Activity of Black Ducks nesting along streams in northeastern Nova Scotia

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Introduction

McKinney *et al.* (1978) stated that most *Anas* species, at some time during their lives, use rivers for some of their requirements. They describe the behaviour of the African Black Duck *A. sparsa,* a river specialist that finds all its breeding requirements on permanently defended territories, and whose river specialisation has significantly influenced its social system.

In northeastern Nova Scotia Black Ducks *A. rubripes* use estuaries extensively during the non-breeding season. However, pairs breed in two main habitats, 1) nesting, foraging, occupying territories, and rearing broods entirely in estuaries, and 2) nesting and occupying territories inland along streams (and in fresh water marshes usually associated with streams), but foraging primarily in estuaries and rearing broods in either streams or estuaries. Breeding activities and behaviours of birds using an estuary have been described previously (Seymour & Titman 1978, 1979), together with details of the marsh and the duck population. This paper deals with pairs using streams.

Study area and methods

The study area consisted of four streams and a 170-ha *Spartina* marsh that they entered at the upper end of a tidal estuary which flowed into St. George's Bay in northeastern Nova Scotia (Figure 1). Black Duck ecology and behaviour have been studied on this marsh since 1972 (Seymour & Titman 1978, 1979).

Except at its periphery, where territories were established in small ponds, the marsh was a communal feeding area, characterized by large, shallow bays and channels interspersed through cordgrass.

The streams were shallow and fast flowing and normally free of ice from early March until mid-December. Flooding was usual during spring and autumn but rare and limited to a few days during the breeding season. Streams varied in width from 20–30 m during April, May and June, but frequently dwindled to a trickle in July and August, as in 1976. Except where streams flowed through agricultural land, trees and shrubs covered the banks to the water's edge, but did not form a canopy over the river. Like most rivers in northeastern Nova Scotia, these streams were nutritionally impoverished (K. Mann, pers. com.); insects with aquatic larval stages began to emerge about mid-May and continued into early September, forming the main sources of animal food.

The duck population was censused throughout the year, while intensive observations were made from early March to early August, 1976-1980. In the marsh, a permanent 8-m observation hide overlooked many of the bays and channels, whereas portable hides were erected along streams wherever broods were located.

During January and February 1978 and 1979, about 500 ducks were trapped in the marsh in wire-mesh traps baited with grain. These birds were marked with plastic wing markers or nasal saddles and released at the trap site. During July and August, trained dogs were used to capture ducklings, females and moulting birds in the marsh, and the larger ducklings were marked with wing tags. No attempt was made to trap birds along rivers, but some of the birds marked in the estuary dispersed there.

The activity of marked birds was observed whenever they were encountered; some territorial males were observed for at least part of the day for several days in succession, and usually observed continuously until they flew away. In addition, four days each week were devoted to continuous observation of birds. Observations totalled 364 hrs along streams and 212 hrs in the estuarine marsh.

Surveys were conducted along rivers every two days from 1 April to 1 June (1977 and 1978) to search for territorial pairs. Helicopter surveys during April and May 1972-79 provided additional information on the location of birds and territories and on the timing of various activities. Helicopter surveys during July of those years helped to

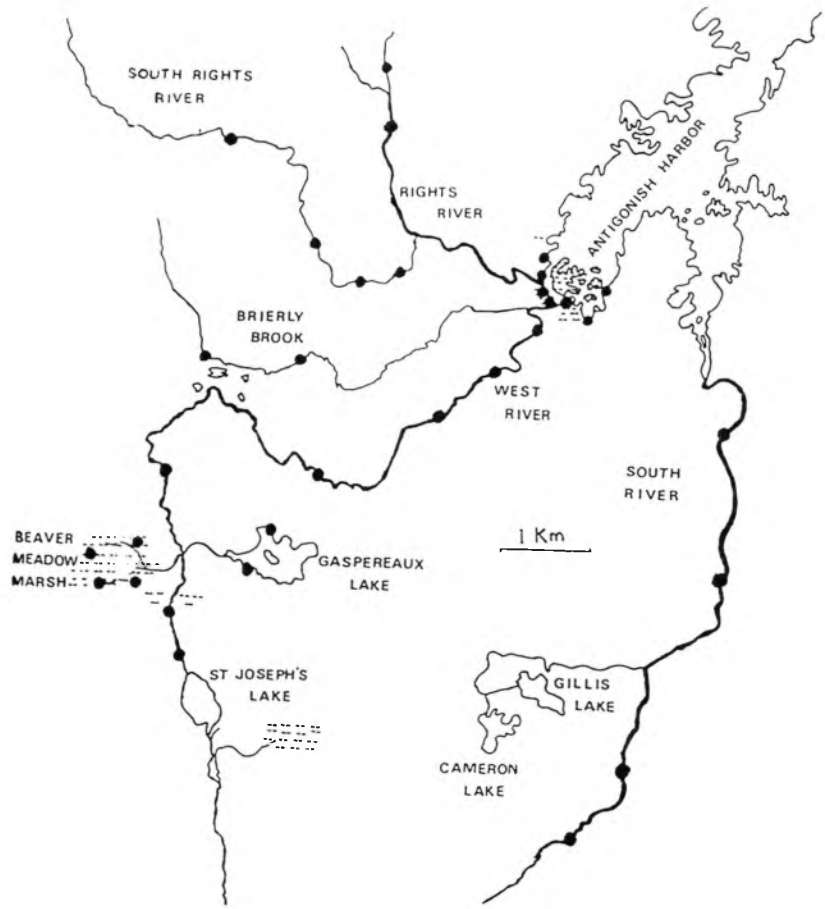

Figure 1. Location of territories in the three major nesting habitats (freshwater marsh, saltwater marsh, stream) on the study area in northeastern Nova Scotia during 1978.

document the distribution of broods along rivers and in the marsh.

Results

Sightings and recaptures of 22 marked birds showed that some of the birds in this population remained in the area all year. They spent from November until March in the ice-free lower estuary, and moved into the marsh when it became free of ice in mid-March. Migrants returned in mid-March and also congregated on the marsh. Pairs began to disperse from here into breeding habitat during the last week of March in each year (1972-1979). The onset of egg laying ranged from 20 March to 15 May. Most females began laying during the period 10-20 April, despite annual variation in weather conditions.

Activity of pairs in the estuary marsh

Stream-nesters did not trespass on territories at the periphery of the marsh, but stayed on the communal area at its centre. Such pairs did not differ in loafing, foraging or aggressive behaviour from the estuarine pairs described previously (Seymour & Titman 1978).

Prior to dispersal to territories, pairs foraged within 25 metres of each other and sometimes (n = 8) joined together in flocks during periods of inclement weather. Even when most pairs held territories elsewhere, hostility on the marsh occurred infrequently, although pairs appeared to avoid each other. Occasional chasing between paired males rarely developed into fighting and there were no pursuit flights. Most disruption of the activities of pairs on the communal area was by unpaired males that

attempted to court paired females (Seymour & Titman 1979). Unpaired males usually (34 of 42 observations) joined pairs that came from inland and landed on the communal area.

Foraging was the major activity of stream-nesting pairs on the communal area whenever they were there in the breeding season. Males spent their time within a few metres of their mates when foraging. They were alert and usually suspended foraging when other pairs or unpaired males were nearby, as was true for estuarine pairs. Stream-nesting pairs spent the night on the marsh during the pre-laying period and probably during all but the last few days of laying. They foraged continuously from dawn until approximately 08.00 to 09.00 hrs and immediately after foraging went to their territories, returning between 16.00 and 17.00 hrs. After the end of April, however, some pairs delayed their return to the estuary until later in the evening, finding food in pasture ponds nearer their river territories.

There was a general increase in activity on the marsh during the period when females began laying. Foraging ceased about 20 min before dark and during the last 15 min before dark, pairs and unpaired males flew about the marsh. Both female decrescendo calls and male "raab" calls were heard. This high level of activity and calling occurred between 5-20 April 1977-79 and more than 80% of calling heard on the marsh during the entire year (1978) occurred then. Throughout 1978, 95% (n = 386) of daily decrescendo and "raab" calling occurred in the last 15 min before dark. Persistent quacking by females was heard when they searched for nest sites and occurred throughout the day.

Establishment of territories and nest sites

Early in March, before dispersal into nesting habitats, pairs made flights from the marsh along rivers. These appeared correlated with weather, as most occurred on mild sunny days. Pairs remained in the estuary during cold, windy days, particularly when it snowed. The frequency of flights peaked in the first two weeks of April, during which time pairs were seen exploring for nesting cover in wooded areas and fields along rivers. Only occasional (<10%) territorial pursuit flights were seen before 10 April but in the next 10 days, most (>90%) territories and nest sites were established.

Prior to establishing territories, pairs were very mobile. They explored quiet backwaters, pasture ponds beside streams, and adjacent nesting cover in woods and fields.

Pairs spent only 1–2 hrs along streams during March, presumably because females foraged heavily in the estuary during the pre-laying period. Pairs frequently moved from one stretch to another, deserting areas unoccupied by other pairs for no apparent reason. During early April, pairs spent more time on rivers and males chased other pairs whenever they were encountered. Approximately 7–10 days before laying, females began to use specific stretches of rivers, and their mates defended these sites against other pairs, even when the females were on nests. While females were still searching for nest sites, males followed their mates when the latter moved elsewhere on the river. One male chased pairs from a stretch of river on 6 occasions in 3 days while he waited for his mate who was searching for a nest site. He then left this area to follow his mate and eventually established a territory 3 km away.

The earliest territories were established within 5 km of the estuary and hostile encounters between territorial males and pairs searching for nest sites occurred there. Spacing of pairs occurred over a dramatically short period. Most (28 of 32) encounters in 1978 occurred between 10–20 April; a similarly high percentage of encounters occurred during this period in 1976 and 1977.

Pursuit flights by territorial males

The pursuit flight was the main manifestation of territorial defence. In general, males that defended territories on the streams were involved in very few flights. Twenty-three territorial males (observed for 312 hrs during 1976, 77, 78) were involved in only 72 pursuit flights, compared with 12 males in the estuarine habitat that were involved in 132 flights during 314 hrs of observation in 1973 and 1974 (Seymour & Titman 1978). In fact, no stream-nesting males were recorded in more than 6 flights throughout the territorial period, and 3 males which were >12 km upstream from

the marsh were never seen to encounter other pairs. Limited visibility and commuting distance of stream-nesting males may have reduced, in part, the frequency of pursuit flights.

However, flight frequency in the estuary and stream habitats were not strictly comparable, for although more pairs nesting in the stream habitat, they were well spaced while estuary nesters were concentrated in a relatively restricted area. The highest frequency of pursuits in the estuary was in the laying period but most flights in the stream habitat occurred during the prelaying period. Dwyer (1974), Smith (1968) and Seymour (1974) found most pursuits in Gadwall *A. strepera*, Pintail *A. acuta* and Shoveler *A. clypeata* occurred during prelaying. During incubation, stream-nesting males were seldom on their territories and were not observed in pursuit flights.

While the highest (>80%) daily frequency of flights in the marsh occurred from 05.00–08.00 hrs, in the river habitat it was from 08.00 to 11.00 hrs. The difference reflects the fact that pairs stopped feeding in the estuarine marsh between 08.00 and 09.00 hrs, and only later did some move to rivers.

Flights at the stream sites were practically identical to those by territorial males in the estuary marsh, and the slight differences observed probably reflected the difference in habitat. Flights by inland males lasted from 23 to 125 seconds (median 33.5 s as opposed to 23.5 s for estuarine pairs). Flights of long duraton in the estuary were caused by females that repeatedly returned to territories of other pairs. However, the generally longer flights by river males rarely (5 of 72 flights in 1976–1978) involved persistent females but reflected the fact that before males could approach intruders, they had to rise vertically for 25 to 30 m to get over the trees on the river bank. In general, chasers did not approach as closely to intruders as they did in the estuary because pairs were several hundred metres away by the time the chasers rose above trees on river banks, and because most intruding females flew away immediately.

Only intruding pairs were chased and were intercepted as they flew over (52 flights) or as they attempted to land (20 flights); none actually landed on territories, or closer than 0.5 km from the territories of the chasers. Most (60 of 72 flights) flew upstream and avoided territories after being chased. Fast moving pairs that were flying to or from the estuary were not chased. Despite the fact that pursuits did not extend beyond 350–400 m, territories were generally more widely spaced (Figure 1).

Males showed no reluctance to leave their mates to chase intruders over streams for up to 2 min. However, these same marked males did not leave their mates to chase when in the estuary where birds were more numerous; there they occasionally rushed a few m towards other birds but immediately returned to their mates. Six of the first pursuit flights observed in 1978 involved the territorial pair, the female lagging 30 m or more behind the three main participants. In each case, the chasing pair had left the area by the next day and subsequently established territories elsewhere. After pursuit, chasers always returned to their territories, sat alertly for several minutes with head held high, and sometimes produced "raab" calls (cf. Abraham 1974).

Males which defended territories in the estuary sometimes attempted to force copulation on strange females before and/or after pursuit flights. Stream-nesting males did not make such attempts when on the communal area of the marsh (316 hrs of observation) before or after they deserted their mates.

Characteristics and utilization of territories

Ponds at the periphery of the estuary marsh were the most assiduously defended areas. There were no such ponds along rivers, but most (45 of 53) territories included small backwaters or expanded stretches of quiet water that were similar in form to estuarine ponds. Males probably defended any stretch of river frequented by their females. During 1978 (Figure 1) and other years, there was a greater density of territories in the marsh (7 along 2 km of shoreline) than along streams (19 along 33 km).

Males used one or two main loafing sites while waiting for their mates during the laying period; these were sometimes logs or rocks which protruded above the surface of the stream but more frequently (267 of 312 hrs of observation) males sat at two or three locations on the river bank. These loafing sites were close together and more than 85% of time (23 males observed for 312 hrs in 1976–78) was spent within 150 m of these sites. Females always (26 observations)

returned to these sites when they left their nests. Males almost never left the streams. A similar restricted use of space within territories had also been seen in estuary nesters (Seymour & Titman 1978).

One male that spent >90% of the 27 hrs observed along 150 m of river, on 4 occasions chased pairs from three ponds which were approximately 125, 225 and 275 m distant. Estuarine pairs exploring for nest sites initiated nest-searching activities from water bodies and did not fly directly into nesting cover. This may be the case with stream nesters also, and by driving pairs from ponds and stretches of stream in the vicinity, males prevent other pairs from nesting nearby.

The approximate flight path of pairs from territories to the estuary was calculated and the farthest territories in the stream were 3.25–6 km from the estuary. The distances that broods would have to travel along streams from these territories were 3.5–7.75 km. Thus, the farthest pair from the estuary was within 15 min flight time, and the farthest broods were within 4–5 days' swimming time of the estuary.

The time spent on territories varied through the season. Prior to laying, pairs remained there for only 2 or 3 hours each day; this was usually (>80%) between 09.00 and 14.00 hrs, with the remaining time spent on the marsh. Loafing was the main activity of pairs on territories. Foraging in the river occurred infrequently and return to territories from the estuary was after bouts of foraging there. Pairs spent considerable time flying low over potential nesting cover searching for nest sites. Most (19 of 21) of the copulations that were observed during the week preceding and during egg laying occurred on territories and not in the estuary.

During laying, pairs were on territories most of the daylight hours; this was exlusive of time spent on nests by females. When these left their nests around midday, they joined their mates and then immediately flew to the estuary to feed. Pairs apparently spent the night in the marsh, as they did during the pre-laying period, and returned to territories between 08.00 and 09.00 hrs. Males loafed or foraged while waiting for females; waiting males left their territories only if disturbed by predators. On 12 occasions, males flew about their territories calling.

When females were off their nests during the incubation period, they spent their time loafing, rarely foraging, on their territories (18 hrs of observation). However, they also flew downstream, presumably to the estuary to forage, even after their mates had deserted them. Territorial males spent less and less time on territories; some males were not seen at all during incubation. These males joined other males on the estuary marsh and remained on the communal area. At least some males remained there to moult. Stream-nesting males appeared to desert their territories and mates by the end of the first week of incubation, rather than mid-incubation as had been found in estuarine pairs (Seymour & Titman 1978). This may have been because stream males spent considerable time in the marsh, which was several km away from their territories; estuary males were rarely more than 0.5 km from their territories. Males in the estuary were on territories for 27–32 days, but inland males only for 20 to 25 days.

Activity of females and broods in streams

Most broods were initially seen in the first week of June and consisted of 1–2 week-old birds. Nests were not in the territory. Broods were very mobile and did not remain on territories and some broods apparently did not go to the territories at all. Females sometimes took their broods to pasture ponds near rivers. One female moved her 3-week-old brood 275 m from the river to a 1-ha pond and remained there for approximately 1 week before going back to the river. Ponds were usually exposed and had little suitable cover from predators. Females usually spent time on ponds only during daylight.

Feeding was the major activity of broods and availability of food probably was the main determinant of their location and the duration of occupancy of streams and estuary by broods. Females kept their broods in backwaters or ponds for 2 or 3 days, especially when rain temporarily increased the flow in streams. In 1977, water remained high and 3 females stayed on the West River until their young fledged. However, most (29 of 33) females on reaching 0.5–1.00 km per day, and arrived at the estuary when their young were 2–3 weeks old.

Ducklings usually stayed within 5–10 m of females and foraged primarily at the sur-

face, occasionally chasing insects across the water or picking at insects on vegetation overhanging streams; ducklings did not penetrate shoreline vegetation to feed.

Broods showed no obvious pattern of spatial dispersion on streams. On 30 occasions, broods were within 100 m of each other. Females and broods showed no obvious hostility, but moved away from each other or remained stationary.

Response of females and broods to predators

McKinney *et al.* (1978) suspected that stream dwelling African Black Ducks are susceptible to attack by predators because streams are noisy and terrestrial cover is dense. This was probably the case in Nova Scotia also, despite the fact that there appeared to be very few diurnal predators along streams. Great-horned Owls *Bubo virginianus* and Bald Eagles *Haliaeetus leucocephalus* were commonly observed and probably the most serious avian predators.

Prior to the brood period, males and/or females swam out into the middle of streams at the approach of raccoons *Procyon lotor* (n = 6), but when disturbed by humans (24) they immediately flew, usually upstream, and often to nearby ponds. Birds followed raccoons until they left the streamside, remained alert for 20 minutes or more and usually remained in mid-stream. Twice when raccoons approached females with two-week-old broods, the females became alert and held their heads high and called quietly; the ducklings clustered near the females and together they swam away in mid-stream. One brood, separated from the female and surprised by a raccoon, immediately hid in shoreline vegetation until rejoined by the female.

On 15 occasions, I myself surprised females and their broods at approximately 50 m. Females held their heads high, ducklings clustered around them and together they rapidly swam away. Twice broods and females swam around a bend in the stream and the young immediately hid in the streamside vegetation on the opposite bank. The ducklings remained in the vegetation until the females returned. On 6 occasions, I walked within 10 m of hiding ducklings; they immediately rushed across the surface of the stream. I encountered females and their broods at distances of more than 100 m on 12 occasions. The young immediately went to the vegetation on the closest bank and the females flew over me, landed within approximately 30 m and flapped away quacking loudly.

Activity of females and broods in the estuary marsh

Most (21 of 29) broods arrived on the communal part of the estuary marsh during the first week of July, and were most frequently seen at the water–vegetation interface where they foraged. In general, females with broods moved extensively, but occasionally loitered in one location for two or three days.

There was a greater density of potential predators in this (170 ha) marsh than along the streams. Although approximately 35 pairs of Osprey *Pandion haliaetus* regularly foraged there from mid-April until mid-September, I never saw one hover over or swoop at adults or ducklings. Black Ducks fly as Ospreys approach when Ospreys first arrive on the study area in mid-April. However, by early May, these same Black Ducks do not interrupt their activities when Ospreys approach, even within 25 m. At least three pairs of mature and six immature Bald Eagles regularly hunted and scavenged on the marsh throughout the year (1976–79). On 9 occasions, eagles hovered over and swooped at ducklings and adults. Ducklings remained in or quickly swam to vegetation when eagles were detected at a distance (n = 16) but when they were surprised (n = 11) by eagles, they initially dived and then surfaced and rushed across the surface into the vegetation. Moulting females usually dived immediately but when eagles hovered above them, they swam, often partly submerged, toward vegetation. I never observed eagles capture ducklings or adults during the breeding season, but I have seen (n = 4) eagles capture adults during winter periods of extreme cold when ducks take flight more reluctantly. Ducks remain wary of eagles although they apparently habituate to Ospreys.

The estuary was also the foraging site for about 100 Great Black-backed Gulls *Larus marinus* and about 200 Herring Gulls *L. argentatus*. Also, 10–15 Great Blue Herons *Ardea herodias* and several Ravens *Corvus corax* regularly foraged there. Although I never saw these species capture

adults or ducklings, Ravens frequently (17 occasions) hovered over ducklings and/or swooped down at them; the ducklings dived and then surfaced and swam to the vegetation. Evidence from tracks suggested that foxes and raccoons frequented the marsh. During 1979, at least one Great Horned Owl hunted on the marsh at night and killed seven banded adults when it gained access to a trap.

Intensive helicopter surveys, coupled with land observations, revealed the disappearance of some broods. It is unlikely that these broods moved since they were not found in adjacent habitat and the marsh is the destination of mobile broods. In 1978 only 2 of 17 broods maintained their original numbers and 4 disappeared completely.

Discussion

Black Ducks in northeastern Nova Scotia primarily use two breeding habitats. Freshwater marshes are available but largely unused. Estuary marshes have a relatively stable and plentiful food resource available to ducks throughout the breeding season but contain high densities of predators, conspecific pairs and unpaired males. Inland streams are nutritionally poor and unpredictable during the breeding season but have a relatively low density of predators and conspecifics.

Male Black Ducks could probably establish and maintain territories comparatively easily along streams because of the abundance and isolating character of stream habitat. Stream nesters avoid the more intense competition for nesting habitat seen in pairs using the estuarine marsh, and seclusion along streams helps females avoid the attention of unpaired males which often disrupt their activities on the communal area (Seymour & Titman 1979). Although adequate food may not be available in streams, territories there are rarely more than 15 min flight time away from the food-rich estuary.

The main advantage of nesting along streams may be a decreased density of predators of ducklings. In addition, nests and broods are more dispersed along streams and hence not as vulnerable to predation as in the estuary marsh. When food is available, broods can take advantage of it with a minimum of competition from other broods. If food shortages force females to take their broods to the estuary, the farthest broods must make only a 3–4 day trek.

The selective advantages of territory are very different in the river specialist African Black Duck and those non-specialized North American Black Duck that select river habitat for breeding. In the African species, seclusion derived from defending well defined territories (Ball *et al.* 1978) appears to be important in maintaining exclusive access to resources, probably primarily food, throughout the entire year (McKinney *et al.* 1978). Reproductive success is linked to maintenance of permanent territories and this is presumably why the African species vigorously defends a specific site against all conspecifics. In contrast, the short tenure and lack of vigour of territoriality in the North American species suggest that food, which is obtained by adults in the estuary and by ducklings outside the territory, is relatively unimportant in the adaptive significance of their territories.

In a motivational sense, male Black Ducks probably remain on territories because their mates spend most of their time there when off their nests and return there when separated from males. Males are thus nearby and ready to copulate whenever females are receptive. Defending the site against conspecifics reduces the chances of insemination by other males through forced copulation; these males accompany their mates for six weeks or longer before egg laying begins.

Males desert their territories and mates early during incubation, indicating that attendance of mates serves mostly to prevent insemination by other males rather than to assist in the foraging of the females.

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Summary

Activities of stream nesting Black Ducks *Anas rubripes* were studied in northeastern Nova

Scotia, Canada. This involved observation of pairs and broods. Birds used the associated estuary to feed and females took broods there. Males defended territories along streams but left territories and mates early in incubation. The pursuit flight was the main mechanism of territorial defence.

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