* (Broderip and Sowerby), and the detritus feeders. These last named creatures pass sand through their alimentary tract, extract the organic matter, and expel the residue onto the sediment surface where it collects at low tide in little cone-shaped piles. They are so abundant as to literally cover the exposed tide flats with their tiny "volcanoes" of sediments. These wash away with the advancing tide, only to be renewed on the next low cycle.

Avian Populations

Because of this large and rich ecosystem very extensive populations

of birds inhabit the region in all seasons. Only when the lagoon freezes are the birds conspicuously absent. Also absent or unavailable in these circumstances are the substantial fish, shell fish, and marine mammal resources present in the same ecosystem. This annual period of freezing would have influenced aboriginal human occupation of the region, and probably accounts for the distribution of permanent village sites only on the Pacific side of the Peninsula.

The types of birds present necessarily reflect the character of the ecosystem. For example, there are few seed eaters and insect eaters that take their food on the wing. The polar maritime climate with its low solar energy and prevalence of wind (average daily wind speed=18.4 mph) creates, the circumstances such that few seeds are produced, and the numerous insects present in the region spend their lives walking rather than flying.

The Passerines - Somehow the bank swallow *Riparia riparia* (L.) has managed to maintain a stable population despite the paucity of flying insects, while the tree swallow *Iridoprocne bicolor* (Vieillot) and the barn swallow *Hirundo rustica* L. have been unsuccessful. I have observed the bank swallow feeding on the ground on adult kelp flies *Fucellia* which would have been blown away had they attempted flight. The birds flew along the beach and alighted to pick up an insect before flying on to the next. It is probably in this way they have overcome the factor limiting the other two swallows. They are migrants, arriving in the Izembek region at the end of May and departing in late August.

The other passerines that take insects are more properly regarded as omnivores, except perhaps for one. This exception is the song sparrow *Melospiza melodia* (Wilson) which in the Aleutian region is restricted to

the beaches in close association with the kelp fly *Fucellia*. Here it feeds on the larvae, pupae and adults of the fly and augments its diet with small marine invertebrates. Little suitable habitat exists for this bird on the Izembek area and few are to be found. It is a permanent resident. The other passerines, which I consider omnivores, are denizens of the ground vegetation and to a limited extent the alder thickets where the insects, hiding from the wind, are to be found. They take such seeds as come their way, and berries in season. The most abundant of these is the Lapland longspur *Calcarius lapponicus* (L.), a migrant that arrives on the Izembek uplands by thousands in early May. They, together with the rock sandpipers *Calidris ptilocnemis* (Coues), produce the nuptial calls that are the harbingers of spring on the Alaska Peninsula. Less conspicuous and more restricted to specific habitats are such migratory birds as the water pipit *Anthus spinoletta* (L.) yellow warbler *Denroica petechia* (L.), Wilson's warbler *Wilsonia pusilla* (Wilson), savannah sparrow *Passerculus sandwichensis* (Gmelin), golden-crowned sparrow *Zonotrichia atricapilla* (Gmelin), fox sparrow *Passerella iliaca* (Merrem); and two resident species - the gray-crowned rosy finch *Leucosticte tephrocotis* (Swainson) and snow bunting *Plectrophenax nivalis* (L.). The only passerine that approaches closely the classification of primarily a seed eater is also the smallest, the common redpoll *Acanthis flammea* (L.). Gabrielson and Lincoln (1959) reported 25% animal matter and 75% vegetable in summer diet, with nearly 100% seeds in winter. They are permanent residents of the Izembek area, and may be seen in winter gathering seeds from the common umbel *Heracleum lanatum* Michx. and the alder *Alnus crispa* (Ait.) Pursh *sinuata* (Regel) Hult., the only plants that assure a supply of seeds in winter.

Four other noteworthy passerines inhabit the Izembek area. The black-billed magpie *Pica pica* (L.) is uncommon, perhaps as Gabrielson and Lincoln (1959) suggest because its long tail is a handicap in a "brisk" wind. Though scarce they are permanent residents and appear largely carnivorous. The common raven *Corvus corax* L., North America's largest passerine, is conspicuously present as a permanent resident in considerable numbers. These great black birds congregate at the town garbage dump in winter, but forage widely in summer when the tide flats of Izembek Lagoon lay exposed during daylight hours. Here, in competition with the glaucous-winged gull *Larus glaucescens* Naumann, the ravens seek any hapless invertebrate. The most frequent victim, because of its abundance, is the helmet crab; but any protein, dead or alive, is taken. Eggs and young of other birds, carrion, microtine rodents, and dead and dying salmon in season all contribute to the food of the raven. Aboriginal human populations have distinguished the raven in legend. The dipper *Cinclus mexicanus* Swainson, as abundant as it ever becomes, is a permanent resident inhabiting the clear mountain streams of the Izembek area. These streams furnish spawning beds for four species of Pacific salmon; pink *Oncorhynchus gorbuscha* (Walbaum), silver *O. kisutch* (Walbaum), red *O. nerka* (Walbaum), and chum *O. keta* (Walbaum), and Dolly Varden char *Salvelinus malma* (Walbaum), which as small fingerlings furnish part of the dipper's diet. The rest consists of aquatic insects. The northern shrike *Lanius excubitor* L. is a regular fall and winter inhabitant of the Izembek area in small numbers, feeding on small birds and microtine rodents.

Gallinaceous Birds - On the scale of energy flow in the Izembek ecosystem the passerines play little role, for their numbers and biomass are

overshadowed by other birds that inhabit the lagoon in one or more periods of the year. In the economy of an aboriginal human population the passerines would also doubtless contribute little more than ornamentation (Spaulding 1955) but there are two terrestrial birds in the Aleutian region that might indeed assume importance in seasons of abundance. These are the rock ptarmigan *Lagopus mutus* (Montin) occupying the Aleutian Islands and the higher elevations of the Alaska Peninsula, and the willow ptarmigan *Lagopus lagopus* (L.) which inhabits the lower elevations of the Alaska Peninsula and Unimak Island. In the Izembek area the willow ptarmigan is much the more common and in times of abundance becomes a conspicuous feature of the landscape. Both species are strictly herbivorous in the Izembek region, except that as chicks they may take insects. Buds and berries of crowberry and lingonberry *Vaccinium vitis-idaea* L. minus (Lodd.) Hult., buds and leaves of willow *Salix* spp. and Dwarf Birch and basal leaves of *Geum macrophyllum* Willd. *macrophyllum* and *Geum calthifolium* Menzies comprise the principal foods of the willow ptarmigan in the Izembek region. The basal leaves of these two species of *Geum* remain green and grow slowly in winter, hence are available and utilized year round by the willow ptarmigan. Occasionally they take seeds of *Carex* spp. Willow ptarmigan are gregarious birds and form large flocks that offer rewards to a food gathering society, but like the biologist such a society would find greater rewards in Izembek Lagoon.

Waterfowl - The large avian populations of Izembek Lagoon are migratory, and in general visit the area in spring and again in fall, though with considerable variation to the pattern. Three species of geese congregate in fall, each having nested in different areas and each bound for different

wintering grounds. Populations of three species of dabbling ducks depart southward in late fall to be replaced by two populations of northern diving ducks that remain in the area until spring. These eight species of waterfowl together represent a resource of nearly one million birds today, while in aboriginal times it must have been a solid million and a half. The geese are (1) lesser Canada goose *Branta canadensis parvipes* (Cassin), (2) black brant *Branta bernicla orientalis* Tougarinov, and (3) emperor goose *Anser canagica* (Sewastianov). The dabbling ducks are (1) mallard *Anas platyrhynchos* L., (2) pintail and (3) green-winged teal *Anas carolinensis* Gmelin. The diving ducks are (1) oldsquaw *Clangula hyemalis* (L.), and (2) Steller's eider *Polysticta stelleri* (Pallas). Several additional species of both dabblers and divers frequent the area, but these eight species comprise the bulk of the resources available in Izembek Lagoon. Outside the lagoon, i.e., in the Bering Sea and north Pacific Ocean exists the huge population of king eiders *Somateria spectabilis* (L.). These and smaller (though considerable) populations of white-winged scoter *Melanitta deglandi* (Bonaparte) and black scoters *Melanitta nigra* (L.) inhabit the deep water bays and open ocean in winter but are uncommon in Izembek Lagoon.

Except for the winter freeze, summer is the period of lowest waterfowl abundance, indeed of avian abundance for a short time. From the viewpoint of an aboriginal human population, this fortunately coincided with the period of greatest abundance of fish and the most readily available shellfish. And seemingly almost by design one of the world's great bird populations, that of the short-tailed shearwater *Puffinus tenuirostris* (Temminck), arrives in Bering Sea just off the lagoon at this time. These

birds nest in the region of Australia during the Aleutian winter and come north at the beginning of the Australian winter.

Few ducks and no geese nest in the Izembek area. Mallards, pintails, green-winged teal, gadwall *Anas strepera* L., greater scaup *Aythya marila* (L.), harlequin duck *Histrionicus histrionicus* (L.), and common elder *Somateria mollissima* (L.) nest in low densities. A small population of non-migratory whistling swans *Olor columbianus* (Ord) inhabits the western end of the Alaska Peninsula and Unimak Island. Several pairs of these conspicuous birds nest in the lakes and marshes adjacent to Izembek Lagoon. Occasionally they alight on the lagoon to feed on eelgrass but more commonly they feed in the lakes, springs and streams. In this area their commonest food is *Ranunculus trichophyllus* Chaix. *trichophyllus*, but *Potamogeton perfoliatus* L. *Richardsonii* (Bennett) Hult. and *Sparganium hyperboreum* Laest. are also utilized. At times the great white birds graze in the marshy vegetation adjacent to the lakes, but what they are eating is unknown. In winter, the springs and a short reach of stream below them remain open, and provide *Ranunculus trichophyllus trichophyllus*. The most common nest building material is *Carex Lyngbyaei* Hornem.

A few non-breeding waterfowl remain in the lagoon for part or all of the summer. Yearling Steller's elders are the most numerous of these, numbering several thousand. A few hundred immature brant and a similar number of emperor geese remain.

The first migrant waterfowl to put in an appearance in late summer are pintails arriving about the middle of August. They arrive in hundreds at first, but by September the numbers rise to thousands. In years of abundance some quarter of a million pintails gather in Izembek Lagoon.

These numbers exhibit wide variability from year to year, reflecting reproductive success in part, but also illustrating the pintail's penchant for wandering to other pastures. Their food at first is exclusively eelgrass seed which they gather from the intertidal stands at times of low tide. Later, perhaps because of a diminution of the eelgrass seed supply, they take the pelecypod *Turtonia minuta* and possibly the gastropods *Lacuna* and *Margarites* epiphytic on the eelgrass leaves. The pintails, indeed all dabblers, divide their time between the lagoon and the ponds along its perimeter, feeding in the lagoon during low tide cycle and flying to the ponds as the tide floods. To where they are bound in migration southward is not known, nor exactly when they leave in October for theirs is not a conspicuous migration. A small number remain in the Izembek area during the winter. In early April the first returning pintails appear in the lagoon. Though they are in thousands, their numbers are much smaller than in fall and they do not remain long. The really large numbers of pintails in spring appear in the marshes associated with the rivers flowing into Ugashik Bay about 275 miles northeast of Izembek Lagoon.

The mallards and green-winged teal occupy the lagoon in much smaller numbers, and tend to concentrate in particular areas. Like the pintails both species utilize eelgrass seeds, and more readily take the tiny pelecypod *Turtonia minuta*. The mallards occasionally gather small fish in the creeks, and frequently harvest seeds of a late maturing species of *Carex*. These grow in marshy areas around the lagoon where they are flooded at about the time the seeds are ripe. Both species remain in the area much later in fall than the bulk of the pintails and some remain all winter.

These frequent the same springs as do the swans, and if driven out by extreme cold, join the emperor geese on the beaches of the islands south of the Peninsula.

Not long after the first pintails arrive in August the geese begin to appear. Exactly when this occurs is a function of wind direction, for the geese literally ride the wind. The first goose to arrive in numbers is the black brant, which can be expected any date after August 20th when a wind blows from the north. They come into the lagoon low over the barrier islands and spits, apparently having flown at low elevation from the vicinity of Cape Newenham directly across Bristol Bay. Not all the brant arrive at once, but the initial influx may be quite large. At about the same time the emperor geese begin to arrive in small numbers, flying down the Bering Sea coast of the Alaska Peninsula from some point where they had crossed Bristol Bay. Within a week the first of the lesser Canada geese put in their appearance. These are high-flying birds, arriving in small flocks that show no discernable pattern indicating the route they had flown.

The entire population of black brant gathers in Izembek Lagoon each fall. In aboriginal times this population numbered about 300,000 (Solomonsen 1958) but is now much reduced - little more than 100,000 in 1974. Usually the bulk of the population is in the lagoon by the third week of September, but if temperatures to the north remain above freezing into October there are late arriving brant. They remain in Izembek Lagoon until certain weather conditions occur in early November.

The size of the emperor goose population is known with less accuracy than the brant, but it may approach 200,000 birds. Though virtually all

of this population goes through Izembek Lagoon in migration, both spring and fall, there are never more than about 40,000 in the lagoon at any one time. They winter in the Aleutian Islands and along the southern coast of the Alaska Peninsula and adjacent Islands as far east as Kodiak Island.

The pattern of migration is one of arrivals from the north, literally into the north end of the lagoon, and departures to the south and west from the south end of the lagoon. Ten to twenty thousand remain in Izembek Lagoon in winter until it freezes, and then cross the Peninsula to the Sandman Reefs, Sanak Reefs, and the Pacific coast of the Peninsula,

A population of about 100,000 lesser Canada geese gather in Izembek Lagoon each fall, but there is considerable variability in their time of arrival. On average, the entire population has assembled in Izembek Lagoon by the first of October, but in 1974 substantial flocks were still arriving October 21st. This population remains in Izembek Lagoon until certain weather conditions occur in early November.

The geese are basically herbivorous. All three utilize eelgrass - the brant nearly exclusively, the emperor geese only slightly less, and the Canada geese less so to the extent that other foods are available. In utilizing eelgrass the geese augment their effective diet with the epiphytes present on the leaves and the crustaceans in the associated water. No quantitative data are available as yet to indicate the energy flow achieved in this way, but data are at hand to establish the presence of very appreciable weights of energy-rich epiphytes on the leaves the geese eat (T. McConnaughey, in litt.). The point here is that grazing of eelgrass is a special case with considerable complexity.

In seasons when berries are abundant on the heath, especially crow-

berry and lingonberry, the emperor geese and Canada geese graze on the berries. This feeding behaviour is particularly marked in the Canada geese. They frequently fly three to four miles from the lagoon when the berries are abundant, but the emperor geese rarely depart more than a few hundred yards from the lagoon and do not maintain this feeding behaviour more than a few days. The Canada geese, however, continue grazing on berries until none can be found, alternating between eelgrass at low tide and berries at high tide. Eventually frost conditions cause the berries to fall from the plant and then all the geese feed on eelgrass. If berry production is poor the geese soon gather the few available and then rely on eelgrass. The brant and Canada geese gain 25 to 30 percent weight in all year classes by the end of October, but no comparable weight gain occurs in the emperor geese.

The three geese may be said to have distinctive domains within the lagoon. In part this is an artifact of the differing feeding behaviour, but it is also a manifestation of preference. As in all such behaviour patterns there is overlap; but generally the brant both feed and rest in the lagoon, the emperor geese feed in and around the lagoon and rest on the beaches, while the Canada geese feed in and around the lagoon and rest on the land. This behaviour is so obvious as to give rise to the names "sea goose, beach goose, and land goose" respectively in the vocabulary of the present-day descendants of the aboriginal human inhabitants of the Aleutian region.

In early to mid-November, when suitable pressure patterns develop to produce northwest winds blowing favorably for hundreds of miles across the north Pacific Ocean the brant and Canada geese depart on migration. The

brant are bound mostly for the lagoons of northwestern Mexico, and the Canada geese for the states of Washington, Oregon and California. The departure of both species is an obvious event that never fails to strike a note of awe in human observers. Most of the Canada geese depart in daylight in flocks of about 200 birds. While this is in progress five or six such flocks may be seen at any moment for several hours. Occasionally these geese may start out in what appears a favorable wind and come laboring back to the lagoon, evidently having found conditions unfavorable. It is not usual for all the Canada geese to depart at the same time. When conditions become favorable for migration the entire population of brant fly aloft to elevations of two or three thousand feet and circle over the lagoon and out into Bering Sea. Sometimes they do not find the conditions they want and return to the lagoon, but if it proves favorable the migration begins just after sundown. Normally the entire population of brant departs at once. The departure of the geese ends the dominion they have exercised over the sound-sphere for many weeks. On the next day the lagoon is silent.

When in March the lagoon is free of ice the emperor geese return in an almost mirror-image reversal of the fall migration. Arrivals from the Aleutians enter the lagoon at its south end, while others depart from the north end. By mid-May only a few thousand remain, all in the north end of the lagoon.

Four and a half months after leaving the lagoon in November, the brant return across the North Pacific in a leisurely migration. The first arrive in Izembek Lagoon about April 15 and the last, in late May. Most arrive by way of Cold Bay, flying just a few feet above the water in small flocks.

They enter Cold Bay at its south end where it opens into the North Pacific, fly to the north end, there climb several hundred feet and cross the narrow strip of land to the lagoon. The paired adults leave the lagoon about the 20th of May, again riding fair winds, on the last leg of their journey to the nesting grounds. The immature birds sometimes remain behind for several days before they drift northward.

The Canada geese do not return to Izembek Lagoon in spring.

In late August the first of the Steller's elders arrive from their nesting grounds in Siberia. These are adult birds that have separated from their young and come on ahead. There is some need for haste, for almost immediately after arrival they proceed into the post-nuptial molt and become flightless for a period of about three weeks. This population exhibits great variability in the time of arrival, molting, and where they choose to gather in the lagoon. Some of the birds apparently molt at other points along the flight and reach Izembek Lagoon much later than the first. By late October approximately 100,000 have arrived in the lagoon where they remain until it freezes. This does not represent the total population for there are other wintering areas, but banding returns indicate the existence of discrete populations using the same wintering area each year.

These are the smallest of the elders, and though excellent divers they prefer to feed in relatively shallow water. Their habits are different from the large elders that inhabit the deep bays and open sea where they dive to the bottom in depths of one hundred feet and more. The Steller's elders feed in the eelgrass beds and drainage channels of the lagoon, utilizing a broad spectrum of the invertebrate populations. The

frequency with which these species are taken appears to reflect their relative abundance. Thus amphipods, the pelecypod *Macoma inconspicua* and *Turtonia minuta*, the gastropod *Margarites*, and the helmet crab are common items in the diet of the little eider.

The color contrast between the two sexes of Steller's eiders in breeding plumage is sharp. The drake is largely white, while the hen is a dark brown. These birds gather in large flocks which in flight emphasize the contrast. The flashing white wings of the drake mingled with the dark brown of the hen gives the flying flock a "scotch plaid" look. Perhaps this is the origin of the name "scotchies", by which the present-day descendants of the aboriginal humans know them. Their ancestors must have hunted "scotchies" with the bola for the large dense flocks appear vulnerable to this weapon. Nelson (1883) reported its effective use by native of the Siberian coast when hunting these ducks.

No amount of rough weather seems to bother the tough little Steller's eider. Only solid ice which denies them access to the water in which they find their food can drive them out. When this happens they simply cross the Peninsula into deep water areas that do not freeze.

Many of the bird populations in the Izembek region exercise dominion over the sound sphere for a time, and I like to think of the phenology of the seasons in terms of the dominant calling of birds. I have already mentioned the sounds of spring, and of geese in fall. In the Izembek region the listener for bird calls must tolerate competition from the wind, but when it falls silent in winter the listener at Cold Bay is treated to the soft whistling of hundreds of black scoters wintering there. But a more insistent call is heard too, and this is the sound that dominates

Izembek Lagoon soon after the departure of the geese. It is the call of the old squaw duck, or long-tailed duck as it is labelled in Europe in recognition of the two greatly elongated central tail feathers of the drake. The scientific name *Clangula* means "noisy" and the old squaw is by all odds the noisiest of ducks. It has several calls, but one commonly heard is *ow owly owly* which has given rise to the name "owly owly" by which it is known to modern Aleuts. It is an extremely abundant duck, and a large population inhabits Izembek Lagoon until ice forces an exodus. This population appears to be the major winter prey of the bald eagle *Haliaeetus leucocephalus* (L.) in the area.

Nothing is known about their food in Izembek Lagoon, except that they dive for it in the same places as do the Steller's eiders. They share with the eiders the habit of diving simultaneously. The sudden disappearance of an entire flock as if pulled on a single string is surprising, especially to the uninitiated, but no less than its sudden reappearance like so many jack's-in-a-box.

Shorebirds - The Izembek area is host to nineteen species of shorebirds in varying degrees of abundance. The numbers are so great and the birds so widely spread that it is not reasonable to suggest a numerical estimate in late summer and fall except in hundreds and thousands. In that season the exposed tide flats are covered at low water by these little birds over the entire lagoon. When they fly their density is so great that the flocks resemble smoke clouds, an illusion enhanced by their tendency to maneuver synchronously.

Two species, the rock sandpiper and the least sandpiper *Calidris minutilla* (Vieillot) nest in the region, both in great abundance. Because

Izembek Lagoon soon after the departure of the geese. It is the call of the old squaw duck, or long-tailed duck as it is labelled in Europe in recognition of the two greatly elongated central tail feathers of the drake. The scientific name *Clangula* means "noisy" and the old squaw is by all odds the noisiest of ducks. It has several calls, but one commonly heard is *ow owly owly* which has given rise to the name "owly owly" by which it is known to modern Aleuts. It is an extremely abundant duck, and a large population inhabits Izembek Lagoon until ice forces an exodus. This population appears to be the major winter prey of the bald eagle *Haliaeetus leucocephalus* (L.) in the area.

Nothing is known about their food in Izembek Lagoon, except that they dive for it in the same places as do the Steller's eiders. They share with the eiders the habit of diving simultaneously. The sudden disappearance of an entire flock as if pulled on a single string is surprising, especially to the uninitiated, but no less than its sudden reappearance like so many Jack's-in-a-box.

Shorebirds - The Izembek area is host to nineteen species of shorebirds in varying degrees of abundance. The numbers are so great and the birds so widely spread that it is not reasonable to suggest a numerical estimate in late summer and fall except in hundreds and thousands. In that season the exposed tide flats are covered at low water by these little birds over the entire lagoon. When they fly their density is so great that the flocks resemble smoke clouds, an illusion enhanced by their tendency to maneuver synchronously.

Two species, the rock sandpiper and the least sandpiper *Calidris minutilla* (Vieillot) nest in the region, both in great abundance. Because

of its abundance and disposition to frequent calling, the rock sandpiper is the most conspicuous bird of the upland in nesting season. When the young of both species can fly, they move to the tidal flats of the lagoon where they augment the swelling numbers of ruddy turnstones *Arenaria interpres* (L.), red phalaropes *Phalaropus fulicarius* (L.), and northern phalaropes *Lobipes lobatus* (L.). These five are the most abundant of the nineteen species of shorebirds. Others that occur in considerable numbers are the semipalmated plover *Charadrius semipalmatus* Bonaparte, American golden plover *Pluvialis dominica* (Muller), and the sanderling *Calidris alba* (Pallas). The following are uncommon or rare: common snipe *Capella gallinago* (L.), whimbrel *Numenius phaeopus* (L.), wandering tattler *Heteroscelus incanus* (Gmelin), greater yellowlegs *Tringa melanoleuca* (Gmelin), lesser yellowlegs *Tringa flavipes* (Gmelin), sharp-tailed sandpiper *Calidris acuminata* (Horsfield), dunlin *Calidris alpina* (L.), short-billed dowitcher *Limnodromus griseus* (Gmelin), long-billed dowitcher *Limnodromus scolopaceus* (Say), and bar-tailed godwit *Limosa lapponica* (L.).

The invertebrate populations furnish food for the shorebirds, and the daily turnover must be immense. Nothing escapes the busy probing and searching of these birds in their hundreds of thousands. The phalaropes appear to be feeding largely on amphipods, while the sandpipers and turnstones probe the sediments and accumulations of detritus and take the clam *Macoma inconspicua* and the detritus feeders as well as the amphipods. Even the relatively large and aggressive helmet crab falls prey to little bands of the sandpipers.

Gulls and Terns - Two species of gulls and two of terns inhabit the region. One of these, the glaucous-winged gull, is a common permanent

resident nesting in small numbers. This large gull forages in the lagoon when it is not frozen, especially in summer when low tides occur in daylight. It takes any invertebrate or small fish that exposes itself and consistently preys on the helmet crab in Izembek Lagoon. It searches the waters and shores of the lagoon and eats dead fish, birds and marine mammals. When salmon are spawning, these gulls follow *en masse* to the streams where they feed on dead and dying fish. Here they join the ravens, bald eagles, and brown bears *Ursus arctos* L. engaged in the same activity. They forage at all seasons in the town garbage dump, but most actively when the lagoon is frozen.

The second gull, the black-legged kittiwake *Rissa tridactyla* (L.) is graceful and dainty, little more than half the size of the glaucous-winged gull. A few are present in winter, but they are quite common in summer. None nest in the immediate vicinity, but a large nesting colony occupies the cliffs of offshore Amak Island 12 miles distant. The food of the kittiwake in Izembek Lagoon apparently consists of small fish which they take by flying and diving. Juveniles of two species of fishes, *Hexagrammos octogrammus* Pallas and *Pholis laeta* (Cope), expose themselves abundantly in the eelgrass beds at low tide where they are taken by the kittiwake and the two species of terns in the lagoon (T. McConnaughey in litt.).

The Arctic tern *Sterna paradisaea* Pontoppidan and the Aleutian tern *Sterna aleutica* Baird are both relatively common, though not to the extent of either of the gulls. Over its range the Aleutian tern is not widely distributed and nowhere abundant. It appears likely that the numbers nesting in the Izembek area are as large as any in its range. Like

the kittiwake the terns take their food consisting of small fish by flying and diving.

Divers - Four species of loons, two of grebes, and three of cormorants occupy the Izembek region in small numbers. The common loon *Gavia immer* (Brunnich) and red-throated loon *Gavia stellata* (Pontoppidan) are permanent residents, the yellow-billed loon *Gavia adamsii* (Gray) and Arctic loon *Gavia arctica* (L.) appear only in winter. The red-necked grebe *Podiceps grisegena* (Boddaert) is a permanent resident, but the horned grebe *Podiceps auritus* (L.) is only a rare winter resident. The double-crested cormorant *Phalacrocorax auritus* (Lesson) is an uncommon summer resident. The pelagic cormorant *Phalacrocorax pelagicus* Pallas, a permanent resident, is the commonest of the cormorants in the Izembek area. The red-faced cormorant *Phalacrocorax urile* (Gmelin), also a permanent resident, is uncommon.

These nine divers are all excellent fishermen and most commonly utilize fish but do not overlook such invertebrates as shrimps and crabs.

Raptors - Two species of hawks occur in the Izembek area, the rough-legged hawk *Buteo lagopus* (Pontoppidan) and the marsh hawk *Circus cyaneus* (L.). They are uncommon and feed on ground squirrels *Citellus parryii* (Richardson) and microtine rodents. Three species of falcons inhabit the area, some individuals as migrants and others as permanent residents. The gyrfalcon *Falco rusticolis* L. is often quite abundant in fall but less so in other seasons. It takes ptarmigan, glaucous-winged gulls, ducks, rodents, and tries occasionally to take a goose, but I have never seen this done successfully. The peregrine falcon *Falco peregrinus* Tunstall is also often abundant. Most are of the dark race *F. p. pealei* Ridgway,

a resident of the Aleutian region. This species takes the passerines and shorebirds most commonly but ducks as well. Like the gyrfalcon it tries to take a goose now-and-then, but I have never observed this effort to be successful. The third falcon, the merlin *Falco columbarius* L., is rare in the Izembek area.

Two species of eagles, the golden eagle *Aquila chrysaetos* (L.) and the bald eagle, inhabit the region. The golden eagle is rare, but the bald eagle is common in one or another part of the area throughout the year. In spring and early summer the adults nest on the coast where they and the non-breeders search the beaches for carcasses cast up at winter's end, engage in fishing in the kelp patches and hunting pelagic birds. In these enterprises they develop individual skills and perhaps preferences. The fish most available in the kelp patches is the fringed greenling *Hexagrammos superciliosus* Pallas, which often lies exposed on a kelp frond just under the surface where it is within reach of the sharp-eyed eagle. The most abundant pelagic birds and therefore most vulnerable to eagles are the short-tailed shearwater common murre *Uria aalge* (Pontoppidan), thick-billed murre *Uria lomvia* (L.), and the tufted puffin *Lunda cirrhata* (Pallas).

In mid-summer the salmon arrive in large numbers to spawn in the streams and the eagles transfer their attention to this plentiful food supply. Several of the big birds can then be observed on any of the salmon streams. They remain concentrated on this resource until spawning is concluded and the last of the carcasses are washed from the streams. This occurs about the end of September and then the birds commence hunting waterfowl in Izembek Lagoon. In present times they find waterfowl crippled

and lost by human hunters, but aboriginal men are unlikely to have created a similar windfall. In addition to the lost and crippled birds, which if they wash ashore must be shared with vigilant mammals (particularly red foxes *Vulpes fulva* [Desmarest]), the eagles actively hunt waterfowl. In the period between their departure from the salmon streams and the arrival of the old squaw ducks the bird most utilized by the eagles is the emperor goose. I have watched bald eagles attempt to take both Canada geese and brant in Izembek Lagoon, but without success. The emperor goose, however, is quite another matter. This goose of the three combines relative unwariness, slow response, low maneuverability, and relatively slow flying speed to make it vulnerable to any hungry eagle. It appears that once an eagle fixes its intent upon an individual emperor goose, that goose has little opportunity to escape.

When the old squaw ducks arrive some of the pressure shifts to them, just by virtue of their greater numbers. These ducks dive at the approach of an eagle, if they see it, only to be met as they return to the surface by the circling eagle. The eagle's secret of success appears to be the selection of one bird which is harried until caught. When Izembek Lagoon freezes the eagles move to the deep bays on the Peninsula's south side where they continue preying on the diving ducks. One of these, the Steller's eider, flies rather than dives at the approach of an eagle, and handily escapes the big bird. Those that do dive in the big bays in deep water have a better chance of escaping than they do in the shallow waters of Izembek Lagoon where the eagle can see them swimming under water.

A few short-eared owls *Asio flammeus* (Pontoppidan) inhabit the Izembek area, most commonly on the islands and along the shore of the lagoon it-

self. The islands and salt marshes of the lagoon support large populations of the tundra vole *Microtus oeconomus* (Pallas) which are the main food source for the diurnal, permanently resident owl.

In certain winters, a few snowy owls *Nyctea scandiaca* (L.) appear in the Izembek area. They are also diurnal in habit and may be seen coursing over the open heath, presumably in search of voles.

Conclusion

This account of the birds of the Izembek region reflects the differing levels of knowledge available at this point. There has been no study dedicated to understanding how each population fits within the system. Some of the birds have been studied intensively, while others are known only from incidental observations. The lagoon itself, however, has been studied widely and those birds directly associated with it are best known, but even here in differing levels. The studies of these populations have demonstrated the central importance of the lagoon in the avian ecology of the region. Since most of these birds are migratory and travel to many corners of North America and Asia, the importance of the lagoon extends far over the horizon to the several destinations of the birds.

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