benefits of the Argo data will be realized when they are assimilated into regional ocean circulation models together with other sources of real-time observations of sea-surface height and sea-surface temperature from satellites in hindcast, nowcast and forecast modes (Davidson et al. 2006). Argo data are available to anyone, and we hope to see more and more people use them for their own needs in the future, as the value of a dataset increases in proportion to its number of users.

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Monitoring Seabirds at Sea in Eastern Canada

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Sommaire

Les données récoltées lors de six missions du PMZA sur le plateau Néo-Écossais, les Grands Bancs de Terre-Neuve, dans la mer du Labrador et dans le golfe du Saint-Laurent sont utilisées afin de décrire la communauté aviaire au large des côtes dans l'est du Canada en 2006. Pendant que le navire faisait route, des observateurs ont identifié et dénombré les oiseaux en regardant à 90° du côté bâbord ou tribord par séquence de 10 min jusqu'à une distance de 300 m pour l'estimation de la densité d'oiseaux marins. Nous avons observé des densités totales plus élevées au printemps par rapport à l'automne et au large des côtes de Terre-Neuve par rapport aux autres régions. Cependant, nos données ont révélé l'importance de toutes les régions pour les oiseaux migrateurs. Le mergule nain a été l'espèce rencontrée en plus grand nombre pendant les relevés et nous avons utilisé ces données afin d'explorer la relation entre cette espèce planctivore et la biomasse de trois espèces de copépodes dominants la biomasse de zooplancton.

Introduction

The east coast of Canada supports large numbers of breeding marine birds as well as millions of migrants from the southern hemisphere and northeastern Atlantic. Although tied to land during the breeding season when they raise their young, seabirds exist mostly in the marine environment. Since many spend much of their lives out of sight of land, knowledge of their pelagic distribution and ecology has been difficult to obtain. In 1969, R.G.B. Brown and P. Germain initiated what was then considered the first "modern" pelagic seabird survey—PIROP (*Programme Intégré de Recherches sur les Oiseaux Pélagiques*)—based on a systematic technique and computer database. The program was operated by the Canadian Wildlife Service (CWS) of Environment Canada and supported by the large DFO (Department of Fisheries and Oceans) oceanographic fleet based in eastern Canada. The results of the surveys were first published in 1975, in the form of an atlas for seabirds off Eastern and Arctic Canada (Brown et al. 1975) that was subsequently updated (Brown 1986). Much of our current knowledge of the marine birds of these areas is based on the PIROP surveys. However, data are limited beyond the mid-1980s.

In 2005, CWS reinvigorated the monitoring program for seabirds at sea with the goal of identifying and minimizing the impacts of human activities. Our sampling strategy relies

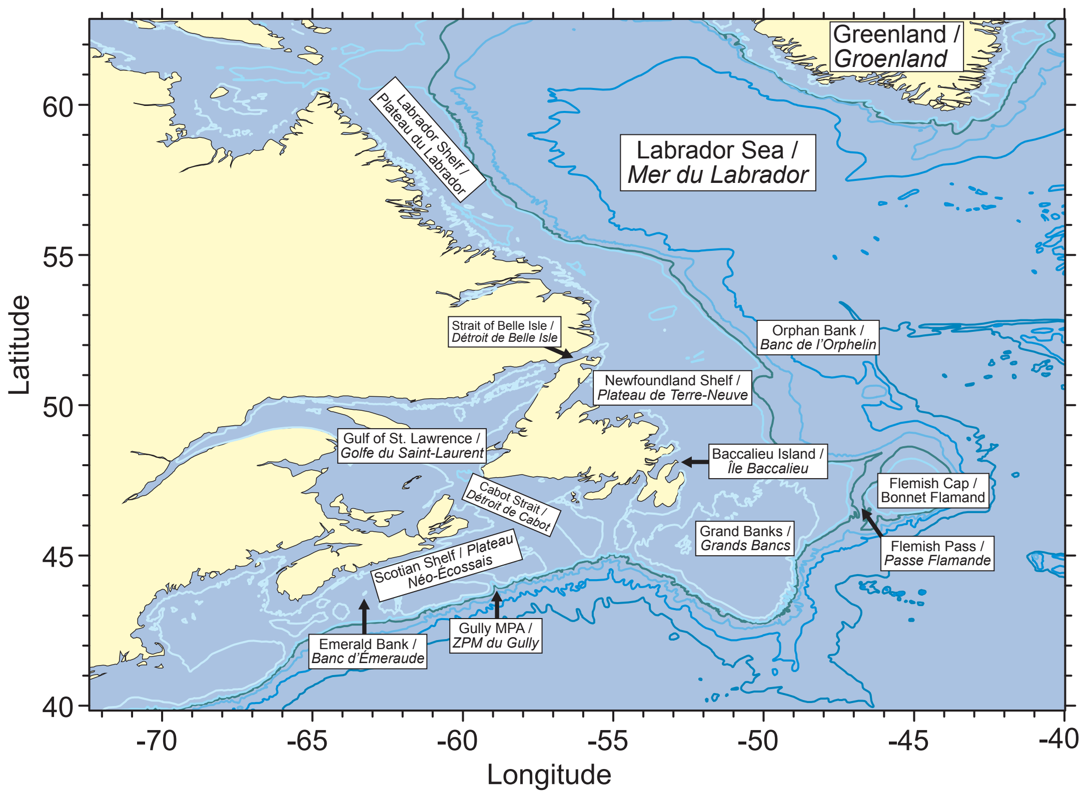

Fig. 1 Region surveyed in 2006. *Région couverte en 2006.*

on ships-of-opportunity that travel throughout the region at all times of the year. The Atlantic Zone Monitoring Program (AZMP) provides observation platforms that sample transects over a broad geographic area and across multiple seasons, allowing us to monitor both intra- and interannual variability in seabird occurrence and to compare marine communities among regions. The data also provide critical, and currently unavailable, information for environmental assessments of offshore developments; identify areas where birds are at high risk for oil pollution and other human activities; and enable us to monitor trends in the marine environment. In addition, the biological, chemical, and physical data collected concurrently by DFO oceanographers provide the means to examine the linkages between seabirds and their marine habitats and to investigate seabird responses to oceanographic variability.

CWS seabird observers participated in six AZMP missions in 2006—two on the Grand Banks and northeast Newfoundland Shelf, two on the Scotian Shelf, one across the Labrador Sea, and one in the Gulf of St. Lawrence (Fig. 1). This article gives a summary of the birds observed during these surveys and highlights differences among regions and seasons. Because seabirds are not uniformly distributed across their marine habitat, but instead are influenced by the physical processes that concentrate prey and make them available to the birds, we also explore the relationship between the surface density of zooplankton and the presence of dovekie (*Alle alle*), the only Atlantic seabird to prey mostly on copepods (Montevecchi and Stenhouse 2002).

The dovekie is considered the most abundant seabird in the North Atlantic. It is a small (ca. 160 g), stout, black and white bird that typically flies with very rapid, insect-like wing beats (Montevecchi and Stenhouse 2002) (Fig. 2). Dovekie breed between May and August in colonies on steep talus slopes in the high Arctic, with particularly large concentrations in northwestern Greenland. During the non-breeding season, they live in the open ocean and are common on the Scotian Shelf, Grand Banks, and Newfoundland and Labrador shelves (Brown et al. 1975, Brown 1986). At this time of year, Brown (1988) found that the largest concentrations occurred over the shelf-breaks where apparently large numbers of zooplankton aggregate. Dovekie dive to depths of between 20 and 30 m (Falk et al. 2000), feeding almost exclusively on planktonic crustaceans. They eat primarily copepods, selecting the largest stages of *Calanus glacialis*, *C. hyperboreus*, and *C. finmarchicus* (Bradstreet 1982, Karnovsky et al. 2003, Jakubas et al. 2007, Steen et al. 2007), but amphipods (*Themisto* and *Apherusa*) are also consumed, especially in the late summer (Bradstreet 1982, Hobson 1993). Dovekie catch one crustacean at a time (Keats 1981) and thus must feed in locally dense patches of prey to meet their daily energy requirements. The extent of the spatial overlap between dovekie and their zooplankton prey is not well known, especially outside of the breeding season. We use data collected during AZMP missions in 2006 to examine this association and predict that the spatial distribution of foraging dovekie can be determined by near-surface prey concentrations.

Fig. 2 Dovekie (*Alle alle*). *Mergule nain (*Alle alle*).*

Seabird Sampling Methods

Surveys were conducted while looking forward from the bridge when the vessel was moving, scanning ahead to a 90° angle from either the port or starboard side, limiting observations to a transect band 300 m wide from the beam of the ship. Each survey lasted 10 min; we conducted as many consecutive surveys as possible during the daylight hours, regardless of whether birds were present. At the beginning of each 10-min survey, we recorded the ship's position, time of day, ship speed and direction, and a number of environmental variables (i.e., visibility, sea state, swell height, wind speed and direction). All birds observed in the transect were counted and identified as present in air or on water. Binoculars were used to confirm the species identification and other details, such as age, moult, and feeding behaviours. We continuously recorded all birds observed on the sea surface throughout the 10-min surveys and estimated their perpendicular distance from the ship (0–50 m, 51–100 m, 101–200 m, 201–300 m). A count of all flying birds passing through the transect would be a measure of bird flux and would overestimate bird density (Tasker et al. 1984). Therefore, we recorded flying birds using instantaneous counts at regular intervals throughout each 10-min survey (Tasker et al. 1984). Seabird surveys were conducted along AZMP sections and while transiting between sections. Overall densities were calculated for each 10-min survey as the number of birds observed in transect (all species combined) divided by the area surveyed.

Because they are small and can be difficult to detect during certain sea conditions, we modelled dovekie detectability and estimated densities using distance sampling methods (Buckland et al. 2001, Thompson 2002). When surveying birds along a transect line, the likelihood of detecting a bird decreases the further it is from the ship, since more distant birds are harder to see and are more likely to be missed. Distance sampling is a conceptually simple technique used in many types of wildlife surveys to account for animals that go undetected. To do this, Program Distance (Thomas et al. 2006) plots a histogram of detection distances and models a detection function to determine the estimated proportion of birds detected as a function of observation distance (detection probability). Since birds are likely distributed randomly across the 300 m transect, the histogram bars would all be roughly the same height (corresponding to equal probability of detection in each distance class) if all birds present were detected. For example, the histogram in Figure 3 shows sharply declining detection probability with increasing distance, which is typical for small seabirds. We used Program Distance to estimate the detection probability of dovekie, also taking into account a number of covariates, including region (Newfoundland Grand Banks and Shelf, Scotian Shelf, Labrador Sea, and Gulf of St. Lawrence), platform speed, visibility, sea state, and wind speed. Model fit and ranking were assessed using Akaike's Information Criterion (AIC) (Burnham and Anderson 2002). Adjusted dovekie densities were then compared to patterns of *Calanus* distribution and abundance.

Zooplankton Sampling Methods

Zooplankton samples were collected at transect stations using 0.75 m diameter ring nets fitted with 200 µm mesh that are towed vertically between the bottom and the surface (if the bottom was shallower than 1000 m) or between 1000 m and the surface (if the bottom was deeper than 1000 m). The samples were preserved in 4% formalin and enumerated using the standard AZMP protocol (Mitchell et al. 2002). In this protocol, subsamples containing at least 100 *Calanus* are analyzed, with each individual being identified to the level of species and stage.

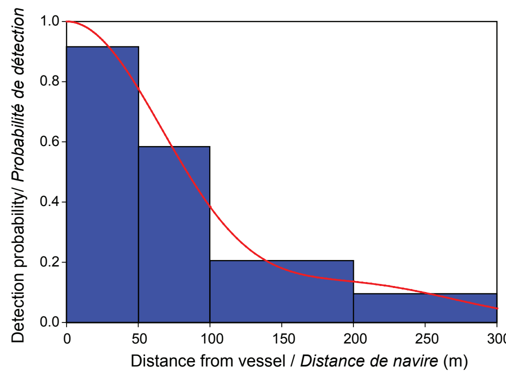

Fig. 3 Histogram and modelled detection function (red line) depicting detection distance of dovekie sightings on the water during 2006 seabird surveys.

Histogramme et la fonction de détection modélisée (ligne rouge) illustrant la distance de détection sur l'eau des mergules nains lors du relevé d'oiseaux marins de 2006.

Three species of *Calanus* (*C. finmarchicus*, *C. glacialis*, *C. hyperboreus*) have been shown to dominate the zooplankton biomass in the Labrador Sea (Head et al. 2003) and on the Scotian and Newfoundland shelves (Head and Harris 2004). Therefore, *Calanus* biomass was used as the index of zooplankton biomass in this study. In spring, *Calanus* are active, feeding, and growing, and it was assumed that all stages of all three species were in the near-surface layers. Thus, for spring samples, near-surface *Calanus* biomass was calculated using water column abundance estimates, as measured above, and the dry weights-at-stage reported by Head and Harris (2004). In fall, most *Calanus* descend to deeper layers as late-stage copepodites to spend the winter in a resting state. In order to calculate the proportion of individuals in the water column that would have been at depths of <100 m (i.e., in the near-sur-

Table 1 Fall percentages of *C. finmarchicus* copepodite stages present in the surface layer versus those in the 0–1000 m or 0–470 m (Cabot Strait) depth range averaged over stations in the slope waters of the Newfoundland Shelf, the eastern and western portions of the Scotian Shelf, and in Cabot Strait.

Pourcentages des stades copépodites de C. finmarchicus *présents à l'automne dans la couche de surface contre ceux présents dans la couche 0 – 1000 m ou 0 – 470 m (détroit de Cabot) de profondeur (moyenne sur toutes les stations de la pente) sur le plateau de Terre-Neuve, les secteurs est et ouest du plateau Néo-Écossais et au détroit de Cabot.*

Stage / *Stade*	CVI	CV	CIV	CIII	CII	CI
Newfoundland Shelf / *plateau de Terre-Neuve*	13	6	23	90	100	80
Cabot Strait / *détroit de Cabot*	48	28	66	100	100	100
Eastern Scotian Shelf / *est du plateau Néo-Écossais*	12	6	17	96	100	100
Western Scotian Shelf / *ouest du plateau Néo-Écossais*	9	3	21	97	100	100

face layers) for stations where depths were >100 m, we used results from a series of Hydro-bios Mulitnet tows that were taken in the slope waters of the Newfoundland and Scotian shelves and Cabot Strait in November 2001 (Newfoundland Shelf) and October 2003 (Scotian Shelf and Cabot Strait). The Multinet has five nets that can be opened and closed sequentially as the net is towed vertically. The surface layer for these tows was generally 0–200 m, except in Cabot Strait, where it was 0–100 m. Vertical distributions of copepodite stage CV *C. finmarchicus* have been reported elsewhere (Head and Pepin 2007), but here we show the percentages of the different stages that were present in the surface versus the total water column abundance (Table 1). These percentages were applied to the total water column abundance data collected using ring nets in fall 2006, together with the dry weights-at-stage reported by Head and Harris (2004), to give the biomass in the 0–200 or 0–100 m layer. For stations having depths <100 m, we used the total water column abundances and dry weights-at-stage from Head and Harris (2004). *C. glacialis* and *C. hyperboreus* were very rare in the surface layers in the Multinet tows and at stations of <100 m depth, so we have discounted their contribution to the total *Calanus* biomass in fall.

Seabird Distribution and Abundance

During the six AZMP missions conducted in 2006, we surveyed over 6883 km of ocean track (Fig. 4A, B) and counted a total of 17,477 birds from 9 families (Table 2). The majority (61%) of the birds observed were from the Alcidae, a primarily marine family of birds confined to the northern hemisphere. Dovekie accounted for most of these observations, although murre (*Uria* spp.) and Atlantic puffin (*Fratercula arctica*) were also common. Members of the family Procellariidae were relatively abundant (22%), specifically the northern fulmar (*Fulmarus glacialis*) and greater shearwater (*Puffinus gravis*). Gulls (*Larus* spp.) and terns (*Sterna* spp.) accounted for over 6% of the observations. Although overall patterns of seabird occurrence were similar among the six missions, differences between the spring and fall and among the regions were evident.

Spring

During the spring (April–June), we surveyed the Scotian Shelf, Grand Banks and northeast Newfoundland Shelf, and the Labrador Sea (Fig. 4A). Although numbers were highly variable, average densities during this time were higher off the coast of Newfoundland (median, range; 9.0 birds km^{-2}, 0–1270, n = 400) than in the Labrador Sea (2.5 birds km^{-2}, 0–103, n = 181) and on the Scotian Shelf (0.8 birds km^{-2}, 0–49, n = 400). Murre, dovekie, and Atlantic puffin together accounted for 62% of the spring observations. Common murre and Atlantic puffin were common in Newfoundland Shelf waters and through the Strait of Belle Isle, while thick-billed murre (*Uria lomvia*)

Table 2 Species composition of marine birds observed within a 300 m transect during six research missions in 2006.

Composition en espèces des oiseaux marins observés sur une distance de 300 m lors des six missions de recherche de 2006.

Family / *Famille*	Species / *Espèces*		Number observed / *nombre observé*
Gavidae	Loon species / *plongeons non identifiés*	*Gavia* spp.	3
Procellariidae	Northern Fulmar / *fulmar boréal*	*Fulmarus glacialis*	2688
	Cory's Shearwater / *puffin cendré*	*Calonectris diomedea*	28
	Greater Shearwater / *puffin majeur*	*Puffinus gravis*	963
	Manx Shearwater / *puffin des anglais*	*P. puffinus*	1
	Sooty Shearwater / *puffin fuligineux*	*P. griseus*	180
	Uknown Shearwater / *puffins non identifiés*	*Puffinus* or *Calonectris*	27
Hydrobatidae	Wilson's Storm-petrel / *océanite de Wilson*	*Oceanites oceanicus*	17
	Leach's Storm-petrel / *océanite cul-blanc*	*Oceanodroma leucorhoa*	331
	Unknown Storm-petrel / *océanites non identifiés*	*Oceanodroma* or *Oceanites*	306
Phalacrocoracidae	Great Cormorant / *grand cormoran*	*Phalacrocorax carbo*	1
	Double-crested Cormorant / *cormoran à aigrettes*	*P. auritus*	1
Sulidae	Northern Gannet / *fou de Bassan*	*Morus bassanus*	281
Anatidae	Common Eider / *eider à duvet*	*Somateria mollissima*	22
	Black Scoter / *macreuse noire*	*Melanitta nigra*	5
	White-winged Scoter / *macreuse brune*	*M. fusca*	5
	Unknown Scoter / *macreuses non identifiés*	*Melanitta* spp.	1
	Common Merganser / *grand harle*	*Mergus merganser*	9
Scolopacidae	Red Phalarope / *phalarope à bec large*	*Phalaropus fulicaria*	465
	Unknown Phalarope / *phalaropes non identifiés*	*Phalaropus* spp.	12
Laridae	Long-tailed Jaeger / *labbe à longue queue*	*Stercorarius longicaudus*	74
	Parasitic Jaeger / *labbe parasite*	*S. parasiticus*	1
	Pomarine Jaeger / *labbe pomarin*	*S. pomarinus*	58
	South Polar Skua / *labbe de McCormick*	*S. maccormicki*	2
	Great Skua / *grand labbe*	*S. skua*	15
	Unknown Jaeger or Skua / *labbes non identifiés*	*Stercorarius* spp.	114
	Ring-billed Gull / *goéland à bec cerclé*	*Larus delawarensis*	6
	Herring Gull / *goéland argenté*	*L. argentatus*	219
	Glaucous Gull / *goéland bourgmestre*	*L. hyperboreus*	39
	Great Black-backed Gull / *goéland marin*	*L. marinus*	98
	Sabine's Gull / *mouette de Sabine*	*Xema sabini*	2
	Black-legged Kittiwake / *mouette tridactyle*	*Rissa trydactyla*	671
	Unknown Gull / *goélands non identifiés*	*Larus* spp.	29
	Tern / *sternes*	*Sterna* spp.	71
Alcidae	Common Murre / *guillemot marmette*	*Uria aalge*	2491
	Thick-billed Murre / *guillemot de Brünnich*	*U. lomvia*	1475
	Unknown Murres / *guillemots non identifiés*	*Uria* spp.	1246
	Razorbill / *petit pinguin*	*Alca torda*	45
	Dovekie / *mergule nain*	*Alle alle*	4519
	Black Guillemot / *guillemot à miroir*	*Cepphus grylle*	8
	Atlantic Puffin / *macareux moine*	*Fratercula arctica*	859
	Unknown Alcidae / *alcidés non identifiés*	Alcidae	83
	Unidentified bird / *oiseaux non identifiés*		6
Total number observed / *nombre total observé*			17477

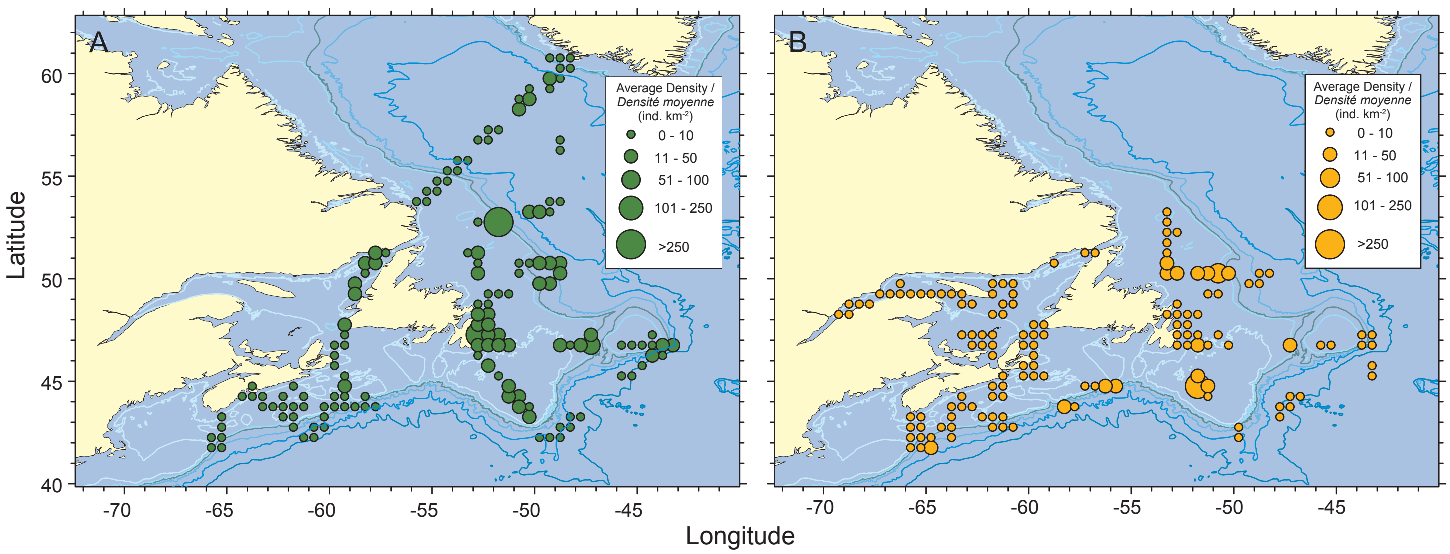

Fig. 4 Bird density (all species, total number of birds km^{-2}) averaged over half-degree quadrats during 2006 AZMP surveys in A) spring and B) fall.

Densité d'oiseaux (toutes les espèces, nombre total d'oiseaux au km^2) moyennée sur des quadrats d'un demi-degré lors de relevés PMZA en 2006 au printemps (A) et à l'automne (B).

and dovekie were observed farther offshore and across the Labrador Sea. Dovekie were especially abundant along the Newfoundland Shelf edge and slope waters (Fig. 5A). At this time of year, murres and puffins are moving from offshore wintering areas and beginning to colonize breeding areas in eastern Newfoundland, Labrador, and the Arctic. Dovekie are migrating towards colonies in the eastern Arctic and Greenland.

Northern fulmar were common (15% of spring observations) throughout the survey area, although less abundant on the Scotian Shelf compared to areas off Newfoundland and Labrador. Storm-petrels (Hydrobatidae) accounted for 4% of the birds observed and were seen throughout the region. They were especially abundant off Baccalieu Island (northeastern tip of the Avalon Peninsula; Fig. 1), which is the largest Leach's storm-petrel (*Oceanodroma leucorhoa*) colony in the world and is estimated to have more than 3 million pairs. Adult and immature black-legged kittiwake (*Rissa tridactyla*) were relatively common in Cabot Strait and off the Avalon Peninsula near breeding colonies. Red phalarope (*Phalaropus fulicaria*) were only observed in large numbers as we approached Greenland, in deep Labrador Sea waters. The phalaropes were all in breeding plumage and were presumably migrating to breeding grounds in the high Arctic.

Fall

The Newfoundland and Scotian shelves and the Gulf of St. Lawrence were surveyed in the fall (October–November; Fig. 4B). Again, we observed the highest bird densities off the coast of Newfoundland (median, range; 2.0 birds km^{-2}, 0–185, n = 326), intermediate densities on the Scotian Shelf (0.8 birds km^{-2}, 0–101, n = 363), and the lowest densities in the Gulf of St. Lawrence (0.01 birds km^{-2}, 0–72, n = 205). For all areas combined, densities in the fall (0.8 birds km^{-2}) were significantly less than those estimated in the spring (3.2 birds km^{-2}; Wilcoxon Test $Z = -11.9$, $P < 0.0001$). Murre, the most common species observed (26%), were concentrated almost exclusively on the Grand Banks and northeastern Newfoundland Shelf. Murre are known to winter in these areas but may also be migrating to areas farther south. Dovekie were observed in all regions but were common on the Newfoundland Shelf and through Cabot Strait (Fig. 5B). Although they are known to occur in large numbers on the Scotian Shelf during the non-breeding season, it is likely that not all had arrived from their northern breeding areas during the time of our fall surveys.

Greater shearwater accounted for 20% of the fall observations and were particularly abundant on the western Scotian Shelf and southeastern Grand Banks. This contrasts with the spring surveys, when greater shearwater observations were uncommon and occurred only on the eastern Scotian Shelf. Greater shearwater breed in the southern hemisphere, and it is thought that most of the non-breeding population can be found in our local waters during the austral winter. Similar to our observations in spring, northern fulmar were common (18%) and ubiquitous in fall, although less so in the Gulf of St. Lawrence. Black-legged kittiwake were distributed farther offshore during fall surveys compared to the spring but were also common in the Gulf. Although relatively rare during the spring missions (0.7% of observations), northern gannet (*Morus bassanus*) made up over 4% of the observations during the fall, all of which were on the Scotian Shelf and in the Gulf of St. Lawrence. During this time of year, immature gannets are moving to wintering areas off the coast of New England, to be followed a short time later by the adults. Leach's storm-petrels were only observed on the Scotian Shelf.

Associations Between Dovekie and Their Zooplankton Prey

Dovekie made up 26% of all the bird observations in 2006, by far the dominant species in the surveys (the next most common bird was northern fulmar, at 15%). To estimate their density more accurately, we first modelled the detection function (the probability of detecting a dovekie on the water at a given distance from the vessel) in relation to the region and several environmental factors and ranked the models

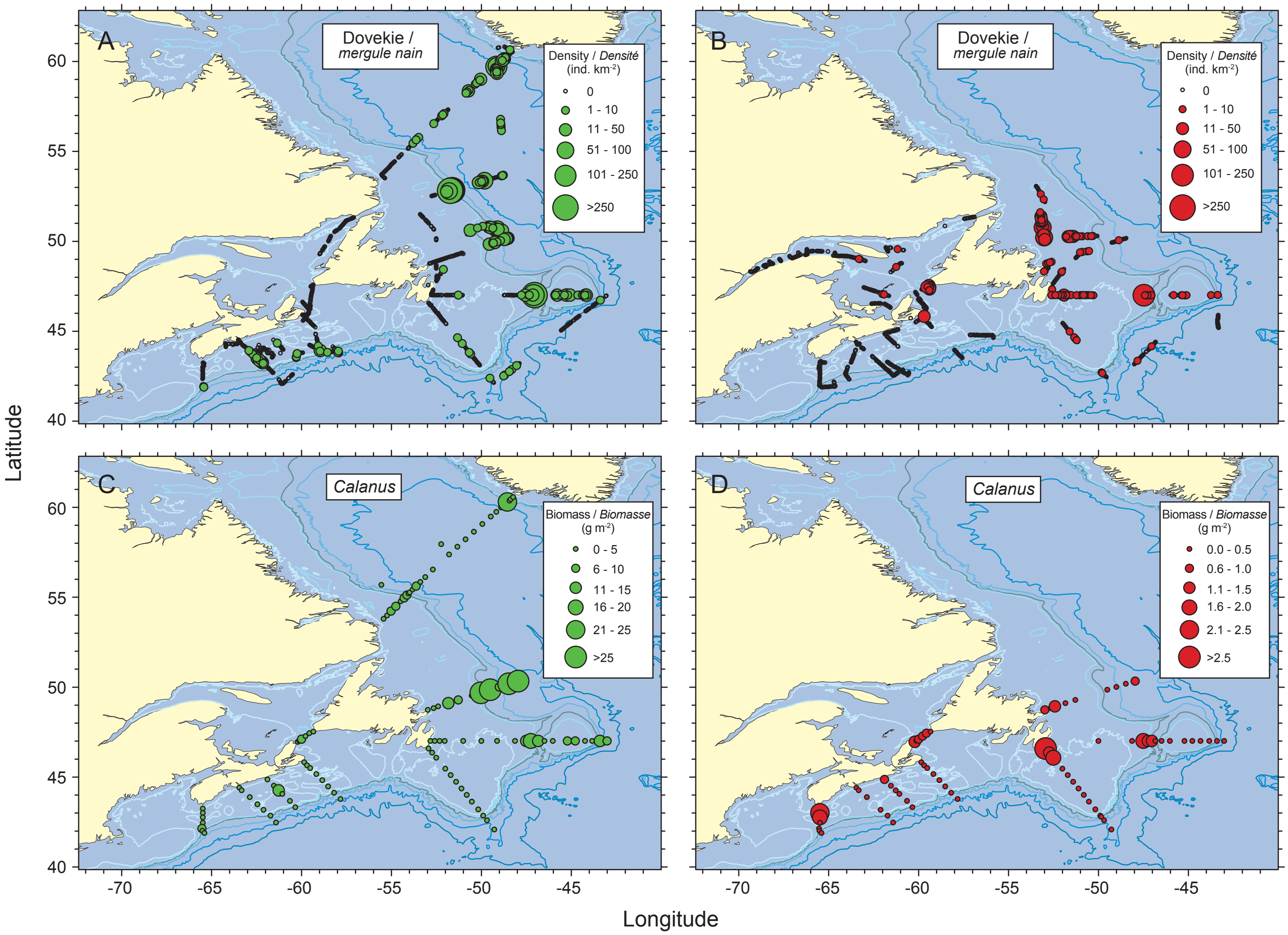

Fig. 5 Dovekie densities calculated for each 10-min survey (A and B) compared to total *Calanus* biomass (C and D) during spring (left) and fall (right) surveys in 2006.

Densités de mergule nain calculées pour chaque relevé de 10 min (A et B) comparées à la biomasse totale de Calanus *(C et D) lors des missions du printemps (à gauche) et de l'automne (à droite) en 2006.*

according to their AIC. Overall, we found that most birds were detected within 100 m of the vessel, but detectability dropped considerably beyond that distance (Fig. 3). Our best fit model was stratified by region and included wind speed as a covariate. Because wind speed disrupts the water's surface, it can significantly reduce the visibility of birds sitting on the water. The model that included relative sea-state estimates did not rank as high (ΔAIC = 117.5), nor did models that included visibility (ΔAIC = 172.9) or ship speed (ΔAIC = 177.7). Using detection probabilities calculated for each region, and taking into account wind speed values of the observations in those regions, we calculated dovekie densities for each of our 10-min surveys.

Overall, dovekie were more numerous during spring surveys compared to the fall. During the spring, dovekie concentrations were highest on the northeastern Newfoundland slope (Fig. 5A), where estimates were as high as 1316 birds km^{-2}. They were also numerous through the Flemish Pass (330 birds km^{-2}), near the southwest coast of Greenland (115 birds km^{-2}), and in Orphan Basin (61 birds km^{-2}). We estimated dovekie densities to be between 11 and 50 birds km^{-2} on the Flemish Cap, the Emerald Bank, and in the Gully Marine Protected Area. During the fall, large numbers of dovekie were again observed through the Flemish Pass (141 birds km^{-2}). Compared to spring surveys, more dovekie were observed closer to shore on the Newfoundland Shelf (up to 60 birds km^{-2}) and through Cabot Strait (Fig. 5B).

Our estimates of *Calanus* biomass in the surface layers were much higher in spring than in fall (Fig. 5C, D). This is partly due to the assumption that we made regarding the depth distributions of *Calanus*: we assumed that all individuals were near the surface in spring and only some in fall. We also note, however, that our depth resolution within the surface layers is poor, so we do not know the proportion of the *Calanus* that would have been available to the dovekie. Thus, our estimates of *Calanus* biomass are at best an index of the availability of this food. Nevertheless, we note certain features that are consistent with expectations. For example, the near-surface biomass of *Calanus* in Cabot Strait was higher, relatively speaking, in fall than in spring, which is the result of their having an extended reproductive and growth season in the region (Head and Pepin 2007). Dovekie could presumably take advantage of this locally abundant food source, which was reflected in the high densities observed in this area during the fall surveys. In addition, *Calanus* biomass offshore from the Greenland Shelf was high in spring, which is a regular feature from year to year and results from high reproductive and survival rates for *C. finmarchicus* in this region (Head et al. 2003). This productivity is likely an important feature for the millions of dovekie that breed along the western coast of Greenland and may explain the large numbers encountered during our survey in 2006. Finally, we note the high concentrations of both *Calanus* biomass and dovekie densities in the Newfoundland slope waters, especially at the northeastern edge of the Grand Banks, which are consistent with the previous observations of Brown (1986, 1988). Future work will include statistical analyses to estimate the degree of overlap between dovekie and their prey.

Conclusions

By utilizing the AZMP sections for seabird surveys, we are able to quantify distribution and abundance over a broad geographic area. Several of the sections are surveyed at least twice a year, allowing us to examine how seabird communities in specific areas may vary by season. Future work will compare these results with historic surveys to determine what changes may have occurred in seabird communities over the past three decades. The data collected in 2006 demonstrate the importance of specific areas in eastern Canada for birds during spring and fall migration. Over time, these data will help identify critical foraging, moulting, and roosting areas; migration routes; and the timing of major migrations. In addition, the physical, chemical, and biological data collected along the same sections allow us to examine linkages between seabirds and their marine habitat. In 2006, we found spatial overlap between high dovekie densities and *Calanus* biomass. High *Calanus* concentrations in Newfoundland slope waters and near the Greenland coast appeared to be important dovekie foraging areas, as did the northeastern Grand Banks and Cabot Strait during the fall. In the future, we can examine the persistence of these patterns between seasons and across years to determine whether marine birds have the potential to be indicators of underlying ecological processes over multiple scales. Because seabird surveys are also conducted between sections where oceanographic data are not collected, a strong association between dovekie occurrence and zooplankton biomass may highlight productive areas that would otherwise go undetected. Similarly, biological surveys conducted at night when seabird surveys cannot be done may reveal important habitat for foraging birds.

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