Status, conservation, and management of nesting *Larus* gulls in the North Pacific

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Abstract

The population status of seven gull species (Black-tailed *Larus crassirostris*, Heermann's *L. heermanni*, Glaucous *L. hyperboreus*, Glaucous-winged *L. glaucescens*, Slaty-backed *L. schistisagus*, Western *L. occidentalis*, and Yellow-footed *L. livens* gulls) in the North Pacific Ocean and of five species (California *L. californicus*, Herring *L. argentatus*, Mew *L. canus*, Ring-billed *L. delawarensis*, and Saunder's *L. saundersi* gulls) that nest irregularly near salt water has been briefly reviewed. The breeding range, nesting habitat, and reproductive success of each species, and the effects of human disturbance on gulls, have also been described.

Immediate conservation measures are urged for three species, Heermann's and Yellow-footed gulls, both of which nest in the Gulf of California, Mexico, are seriously threatened by human disturbance, including a sardine fishery. Saunder's Gull, which has the smallest population of any gull species in the North Pacific, could become endangered by the construction of a seawall around its coastal nesting marsh in China.

Management of a potential problem species, the Glaucous-winged Gull, may become necessary, because the species represents a potential threat to the American Black Oystercatcher *Haematopus bachmani*, by usurping the latter's nesting habitat. The Glaucous-winged Gull also has become a nuisance in coastal towns and cities of British Columbia, where its nesting on roofs of buildings has been rapidly increasing.

Résumé

Les auteurs étudient brièvement la situation des populations de sept espèces de goélands répandus dans le Pacifique Nord (Goéland à queue noire *Larus crassirostris*; Goéland de Heermann *L. heermanni*; Goéland bourgmestre *L. hyperboreus*; Goéland à ailes grises *L. glaucescens*; Goéland à manteau ardoisé *L. schistisagus*; Goéland d'Audubon *L. occidentalis*; Goéland de Dwight *L. livens*) et de cinq autres espèces qui nichent de façon marginale près de l'eau salée (Goéland de Californie *L. californicus*; Goéland argenté *L. argentatus*; Goéland cendré *L. canus*; Goéland à bec cerclé *L. delawarensis*; Mouette de Saunders *L. saundersi*). L'aire de reproduction, l'habitat de nidification, la réussite de la couvaison et les effets des perturbations par les humains sont les sujets à l'étude.

Des mesures immédiates de conservation s'imposent pour trois espèces. Le Goéland de Heermann et le Goéland de Dwight, qui nichent dans le golfe de Californie, au Mexique, sont très menacés par les perturbations, y compris la pêche de la sardine. La Mouette de Saunders, qui se distingue par la plus petite population de cette famille dans le Pacifique Nord, pourrait être fortement affectée par la construction d'un ouvrage longitudinal autour de son marais côtier de nidification, en Chine.

Le contrôle des populations de Goélands à ailes grises pourrait s'imposer, étant donné que l'espèce représente une menace possible pour l'Huîtrier de Bachman *Haematopus bachmani*, dont il s'approprie l'habitat de nidification. Le Goéland à ailes grises est devenu une nuisance dans les villes et localités côtières de la Colombie-Britannique, où on le retrouve de plus en plus niché sur les toits des bâtiments.

1. Introduction

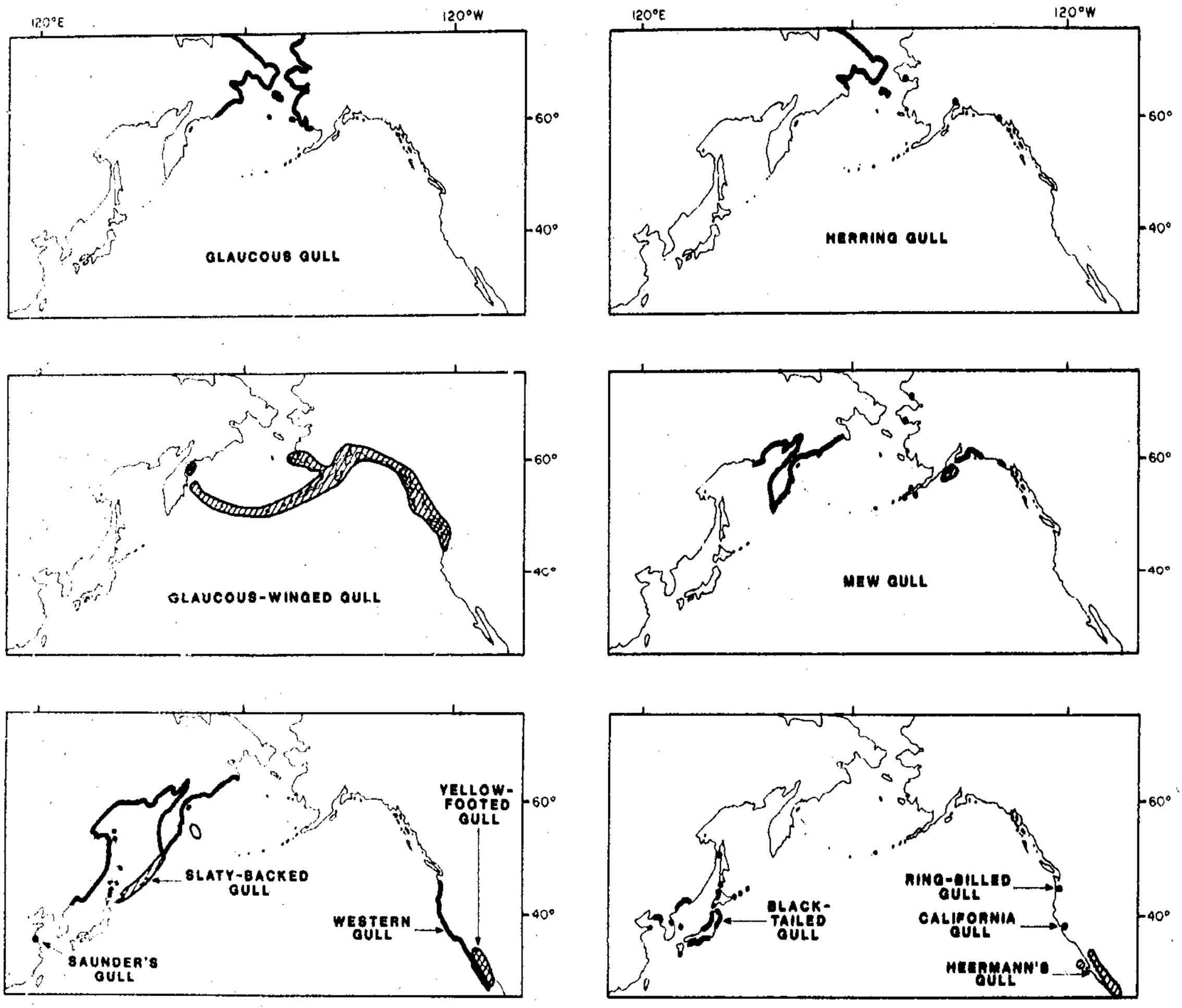
In the North Pacific Ocean, nine gull species breed almost exclusively in the marine environment; five species nest irregularly in the marine environment, and seven species do not nest there but are common visitors (Table 1). The objective here is to investigate the present nesting populations of gulls inhabiting North Pacific coasts, and to determine if any species are endangered or have become a nuisance. We therefore will examine the status, habitat, and reproductive success of the seven marine-nesting *Larus* species, as well as that of the five peripheral nesters. The ecology of two other marine-nesting gulls, the Black-legged *Rissa tridactyla* and the Red-legged *R. brevirostris* kittiwakes, will be dealt with in this volume by Hatch et al.

Table 1
Gull species inhabiting or visiting the temperate and coastal North Pacific

Species nesting mainly or only in marine habitat	Species nesting peripherally in marine habitat	Visiting species only
Black-tailed Gull	California Gull	Black-headed Gull
Glaucous Gull	Herring Gull	Bonaparte's Gull
Glaucous-winged Gull	Mew Gull	Franklin's Gull
Heermann's Gull	Ring-billed Gull	Little Gull
Slaty-backed Gull	Saunder's Gull	Ross' Gull
Western Gull		Sabine's Gull
Yellow-footed Gull		Thayer's Gull
Black-legged Kittiwake*		
Red-legged Kittiwake*		

* Not dealt with in this paper

Figure 1
Nesting ranges of Black-tailed, California, Glaucous, Glaucous-winged, Heermann's, Herring, Mew, Ring-billed, Slaty-backed, Saunder's, Western, and Yellow-footed gulls in the North Pacific (based on Penland and Jeffries 1977; Hoffman et al. 1978; Sowls et al. 1978; Patten and Patten 1983; Jones 1986; Ilichev and Zubakin 1988; Shi et al. 1988; D.W. Anderson and M.E. Velarde, unpubl. data)



2. Breeding range and nesting habitat

2.1. Marine-nesting species

The breeding ranges of the seven marine-nesting *Larus* species are shown in Figure 1. The Black-tailed *Larus crassirostris* and Slaty-backed *L. schistisagus* gulls are restricted to the western North Pacific, and Western *L. occidentalis*, Yellow-footed *L. livens*, and Heermann's *L. heermanni* gulls to the eastern North Pacific, while Glaucous *L. hyperboreus* and Glaucous-winged *L. glaucescens* gulls nest on both sides of the North Pacific. The Glaucous and Glaucous-winged (both light mantled) and the Slaty-backed, Western, and Yellow-footed (all dark mantled) are closely related, and belong to the Herring Gull *Larus argentatus* species and semi-species group (Patten and Patten 1983). Members of this group are morphologically similar, and differ mainly in eye, mantle, and wing colour. Glaucous-winged Gulls interbreed but mate assortatively with both Herring Gulls *L. a. smithsonianus* in Alaska and Western Gulls in Washington, and form stable zones of overlap in each instance (Hoffman et al. 1978; Patten and Patten 1983). The Glaucous-winged Gull also interbreeds with the Glaucous Gull on the western coast of Alaska (Strang 1977; Patten and Patten 1983). In the northwestern Pacific, the Slaty-backed Gull interbreeds with the Herring Gull *L. a. vega* along the Bering Sea coast of Russia (Portenko 1963; Kistchinski in Patten and Patten 1983).

Members of the Herring Gull species group are flexible in their choice of nesting habitat. For instance, Glaucous-winged Gulls, the most numerous gull in the northeastern Pacific, nest chiefly on small to moderate-sized islands, but will

also nest on barges, beacons, bridge supports, cliff ledges, derricks, log booms, and pilings, as well as in cliff cavities (Vermeer and Devito 1987). This gull has recently started to nest in large numbers on the roofs of buildings in coastal cities (Eddy 1982; Vermeer et al. 1988). Where Glaucous-winged and Western gulls occur together on the same islands off the state of Washington, the Glaucous-winged Gull nests chiefly in tall, moderate, or short grass, whereas the Western Gull usually occupies bare rocky areas and, less frequently, short grass substrate (Hoffman et al. 1978). The Western, like the Glaucous-winged, also nests on human-made structures (Bayer 1983) and has recently started to nest on the roofs of buildings in coastal cities (e.g., San Francisco; R. Mewaldt, pers. commun.).

The Glaucous Gull has a circumpolar breeding distribution and nests both on the ground and on cliff ledges on islands along arctic coasts. The species also nests inland on boulders and on small islands in lakes, but generally never far from the coast (Macpherson 1961; Godfrey 1966).

The Slaty-backed Gull nests primarily on the ground on isolated islands off Japan. The species nests on *Elymus*-covered flat areas above cliffs, on boulder beaches, and on rock stacks and cliff ledges.

The Yellow-footed Gull nests primarily in small colonies (average 12.5 pairs) on beach-berm substrates; it can also nest as solitary pairs on the talus-boulder substrates, on barren and desert-like islands in the Gulf of California (Spear and Anderson 1989). This species, endemic to the Gulf of California, appears more restricted in its choice of nesting habitat than any other member of the Herring Gull species group in the North Pacific. The Yellow-footed Gull nests mostly (90%) in a linear fashion directly above the high-tide line (Hand et al. 1981). Yellow-footed Gull territories predominantly border the waterfront, providing their occupants unimpeded access to the water without having to cross other territories. Hand et al. (1981) postulate that the linear nest arrangement relates chiefly to water access for thermoregulation, as Yellow-footed Gulls experience considerable heat stress. Adults frequently visit the water to bathe and/or drink during the nesting season.

Two marine-nesting species, Heermann's and Black-tailed gulls, are not related to the Herring Gull group or to one another. Both species are much smaller (length 46–53 cm) than the previously mentioned members of the Herring Gull group (61–77 cm).

Heermann's Gull is the most numerous gull in the Gulf of California but, unlike the Yellow-footed Gull, is not endemic to it (Fig. 1). Heermann's Gulls nest up to 500 m from the high-tide line on desert islands, either on plateaus with young volcanic soil or in valleys with guano deposits, and sporadically on beds of halophyte vegetation, and seldom on bare volcanic rock (Rasa Island). They nest in areas with good visibility (120° to 360°), and at densities from 1 to 100 nests/100 m^2 (Velarde 1989). Heermann's Gull territories, unlike those of Yellow-footed Gulls, lack direct access to the water. Unless relieved by their mates, Heermann's Gulls generally do not make trips to the water, but sit tightly and continuously on their eggs during the heat of the day, thereby preventing lethal overheating and water loss by the eggs (Bartholomew and Dawson 1979; Hand et al. 1981). Hand et al. (1981) postulate that the differences in nesting behaviour of Heermann's and Yellow-footed gulls relate to differences in plumage colour. The dark plumage of the Heermann's Gull may facilitate nesting away from the immediate vicinity of water by prolonging the gull's period of tolerance to heat stress (Howell et al. 1974; Walsberg et al. 1978). Also important is the adults' habit of regurgitating water to their chicks, which undoubtedly allows the chicks to stay longer at the nest site and thereby reduces their mortality (Velarde 1989).

Black-tailed Gulls nest on islands off the coasts of China, Korea, Japan, and Pacific Russia (Fig. 1). In Japan, Black-tailed Gulls nest on isolated islands off Hokkaido. They also breed on northern Honshu, on rocky stacks and cliffs. A few of them also nest on *Juniperus* branches. Where they nest together with Slaty-backed Gulls on Teuri Island, Black-tailed Gulls nest on the upper shoulder slopes covered with *Calamagrostis*, whereas Slaty-backed Gulls breed on the lower rocky shoulder slopes, on cliff ledges, and on isolated rock stacks.

2.2. Peripheral marine-nesting species

The marine breeding localities of five of the gull species—Herring, California *Larus californicus*, Ring-billed *L. delawarensis*, Mew *L. canus*, and Saunder's *L. saundersi* which nest only peripherally in the North Pacific are shown in Figure 1. Of all members of the Herring Gull species group, the Herring Gull itself is the most flexible in its choice of nesting habitat. Herring Gulls breed extensively on lake islands throughout the interior of Canada and Russia, and in much smaller numbers off the coasts of Alaska and Siberia. Where Herring and Glaucous-winged gulls interbreed in Alaska, the former is the more flexible as to nesting habitat. Herring Gulls nest both along the coast and in the interior of Alaska, whereas Glaucous-winged Gulls nest only along the coast. On the coast, the two species chiefly mix and interbreed on gravel bars of river deltas, on islands in tidal bays, and on sea cliffs near glaciers (Patten and Patten 1983).

The California Gull was considered by Stegmann (1934) and Fisher and Lockley (1954) to be another member of the Herring Gull group, although it is much smaller (wing length: 34–43 cm, Jehl 1987) than other members of that group. The species nests almost exclusively on islands in lakes (but sometimes in rivers) throughout the western interior of Canada and the United States (Vermeer 1970; Jehl 1987). In about 1980, California Gulls began nesting on the south side of San Francisco Bay near the town of Alviso, where they established a colony on a roadway edge through an estuary (Jones 1986). The new site represents a western and somewhat southern extension of the breeding range.

The Ring-billed Gull mostly breeds on islands in lakes in interior western North America, in the Great Lakes and James Bay, and off the east coast of Canada (Vermeer 1970). The species has nested in the Columbia Basin, Washington State, as early as 1930 (Jewett et al. 1953), but was first recorded nesting on the coast in 1976 (Penland and Jeffries 1977). Several nests were observed on low-lying sand islands in Willapa Bay and on Whitcomb Island in Grays Harbor that year (Penland and Jeffries 1977).

The Mew Gull, a close relative of the Ring-billed Gull, is circumpolar in its distribution except for a breeding gap in northeastern Canada and southern Greenland. The species breeds chiefly on lakes in the interior of western Canada and Russia, but in Alaska and in Europe it nests both in fresh water and in the marine environment. In the North Pacific, the species nests in moderate numbers on islands off Alaska (Sowls et al. 1978) and off Siberia. The Mew Gull appears to be even more flexible in its choice of nesting habitat than the Herring Gull, as it nests on islands in lakes, rivers, and the sea, in bogs and

marshes, on pilings and in trees, and on roofs of houses (e.g., Vermeer and Devito 1987).

Dwight (1925) and Peters (1934) noted that Saunder's Gull breeds in northern China and Mongolia. However, it was not until 1984 that a nest was actually found along the She Yang coast in China (Shi et al. 1988). Although Saunder's Gull appears to nest mostly along the coast, it is included here with the other four peripherally marine-nesting species because it nests at some distance from shore; colonies far inland may still be discovered (one small colony has been found on an island in a lake in Inner Mongolia). Saunder's Gulls nest mainly 400 m to 1 km inland from the high-tide level along the Yellow Sea coast of the central Chinese province of Jiangsu (Shi et al. 1988). Two colonies of this gull have been discovered recently in a salt marsh several kilometres from the coast. Nests in the marsh were situated either in the open or on top of small, dead *Suaeda* bushes (10 cm high) often found adjacent to tidal creeks (Shi et al. 1988).

3. Populations and reproductive success

One of the best means of determining the size of breeding gull populations is to census active nests in colonies during advanced incubation. When populations are counted over many years one can determine trends and rates of increase or decrease. To understand these trends it is necessary to measure the reproductive success; the postfledging, juvenile, subadult, and adult survival; and the factors affecting those parameters. Of these parameters, reproductive success in the colony is the easiest to measure; factors affecting reproduction can also be determined. It is more difficult to study survival rates of gulls away from the colony. Survival of adults is best measured by determining the number of marked birds returning to the breeding colony from one year to the next. For most marine-nesting species in the North Pacific, only rough estimates of nesting populations exist, and reproductive success in colonies has been investigated only for one or two years. Nevertheless, we will review the available information to identify the status of, including gaps in, our present knowledge on the ecology of North Pacific gulls.

3.1. Marine-nesting species

3.1.1. Glaucous Gull

Sowls et al. (1978) estimated the total nesting population of Glaucous Gulls in Alaska at 15 000 pairs. At present, there are 112 known colonies in Alaska, of which the largest contains about 1000 gulls. No estimate is available of the magnitude of the Glaucous Gull population from Russia.

Strang (1973) reported that the average clutch size of this species nesting on ponds in the Alaska tundra was 2.88 eggs, from which an average of 1.25 young per nest fledged. Swartz (1966) observed an average clutch of 2.86 eggs for Glaucous Gulls nesting along the Bering Sea at Cape Thompson. There was nearly complete reproductive failure in areas accessible to red foxes *Vulpes vulpes*, but 18 pairs of Glaucous Gulls fledged 1.43 chicks per nest in areas inaccessible to foxes.

3.1.2. Glaucous-winged Gull

Counts of nesting Glaucous-winged Gulls are 133 009 pairs in Alaska (A.L. Sowls, pers. commun.), 29 000 pairs in British Columbia (Vermeer and Irons 1991), and 10 000 pairs along the inner coast of Washington—Seattle, Puget Sound, and San Juan Islands (Speich and Wahl 1989). There are no separate counts for Glaucous-winged and Western gulls along the outer Washington coast, as the two species hybridize extensively there. Speich and Wahl (1989) estimated the combined nesting number of these two species on the outer Washington coast to be 8500 pairs. Using the extent of hybridization reported by Hoffman et al. (1978), the total number of Glaucous-winged Gulls was estimated to be 4500 pairs. Pitman et al. (in press) estimated that there are roughly 100 pairs nesting in northern Oregon. We do not know how many Glaucous-winged Gulls nest in Pacific Russia, but because that region represents the northwestern outskirts of the species' breeding range, we conservatively estimate the overall nesting population of Glaucous-winged Gulls in the North Pacific at 200 000 pairs.

The reproductive success of Glaucous-winged Gulls has been studied in Alaska and British Columbia by Vermeer (1963), Patten and Patten (1983), Murphy et al. (1984), Verbeek (1986), Vermeer et al. (1988), and Vermeer and Devito (1989). The average clutch size and fledging success of one gull colony in Alaska varied much between years (Table 2), and may have been food related. Murphy et al. (1984) observed that when adult gulls ate primarily blue mussels *Mytilus edulis*, reproductive success suffered. However, when fish became prevalent in the gull diet, reproductive performance improved. In contrast to the Alaskan colonies, clutch size on Mandarte Island, British Columbia, was relatively high during four years of observation, and fledging success was good during the two years of investigation (Table 2). These results suggest a more reliable annual food supply for gulls on Mandarte Island than for those in Alaskan colonies. Reproductive success of Glaucous-winged Gulls in 16 small colonies was much lower (0.3 fledglings/nest) than in two large colonies (1.0–1.5 fledglings/nest) in the Strait of Georgia, British Columbia (Vermeer and Devito 1989). The low success of small colonies was related to predation by Bald Eagles *Haliaeetus leucocephalus*, river otters *Lutra canadensis*, and Northwestern Crows *Corvus caurinus*.

Reproductive success of Glaucous-winged Gulls nesting on city roofs of Vancouver, British Columbia, is compared with that of gulls nesting on islands in Table 2. Dispersed roof nesters produced as many young per nest as did gulls of the large colony on Mandarte Island, but colonial roof nesters produced fewer young than did dispersed roof nesters. The main cause of chick mortality in a roof colony was attacks by adult gulls. These attacks apparently resulted from a high nesting density and territorial clashes. As there were few places for chicks to hide from attacks, mortality was high.

3.1.3. Western Gull

The numbers of Western Gulls breeding in Washington, Oregon, and California are estimated to be 4000, 3500 (Pitman et al., in press), and 25 500 pairs (Sowls et al. 1980), respectively. Everett and Anderson (1991) estimate that about 30 000 pairs of Western Gulls nested along the Pacific coast of Baja California, Mexico. Therefore, we estimate the total nesting population of Western Gulls to be about 65 000 pairs.

The clutch size and reproductive success of Western Gulls has been examined at the Catalina, Channel, and Farallon islands in California (Table 3). Penniman et al. (1990) summarized information on clutch size and reproductive success of Western Gulls at the Farallon Islands from 1971 through 1983. Over that 13-year period, the mean clutch size varied only from 2.6 to 2.8 eggs, but the number of young produced ranged from 0.6 to 1.9 fledglings/nest (overall

Table 2
Clutch size and reproductive success of Glaucous-winged Gulls in Alaska and British Columbia

Location, year	No. of eggs laid	Mean clutch size (no. of nests)	Hatching success (%)	Fledging[a] success (%)	Fledglings per nest	Source
Egg Island, Alaska, 1975	313	2.05 (153)	69	50	1.0	Patten and Patten 1983
Egg Island, Alaska, 1976	476	2.56 (186)	77	44	1.1	Patten and Patten 1983
Squab Island, Alaska, 1979	472	2.06 (229)	50	46	1.0	Murphy et al. 1984
Squab Island, Alaska, 1980	1471	2.59 (568)	42	10	0.25	Murphy et al. 1984
Squab Island, Alaska, 1981	328	2.80 (117)	—	—	—	Murphy et al. 1984
Mandarte Island, B.C., 1961	266	2.74 (97)	71	36	1.0	Vermeer 1963
Mandarte Island, B.C., 1962	1386	2.82 (479)	83	58	1.7	Vermeer 1963
Mandarte Island, B.C., 1979	799	2.69 (297)	—	—	—	Verbeek 1986
Mandarte Island, B.C., 1980	1155	2.77 (417)	—	—	—	Verbeek 1986
Colony nesters on city roofs, Vancouver, B.C., 1986	216	2.70 (80)	37	13	0.35	Vermeer et al. 1988
Dispersed nesters on city roofs, Vancouver, B.C., 1986	144	2.77 (52)	73	40	1.1	Vermeer et al. 1988

[a] Fledging success is defined as percentage of chicks fledged per eggs laid.

Table 3
Clutch size and reproductive success of Western Gulls in California

Location, year	No. of eggs laid	Mean clutch size (no. of nests)	Hatching success (%)	Fledging[a] success (%)	Fledglings per nest	Source
Bird Rock, Santa Catalina Is., 1965	58	2.41 (24)	76	46	1.33	Harper 1971
Bird Rock, Santa Catalina Is., 1966	67	2.69 (25)	80	64	0.96	Harper 1971
San Nicholas Is., Channel Is., 1968	429	2.86 (150)	55	—	—	Schreiber 1970
Santa Barbara Is., Channel Is., 1972	177	2.81 (63)	56	46	1.3	Hunt and Hunt 1975
Farallon Is., 1968	503	2.66 (189)	78.3	—	—	Coulter 1973
Farallon Is., 1970	470	2.73 (172)	74.5	—	—	Coulter 1973
Farallon Is., 1971–83	2765	2.7 (1024)	76	54	1.4	Penniman et al. 1990

[a] Fledging success is defined as percentage of chicks fledged per eggs laid.

average: 1.4 fledglings/nest). One of the main factors affecting reproductive success was the habit of adults attacking neighbouring chicks wandering into "others' " territories, and starvation caused much mortality in some years (Coulter 1973; Spear et al. 1987). Reproductive success varied with the type of food eaten. Fledging success correlated positively with the percentage of fish and negatively with the percentage of garbage in the chicks' diet (Penniman et al. 1990).

3.1.4. Yellow-footed Gull

The total population of Yellow-footed Gulls consists of somewhere between 10 000 and 20 000 pairs (Anderson 1983). Average clutch size of Yellow-footed Gulls during the peak of laying on Isla Cardinosa in 1976 was 2.47 eggs (Hand 1980). Observed reproductive success was generally low. Hand (1980) observed 0.12 (n=118) and 0.03 chicks/nest on Islas Angel de la Guarda and on Mejia, respectively. Spear and Anderson (1989) reported an average of 0.12 chicks/breeding pair in colonies on Islas Coronada and on La Ventana (n=133), and 0.11 chicks/pair at Bahia de Los Angeles (n=97). Solitary pairs produced 0.14 chicks/pair at the latter locality. Spear and Anderson (1989) observed higher reproductive success on Islas Rasita (0.71 chicks/pair, n=31) and on Bota (0.33 chicks/pair, n=26). The low reproductive success of the Yellow-footed Gull resulted from human disturbance.

3.1.5. Slaty-backed Gull

About 55 000 pairs of Slaty-backed Gulls breed along the coast of Kamchatka (Vyatkin 1986), 45 000 pairs on the Kuril Islands (Shuntov 1986), and about 10 000 pairs along the coast of Hokkaido (Watanuki, unpubl. data).

The Slaty-backed Gull clutch in three nesting colonies near Hokkaido was on average about 2.7 eggs (Table 4). Hatching and fledging success was 72.7% and 27.3%, respectively. Most reproductive failure occurred in the chick stage; many chicks disappeared without a trace. Of 39 chicks on Teuri Island that died of known causes, 24 had been preyed upon by conspecifics, nine had been killed by neighbouring adults, and six died accidentally because of nest-site erosion. Predation on chicks by conspecifics was highest where nesting density was lowest, and attacks on chicks by neighbours occurred chiefly where nest density was the highest. Jungle Crows *Corvus macrorhynchos* and Peregrine Falcons *Falco peregrinus* were minor predators on chicks.

3.1.6. Heermann's Gull

At present, practically all Heermann's Gulls breed on islands in the Gulf of California, with Rasa Island supporting by far the largest colony. The Rasa colony has fluctuated between 12 000 and 800 000 pairs, but has now stabilized at between 150 000 and 200 000 pairs (Boswall and Barrett 1978; Anderson 1983; Velarde 1989). The total nesting population of the species is unknown, but Everett and Anderson (1991) estimated it to range between 250 000 and 400 000 pairs.

The average clutch size of Heermann's Gull on Rasa Island was 1.8 eggs, with a reproductive success ranging from 0.05 to 1.6 chicks/nest (Velarde 1989). The most important chick mortality factors were limited food supply, weather (which affected food availability), and predation by Yellow-footed Gulls (Velarde 1989). Human disturbance at critical stages of chick development caused massive mortality, due to the chicks being lost in the colony and then being unable to return to their nest site.

3.1.7. Black-tailed Gull

In Japan, about 45 000 pairs of Black-tailed Gulls breed around Hokkaido, and approximately 50 000–70 000 pairs breed in northern Honshu. In Russia, the number of Black-tailed Gulls does not exceed 8500 pairs, and 90% of them breed in Peter the Great Bay (Ilichev and Zubakin 1988). The average

Table 4
Clutch size and reproductive success of Slaty-backed Gulls in Japan (Watanuki 1988)

Location, year	No. of eggs laid	Mean clutch size (no. of nests)	Hatching success (%)	Fledging[a] success (%)	Fledglings per nest
Teuri Island, 1980	111	2.6 (42)	71.1	27.9	0.74
Teuri Island, 1984	188	2.7 (71)	67.5	28.2	0.75
Teuri Island, 1985	176	2.8 (63)	78.4	28.4	0.79
Daikoku Island, 1982	314	2.8 (114)	73.3	28.9	1.07
Yururi Island, 1983	143	2.8 (102)	73.4	23.1	0.32

[a] Fledging success was determined as a percentage of chicks attaining 35 days of age per egg laid.

Table 5
Reproductive success of Black-tailed Gulls on Kabushima Island (Narita 1985) and on Teuri Island (Watanuki 1987)

Location	Year	No. of eggs laid	Mean clutch size (no. of nests)	Hatching success (%)	Fledging[a] success (%)	Fledglings per nest
Kabushima I.	1964	184	2.2 (83)	70.6	27.7	0.61
	1965	128	1.9 (74)	68.1	23.4	0.41
	1966	179	2.2 (86)	71.5	31.2	0.65
	1967	196	2.3 (84)	70.4	31.2	0.73
	1968	183	2.2 (82)	54.1	9.8	0.22
	1969	201	3.3 (86)	71.1	30.3	0.71
	1970	188	2.2 (84)	71.8	23.9	0.54
	1971	163	2.0 (78)	49.6	30.7	0.64
	1972	183	2.2 (84)	73.2	27.8	0.61
Teuri I.	1980	188	1.8 (104)	80.3	30.3	0.55
	1984	123	1.7 (85)	70.7	13.0	0.19
	1985	161	1.9 (85)	67.7	31.1	0.59

[a] Fledging success was determined as a percentage of chicks attaining 30 days of age per egg laid.

Black-tailed Gull clutch in two colonies in Japan was 2.16 eggs (Table 5). Average hatching and fledging success was 63.3% and 25.9%, respectively. On Teuri Island, the main predator on Black-tailed Gull chicks was the Slaty-backed Gull (Watanuki 1982).

3.2. Peripheral marine-nesting species

3.2.1. Herring Gull

Only about 100 Herring Gulls in four colonies nest along the coast of Alaska. The inland population is many times that size (A.L. Sowls, pers. commun.). No data are available for the Herring Gull population off Pacific Russia. No information appears to be available on the reproductive success of a "pure" Herring Gull colony along the coast of Alaska. However, in a study at Lake Louise in the interior of south-central Alaska, Patten and Patten (1983) observed that 77 pairs laid on average 2.74 eggs, and produced 0.95 fledglings/pair.

3.2.2. California Gull

California Gulls started to nest at San Francisco Bay near the town of Alviso around 1980, and the population grew rapidly from 12 nests in 1980 to 31 in 1981, 206 in 1982, 671 in 1983, 886 in 1984, 1576 in 1987, and 2049 in 1988 (Jones 1986). Clutch sizes at this colony averaged 2.44 eggs in 1983 (n=97), 2.75 eggs in 1984 (n=113), and 2.62 eggs in 1985 (n=151) (Jones 1986). Overall hatching and fledging success for California Gulls was 82.4% and 41.4%, respectively, in 1983 and 1984.

3.2.3. Ring-billed Gull

In 1981, 306 Ring-billed Gulls were observed nesting in Willapa Bay (Speich and Wahl 1989), and the population appears to be slowly increasing there. No information is available on the reproductive success of this species on the coast.

3.2.4. Mew Gull

A.L. Sowls (pers. commun.) reported 70 colonies of Mew Gulls along the coast of Alaska, with an estimated population of 15 000 birds in 1988. The average size of 66 colonies was 233 birds, with the largest colony consisting of 3800 birds. No information is available on the status of Mew Gulls nesting off the coast of Pacific Russia. On Kennedy Lake, Vancouver Island, British Columbia, Mew Gulls laid an average clutch of 2.4 and 2.6 eggs, from which 0.24 and 0.52 fledglings/pair were produced in 1984 and 1985, respectively (Vermeer and Devito 1986). These gulls nested mostly as solitary pairs, and predation on eggs and chicks was high. The species of predators were mostly unknown, but Bald Eagles were observed preying upon gull chicks. Hatch et al. (1978) reported that Mew Gulls on Mary Island in Chiniak Bay, Alaska, had an average clutch of 2.63 eggs (n=60), and fledged 0.8 chicks/nest. Most chick mortality at Chiniak Bay resulted from starvation and storm exposure.

3.2.5. Saunder's Gull

In 1987 at least 40 nests and 540 Saunder's Gulls were observed along the coast of She Yang County of China (Shi et al. 1988). At another nesting locality at the border of Dafeng and Donghai counties, 350 gulls were counted in 1987. No thorough survey has been conducted, but Shi et al. (1988) estimated that about 1000 gulls nested at the two locations. One other site with six nests was discovered at the edge of a small island in Lake Hulun Nur, Inner Mongolia, in 1987 (Shi et al. 1988). Information on the reproductive success of Saunder's Gulls may soon be available, as a study on the breeding biology of the species has been planned for the immediate future (Shi et al. 1988).

4. Human disturbance and conservation

One of the main disturbances to gull colonies in the past was the harvesting of eggs. For example, before and during early settlement of British Columbia, native Canadians used the eggs from Glaucous-winged Gull colonies as a food source (native Alaskans still do so; see Baird and Moe 1978). With more and more fishermen taking part, "egging" reached alarming proportions during the first quarter of this century. To save some of the colonies, wardens were posted on them (Drent and Guiguet 1961). Egging, with a few exceptions (Vermeer et al. 1991), has now gone out of fashion in British Columbia, but by visiting colonies, people still cause disturbance. Such disturbance, however, has not prevented the Glaucous-winged Gull population in British Columbia from rapidly expanding over the last three decades (Vermeer and Devito 1989).

In the past, people harvested eggs of Black-tailed Gulls on Kabushima, Enoshima, Teuri, and Kishiri islands and eggs of Slaty-backed Gulls on Daikoku, Yururi, Moyurori, and Teuri islands, Japan (Kuroda 1963; Narita 1985; Watanuki, unpubl. data). Most of those colonies are now legally protected as natural monuments, and egging has therefore stopped. Black-tailed and Slaty-backed gulls are currently the most numerous gulls in the northwestern Pacific.

In the Gulf of California, Mexico, commercial harvesting of Heermann's Gull eggs was common from the early 1950s through the early 1960s (Anderson et al. 1976). Rasa Island became a National Reserve Zone and a Bird Refuge in 1964, and people who could no longer harvest at Rasa turned to egging the Yellow-footed Gull on surrounding islands (Hand 1980). In 1978, the Mexican government established 33 islands in the gulf as Reserve Zones and Refuges for Migratory Birds and Wildlife. Egging has been limited by this action, but continues at unprotected nesting sites (Hand 1980). Heermann's Gull eggs are still harvested at Cardonosa Island by local inhabitants. More disturbing than the egging are the increasing visits by boaters and tourists. When people enter colonies, gulls leave their nests and neighbouring gulls use the opportunity to take unprotected eggs and chicks. Chronic disturbances result in decreased reproductive success and may ultimately cause populations to decline. Of all gull species in the North Pacific, Heermann's and Yellow-footed gulls appear to be most affected and threatened by human disturbance.

An important developing conservation issue for the Heermann's Gull population in the Gulf of California is the commercial fishery of Pacific sardines *Sardinops sagax*. Heermann's Gulls fed mainly (88%) on sardines in 1983. In 1989, over 90% of the gulls' diet was made up of northern anchovy *Engraulis mordax*. The sardine fishing fleet's catches have increased from 24 to 43% per year over the last 10 years. We do not know if the Heermann's Gull and other seabirds of the Gulf of California will be able to cope with the changes imposed on the food web by the sardine fishing industry.

Little is known about factors affecting the nesting of Saunder's Gull, which has the smallest population of any gull species in the North Pacific. It was a fortuitous discovery that about 1000 birds still nest on China's coast. Shi et al. (1988) reported that both nesting localities in Jiangsu were within the Yancheng Nature Reserve area and were legally protected. There are plans to construct a new seawall around the salt marsh in which the species nests, but Shi et al. believe that the wall will not have an adverse effect on the gulls if it is situated at least 1 km from the high-tide line and if precautions are taken to avoid disturbance to nesting birds during its construction. Further detailed information on the nesting requirements of the species and constant monitoring by biologists and conservation agencies as construction of the wall progresses are essential to safeguard the existing population.

5. Management of a potential problem species

The Glaucous-winged Gull, with an approximate nesting population of 200 000 pairs, is rapidly increasing in some portions of its breeding range. The species has started to nest on roofs of buildings along the waterfronts of towns and cities in British Columbia and Washington and is becoming a nuisance (Vermeer et al. 1988). The gulls are also a nuisance at garbage dumps and a safety risk at airports (Vermeer and Irons 1991). Furthermore, Glaucous-winged Gulls represent a potential threat to the American Black Oystercatcher *Haematopus bachmani*, by usurping oystercatcher nesting habitat along the periphery of gull colonies (Vermeer et al. 1989).

The population trend of Glaucous-winged Gulls has been most intensively investigated in the Strait of Georgia, British Columbia, which contains many islands on which this gull nests. Changes in the gull population in the strait have been documented over the last 30 years. The population increased from about 6150 nesting pairs in 1960 to 9800 pairs in 1975 and to 13 000 pairs in 1986, at an average rate of increase of about 2.9% per year (Vermeer and Devito 1989). The average growth rate of the population between 1975 and 1986 was 2.6%. On the basis of known reproductive success in both small and large colonies in the strait (about 0.85 fledglings/year), postfledging survival up to seven months after colony departure (41%, Verbeek 1986), and subsequent survival of juveniles, subadults, and adults (about 90%), Vermeer and Devito (1989) calculated the present rate of increase at 2.7%, which is near the 2.9% rate observed between 1975 and 1986. If the 2.7% growth rate continues, we estimate that the 1986 nesting population of 13 000 pairs in the strait will increase to 14 500, 16 500, and 18 900 pairs by the years 1990, 1995, and 2000, respectively.

Management of the gull population in the Strait of Georgia may be needed in the near future. Since the present gull expansion in the strait is thought to be facilitated primarily by an increasing supply of human refuse, the closing of landfills should result in either a decline or stabilization of the Glaucous-winged Gull population (Vermeer 1992).

6. Recommendations

All nesting colonies of Heermann's and Yellow-footed gulls in the Gulf of California should be censused every five years, to determine changes, if any, in the populations of these two species. Little information exists on the reproductive success of small Heermann's Gull colonies. To understand overall population changes for both Heermann's and Yellow-footed gulls in the region, the reproductive success of a whole series of small and large colonies needs to be investigated simultaneously to determine the various factors affecting that success in different-sized colonies (see Vermeer and Devito 1989). No data exist on adult and postfledging survival of the two species. Those data need to be collected to understand the population dynamics of Heermann's and Yellow-footed gulls in the Gulf of California. The diet of the two species during the breeding season needs to be thoroughly investigated, to determine the niche the gulls occupy in the food web of the Gulf of California, as well as to determine the importance of sardines versus alternate prey in that diet. It is also urged that the Mexican government take measures to reduce the harvesting of sardines, if it is found that seabird populations in the Gulf of California start to decline as a result of that fishery.

The status of a nesting population of Saunder's Gulls in a salt marsh on the coast of China needs to be thoroughly documented, and the nesting requirements of this species should be studied in detail. The impact of construction of the seawall around the saltmarsh colony and any other human disturbances should be closely monitored. After the nesting requirements of the Saunder's Gull have been determined, former and potential nesting habitat should be acquired for (re)introducing the species to increase population levels, thereby removing the species from the threat of extinction. As with Heermann's and Yellow-footed gulls, frequent censuses of the overall population of Saunder's Gulls are needed, and data on the population dynamics of the species should be collected. Members of seabird groups who study the ecology of gulls should provide advice to Chinese biologists who study Saunder's Gull for protecting and conserving that species.

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