

The waterfowl of the Fraser Delta, British Columbia

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Introduction

An account has been given earlier (Leach 1970) of the establishment of a 'Slimbridge on the Pacific'. This paper describes the surrounding area, its waterfowl populations and the management problems.

The Fraser delta is part of the lowland which extends from the Coast Mountains of British Columbia southward across the alluvial plains of the Fraser River, the Skagit and other small rivers, to the southern extremity of Puget Sound in the State of Washington. It may, however, be treated as a clearly defined sub-unit of this ecological area because recent environmental changes in the Fraser Valley have been more intensive than in the neighbouring area of Washington State immediately south of the international border. In this study the 'Fraser delta' will include those parts of the Fraser Valley's alluvial plain which are contained between the coasts and tidal reaches of the Fraser, Pitt, Serpentine, Nicomekl and Campbell Rivers (Figure 1).

The climate of the delta is mild, but subject to considerable variation. The

average annual rainfall on the north mountainous side is 200 mm. (80 in.). In the centre, at Steveston on Lulu Island, it is 100 mm. (39 in.) and on the south side, at Boundary Bay it is 90 mm. (36 in.). Snowfall averages 36 mm. (14 in.) but in some winters it remains only a day or two. The average annual temperature at Ladner in the centre of the delta is 9.5°C. The minimum frost-free period is about 150 days per year and the average annual period is some 200 days (Taylor 1970). Due to the 'puddling' of cold air between the dykes, frosts tend to linger on the delta farmlands. The growing season begins in mid-March and lasts for 250 to 265 days.

The main geographical features of the lower valley and delta of the Fraser River were formed during the retreat of the Cordilleran ice sheet between fourteen and eleven thousand years ago. The great thaw left a broad fjord between the Coast Mountain Range to the north and the Cascade Range to the south-east. Relieved of the burden of ice 1,700 metres (5,500 feet) thick, the land rose about 300 metres (1,000 feet) so that by 9500 B.C.

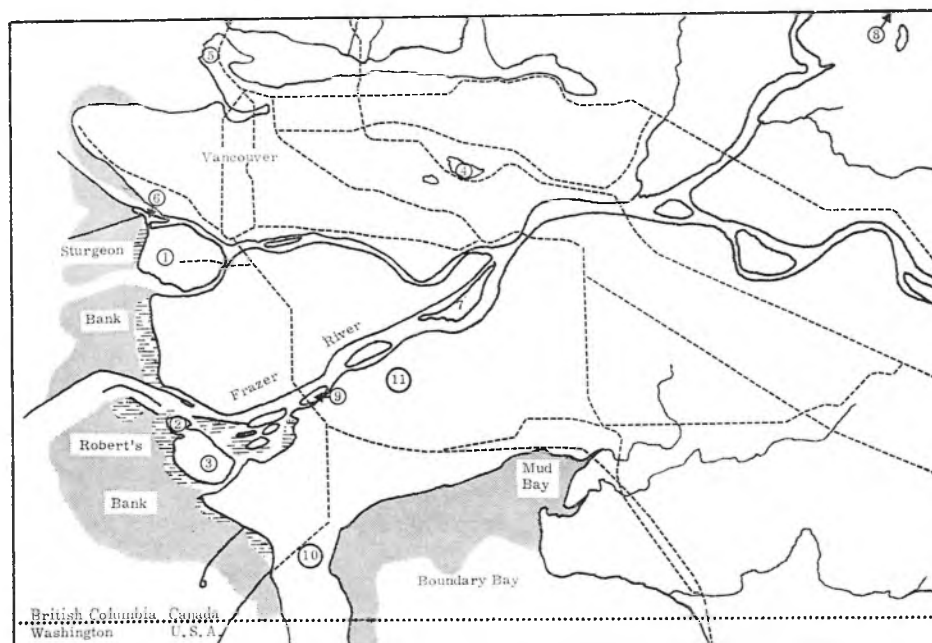


Figure 1. Map of Fraser Delta, British Columbia. Localities numbered on map: 1 Sea Island; 2 Reifel Island; 3 Westham Island; 4 Burnaby Lake; 5 Stanley Park; 6 Iona Island; 7 Annacis Island; 8 Pitt Lake, Pitt Valley; 9 Deas Island; 10 Tsawwassen; 11 Burns Bog.

the elevation was within 30 metres (100 feet) or less of its present elevation. The large moraines of glacial till, strewn across the lower parts of the valley, helped to contain vast alluvial deposits which raised the valley bottom out of the sea. Most of the present alluvial plain was marsh, but the hills formed by the moraines were covered with dense temperate Pacific coast rain forest predominantly cedar, fir and hemlock, with spruce, alder, maple and willow along the fringes.

The water levels of the Fraser River marshes were subjected to considerable changes by the spring run-off from the ice and snows of the vast mountain ranges in the river's watershed. These, together with the effects of the tides on the delta, reduced the habitat for waterfowl nesting in the larger marshes. However, the growth of a large population of beaver led to the creation of many ponds in the upland areas which provided breeding habitat for ground nesting waterfowl as well as tree nesting species such as the Wood Duck, Hooded Merganser, and perhaps American Goldeneye. Natural catchments in the hilly areas and depressions in the alluvial plain formed lakes, some covering hundreds of hectares. The larger islands of the delta comprised from west to east: tidal marshes, in which bulrush and cattail predominated; marshy meadows of grasses and sedges; and peatbog dominated by labrador tea and hard-hack. The combination of tidal marshes, islands, fresh marshes and lakes made the lower Fraser Valley the first major stopping place for waterfowl migrating southward down the Pacific Coast from Eastern Siberia, Alaska, and Arctic Canada.

The Stalo groups of the Coast Salish Indians settled in places where the forest met the river or tidal marshes. Here they had unlimited supplies of timber for houses and boats in close proximity to their main foods, salmon and shellfish. However, they also hunted mammals and birds in the river marshes. Night-hunting for waterfowl was conducted in dug-out canoes with a bright pitch fire burning on the prow. The hunters crouched in the shadow of a mat screen and paddled or drifted downstream close enough to reach the birds with five-pronged spears or nets. This method was remarkably similar to that used on the marshes of the Caspian Sea as described by Savage (1963). The Stalo Indians also hung nets between poles on the tidal flats in order to catch low flying waterfowl at night. Waterfowl feathers and down were woven together with the hair of dogs and

mountain goats into the famous beautifully patterned blankets.

The arrival of the white colonists began a series of drastic environmental changes. The establishment of a Hudson's Bay trading post in 1827 at Fort Langley 56 km. (35 miles) from the mouth of the Fraser encouraged intensive beaver trapping. The depletion of this animal led to the disappearance of many ponds. The Gold Rush of 1858 resulted in a sudden influx of settlers, and the pre-emption, clearing and draining of land. In 1898 a great flood demonstrated the need to dyke the sea coast and tidal reaches of the rivers. This vast undertaking transformed most of the tidal marshes into farmland. Inland water bodies were also drained so that of the three hundred lakes and large ponds described by early settlers in the Municipality of Surrey, none now remains. Sumas Lake, which supported a large waterfowl population in the central part of the Lower Fraser Valley, was drained in the 1920's to yield 365 hectares (900 acres) of agricultural land.

In spite of the reduction of the marshes, large numbers of waterfowl continue to visit the Fraser delta during their migratory journeys. This is due to the survival of the extensive tidal mudflats of Boundary Bay and the estuarine marshes of Roberts Bank and Sturgeon Bank, which offer secure resting areas. Furthermore, these are matched by feeding habitat in the 70,000 hectares (175,000 acres) of meadow and arable lands still regularly flooded by the heavy rains between November and April.

Wetlands of the Fraser River Delta

Boundary Bay—Mud Bay

This bay was formed by tidal flow in the post-glacial period when the Fraser Valley was a fjord. The 6,000 hectares (14,800 acres) of inter-tidal flats are deltaic deposits of sands, interspersed with thin seams of clayey silt, mica, shells and organic materials. These support three basic plant communities important to waterfowl. (a) The eel grass *Zostera marina* beds on the lower tidal flats, which support considerable numbers of Black Brant, especially during the spring. (b) The red, green and blue-green algae community on the inter-tidal flats, associated with a large variety of small marine animals which are eaten by waders and dabbling ducks, especially Green-winged Teal. (c) The salt marsh, with several species of terrestrial halophytic plants, beyond the sea-dyke and on a

number of small islands in the eastern part known as Mud Bay. This community provides subsidiary foods for dabbling ducks and, in Mud Bay, an important loafing area, especially at high tide or rough weather. Beyond the flats the tidal waters provide feeding opportunities for large flocks of diving ducks, especially the scoters and scaup.

Roberts and Sturgeon Banks

These are the Fraser River's estuarine deposits of sand and silt which extend for several kilometres into Georgia Strait creating 13,000 hectares (31,800 acres) of inter-tidal flats. The higher foreshores of the delta islands support thick stands of bulrush *Scirpus* spp. and cattail *Typha* spp. Along the outer fringes the Lesser Snow Geese feed on rhizomes and shoots, associated with large flocks of American Wigeon and loafing Pintail. As in Boundary Bay, the deeper waters are attractive to a variety of diving ducks, grebes and loons.

The Fraser River Islands

The estuarine islands have a similar flora to the foreshore marshes described above. Their shores and channels are frequented by dabbling ducks. Further upstream, the larger river islands are intensively farmed and provide feeding areas for dabbling ducks. The trees along their shores afford nesting habitat for Wood Duck.

The Pitt River

This short river flows from Pitt Lake to join the Fraser a few miles east of New Westminster. The marshes south of the lake have been much reduced in recent years, but a wild remnant still offers habitat for Coast Deer *Odocoileus hemionus columbianus*, Black Bear *Euarctos americanus*, Bald Eagle *Haliaeetus leucocephalus*, Osprey *Pandion haliaetus carolinensis*, and Sandhill Crane *Grus canadensis*. Considerable fluctuations in water

levels due to heavy rainfall and the seasonal run-off from the adjacent mountains virtually limit waterfowl breeding to tree nesting species. Flocks of dabbling duck congregate in the Pitt River marshes in early autumn. Geese are also attracted to the more secluded parts of the marsh.

The Fraser Valley Farmlands

Together with the tidal flats and marshes, the farmlands constitute a major attraction to waterfowl. The most important are those closest to the estuarine marshes on Sea, Lulu, Reifel and Westham Islands and on the mainland north of Boundary Bay and along the valleys of the small rivers draining into Mud Bay. Further up the valley, Sumas Prairie, formerly the site of a shallow lake, and other extensive areas of stubble, maize, meadow and arable land also attract flights of dabbling duck.

Peat Bogs

Large sphagnum peat deposits are located on Lulu Island and south of the Fraser at Burns Bog. Although they are subject to flooding in winter and contain large open bodies of water in peat cuttings, the peat bogs lack vegetation attractive to waterfowl. Migrating waterfowl sometimes rest on the open waters and a few pairs of Mallard and Blue-winged Teal nest on the fringes of the bogs.

Lakes and ponds

The only natural shallow lake in the delta area frequented by waterfowl is one of 137 hectares (339 acres) located in the centre of Burnaby, an eastern suburb of Vancouver. Its shores are lined with cattail, and yellow flag *Iris pseudacorus* backed by marshy land and mixed woodland. Mallard, Blue-winged Teal, Cinnamon Teal, Gadwall and Wood Duck nest there. These are joined by flocks of migrating ducks in the autumn. Canada Geese visit the lake regularly. The White-fronted Goose and the Whistling Swan are rare visitors there.



Waterfowl

Forty-one species of swans, geese and ducks have been recorded on the Fraser River delta.

Group A. Breeding birds and regular wintering population.

1 Lesser Snow Goose *Anser caerulescens caerulescens*

This is the commonest wintering goose on the marshes of Roberts and Sturgeon Banks. From October till March there are usually about 3,000-4,000, but between March and April as many as 6,000. They feed along the tide line on the roots of bulrush, and very occasionally cattails. John Work, who kept a journal of the first exploration of the delta in December 1824, recorded that:

"On the low land at the entrance of the (Fraser) River geese, particularly white ones, were very numerous and were by no means shy, they allowed themselves to be approached easily. Mr. McKay killed 3 of them."

Since then the Snow Geese have learnt to be more wary and they seldom venture over the sea-dykes except in stormy periods at high tide. However, in November 1971 at the Reifel Island refuge about 250 birds began to feed regularly on young grain beside the entrance road in close proximity to visitors. In the early 1960's several ringed geese were recovered indicating that they were hatched on Wrangel Island, NE. Siberia. Others have been recovered in central Oregon and south central California. This suggests that the Fraser and Skagit (Washington) deltas are mainly stopping places for birds wintering further south.

2 Great Basin or Moffitt's Canada Goose *Branta canadensis moffitti*

This is the large 'honker' which nests in the interior valleys of British Columbia. In the past it has been asserted that some of these birds migrate to the Fraser delta, but this is not proven. The status of this race has become difficult to define since the establishment of breeding populations of uncertain origin at Stanley Park in Vancouver, at the waterfowl refuge on Reifel Island, and at Burnaby Lake. Over a hundred pairs of these birds now nest in the Lower Fraser Valley. Some geese from the flock introduced to Elk Lake on Vancouver Island may also cross the Strait of Georgia to the Fraser River marshes.

3 Lesser Canada Goose *Branta canadensis parvipes*

This medium-sized Canada Goose is seen on the coast of British Columbia in October and November. Dozens of skeins, each of between 50 and 200 birds pass over the Fraser delta in mid-October. Some of these alight to feed on the meadows or to rest and preen on the tidal mud-flats or open water areas in Burns Bog. In the early 1960's a flock of up to two thousand birds wintered on Mud Bay, feeding on an 80 hectare (200 acre) private sanctuary in the vicinity. Increasingly frequent disturbance by poachers put an end to this situation. In 1963 gales drove unusually large numbers of these geese east of their main migration route along the west coast of Vancouver Island. About 10,000 spent several days on the Fraser delta, until the opening of the shooting season drove most of them southward. However, 2,000 remained till January at the newly-established waterfowl refuge at Reifel Island. Since then flocks of between 20 and 200 birds have visited the refuge annually between October and January.

4 Black Brant *Branta bernicla orientalis*

The main southward migration of Black Brant from Alaska to Baja California, passes the British Columbia coast far out to sea. However, several small groups arrive on the inside passage between Vancouver Island and the mainland, and winter in the shallow bays of Georgia Strait and Puget Sound, Washington. In recent years the beds of eel grass in Boundary Bay have supported a wintering population of only a few dozen birds. A decade ago 500-1,000 Brant were regularly seen there in mid-winter. Between March and May the northward migration progresses along the coast. The Canadian Wildlife Service estimates that about 14,000 birds pass through Boundary Bay in this period. A few birds also occur regularly at Tsawwassen, South Roberts Bank. Non-breeding birds occasionally remain throughout the summer.

5 Pintail *Anas acuta acuta*

Like the American Wigeon, the Pintail is mainly a passage migrant but considerable numbers are present throughout the winter. Their preference for flooded arable land causes them to concentrate in the southern half of the delta. They arrive in August and their numbers peak in late October. The average number present October-December 1969 was

32,326. By mid-December most of them have moved south, but numbers build up again in February and remain high till early April. One pair nested for three successive years (1966-1968) at Serpentine Fen near Mud Bay, and three pairs successfully hatched a total of 16 ducklings at Iona Island in 1968.

6 American Green-winged Teal *Anas crecca carolinensis*

This little duck arrives on the coastal marshes in large numbers in September. In early October it appears to outnumber all other ducks, but by November there is a marked reduction from 20,000 to 3,000-4,000. Munro (1949) counted 4,500 in 1947, 4,000 in 1948 and 3,200 in 1949, all in January. During the spring this bird passes through the delta rapidly and the flocks are never as conspicuous as those in the autumn. This species occasionally breeds in the Lower Fraser Valley. A nest was unfortunately destroyed in the course of bulldozing the pen ponds at the Reifel Waterfowl Refuge in 1966. One pair nested at Iona Island in 1969.

7 Mallard *Anas platyrhynchos platyrhynchos*

The Mallard nests in the marshes, farmlands and parks of the Lower Fraser Valley. Large numbers pass through or winter on the delta. The Canadian Wildlife Service Census for October, November and December 1969 showed an average total of 34,602 on the tidal marshes. Although not the most numerous wintering duck they are the most highly prized quarry and constitute about 38% of the ducks shot on the Lower Mainland.

8 Gadwall *Anas strepera strepera*

Like the Cinnamon Teal, the Gadwall has increased as a breeding bird. About twenty pairs nest in the coastal area beside brackish sloughs and fresh water areas, especially at Burnaby Lake, Reifel Island, and near the Iona Island sewage lagoons. This duck is also present in the winter.

9 American Wigeon *Anas americana*

Large flocks of 'Baldpates' are evenly distributed throughout the marshes of the delta. Fluctuations in numbers in the autumn suggest that many thousands of birds are on passage to Oregon and California. Census figures for Wigeon show an average total of 45,582 birds between October and December. In January numbers drop, especially if frost

or snow limits the grazing. Estimates by Munro (1949) of wintering populations in January of three consecutive years showed considerable variation. He counted from Fraser River mouth to Boundary Bay and found 7,590 in 1947, 1,060 in 1948 and 3,151 in 1949. Wigeon make up about 21% of the wildfowlers' annual bag. The main exodus is in April. A few birds linger into May but there are no nesting records for the Lower Mainland.

10 Blue-winged Teal *Anas discors discors*

This is a summer resident breeding in flat, open farmlands of the Lower Fraser Valley wherever ditches, sloughs, ponds and rivers offer suitable habitat. Numbers of breeding birds show considerable annual variation. They respond very readily to habitat management. The addition of small ponds and clumps of rushes to an open 12 hectare (30 acre) meadow on the Reifel Refuge resulted in a quadrupling of the nesting population the following spring. They arrive late in April and are gone by September. Some birds on passage north also visit the delta in May but they are seldom identified in the fall.

11 Cinnamon Teal *Anas cyanoptera septentrionalium*

Also a summer visitor, the Cinnamon Teal arrives early in April and nests in the same localities as the Blue-winged Teal. Numbers seem to have increased in the last decade; usually about forty pairs breed in the coastal area. It, too, leaves in late summer. Few birds have been recorded in winter.

12 Shoveler *Anas clypeata*

This duck is a local resident in the Lower Fraser Valley. In the winter it is usually seen in small groups of a score or two among large flocks of other species. It nests only in the few remaining localities where reedy cover adjoins a fresh or brackish pond. Thus the total breeding population in the delta is seldom more than ten pairs, located mainly at Iona, Sea and Reifel Islands.

13 Canvasback *Aythya vallisneria*

Flocks totalling about 200 winter on the coast. Smaller groups are also found on the inland waters of the Lower Fraser Valley.

14 Lesser Scaup *Aythya affinis*

This duck is found in small or scattered groups on inland waters or on the tidal

sloughs and bays between October and March. A few remain on the coast throughout the summer, but they do not nest.

15 Pacific Greater Scaup *Aythya marila mariloides*

This species winters in large numbers on the coastal waters especially in Boundary Bay where very large concentrations have been seen during peak migration between mid-October and December. During the rest of the winter the population is about 3,300 birds.

16 Wood Duck *Aix sponsa*

A common resident breeding where there are suitable nesting trees near bodies of fresh or brackish water large enough to offer it security. The felling of old poplars along the Fraser River and marshy sloughs led to a drop in numbers, but during the last decade the provision of nesting boxes in the Pitt Valley, Burnaby Lake, Reifel Island and Stanley Park has resulted in an encouraging increase. The Lower Fraser and Pitt Valleys have a nesting population approaching 200 pairs. Winter counts in the last two years have also shown an increase in numbers.

17 American Black Scoter *Melanitta nigra americana*

This species occurs less frequently than the other scoters. It is unusual to see more than a score or two wintering in any single location. They arrive early in October and all but a very few depart by late April.

18 Surf Scoter *Melanitta perspicillata*

This is the most common scoter on the open coastal waters. The total wintering populations number several thousand but they are so spread over the waters of Boundary Bay and Georgia Strait that it is difficult to make an accurate count. They arrive in late September and most depart by mid-April. Flocks of non-breeders, sometimes several thousand strong, linger through the summer months.

19 Pacific White-winged Scoter *Melanitta fusca dixonii*

This species arrives in mid-October, and reaches a total wintering population of about a thousand. Numbers dwindle through April and May. It is rare in summer.

20 Pacific Harlequin Duck *Histrionicus histrionicus pacificus*

These occur frequently in small groups on the coastal waters of the Lower Mainland. They nest along the mountain streams of the Coast Range. In mid-June the drakes return to the sea, where they are joined by the ducks and young in September or October. They prefer rocky shores and kelp beds and are less often seen off the estuary marshes.

21 Long-tailed Duck *Clangula hyemalis*

The 'Old Squaw' winters in large numbers on the open coastal waters. Flocks of several hundred birds are present from mid-October till mid-March.

22 Barrow's Goldeneye *Bucephala islandica*

This species nests in the southern interior of British Columbia and occurs on rocky sections of the Lower Mainland Coast between October and March in larger numbers than the American Goldeneye. The total of 3,388 counted within 15 miles of Vancouver in December 1970 is the largest concentration reported in the North American Christmas count.

23 American Goldeneye *Bucephala clangula americana*

Commonly observed in small or scattered groups along the coast and on inland waters between October and March. Small flocks remain until April. A few birds are seen during the summer, and one pair has nested at Burnaby Lake.

24 Bufflehead *Bucephala albeola*

This little duck is very common on salt and fresh waters throughout the winter. Even roadside ditches or ponds a few yards wide attract a bird or two. Because the wintering population is so scattered it is very difficult to assess its size. Only a few remain later than April or early May.

25 Hooded Merganser *Mergus cucullatus*

This species frequently winters on the coast. A few pairs also nest beside secluded wooded ponds and lakes in the Lower Fraser Valley.

26 Red-breasted Merganser *Mergus serrator serrator*

This species is common in the delta waters in the winter, arriving in September and October, when it prefers salt

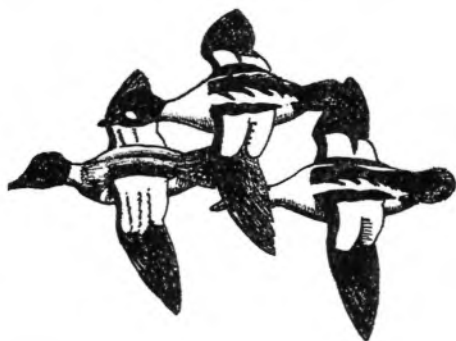
water. However, it is also attracted up the river estuaries by the movements of salmon parr. It leaves in March for the boreal forest in the north which it approaches via the Pacific Coast and major inlets.

27 American Merganser *Mergus merganser americanus*

This large 'saw-bill' is a frequently observed resident in the Lower Fraser Valley. During the winter it is found on fresh or brackish waters, usually in small flocks of up to twenty birds. However, over 400 have been seen together on one small lake. In the spring the pairs move into the clear waters associated with the mountains north of the delta.

28 Ruddy Duck *Oxyura jamaicensis jamaicensis*

This winters on tidal sloughs and sewage lagoons, normally in flocks of up to 50. However, congregations of several hundred have been reported. One or two pairs nest occasionally beside Iona Island sewage lagoons, and Burnaby Lake.



Group B. Species which occur regularly in small numbers.

1 Whistling Swan *Cygnus columbianus columbianus*

This species is an occasional passage migrant and rare winter visitor. Though their usual migration route is in the interior, in some autumns groups of over twenty fly over the delta. In 1965 many alighted in the valley near Mud Bay where over a score were illegally shot. Several of the survivors were nursed back to health in Stanley Park. A pair of these birds placed on Burnaby Lake nested there. Unfortunately the eggs were destroyed in 1966 and the cygnets were killed by waste oil discharged into the lake in 1967. A flock of 29 wintered in 1966 on Westham Island, 28 were seen on Sea Island in 1961, and groups of four to six birds occur regularly near Cloverdale between February and early May.

2 Trumpeter Swan *Cygnus cygnus buccinator*

A rare migrant on the coast. A pair lingered at Reifel Island for several weeks in the spring of 1969. They also occur regularly at Pitt Lake and Lulu Island.

3 Pacific White-fronted Goose *Anser albifrons frontalis*

This goose occurs occasionally in small numbers as a passage migrant in late September and early October. Groups of 30-40 birds remain on the delta for a few days, roosting on Roberts Bank or Boundary Bay and grazing on the adjacent farmlands. They also occur in the Pitt Valley. Single birds or pairs have wintered in recent years at Reifel Island, Burnaby Lake and Stanley Park.

4 Dusky Canada Goose *Branta canadensis occidentalis*

Vancouver Canada Goose *Branta canadensis fulva*

The large, dark plumaged Canada Geese which are occasionally observed or shot on the Fraser delta have usually been recorded as 'Western Canada Geese' or 'Queen Charlotte Canada Geese' because dark birds are found nesting on the Queen Charlotte Islands (*fulva*). However, *fulva* tends to be sedentary, whereas considerable numbers of *occidentalis* migrate along the west coast of Vancouver Island and winter in Oregon. Thus dark birds seen on the Fraser delta are likely to be the latter race.

5 Cackling Goose *Branta canadensis minima*

This little goose winters in small groups or singly on the delta, and occurs regularly at Reifel Island and Stanley Park.

6 European Green-winged Teal *Anas crecca crecca*

Recorded as a regular, rare transient in the Lower Fraser Valley. Its resemblance to *carolinensis* makes it easy to overlook. At least ten birds were observed in 1971.

7 European Wigeon *Anas penelope*

This bird winters regularly in very small numbers. A group has been observed feeding on the same meadow on Reifel Island throughout the last decade.

8 Redhead *Aythya americana*

Small numbers have been recorded on the delta coast during spring and winter months. The flock of 61 seen on Pitt Lake in February 1972 is the largest recorded.

9 Ring-necked Duck *Aythya collaris*

Small groups winter on freshwater ponds and sloughs in the Lower Fraser Valley. Occurs regularly at Burnaby Lake, Lost Lagoon and Pitt Valley.

Group C. Casual migrants and 'accidentals'.

1 Emperor Goose *Anser canagicus*

A casual winter visitor. A single bird wintered at White Rock, 1965-1970. It fed along the shore and roosted on a jetty beside the pier.

2 Baikal Teal *Anas formosa*

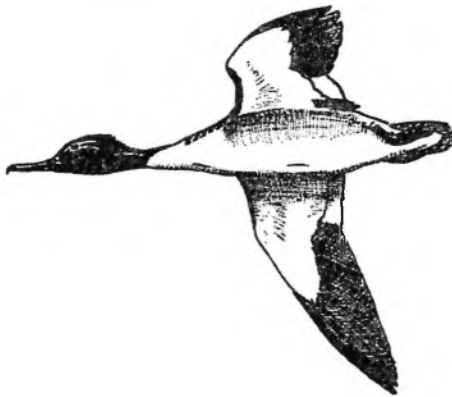
Recorded as accidental in the *Checklist of Vancouver Birds*.

3 Tufted Duck *Aythya fuligula*

A casual visitor to the Fraser Valley. One or two birds have occurred at Iona Island in the spring, and at Stanley Park in the autumn 1961, 1970 and 1971.

4 Smew *Mergus albellus*

One adult male seen on three occasions at Lost Lagoon, Stanley Park, Vancouver, in November 1970.



Management problems

Land use

The construction of 530 km. (330 miles) of dykes along the coastal and estuarine shores of the Lower Fraser Valley entirely changed the ecology of the delta. Though most of the construction took place at the turn of the century, the distributions and habits of the higher animals of the region are still undergoing responsive changes. These are further complicated by the impact of other human developments in agriculture, industry and urban growth.

Changes in agricultural practices in the Fraser Valley have resulted from improve-

ments in soil analysis, drainage and irrigation, and from shifts in economic demands. Early in the present century grain farming was predominant, but dairy farming, beef-cattle finishing, poultry growing and market gardening have now taken over. It is claimed that reduction in the acreage under grain led to a drop in the wintering population of waterfowl, which were formerly attracted to the stubble fields. However, it seems likely that other changes, especially industrial and urban growth and increased hunting pressure, have had more detrimental effects upon the wintering waterfowl population.

The shores of the Fraser's North Arm have now become so congested with industrial activity that the only remaining waterfowl habitat of any significance is Iona Island, where sewage lagoons provide an artificial attraction to ducks. Sea Island foreshore is still valuable habitat, but the location of Vancouver International Airport there has resulted in action to reduce the avian population in order to prevent 'bird strikes' on aircraft. Annacis Island and the upper reach of the South Arm have also become industrial areas, but efforts are now being made by the Provincial Fish and Wildlife Branch and the Canadian Wildlife Service to secure the islands in the lower reaches for wildlife management. Further south, the construction of a large coal-loading jetty on Roberts Bank is the first phase in the development of a major deep-sea harbour. The loss of half of South Roberts Bank will be matched by the urban-industrial development of the adjoining delta farmlands. However, even this seems preferable to the six reclamation schemes proposed in the last decade, which would have converted much of Boundary Bay into industrial or residential sites. Though public protests have blocked these plans, suburban housing developments have covered much of the neighbouring farmlands around Ladner, and more are planned for the west shore of Boundary Bay.

The extension of suburban sprawl beyond the South Arm of the Fraser resulted from the construction of the Deas Island Tunnel in 1960. Ease of access also encouraged an increase in hunting pressure. This, in turn, has had effects upon the habits of waterfowl wintering on the delta, especially the geese.

Wintering populations

During the last three decades the Canadian Wildlife Service and the

Provincial Fish and Wildlife Branch have collected information about the size and content of the wintering wildfowl population. This process has been sporadic and conducted mainly to demonstrate the value of the waterfowl resources in terms of hunting recreation, rather than to provide ecological data (Taylor 1970). However, when combined with data from the Vancouver Natural History Society's annual bird counts and the observations of many other groups and individuals, the official statistics confirm that the Fraser delta has retained its importance as a wintering area or resting place for migratory waterfowl.

If it is to continue to do so provision must be made in the development of Greater Vancouver for the conservation of three types of habitat: (i) coastal waters and tidal flats; (ii) estuarine marshes; (iii) deltaic farmlands.

The coastal waters and flats meet the needs of the diving ducks, especially the scoters, scaups, goldeneyes, Buffleheads, and Long-tailed, Ruddy and Harlequin ducks. The eel grass beds of Boundary Bay are essential to the ecology of the Black Brant and are also important to the American Wigeon which use them as a secondary source of food, and to the diving ducks which seek animal foods therein.

The estuarine marshes must be considered together with the deltaic farmlands. The loss or reduction of either would seriously deplete the numbers of wintering dabbling ducks. The loss of the foreshore marshes would deprive the Lesser Snow Geese of an important staging and wintering area. Conversely, the preservation of these marshes alone might meet the needs of the Lesser Snow Geese, but it would not ensure the maintenance of the present wintering duck populations. The latter depend for much of their food upon the neighbouring agricultural areas and the tidal areas provide only secondary feeding opportunities. When frost or snow deprive the dabblers of their inland feeding opportunities, the numbers fall from several thousand to a few hundred. The survival of low-lying farmlands further up the Fraser Valley or in Washington State will not compensate for losses on the delta because the inland areas are more frequently under frost or snow.

Reductions in wintering populations of dabbling ducks and Canada Geese are undoubtedly also caused by the traditional shooting methods and the absence of any waterfowl management practices, other than the fixing of seasonal dates and

daily bag limits. Apart from about 200 hectares (500 acres) of tidal marsh within the Reifel Waterfowl Refuge, all foreshore areas are open to shooting, as are all lands not specifically posted with 'No Hunting' signs. In these areas an average of over 15,000 duck hunters are able to hunt between sunrise and sunset. In 1965, for example, 16,600 hunted an average of 14.4 days each. This gives a total of about 240,000 waterfowl hunting days in the Lower Mainland. This figure is an impressive illustration of the economic and recreational value of the waterfowl resource. But, in the absence of any management or control, it also represents a terrible degree of continuous harassment for the ducks and geese. The harassment probably has more effect upon the survival rate of waterfowl than the actual annual bag of about 115,000 birds. The ability of the survivors to feed is severely restricted by the almost continuous presence of hunters in the most favourable marshes and meadows. Within a week or two of the opening of the season the great majority of geese quit the delta for the great refuges of Oregon and California. Most of those duck remaining quickly adopt the habit of flying inland after sundown and feeding under the cover of darkness.

The situation would be much improved if sanctuaries were established in the main feeding areas. In order to attract and hold a wintering population of geese they would each have to cover at least 200 hectares (500 acres). As described above, the provision of temporary sanctuary in Langley and a permanent refuge at Reifel Island had an immediate effect upon the migratory habits of considerable numbers of Lesser Canada Geese. There have also been progressive adjustments in the feeding habits of the Lesser Snow Geese at Reifel Island. The regular appearance of Moffitt's Canada Geese and White-fronted Geese in the Pitt Valley is clearly attributable to the presence there of large privately owned marshes where shooting is strictly limited.

The effect of the establishment of the Reifel Refuge upon the duck population is more difficult to assess. In the mid-sixties there were about 30,000 dabbling ducks there by November. According to T. Burgess, who has been working there on a study of duck food ecology, the peak number in 1968 was 63,500 and in November 1969 it reached 136,000. Casual observations at Boundary Bay and Sturgeon Bank did not indicate a corresponding decrease, so the increase at Reifel Island could be attributed to birds which

would previously have flown further south in earlier years.

In spite of these indications of the beneficial effects of refuges upon the size and variety of the wintering waterfowl populations, attempts to establish new refuges on the delta farmlands or to extend the boundaries of the Reifel Refuge to include more of the tidal flats and estuarine marshes have not yet met with success.

Breeding populations

The breeding populations of waterfowl in the Lower Fraser Valley are limited by the lack of suitable nesting areas beside fresh or brackish waters. Furthermore, there are considerable numbers of predators, including the Great Horned Owl *Bubo virginianus*, Cooper's Hawk *Accipiter cooperii*, Red Fox *Vulpes fulva*, Raccoon *Procyon lotor*, Mink *Mustela vison*, Opossum *Didelphis marsupialis virginiana*, several species of weasels and skunks, domestic cats and dogs. Nevertheless, the provision in a few localities of nest boxes for Wood Ducks, and of new nesting sites for Canada Geese, Mallard, Blue-winged Teal and Gadwall has evoked an immediate response from the birds. There is no doubt that an extension of this type of work would have marked effect upon the size of the breeding population of these species.

The shift towards habitat management

It is generally accepted that a clear habitat management plan would result in an immediate increase in both the wintering and breeding populations of waterfowl on the Fraser Delta. It would also help to prevent the loss of further valuable habitat, especially if the plan was part of a regional policy for the conservation of beaches and green belts. But until recently both the federal and provincial governments have been reluctant to acquire lands for wildlife management purposes. Similarly, duck hunters, who traditionally regard wildlife as common property, have strongly resisted attempts to place choice habitat in the exclusive

hands of any limited group, whether for controlled hunting or sanctuary purposes. However, the deterioration in the quality of duck hunting and the closing of many areas close to the ever expanding suburban developments has made the British Columbia Wildlife Federation, which acts on behalf of the hunters' clubs, receptive to the idea of management policy for the remaining waterfowl habitat.

The development of the Reifel Refuge demonstrated on a small scale the value of habitat management. It also resulted in the decision by Ducks Unlimited (Canada) to extend its work into British Columbia. Together with the federal and provincial wildlife authorities this organisation has contributed to the establishment of a 6,500 hectare (16,000 acre) Wildlife Management Area in the Creston Valley in the interior of British Columbia. A similar Management Area embracing Boundary Bay, the North Roberts Bank, and the islands and waters of the South Arm of the Fraser River would seem an impossible dream if it were not for the fact that a green belt, extending across these areas and the farmlands between them, would also meet many other recreational and environmental needs of Greater Vancouver. Recent developments in regional government have brought the creation of such a green belt within the realm of possibility. Similarly, in some areas of the valley a few hunting clubs have taken the first steps towards the management of specific areas of farmland in co-operation with the owners. Some are now examining the possibility of habitat improvements and the introduction of Canada Geese, Wood Ducks and Mallard. Thus it is a time both of change and of opportunity for waterfowl conservationists in the Fraser River delta.

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Summary

The Fraser River Delta, British Columbia, has extensive waterfowl habitat with both estuarine and freshwater marshes. Drainage and reclamation has significantly reduced these areas but sufficient remains to support substantial numbers of wintering waterfowl of a wide variety of species. The Delta is also of importance to migrant waterfowl, while small numbers breed there. Industrial and urban growth and increased hunting pressure are having detrimental effects on the wintering waterfowl population and it is vital that the various habitats are conserved, and sanctuaries provided to reduce the disturbance from shooting. The breeding population would benefit from the provision of nesting boxes and protection from predators. Habitat management is seen as the answer to the various threats.

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