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STUDIES OF WATER-FOWL IN BRITISH COLUMBIA

No. 9

BARROW'S GOLDEN-EYE, AMERICAN GOLDEN-EYE

By J. A. MUNRO

Chief Federal Migratory Bird Officer for British Columbia

INTRODUCTION

The present paper deals with the distribution, life-history, and economic status in British Columbia, of the Barrow's Golden-eye, *Glaucionetta islandica* (Gmelin) and the American Golden-eye, *Glaucionetta clangula americana* (Bonaparte).

Field observations of golden-eyes have been carried on at intervals since 1911, the earlier work comprising chiefly studies of distribution and general life-history. Since 1930 the investigation has included the examination of the stomach contents of specimens and more recently an attempt has been made to obtain quantitative data in respect to the numbers comprising the summer population, the survival of young, feeding habits and the relation of the species to other animals. In connection with the analyses of stomach contents, it was realized that this method by itself was of limited value and that a reasonably correct interpretation of such data is possible only when supported by field observations. Stomach analyses reflect what the bird has eaten but give little indication of how such food has been obtained. The author feels that the greatest value of analyses is in checking or supplementing studies of the feeding habits of the bird in its environment. Furthermore it is believed that a small number of specimens taken under known circumstances, in a habitat which is being studied, is of greater value than a large general collection about whose origin nothing is known except the date and place of capture. The stomachs used in this study were collected either personally by the author or, with a few exceptions, collected at certain places at certain times under his direction.

The study of the food in the digestive tracts of most of the golden-eyes examined was conducted as a joint undertaking by Dr. W. A. Clemens, Director of the Pacific Biological Station, and the author. The material was examined with a binocular microscope and all items were checked by each investigator. Dr. Clemens also assisted the author in the preparation of this paper. Grateful acknowledgment is made to him for this co-operation and to the Fisheries Research Board of Canada for the use of laboratory facilities.

The author wishes to express appreciation of the assistance given by the United States Bureau of Biological Survey in making available additional analyses of specimens collected by the author during the period 1911 to 1917; to the National Museum of Canada for the loan of study skins; to the Dominion Department of Fisheries in supplying specimens from the Cowichan river; to Mr. R. A. Cumming, Dr. C. N. Bastin, Dr. M. Y. Williams, Mr. P. M. Martin and Mr. Dennis Ashby for similar favours; to Mr. W. N. Newcombe and Dr. Josephine F. L. Carl for the identification of certain mollusks and crustaceans, and to Dr. Ian McTaggart Cowan, Mr. H. M. Laing and Mr. T. E. Randall for permission to use unpublished records. Special thanks are due Mr. L. Crowe for co-operating in the study of the Barrow's Golden-eye population at Paul lake.

DESCRIPTION OF SPECIES

Golden-eyes are medium-sized, rather heavily built diving ducks with relatively short necks and large heads. The males average twenty inches in length and the females are somewhat smaller. The adult males of both species are predominantly black and white; the American Golden-eye has a greenish coloured head with an oval white spot on each cheek at the base of the bill, while Barrow's Golden-eye has a violet-coloured head and a crescentic white patch at the base of the bill. The latter species has less white on the back and the flank plumage has more black on the feather margins as compared with the same area on the American Golden-eye so that in general appearance Barrow's Golden-eye is the blacker of the two. This is a better distinction in the field than is the difference in head coloration and shape of white cheek patches, which cannot readily be seen at all times. In both species the bill of the male is black, the feet chrome and the iris clear yellow.

The adult females, yearling females and yearling males of the two species are of similar coloration with brown heads (varying in shade with age and wear), dark grey backs and flanks (feathers dusky grey margined with lighter grey), grey chest, white neck and white underparts. Slight differences in colour due to age and specific differences, while noticeable in museum specimens, are not usually apparent in life. For the period from February to May the bill of the adult female Barrow's Golden-eye is cadmium yellow to orange usually freckled with brown on the basal half, while that of the adult female American Golden-eye is dark olive brown sometimes suffused with yellow at the base or on the terminal third. This colour distinction disappears after the breeding season. The bills of young females of both species are dark olive brown. The iris is clear yellow in the adult female, greenish yellow in yearling females and amber in the young.

Young females of both species in first plumage resemble the older females in colour and pattern but the chest band and flanks are usually more fawn than grey and the neck is not white as in the adult female but of the same brown colour as the head, or a few shades lighter. They continue a slow moult through the year and by the following spring are usually indistinguishable from the adult female except for the difference in bill coloration.

Young male golden-eyes have the same colour formula as the females but may be recognized as males by their larger size. The fawn, grey, white and brown coloration of the first plumage is held until early in the first winter, after which the fawn-coloured contour feathers are gradually replaced by grey, the neck gradually becomes white and a few white feathers appear on that area at the base of the bill which later will develop as a white patch on the brown head. By the following spring the white area may be quite conspicuous on some individuals. The coloration of the iris follows the same development as in the females.

The downy young of the two species are indistinguishable except for differences in shape of bill and in the trachea, which are referred to later. The down is blackish above (with small white area on wing and rump) and white below, the line of demarcation crossing the cheek below the eye so that the appearance on the water is that of a blackish bird with a black and white head. The same general arrangement of black and white is found in the downy young of Bufflehead, *Charitonetta albeola*. In large, downy young the upper surface may be faded to light brown before the first dorsal feathers appear.

For some time after the downy stage has been replaced by the first plumage, filaments of white down continue on the cheeks. Thus young birds half or three-quarters grown appear to have definite white cheek patches when viewed at a distance.

A variable but generally appreciable difference between the two species of whatever age or sex is to be found in the shape of the bill (fig. 1). In Barrow's Golden-eye the bill is shorter and narrows more deeply towards the tip as compared with that of the American Golden-eye. The nail (the process at the end of the bill) is wider at the front, projects farther over and is slightly raised above the bill, so as to form a noticeable hump. In the American Golden-eye the nail is narrower with much individual variation. Sometimes it is flush with the surface of the bill and for that reason not conspicuous. There is reason to believe that this distinction does not always hold good, as will be explained later, but in the case of the young as well as the mature males there is another anatomic character that is apparently infallible. This is a difference in the shape of the trachea (fig. 2), which in Barrow's Golden-eye shows a gradual swelling

and attenuation and in the American Golden-eye is provided with a circular, centrally depressed enlargement.

The distinctive characters of the *islandica* bill hold good in all adults, yearlings, and all Okanagan-taken juveniles, recently examined by the author (5 ad. ♂, 3 ad. ♀, 6 yearling ♀, 3♂, 2♀, young of the year). They hold good in only one of ten young birds from the Cariboo region. In this series of seven males and three females, from two to three months old, one female has the tapering bill with wide, raised and conspicuous nail characteristic of *islandica*. The remainder have wide, straight bills with narrow, depressed inconspicuous nail and cannot be distinguished from *americana* of comparable age on the basis of any external character known to the author. Nevertheless the males are identified as *islandica* on the basis of the diagnostic trachea, the two females on presumptive evidence as they belonged to broods from which identifiable males were collected. So far as is known *americana* does not breed in the Cariboo. Three yearlings and one adult female specimen from this region have the typical *islandica* bill.

From the foregoing it seems evident that young male golden-eyes can always be identified specifically by the shape of the trachea but in the case of young females the identification of some individuals is impossible on the basis of any known characterization.

BARROW'S GOLDEN-EYE, *GLAUCIONETTA ISLANDICA*

LIFE-HISTORY

Distribution

An eastern population of Barrow's Golden-eye breeds in Iceland, Greenland and Labrador, and a western population in southern Alaska, British Columbia and the Rocky Mountain states south to northeastern California (fig. 3). The intervening territory from eastern Quebec west to the Rocky Mountains is not occupied by this species.

Dr. H. F. Lewis recently brought together the best available information concerning the distribution of the species in eastern North America but, because reliable information is scarce, considers the result unsatisfactory. The following four paragraphs have been abstracted from a personal communication on the subject.

The winter range is considered to be well stated by Bent (1935) as follows: From the Gulf of St. Lawrence southward along the coast regularly to eastern Maine (Washington County), rarely to southern New England and as a straggler beyond.

Concerning the breeding range, Dr. Lewis found nothing to add to the statement by John C. Phillips (1925) that this duck breeds in south-

western Greenland and on the extreme northeastern part of the Labrador peninsula probably as far south along the Atlantic coast as Davis inlet, or even farther.

It is quite common during spring and fall migrations at Metis, Quebec, on the south shore of the lower part of the St. Lawrence estuary, and R. W. Tufts considers it to be a fairly common winter visitant to suitable localities throughout the Maritime Provinces.

Mr. James L. Baillie states that the only definite Ontario record concerns a drake taken at Toronto on April 18, 1885, and recorded by Seton (1885). Nevertheless it is necessary to consider a statement by Dr. D. G. Elliott, 1898, as quoted by Bent (*loc. cit.*), as follows: "I have found it at times quite numerous on the St. Lawrence near Ogdensburg, and have killed a goodly number there over decoys, and some specimens, procured on these occasions, are now in the Museum of Natural History in New York". This is an indication of occurrence in Ontario as Ogdensburg is just across the river from Prescott, Ontario, about a mile away.

In British Columbia the species breeds throughout the interior, more commonly in the Dry Belt than elsewhere, and has been reported from various lakes west of the Cascade Mountains where evidently the nesting populations are smaller than those of the interior.

Racey (1926) in June, 1924, found from one to three females, believed to be nesting, on each of several lakes including Alpha (1 mile), Alta ($1\frac{1}{4}$ miles), Green ($2\frac{3}{4}$ miles), tributary to the Cheakamus or Lillooet rivers. Alta lake, near the middle of this lake chain, is thirty-eight miles northeast of the head of Howe sound, at an altitude of 2,197 feet. This author in a personal communication reports that golden-eyes (originally recorded in *The Auk* as *americana* but subsequently identified as *islandica*) breed regularly on all the small lakes of this region, where he observed broods of young at different times.

H. M. Laing reports in a personal letter that on Owikeno lake at the head of Rivers inlet, eight young golden-eyes able to fly, and other young not so far advanced, were seen on August 19, 1937. On August 28, 1937, a brood of seven young, perhaps the same encountered on the earlier date, was recorded. Specimens were not collected and there is some doubt as to the specific identity of this population.

Several reported breeding records from Vancouver island (Forbidden Plateau and Upper Campbell lake) and Graham island are not supported by the evidence of specimens. The species is rare on the Queen Charlotte islands at any season.

Dr. Ian McTaggart Cowan states: "In 1936 when we worked the Ootsa lake district we found golden-eye scarce. This is probably accounted for by the nature of the lakes themselves. They have steep,

rocky shores, calculated to produce little food suitable to the golden-eye. Between Eutsuk lake and Whitesail lake on the Tahtsa and Whitesail rivers on July 14th we saw two golden-eye. On July 16th on Eutsuk lake we saw two more, these four being all those seen in over two hundred miles of travel on the lakes named. Tom McKinley, a trapper on Pondsby lake, reported to me that a golden-eye nests near his cabin every year." (Personal communication April 4, 1938.)

M. Y. Williams (1923) records the presence of a small population on the Fort Nelson river, June 11 to June 16, 1922.

Swarth (1937) lists it as a summer resident "the most abundant and most generally distributed species of duck" in the Atlin region, but includes no population counts. The earliest date of arrival in spring (1933-35) was April 23 and it was last recorded in autumn on October 21 (1931). This author (1922) also records it from various points on the Stikine river near Telegraph creek and on Sawmill lake; it is evident from his report that in none of these places was the species abundant.

The species is reported from the base of the Alaska peninsula by Osgood (1904), who states, "One was seen on the Nogheling river July 20, and one was killed there some days later; another was shot by W. L. Fleming on a small pond near the head of Lake Clark, July 28. Several immature birds were killed at the mouth of the Chulitna river, August 4. Rather common at intervals along the Chulitna river, August 12 to 17; generally seen in family parties of 6 to 10. Near Swan lake a flock of about 15 was seen feeding on a shallow lake in company with a flock of 10 swans. Seen almost daily in pairs or small flocks along the Malchatna and upper Nushagak, September 3 to 6".

The centre of the densest nesting population is the dry belt region of the Okanagan, Nicola, Kamloops, Chilcotin and Cariboo districts. The last name is used to identify the area lying between the Fraser river and the North Thompson river from latitude 51 to latitude 52. Briefly it can be said that the greater part of the population nests in the interior and winters on the coast. The number of wintering records for the interior is small. Details of the seasonal movements, which are complex and not thoroughly understood, are discussed in the following section.

Seasonal Movements and Numerical Status

The summer home of the Barrow's Golden-eye is chiefly on the lakes and ponds in the interior of the province. As previously stated they are less common, at this time, on coast lakes. The movement from the coast to the interior extends over a period of six weeks or longer. H. M. Laing (1925) in a voyage north through the inside passage between the islands along the coast in March, 1924, saw Barrow's Golden-eye in flocks of ten

to twelve as far north as Swanson harbour, Alaska, the exact counts being: Trout harbour, March 3, eleven; Prince Rupert, March 5, six and fifteen; Wrangell island, March 7, twelve; Taku Cannery, March 9, ten; Juneau, March 9, twelve; Swanson harbour, March 11, ten. The last four localities are in Alaska. In the spring of 1926 a flock of forty appeared on Vasseaux lake in the Okanagan valley (February 19, 1926), and exactly one month later (March 19, 1926), a flock of similar size was observed on the Cowichan river, Vancouver island. A flock of thirty arrived at the north end of Okanagan lake on March 30, 1926, and this did not represent the end of the migration. On April 21, 1931, a flock of twelve appeared at a place on Okanagan lake which was under daily observation. These birds were asleep on the water when first seen and remained in the vicinity all that day as if resting after a long flight.

Concentrations take place on the lower mountain ponds and lakes as early in the spring as any open water is available and they gradually disperse as the ice melts on other lakes at higher altitudes and these waters become available. The larger lakes are frequented less and it is not usual to find large numbers of birds on them except for a short time in early spring before open water appears on the smaller lakes.

Dates for the first appearance of the species on a series of ponds five hundred feet or so above Okanagan lake are: March 9, 1913; March 22, 1914; March 16, 1916; March 17, 1917. On April 12, 1933, Madeline lake, seventeen miles northwest of Vernon, was becoming free of ice and forty adults and yearlings were on the open water along the shore. A week later, when all the ice had disappeared, the population was reduced to seventeen. Munson's lake, in Dry Valley near Kelowna, was free of ice on April 13, 1933, and eighty adults and yearlings were present. The number was reduced to twelve on May 9, 1933. Other counts on this lake were: April 20, 1934, fifty-eight; May 8, 1937, fifty; April 23, 1938, seventy-five. The total population of Trapp, Shumway and Napier lakes in the Nicola district on April 19, 1933, was seventy-eight individuals.

At this time, as on the wintering grounds, there is a free association between adults and yearlings of both sexes. The courtship period is at its height.

A month or so after their arrival the adults have paired and are scattered throughout the district, some pairs in single possession of small ponds, others in defined territories on mountain lakes. The important factor in their distribution is probably an abundance of food rather than availability of nesting sites.

A large population of yearlings of both sexes continues in occupation of the ponds or lakes which earlier were the scene of lively courtship on the part of the adults. Thus at Rollings lake on May 28, 1919, the popu-

lation consisted of four mated pairs, one yearling male and sixteen yearling females. By the first week in June these flocks begin to diminish in number, the males leaving in advance of the females. Meanwhile some adult males, probably those in which the reproductive process has passed the mating stage, again are present and mingle with the yearlings as they had done earlier in the season, but their stay is short. Through the first three weeks in June a gradual exodus takes place until all save the yearling females have disappeared. The following examples will illustrate the changing populations as the season advances:

On May 25, 1937, a small alkaline lake near Savona contained eight adult males, ten yearling males and forty-two females, most of which were believed to be yearlings, a total of sixty individuals. Two weeks later the population comprised three adult males and twenty-two yearling females.

On the same date (May 25, 1937) a chain of small alkaline lakes near Clinton contained a total of sixteen adult males, fourteen adult females, and eleven yearling females. On June 7, 1937, the population as noted comprised four adult males, six adult females and fifteen yearling females. At this time a number of adult females were incubating eggs and so were not visible. On July 13, 1937, in addition to the females with broods there was a flock of twenty-one females, all of which were thought to be yearlings. By the first week in June segregation of the sexes is almost complete.

In the author's fairly long acquaintance with the species, males rarely have been encountered in the summer subsequent to the breeding season. By the time the first young are on the water usually the last of the breeding males has disappeared and it is unusual to see them after the first week in June. A mated pair, the male actively displaying, was seen on Hunter's lake south of Kamloops on June 11, 1938, this being an exceptional record. A light-coloured male was seen on a small mountain pond on the Monoshee divide in July, 1932, and two others of similar appearance in the Cariboo in August, 1936. These may have been yearling males far advanced in the moult to adult plumage or they may have been adult males in partial eclipse. During July and August of 1936, 1937 and 1938, when this species was being observed nearly every day, a total of eight males was observed; three of these have been referred to, of the remainder three were definitely yearlings and two were adults in full breeding dress. One of the latter was in company with seven yearling females on 150 Mile lake, July 8, 1938; this bird was not present when the lake was next visited on July 22. The other adult male was recorded on Sorenson lake in Chimney creek valley on July 9, 1938. The only

available fall record for an adult male is a specimen collected in the Okanagan valley on October 23, 1918.

At Atlin, Swarth saw six adult males on June 14, 1924, "being first evidence of the impending departure of the drakes and during the next few days southward flying flocks were noted over lake Atlin and elsewhere. No old drakes were seen during the latter part of the summer. One shot on June 30 was beginning to moult into the eclipse plumage" (Swarth, 1926).

The general absence of adult and yearling males in the interior from mid-June to the following spring is of particular interest because it has been recorded by Skinner (1937) that males form part of the summer population in the Yellowstone National Park, Wyoming.

Summarizing the foregoing it can be stated briefly that yearling males (which have associated with the adults on the wintering grounds and accompanied them to the interior in the spring) disappear during the time the adults are absorbed in the reproductive process—the period during which the numbers gradually become less may extend over a month or six weeks. Later the adult males retreat. A large number of yearling females remain all summer in the interior, possibly the entire number does so. In early fall the yearling and adult females and finally the young of the year migrate.

The following dates are of last appearances of young birds on a series of small ponds in the Okanagan: October 11, 1912; October 6, 1915; October 23, 1916; October 24, 1918.

Winter records for Okanagan lake (all young birds) January 20, 1914; January 7, 1916; December 30, 1916; January 15, 1917.

The seasonal movements are outlined in the following table:

January-February.....	Association of both sexes and all ages on coast waters.
March-April.....	Migration to interior.
April-May.....	General concentration on interior waters; adults mate and depart to nesting grounds.
May-June.....	Gradual segregation of sexes; adult and yearling males gradually disappear; yearling females remain; adult females bring young to water.
July-August.....	Population restricted to adult females with young and yearling females.
August-September.....	Adult and yearling females moult and then migrate.
September-October.....	Young of the year migrate.
November-December.....	Association of total population on coast waters.

So far as is known no locality frequented by a summer population of adult and yearling males has been discovered, but there is strong presumptive evidence that the location is on salt water. If these males spend the summer on interior waters it seems remarkable that this fact should have escaped discovery. On the other hand the coastal waters, comprising a shore line of 7,000 miles in British Columbia alone, are comparatively unknown ornithologically. Furthermore it is well known that the adult males of other species of inland nesting sea-ducks, for example the Harlequin duck, do make this post-breeding flight to the sea where they associate in large flocks during the flightless period.

However this may be, it is well known that from early fall until spring Barrow's Golden-eye of all ages associate in flocks on the coastal waters both salt and fresh and that only a few individuals winter on inland waters.

It must not be inferred from the foregoing that all the Barrow's Golden-eye which have nested in the interior of British Columbia fly westward to the coast. Very likely there is a migration route down the Columbia valley and east of this also. The species breeds and some individuals winter in Wyoming; a migratory movement also has been observed there. It is not improbable that some birds originating in British Columbia winter in the Rocky Mountain states as well as on the coast regions of Washington and Oregon.

Courtship and Nesting

The courtship period is of long duration, commencing on the coast and reaching its greatest activity in April on the lakes of the interior where large concentrations take place. When displaying the male throws back the head with a quick jerk until the bill points backward, or merely stretches the neck upward to its greatest extent, or makes a succession of quick bows. Usually the head movements are accompanied by a quick backward thrust of the foot that may send spray flying. These actions vary in intensity and have numerous modifications. The male may also thrust his neck forward and thus flattened surge over the water sometimes towards a female but more often in the direction of a second male, or he may dive and emerge close beside another male as if trying to strike from below. The male may display in the presence of females, beside a particular female, or when alone, and the whole performance of bowing or jerking suggests a spasmodic and automatic tic over which the bird has no control. The female may respond by a series of quick bows and sometimes may swing around in a half circle so that she faces away from the male.

A sudden rise from the water and a rapid flight around or above the

lake, through or above the trees, or a circle high in the air are part of the courtship ritual. These actions may be performed by one pair, the female in the lead, or by a female and several males, or by larger groups and sometimes by single birds of either sex. These flights are continued with less frequency during the time that the female is incubating eggs and the males are occupying a territory which she visits once or twice a day.

Thus at Horse lake (May 16 to June 1, 1937) an adult male spent most of each day within a small area along the shore of a wooded peninsula on the L-Y ranch. Here he was joined, usually in the early morning or in the evening, by an adult female and the two fed together on this territory. The female also was seen a number of times flying over the peninsula (where undoubtedly her nest was located) and sometimes was accompanied by the male. One such flight was observed at 5.00 a.m. on May 28 when the female was accompanied by four yearling females and the male followed about one hundred yards behind. One of the females, presumably the adult, uttered a shrill call during the entire flight which lasted five minutes or so—the vowel sound “e” on a high note repeated rapidly gives a fair imitation of the sound. The male called continuously also—a similar note on a lower key repeated less rapidly. These high-pitched notes are quite different from the hoarse croaking note that is heard under ordinary circumstances.

During the courtship period there is a great deal of excited and excessive activity and there is often displayed a considerable amount of apparent hostility on the part of males toward other males. On one occasion (April 26, 1918) the males of two pairs on a small pond were actively hostile, swimming rapidly towards each other and when meeting standing upright and striking with their wings. During an interval between hostilities when the mated birds were together, a third female alighted on the lake and immediately one of the males left his mate and flew to the strange female. He bowed vigorously for a few minutes and then dived and attempted to emerge below the female, whereupon she flew to a distant part of the pond and the male returned to his mate. It was observed on another lake (May 7, 1922) that two yearling males in company kept apart from a group of three mated pairs which were displaying almost continuously and making short flights around the lake. On one of these periodic flights by a mated pair a second male flew in pursuit and followed closely until the pair slanted down to the water when he sheered off. One mated pair on the water drifted gradually towards the two yearling males. When the two couples were fifty yards or so apart the adult male charged over the surface towards the yearlings and drove them to another part of the lake.

A considerable portion of the Okanagan, Nicola, Kamloops, Cariboo

and Chilcotin districts in the southern interior of British Columbia is more or less open, rolling, sparsely timbered country and many of the declivities contain ponds, sloughs or small lakes. The majority of these waters are alkaline to a greater or lesser degree and this governs the amount and variety of vegetation in and around them. The less alkaline are fringed with *Scirpus* or *Carex* or both and usually contain other aquatic plants. Others, more strongly mineralized, show alkaline efflorescence on the hard shores with marginal growth usually limited to *Salicornia europaea* or *Hordeum jubatum*. Most of these waters of whatever alkalinity contain amphipods, phyllopods and other small animals. These alkaline ponds are favoured by Barrow's Golden-eye during the courting period and when the birds have paired off the smaller ponds will be occupied by a single pair only.

There is some competition for certain sloughs, favourably situated as to food and nesting sites, and should anything happen to the pair in possession another pair may move in. Thus when a pair was killed on a small pond near Vernon, April 26, 1918, it was observed, May 14, 1918, that another pair had taken possession of the territory. These waters also serve as nurseries for the young and a family, if not molested, may remain on the same pond for some time after it has reached the flying stage.

The relative value of food and nesting sites in determining breeding locations is a point of interest. Normally a hollow tree or tree cavity is used as a nesting site but the first essential is food and lakes seem to be selected on this basis rather than on the availability of nesting sites.

Rollings lake, a shallow, muddy lake of 300 acres, near Lumby, contains great numbers of amphipods, *Hyalella azteca* and *Gammarus limnaeus*, besides a dense growth of sago pondweed and other suitable foods. The population of this lake has varied only slightly in twenty years in spite of a gradual reduction in the number of normal tree-nesting sites. When this lake was first visited in 1915 a large number of dead, hollow trees were standing close to the lake and some were used as nesting sites. Many of these fell or were cut down from time to time but the Barrow's Golden-eye population decreased very little. The birds evidently adapted themselves to changed conditions and found nesting sites at greater distances from the lake, sometimes a mile or more away. This was confirmed by an observation made on May 23, 1926, when a female followed by ten downy young was seen walking along a dusty road and headed for Rollings lake about three miles away. The nesting population as observed at intervals during the period from 1918 to 1936 was as follows: May 25, 1918, 5 pair; May 28, 1919, 4 pair; June 4, 1925, 4 pair; May 12, 1930, 4 pair; May 18, 1936, 3 pair.

Brants lake, near Summerland, is a long, narrow artificial lake between low, bare hills; normal nesting sites are very scarce, indeed no tree-nesting sites have been found. The lake contains numerous amphipods. The population on May 12, 1918, comprised twelve mated pairs and six yearlings and on June 20, 1920, ten females with broods averaging six young as well as a small number of yearling females.

Through these regions also, generally at higher altitudes, are many other nesting grounds comprising true mountain lakes with deep, fresh water and wooded shores. If these contain suitable food, as most of them do, they may support a large nesting population. For example, Paul lake, three and one-half miles long, was occupied by eleven pairs in 1936 and nine pairs in 1937.

Precipitation is an important factor in relation to reproduction. In average years all ponds contain water and evidently food but during periods of decreased precipitation many ponds are greatly reduced in size or dry up entirely and as a consequence local populations decrease in numbers.

A series of small ponds near Vernon maintained about the same population of Barrow's Golden-eyes during the period 1911 to 1920. These were years of average precipitation and all of the ponds contained water. Some of the ponds dried out during a period of decreased precipitation from 1928 onward and the duck populations decreased. Similar observations in later years were made in the Cariboo region and it would seem that the amount of suitable water available has a very direct bearing on the size of the Barrow's Golden-eye population.

In British Columbia the Barrow's Golden-eye usually lays its eggs in a tree cavity which may be a hole in a live tree, a low tree stump hollowed out by fire or decay, or a tall dead stub. While laying is in progress, and afterwards, the female plucks down from her abdomen and places it in the nesting cavity. The amount varies in quantity in different nests; in some it is sufficient not only to insulate the circumference of the nest but to cover the eggs as well. Most of the sites that have been described were in or close to water but it is probable that the majority are located at a distance from water. Nests have been found by watching a female fly from her feeding ground to the nesting tree, by the detection of down adhering to the edge of the nesting cavity, or by accidental discovery.

A. Brooks (1903) refers to a nest in a hole fifty feet from the ground in a Douglas fir that was situated about 400 yards from the nearest water. Munro (1918) describes three nests discovered in the Okanagan valley and (1935) records a nesting site in the burrow of a Yellow-footed Marmot, *Marmota flaviventris avara*.

The author discovered another nest at Rollings lake on May 28, 1919, an illustration of which appears without detailed description in Bent (*loc. cit.*, plate 6). This was situated in a hole near the top of a twenty-five foot fir stub standing in water close to the lake shore. The cavity contained six eggs and a large quantity of down. So far as known the foregoing are the only published descriptions of nests found in British Columbia. Skinner (1937) reports that all the nests he found were in hollow trees, "either standing on the shore, or within a hundred feet of lakes, small natural ponds, beaver ponds or streams". The few additional American records of nesting all refer to nesting sites in trees.

In Iceland the manner of Barrow's Golden-eye nesting is quite different. J. G. Millais (1913), as quoted by Bent (*loc. cit.*, p. 17), states that the nest is usually placed "in a hole in the bank of a stream flowing into a lake, in a hole in the lava rocks close to the water, or on some low island under bushes of dwarf willow, or dwarf birch, amongst coarse grass or low shrub".

No observations of the method by which downy Barrow's Golden-eyes leave their nests (some of which are situated fifty or more feet from the ground) have been recorded. Very probably the young tumble out of the nest in the same manner as do the downy American Golden-eye (Bent, *loc. cit.*).

Reports of young Barrow's Golden-eye being carried to the water one at a time in the bill of the mother, or on the mother's back, belong to the annals of folklore rather than to natural history.

Behaviour of Yearlings

There is no evidence that yearling Golden-eyes breed although during the spring there is some manifestation of sexual excitement amongst them and they go through various performances which in the adults form part of the reproductive process. A yearling male has been observed to fly in pursuit of a yearling female which had taken wing from the surface of a pond, circle the pond, then splash into the water and after a quick dive take flight again. Similar actions may be performed by two young females. Moreover, yearling females have been seen entering tree cavities that were suitable nesting sites. Thus at Nicola lake on June 15, 1917, five yearling females passed in rapid flight through and over the cottonwoods along the lake shores, after which they splashed into the water and paddled ashore where all stood close together on a prostrate log. Later several flew into nesting holes which inspection showed to be unoccupied. No adults were in the vicinity. At Rollings lake, May 28, 1919, a yearling male, with white crescent on the head, acted as if mated

to a yearling female. The two birds remained close together and did not associate with the other golden-eyes on the lake.

Sometimes yearlings may invade a territory occupied by a breeding pair where they make display flights and perform the various courtship actions.

At Horse lake (May 26 to June 1, 1937), a territory, occupied by a breeding male whose mate was incubating, was visited by a number of yearling females, as stated earlier. Precisely the numbers were five on May 28, ten on May 30 and seven, accompanied by a yearling male, on June 1. Their visits took place in the early morning and after feeding they rested, usually inside a pole corral which was built half in the water and half on land immediately in front of a log stable. Here they relaxed, some drifting about on the water, others crouched on the poles above it.

It was observed at Paul lake and elsewhere that a single yearling female may become attached to a breeding pair and continue the association after the male has left, remain in the vicinity during the time that the female is incubating and resume the association when the female has led her brood to the water.

The following incident, observed on a small lake near Kamloops on June 11, 1938, suggests also that a yearling female may sometimes take forcible possession of a brood. A yearling female pursued and drove on to the shore an adult female which was leading a brood of seven downy young. When reaching the shore the yearling grasped the tail of the adult in her bill and held on while the adult with difficulty struggled over the stony ground, dragging the second duck. Six of the young followed close behind, tumbling over one another and over the stones that impeded their progress; the seventh young bird remained on the water. The yearling finally relaxed her hold, flew to the single young bird on the water and the two swam off together. The adult female led the six young to the water and swam away in a different direction.

Until about the end of July yearling females are present on many of the lakes occupied by females and their broods; for example, on a small lake south of Clinton, twenty-three were gathered in one flock on July 13, 1937. By early August many of them have left these lakes and joined other species of diving ducks on certain waters favoured during the flightless period. For example, at 103 Mile lake on August 14, 1937, approximately sixty, some of which may have been post-breeding females, were associated in a large raft with Buffle-head, Lesser Scaup and Ruddy Duck, most of them being flightless. All but one of the Barrow's Golden-eye were females, the exception being a yearling male. Another similar raft on 105 Mile lake (August 6, 1937) contained about eighty females; most

of these also were flightless. By August 25, 1937, all the ducks present on these two lakes were in flying condition.

A total of 150 (estimated) yearling females was present on Green lake, July 27, 1937. Some were associated with a large flock of non-breeding White-winged Scoters, and two separate flocks of seventeen and twenty-five were counted. The mineral content of this lake is high and the waters are very clear; it contains none of the plant foods eaten by ducks nor do any cover plants grow on its shores, consequently it is not used by nesting ducks. There are numerous amphipods in the lake and it seems likely that this food attracts the non-breeding water-fowl.

The appearance of yearling females in the Cariboo region becomes progressively lighter in colour as the summer advances. Usually the head fades to buffy brown, even showing areas of white where the pigment has entirely disappeared (Plate I). Flanks, chest, tail and back may become so light that the bird has the appearance of an albino. Adult females usually show less fading; possibly the time spent in darkness while incubating eggs may retard plumage disintegration. Another pertinent factor may be the generally different summer habitats of adult and yearling females; the former more often frequenting shaded lake margins and the latter the more open waters.

General Observations of Females and Young

In life the well-grown young seem darker than the adult female which usually accompanies them, and still darker than the generally more faded yearling females. Under normal condition of observation the brown colour of the head appears to be blacker in the young than in the adult female, in which, at this season, it has usually faded from the deep, rich brown of spring to a more tawny, golden shade. The young birds have a sleek, trim appearance while that of the adult is unkempt. Other age distinctions noticeable in life are the absence of the white collar in the young and the difference in colour of the iris, which is clear yellow in the adult female and dark amber in full-grown young.

Females sometimes leave their broods (in order to moult) before the young are able to fly and when this occurs the brood may hold its entity, or it may scatter, or it may join with other broods. Thus at 150 Mile lake on August 2, 1937, a band of seventeen young, well-grown but unable to fly, was unaccompanied. For a time this particular band was led by a female Lesser Scaup. Various other instances of unaccompanied young might be cited.

On small lakes inhabited by a large, mixed population of diving ducks the female plus brood association is less apparent than it is on large, thinly populated lakes. In the former, ducks of several species, of both sexes in

some species, and of all ages congregate in rafts and when this happens broods of Barrow's Golden-eye lose their identity at a comparatively early stage of development. These large associations of several species of ducks, which usually contain American Coot, *Fulica americana americana* and Holboell's Grebe, *Colymbus grisegena holboelli* also, have a decided survival value for all concerned; all of the individuals comprising it become exceedingly wary and the actions of the young Barrow's Golden-eye, diving and hiding when first alarmed, are in marked contrast with the action of those on other waters where these mixed associations do not occur.

This tolerance of other species, including coots, observed on crowded lakes, is not always the case elsewhere. On a small pond (July 9, 1915) a coot that tried to feed with a brood of half-grown Barrow's Golden-eye was repeatedly attacked by the adult female, who rushed over the water and struck the coot with her bill. (It has been reported verbally that coots kill young Barrow's Golden-eye, but no instance of this has been observed by the author.)

The adult females leave their broods early in August and proceed to moult; the flightless period is estimated to be two to three weeks. A specimen collected on August 6, 1937, still carried some of the secondary wing feathers; the new primaries were sheathed; the tail feathers faded to pale drab; the bill brownish olive with a suggestion of dusky yellow on the sides of the terminal third and the inter-ramil region; the iris clear yellow; the ovaries small.

Females which have raised broods on some of the larger mountain lakes where there is competition for food may fly some distance just prior to the moult and join the yearling females, the Lesser Scaups and other ducks, which probably have commenced moulting earlier. This is an assumption only; moulting adult females possibly may remain on these nesting grounds and hide so successfully as to escape observation. It seems clear that on certain other lakes (which, in addition to being nurseries for young Barrow's Golden-eye are used also as retreats by other diving ducks during the flightless period) the adult females remain and, with their young, form part of these mixed populations.

The adult females leave the interior before the young of the year, very likely shortly after the moult and in company with the yearling females. This statement is based upon the author's extended observations which show that the interior autumn population is almost entirely restricted to birds of the year. These may appear in small companies up to six or seven, perhaps in some cases representing definite broods originating on a small lake where there was no tendency to separate, or else in flocks of relatively large numbers. Such flocks are sometimes seen in the late

summer prior to any general migration of adult females and yearlings. Thus at Goose lake near Vernon on August 10, 1919, a flock of fifty had assembled.

POPULATION STUDIES

The general behaviour of breeding birds in the spring and of summer populations is illustrated in the following studies, one made at Paul lake and adjacent lakes, the other at Horse lake in the Cariboo District. The first describes the behaviour of mated birds and females with downy young; the second is chiefly concerned with the behaviour of females and older broods.

Paul lake

Paul lake is situated in a narrow, mountain valley between the North and South Thompson rivers, at an altitude of 2,550 feet, about twelve miles northeast of Kamloops. It is approximately three miles long and one-quarter to one-half mile in width. The surrounding steep mountain slopes are covered by coniferous forest with trembling aspen replacement on burnt-over areas. Shoreline tree-growth consists of Douglas fir, yellow pine, black cottonwood, trembling aspen, mountain birch and Sitka alder. Several low-lying tracts on the north side subject to inundation are partly covered by low brush, chiefly willow and dogwoods, and this vegetation is general east of the lake in the valley bottom through which flows a tributary stream draining Pinantan lake two miles distant. (Paul lake drains into the North Thompson river through a rapid stream which leaves the lake at its western extremity.)

This lake provides the food and shelter necessary for the production of a large population of Barrow's Golden-eye. Along much of the shore line for a short distance out the waters are shallow enough so that diving ducks may secure food without difficulty; elsewhere the lake is deep and feeding grounds are therefore limited to shoreward areas. The bottom vegetation is chiefly *Chara* and rich in such food organisms as amphipods, gastropods, pelecypods and the larvae of numerous species of insects.

Nesting requirements are available close to shore where many dead trees of large size, sheltered by surrounding live growth, remain upright, while on the rocky forested mountain side other less conspicuous sites, such as rock crevices, perhaps are used. One nest in the hollow, dead top of a live Douglas fir was definitely located. Resting places are provided by stretches of shore-growing brush overhanging the water, by prostrate tree trunks anchored by their branches to shore and lake bottom, and in the flooded brush-covered sections.

In order to enumerate the Barrow's Golden-eye population and to obtain qualitative data concerning their life-history, Paul lake was visited

during 1936 for the period May 11 to May 15, on June 16 and 17, and on July 20 and 21. On each occasion a survey by canoe was completed. During the intervals between visits to the lake, Mr. Lyle Crowe, who spent the entire summer at Paul lake, undertook to keep a record of the number of adult males present, and later, so far as possible, of the broods. His observations are included in the following account.

Adult and Yearling Population

Population counts during the period May 11 to May 15 were made on three days at different hours. At this time mated pairs were in possession of definite territories, comprising shallow inshore areas, and the procedure in counting was to paddle slowly along shore until birds were sighted and then to make a wide outward semi-circle in order not to put them to flight. By so doing the chance of counting the same birds twice was lessened.

It was established that the breeding population consisted of thirteen pairs; of these one pair, and the mate of a female believed to be incubating eggs, were collected for the purpose of stomach analyses. The population then consisted of eleven adult males, twelve breeding females and in addition, six non-breeding females, most of which were considered to be yearlings. No yearling males were on the lake.

There was, of course, no difficulty in identifying the males as *islandica*. In the case of most of the females it was possible, at one time or another, to approach close enough so that through 6X binoculars the contour and colour of the bill could clearly be seen. The latter character at this time of year served with a fair degree of certainty to distinguish old females from yearlings, in which the yellow coloration is less pronounced. A dissimilarity in the colour of the iris, noticeable in freshly taken specimens, was not apparent in life. Later in the season the difference in bill coloration due to age could not readily be detected in life but was apparent in freshly killed specimens. Thus, in the case of two non-breeding females, an adult and a yearling, collected on June 17, 1936, the colours of soft parts were recorded as follows:

No. 1 ♀ adult, iris wax yellow; upper mandible chiefly faded yellow to cream with dark brown base and black nail; rami honey yellow and inter-ramal region olive brown; tarsi honey yellow. This bird had well-developed ovaries but apparently had not nested as no down had been plucked from the belly.

No. 2 ♀ yearling, iris oil yellow, decidedly more greenish than No. 1; upper mandible fuscous, area behind nail clouded with saccardos umber, nail black; rami olive brown; inter-ramal region honey yellow; tarsi yellow ochre. (Colour-terms are those of Ridgeway, Color Standards and Color Nomenclature, 1912.)

According to the observations of Mr. Crowe, the adult males began to leave the lake shortly after the author's first visit was concluded, and the last was seen on June 8. His counts are as follows: May 16, eleven; May 18, seven; May 20, five; May 22, seven; May 25, five; May 26, four; May 27, four; June 1, six; June 2, six; June 5, six; June 6, two; June 7, one; June 8, one.

Mr. Crowe also reported that in the period June 1 to June 5 six adult males, sometimes accompanied by twelve or more females, which were identified as yearlings, associated in one flock. They appeared to be restless, flying from one place to another near the west end of the lake. At this time also an evening flight over the lake was observed several times. The number of birds was not counted.

Distribution

From May 11 to May 16, mated pairs were distributed as follows: one pair in a swampy bay at the outlet of Paul creek; two pairs about one mile apart on the south shore; eight pairs along the north shore. The latter district is the most desirable in respect to nesting sites, food and shelter; it includes sloping shores overhung with brush and an area of willow and dogwood swamp in which are several beds of *Scirpus* and *Typha*. The territories of four pairs centred about this swamp, which is a mile long and two or three hundred yards wide.

With two exceptions the mated pairs were always seen together; evidently at this time most of the females were laying and the periods spent on the nest were of short duration. The exceptions noted refer to males in single occupation of territories which they seemed loath to leave even when approached within a few yards; possibly in these cases the females had commenced incubation but the sexual process of the males had not reached a comparable stage.

Each pair remained fairly constantly within an extent of shore line which varied in length at different parts of the lake—the territories on the more populated north shore being smaller and less well defined than those on the south shore. Here the golden-eyes might sometimes be seen feeding but more often resting on the water or on one of the numerous prostrate trees lying at right angles to the shore or projecting above the surface of the lake. These latter, standing at various angles, several with ends broken five feet or more above the water, were favourite perches.

The posture of a resting bird was one of complete relaxation, the belly pressed against the log, the tarsus flexed and the bill hidden in the billowed chest. A female resting in this manner upon a half-submerged log was visited by a male, presumably her mate, which was seen first flying swiftly, low down, over the still lake. When quite near, with steadied

wings and out-thrust feet braking the swift flight, he splashed into the water and a moment later climbed on to the log and crouched down close to the female.

These periods of rest were subject to various alarms and interruptions caused by passing fishermen, but while the ducks would submit to a close approach without moving from their resting place they showed increasing signs of awareness as an observer drew nearer. Usually a duck thus disturbed would rise on its toes and after some hesitation step into, or fly down to, the water; rarely did it take flight.

While for the most part the males remained close to their mates, occasionally one, or sometimes two or more in company, made excursions into an adjoining territory and joined the pair that was in occupation. When this took place little demonstration of sexual excitement was made by any of the birds which had come together, as would have been the case at an earlier stage of the reproductive period. Not infrequently a male left his mate and performed a short flight. This was the only part of the nuptial display observed at Paul lake. Very often one of the yearling females attached herself to a mated pair, several such trios being encountered at different times. Such associations were not constant, as the yearlings would sometimes return for a short time to the small flock of non-breeding females which for the most part kept together. Subsequent observations elsewhere of normal sized broods accompanied by two females suggested that a companionship between an adult and an immature female persisted after the male had left and continued through the entire summer. No doubt while incubation was in progress the breeding female, during the times spent on the water, would join the yearling and thus the connection would be maintained until such time as the young were brought to the water; after which the two females would again be in close association.

Summer Population

By June 17, two broods, of eleven and twelve respectively, had been brought to the water; the only other Barrow's Golden-eyes seen on that date were three yearling and one adult non-breeding female which were together when observed. Two of these were collected as has been noted. The females which still were incubating eggs did not appear on the lake at the times it was under observation.

During the interval between June 17 and July 21, when the lake was next visited by the author, Mr. Crowe kept a record of several broods, which were seen at different times on definite territories, in order to establish the date of their first appearance and the rate of survival. Circumstances did not permit detailed inspections so that all the broods were

not enumerated, and no doubt Mr. Crowe sometimes did not see all the members of a brood, nevertheless his observations as tabulated below are of value.

No. 1—June 21, five or more; June 30, six; July 6, ten; July 8, nine.

No. 2—June 27, nine; June 28, nine; June 29, nine; July 13, nine.

No. 3—June 28, three; June 30, three; July 1, ten.

No. 4—June 28, eight; June 30, eight; July 1, eight.

The total population on July 21 was as follows:

3 adult ♀ with broods	3, 8, 12	$\frac{1}{4}$ grown
2 " ♀ " "	2, 8	$\frac{1}{3}$ "
4 " ♀ " "	2, 3, 6, 8	$\frac{3}{4}$ "
Young not accompanied	2	
Non-breeding ♀	7	

Total population 70, of which 52 were young.

Of the eleven mated pairs observed in May, nine had succeeded in bringing broods to the water. The average number in a brood on July 21, that is, approximately a month after hatching, was six, which represents a survival of 66.6 per cent on the basis of an original average of nine young to a brood.

It is difficult to account for the loss. On the assumption that it is caused by natural enemies it would be necessary to consider horned owls, which are known to nest near the lake, and loons, of which one pair nested but did not raise young. There was no evidence of other predators being present. Neither coots nor grebe nested on the lake. The partially decomposed carcass of a half-grown Barrow's Golden-eye was found floating on the lake and an examination of this specimen, necessarily superficial because of the bird's condition, showed no sign of bodily injury. This was the only evidence which suggested predation.

Behaviour of Young

In most cases a brood when first detected was close to shore, often under the shelter of overhanging brush. Sometimes the young birds swam in a massed flock, again in single file behind the female. One brood of nine was grouped about an adult female resting on a half submerged log and in the water close by lingered a second female, probably a yearling, which had attached herself to the family. A brood of eight, about one-third grown, swam out from shore keeping close together and commenced diving for food close to the canoe in which the observer was seated. After a short submersion the small birds popped up buoyantly to the surface, one at a time, and in a second or so dived again, exactly as adults do when feeding. As the canoe drifted closer, the birds re-

assembled in a flock, their heads, on which white cheek patches were still prominent, all pointed in the same direction as the little group followed close behind the female. For a few minutes they swam thus, then strung out one behind the other with the female leading.

Elsewhere the downy young have been seen feeding from the surface, gliding rapidly along and making quick darts from side to side during which they picked up small objects, perhaps insects, from the water.

On May 19, 1937, the population consisted of nine pairs and five yearling females. The territories occupied by the breeding birds were practically the same as those occupied in 1936. In three instances mated birds were feeding or resting on their respective territories; they were very tame and kept close together; the other territories were in possession of males only, the females probably being on their nests. One male was mated to a female which had an entirely dark bill.

Horse Lake

Horse lake (altitude, 3,600) is eight miles long with a maximum width of one mile and lies almost due east and west. It is a deep lake and contains the food necessary for the support of a large fish population (including Kamloops trout, lake charr, squawfish, suckers and lake shiner) as well as various waterfowl of which Barrow's Golden-eye is the most conspicuous during the breeding season.

The land on the north side rises steeply from a narrow flat which terminates in a stony beach. Part of the slope is covered with Douglas fir, lodge-pole pine and poplar forest; the remainder is open grass-land broken at almost regular intervals by brushy draws. The shoreline tree-growth is chiefly poplar, willow, dogwood and alder (the latter overhanging and screening the stony beach in many places) and farther back from the water taller, isolated balm-of-gilead and scattered Engelmann's spruce. There is no marsh growth on this side of the lake. Along the south shore are low, timbered mountains; between them, open draws slope to the lake and end in wide flats or benches; adjacent to these flats are stretches of boggy ground covered with willows and various species of sedge *Carex*. The prevailing type of overhanging alder cover is present along the narrow base of the timbered, mountain portions. It was noted time after time how dependent upon this growth were young golden-eyes when seeking cover, also that the shallows directly beneath them were the most important feeding grounds. From a point near the west end of the lake for a distance of approximately three miles eastward, the water shallows inshore and a continuous belt of *Scirpus*, of varying width and density, is present.

At both ends of the lake, the inlet and outlet respectively of Bridge

creek, are shallow areas with *Typha*, *Scirpus* and *Carex* marshes. The bottom is sandy and supports a considerable growth of various *Potamogeton*, *Ceratophyllum*, *Myriophyllum*, *Utricularia*, *Sagittaria* and other aquatic plants interspersed with areas where yellow pond-lily, *Nymphaea*, is dominant.

In these shallows is an abundant supply of small animals including snails (*Planorbis*, *Lymnaea* and *Physa*), insect larvae, leeches and amphipods, but the latter are more plentiful in the main body of the lake where the dominant bottom growth is *Chara*.

A wide, shallow bay with a marl bottom, on the south side of the lake two miles from the eastern end, is less well supplied with aquatic plants and their attendant animals except along the *Typha* and *Scirpus* fringed shores where the marl contains a larger admixture of humus. Extending from the mouth of this bay westward is a narrow reef where the water shallows to eight feet or less and over a portion of this reef is an "island" of *Scirpus* roughly fifty by three hundred yards. Amongst these rushes, which are so widely spaced as to offer no obstacle to the progress of a canoe, are various long-stemmed plants, including *Potamogeton natans* and *Potamogeton foliosus*, rising through the clear depths. Both these plants and the sturdier rushes form emerging ladders for the larvae of aquatic insects and clinging places for snails. This reef proved to be an important feeding ground for Barrow's Golden-eye, as did the other shallow areas mentioned.

Studies of the summer population of Barrow's Golden-eye at Horse lake were carried on during July and August in 1936 and 1937.

Observations in 1936

The association of two females with one brood was noted several times but it was not always possible from observation to decide if one of these was a yearling, although, from the different actions of the two individuals when alarmed, it seemed probable that the associations were similar to those observed at Paul lake.

When females with broods were approached it was unusual for the parent to fly; more often the female, slightly in advance of the young which swam sometimes in single file, sometimes in a compact flock, led them to open water or, if near shore, to the shelter of the overhanging alders. Here they would dive and separate to reappear at various points along the shore. This was the behaviour most commonly observed but, as is the case with other duck species, certain individuals showed less concern about their young than did the majority. Thus on a small pond near Horse lake, occupied by a female with twelve small young and a second female with ten young, two different reactions to alarm took place.

The first female led her brood, in the normal manner, to a distant part of the lake; the second when first detected was ten yards or so from one group comprising five of her brood and continued diving there, amongst a growth of lily pads, while the five young swam towards and finally joined the rest of the brood which were swimming alongside a wooded bank about a hundred yards distant.

It was observed that many broods of young break up at a comparatively early stage. It was common to see one, or more often two, young birds frequenting certain stretches of shore line and to find them in the same place day after day. After the brood has once broken up the female apparently does not attempt to bring the young together again. The brood of nine, from which one was collected on July 24, became scattered shortly afterwards and the female disappeared, probably to moult. One individual of this brood remained within a quarter mile stretch of shore line where it was seen whenever this particular area was visited and was last observed on August 23, nearly a month later.

When a brood has strayed the female may attach herself to another brood, but in such cases, and they were noted frequently, there is some doubt whether the second female is an adult or a yearling. At this season the character of bill coloration is not available as a means of age determination, nevertheless yearling females usually can be distinguished from adult females by the relatively lighter colour of the former. When two females attend a brood usually only one shows concern for the young in the presence of enemies. Thus in the example of the two females with a brood of nine recorded above, one female remained with the brood and the other flew away and was not seen to return, although it was again with the brood on the following day when it acted in a similar manner.

This straying of young and joint caring for a brood by two or more females may be well illustrated by setting forth the population on a two-mile stretch of Bridge creek which on July 27, 1936, was as follows: female, six young; female, one young; female, one young; brood of four without parent; brood of three accompanied by three females.

Possibly bald eagles may be implicated in the general scattering of golden-eye broods. Two pairs of bald eagles had nested earlier on the shore of Horse lake and, while no instance of their attacking golden-eyes was personally observed, one such instance was reported by a local resident; also a headless body of a half-grown golden-eye was found under a fir tree near one of the eagle's nests.

On August 18, 1936, all the young golden-eyes recorded had reached the flying stage and there were no definite broods. As was the case earlier in the summer these birds frequented the edge of marsh areas or shallow water close to the wooded shore sometimes under the overhanging

branches of willows and alders. The numbers of birds for a distance of two miles of lake shore on August 18, 1936, was:—1, 1, 3, 1, 1, 2, 2, 2, 2, 1,—a total of 16. All these were tame and usually it was possible to paddle within a few yards before they became alarmed and flew. Their tameness was particularly apparent when they were feeding close inshore under the overhanging branches or resting on some log or fallen tree extending out from the lake's edge.

Observations in 1937

In 1937 studies of the summer populations were resumed on July 14 and continued at intervals until August 26.

On July 22 the population as counted during a circuit of the lake by canoe comprised four non-breeding females, probably yearlings, fourteen females accompanied by young, none of which had reached the flying stage, and four half-grown young not accompanied by an adult female. The numbers in the broods were as follows: 1, 1, 4, 5, 6, 6, 7, 8, 8, 9, 9, 9, 16, 19. No doubt both the two large bands included a number of young which had strayed from their rightful mothers. The average number in a brood, approximately a month after hatching, was eight.

Some of these broods when first seen were feeding or travelling along shore, others were resting on logs either on or close to the shore. In two instances the female left her brood when disturbed; in all others the females remained with the young.

It was observed that with some exceptions the young remained in their respective broods (a condition which was less evident during the same period in 1936), also that they made somewhat extended journeys along the shore, returning later to the areas usually occupied. Thus a band of nineteen led by one female was seen first on July 15, again on July 21 at the same place, but on the following day was found three miles to the east. These particular birds were all of similar size and when floating high on the water, as normally they did, looked as large as the adult female which accompanied them. When alarmed they sank lower in the water so that not much more than the head and top of the back were visible; in this position they looked much smaller and the greater size of the female was readily apparent. When swimming in the normal manner they kept close together, sometimes in a line, sometimes "bunched". In the second position the young ducks often were so close that their flanks almost touched; in the first position the head of one bird was close to the tail of the bird in front.

At one time these particular golden-eyes were under close observation for half an hour while they dived for food and it was seen that they submerged almost simultaneously while the female always remained on the

surface as if on the watch for enemies. A band of sixteen, which was feeding within or beside an open growth of bulrush close to shore, behaved in the same manner. This second group included birds of several ages, some with completely brown heads, others with patches of white down on the cheeks. They were remarkably fearless and when following them slowly in a canoe it was possible to approach within twenty feet of them before they increased their leisurely swimming speed. Only when the distance between canoe and ducks diminished to ten feet or so did they show alarm and scamper over the water.

A second complete census was made on August 19 when the population, so far as could be determined, consisted entirely of young of the year. Apparently both the adult females which in late July were accompanying broods and the small population of yearling females had left the lake, presumably to moult. Either this was the case or else they were so shy in their flightless condition and hid themselves so well as to escape observation. Many of the young were solitary and the largest number seen together was eight. They were scattered at intervals along the twenty-three miles of shore line, feeding in the shallows close to overhanging alders, in or at the edge of the numerous bulrush beds, or else a short distance out from shore. None was seen on the open lake. The majority had reached the flying stage but some were stronger on the wing than others; this was apparent even among members of the same flock or brood.

The following is a list of the birds as encountered: 1, 3, 1, 2, 1, 1, 1, 4, 5, 2, 2, 1, 2, 4, 5, 1, 2, 1, 3, 2, 8, 2, 3, 5, 2, 1, 1, 3, 2, 1, 1, 2, 2, 3, total 80. Thus of the 116 flightless young representing fourteen broods observed on July 22, eighty had survived, and most of them had reached the flying stage, by August 19.

On the basis of an original average of 9 young to a brood (as computed for Paul lake and elsewhere) the survival at approximately one month and two months after hatching was 92 per cent and 63.5 per cent respectively.

Summer Population Counts

The following presents a record of summer populations on certain waters where enumerations could be made with a fair degree of accuracy.

SUMMER POPULATIONS OF BARROW'S GOLDEN-EYE

Locality	Date	Adult ♀	Young	Yearling ♀	Adult and Yearling ♂
Brant's lake.....	June 20, 1920	10	60	8	0
Clinton lakes.....	July 25, 1933	5	38	3	0
	July 22, 1936	13	65	5	0
	Aug. 24, 1936	0	79	4	0
	July 13, 1937	8	38	30	0
	June 30, 1938	13	81	24	0
	Aug. 18, 1938	0	113	0	0
Horse lake.....	July 22, 1937	14	116	4	0
Disputed lake.....	July 29, 1936	2	22	0	0
	July 25, 1937	2	14	0	0
Longbow lake.....	July 29, 1936	0	0	1	0
	July 25, 1937	2	12	0	0
Irish lake.....	July 26, 1937	2	16	0	0
Green lake.....	July 27, 1937	0	0	150 (est.)	0
103 Mile lake.....	Aug. 8, 1936	15	27	17	1 yearling
	Aug. 4, 1937	20	26	40	0
	July 19, 1938	4	32	6	0
105 Mile lake.....	Aug. 6, 1936	1	4	9	1 yearling
	Aug. 6, 1937	1	21	0	0
	July 3, 1938	2	13	1	1 yearling
	Aug. 6, 1938	1	20	30	
Lily Pad lake.....	Aug. 7, 1937	5	16	25	0
149 Mile lake.....	July 31, 1936	4	22	9	0
	Aug. 2, 1937	1	20	0	0
	July 12, 1938	4	39	0	0
150 Mile lake.....	July 31, 1936	2	9	7	2 yearling
	Aug. 2, 1937		17		
	July 8, 1938	1	8	7	1 adult
Paul lake.....	July 21, 1936	9	54	7	0
Anthony lake.....	Aug. 5, 1936	1	17	0	0
Mirage lake.....	Aug. 1, 1938	0	0	15	0
Tad lake.....	Aug. 1, 1938	1	18	0	0
Cummings lake.....	Aug. 10, 1938	4	39	0	0
Westwick lake.....	July 9, 1938	4	34	13	0
Sorenson lake.....	July 9, 1938	5	31	13	1 adult

Survival of Young

The following table was prepared to show the rate of the survival of young as the summer season progressed. Except in a few instances circumstances did not permit the counting of broods in any one locality more than once so that these enumerations have only a limited value.

	1936	1937	1938
July	21—2, 2, 3, 3, 6, 8, 8, 12.	July 13—2, 3, 5, 5, 6, 7, 7.	July 9—4, 5, 6, 7, 7,
"	22—2, 3, 3, 4, 5, 5, 5, 5,	" 20—5.	8, 9, 9, 10.
	5, 5, 6, 6, 7, 7, 8.	" 22—1, 3, 4, 5, 5, 6, 6, 7,	" 12—6, 6, 8.
"	23—9.	8, 8, 9, 9, 9, 16, 19.	" 13—6, 6, 6, 6, 8.
"	27—3, 4, 6.	" 25—5, 6, 7, 8.	" 15—8, 13.
"	29—10, 12.	" 26—7, 9.	" 18—4, 5, 6, 8, 9, 9.
"	31—2, 6, 7, 7, 7.	" 31—5.	" 20—4, 14.
Aug.	4—4.	Aug. 2—5, 5.	" 21—8.
"	5—6, 11.	" 3—3, 4, 6, 7, 8, 8, 9.	" 22—3.
"	8—6, 7.	" 4—5, 6, 6, 9.	" 23—7.
		" 6—8.	" 27—6.
		" 7—8, 8.	Aug. 1—9, 9.
			" 10—6, 6, 9, 9, 9.

Winter Populations

Information is lacking as to the dates upon which the adult females, females, yearling females and young of the year appear on the coast in the autumn. Birds of both sexes and all ages were common on Henderson lake, Vancouver island, November 10, 1922, but undoubtedly had arrived some time before this date. It seems probable that part, at least, of the southern interior population winters on the British Columbia coast, rather than on more southern coast localities, and the arrival of these birds would likely be at different periods following closely on the departure from the interior of the different age groups, which commences in late August and continues through September, October and November. By late October most of the males from the previous year would be in adult plumage and these, together with the older males, presumably are on the winter grounds when the interior summer population arrives.

Barrow's Golden-eye seems to prefer fresh or brackish water to the more highly saline water. Thus we find the species common on coast lakes and rivers and in waters adjacent to the Fraser river. It winters commonly in Burrard inlet and Howe sound where the water is comparatively fresh, but according to the author's experience, is scarce on the east coast of Vancouver island where the waters are more saline. At Departure bay, during parts of ten winters spent there, a total of four individuals only was observed. Apparently the toleration of the species for water with a highly saline content is limited and the chief wintering grounds are on the rivers and lakes.

Probably also the food supply has a definite bearing on the winter distribution. As with the American Merganser, salmon eggs are one of the chief winter foods and wherever salmon have spawned the Barrow's Golden-eye is likely to occur. Usually it is associated with American Golden-eye but only a small percentage of the latter frequent fresh water.

(This species is a true sea-duck during the winter and frequents even the most saline waters.)

The Cowichan river on Vancouver island usually attracts a mixed population of golden-eyes, as do the Chemainus, the Courtenay, the Nanaimo and other streams.

On Clements creek, tributary to Henderson lake (November, December, 1922), Barrow's Golden-eye represented about ninety-five per cent of the golden-eye population, which varied from ten to one hundred and sixty estimated (Munro, 1922). This condition has not been observed elsewhere on the salmon streams along the coast.

Restrictive Factors

Various factors operate to hold populations at about the same level from year to year—excluding the periods when a general reduction is brought about by drought conditions in the dry belt. Hunting is not so important a factor as it is with some other species of ducks for reasons which are given later. As the Barrow's Golden-eye usually nests in hollow trees the eggs are not commonly taken by crows and other predators as is the case with many other species of ducks. Horned owls and bald eagles prey upon both adults and large young and no doubt other forms of predation occur. An account of probable predation by horned owls at Rollings lake in the Okanagan valley has been recorded by Munro (1929).

Another instance of predation, probably by a horned owl, was observed on a small, rocky inlet in 105 Mile lake, Cariboo, August 15, 1938. The freshly severed wing of a young male Barrow's Golden-eye was found on the shore; beside it was fresh blood, several horned owl feathers and a large owl pellet composed of duck feathers. Elsewhere on the shore were scattered the remains of three young Holboell's Grebe, indicating this to be a favoured feeding place for horned owls.

Broods of young golden-eyes during the first few weeks of life are reduced by various misadventures which in some districts (according to report) include destruction by crows. Very often small downy young become lost and lacking the care of the parent become casualties. Unattached downy young frequently are encountered: for example, on June 8, 1911, two downy young a few days old were seen on Okanagan lake far from any known nesting site. These were struggling to maintain their equilibrium against the force of white-capped waves that rolled up on a stony beach; a similar incident was witnessed at the same place several years later. It seems probable that many downy young are killed by exposure to rough water on some of the larger lakes.

FOOD STUDIES OF BARROW'S GOLDEN-EYES

Feeding Habits

The feeding habits of the summer populations on the small lakes of the interior are recorded in the section, "Population Studies". The behaviour, common to both species of golden-eyes, when feeding on the larger lakes of the interior and on coast streams has been described, Munro (1918 and 1923).

Review of Literature

Ornithological literature contains few references to the food of Barrow's Golden-eyes. In Bent (*loc. cit.*) appears the following: "Dr. F. Henry Yorke (1899) records it as feeding on minnows and small fishes, slugs, snails, and mussels, frogs and tadpoles, in the way of animal food; he has also found in its food considerable vegetable matter, such as teal moss, blue flag, duckweed, water plantain, pouch-weed, water milfoil, water starwort, bladderwort and pickerel-weed". Apparently these remarks have reference to localities in the Eastern United States.

Dr. C. Cottam (1937) has presented a summary of food percentages of eighty-six specimens, from various localities not specified, as follows: Muskgrass and algae, .38; pondweeds, 8.19; wild celery, 1.57; misc. plants, 12.20; fish, 1.14; amphipods and isopods, 11.02; crabs and other decapods, 2.49; barnacles, .25; crustaceans, 3.95; blue mussel, 12.25; misc. pelecypods, .93; *Littorina*, 2.39; misc. gastropods, 3.11; caddisflies, 6.32; misc. insects, 30.08; misc. animals, 3.73. Total percentage of plants, 22.34 total percentage of animals, 77.66. Data representing the food of forty-six specimens in the above lot taken in British Columbia have been included in the present study by permission of the Bureau of Biological Survey, Washington, D.C.

Munro (1923) has recorded on a quantitative basis the food of fourteen specimens from Henderson lake, Vancouver island. These data are included in the following summaries.

Food Summaries

The following section summarizes the food eaten by the Barrow's Golden-eye as determined through the examination of 116 stomachs containing food material. Percentages refer to percentage volume obtained by segregating and estimating the individual items.

The material is assembled under two headings: (1) winter food on the coast, (2) food in the interior.

Winter Food of Barrow's Golden-eye on the Coast Region

Henderson lake is represented by a sufficient number of specimens to provide a picture of the food range throughout the winter and the data

for this locality are presented separately; other localities are grouped according to whether they represent specimens taken on fresh water or on the sea.

Henderson lake (mouth of Clements creek)

Number of specimens: November, thirteen; December, five; January, two; February, eight.

Salmon eggs. Fourteen specimens taken in November and December contained a total of 1,300 sockeye salmon eggs, 300 being the largest number in one stomach; two specimens taken on February 13, 1923, contained a few salmon egg cases.

Salmon flesh. Evidence that salmon flesh had been eaten was found in two specimens taken February 13, 1923.

Unidentified fishes. Bone fragments of small fishes were found in four specimens taken in January and February; in each case these formed a minor item of the total stomach contents.

Crustaceans. Three amphipods were present in a specimen taken February 13, 1923.

Mollusks. Fragments of blue mussel (*Mytilus edulis*) occurred in one specimen and four fresh-water snails (*Planorbis callioglyphus*) in another; both specimens were taken on February 13, 1923.

Caddis. Caddis larvae were detected in six stomachs taken in January and February; in two instances no other food was present.

Summary. Salmon eggs are the principal food during November and December; there are six instances of caddis larvae, and three instances of small fishes being eaten; the marine items noted probably were taken just prior to the ducks' flight from the sea to freshwater.

Rivers on Vancouver Island

Number of specimens. Cowichan river, December, two; Chemainus river, December, one, January, four.

Salmon eggs. Fragments of salmon egg cases were contained in each of three specimens from the Cowichan river; in one Chemainus river specimen were fifty-five chum salmon eggs and a mass of salmon egg cases representing a much larger number.

Salmon flesh. Broken-down salmon flesh represented the entire contents of two specimens taken on the Chemainus river, January 30, 1932.

Mollusks. Fragments of marine gastropods were a minor item in a stomach containing salmon eggs; six whole *Littorina* and fragments of other mollusks formed forty per cent of the contents of another stomach.

Caddis. Caddis larvae and cases formed over half the contents of a well-filled stomach from a specimen taken on the Cowichan river, December 30, 1933.

Misc. vegetable matter. One bulrush seed, *Scirpus americanus*, and fragments of marine algae represented the only identifiable vegetable matter.

Summary. As at Henderson lake the most important food is salmon eggs; salmon flesh is second, and marine algae third in percentage volume.

Estuaries and salt water, Vancouver Island and Mainland Coast

Number of specimens. Bowen island, January, one, March, six; Horseshoe bay, January, one; Departure bay, March, one; Prince Rupert, March, one.

Herring, *Clupea pallasii*. Twelve herring eggs formed less than one per cent of the Departure bay specimen.

Mollusks. Shell fragments of blue mussel constituted the sole contents of seven, fifteen per cent of another, and was represented by a few fragments in other specimens. Gastropods of various species occurred in three stomachs, the following species being identified: *Littorina scutulata*, *Littorina sitchana*, *Columbella gausapata*, *Margarites pupilla*, *Thais* sp.

Crustaceans. Fragments of small crabs were detected in the Bowen island and Prince Rupert specimens.

Vegetable matter. Pieces of marine algae, totalling 2 cc., constituted twenty per cent of the contents of one, and sea lettuce (*Enteromorpha* sp.) represented fifty per cent of the total food in another stomach.

Summary. On salt water blue mussel and various gastropods are the chief food; marine algae is second in percentage volume; other items are of minor importance.

FOOD IN THE INTERIOR

Okanagan lake

January, three; March, 1; October, one; December, two.

Unidentified fishes. Unidentified fish remains were a minor item in one stomach.

Crayfish (*Potamobius klamathensis*). Crayfish formed the chief item in two well-filled stomachs.

Amphipods. One occurrence represented twenty-six per cent of the contents of a well filled stomach.

Caddis. In one specimen 302 caddis larvae cases constituted seventy-seven per cent of the contents of a full stomach and caddis occurred in another as a minor item.

Other aquatic insects. Corixidae, *Notonecta*, Dytiscidae, *Gyrinus* sp., Anisoptera larvae, and unidentified insect fragments constituted sixty-seven per cent of a well filled stomach. Insect remains including mayfly, stonefly and Coleoptera, occurred in two other specimens.

Mollusks. Mollusk fragments were a minor item in three specimens.

Vegetable matter. Potamogeton tubers and plant fibre formed in one case ninety-seven per cent, and in another ninety per cent of a full stomach. *Scirpus* and *Carex* seeds and Characeae were minor items detected.

Summary. Food taken on Okanagan lake listed in the order of importance comprises crayfish, pondweeds, aquatic insects, amphipods and mollusks.

Swan lake

September, one.

The contents of a single specimen consisted of comminuted vegetable matter exclusively of which filamentous algae and one seed of *Potamogeton heterophyllus* was identifiable.

Small alkaline ponds near Okanagan landing

April, eight; May, one; June, five; July, six; September, sixteen; October, one.

Sponge, *Porifera*. Sponge occurred as a small item in two stomachs.

Crustaceans. Amphipods (and probably other small crustaceans) were the chief item in five stomachs, representing in three cases ninety per cent or more, and in two cases fifty per cent or more, of the total contents. Another specimen contained a small amount of crustacean material.

Water mites, *Hydrachnidae*. Water mites were present in four stomachs.

Aquatic insects. Corixids were present in twenty-three, *Notonecta* in seven, odonate nymphs in fourteen, chironomid larvae in five, Haliplidae in seven, Dytiscidae in two and other Coleoptera in seven of the specimens examined. Caddis larvae occurred twice and stonefly nymph once.

Vegetable matter. Pondweeds including *Potamogeton pectinatus* and *Potamogeton pusillus*, both seeds and plant fibres, represented a large proportion of the plant material eaten and were present in eighteen stomachs. In one April specimen seeds of *P. pectinatus* represented ninety-eight per cent (3 cc.) of the stomach contents and in another

was the chief item present. *Carex* seeds occurred in six, *Scirpus* seeds in nine, and *Myriophyllum spicatum* seeds in five stomachs. Other plants represented by seeds were: *Ruppia* sp., *Zanichellia palustris*, *Spartina* sp., *Hordeum* sp., *Polygonum* sp., *Rumex* sp., *Chenopodium* sp., *Ranunculus* sp., *Prunus demissa*, *Rosa* sp., and *Hippuris* sp.

Chara fragments and oogonia were noted in two specimens.

Mollusks. Shell fragments of snails were a minor item in three stomachs.

Summary. The most important food in the small ponds, upon which the young are raised, appears to be aquatic insects, particularly Odonata nymphs and Hemiptera. Caddis larvae occur less frequently than in larger lakes. Plant material, including the seeds of numerous aquatic and hydrophytic species, although present in most of the stomachs examined form about one-quarter (25.3 per cent) of the total food. No difference between the food of adults and that of well-grown young was detected.

Osooyos lake

May, two.

One full stomach contained eighty per cent insect material comprising forty-eight whole and fragments of eighty or more damselfly nymphs *Enallagma* sp., four other odonate nymphs, twelve or more caddis larvae, Corixidae, chironomid adults, pupae and larvae, Plecoptera nymph, *Halipplus* sp., and fifty or more *Sayomyia* larvae. The remaining nine per cent animal material consisted of bone fragment of an *Amblystoma*, a few *Hyalella azteca* and Hydrachnidae. Vegetable matter consisted of twenty-six seeds of *Potamogeton pectinatus* and seeds of another pond-weed, *Scirpus occidentalis*, *Polygonum remosissimum*, algae and miscellaneous plant material.

A second specimen contained caddis larvae as the main item with odonate nymphs, Haliplidae larvae and miscellaneous insect material constituting seventy-eight per cent of the total. Other animal items were mollusks, water mites and amphipods; plant material represented sixteen per cent of the total.

White Lake, Similkameen Valley

June, one.

This specimen contained eighteen per cent animal matter, including fragments of mollusks, chironomid larvae, Orthoptera eggs, Plecoptera nymph, Carabidae, *Hydroporus* sp., and other aquatic and terrestrial beetles. Vegetable matter included seeds and plant fibre of *Ruppia maritima*, approximately 100 seeds of *Zanichellia palustris*, and 200 of *Potamogeton pectinatus*.

Pond, Nicola Valley

June, one.

Crustacean (probably amphipod) fragments represented seventy-five per cent of the total, the balance being made up of insect fragments including Diptera, caddis larvae and *Dytiscus* sp.

Paul Lake

May, three; June, two; November, two.

Caddis. Caddis larvae constituted the total contents of four, and were present in a fifth stomach, the numbers of insects in individual specimens being 3, 8, 10, 38, 48.

Odonata. Parts of dragonfly nymphs were the only item in two November specimens. Three complete damselfly nymphs and fragments of at least thirty others were the chief item in another stomach.

Other aquatic insects. Fragments of Corixidae were present in one stomach.

Mollusks. Broken up snail shells formed twenty-five per cent of the contents of one stomach.

Misc. vegetable matter. Excepting small quantities of vegetable debris in most of the specimens a single *Carex* seed was the only indication that vegetable matter had been eaten.

Summary. The food of five adults and yearlings taken in May and June and two young males taken in November consisted chiefly of aquatic insects; mollusks occurred once; there was no evidence that amphipods had been eaten although these crustaceans are particularly common in Paul lake.

Horse Lake

July, three; August, three.

Caddis. This item occurred in three stomachs.

Other aquatic insects. Mayfly nymphs occurred in three stomachs, chironomid larvae and larvae of a dytiscid beetle in each of two others.

Odonata. Twelve dragonfly nymphs were the exclusive food item in one specimen.

Corixidae. Water boatmen occurred in three stomachs, in one case constituting the entire contents.

Terrestrial insects. An ichneumon fly and small pieces of other terrestrial insects formed the entire contents of one stomach; in another fragments of unidentified insects constituted twenty per cent of the stomach contents.

Misc. vegetable matter. Five seeds each of *Sparganium* and *Carex* constituted two per cent of the food in one stomach; *Chara* and unidentified vegetable matter formed ten per cent of the contents of another and one seed of *Potamogeton pusillus* was present in a third stomach.

Summary. The food of six Barrow's Golden-eye, from three weeks to two months old, at Horse lake was chiefly insects, both aquatic and terrestrial species being taken. Caddis larvae (an important item in the diet of adults in most localities) was eaten less than were water boatmen and terrestrial insects. This agrees with field observations which showed young golden-eyes feeding from the surface of the water to a greater extent than did the adults. Vegetable matter and mollusks apparently are not important items in the food of the young, no trace of amphipods was detected.

105 Mile Lake

August, two.

The stomach contents of a yearling comprised terrestrial insects 50 per cent, water boatmen 20 per cent and mollusk shell fragments 30 per cent. One *Sparganium* seed had also been eaten. Comminuted amphipods represented 95 per cent of the food eaten by a full-grown young female; the remaining items being one sow bug, 3 per cent, and corixid fragments, 2 per cent.

Mirage Lake

August, three.

Three yearling females had eaten water boatmen, adults and nymphs, exclusively.

Anthony Lake

July, two.

The chief item in one specimen was comminuted amphipods, 98 per cent, the remainder being water boatmen fragments and one *Myriophyllum* seed; in the other caddis represented 94 per cent and water boatmen 1 per cent; the remainder comprised approximately fifty seeds of *Eleocharis palustris* and one *Polygonum* sp. seed.

White Horse Lake

July, one.

Caddis totalled 95 per cent of the stomach contents, the remainder being odonate nymph and water boatmen 4 per cent and two seeds of *Potamogeton pectinatus*, 1 per cent.

Westwick Lake

July, one.

A downy young several days old contained caddis 75 per cent, dytiscid beetle 20 per cent and filamentous algae 5 per cent.

Summary. The food of four yearling females and five juveniles taken at five small lakes in the Cariboo region was chiefly aquatic insects with water boatmen of first and caddis of second importance. Amphipods had been eaten in the two lakes where these are known to occur.

Fairy shrimps (*Branchinecta* sp.) were not found in any of the three specimens collected at Mirage lake where these crustaceans are abundant.

GENERAL SUMMARY AND DISCUSSION

The food item of chief economic importance on the coast is salmon eggs, which would seem to be the sole food in some places during the period of the salmon run. This was the case at Henderson lake in November and December, 1922.

On all salmon streams a large number of eggs are not permanently covered during the spawning process and these drift downstream and lodge here and there in the stream bed. Some of these eggs may later be covered with gravel, and, if not injured during their progress downstream, may successfully hatch. Probably the larger number of these drifting eggs do not become covered and because of exposure to light, mechanical injury, or some other cause, lose their vitality. In the early part of the spawning period they are rose coloured and semi-transparent; later those that have lost their vitality turn pale pink in colour and become opaque. Early in the season most of the eggs found in the gullets of golden-eyes are clear; no doubt many are still vital and capable of producing fry. Later most, if not all, the eggs consumed are in various stages of opacity and are considered to be dead eggs. The destruction of the clear eggs in the early part of the salmon run may represent a drain upon salmon production but of what extent it seems impossible to estimate.

Remains of small unidentified fish occurred in several stomachs; it is possible that trout and salmon fry are eaten in some localities; caddis larvae are an important food.

Salmon eggs may also be taken in the interior of the province although no evidence of this is available. The present data indicate that elsewhere than on the coast the Barrow's Golden-eye is related to the fisheries only insofar as it may be a food competitor of trout. Specimens taken in the interior had been feeding chiefly on aquatic insects, crustaceans and

vegetable matter (animal matter ninety-six per cent, vegetable matter four per cent).

It has been recommended by anglers that the Barrow's Golden-eye population of Paul lake be destroyed on the grounds that the ducks eat trout fry and that they are competitors of Kamloops trout for food. Paul lake was barren of fish life until Kamloops trout were successfully introduced some years ago. Since that time the lake has developed as an angling resort and in this development financial investments of various kinds were made. Those interested believe that the removal of possible predators and food competitors of trout would improve the fish population and increase the financial return on investments. To the author the success of such an undertaking seems doubtful. The data available on the food of Barrow's Golden-eye do not indicate predation; as to their being food competitors of trout undoubtedly this is true. It is true also that practically all other species of birds which nest along the lake shore feed to some extent upon aquatic insects. Spotted Sandpipers, swallows, Yellow-throats, Yellow Warblers, Cedar Waxwings and other birds are competitors of trout for food to the extent to which they consume midges, caddisflies, damselflies and other insects. This statement is substantiated by field observations.

FOOD PERCENTAGES BARROW'S GOLDEN-EYE

Locality	No. of specimens	Salmon eggs	Salmon flesh	Sculpins	Unidentified fishes	Crustaceans	Caddis	Other insects	Mollusks	Misc. animals	Misc. vegetable matter
Henderson lake . . .	28	54.45	16.42	7.75	.18	14.11	3.51	3.58
Vancouver I. rivers . . .	7	32.00	25.00	11.42	6.43	25.15
Estuaries	10	8.40	89.10	2.40
Okanagan lake	7	28	31.57	11.14	13.29	.43	43.29
Swan lake	1	100.00
Pond, Okanagan	37	11.41	7.24	58.87	.32	1.20	20.96
Osooyos lake	2	2.00	39.50	39.50	.50	7.50	11.00
White lake	1	16.00	1.00	2.00	81.00
Pond, Nicola	1	75.00	1.00	24.00
105 Mile lake	2	47.50	36.00	15.00	1.50
Horse lake	6	15.00	83.00	2.00
Paul lake	7	58.57	37.86	3.57
Mirage lake	3	100.00
Anthony lake	2	49.00	47.50	1.00	2.50
White Horse lake . . .	1	95.00	4.00	1.00
Westwick lake	1	75.00	20.00	5.00

Barrow's Golden-eye and the other birds mentioned are valuable in themselves and their destruction would mean a distinct loss to the community not only from the standpoint of national economy but from the aesthetic point of view.

Considered solely from the sportsmen's point of view a good case can be made for the argument that the ducks are valuable in the same sense as trout are valuable, that is to say, as objects of sport and food.

The Barrow's Golden-eye is regarded in the interior of British Columbia as a game bird of minor importance. Nevertheless in some localities, for a short time in the early part of the hunting season, this duck may represent a considerable fraction of the hunter's bag. In the interior its flesh is palatable, but on coast waters the flesh becomes tainted from the diet of salmon eggs and marine food, consequently the duck is not hunted or used as food to the same extent as in the interior. Figures are not available but it seems likely that (in proportion to relative numerical abundance) a greater number of Barrow's Golden-eye are killed by hunters than is the case with more common species of ducks. When disturbed from a pond they have a habit of circling, usually passing close to anyone standing on the shore, so that the hunter has an advantage which he does not have in the case of other ducks which fly straight away.

AMERICAN GOLDEN-EYE, *GLAUCIONETTA CLANGULA AMERICANA*

LIFE-HISTORY

Distribution

The American Golden-eye is extensively distributed in North America, having a summer range which includes most of the timbered portions of northern Canada (except in British Columbia) and a winter range on the Great Lakes, the Atlantic and Pacific coasts (fig. 4). It is a much more abundant species than Barrow's Golden-eye. An old world form of the species breeds in Northern Europe and Asia.

Four instances of the American Golden-eye nesting in British Columbia have been recorded (Munro, 1935), two of these records being based solely on the presence of mated pairs during the nesting season. It is quite possible that it nests regularly in the northern part of the province, although this fact has not been established. The species nests commonly in Alberta from the Edmonton region north and in the Yukon and the Northwest Territories of Canada. In British Columbia it is a common migrant, appearing spring and fall on many of the inland waters. It seems reasonable to conclude that many of these birds are en route to

and from nesting grounds which lie to the northeast. The chief wintering ground is on the coast where the species shows preference for a salt water habitat.

Seasonal Movements and Numerical Status

In the interior of British Columbia the two species of golden-eye appear at about the same time in spring (usually in early March). Early arrivals frequent the larger lakes, which may have been free of ice all winter and in any case are open before the small ponds. In these first spring flocks the American Golden-eye usually predominate and in some the less common species may not be represented. Later in the spring the two species associate on the ponds and small lakes—the courting grounds of Barrow's Golden-eye. For a time the American Golden-eye may continue in the majority as at Napier lake, April 19, 1933, where a census showed sixty *americana* and sixteen *islandica*, and at Rollings lake, April 24, 1937, where the count was fifteen *americana* and twelve *islandica*.

These flocks contain both adults and yearlings. As pointed out earlier it is difficult to distinguish in the field between yearlings of the two species, particularly when a large number of birds are to be examined. Thus it frequently proved impossible to decide what percentage of yearlings in these mixed flocks was *americana*. Under favourable field conditions comprising nearness to the birds and good visibility, it is possible with the aid of binoculars to identify yearlings specifically. At these times it was observed that the number of adult male *americana* equalled the total number of adult females, yearling females and yearling males of the species (in flocks of Barrow's Golden-eye it is usual in the spring to find a minority of adult males). If this condition is of regular occurrence, it would suggest that all the yearling American Golden-eyes do not accompany the adults to their breeding grounds as apparently is the case with Barrow's Golden-eye. Observations on the Tlell river, Queen Charlotte islands, suggest that yearlings may migrate later than do the adults; on the other hand it is not improbable that numbers of them may spend the summer on salt water. Counts taken near the outlet of the Tlell river in May, 1935, showed that the population changed from day to day which would indicate a migratory movement amongst some at least of its members. On the other hand, American Golden-eyes are not commonly seen in the interior at so late a date.

Daily record of American Golden-eye, Tlell river, 1935:

May 2—50	May 14—16
" 3—30	" 15— 7
" 4—66	" 26—24
" 10—60	" 20—14

The spring migration from the coast to the breeding grounds (as observed in the southern interior of British Columbia) covers the period from early March to late April. The following counts were made by R. M. Robertson on the Thompson river at Kamloops during March, 1938: 4, (28), 5, (24), 7, (16), 8, (21), 10, (30), 11, (30). It is unusual to find birds in May and latest records available are May 8, 1928, of a yearling male and one yearling female near Oliver; May 29, 1938, two yearling males near Vernon. Flocks of adults, usually accompanied by yearlings, are still on the coast long after the species has become common in the Okanagan and Nicola districts, for example: Morris creek, April 10, 1936, (40); Cultus lake, April 17, 1935, (8); Esquimalt lagoon, March 28, 1938, (62).

Laing (1925) reports seeing two or three adult males at Juneau, Alaska on March 9, and three at Uyak bay, Kodiak island, on March 31. Other golden-eyes at Unalaska and Adak island were not satisfactorily identified.

Swarth (1936) records it as a migrant of regular occurrence in spring but in small numbers in the Atlin district. Earliest arrivals are given as April 28, 1934; May 6, 1935.

It seems probable that adult males remain all summer near their nesting ground, although no definite information on this point is available. At any rate, adult males, accompanying females, young of the year, and a few yearlings, again appear in the interior of British Columbia in the late fall. Dates of arrival on Swan lake near Vernon in recent years are November 11, 1932 (50), November 1, 1933 (10). Should mild weather continue, flocks may remain for some time. Thus on December 18, 1937, a total of eighty-nine was observed on Woods lake and Duck lake. The species begins to appear on coast waters at about the same time in November; a flock of ten was noted on Esquimalt lagoon, November 16, 1936.

Winter populations in the interior are usually small, restricted to a few birds which frequent rapid stretches of rivers and the larger lakes which remain free of ice. At the north end of Okanagan lake, the American Golden-eye was of regular occurrence during the winters from 1911 to 1919; throughout the winter of 1917-1918, eight was the largest number seen in one day. Subsequently it became scarce and some winters none was seen. More recently small numbers have again appeared on this lake. It is reported to be "very common" in winter on the Arrow lakes but enumerations are not given (Kelso, 1926). It is believed that over ninety-five per cent of the winter population is to be found on the coast where the species is common on all sheltered waters.

The summer population in the interior of British Columbia is limited

to an occasional female and brood. As stated earlier, only four cases of nesting have been recorded and not all of these records are entirely satisfactory. Nothing is known concerning a salt-water, summer population of non-breeding birds, if such exists.

Courtship and Nesting

The sexual displays of the two species of golden-eye are of similar character and early manifestations by adult males take place during the winter. Thus at Departure bay on February 11, 1938, several males were observed at different times swimming with the neck outstretched on the water and the bill pointing slightly upward, so that the chin was raised above the surface. After swimming for a short distance in this position the bird would dive and swim towards another male; usually after such a performance the male which had been the pursuer would stand upright and shake his wings, curving them forward in front of his body. At the same place during the period February 27 to March 31 courting was actively pursued by the members of a flock numbering thirty of which males were in the majority. The actions included various modifications of the quick backward jerk of the head; the back kick, displaying orange feet against white flanks; the rush across the surface with neck outstretched; the sudden dive, reappearance and copulation. The courtship as observed in March is described in further detail by Munro and Clemens (1931). Courtship is continued during the period in spring when the birds are making a short stay in the interior while en route to their nesting grounds.

The author has not studied the American Golden-eye on its nesting ground. The nesting habits of the two species are reported to be similar; both commonly occupy a site in a hollow tree and the males leave the females before the eggs are hatched. Mr. T. E. Randall has found it nesting at Sylvan lake, Gull lake and other places in southern Alberta. In a personal communication he states: "The great majority of the nests found by me have been in old nest-holes of the Pileated Woodpecker. Failing a supply of these, hollow stumps are used and I know of five places where a chimney is used."

"Nesting sites are used year after year and I found a stump west of Rochester that held sixteen nests which filled the hollow to a depth of five feet. Strangely enough, in six of the nests the eggs had not hatched and in one or two of the lower nests they were so discoloured by age that the green colouring of the shell was scarcely distinguishable. Another tree in the Athabasca district held three new nests, there being five old holes and one new one which contained four eggs of the Pileated Wood-pecker. The American Golden-eye lays from nine to sixteen eggs but

this number is sometimes exceeded and I once found twenty-three in a woodpecker's hole."

Details of the subsequent behaviour of females and young are not available. Yearlings apparently do not breed although, like yearling Barrow's Golden-eye they perform parts of the courtship display. Sometimes a yearling male and female remain together and act generally as if paired.

FOOD STUDIES OF AMERICAN GOLDEN-EYE

Feeding Habits

Flocks of large size may assemble when feeding conditions are particularly favourable as, for example, on Esquimalt lagoon, February 25, 1936 (150 estimated), Departure bay, March 12, 1930 (500 estimated). At other times it is more usual to see single birds or a few individuals feeding together. The concentration of 500 at Departure bay followed a spawning of herring at the head of the bay as recorded by Munro and Clemens (*loc. cit.*). The ordinary winter population of Departure bay, which is typical of similar populations elsewhere, is set forth in the following table of enumerations during February and March, 1929. At this time the golden-eyes were feeding on shore-crabs and gastropods.

Date	No. adult males	No. females
February 25.....	2	0
" 26.....	3	1
" 27.....	3	1
" 28.....	10	0
March 1.....	6	0
" 2.....	8	7
" 11.....	3	0
" 12.....	12	7
" 13.....	10	20

When diving in deep water this species appears to submerge more quickly than other diving ducks; the birds turn almost at a right angle to the swimming position and, with tail bent slightly backward, go almost straight down.

The behaviour when feeding on salmon eggs is identical with that of the Barrow's Golden-eye, Munro (1923). The eggs are taken from the bottom of the stream in shallow water or from the eddies where drifting eggs accumulate. No evidence of eggs being dug from gravel has been obtained. On any salmon stream there is some movement of birds during the greater part of the day between the sea or lake and the upper

reaches of the stream but the main flights are in the morning and evening. Apparently all the gold-eyes which feed on the salmon streams spend the night on the sea or on adjacent lakes.

Review of Literature

In the somewhat extensive literature on the American Golden-eye are numerous references to food on a qualitative basis. A summation of data by Bent (1925) mentions mussels, mollusks and seeds of eelgrass, as marine food eaten on the Atlantic coast; mussels, crabs, marine worms and salmon flesh are mentioned for the Pacific coast. Seeds of various aquatic plants, insect larvae, fish spawn and crayfish are recorded as food eaten on fresh water.

This author also makes the following statement on the authority of W. L. Dawson, 1909 (*The Birds of Washington*): "on inland waters it may often be seen in the rapids chasing young trout or other small fishes". It is not stated whether the observation was verified by stomach analyses.

Cottam (1937) has presented a summary of food percentages of 441 specimens from various localities not specified, as follows: Muskgrass and algae, .80; pondweeds, 8.62; wild celery, 3.42; misc. plants, 13.25; fish, 3.16; amphipods and isopods, 5.00; crab and other decapods, 22.57; barnacles, .48; misc. crustaceans, 4.37; blue mussel, 2.53; *Paphia*, etc.. .19; oysters and scallops, .11; misc. pelecypods, 1.37; *Littorina*, .52; misc. gastropods, 4.99; caddisflies, 12.32; misc. insects, 15.66; echinoderms, .02; misc. animals, .62. Total percentage of plants, 26.09; total percentage of animals, 73.91. Data representing the food of thirty-one specimens in the above lot taken in British Columbia have been included in the study by permission of the Bureau of Biological Survey, Washington, D.C.

Apparently the relation of the European Golden-eye *Glaucionetta clangula clangula* to the fisheries in the British Isles has not been established. Berry (1935) lists various food items including fresh-water mollusks, crustaceans, larvae of aquatic insects, aquatic plants, small fish not exceeding two inches in length, and tadpoles. The author also states that "the European Golden-eye is said to dig up spawning redds with its feet and then drop downstream to swallow the spawn washed out". This behaviour has not been observed on British Columbia salmon streams. Berry also quotes an authority for the statement that in Switzerland golden-eyes eat Miller's thumb (*Cottus gobio*). His conclusions are expressed as follows: "These birds should not, therefore, be condemned until definite knowledge of their usual diet in any given locality has been ascertained. Nevertheless they are at all times to be regarded with grave suspicion, for at least one specimen has been shot on an English river (quoting) "with salmon spawn oozing from its bill".

Food Summaries

The following section presents a summary of the food eaten by 80 American Golden-eyes taken during the winter and spring months on the coast and in the interior of British Columbia. The data are assembled under six headings: (1) Cowichan river, (2) Other rivers and lakes on Vancouver island, (3) Estuaries and Salt water, (4) Tlell river, Queen Charlotte islands, (5) Okanagan lake, (6) Alkaline pond, Okanagan valley.

Cowichan river

Number of specimens: December, thirteen; January, fifteen; March, one.

Lamprey (*Entosphenus tridentatus*). One lamprey measuring 65 mm. was found in the stomach of a specimen taken on January 3, 1934.

Salmon eggs. Sixteen specimens taken between December 26, 1933, and January 10, 1934, contained salmon eggs varying in amount from a few fragmentary egg cases in several stomachs to a large amount, comprising 150 whole eggs plus a quantity of partly digested egg cases, in another specimen. The total number of eggs (by computation) in the sixteen stomachs was 402; all these eggs were opaque.

Salmon flesh. Small fragments of salmon flesh were noted in three specimens taken December 30, January 7 and January 10.

Unidentified fishes. Bone fragments of small fishes occurred in four specimens. This material was too much abraded to permit further identification.

Earthworm, Oligochaeta. One earthworm was a minor item in a well-filled stomach.

Crustaceans. Each of three specimens, which were shot while flying up the river from the sea, contained fragments of crab, identified as *Hemigrapsus nudus* and *Hemigrapsus oregonensis*.

Mollusks. One of the specimens mentioned under the heading crustaceans also contained a number of small gastropods, including six *Littorina scutulata*; mollusk shell fragments were noted in another specimen.

Insects. Caddis larvae and cases were represented in eighteen of the twenty-nine specimens examined, by quantities varying from fragments of several to a maximum of twenty-one whole insects; in one case this item formed ninety per cent of the entire stomach content. Alder fly (*Sialis*) larvae were of next importance in terms of percentage volume, ten being found in one, and thirty-three in another specimen. Other insects taken were: Dipteron larvae in two specimens and one instance each of beetle larva (Dytiscidae), cranefly

larva (Tipulidae), mayfly nymph, *Ephemerella*, and caterpillar (Lepidoptera). The March specimen contained 12 cc. of insect food all *Simulium* larvae and pupae except for one chironomid and one caddis larva.

Misc. vegetable matter. Seeds of various plants occurred as a minor item in nine specimens, the species identified being: Knotweed (*Polygonum paronychia*), Brome grass (*Bromus hordeaceus*) and Bulrush (*Scirpus americanus*). The other stomachs contained comminuted vegetable matter not identified; in one instance this was the exclusive, and in another the chief item.

Summary. Salmon eggs are the food of first importance and insects are second in terms of percentage volume, while vegetable matter is of some importance. Remains of small fishes may represent either marine or freshwater species and the data are valuable only as indicating that the American Golden-eye eats small fish. Mollusks and crustaceans, representing food taken in the sea, and other items mentioned are of slight importance in the specimens examined.

Other rivers and lakes on Vancouver island

Localities and numbers of specimens: Goldstream river, December, one; Chemainus river, November, one; December, one; Quamichan lake, December, one; Henderson lake, November, four, February, one.

Salmon eggs. Seven chum salmon eggs were the sole item in the Goldstream river specimen; this food also was taken by the two specimens from Chemainus river, and by one from Henderson lake.

Sculpin (*Cottus asper*). The Quamichan lake specimen had eaten seven sculpins measuring 26 to 43 mm.

Unidentified fishes. One of the Chemainus river specimens contained a few bone fragments of a small fish.

Mollusks. Two Henderson lake specimens contained pieces of blue mussel, the remains of an earlier feeding on the sea.

Caddis. Two caddis larvae were a minor item in one of the Chemainus river specimens.

Summary. The small number of specimens available reflect the same general food range as that pertaining to the Cowichan river. The identification of the sculpin, *Cottus asper*, as the sole item in the stomach contents of a specimen shot on a lake is of interest.

Estuaries and salt water (Vancouver island and Mainland coast)

Localities and numbers of specimens: Horseshoe bay, January, one; Cowichan flats, January, one, December, one; Departure bay, January, two, February, three, March, one.

Herring. It was noted by observation at Departure bay and Nanoose bay that American Golden-eyes were diving for herring eggs in company with a large number of other water fowl. No specimens were collected at this time.

Crustaceans. Small crabs of several species had been eaten by seven of the nine specimens examined. The species identified were: *Hemigrapsus oregonensis*, *Hemigrapsus nudus* (Dana), *Lophopanopeus bellus* (Stimpson). In one case *Hemigrapsus oregonensis* in fragments was the sole item and comprised 12 cc. of food; eight whole crabs were found in another and seven in a third specimen.

Marine worms, Polychaeta. Jaws of a large polychaete were detected in one specimen.

Mollusks. Blue mussel was the sole item in one, and small gastropods were found in four other specimens. In one instance gastropods had been taken exclusively, the species identified being *Littorina scutulata*, *Alectriion mendicus* and *Thais lamellosa*.

Summary. On the sea crustaceans and mollusks are the chief food. During the spawning operations of herring, American Golden-eyes may assemble in large flocks and for a few days feed on herring ova.

Tlell river, Queen Charlotte islands

Number of specimens: May, three.

Sculpin. The specimens contained fragments of sculpins, which in one case was identified as *Cottus asper*.

Crustaceans. Isopods and amphipods constituted the chief item in two, and were represented in a third stomach.

Caddis. Caddis larvae were a minor item in one stomach.

Okanagan lake

Number of specimens: November, one; December, eight; January, thirteen; February, five; March, two.

Sculpin (*Cottus asper*). Fragments of cottids were detected in eighteen specimens. These fish are captured under stones in shallow water in the same manner as crayfish are taken (Munro 1918).

Unidentified fishes. This item comprised fragmentary fish remains which in one case was identified as cyprinoid.

Crustaceans. On numerous occasions American Golden-eyes were seen capturing crayfish (*Potamobius klamathensis*) in the shallow waters. The importance of this food as suggested by field observation is borne out by the examination of stomach contents which showed it

to be the major item in several specimens with a total of twenty-four occurrences. There were fifteen occurrences of other crustaceans most of which probably represented *Gammarus limnaeus* and *Hyalella azteca*.

Insects. Encased caddis larvae are the most important insect food in number of occurrences with sixteen recorded; in one instance 271 larval cases of *Brachycentrus* sp. constituted eighty-eight per cent of a full stomach. Other occurrences were Ephemoridae (6), Odonata (9), Corixidae (2) and Coleoptera (2).

Mollusks. Twenty-seven occurrences indicate the importance of mollusks as food; *Lymnaea vahlii* appeared the most frequently and *Eluminicola* sp. and Unionidae also were reported. Much of the mollusk material was in the form of debris.

Misc. vegetable matter. Plant material was present in twenty-two stomachs, in only one constituting more than fifty per cent, and in the majority representing less than five per cent of the total contents. Characeae was reported from five, *Hordeum* sp. from one, pondweeds from two and *Carex* seeds from four specimens.

Small pond near Okanagan Landing

Number of specimens: April, one.

This specimen contained sixty-nine per cent insect fragments, chiefly odonate nymphs but including also Corixidae, Chironomidae, Coleoptera and caddis; two per cent mollusk fragments and nineteen per cent vegetable matter composed of plant fibre and sixteen seeds of *Potamogeton pectinatus*, two seeds of *Scirpus* sp., floral fragment of *Rumex* sp. and one seed of *Eleocharis* sp.

Summary. The percentages of animal and vegetable matter in thirty specimens were 84.5 and 15.5 per cent respectively. In numbers of occurrences mollusks are the food of first importance, crayfish second, insects third and amphipods fourth. One specimen collected on an alkaline pond had eaten insects, crustaceans, mollusks and plant material.

GENERAL SUMMARY AND DISCUSSION

The winter food of the American Golden-eye on coast waters appears to be substantially the same, under similar conditions of time and place, as that of Barrow's Golden-eye. While on fresh water both species feed upon salmon eggs, insect larvae, and occasionally small fish. On salt waters they eat crustaceans and mollusks and, for a short time, herring ova.

The American Golden-eye is much the more abundant of the two species and consequently is of the greater economic importance. The

question of the effect on salmon production by the consumption of salmon ova was discussed in the general summary in the section "Food Studies of Barrow's Golden-eye". In the author's opinion this predation does not cause an appreciable drain and it seems reasonable to assume that for the loss suffered there is compensation in the value of the ducks.

The value of the American Golden-eye as an object of sport in British Columbia is probably less than the value of the rarer species. The former is not present in the interior at the time the hunting season opens and may not arrive until after the small sloughs, where much of the hunting is done, are frozen over. Consequently its fall and early winter habitat is largely restricted to rivers and the larger lakes. On the lakes it has a better chance of survival than has Barrow's Golden-eye on the small ponds earlier in the season. As stated earlier, golden-eyes are not commonly hunted on the coast for food. In spite of these limitations the species is of economic value, perhaps more so in the general region of its nesting grounds in the north and the east than in British Columbia.

Contrary opinions, both as to the effect of predation by golden-eyes and as to the value of these ducks as game birds, have been expressed to justify the undertaking of control measures. It is unfortunate that any control measures which might be undertaken would have to include both species because of the difficulty in distinguishing them, particularly females and yearlings, a difficulty that would amount to impossibility as far as the majority of persons are concerned.

The breeding range of the American Golden-eye is extensive and because of its northern situation the species is not subject to many of the vicissitudes connected with the propagation of the more southern nesting

FOOD PERCENTAGES, AMERICAN GOLDEN-EYE

Locality	No. of specimens	Salmon eggs	Salmon flesh	Sculpins	Unidentified fishes	Crustaceans	Caddis	Other insects	Mollusks	Misc. animals	Misc. vegetable matter
Cowichan river.....	29	41.41	4.1459	5.34	31.38	6.10	2.83	.55	7.66
Other rivers & lakes on Vancouver I..	9	44.11	22.22	11.11	34	22.22
Estuaries and Salt water.....	9	83.56	16.44
Tlell river, Queen Charlotte Islands.	3	38.34	60.00	1.66
Okanagan lake.....	29	7.11	.41	39.31	7.62	2.34	32.22	.79	10.20
Pond, Okanagan	10.00	8.00	61.00	2.00	19.00

ducks. For this reason and because of its general abundance there is no immediate danger of any serious reduction in numbers. The situation in respect to Barrow's Golden-eye is quite different. The breeding range is comparatively small and includes much of the settled regions of British Columbia where young birds are shot for food and sport early in the hunting season. Nowhere does the species occur in numbers comparable to those of the American Golden-eye and summer populations may be reduced by drought as is the case with other southern nesting ducks. Thus any general project of control might seriously reduce the population of Barrow's Golden-eye.

BARROW'S GOLDEN-EYE

NUMBER OF SPECIMENS AND FOOD PERCENTAGES

Henderson lake (28)

	Occ.	Av. Per cent Vol.
Salmon eggs.....	16	54.45
Salmon flesh.....	5	16.42
Unidentified fishes.....	3	7.75
Amphipods.....	1	.18
Caddis.....	6	14.11
Gastropods.....	1	1.72
Blue mussel.....	1	1.79
Marine algae.....	1	3.58

Rivers on Vancouver island (7)

	Occ.	Av. Per cent Vol.
Salmon eggs.....	4	32.00
Salmon flesh.....	2	25.00
Caddis.....	1	11.42
Gastropods.....	2	6.43
Misc. Vegetable matter.....	2	3.72
Marine algae.....	2	21.43

Estuaries and salt water—Vancouver island and mainland coast (10)

	Occ.	Av. Per cent Vol.
Herring eggs.....	1	.10
Crab.....	2	8.40
Gastropods.....	3	17.10
Blue mussel.....	9	72.00
Marine algae.....	1	2.40

Okanagan lake (7)

	Occ.	Av. Per cent Vol.
Sculpin.....	2	.28
Crayfish.....	2	27.86
Amphipods.....	1	3.71

Corixidae, Notonectidae.....	1	
Odonata.....	2	
Caddis.....	2	1
Other aquatic insects.....	3	
Mollusks.....	4	
Pondweeds.....	4	3
Misc. Vegetable matter.....	5	

Swan lake (1)

	Occ.	Av. Pe
Misc. Vegetable matter.....	1	10

Alkaline ponds near Okanagan Landing (37)

	Occ.	Av. Pe
Amphipods.....	9	
Terrestrial insects.....	9	
Corixidae and Notonectidae.....	28	1
Odonata.....	22	
Caddis.....	6	
Other aquatic insects.....	35	2
Mollusks.....	3	
Misc. Animals.....	13	
Pondweeds.....	18	
Misc. Vegetable matter.....	35	

Osooyos lake (2)

	Occ.	Av. Pe
Amphipods.....	2	
Corixidae.....	1	
Odonata.....	2	
Caddis.....	2	
Other aquatic insects.....	2	
Misc. Animals.....	2	
Mollusks.....	1	
Pondweeds.....	1	
Misc. Vegetable matter.....	1	

White lake (1)

	Occ.	Av. Pe
Terrestrial insects.....	..	
Aquatic insects.....	..	
Misc. Animals.....	..	
Mollusks.....	..	
Pondweeds.....	..	
Misc. Vegetable Matter.....	..	

Pond, Nicola valley (1)

	Occ.	Av. Pe
Amphipods.....	..	
Corixidae.....	..	
Caddis.....	..	
Other aquatic insects.....	..	

Paul lake (7)

	Occ.	Av. Per cent Vol.
Corixidae.....	1	.72
Odonata.....	3	37.14
Caddis.....	5	58.57
Mollusks.....	1	3.57

Horse lake (6)

	Occ.	Av. Per cent Vol.
Corixidae.....	3	25
Odonata.....	1	16.67
Caddis.....	3	15
Other aquatic insects.....	3	21.33
Terrestrial insects.....	2	20
Misc. Animals.....	1	0
Pondweeds.....	1	0
Misc. Vegetable matter.....	2	2

105 Mile lake (2)

	Occ.	Av. Per cent Vol.
Amphipods.....	1	47.50
Crustaceans.....	1	1.50
Terrestrial insects.....	1	25.00
Corixidae.....	2	11.00
Mollusks.....	1	15.00

Mirage lake (3)

	Occ.	Av. Per cent Vol.
Corixidae.....	3	100.00

Anthony lake (2)

	Occ.	Av. Per cent Vol.
Amphipods.....	1	49.00
Corixidae.....	2	1.00
Caddis.....	1	47.50
Misc. Vegetable matter.....	1	2.50

White Horse Lake (1)

	Occ.	Av. Per cent Vol.
Corixidae.....	..	2.00
Caddis.....	..	95.00
Other aquatic insects.....	..	2.00
Misc. Vegetable matter.....	..	1.00

White Horse Lake (1)

	Occ.	Av. Per cent Vol.
Caddis.....	..	75.00
Other aquatic insects.....	..	20.00
Misc. Vegetable matter.....	..	5.00

AMERICAN GOLDEN-EYE

NUMBER OF SPECIMENS AND FOOD PERCENTAGES

Cowichan river (29)

	Occ.	Av. Per cent Vol.
Salmon eggs.....	16	41.41
Salmon flesh.....	3	4.14
Unidentified fishes.....	4	.59
Crabs.....	2	5.34
Caddis.....	18	31.38
Other aquatic insects.....	6	6.10
Mollusks.....	2	2.83
Misc. Animals.....	3	.55
Misc. Vegetable matter.....	9	7.66

Other rivers and lakes on Vancouver island (9)

	Occ.	Av. Per cent Vol.
Salmon eggs.....	4	44.11
Salmon flesh.....	2	22.22
Sculpin.....	1	11.11
Caddis.....	1	.34
Blue mussel.....	2	22.22

Estuaries and salt water—Vancouver island and mainland coast (9)

	Occ.	Av. Per cent Vol.
Crabs.....	8	83.56
Blue mussel.....	1	11.11
Gastropods.....	3	5.33

Tl'ell river, Queen Charlotte islands (3)

	Occ.	Av. Per cent Vol.
Sculpin.....	2	38.34
Crustaceans.....	3	60.00
Caddis.....	1	1.66

Okanagan lake (29)

	Occ.	Av. Per cent Vol.
Sculpin.....	17	7.11
Unidentified fishes.....	6	.41
Crayfish.....	24	34.52
Amphipods.....	15	4.79
Caddis.....	16	7.62
Other aquatic insects.....	22	2.34
Mollusks.....	27	32.22
Misc. Animals.....	2	.79
Pondweeds.....	2	1.82
Misc. Vegetable matter.....	21	8.38

Alkaline pond near Okanagan Landing (1)

	Occ.	Av. Per cent Vol.
Amphipod	10.00
Caddis	8.00
Other aquatic insects	61.00
Mollusks	2.00
Pondweeds	10.00
Misc. Vegetable matter	9.00

LITERATURE CITED

- BENT, A. C., 1925—Life-histories of North American Wild Fowl, order Anseres (part), Bull. 130, U.S.N. Mus., Washington, p. 24.
- BERRY, JOHN, 1935—British Mammals and Birds as enemies of the Atlantic Salmon, Avon Biological Report, Wm. Hobbs and Son, Shirley Rd., Southampton.
- BROOKS, A., 1903—Notes on the birds of the Cariboo District, British Columbia, *The Auk*, Vol. 20, pp. 277-284.
- COTTAM, C., 1937—Food Habits of North American Diving Ducks. Summaries of Doctoral Theses, pp. 66-70. The George Washington University, Washington, D.C.
- KELSO, J. E. H., 1926—Birds of the Arrow Lakes, West Kootenay District, British Columbia. *The Ibis*, October, 1926, pp. 689-723.
- LAING, H. M., 1925—Birds collected and observed during the cruise of the Thiepvale in the North Pacific, 1924, Mus. Bull. No. 4, Vict. Mem. Mus., Ottawa.
- MUNRO, J. A., 1918—The Barrow's Golden-eye in the Okanagan Valley, British Columbia, *The Condor*, Vol. 20, pp. 3-5.
- 1923—A preliminary report on the relation of various ducks and gulls to the propagation of sockeye salmon at Henderson lake, Vancouver Island, B.C. *The Canadian Field Naturalist*, Vol. 37, pp. 107-116.
- 1929—The Horned Owl an enemy of Barrow Golden-eye. *The Condor*, Vol. 31, p. 74.
- 1935—Barrow's Golden-eye nesting in Marmot's burrow. *Ibis*, Vol. 37, pp. 82-83.
- 1935—Recent Records from British Columbia. *Ibis*, Vol. 37, p. 178.
- MUNRO, J. A. AND CLEMENS, W. A., 1931—Waterfowl in relation to the spawning of herring in British Columbia. Bull. No. 27, Biol. Board of Canada.
- OSGOOD, W. H., 1904—Biological Reconnaissance of the base of the Alaska Peninsula, North Am. Fauna, No. 42, Washington, D.C., Government Printing Office.
- PHILLIPS, JOHN C., 1925—A Natural History of the Ducks. Vol. 3, pp. 326-327, Cambridge, Mass.
- RIDGEWAY, ROBERT, 1912—Color Standards and Color Nomenclature, Washington, D.C., published by the Author.
- RACEY, K., 1926—Notes on the birds of the Alta Lake Region, B.C. *The Auk*, Vol. 43, pp. 319-325.
- SKINNER, M. P., 1937—Barrow's Golden-eye in the Yellowstone National Park, The Wilson Bulletin, Vol. 44 (new series), pp. 1-10.
- SWARTH, H. S., 1922—Birds and Mammals of the Stikine river region of Northern British Columbia and South-eastern Alaska, University of California publications in Zoology, Vol. 24, No. 2, pp. 125-314, University of California Press, Berkeley, Calif.

— 1926—Report on a collection of Birds and Mammals from the Atlin Region, Northern British Columbia, University of California Publications in Zoology, Vol. 30, No. 4, pp. 51-162, University of California Press, Berkeley, Calif.

— 1937—A list of the Birds of the Atlin region, British Columbia, Proc. Calif. Academy of Sciences, San Francisco, pp. 35-38.

WILLIAMS, M. Y., 1923—Biological notes covering parts of the Peace, Liard, MacKenzie and Great Bear River Basins, *The Canadian Field Naturalist*, Vol. 47, pp. 23-31.

To BE INSERTED BETWEEN PAGES 314 AND 315
TRANSACTIONS OF THE ROYAL CANADIAN INSTITUTE
VOL. XXII, PART 2, 1939.
PAPER BY J. A. MUNRO

BILL OUTLINES OF AMERICAN AND BARROW'S GOLDEN-EYE
Clangula islandica: (1) No. 4743, ad. ♂, (2) No. 144, yearling ♂, (3) No. 4702, ad. ♀, (4) No. 3500, (5) No. 4899, variation in young ♂.
Clangula americana: (6) No. 4276, ad. ♂, (7) No. 2923, yearling ♀ (J.A.M. coll.), (8) No. 10464, ad. ♀ (Can. Nat. Mus. coll.).

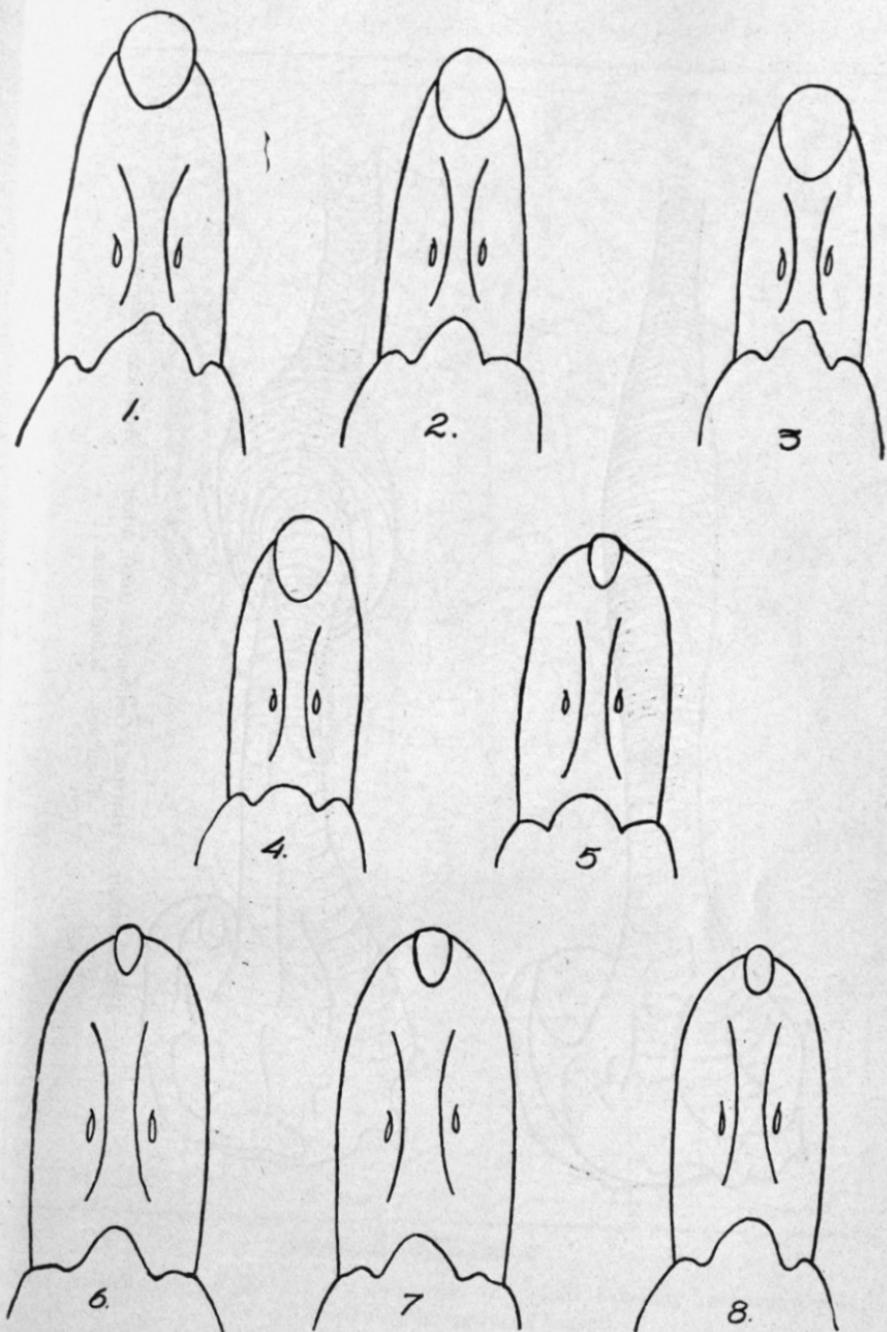


FIG. 1. Bill outlines, Barrow's Golden-eye, American Golden-eye.

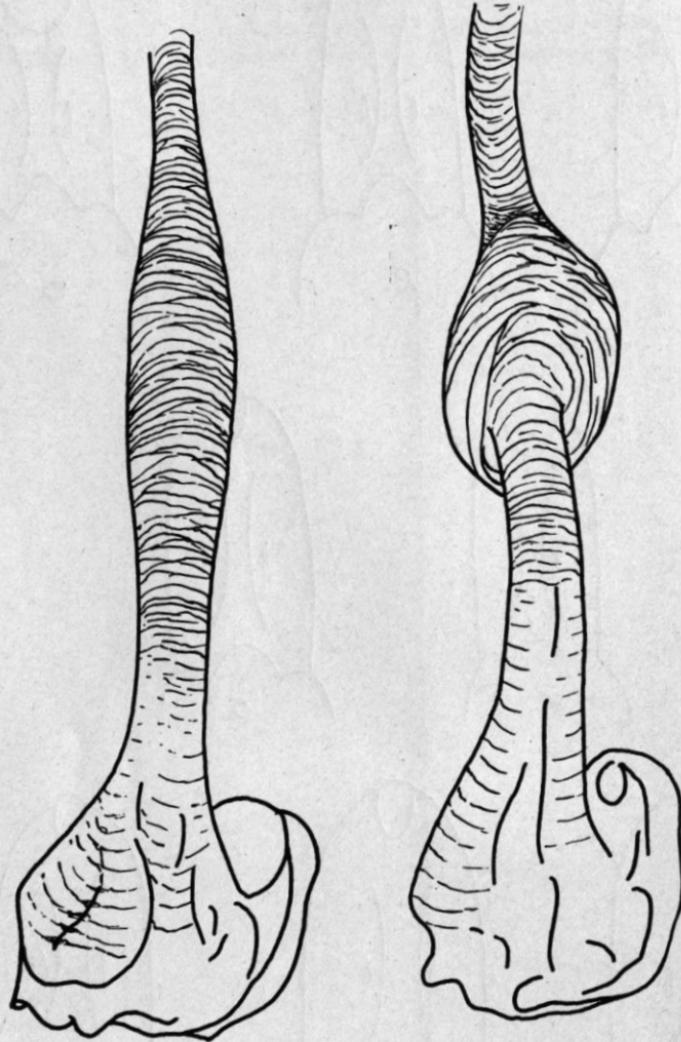


FIG. 2. Trachea adult ♂ Barrow's Golden-eye (top), adult ♂ American Golden-eye (bottom). Natural size.



FIG. 3. Distribution of Barrow's Golden-eye. Principal breeding range outlined; principal known wintering range dotted.



FIG. 4. Distribution of American Golden-eye. Principal breeding range outlined; principal wintering range dotted.



BARROW'S GOLDEN-EYE ADULT ♂ (LOWER)

AMERICAN GOLDEN-EYE ADULT ♂ (UPPER)

Frank L. Beebe - 1939