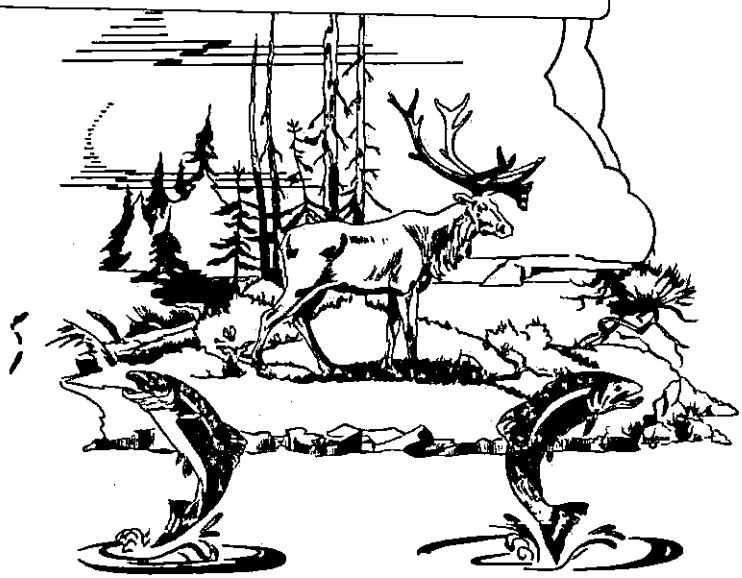
WILDLIFE MANAGEMENT BULLETIN



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THE AMERICAN GOLDENEYE IN CENTRAL NEW BRUNSWICK

by

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Wildlife Management Bulletins are produced to make available to wildlife administrators the information contained in reports which are submitted by officers of the Canadian Wildlife Service.

The reports do not, in most cases, cover extensive studies and are not written primarily for publication. Recommendations arising from the studies are not included.

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Introduction

This study of the American goldeneye (Bucephala clangula) in New Brunswick was sponsored by the Northeastern Wildlife Station of the Wildlife Management Institute at Fredericton, New Brunswick, and was carried out under the direction of Bruce S. Wright, Director of the station. Throughout the study, the writer had the capable assistance in the field of A.W. Skead. All the field work was done in the lower Saint John River Valley in the years from 1946 to 1950, inclusive.

The American goldeneye is widely distributed in New Brunswick and is found wherever there is suitable habitat. It prefers water areas having marshy shores with adjacent stands of old hardwoods to provide nesting sites. The largest breeding population in New Brunswick is found in the lower Saint John River Valley, but the species also breeds on the salt marshes along the south and east coasts. It is a fairly common winter resident and is usually present in considerable numbers off the coasts in that season.

The Study Area

Most of the data presented in this paper were obtained on the upper portion of the estuary of the Saint John River. The study area is 32,500 acres in extent, and is one of the best breeding areas for waterfowl in the Maritime Provinces of Canada.

The study area is located on the eastern bank of the river, its upper end about 16 miles below Fredericton, in what is known as the Sheffield-Maugerville Intervale. The major physical features of the area are the five river islands and Portobello Creek.

The five islands - Middle, Gilbert, Ox, Grimross, and Grimross Neck - are low-lying and are annually inundated by the spring freshets. There are sloughs of varying depths and sizes on all the islands, which in late summer are usually covered by emergent aquatic vegetation. Most of the sloughs are surrounded by stands of hardwood with a dense understory of raspberry (Rubus sp.), wild rose (Rosa sp.), alders (Alnus sp.), wild cucumbers (Cucurbita sp.), nettles (Urtica sp.), and young hardwoods. The

non-wooded areas of the islands are meadowlands and produce a very heavy hay crop in those areas that are fenced off from the grazing cattle owned by the farmers on either side of the river. The upper and lower ends of the islands have long bare sand spits, which are gradually exposed as the water level recedes after the spring freshet. When the water level is at its lowest, sand bars along the sides of the islands form excellent loafing sites for the dabbling ducks that breed in the study area.

Portobello Creek is about ten miles long and has two main tributaries - the Little Portobello and the Noonan - joining the main stream from the north. The creek is about 100 yards wide at its mouth and but a few feet at its source. During the summer, the level of the creek becomes so low that stretches near the centre of its length cannot be travelled by canoe. It is sluggish and its course is contorted. The general direction of its flow is west to east. It flows into the narrows between Indian and French Lakes, which are on the northern boundary of the study area. Marshes on each side of the creek extend from the mouth to about five miles up-stream, and vary in width from a quarter of a mile to half a mile. During the spring freshet, the marshes are completely inundated but slowly emerge as the water goes down. Aquatic vegetation - emergent, surface, and submersed - is very dense and supplies ample duck food and cover during the summer and autumn.

The waterways of the study area converge at the junction of the Grand Lake drainage system with the main river. That system drains an area of 940,800 acres, the third largest watershed in the Saint John River basin. It is exceeded in size only by the Aroostook and Tobique watersheds.

The study area contains four main types of waterfowl habitat and two types of shoreline. The habitat types may be classified as cultivated land, hardwood swamp, open marsh, and open water. The shoreline types are slough shoreline, which bounds enclosed bodies of water or sloughs, and perimeter shoreline, which bounds rivers and open lakes. The total areas of each of the four types of habitat and the total lengths of each of the two types of

shoreline were calculated from the National Defence Department Grand Lake Sheet, on a scale of one inch to one mile. The data are given in Table I. Since the region is subject to seasonal variation in water-level, the acreage and mileage figures given are averages for the summer season.

Table I. Habitat Areas and Shoreline Lengths.

	Open Water	Open Marsh	Culti-vated Land	Hard-wood Swamp	Total	Perimeter Shoreline (Miles)	Slough Shore-line (Miles)
Acres	2,117	9,638	4,682	16,062	32,499	73.4	108.5
Per Cent of Total	7	30	14	49	100		

The three vegetated habitats may be described as follows:

(i) Cultivated land (14 per cent of the total). This is diversified farming land (pasture for cattle, truck gardens, a few orchards, and hay meadows).

(ii) Hardwood swamp (49 per cent of the total). The dominants in this habitat type are red maple (Acer rubrum L.), silver maple (Acer saccharinum L.), black ash (Fraxinus nigra Marsh.), and American elm (Ulmus americana L.). From time to time a little hardwood logging is carried out in this habitat type during the winter.

(iii) Open marsh (30 per cent of the total). Aquatic vegetation is dense in this habitat and also along both types of shoreline except where there are sand bars. The following plants are found in the open marsh and along the shorelines. The list, which also gives the relative abundance of each species, is not complete, but includes those present of importance to waterfowl.

Arrowhead - Sagittaria latifolia Willd. - abundant all over the area.
Blue-joint - Calamagrostis sp. Adans. - abundant in the marsh meadows.
Bulrush, hard-stem - Scirpus acutus Muhl. - common along shorelines of the Saint John River and large lakes, but scarce elsewhere.
Bulrush, river - Scirpus fluviatilis (Torr.) Gray - scarce.
Bulrush, soft-stem - Scirpus validus Vahl. - common along shorelines of the Saint John River and large lakes, but scarce elsewhere.
Bulrush, three-square - Scirpus americanus Pers. - scarce.
Bulrush, water - Scirpus subterminalis Torr. - common in sloughs, but scarce elsewhere.
Bur-reed - Sparganium sp. (Tourn.) L. - common.
Coontail - Ceratophyllum demersum L. - abundant in sloughs, bays and creeks.
Cord-grass - Spartina pectinata Link. - abundant in marsh meadows.
Duckweed - Lemna sp. L. - scarce except in stagnant water.
Pickerelweed - Pontederia cordata L. - abundant.
Pondweed, bushy - Najas flexilis (Willd.) Rostk and Schmidt - scarce.
Pondweed, clasping-leaf - Potamogeton perfoliatus L. - abundant.
Pondweed, flat-stem - Potamogeton zosteriformis Fern. - common.
Pondweed, floating-leaf - Potamogeton natans L. - abundant.
Pondweed, ribbon-leaf - Potamogeton epihydrus Raf. - common.
Pondweed, variable-leaf - Potamogeton gramineus L. - common.
Sedge, three-way - Dulichium arundinaceum (L.) Britton. - common around the edges of sloughs.
Smartweed, water - Polygonum amphibium L. - common in sloughs, bays and creeks.
Spike-rush, common - Eleocharis palustris (L.) R & S. - common.

Wild celery - Vallisneria spiralis L. - common.
Wild rice - Zizania aquatica L. - common along the Saint John River.
Yellow pondlily - Nymphaea tuberosa Paine. - abundant in sloughs and bays.

Data on composition and approximate weight of the aquatic vegetation in three localities were obtained in mid-summer 1946 by collecting and weighing all the vegetation and animal life contained in one-quarter-square-metre quadrats to a depth of two inches below the water surface.

The two types of shoreline are different in appearance and can be distinguished by differences in the banks and the vegetation. Generally, the perimeter shoreline is characterized by cord-grass and blue-joint and has a definite bank, which is generally abrupt as it falls off to the water-level. The bottom is sandy and supports a growth of wild rice, pondweed species, hard- and soft-stem bulrush, and yellow waterlilies.

The slough bank descends very gradually to water and is usually soft and muddy. It is characterized by grass or bushes which give way to aquatics near the water's edge. The aquatics are arrow-head, pickerelweed, wild rice, and spike-rush, which merge into pondweeds, clumps of pickerelweed, and quite dense stands of wild rice, with an understory of water-shield.

The Spring Migration

In central New Brunswick, some American goldeneyes appear before the ice breaks up. They occupy many of the small open holes in the ice of the rivers, streams, and lakes. The early migrants arrive in small groups and almost immediately begin their courtship displays.

Date of Arrival

The average arrival date on the study area for the period from 1946 through 1950 was March 25, which was 15 days before the average break-up date

(April 10) for the ice on the Saint John River at Fredericton. The maximum and minimum intervals between arrival and break-up occurred respectively in 1947 when the goldeneyes were first noted 27 days before the ice went out, and in 1949 when the interval was only 6 days. The earliest date on which they were observed during the five-year study period was in 1946 when they arrived on March 14, but that was only 15 days before the break-up; the latest arrival date was in 1950 on April 7, 14 days before break-up, which was late that year. Table II shows the break-up and arrival dates for the five-year period.

Table II. Dates of Arrival of Goldeneyes and Break-up of the Ice at Fredericton, N.B., 1946-1950.

Year	Arrival Date	Break-up Date	Interval (Days)
1946	March 14	March 29	15
1947	March 23	April 19	27
1948	March 19	April 9	21
1949	March 30	April 5	6
1950	April 7	April 21	14

Fluctuations in the Spring Population

In the first week of April there are usually very few goldeneyes on the area, but during the next ten days the population more than trebles as the main migration passes through on its way northward. More goldeneyes are seen on the study area during that time than during any other period of the year. Towards the end of April, the numbers drop slightly, but they do not decline sharply until the first week in May. Most of the birds which nest farther north leave the area then, and only the residents and a few stragglers are left. Appearance and behaviour of the stragglers indicate that nearly all are non-breeding immature birds of the previous season. After the first week of May, another small decrease in numbers observed occurs as the immature

ducks disperse throughout the waterways, and the residents settle down to nest. The rise and fall of the spring population on the study area is shown graphically in Figure I.

During April when the migration is at its peak, large flocks of goldeneyes are usually found on the open water - only a few pairs or singles are found in shallow water or in the marshes. In the first hour of daylight, they are found in single pairs or small courting groups and they are seldom seen to feed at that time. Later in the day, they flock together in large numbers, diving and feeding with little sign of rivalry, although those that are paired keep fairly close to their mates. A little before dusk, they again break up into individual pairs and small groups and scatter widely. The daylight flocks vary in size from 3 to more than 100 birds. The average size of the flocks observed during the height of the spring migration (April 15 to May 5) from 1946 through 1950 was 15; the largest flock was 113, noted in 1950.

The number of goldeneyes migrating through the study area in the early spring seems to bear no relationship to the number found on the area late the following summer (Figure II).

Pairing

Average figures over the five-year period show that when the goldeneyes first arrive on the study area, 62.5 per cent of those seen are paired, and 13.2 per cent are lone drakes. The single drakes are probably paired but separated from their females at the time of observation.

If those females which are unseen but presumably paired to the lone drakes are taken into account, then it is calculated that, on the average, 78.6 per cent of the birds are paired on arrival. The remainder are unpaired adults which make up the courting groups and immature young of the previous year.

By the middle of April, the calculated percentage of paired ducks seen drops to 50 per cent of the total (Table III), mainly because of the

Figure I

Per Cent of Total Goldeneyes Observed by Ten-day Intervals During the Spring Migration, 1946-1950

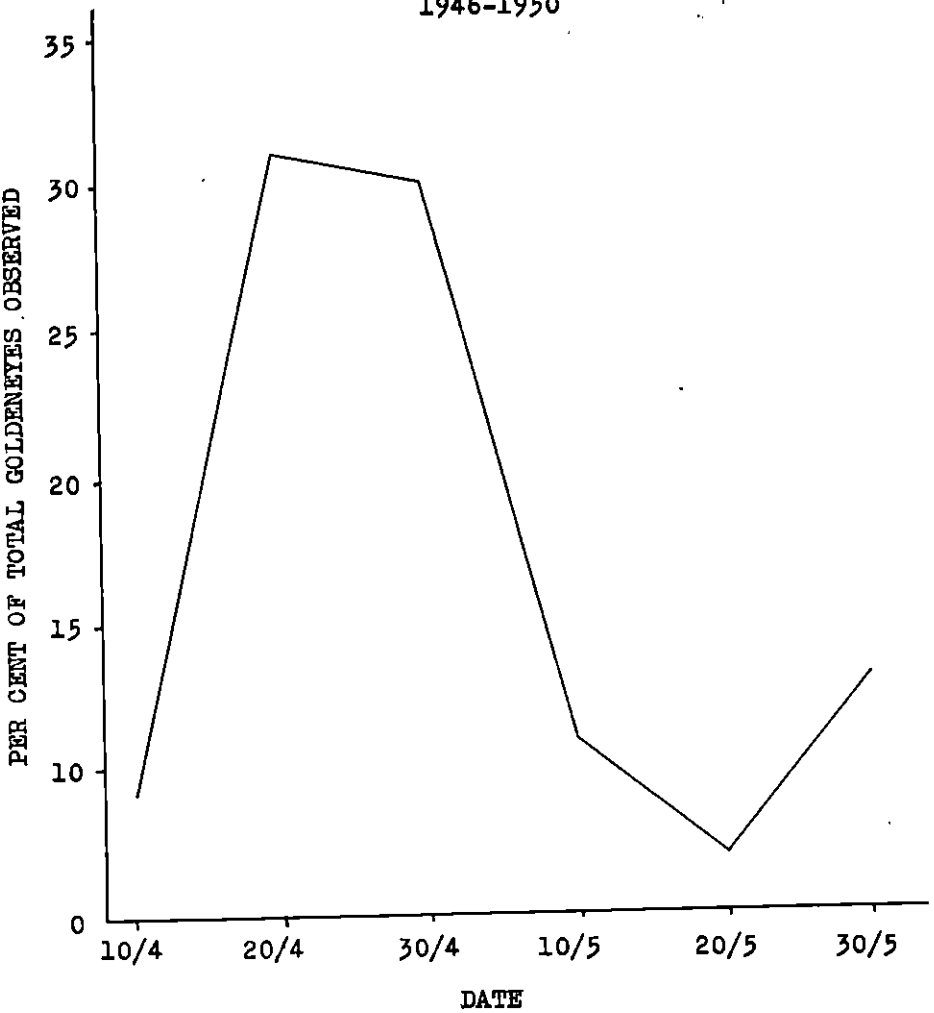
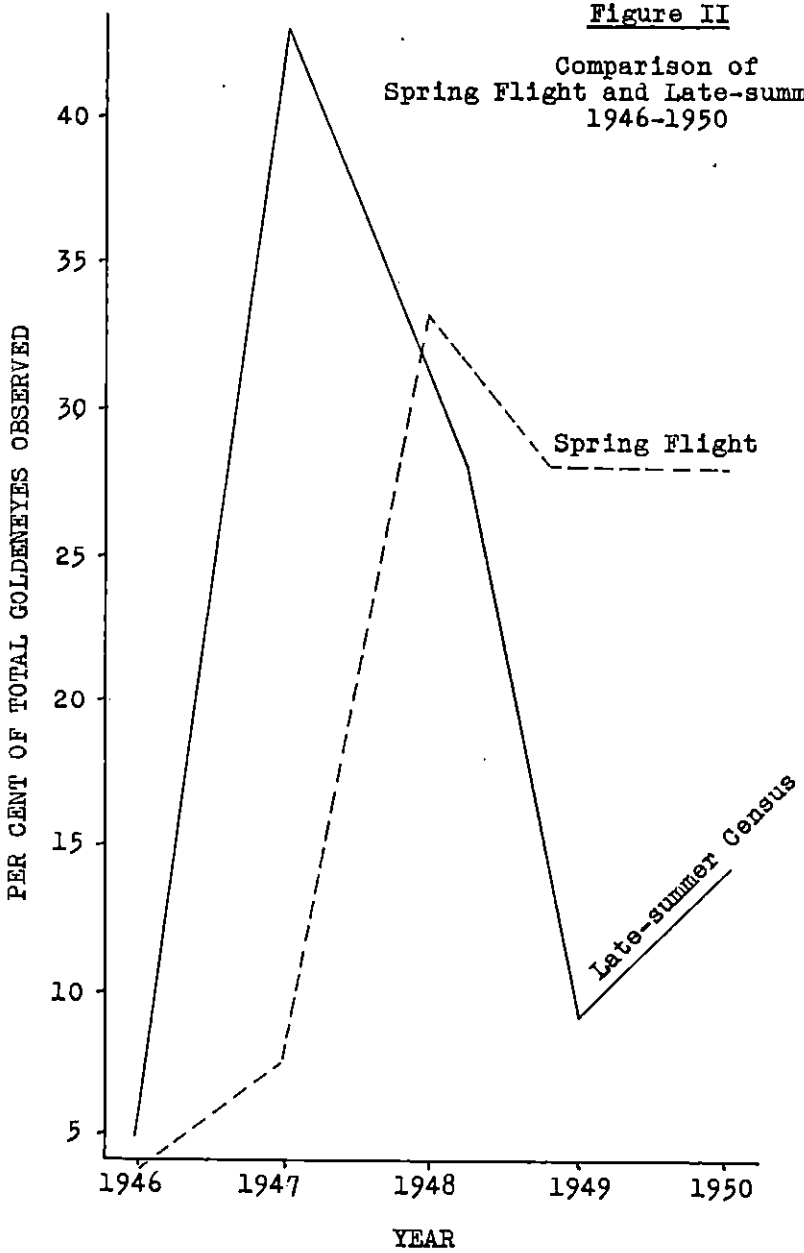


Figure II

Comparison of
Spring Flight and Late-summer Census
1946-1950



increase in number of immatures, which arrive on the area later than the older ducks. At the end of the month, it rises again to 62 per cent of the total. After that time, it steadily declines, probably because of nesting activities. Figure III compares the percentages of paired, unpaired, and single male goldeneyes during the spring flights from 1946 through 1950, inclusive.

Table III. Five-Year Average Numbers of Pairs, Single Drakes and Unpaired Goldeneyes Observed During the Spring Flight, 19 6-1950.

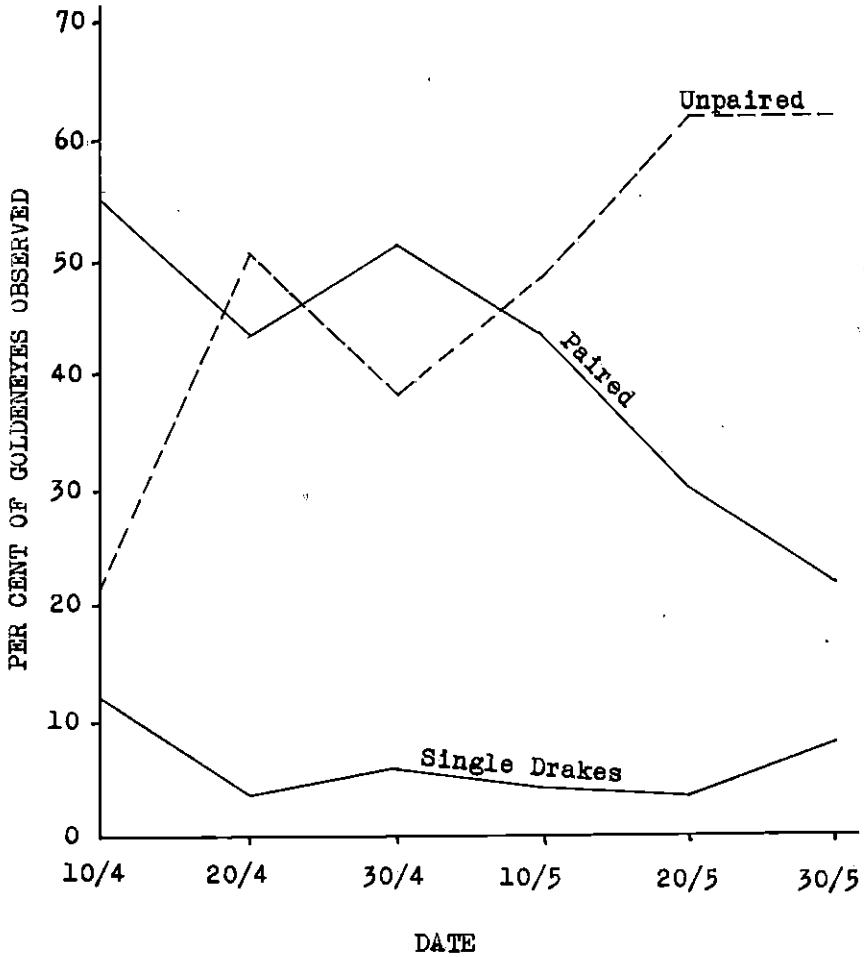
Date	10/4	20/4	30/4	10/5	20/5	30/5	Total
Observed Pairs	99	256	293	80	43	51	822
Indicated Pairs (single drakes)	42	44	60	18	12	39	215
Total Pairs	141	300	353	98	55	90	1,037
Total Paired Birds	282	600	706	196	110	180	2,074
Unpaired Birds	77	598	435	180	159	294	1,743
Total	359	1,198	1,141	376	269	474	3,817
Per Cent Paired Birds of Total	79	50	62	52	42	38	

Nearly all unpaired birds observed during the spring flight carried on courtship, and groups consisting of two females and five or six drakes were seen scattered all over the main river.

The transient goldeneyes that use the study area during the migration are usually found in large flocks which do not readily break up during the feeding hours. In the early dawn, when the resident ducks are found in single pairs or in small groups of four or five, the transients remain rafted in large numbers on the deep waters. They do not disperse widely into small courting groups, but carry out courtship displays within the large groups. There is a considerable amount of flying about, and

Figure III

Composition of the Spring Migration, 1946-1950



later in the day the paired residents join the outskirts of the transient flocks where they feed, each drake carefully guarding his mate.

Sex Ratio

The average observed sex ratio during the spring flight for the years from 1946 through 1950, from April 1 to May 30 in the study area, showed that the drakes were in the majority by 160 to 100. The sex ratio varied during that period, but always favoured the drakes. The number of females most nearly approximated that of the drakes about the first week of May when most of the migrants had left the area. By the next week, drakes were 85 per cent the more numerous, probably because nearly all the females were laying or incubating. Figure IV shows the proportion of males to 100 females for the five years of study.

Association With Other Species

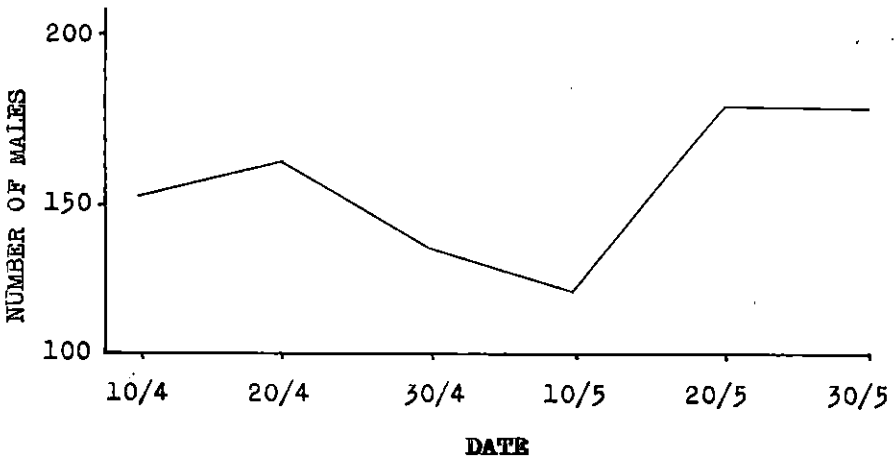
As the ice disappears and more ducks arrive, goldeneyes are seen during the early hours of the morning in the same general areas as black ducks (Anas rubripes), wood ducks (Aix sponsa), and blue-winged teal (Anas discors). Later in the day, the great majority of them leave the habitat frequented by the dabbling ducks (the shallow waters) and gather in flocks in the deep, open water. Sometimes large rafts of black ducks and goldeneyes are found close together, but rarely is there much intermingling of the two species. The only other important resident diving species, the ring-necked duck (Aythya collaris), does not arrive on the study area until a month after the goldeneyes, so the association between the two is limited. In general, small numbers of goldeneyes, usually singles and pairs, are found with all the other species of ducks that use the study area, but large groups tend to keep together and are seldom found intermingled with other species. No friction was observed between goldeneyes and other ducks.

Courtship and Pairing

As pointed out previously, many of the goldeneyes are already paired when they arrive on the study area in late March and early April. There

Figure IV

Average Proportion of Males to 100 Females
in 2,733 Sexed Goldeneyes,
1946-1950



is considerable courtship activity among the birds in unpaired groups as well as among the paired birds. Much of it is confined to courting groups which consist of unpaired birds of both sexes.

Courting Groups

Courting groups can be distinguished from groups of paired and non-courting birds by the greater activity and different behaviour of the drakes. In most goldeneye courting groups, the number of males exceeds the number of females by two or three to one, but in one or two instances observed, the females outnumbered the males.

In 1950, the only year in which a specific count of courting ducks was made, 8 per cent of the total goldeneyes observed before May 20 were in courting groups. The average group contained nine ducks, six of which were males and three females. The largest group seen was made up of seventeen males and ten females. The behaviour was the same in groups of all sizes. It was not apparent that any of the males singled out a particular female for his attention. Each addressed himself to the nearest female.

Display

The most frequent action seen in courtship is the head bob of the male. In that performance, the male swims back and forth and around the female, stretching his neck forward and downward until it is parallel with the water, then jerking the head and neck backward so that the back of the head almost touches the back and the bill is pointed straight up. As the movement is completed, the drake produces a very high pitched, squeaky quack.

In June, 1947, a pair of goldeneyes was observed in full courtship display off the shores of Oromocto Island. The drake was following the duck on the water, bobbing his head at intervals. From time to time, the birds dived and came to the surface together and the head bobbing actions of the male started again. Every now and then, both duck and drake turned on their sides in the water until their white bellies could be seen - sometimes back to back,

sometimes belly to belly, and not always close together. Each performed the action independently. Occasionally, the female stretched out her neck on the water and drifted with the current. The courtship display lasted about 15 minutes, until the pair drifted out of sight on the current. My observation agrees fairly well with the description given by Townsend (1910) although he does not mention the lifeless drifting performance of the female. Alford (1921) describes similar behaviour in the goldeneye in Europe.

During the early courtship, there is some antagonism among the drakes. It consists mainly of one drake chasing away other drakes that come too close to the favoured female. He is by no means consistent in his antagonism. When two or more drakes are courting a single female, it is quite common to see one of the males chase another of the party away. The pursued one may return, in fact very often does so at once, and the defending drake may pay no attention to him for some time; but sometimes the defender may be chased off by the returning male. This goes on for some time, with the female paying very little attention. No fighting or physical contact was observed between the drakes in the chases.

The courtship flight does not seem to play such an important part in the life of goldeneyes as for other species. Short irregular flights of three or four birds, with the female invariably leading, are seen occasionally; but most of the courtship is carried out on the water. During the courtship display, both sexes do considerable diving, but it is not known whether that action is part of the courting procedure or not.

The reduction of a courting group to a pair appears to be a process of elimination and endurance on the part of the drakes. The largest courting groups are seen during the early spring, and they grow progressively smaller as the season advances. What appeared to be the final transition from a courting group to a pair was observed on the upper reaches of the Oromocto River on May 12, 1950. In that case, a group of two drakes and one female was seen, the males courting the female by head-bobbing.

One of the drakes was by far the more aggressive and displayed the greater zeal. This more ardent drake frequently interrupted his courting to chase the other, which moved away quite readily. Finally, the less aggressive drake seemed to give up the unequal contest and flew away, leaving the other two as a pair.

Courting and recently paired goldeneyes are usually grouped separately, but occasionally they are found with other species. No antagonism between species has been observed. The field notes for April 28, 1949, state that pairs of wood ducks, black ducks, and goldeneyes were seen within ten feet of each other in apparent harmony.

It is interesting to note that, among goldeneyes (as among ducks of other species) during the spring, it is nearly always the female that takes the lead in everyday activities. She leads while the pair is feeding and loafing, and is always the first to move from one area to another. In an emergency, such as the approach of a canoe, the female takes alarm first and starts to swim away; if the canoe is too near, she takes flight first with the male following. The drake is a mere follower.

The Waiting Area

During late courtship, egg laying, and early incubation, the drake waits for the female on a water area in the vicinity of the nest. This area is a little different from the "territory" described by Hochbaum (1944). Goldeneye drakes were never seen defending a water area, although they were seen driving away other drakes from the vicinity of their mates. In those instances, the males were very definitely not defending an area - only their females - and the chases usually occurred among groups, whether of paired or unpaired birds. The water area was only a "waiting area" that the drake used while the female was on the nest either laying or incubating. With the annual freshets and the continual rise and fall of the water-level, the drake's territory would vary so much that he would find it difficult to defend, since his defined boundaries might be visible one day and a few days later under water; or the whole waiting area might be out of water.

Nesting

American goldeneyes which arrive on the study area during the last week of March do not start nesting at once. There is a period of waiting which lasts about two or three weeks. During that time, the birds that are paired on arrival (they are the first to nest) carry out the last stages of courtship. In that respect, they differ from black ducks which nest within 10 days of their arrival on the study area. Not until the second week in April are goldeneyes observed hunting for nesting sites; about a week later the first egg is laid.

The Site

The goldeneye, in common with the wood duck, buffle-head (Bucephala albeola), and a few other species, is a tree-nesting duck. Therefore, the usual nesting requirements of the species include an abundance of trees with cavities already existing in them. The trees must be near or fairly near water containing sufficient food and cover for the young. From the location of the nests found on the study area, it seems to be immaterial whether the nest is near deep water, such as the main river, or shallow water, such as the sloughs.

All but one of the nests found in the study area were in trees; of those in trees, 89 per cent were in cavities in maples which had an average breast-high diameter of eight inches. The average height of the cavities above the ground or water was 18 feet.

Other types of nesting sites are used occasionally. In one unusual instance on the study area, a female used a ledge inside a church tower which she was able to enter where a slat was broken in a ventilator.

A few goldeneyes are killed by smoke annually in the Fredericton area when attempting to nest in chimneys. The tendency to nest in chimneys can be dangerous to the bird, not only because of the smoke, but also because it may go down the chimney and out the fireplace into a room from which it can find no escape. Such an accident happened about April 15, 1947, when an adult female was found in D. W. Olts'

camp at Davidson Lake, York County, New Brunswick (about 32 miles north of Fredericton). The camp had been closed and shuttered for the winter and the only entrance to the interior was by the chimney, which had not been covered. The duck was dead when it was found in the living room into which the chimney led by way of the fireplace. It had not been dead long and there were no signs of injury on the body. Presumably while searching for a nesting site, it must have gone too far down the chimney and entered the room. Not being able to find its way out, it died of starvation.

On May 19, 1950, a nest was found beside No. 9 Highway in a tree in the corner of the Sheffield School yard. The entrance was eight inches by seven inches and was seven feet above the ground. It seemed a strange place for a nest, beside a fairly busy highway and a very noisy school yard; but at the time of discovery, the female had laid three eggs. The school children knew of the nest, and it was only a matter of time before it was destroyed.

On the study area, goldeneye nests are usually located in maples (silver or red). This does not mean that the goldeneyes have any particular preference for the species, but that most of the available cavities in the area are in maples. They are old second-growth maples with a considerable amount of heart rot. Cavities, many unsuitable for nesting, occur in nearly all the maples more than eight inches in diameter.

Nest Entrance

The goldeneyes seem to prefer some types of holes to others. On the study area, most of the cavities used had lateral openings; in only one case was the nest open to the sky. This is in contrast to many of the cavities used as nesting sites by black ducks. The goldeneye cavity is usually a split in the side of a tree, an old enlarged woodpecker cavity, or the rotted centre of a broken branch. When searching for goldeneye nests, those are the three main types of cavity to look for. Late in the season, down clinging to the opening is the best indication that the hole is occupied.

The size of the opening to the nest cavity varies considerably. Some are very large and others very small - so small, in fact, that it does not seem possible for the female to pass through them. A nest containing six eggs was found on Middle Island with an entrance only about two inches wide and eighteen inches long. On the average, the entrances to the cavities are larger, and are about seven to eight inches in width and the same or a little longer in length.

The entrances to some of the nesting cavities afford little or no foothold for the bird, yet the female seems to enter and leave these small holes with ease. On June 11, 1946, a female was observed entering and leaving an old woodpecker's hole in a seven-inch dead maple, 20 feet above the water level. The bird flew directly to the hole and into it without a pause; only at the last instant did she close her wings. The only sound heard was a slight scratching after she disappeared into the entrance. On leaving the hole, she was not so precipitate. First there was a scratching inside the cavity, then her head and neck were thrust out and she looked around for about a second. She then pushed herself completely out and started flying at once, losing very little altitude. Entering and leaving the cavity was accomplished with great ease through a hole as small as three inches in diameter.

Height

The height of the nesting cavity above the ground varies greatly, and seems to be of little importance to the goldeneye. However, on the study area, early nests below a minimum height may be affected by the annual flood. This is important only where the nests are in trees near the water's edge or on the low lying islands and intervales. The frequency of flooded nests on the study area was not determined because those likely to be flooded had to be found before the freshet rose, while those already flooded were below the water-level. During the five years of nest hunting, only one nest out of a total of 17 found was flooded. It was discovered on May 19, 1947, in a 12-inch maple on Gilbert Island, in the main river. The water had risen to a height of about one foot above the eggs and had covered them

with sediment and rotten wood. At the time of discovery, the water-level had fallen to three feet below the level of the eggs. There were ten eggs in the nest but no down. The eggs were examined and it was determined that incubation had not yet started. The nest highest above ground or water-level on the study area was found on June 4, 1948. It was about 50 feet from the ground. The lowest, excluding the one that was flooded, was five feet above water. The average estimated height for 16 nests was 18 feet.

Nest Material

The nesting material in the bottom of the nest usually consists of flaked rotten wood from the sides of the cavity and a small amount of grass and dead leaves. Whether the leaves are brought in by the female or by other birds and mammals, or blown in before the cavity is occupied, was not determined.

When the nest is first occupied, no down is used; but as the eggs are laid, down is added to the nesting material until the clutch is completed. At that stage, the eggs are completely surrounded by the down. As incubation progresses, more down is added until there is sufficient to cover all the eggs; this takes about a week or ten days. When the female voluntarily leaves the nest, the eggs are covered with a light layer of down; if she is flushed, the down is scattered and the eggs exposed. As she leaves and returns, she disturbs the down and some of it often clings to the entrance of the cavity. As previously mentioned, it can be seen from the ground and is a sign to watch for while nest hunting. Usually it is visible only after the clutch is almost completed; before then there is not enough to be noticeable outside. The down of the American goldeneye is white and the breast feathers are white with a dark shaft. These characters distinguish the species from any other waterfowl occurring in New Brunswick.

Brewster (1900) suggested that two females sometimes lay in the same nest. No such instance was found in the present investigation; the largest number of eggs in any nest was 12 and presumably there would be a larger number if two females were laying. However, very large broods only a quarter grown are sometimes seen on the area, which suggests that they may have been hatched from the same nest or that two broods had combined.

Successive Annual Use

At present, it is not known whether the female goldeneye returns to the same nest cavity in successive years. This remains to be determined when a successful technique for trapping the female on the nest is worked out.

Only once was the same cavity used in successive years on the study area. That was a cavity within ten yards of Highway No. 9 and the Saint John River; it did not seem to have anything to recommend it above other cavities near it. Instances have been recorded of goldeneyes using the same chimneys four years in succession; but these have come from the prairies where, presumably, there is a scarcity of nesting sites.

Defence by Female

Observations of goldeneyes during the five years of study have failed to show that the female makes any attempt to defend her nest. This is in contrast to the blue-winged teal, which often makes a great show of feigning injury. If incubation is far advanced, the female sometimes stays on the nest, but she does so passively. On May 14, 1947, a bird was found nesting in a cavity in a small seven-inch maple. The entrance was about five feet above the water, which was at flood height. Incubation was well advanced as shown by the large amount of down present. The female stayed on her eggs in spite of the canoe bumping against the tree and permitted herself to be lifted off the nest by hand. She was quite passive even when handled and photographed, and showed little fear.

Bent (1925) says that the female is alleged to desert the nest if the eggs have been handled and that they did so on the two occasions be tried it. On the study area they did not. In many instances it was not possible to see to the bottom of the cavity; to ascertain the number of eggs, it was necessary to handle them and one had to be brought out for identification. In some nests the eggs were handled two or three times and the female flushed each time. In no case did she desert.

Clutch Size

The number of eggs that make up a complete clutch is variable. It may be as high as 19, but is usually from 8 to 12. (Kortright, 1943.) The average number of eggs in nine completed clutches observed on the study area during the five years was 9; the range was from 7 to 12.

Incubation

No more than one egg that did not hatch was found in any nest on the study area. The percentage of such eggs for the five-year period from 1946 through 1950, was 3.8 per cent of the 79 eggs found, excluding the ten found in the flooded nest mentioned before.

It was found that as incubation progressed, the eggs and the surrounding down became dirtier due to defecation by the female. The less the female was disturbed, the cleaner the nest, although no nest was very clean. When she was frightened and flushed, she usually defecated as she left the nest.

Departure From the Nest

A short time after hatching, when the ducklings are ready to leave the nest, the female calls to them from the ground and the ducklings jump from the nesting hole. The height of the nest appears to make no difference to them and they land on the ground or water quite gently.

On June 29, 1948, Miss Jessie MacDonald observed goldeneyes leaving their nest at Woodman's Point on the Lower Saint John River. The nest was a hole about four feet up in an old stub at the landward edge of the beach. The female appeared at the mouth of the cavity first and flew to the ground below the hole. From there she clucked and called to the young. They came to the opening and, without any hesitation, jumped to the ground, flapping hard with their wings. In all, eight ducklings jumped to the ground in that manner. Then the mother gathered them together and led them off across the beach to the river.

Although there is always water near the site when nesting starts in early spring, a few goldeneye nests are a long way from water by the time the eggs are hatched, because the river has returned to its normal level. The young from those nests have a long and rigorous journey to the water through open fields and woodlands. On July 7, 1949, a female and five young ducklings, just hatched, were observed going towards the river across the Sheffield Intervale. They must have come a considerable distance, since the nearest trees were at least a quarter of a mile away. They still had a main highway and brush-grown shore to cross before they came to the river. It is possible that many ducklings succumb to predation, accidents and exhaustion on the journey to water, although no direct evidence of that was found.

The Brood Season

The first broods on the study area usually appear about the last week of May (Figure V). The number observed increases until about the third week in June when the peak is reached; after that there is a gradual falling off until the end of the brood season, which occurs, on the average, about the second week in August. During the three months of the season, broods of different sizes and ages are present on the study area at all times.

The size of goldeneye broods observed in the study area varies considerably. The largest broods are generally composed of the youngest ducklings.

In this discussion, Class I ducklings are those up to one-quarter grown - that is, they still show considerable down; Class II are from one-quarter to three-quarters grown; and Class III from three-quarters grown to full size. This classification is used throughout the study.

The size of the average Class I brood for the six years (1945-1950) was 6.2 ducklings from 127 broods; for Class II, 4.7 from 58 broods; and for Class III, 4.8 from 49 broods.

Class I broods were first observed about the end of May and then increased in number until the third week in June. (Table IV and Figure VI.)

Figure V

Chronology of the Goldeneye Nesting Season on the Study Area.

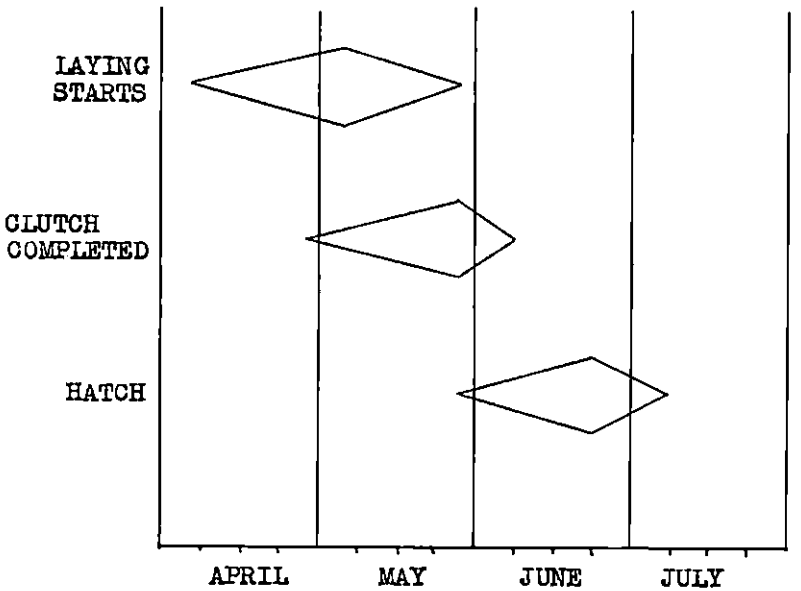


Table IV. Number of Ducklings Observed by Age Classes for Weekly Periods During the Brooding Season, 1945-1950.

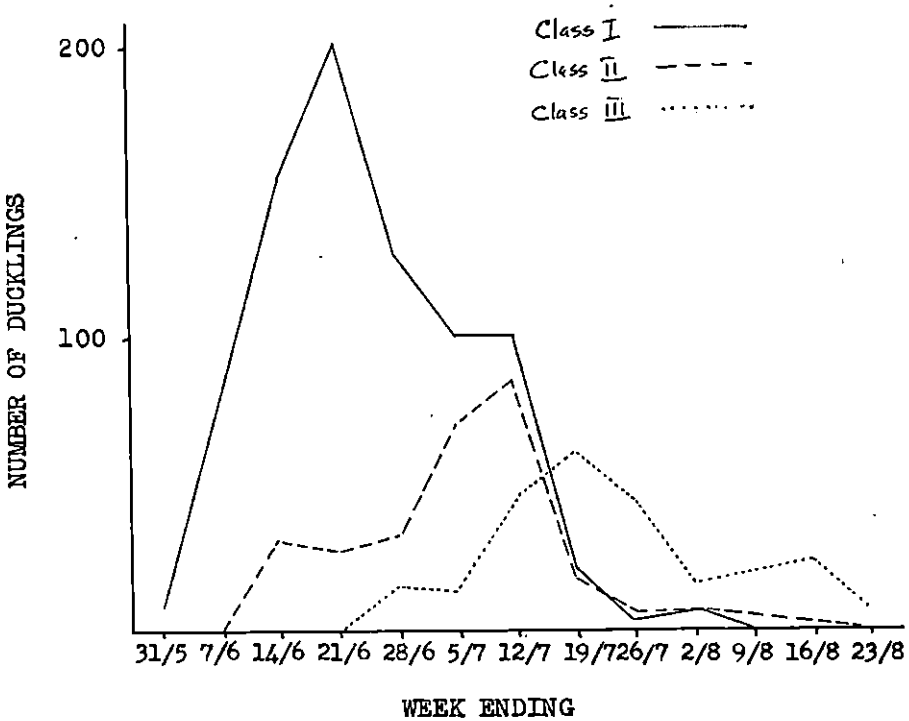
Year and Class	Number of Ducklings Observed in Week Ending						
	31/5	7/6	14/6	21/6	28/6	5/7	12/7
1945							
I	Nil	Nil	Nil	Nil	Nil	Nil	Nil
II	"	"	"	"	"	"	"
III	"	"	"	"	"	"	"
1946							
I	"	4	6	8	7	12	17
II	"	Nil	Nil	Nil	11	14	19
III	"	"	"	"	Nil	Nil	Nil
1947							
I	"	11	"	40	26	"	"
II	"	Nil	"	4	15	39	"
III	"	"	"	Nil	15	Nil	4
1948							
I	"	36	54	117	52	59	28
II	"	Nil	Nil	8	Nil	14	37
III	"	"	"	Nil	"	Nil	11
1949							
I	6	19	75	28	43	15	Nil
II	Nil	Nil	29	7	5	3	9
III	"	"	Nil	Nil	Nil	12	27
1950							
I	"	16	18	8	"	4	45
II	"	Nil	Nil	7	"	Nil	20
III	"	"	"	Nil	"	"	Nil
Subtotals							
I	6	86	153	201	128	90	90
II	Nil	Nil	29	26	31	70	85
III	"	"	Nil	Nil	15	12	42
Total	6	86	182	227	174	172	217

Table IV. (con't) Number of Ducklings Observed by Age Classes for Weekly Periods During the Brooding Season, 1945-1950.

Year and Class	Number of Ducklings Observed in Week Ending						
	19/7	26/7	2/8	9/8	16/8	23/8	Total
1945							
I	Nil	Nil	Nil	Nil	Nil	Nil	Nil
II	6	"	"	4	"	"	10
III	5	"	"	3	"	6	14
1946							
I	Nil	"	"	Nil	"	Nil	54
II	"	"	"	"	"	"	44
III	"	14	3	"	"	"	17
1947							
I	"	Nil	Nil	"	"	"	77
II	4	"	"	"	"	"	62
III	20	15	13	"	"	"	67
1948							
I	2	2	5	"	"	"	355
II	2	Nil	5	"	1	"	67
III	28	8	Nil	4	17	"	68
1949							
I	Nil	"	"	Nil	Nil	"	186
II	6	"	"	"	"	"	59
III	3	7	"	"	"	"	49
1950							
I	18	Nil	"	"	"	"	109
II	Nil	3	"	"	"	"	30
III	4	Nil	"	11	5	"	20
Subtotals							
I	20	2	5	Nil	Nil	Nil	781
II	18	3	5	4	1	"	272
III	60	44	16	18	22	6	235
Total	98	49	26	22	23	6	1,288

Figure VI

Chronology of Abundance of 1,288 Ducklings Observed, 1946-1950



After that date, they decreased in number until the beginning of August when no more were seen for the season. Class II broods were observed about the second week of June and increased in numbers seen until the second week of July. After that they gradually decreased, and few were observed after the second week of August. Class III ducklings appeared on the study area about the end of June. They reached a peak about the middle of July and the last were seen during the third week of August.

On the study area, most of the young were flying by the middle of August. Since the average date of hatch was June 20, the approximate length of time required to attain flight was 56 to 57 days.

By the third week in August many of the broods have broken up and most of the young are flying; after that date, they are scattered throughout the waterways of the area and few of them are found in family groups. When the young are flying, it is not possible to distinguish them from adults with any certainty in the field.

July 17 is the average date for the years from 1947 through 1950 when the first flying young were observed on the study area. The dates of observation cover a span of 17 days. In 1947, the first flying young were observed on July 11; in 1948, on July 16; in 1949, on July 28; and in 1950, on July 14.

Brood Losses

There is a considerable loss of young goldeneyes between the time when the clutch is completed and when the young are able to fly. These losses could be attributed to the 3.8 per cent failure to hatch, and to predation, disease and accidents during the period of growth to flying age.

The average successful clutch of goldeneye eggs on the study area was nine. If on the average, 3.8 per cent or 0.3 egg per clutch failed to hatch, then 8.7 eggs hatched per successful nest. The average Class I brood found on the study area contained 6.2 ducklings (Table V). It appeared that 2.5 ducklings were lost during the first week of life, as the average Class I brood was about a week old.

The average loss from Class I to Class III is 1.4 ducklings per brood or 22.5 per cent.

Table V. Average Number of Ducklings per Brood, 1945-1950.

Year	Class I			Class II			Class III		
	No. Broods	No. Ducklings	Av./ Brood	No. Broods	No. Ducklings	Av./ Brood	No. Broods	No. Ducklings	Av./ Brood
1945	Nil	Nil	Nil	2	10	5.0	3	14	4.7
1946	12	54	4.5	10	44	4.4	3	17	5.7
1947	9	77	8.6	11	62	5.6	13	67	5.1
1948	57	355	6.2	16	67	4.2	12	68	5.7
1949	35	186	5.3	15	59	3.9	11	49	4.4
1950	14	109	7.8	4	30	7.5	7	20	2.9
Total	127	781	6.2	58	272	4.7	49	235	4.8

Grand Totals All Ages

Number of Broods	234
Number of Ducklings	1,288
Average per Brood	5.5

Thus, the total loss from the time that the successful clutch is completed until the brood is flying is 4.2 ducklings or 47 per cent of the original clutch.

Chances to obtain repeated observations of an individual brood in the wild are few in the area studied; however, in July, 1949, a small brood was observed for a period of 14 days in Haystack Island Channel. Since the channel is narrow and there was no female with the brood, it is certain that the same brood was observed each time. It was first seen on July 14 and at that time consisted of three three-quarter-grown ducklings. The next observation was on July 20, when the brood was reduced to two. Five days later, on July 25, it was again seen in the same area and still numbered two ducklings. The last time that brood was observed was on the 28th, when there was only one left - still unable to fly. There was no reason to believe that any of the brood had flown or were able to fly, since they were examined carefully at close range with binoculars and when they were chased on July 25, their primaries were less than half developed. It seemed that some predator was taking them one by one, although none was identified.

The only other brood certainly observed more than once was on the Oromocto Flats. There a female with 11 quarter-grown young was seen in a small alder-fringed pothole on June 4; the next day the brood had been reduced by one - the cause of reduction was not determined.

Defence of the Brood

A common reaction of the hen of most species, when the safety of her young is threatened, is the "broken wing" performance which often serves to divert the attention of the intruder. In five years of study, the female goldeneye was only occasionally observed to give any sign that she would protect her young in case of danger, and she was seldom seen to give the broken wing display. When the safety of the brood was threatened, the female usually gave a low-pitched croak which made the young ducklings scatter and sometimes dive. She then flew off in a large circle so as to approach the hiding place of her brood from behind as soon as the danger had passed. There seemed to be very little protective maternal instinct in female goldeneyes in comparison with other ducks.

Young goldeneyes are well able to take care of themselves. They were chased several times with a canoe and outboard motor and the speed at which they could travel along the surface of the water was amazing. The canoe was barely able to overtake them when going at a speed of about ten miles per hour. When it got too close during the chase, they dived with no pause in their speed and came up behind to skitter away in the opposite direction until they finally found cover. If the chase was long, the only apparent sign of fatigue shown was a reduction in the duration of the dives.

It is not uncommon to see a goldeneye brood without a female in attendance. The black and white colouring of the ducklings makes their identification much easier than that of other species of ducks, so the absence of the mother does not hamper the observer. As would be expected, it is the oldest broods which are most often observed without females. Field notes from 1945 through 1950 show that out of a total of 234 goldeneye broods observed, 34 were without females - 14.5 per cent of the total. Seven of the broods were in Class I, nine in Class II, and eighteen in Class III (Table VI). Female goldeneyes apparently abandon the broods when they are much younger than do other species.

Table VI. Number of Broods Observed Without Females, 1946-1950.

Year	Age Class I	II	III	Total
1946	1	1	1	3
1947	Nil	Nil	5	5
1948	5	2	Nil	7
1949	Nil	6	6	12
1950	1	Nil	6	7
Total	7	9	18	34
Per cent of Total Broods w/o Females	21	26	53	100

5.5 per cent of all Class I broods observed were without females.
15.5 per cent of all Class II broods observed were without females.
36.7 per cent of all Class III broods observed were without females.
14.5 per cent of all broods observed were without females.

Occasionally, the young of other species are found mixed with goldeneye broods. Only one mixed brood was observed on the study area, on Portobello Creek on June 11, 1951. In that case, a single quarter-grown goldeneye was seen in a brood of wood ducks of the same age.

Rearing Cover

When the ducklings leave the nest, they are found on the nearest water. After the first week of life, most of the broods are observed along the shorelines of large bodies of water where the emergent vegetation provides cover. It is not unusual to find broods of quarter-grown ducklings some distance out in open water, where they appear to be quite at home.

During the earliest stages of brood development, the cover along the shoreline of the river is rather sparse because the emergent vegetation has not developed sufficiently. In the sloughs, the cover is a little better, as the shorelines are surrounded by trees and bushes and, in many cases, by brush and debris washed there by previous spring freshets.

There is no lack of cover during the later stages of duckling development which are spent along the shorelines of large bodies of water. The cover consists mainly of bulrushes - both hard-stem and soft-stem - and of arrowhead, pickerelweed, and wild rice. However, the young do not use cover to the same degree as other species of breeding ducks on the study areas, and they are frequently found farther out in the open water.

Post-Breeding Season and Autumn

Moulting

From the beginning of the brood season, there is a gradual decrease in the number of drake goldeneyes observed on the study area. This decrease is because the moult of the males is approaching with its flightless period. In contrast to black ducks, goldeneyes do not concentrate in large flocks but rather in small groups widely scattered over the available water areas. During the later stages of the moult, they are extremely hard to find, and only two or three flightless goldeneyes have been observed on the study area. The large majority of drake goldeneyes leave the study area altogether and have been observed along the river mouths and inlets of New Brunswick's coastline.

By the end of July, most of the drakes have started to moult into their eclipse plumage and have left the females to carry out incubating and rearing alone. During the moult, the males are flightless for about three to four weeks while shedding their flight feathers and growing new ones. Their new plumage resembles that of the female, which makes sexing in the field during that time of year nearly impossible. The only difference that can be recognized, except at very close range, is the larger size of the male. The eclipse plumage is retained until early autumn when a very gradual moult into the winter or nuptial plumage is started. The moult usually is not completed on the study area. Migrants coming into the area from the north are in different stages of moult and are seen almost every day until freeze-up.

Few female goldeneyes moult before their broods are flying or nearly ready to do so. Thus, by about the second week in August, most of the females are in varying stages of moult. It seems that the earlier the female nests, the earlier she is ready to moult - some females are starting to moult by the first week of July. This also seems to apply to the drakes - the earlier their courtship and pairing is finished, the sooner they leave the females to gather with other males to moult.

Autumn Migration

The American goldeneye is a late autumn migrant, and can be found wherever there is open water in their range. As the waters of the north gradually freeze over,

the birds are forced south, but they seem to leave the cold waters reluctantly, and massed flights are seldom seen. The general direction of their migration in the Atlantic Flyway is southward and southeastward, and from the inland waters to the coast. In New Brunswick, the first movement is to the coasts eastward and southward where large numbers were found rafting and feeding off the rocky ledges.

Departure of locally raised birds from central New Brunswick usually occurs during the last two weeks of October. The majority move toward the coast before they begin their southward migration.

In central New Brunswick, there is a distinct gap between the early coastwise movement and the arrival of migrants from the north. Toward the end of October, the southward migration is in full swing and many birds are seen along the main river and in the large lakes. At that season, the goldeneyes keep together in flocks of ten to fourteen birds and tend to raft in the deeper waters. Sometimes, numbers of greater scaup (Aythya marila) raft with them but more often the goldeneyes are alone.

Later in the autumn, the migrants spend most of their time rafted in deep water, coming into shallow water to feed only in early morning and at evening.

Many goldeneyes gather in the river at Fredericton during the late autumn where they feed and dive, thus affording a good opportunity for observation. In late November and early December, they are the only ducks abundant on the study area. Most of those observed feeding at Fredericton are in small groups of four or five; several large flocks are sometimes present, but they either break up into smaller flocks or move on to other areas. At that time, many old drakes and yearling males are observed during the change of plumage. The face patch of many of the drakes is mottled and the heads still show some of the brown feathers.

There are usually a few herring gulls (Larus argentatus) among the small groups of feeding goldeneyes in the Fredericton area. The gulls compete for the same food, although they do not dive for it. There is little evidence of antagonism between the two species. Occasionally, gulls chase goldeneyes when the latter come up from diving, and apparently attempt to force them to give up food.

The duration of the feeding dives varies considerably. Twelve dives of different individuals were timed and they varied from as low as 7 seconds to as high as 29 seconds; the average for the 12 dives was 19 seconds. If the food is plentiful, the dive is short, but if it is scarce, more time appears to be required under water. The goldeneye leaves the surface of the water smoothly, with scarcely a ripple. The head is first dipped below the surface and the body follows in a continuous movement. When coming to the surface, the duck bobs up like a cork and appears on the water in a sitting position, not head first as if it had swum along an inclined plane. While watching the goldeneyes off Fredericton, it was noticed that they usually pointed up-stream before the dive and that they surfaced about ten yards below the spot from which they had submerged. Thus, there was a gradual drift down-stream during the dive. Every few minutes the birds flew back up-stream to their feeding area.

With the onset of freezing weather and the formation of shore ice during the night, goldeneyes are found feeding in the warm water below Fredericton's sewer outlet. They use that feeding area until the ice drives them out in early December. In 1950, five drake goldeneyes were observed there on December 20, just two days before the river froze at Fredericton.

The Hunting Season

The American goldeneye is not usually one of the most sought-after ducks, as it is not considered a particularly good "table bird". However, a goldeneye that has been feeding in fresh water all summer is very good eating; it has not yet acquired the fishy taste and odor it gets from feeding in salt water. Periodically, "whistler" shooting takes on a new importance when the species generally considered more palatable decline in numbers. Very few goldeneyes are taken during the early part of the open season because there are not many to be shot, and also because there are more of the species hunters prefer. Most of those taken are shot during the latter part of the season when the number of black ducks has fallen off and the late goldeneye migrants are coming in from the north. Some of them are shot inland but many more are taken along the coast when the inland hunting season is closed.

The hunting season for ducks formerly opened on September 15 in New Brunswick, which was rather too early for the breeding ducks of the area, many of the late nesters being still flightless and their young barely accustomed to flying. In 1948 the opening date was changed to October 1 over much of the province. The province was divided into three zones - one mainly for inland shooting and the other two for coastal shooting (Figure VII).

The legal bag limit in 1950 for New Brunswick was seven ducks per day and the possession limit was 14. Hunting on Sundays was forbidden. Since 1953 the daily bag limit has been eight and the possession limit 16.

Hunting Methods

The method most generally used for goldeneye hunting along the Saint John River is shooting from a blind over decoys. The decoys are anchored in hook formation with the curved part of the hook up-wind. On the cold blustery days of the late autumn there is a considerable amount of "trading" back and forth by the goldeneyes; and they decoy very well as long as the hunter is hidden and keeps still. The goldeneye is a wary bird and the least movement on the hunter's part causes him to veer away. In some instances, when the birds have been made wary by much hunting, they alight on the water out of gunshot and swim cautiously in towards the decoys; at any suspicious sound or movement they dive and do not surface until out of range. Goldeneyes are deceptively fast fliers and provide sporty shooting.

Jump shooting, as the name implies, means that the shooting is done by flushing the ducks from the streams and rivers either by walking the banks or by moving along them in a canoe or boat. Some consider this better sport than shooting with decoys, as the hunter has to be ready at all times.

Shooting goldeneyes on the coast is considered one of the finest sports and demands skill with the shotgun, especially on windy, wet days. On the rocky coasts bounded by deep water, the general practice is to set up a blind on some out-thrust of rocks with the decoys in front.

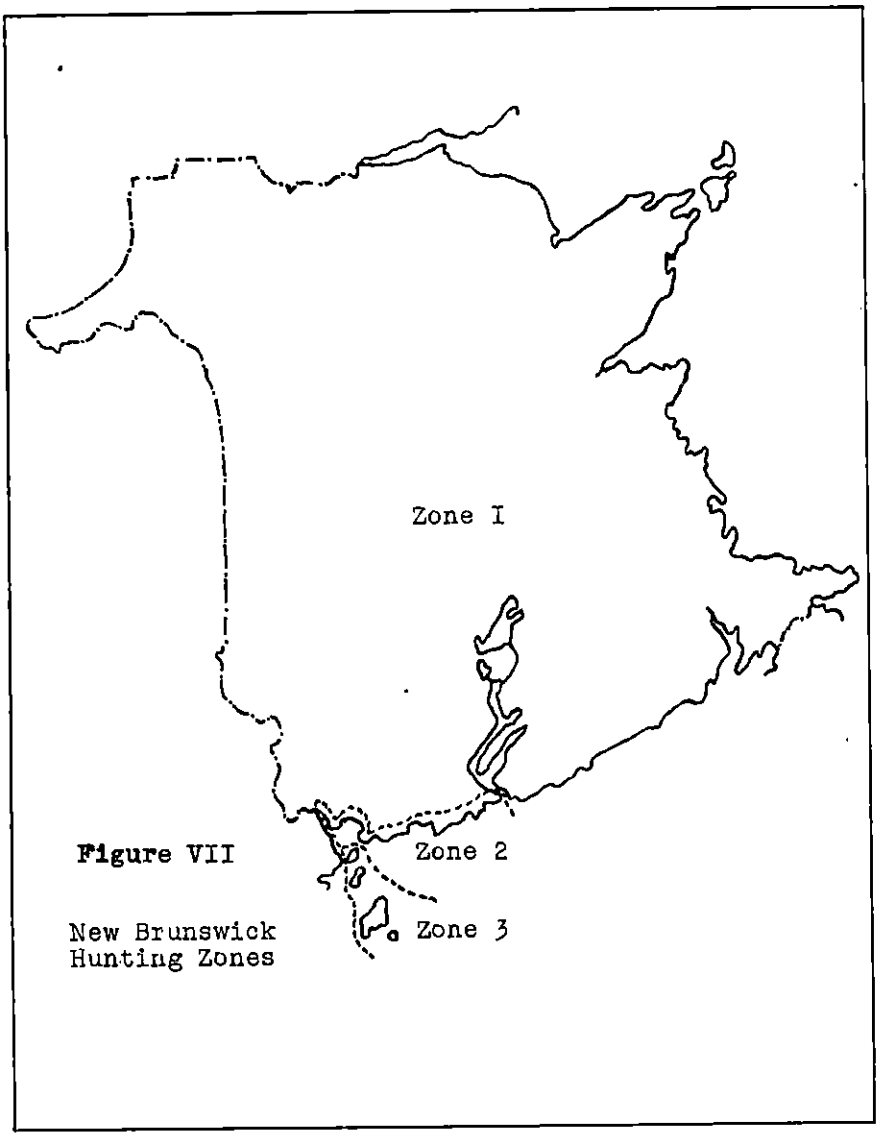


Figure VII

New Brunswick
Hunting Zones

Until the middle of the 1930's, when the duck population reached an all-time low, the goldeneye was not considered a game bird in the full sense of the word in New Brunswick. When other species became scarce in the Atlantic Flyway, the goldeneye was much more sought after than before as an inland game duck, and it thus acted as a buffer species for the black duck, whose numbers had declined greatly. Hunters discovered that goldeneyes provided very good shooting. That realization by the hunters in the northeastern part of the flyway has increased the kill of the species during the late part of the hunting season.

Bag Check

A hunter bag check was conducted on the study area during the years from 1946 through 1950 and a record made of the age, sex, and species of ducks shot. The number of goldeneyes shot and the percentage composition of the bag varied considerably in different years. For two years - 1947 and 1948 - they made up 39 per cent and 38 per cent of the bag, respectively. On the average of the five years, 19 per cent of the ducks shot on the Saint John River and in the vicinity were goldeneyes. Of the goldeneyes, 30 per cent were adults and 60 per cent were males. (Table VII.) Such proportions seemed fair as the population figures showed a preponderance of males both on the study area and among the migrants passing through it. The percentage of immature goldeneyes in the bag may have been a little high, but it did not appear high enough to effect the total population adversely.

Populations

In considering the goldeneye population, even in such a limited area as central New Brunswick, many factors must be taken into account. Because of the smallness of the area compared with the range of the American goldeneye, there is a considerable amount of "ebb and flow" of the breeding population from year to year. The figures gathered during the years of study show a trend, but do not indicate the actual numbers resident and produced in the area.

Table VII. Goldeneye Bag Tally 1946-1950, Fredericton Area, N.B.

Year	Male Ad.	Male Imm.	Female Ad.	Female Imm.	Total Male	Total Female	Total Ducks	Per Cent of Total Kill	Sex Ratio M.per 100 F.	Age Ratio Ad.per 100 Imm.
1946	1	13	1	11	14	12	26	10	117	8
1947	8	32	4	25	40	29	69	39	152	21
1948	8	11	1	17	19	18	106	38	105	32
1949	Nil	2	Nil	1	2	1	11	3	200[1]	0
1950	30	7	3(12)[2]	1	37	16	53	15	231	410[2]
Total	47	65	9(12)	55	112	76	265	19	147	45

[1]Not a true indication since samples small.
[2]Not a true indication since 12 females not aged.

Annual Census

An annual census of the study area has been carried out every year since 1945 to obtain a species trend. The dates selected for taking the census were early enough to exclude early migrants from the north, yet late enough so that most of the late broods were at the Class II stage or older. The dates best suited for the study area were from July 16 to August 17. Each day's run was carried out as nearly as possible on the same date each year.

The census work was conducted on foot and in a 17-foot square-sterned freighter canoe equipped with a five-horsepower outboard motor. A canoe that size has some disadvantages due to its bulk and weight, but it more than makes up for them by its steadiness and seaworthiness. Steadiness is especially required as at the time of the census, the emergent vegetation (especially the wild rice) is very high. It is impossible to see over it or through it for any considerable distance unless the observer stands up in the canoe.

The census-taking is done by tallying species, sex, and age of all ducks observed along all the shorelines of the study area. Most of it can be done by canoe but some must be done on foot. Care has to be taken that ducks are not counted twice as some species (among them the goldeneye) have a tendency to fly and settle ahead of the canoe. However, the census results are not expected to give the actual number of ducks populating the area, but to indicate a trend when compared with other years.

Sex Ratio

The average sex ratio during the five years (1946 through 1950) on the study area was 118 males to 100 females for the whole season. As the spring migrants passed through, the ratio of males to females was 160 to 100. The preponderance of males soon dwindled and during the early summer, the ratio was 70 to 100. Irregularities of the sex ratios during the early summer as shown in Table VIII are caused by more drakes moulting on the study area in some years than in others. That was particularly evident in 1947 when flocks of moulting drakes were observed. In the late summer and early autumn, the males in their eclipse plumage resembled

the females so closely that it was impossible to tell the two sexes apart with accuracy, so no sex count was tabulated. Late in the autumn, when the hunters' bags could be checked, the proportion of males had again increased, and they outnumbered the females by 147 to 100.

Table VIII. Early Summer Sex Ratios for the Study Area, 1946-1950.

Year	Male	Female	Sex Ratio	Totals
1946	23	29	80:100	52
1947	130	69	188:100	199
1948	22	127	17:100	149
1949	40	116	35:100	156
1950	64	60	107:100	124
Total	279	401	70:100	680

Productivity

To measure the annual productivity of an area, it is first necessary to know the approximate number of breeding adults occupying it. On the study area of 32,500 acres, it is impossible to arrive at an exact figure for the number of breeding pairs. However, an average for the five years from 1946 through 1950 of the number observed during the two nesting months, May and June, should give a fairly accurate approximation. As nest losses averaged 40 per cent (Kalmbach's (1939) generalized mortality data are used in the absence of specific data for northeastern Canada), the number of successful pairs should be about 60 per cent of the number of pairs observed. The number of broods multiplied by the number of ducklings per brood that reach flying age gives a fairly reliable figure for the productivity of the area. To bring that result to a workable figure from the management point of view, it is only necessary to divide it into the number of acres of breeding habitat.

An average (for the years from 1946 through 1950) of 319 adults was observed during the nesting months of May and June. Since the sex ratio at that time was 117 to 100 in favour of the males (a five-year average), there were 147 females available for nesting (46 per cent of 319). Assuming that all the females pair and mate, there were 147 pairs breeding on the area. The number of successful pairs was 60 per cent of 147 or 88. The average number of ducklings per brood reaching flying age for the five-year period was 4.8, that is, each successful pair produced 4.8 birds at the end of the brood season. In total this is 422 young goldeneyes per year.

On the study area, the habitat includes hardwood swamp (16,052 acres) and open water (2,117 acres), a total of 18,169 acres. On that area 422 young goldeneyes at flying age are produced, or one for every 43 acres. This represents a low rate of production, and there is no doubt that it could be higher if the breeding pairs returning north in the spring stopped to breed in greater numbers. If the area could be made more attractive, more pairs would probably do so, but probably at the expense of other areas farther north. The result might not be an increase in the total flyway population.

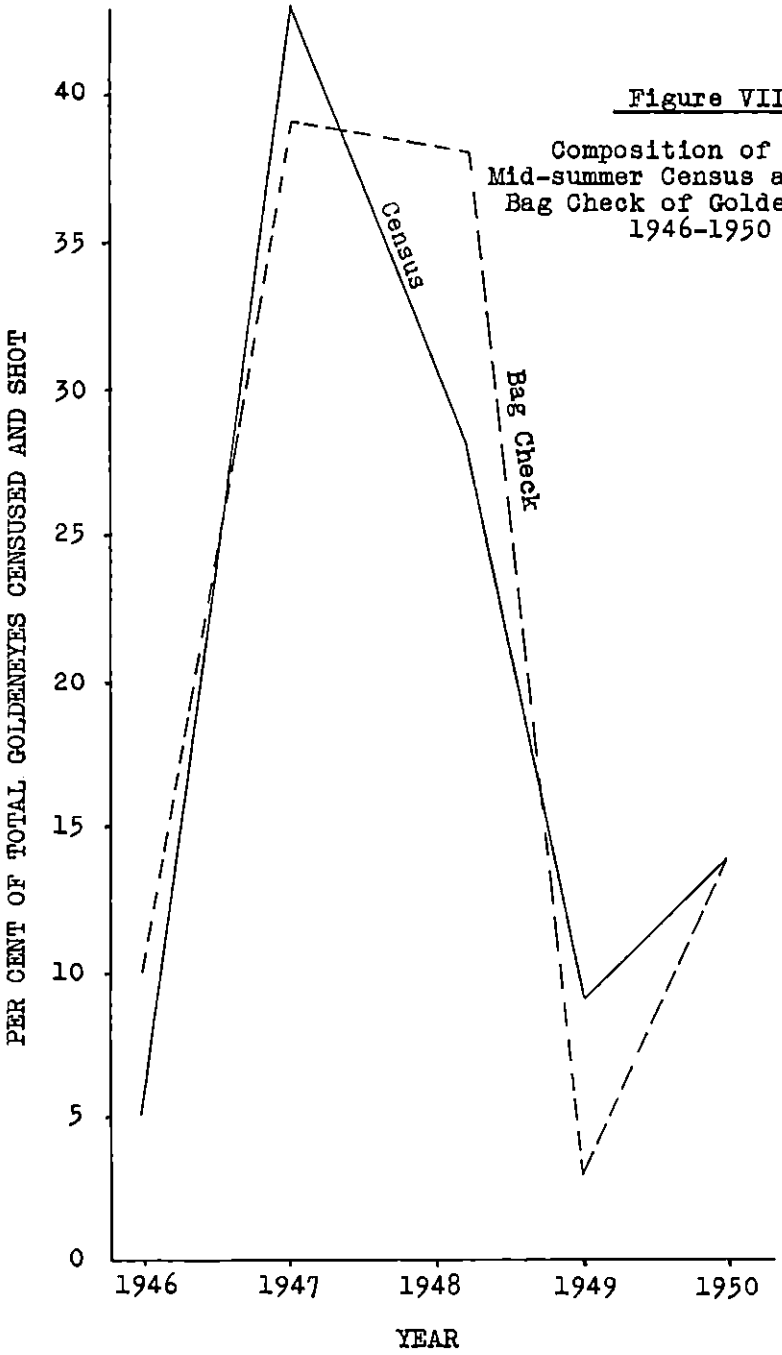
Control Factors

Many factors tend to reduce the population of the species. Adverse factors are imposed by the environment and by man. Some of these are controllable and some are not.

Hunting is a limiting factor on the species which is subject to control. To restrict the bag limit for any particular species is difficult, although it seems to have been fairly successful in the case of the wood duck. The number of goldeneyes shot during the hunting season in the study area varied with the number available as well as the weather and economic conditions. A high population produced a high number in the bag. Figure VIII compares the annual census with the bag check during the years from 1946 through 1950. Goldeneyes made up a larger percentage of the bag in central New Brunswick than in other areas. Mendall (1949) says that, in 1948, exclusive of sea ducks, Maine hunters shot more than 40 per cent black ducks, 18 per cent green-winged teal, and 9 per cent goldeneyes. That

Figure VIII

Composition of Annual Mid-summer Census and Annual Bag Check of Goldeneyes, 1946-1950



year goldeneyes made up 38 per cent of the bag on the study area in New Brunswick. Corresponding percentages in Maine were 12.6 per cent in 1949 and 4 per cent in 1950.

Other factors which could affect the goldeneye population on the study area are:-

(a) accidental death in muskrat traps;
(b) flooding of nests;
(c) predation by foxes, raccoons, mink, great horned owls, marsh hawks, pickerel, and snapping turtles.

Little or no evidence was found during the study of population losses by those agencies.

Blood from four juvenile goldeneyes, taken from the study area, was examined. Only one specimen was found to have Leucocytozoon anatis (Wickware) present. No other blood parasite was found in any of the specimens.

Suggestions for Further Study

(1) At present, very little is known about the migration routes of the goldeneye in eastern Canada. The locations of the areas supplying most of the goldeneye shooting along the eastern part of the Atlantic Flyway would help in directing management practices. Few goldeneyes have been banded in eastern Canada, due to the difficulty of catching them. In that region, diving ducks do not come readily to traps.

Goldeneye banding has been conducted successfully in British Columbia (Cowan & Hatter, 1952) by driving the birds into traps. This method has been tried both on the study area and on the Hampton marshes lower down the Saint John River Valley, but in both areas without success because adjacent water was too close. Goldeneyes take grain bait, and once they become accustomed to it, seem to have a slight preference for it. Half-submerged floating traps, baited with whole corn, might be used successfully in areas of high goldeneye population.

(2) A study to determine whether the condition of natural cavities is a limiting factor in the number of nesting pairs might be carried out. By improving

the number and condition of cavities in one area and using a similar area without improvement as a control, nesting preferences could be studied.

(3) The study of goldeneye food habits in freshwater habitats needs to be greatly expanded.

(4) More information is required about the effect of predation on the goldeneye. Predation during the breeding season may be more serious than believed at present. Predation by eagles, hawks, and owls on wintering goldeneyes along the coasts also needs further investigation.

(5) Further research on the life history of the goldeneye is required to determine the length of incubation period, the mortality from disease and parasites, and losses during the nesting period and winter.

(6) Hunter bag checks should be carried out at all major shooting areas to determine hunting loss and crippling loss.

Summary

A study of the American goldeneye (Bucephala clangula) in central New Brunswick was made over a five-year period from 1946 through 1950.

A 32,500-acre area on the estuary of the Saint John River was used for the detailed work of this study. This area includes lakes, river islands, marshes, cultivated lands, creeks, sloughs, and the main river itself. The area is flooded annually to a depth of about ten feet.

Goldeneyes arrived on the area about the end of March, and by the third week of April the peak of the northward migration had arrived. After that date the number declined until only the residents remained. Seventy-nine per cent of the goldeneyes were paired on arrival, but this percentage decreased as immature, unpaired birds arrived. The sex ratio during the spring flight was 160 males to 100 females.

The drake goldeneye did not appear to establish a true territory but rather a waiting area.

Goldeneye nests are found in cavities of rotten trees, or in holes excavated by woodpeckers. Other nesting sites are unused chimneys, deserted buildings and the occasional nesting box.

Completed clutches observed on the study area averaged nine eggs per clutch. Unhatched eggs accounted for 3.8 per cent of all the eggs found.

After hatching the ducklings spent the first week in the vicinity of the nest; later they were found along the shores of the larger bodies of water where the emergent vegetation provided cover.

The first goldeneye broods appeared on the study area about the third week in May and few broods were seen after the second week in August. The average brood size for 1945 to 1950 for Class I ducklings was 6.2; for Class II, 4.7; and for Class III, 4.8. From the age of one week to attaining flight, there was a reduction in brood size of 22.5 per cent: the total loss from the time that the successful clutch was completed until the brood was flying was 47 per cent. The data indicate that young goldeneyes were 50 to 65 days old when flight was attained.

The goldeneyes were late autumn migrants and stayed on the study area until the ice drove them out. The general direction of their migration was southward and southeastward and from the inland waters to the coast.

The average for 1946 through 1950 showed that goldeneyes made up 19 per cent of the hunters' bag in central New Brunswick. Of this 19 per cent, 32 per cent were adults and 60 per cent were males.

An annual census showed that the goldeneye population reached a peak in 1947, declined to 1949 and recovered slightly in 1950.

The annual productivity of the study area was low. One goldeneye at flying age was produced for every 43 acres of breeding habitat.

Factors which appear to limit in varying degrees the goldeneye population of the study area were hunting, accidents, predation, and parasites.

Suggestions are made for future studies that may be of aid in the management of the American goldeneye.

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