

## LOCATION OF FORAGING ACTIVITY BY BLACK DUCK (*ANAS RUBRIPES*) BROODS IN A NOVA SCOTIA ESTUARINE MARSH

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Use of habitat for foraging by black duck (*Anas rubripes*) broods was investigated in a Nova Scotia estuarine marsh during the 1988 brood rearing season. Some data for other years are reported. Algal and flowering plant species, water chemistry and several physical factors such as depth of water and degree of exposure to wind/tide, were recorded for each of 51 sampling plots (15 x 15 m). Ducklings were nonrandomly distributed in the marsh. Principal component analysis (PCA) of utilized sites alone, indicated a relationship between duckling distribution and the presence of floating algal mats, which included species of *Rhizoclonium*, *Cladophora*, and *Ectocarpaceae*. Prior to the appearance of algal mats in late June, ducklings were not associated with specific vegetation types, but were associated with sheltered sites.

On a examiné l'usage de l'habitat en but de fourrager par des couvées du canard noir (*Anas rubripes*) dans un marais de la Nouvelle-Ecosse en 1988 durant la saison de l'élevage des couvées. Des données se rapportant à d'autres années sont aussi présentées. On a rapporté les espèces d'algues et des plantes à fleurs, la chimie de l'eau, et quelques facteurs physiques tels que la creuseur de l'eau, et le taux d'exposition au vent et aux marées pour chacune des 51 parcelles d'échantillonnage (15 x 15 m). Les canetons n'étaient pas distribués au hasard dans le marais. Une analyse des composants principaux des lieux utilisés a démontré un rapport entre la distribution des canetons et la présence de tapis d'algues flottantes comprenant des espèces de *Rhizoclonium*, de *Cladophora*, et des *Ectocarpaceae*. Avant l'apparition des tapis d'algues (vers la fin de juin), les canetons n'étaient pas associées avec des types spécifiques de végétation, mais démontraient un rapport avec des sites abrités.

### Introduction

Many workers have studied habitat use by ducks, but there are few studies on brood use of habitat for foraging (Bengtson, 1972; Sugden, 1973; Ringelman and Flake, 1980). Reinecke (1979); Ringelman and Longcore (1982) and Hickey and Titman (1983) investigated aspects of the ecology of black duck (*Anas rubripes*) broods, but the study by Courcelles and Bédard (1979) is the only one to report details of use of a fresh water marsh by broods of dabbling ducks (Anatini), including the black duck. They showed that broods preferred habitat characterized by specific aquatic plants and correlated this with physical and chemical features of the habitat.

MacLean (1988) studied black duck brood mortality in a Nova Scotia estuarine habitat, but no attempt was made to correlate habitat use with plant community types. Our study was done on the same marsh and the objectives were to determine the location of foraging activity by black duck broods throughout the brood rearing period, to test the hypothesis that broods were randomly distributed within a zone of frequent use, and to attempt to link foraging activity to specific patterns of vegetation.

### Materials and Methods

The study area was a heterogeneous 1.5 km<sup>2</sup> tidal marsh at the N.W. end of a 10 x 2 km estuary that drains a 750 km<sup>2</sup> watershed into St. Georges Bay in the outer St.

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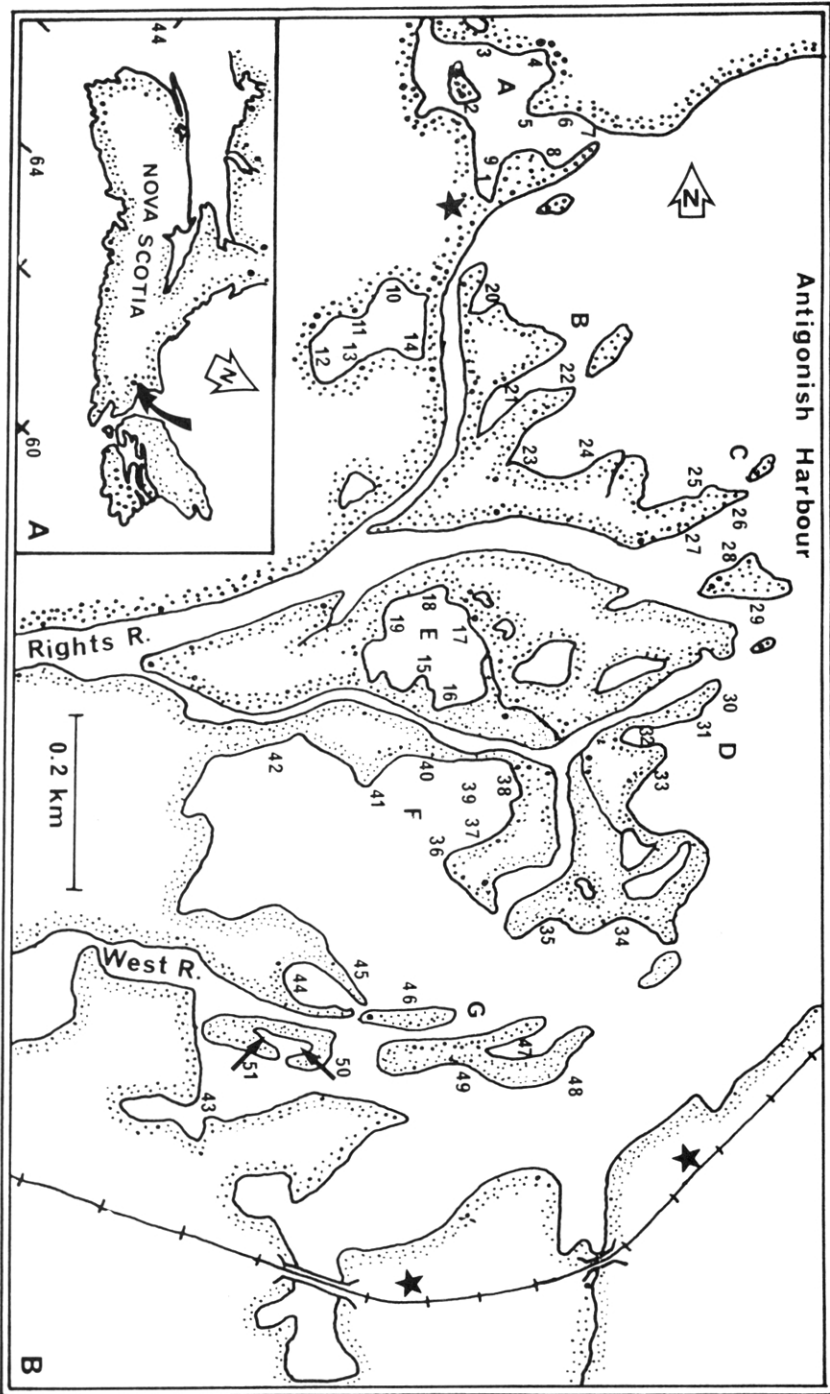


Fig 1 A) Map of Nova Scotia with arrow indicating general location of Antigonish Harbour. B) Detail of *Spartina* marsh at head of Antigonish Harbour showing locations of sampling sites. Note groupings of sites A-G. Stars indicate observation points.

Lawrence River estuary near Antigonish, Nova Scotia (Fig 1). Several topographically distinct areas of the marsh can be identified according to water depth, extent of tidal influence, sediment composition, degree of exposure to wind/wave action and availability of cover that provided ducklings protection from predators and/or severe weather.

Except for two river channels and associated small backwaters and gullies, the upper part of the marsh was a continuous, dense stand of largely terrestrial vegetation (trees, shrubs, herbaceous plants and grasses). This gave way to an inter-tidal zone of predominantly emergent plants dominated by *Spartina alterniflora*, and associated *S. patens* and *S. pectinata*, *Juncus* spp. and *Carex paleacea*. Much of this zone held permanent water, or experienced periodic tidal flooding. Dense stands of submergent vegetation, predominantly *Potamogeton* spp., and an associated complex of algae *Cladophora* spp., *Enteromorpha* spp., *Rhizoclonium riparium* and *Spirogyra* sp.) characterized the open water for 50-100 m beyond the highly indented marsh edge, and in the coves, ponds, inlets and 5 permanently water-filled tidal pools at the periphery (Fig 1). Algae formed floating mats over the pond weeds after mid-June. Fig 1 shows the indented ( $\approx 15.25$  km) nature of the interface between water/vegetation in the outer  $\approx 70$  ha of the marsh where most brood activity occurred.

Each year, from 1972 - 1988, the marsh was used for brood rearing from late May until late August by several females ( $\bar{x} = 11$ , range 8-16). More information on this population of black ducks can be found in Seymour and Titman (1978, 1979) and Seymour (1984).

*Field Studies* Regular monitoring of the marsh provided a profile of seasonal changes in vegetation. Prior to the appearance of broods, fifty-one 5 m<sup>2</sup> sites were selected and delineated (Fig 1). Sites were either over open water, or at the interface between emergent vegetation and water. Samples of algae and flowering plants, as well as water samples for chemical analysis, were taken at each site during 3 periods (7-14 June, 13-21 July, 15-25 Aug.). Random samples of algae were identified for each plot. All submergent and emergent vegetation was removed from 3 randomly selected 0.25<sup>2</sup> quadrats within 3 m - long strips at the interface ( $\approx 1.5$  m of water/1.5 m of marsh) of each plot. Vegetation was taken to the laboratory where wet biomass, and approximate density of each species were determined for each quadrat.

The distribution of 15 broods (70 ducklings) was determined during road transects that allowed complete surveillance of the part of the marsh used for foraging by broods. Transect observations of broods were related to the plots used to collect environmental data. Only location of foraging activity was examined and potential resting areas were not observed. Ninety-three transects (160 h observation) were made over the entire brood-rearing period. Most transects were conducted during the daylight hours of early morning or evening when broods on this marsh forage most actively (Seymour unpublished observation). The number of ducklings present, and whether they were foraging or resting were recorded during each transect. It was determined that birds were foraging by observing their behavior for periods of 10-45 min. Frequently several broods could be simultaneously observed. No attempt was made to determine either food selection, or availability of food. A subjective value, where 5 indicated high exposure on a scale of 1-5, was used to estimate wind/wave action at each site. Additional data presented in the results section of this paper were collected in 1983, 1986, 1987 during studies and of breeding black duck pairs. The same transects and schedule of monitoring birds used in this current study was used then.

*Data Analysis* Morisita's index of dispersion (Zar, 1984) was used to test for non-random distribution patterns of broods. The significance of the resulting values was investigated using standard chi-square tests. Principal component analysis (PCA) (Sneath and Sokal, 1973; Clifford and Stephenson, 1975; Seber, 1984) was used to

further discern spatial variation among sites. Principal component analysis selects a sequence of (linear) combinations of the (random) variables which explain a large proportion of the total dispersion of the sample covariance matrix. The first principal component has or explains the maximum variance among all possible (linear) combinations of the variables while subsequent principal components have or explain the maximum variance among all possible (linear) combinations of the variables which are uncorrelated with previous principal components. The distance measure used was standard Euclidean metric. PCA was carried out using algorithms in Systat (Wilkinson, 1986). Analysis was done on data sets containing presence or absence information for each of the algal and higher plant species, pH, salinity, temperature, and the subjective shelter values for each sample site. Further analysis utilizing quantitative measures of higher plant density and wet biomass were also carried out.

### Results

Although the area of marsh and tidal pools was 150 ha, almost all foraging occurred in the outer 70 ha, as was noted during studies of black duck broods in 1983 (216 h observation of 12 broods), 1986 (309 h observation of 16 broods), and 1987 (301 h observation of 18 broods). However, foraging activity was restricted to a 5 m wide zone at the interface of emergent vegetation and water, except for forays of up to 30 m from the edges, over mats of vegetation in July and August. Indeed, most foraging

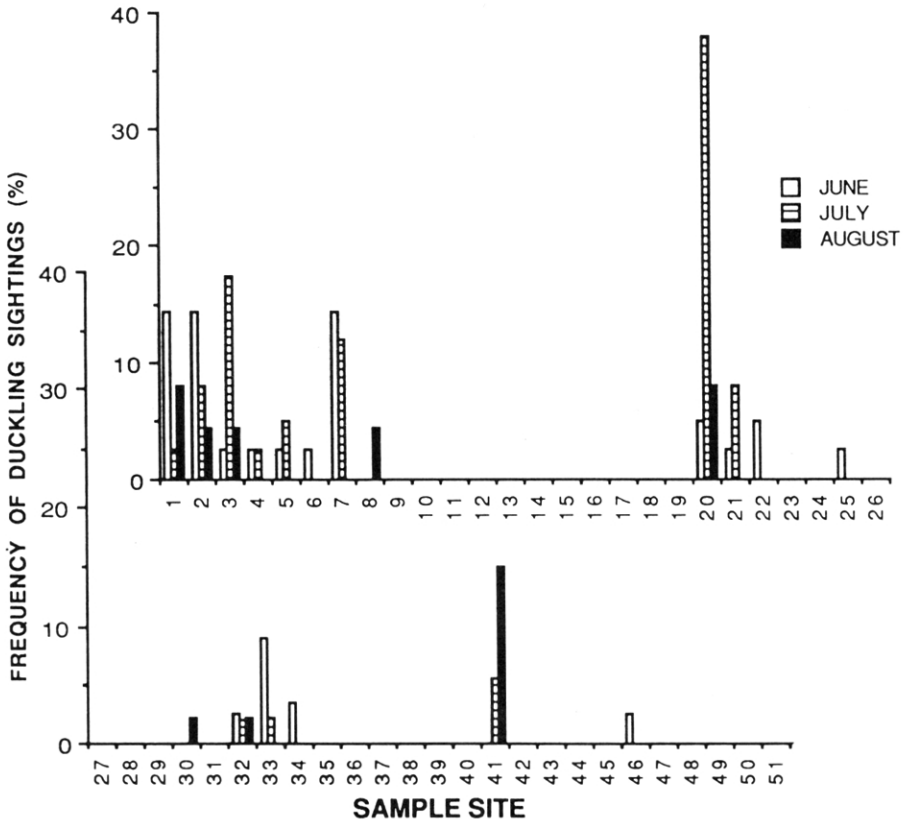


Fig 2 Histogram indicating frequency of brood occurrence at study sites from May to August, 1988 in *Spartina* marsh at head of Antigonish Harbour.

**Table I** Rotated factor loadings on axes 1 and 2 for ordination shown in Fig 3. Note: 18 factors loading high on axes 1 and 2 are included.

Species Variance explained	Factor 1 16.2%	Factor 2 10.8%
<i>Rhizoclonium riparium</i> (Roth) Harvey	0.703	0.002
blue-green algae	0.671	-0.247
<i>Agrostis alba</i> L.	-0.569	-0.402
<i>Ectocarpus</i> sp.	0.549	-0.047
<i>Solidago sempervirens</i> L.	-0.527	0.132
<i>Spartina patens</i> (Ait.) Muhl.	-0.525	-0.422
<i>Cladophora</i> sp.	0.188	0.714
<i>Spirogyra</i> sp.	0.372	0.638
<i>Spartina pectinata</i> Link	-0.016	0.605
salinity	0.033	-0.598
pH	0.103	-0.556
<i>Enteromorpha</i> spp.	0.487	0.538
<i>Scirpus maritimus</i>	-0.458	0.538
shelter	0.416	0.231
<i>Capsosiphon fulvescens</i> (C. Ag.) Setch. & Gard.	0.310	-0.197
<i>Klebsormidium</i> sp.	0.463	0.175
<i>Blidingia</i> spp.	0.372	0.064
<i>Pilayella littoralis</i> (L.) Kjellm.	0.353	-0.077

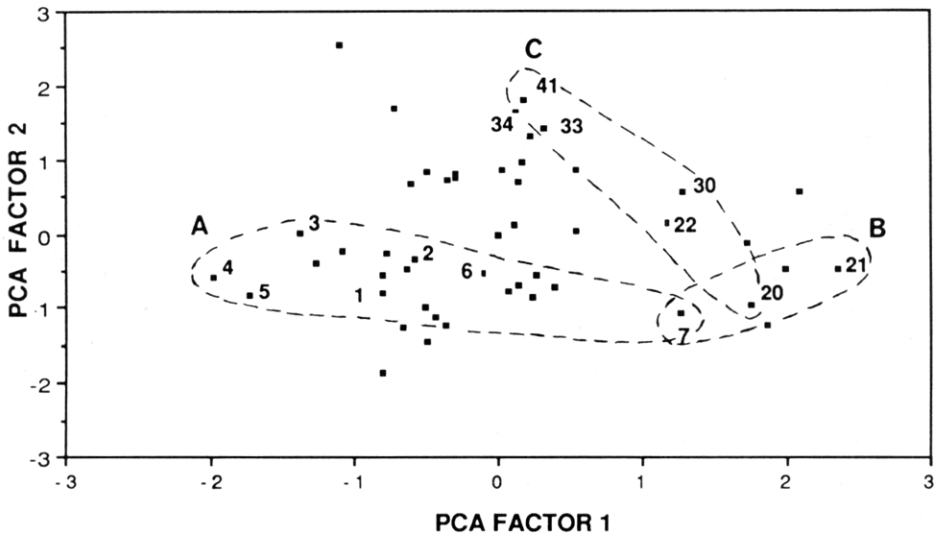


Fig 3 Ordination of sampling sites based on principal component analysis using physical environmental data, and presence/absence of flowering plants and algae. Numbered sites indicate those most highly utilized (cf. Fig 1). A indicates highly utilized sites in June. B Includes additional sites utilized in July. C includes additional sites utilized in August. See Table I for factor loadings.

by broods occurred within <8 ha of the marsh and 88% (n=73) of sightings of broods were at 3 sites which encompassed an area of 2 ha.

Analysis of the sample sites within this 5 m wide 8 ha zone indicated that the highest frequency of occurrence of ducklings was in the northeast corner of the marsh (sites 1-8, 20-22, 33 and 41) (Fig 2). When pooled, brood distributions observed during 93 transects produced a value of Morisita's index of dispersion of 0.540 (a value of > 0.5 indicates randomness with 95% confidence). When analyzed on a monthly basis, similar results were found (June 0.5306, n = 36; July 0.585, n = 32; August 0.5850, n = 24). Median tests showed that ducklings occurred most frequently at sites 1, 2 and 7 during June, at site 20 during July, at sites 1, 20 and 41 during August.

The results of PCA are summarized in Table I and Fig 3. It is clear that axis 1, which accounts for 16.2% of the total variation among sites, may be related to the presence of filamentous algae that made up the floating mat community. High positive loadings are found for algal genera *Ectocarpus*, *Enteromorpha*, *Capsosiphon*, *Rhizoclonium*, *Klebsormidium*, *Pilyella*, and *Blidingia*, which often occur together in floating mats (accompanied by blue-green algae). The subjective shelter value also shows a strong positive loading on PCA axis 1. Ordination of the sample plots (Fig 3) shows that two relatively distinctive groupings of utilized sites may be discerned along axis 1. Fig 2 shows that group A (sites 1-7) was utilized primarily during the first 3 weeks of brood rearing (June), whereas group B (sites 7, 20 and 21) showed large increases in duckling occupancy in July. This was particularly evident in site 20, which, through its position on axis 1, has many of the algal species that contribute to floating masses. Visible algal mats were first noted in mid to late June and their appearance was shown to correspond with the shift from group A (low algal presence) to group B sites (high algal presence).

## Discussion

Courcelles and Bédard (1979) demonstrated that broods of black ducks and other species of ducks were four times more abundant in preferred (vs next best) locations in freshwater marsh habitat. They linked distribution of ducklings in five habitats to distribution of aquatic vegetation, and they further determined the ecological variables (water depth, available phosphorus, organic matter, pH, etc.) that correlated with plant distribution. Our observations show that all foraging activity by black duck ducklings in this study occurred within a narrow zone at the edge of the estuarine marsh. There was a high (88% of observations at 3 sites) frequency of use of specific sites within this zone. Indeed, only a very small area of the marsh was used. MacLean (1988) found that all (168 h observation, 187 sightings of broods) foraging of black duck broods in 1987 occurred within the 5 m zone, 71/79% at 7 sites of  $\approx 4$  ha; 52% occurred at 3 sites of  $\approx 2$  ha. The analyses in this study suggested that foraging activity was linked to the presence of floating mats of a composite of algal species. Although the amount of time spent at sites differed in this study from MacLean's (1988), the same sites were used by ducklings, and algal mats were the common denominator, though no specific algal species occurred throughout the sites.

Bengtson (1972) found food to be a critical factor influencing the pattern of distribution of duck broods and Hickey and Titman (1983) found that feeding was the major activity of black duck broods in Prince Edward Island. It is well known that the diet of ducklings consists of a high component of invertebrate matter (Collias and Collias, 1963; Bengtson, 1972; Sugden, 1973; Reinecke, 1979). Although the vegetative parts of aquatic plants are believed to be poor food for young waterfowl, it is indirectly important because of the high densities of macroinvertebrates typically

associated with it. Berg (1949) and McGaha (1952) concluded that a variety of aquatic insects are restricted to one or a few closely related species of plants with floating or emergent parts. Krull (1970) confirmed a macroinvertebrate - submerged aquatic macrophyte association.

Our observations showed that a shift occurred in use of sites by ducklings after they were approximately three weeks old, from a sheltered northeastern pond to specific sites where floating mats of algae were found. MacLean (1988) reported a similar shift in habitat use by ducklings of this age to areas within the zone characterized by floating mats of algae, although she did not monitor the development of these mats. While algal mats are undoubtedly important to foraging ducklings, the presence of an extensive stand of dense emergent vegetation provides shelter from weather, and perhaps more significantly from the frequent avian predator attacks that occur during the first few weeks that broods are out on this marsh.

During 1986, the survival rate of ducklings in 16 black duck broods on this marsh was 95% after ducklings had reached 2 weeks of age, as opposed to <60% for ducklings during the first 2 weeks of life. Predation was the main source of duckling mortality. It is probable that this extensive zone, where both cover and food can be obtained, is the most important feature attracting females to this habitat for brood rearing.

Natural habitats that support algal mats appear to be suitable for brood rearing. Physical/biotic factors that increase the development of algal mats in association with emergent vegetation, should enhance the quality of habitat for brood rearing. While the foraging benefits appear obvious, cover from predators may be equally important (Seymour personal observation). Any management plan designed to concentrate broods in high nutrient areas must also provide suitable cover, and an extensive length of indented emergent edge should provide this.

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