FEEDING ECOLOGY OF NONBREEDING POPULATIONS OF LARIDS OFF DEER ISLAND, NEW BRUNSWICK

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ABSTRACT.—Nonbreeding populations of three species of larids were studied off Deer Island, New Brunswick, Canada prior to migration to determine the extent of feeding interaction. The distribution of birds in the area followed prey distribution, with the Bonaparte's Gull frequenting areas with surface euphausiid concentrations and the Common and Arctic terns occupying areas harboring schools of small fish. Feeding distribution patterns were associated with the combined effects of tide phases and bottom topography on the availability of surface prey. The Bonaparte's Gull fed predominantly on euphausiids and insects. The Arctic Tern fed frequently on euphausiids and a variety of small fish, whereas the Common Tern took only small fish. *Received 16 September 1980, accepted 9 July 1981.*

MOST feeding studies of seabirds have dealt with breeding populations where food acquisition has an especially high priority due to the food requirement of the young (Boecker 1967, Lemmetyinen 1973). Once the breeding season has ended, adults must replenish their spent energy reserves and molt in preparation for migration to distant wintering grounds. Such needs are most effectively met in areas where there is easy access to high concentrations of food. Late summer-early autumn staging areas have been documented for many species, including Lesser Snow Geese (*Chen caerulescens*) in Manitoba (Blokpoel 1974) and Northern Phalaropes (*Lobipes lobatus*), Black-legged Kittiwakes (*Rissa tridactyla*), and Common Murres (*Uria aalge*) off eastern Canada (Brown et al. 1975).

Common Terns (*Sterna hirundo*), Arctic Terns (*S. paradisaea*), and tern-like Bonaparte's Gulls (*Larus philadelphia*) pass through the Bay of Fundy during fall migration. Coastal waters off southwestern New Brunswick, Canada host particularly large numbers of migrating gulls and terns, making possible the study of feeding behavior in nonbreeding populations of these birds.

MATERIALS AND METHODS

The study area lies in the proximity of Deer Island off southwestern New Brunswick. In order to facilitate spatial comparisons, the study area was divided into 10 divisions, each of which was assigned a number. These spatial units were designed so that they could be easily defined at sea by lining up prominent landmarks. Three major zones were defined: Zone I (Divisions 1–3), Zone II (Divisions 4–6), and Zone III (Divisions 7–10) (Fig. 1).

Semi-diurnal tides of between 5.6 and 8.3 m, with an average range of 6.4 m, are characteristic of the area (Macmillan 1966). The complete tidal cycle (flood tide plus ebb tide) was divided into eight phases: slow flood 1 (SF_1), fast flood (FF), slow flood 2 (SF_2), slack high water (SH), slow ebb 1 (SE_1), fast ebb (FE), slow ebb 2 (SE_2), and slack low water (SL). These phases were based on current velocities, which slowly increase as the tide starts to run until they reach fast water, after which they slowly decrease in velocity until slack water. Each phase lasts approximately 90 min.

Attempts were made to record observations in each study division during each tidal phase. Observations within a study division were rarely feasible for a whole tidal cycle due to shifts in the loci of seabird activity and changes in weather conditions. Therefore, data on spatial distributions of feeding birds relative to the tidal cycle were pooled for July–September. This treatment of data can be justified by the stable oceanographic conditions during mid-July–September (Gaskin and Smith 1979), and by the fact that the birds in this area are not in breeding condition during this period, so their nutritional needs should remain more or less constant. Although bird numbers changed over the season, their distribution remained proportionately the same.

The main study extended from 1 June to 10 October 1977 and from 12 June to 2 December 1978. Supplemental data were collected during 1979. Investigations during 1977 were largely preliminary. Most sightings were made at sea from a 6.5-m outboard cruiser. Common and Arctic terns, when they could not be distinguished, are referred to here as "Comic Terns," a name often used with reference to these two species (Grant and Scott 1969).

Monthly populations were estimated by setting

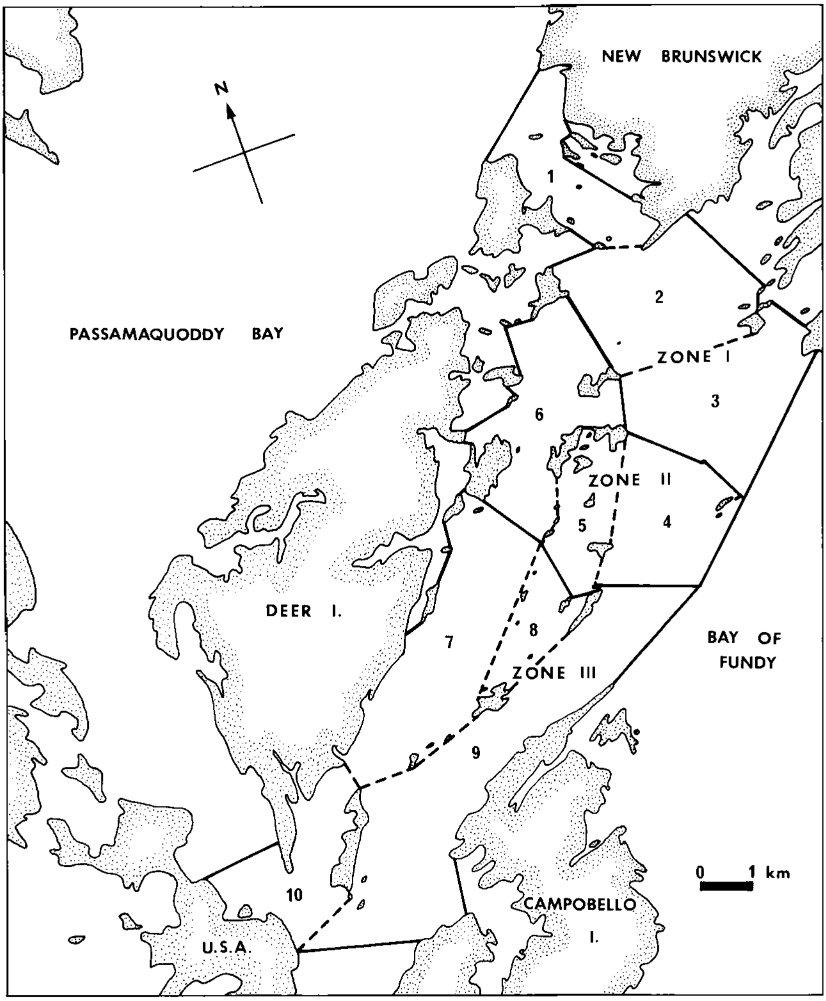

Fig. 1. The study area showing zones and divisions: Zone I—Divisions 1–3; Zone II—Divisions 4–6; and Zone III—Divisions 7–10.

minimum and maximum limits to numbers of Bonaparte's Gulls and Comic Terns based on sightings that, in this study, applied to contacts isolated in time. The minimum limit was taken as being the maximum number of birds of a given species recorded during one sighting (Vermeer 1977). The maximum limit was taken as the sum across the divisions of the maximum numbers of birds of a given species recorded during one sighting per study division. This method was used because none of the species studied breeds in the immediate area, thus eliminating the possibility of using nest counts for breeding pairs to establish population size.

The larid and prey distributions among the three zones were compared by calculating Chi-squared values; expected values were based on actual number counts. Zones I and II are approximately equal in size, but the effective water surface area of Zone III is about 1.5 times the size of Zone I or II. Data and Chi-squared values given were not corrected for differences in zone areas, because this procedure did not significantly affect the final conclusions, nor were prey distributions based on plankton tows corrected for numbers of tows taken in each zone, because the final conclusions were, again, not significantly affected. Probability values greater than 0.05 were judged nonsignificant.

During 1977, 27 surface plankton tows were taken between 23 June and 8 October, and during 1978, 68 surface plankton tows were taken between 26 June and 29 October. In 1977 and 1978, 22 and 38 of the surface plankton tows, respectively, were taken in conjunction with behavioral observations of birds in the area. Surface plankton tows were taken using a hand-held plankton net with 1.0-m diameter opening and a mesh size of 0.333 mm during the early

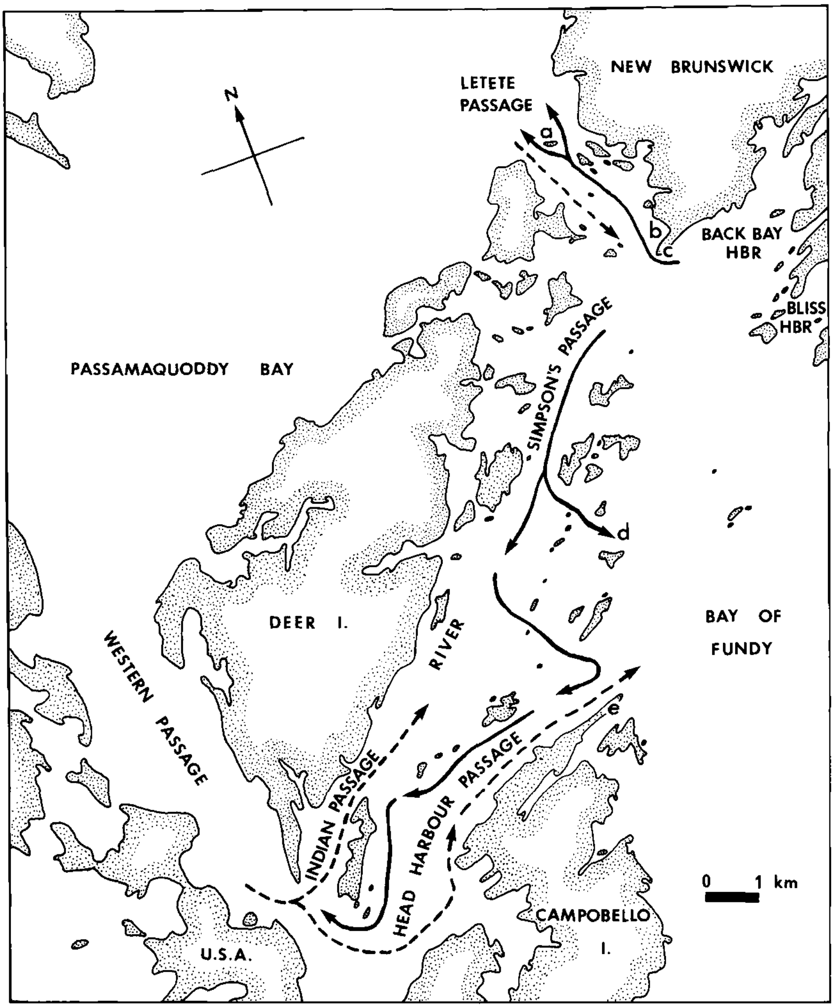

Fig. 2. Distribution patterns of feeding Bonaparte's Gulls and Comic Terns relative to the tidal cycle, showing concentrations of feeding birds shifting with the flood tide (→) and with the ebb tide (— →). Lettered areas are as follows: (a) Thumb I, (b) Kelly's Cove, (c) Green's Point, (d) Nubble-White Gap, and (e) East Quoddy Head.

part of 1977 and an 0.5-m diameter opening and a mesh size of 0.646 mm during the latter part of 1977 and all of 1978. The average towing speed was 1.7 knots. Plankton samples were preserved in 10% formalin for later analysis.

Samples of stomach contents obtained during early September 1978 totalled 18 Bonaparte's Gulls, 5 Arctic Terns, and 4 Common Terns and during early August 1979, 7 Bonaparte's Gulls, 14 Arctic Terns and 2 Common Terns. Birds were sampled from all three study zones. Carcasses were eviscerated and briefly examined immediately after collection so that, as suggested by Hanson and Graybill (1956), sampling could be terminated as soon as a homogeneous trend in stomach contents was established. In this study, this condition was assumed to have been met when the range of food items no longer appeared to increase with further collection.

Esophagus, proventriculus, and gizzard (ventriculus) were removed as a unit by severing the esophagus just posterior to the pharynx and the duodenum just behind the gizzard. The proventriculus was slit open and the contents preserved in 10% formalin during 1978 and 70% alcohol during 1979 for later analysis. Preserved esophageal, proventricular, and gizzard contents were analyzed together. No regurgitation was seen during the collection of samples.

The adopted categorization of data is comprised of "identifiable food items," "unidentifiable food

TABLE 1. Distribution of feeding birds during 1977 and 1978.

Species	Nx[a]	Ny[b]	Zone I	Zone II	Zone III
1977					
Bonaparte's Gulls	58	31,034	3.6[c]	3.4	93.0
Comic Terns	89	3,906	67.6	3.6	28.8
1978					
Bonaparte's Gulls	231	30,411	6.0	15.1	79.0
Comic Terns	135	1,768	42.9	28.5	28.6
1977–1978					
Bonaparte's Gulls	289	61,445	4.7	9.2	86.1
Comic Terns	224	5,674	59.9	11.3	28.8

[a] Total number of occasions feeding birds observed.
[b] Total number of feeding birds observed.
[c] Percentage of Ny: $\chi^2_{77} = 14{,}948.69$; $P < 0.001$; $\chi^2_{78} = 3{,}611.73$; $P < 0.001$; $\chi^2_{77\text{–}78} = 18{,}904.42$; $P < 0.001$.

items," and "nonfood items." Food items were identified at least to taxonomic order where possible, counted, and weighed to the nearest 0.1 g wet weight, as was the stomach. Fish still intact were identified from morphological characteristics described in Leim and Scott (1966) and otoliths illustrated in Smith and Gaskin (1974). Numbers of fish were calculated based on counts of vertebrae and otoliths found in the gizzard.

RESULTS

Population estimates and general distributions.— Bonaparte's Gulls were present in the study area from 12 July to at least 8 October 1977 (field season ended 10 October) and from 21 June to at least 2 December 1978 (field season ended 2 December). Minimum and maximum monthly population estimates for the study area indicate that numbers of Bonaparte's Gulls peaked rather abruptly in August at 5,000–10,000 birds and stabilized between 2,000 and 5,000 birds during the fall season. Monthly distributions of Bonaparte's Gulls by zone, based on the sum of the maximum number of birds recorded during one sighting per division, showed a significant trend during both 1977 ($\chi^2 = 1338.19$, $P < 0.001$) and 1978 ($\chi^2 = 5302.27$, $P < 0.001$) (Braune 1979). The birds were first seen in Zones I and II but quickly concentrated in Zone III during the period of July–September, only to spread intermittently back into Zones I and II during the fall.

Comic Terns were present from 25 July to 9 October 1977 and from 19 July to 8 October 1978. Tern numbers peaked rapidly in August at 200–1,000 birds. Numbers declined slightly during September and then rapidly, as all the terns left the area in early October. Monthly distributions of Comic Terns throughout the zones also showed a trend during both 1977 (insufficient data for χ^2 analysis) and 1978 ($\chi^2 = 196.60$, $P < 0.001$) (Braune 1979). During 1977, terns appeared earliest in Zone III, shifted to Zone I during August, and returned to Zones II and III in the fall. During 1978, terns were first seen in Zone II but quickly concentrated in Zone I, basically the reverse of the pattern observed for Bonaparte's Gulls during 1978.

The distributions of feeding birds with respect to tidal phases differed slightly between 1977 and 1978, but certain tidally related, feeding-distribution patterns emerged (Fig. 2). Detailed patterns are illustrated in Braune (1979).

Letete Passage (Zone I) was more important as a feeding area during 1977 than 1978 and was significantly more heavily exploited by terns than by Bonaparte's Gulls during both years (Table 1). Bird numbers built up in lower Letete Passage during the flood tide and moved with the tide towards Passamaquoddy Bay until slack high water. During the ebb tide, feeding activity was concentrated midway down the Passage, although some feeding occurred at both ends as well. Letete mouth was most heavily utilized, again by terns, just south of Green's Point and in Bliss Harbour mouth. They fed less frequently in the open water areas. They also fed in waters south of Green's Point, mainly during slack high water and into the ebb tide, with a second strong resurgence during the slow flood 1. The mouth of Bliss Harbour was also frequented by small numbers of Bonaparte's Gulls but was used as a feeding area only during slack water periods.

Upper Simpson's Passage was used by both Comic Terns and Bonaparte's Gulls for feeding during slow flood 2. In the case of the terns,

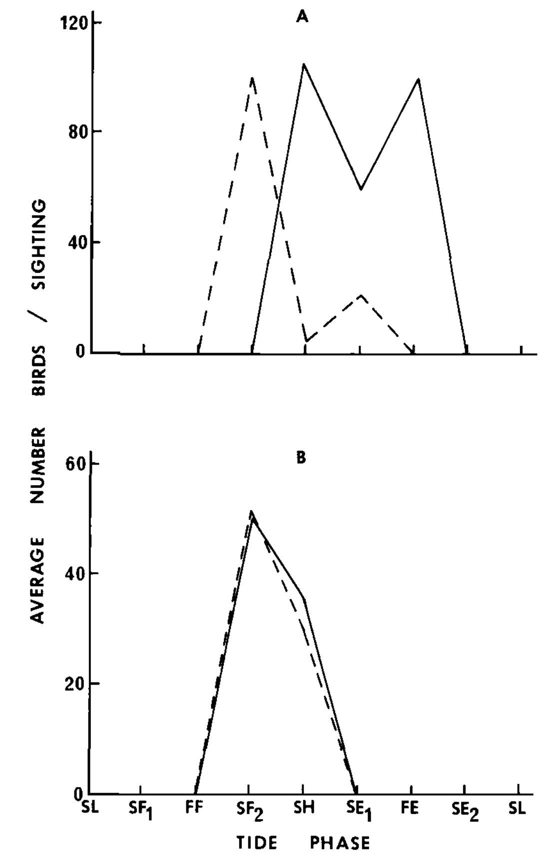

Fig. 3. Sample graphs showing average numbers of nonfeeding birds (– – –) and feeding birds (———) throughout a tidal cycle averaged for July–September 1978. (A) Bonaparte's Gulls in a section of Zone III. (B) Bonaparte's Gulls in a section of Zone I. Detailed graphs for the entire study area may be found in Braune (1979).

this concentration coincided with feeding activity between Back Bay and Simpson's Passage. For the gulls, it appeared to be the start of a feeding cycle that developed and extended through Zone II and into Zone III. The gull concentration then shifted down Simpson's Passage during slack high water. Tern and gull feeding activity in the Nubble-White Gap peaked toward the end of the flood tide and during early ebb tide. Activity in Simpson's Passage occurred intermittently throughout the ebb tide into the early flood tide.

Bonaparte's Gulls foraged in significantly greater numbers in Zone III (Table 1), and, therefore, the feeding distribution pattern in the Head Harbour Passage-Indian Passage-

TABLE 2. Distribution of prey types during 1977 and 1978.

Prey	n[a]	Zone I	Zone II	Zone III
1977				
Insects	—	—	—	—
Euphausiids	24	20.8[b]	16.7	62.5
Small fish	8	62.5	37.5	—
1978				
Insects	44	20.5	25.0	54.6
Euphausiids	47	14.9	29.8	55.3
Small fish	34	38.2	41.2	20.6
1977–1978				
Insects	44	20.5	25.0	54.6
Euphausiids	71	16.9	25.3	57.8
Small fish	42	42.8	40.5	16.7

[a] Based on surface plankton tows and/or recorded observations.

[b] Percentage of n: $\chi^2_{78} = 12.89$; $0.02 > P > 0.01$; $\chi^2_{77-78} = 20.83$; $P < 0.001$. Sample sizes in 1977 are insufficient for statistical analysis. Smaller sample sizes for 1977, particularly of small fish, are due to the fact that only a preliminary survey of prey types was taken during that year.

River area is based on their movements (Fig. 2). Bird concentrations built up rapidly in the River during the flood tide and shifted to waters off East Quoddy Head and the Indian Passage-Western Passage-Head Harbour Passage junction at slack high water. After the tide turned, the major feeding concentrations moved back up Head Harbour Passage and up Indian Passage into the lower River area with the ebb tide. Comic Tern movements followed basically the same pattern. Slack low water was the period of least feeding activity by all three larid species throughout the study area.

The build-up of numbers of nonfeeding and feeding birds was analyzed based on observations of 235 nonfeeding flocks and 513 feeding flocks involving 17,499 and 67,119 birds, respectively. Numbers of nonfeeding birds peaked one tidal phase before numbers of feeding birds peaked (Fig. 3A) in about 20% of the observations averaged over 2 yr. Anticipation of prey availability is strongly suspected from these observations. Because peaks of numbers of feeding and nonfeeding birds occurred at different phases of tide, these areas must have had consistently abundant prey. In some other parts of the study area, birds also occurred regularly; sometimes most were feeding, but on other occasions at the same time of tide, most were not feeding (Fig. 3B). This suggests an expectation of a prey concentration that did not always develop or developed less fully in time and space. This occurred during

TABLE 3. Distribution of euphausiids during 1977 and 1978.

Year	Nn[a]	Nm[b]	Np[c]	Nq[d]	Zone I	Zone II	Zone III
1977	37	23	14	5,065	28.8[e] (12-7-4)[f]	8.0 (8-2-1)	63.2 (17-14-9)
1978	68	24	17	5,483	0.6 (15-6-2)	1.2 (16-6-4)	98.2 (37-12-11)
1977–1978	105	47	31	10,548	14.1 (27-13-6)	4.5 (24-8-5)	81.4 (54-26-20)

[a] Nn = total number of surface plankton tows taken.
[b] Nm = total number of surface plankton tows taken in which euphausiids were found.
[c] Np = total number of surface plankton tows taken in conjunction with observations of feeding Bonaparte's Gulls and Comic Terns and in which euphausiids were found.
[d] Nq = total number of euphausiids taken.
[e] Percentage of Nq.
[f] Number of tows taken in that zone (Nn-Nm-Np). $\chi^2 = 2{,}160.33$; $P < 0.001$.

28% of the observations. During 52% of the observations, no apparent build-up of nonfeeding birds of a given species occurred, but feeding did occur. In this situation, birds may have been following a prey concentration that was drifting with the tidal flow, or, alternatively, the birds were being attracted by feeding members of another species to an area in which they did not normally search for food. It is impossible to determine prey availability indirectly in either case.

Prey, grouped into insects, euphausiids, and small fish eaten by the gulls and the terns, showed a disparate distribution by zone that was statistically significant (Table 2). Sampling and visual observations showed small fish to be found mainly in Zones I and II and euphausiids (Table 3) plus insects trapped in the water surface layer (Table 4) in Zone III; Zone II was a transitional area.

Stomach contents.—Analysis of stomach contents suggests that Bonaparte's Gulls fed primarily on insects and euphausiids in both numerical proportions and according to frequency of occurrence in the stomachs (Table 5), but euphausiids predominated by weight. Arctic Terns fed on euphausiids in higher numerical proportions than on small fish, but the frequency of occurrence in the stomachs of both food types was high. Common Terns appeared to feed mainly on small fish.

DISCUSSION

Feeding strategy.—The chronology and regularity of the build-up of numbers of nonfeeding and feeding birds may indicate the "reliability" of a feeding area, that is, whether or not food occurs there with tidally dependent regularity. Reliability of and prey availability in a feeding site depends on upwellings and on the presence of food to be brought to the surface. Most of the heavily exploited feeding areas have sharply defined topographic features exposed to a strong tidal flow.

Interestingly, the two heavily utilized feeding areas where prey occurrence is irregular are in the entrances to Back Bay and Bliss harbours. These two areas contain large schools of small fish. Fish are perhaps more mobile than euphausiids and more independent of tidal flow. This may partially explain the apparent irregular prey availability in these two feeding sites. The regular build-up of numbers of birds in areas of high but irregular prey

TABLE 4. Distribution of insects trapped in the water surface layer during 1978.

Nn[a]	Nr[b]	Ns[c]	Nt[d]	Zone I	Zone II	Zone III
68	36	20	1,399	1.8[e] (15-8-1)[f]	2.0 (16-8-6)	96.2 (37-20-13)

[a] Nn = total number of surface plankton tows taken.
[b] Nr = total number of surface plankton tows taken in which insects were found.
[c] Ns = total number of surface plankton tows taken in conjunction with observations of feeding Bonaparte's Gulls and Comic Terns and in which insects were found.
[d] Nt = total number of insects taken.
[e] Percentage of Nt.
[f] Number of tows taken in that zone (Nn-Nr-Ns).

TABLE 5. Composition of stomach contents of Bonaparte's Gulls, Common Terns, and Arctic Terns collected during September 1978 and August 1979.

	Bonaparte's Gulls					Arctic Terns					Common Terns				
	Number	% total number[a]	Weight (g)	% total weight	% frequency of occurrence	Number	% total number	Weight (g)	% total weight	% frequency of occurrence	Number	% total number	Weight (g)	% total weight	% frequency of occurrence
1978			n = 18					n = 5					n = 4		
Identifiable food items															
Insects[b]	189	44.2	0.5	1.1	70.6										
Euphausiids[c]	195	45.6	23.5	51.5	70.6	52	89.7	2.5	89.3	100.0					
Small fish[d]	10	2.3	21.4	46.9	41.2	5	8.6	0.3	10.7	80.0	7	100.0	10.1	100.0	100.0
Other species[e]	34	7.9	0.2	0.4	47.1	1	1.7	negligible	—	20.0					
Unidentifiable food items	—	—	9.8	98.0	94.4	—	—	0.9	100.0	100.0	—	—	0.9	100.0	100.0
Nonfood items															
Pine needles	20	62.5	0.1	1.0	22.2										
Pebbles	3	9.4	negligible	—	11.1										
Plastic particles	9	28.1	0.1	1.0	11.1						1	100.0	negligible	—	25.0
Number of prey species identified			20					4					1		
1979			n = 7					n = 14					n = 2		
Identifiable food items															
Insects	45	14.1	0.5	6.7	85.7	6	2.6	0.1	0.2	14.3					
Euphausiids	260	81.5	6.5	86.7	85.7	202	87.1	29.5	71.1	78.6					
Small fish	6	1.9	0.4	5.3	57.1	24	10.3	11.9	28.7	64.3	5	100.0	5.8	100.0	100.0
Other species	8	2.5	0.1	1.3	42.9										
Unidentifiable food items	—	—	2.9	100.0	100.0	—	—	4.7	100.0	100.0	—	—	0.8	100.0	100.0
Nonfood items															
Pine needles	7	100.0	negligible	—	28.6	2	100.0	negligible	—	7.1					
Number of prey species identified			12					7					1		

[a] (total number items of given prey type/total number prey items in stomach) × 100.
[b] Hymenoptera, Diptera, Homoptera, Coleoptera; also Trichoptera during 1978, and Hemiptera during 1979.
[c] *Meganyctiphanes norvegica* and *Thysanoëssa inermis*.
[d] Herring (*Clupea harengus*); also pollock (*Pollachius virens*) and smelt (*Osmerus mordax*) during 1979.
[e] Gastropoda, Decapoda, Amphipoda; also Bivalvia, Oligochaeta, *Calanus* spp. and assorted other Crustacea during 1978.

availability suggests that the birds have learned the relative quality of different localities and are hunting accordingly (Gibb 1962). It is obvious that the study area as a whole is important for feeding for both Bonaparte's Gulls and Comic Terns due to the abundance and availability of prey.

Distribution of feeding birds.—The distribution of feeding birds was dependent mainly upon prey species and prey-size distributions. It has been shown that herring segregate by size and age in this area. Smaller herring frequent the Letete Passage-Back Bay Harbour-Bliss Harbour area (Zone I), whereas larger herring occur in Head Harbour Passage (Zone III) (Graham 1936). Fish much larger than this were probably not swallowed with ease by the smaller larids, as substantiated by one Common Tern found with the tail of an intact herring of about 8 cm in the esophagus and the head of the same fish in the gizzard. Bent (1921) maintained that a fish of about 10 cm is the maximum size that a Common Tern can consume.

On this basis it might be expected that most of the birds feeding on fish would be restricted to the northeastern section (Zone I), where the smaller fish predominate. Birds feeding on euphausiids occurred mainly in the southwestern section (Zone III), where the densest concentrations of euphausiids were found (Table 3; Gaskin and Smith 1979). Consequently, Bonaparte's Gulls, which fed predominantly on euphausiids and insects, concentrated in Zone III; Arctic Terns, which fed on euphausiids and small fish, were found in Zones II and III; and Common Terns, which fed chiefly on fish, occurred in Zones I and II (Braune 1979).

The combined effect of bottom topography and tidal currents on water movements manifests itself by concentrating some prey types, causing feeding to be extremely patchy in occurrence (Hamner and Hauri 1977, Brown et al. 1979). As waters of the flood tide are forced up over successive rises in the seabed of Letete Passage, food becomes available at the surface. When the tide turns, the reverse occurs. Now, however, small fish, which probably sought refuge from tidal currents in Kelly's Cove just north of Green's Point, are carried back over the ledges off Green's Point by the ebb tide. Consequently, feeding activity during the ebb tide centered just south of Thumb Island and Green's Point.

Hamner and Hauri (1977) found that zooplankton accumulated in stagnation zones, upwellings, convergences, and divergences caused by headlands interrupting a strong tidal flow. When zooplankton concentrations become high, fish and seabirds begin to feed preferentially in these areas. Similarly, Brown (1980) has shown that strong tidal streams in the Bay of Fundy result in upwellings and convergences when forced to the surface over underwater ledges. Zooplankton, such as copepods and euphausiids, are concentrated in streaks or areas of calm water associated with the upwellings and convergences. Near Brier Island, Nova Scotia these zooplankton accumulations form the basis of marine food chains involving fish, squid, gulls, shearwaters, and phalaropes. The phalaropes feed exclusively in the streaks, which Brown (1980) believes they use as indications of high food concentration.

Most study area locations with feeding activity can be explained by similar circumstances. In areas where rises and shelves occur, the flood waters wash up around the island chain onto the shoals and upwell over successive rises down Head Harbour Passage, as well as Indian Passage, bringing food to the surface (Gaskin and Smith 1979). As the tide turns, the reverse occurs. Areas of little feeding activity, such as open water areas, contain no significant topographic anomalies. Therefore, little food is available at the surface in these areas.

Birds search mainly in the most profitable areas and spend correspondingly less time foraging in other areas. Smith and Sweatman (1974), however, have shown that there is a tendency for the first moves to be from a preferred search area, should it prove unproductive, to an adjacent area, regardless of its usual level of productivity, rather than for direct flight from one preferred search area to another, perhaps more distant preferred area, as might be expected. Later moves may be made to another high profit area. This may partially explain the sequential pattern of feeding areas in Letete Passage and Head Harbour Passage. Birds can readily detect and respond to a simple change in food distribution in an otherwise stable environment with only a temporary drop in feeding rate. This is achieved by increasing the search effort in an area previously ranked second in profitability (Smith and Sweatman 1974). Thus, irregular prey availability in an important feeding division probably causes little inconvenience to the birds in a region as rich in food supply as the present study area.

Food items.—In the study area, Bonaparte's Gulls had the greatest variety in their diet, with euphausiids, insects, and small fish being of greatest importance. The gulls probably took insects from the water surface layer or from floating weed fragments. Baltz and Morejohn (1977) found that Bonaparte's Gulls in winter off the coast of California fed mainly on insects, euphausiids, and other invertebrates, and less on fish.

Common Terns in the Deer Island area appeared to feed on small fish, whereas Arctic Terns took euphausiids and other crustaceans as well. Gochfeld (1978) suggests that Common Terns feed extensively on crustaceans only when fish are scarce or difficult to locate.

Although the actual food types did not change between 1978 and 1979, the numerical proportions of euphausiids and insects varied. Proportionately greater numbers of insects were taken by Bonaparte's Gulls during September 1978 than August 1979. Insects were taken by Arctic Terns during August 1979, but not September 1978. This difference may be a function of unequal sample sizes of each species for the 2 yr or the absence of insect flight swarms during the latter month.

Food preferences appear to change readily and appropriately with changes in the environment. Small fish may not always be as available and easy to catch as euphausiids, for example. Euphausiid swarms occur in the study area annually in late summer (Gaskin 1973), whereas schools of small fish appear around late August and remain until October (Graham 1936). Insect swarms trapped in the water surface layer may temporarily be more efficiently exploited than scattered euphausiids, particularly after the large-scale emergence of certain insects, which usually occurs in August.

There will be little competition between bird species if the amount of potential prey available at the surface in an area where a flock is feeding is far greater than the birds can utilize (Sealy 1973). The high productivity and availability of plankton and fish in the North Atlantic during summer minimizes food competition for most seabirds (Salomonsen 1955, Lack 1968). This is probably true for the study area during summer. Vigorous competition begins in the fall as supplies of available food decline (Salomonsen 1955), which may partially explain the early departure of the terns we observed.

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