

SHORT COMMUNICATION

Foraging areas of Short-tailed Shearwaters during their northward migration along the Pacific coast of northern Japan

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I studied the distribution of Short-tailed Shearwaters *Puffinus tenuirostris* off the Sanriku and Joban districts of northeastern Japan in April 1999 during their northward migration. Short-tailed Shearwaters breed in southeastern Australia and Tasmania and migrate to the North Pacific in the non-breeding season. During migration, part of the population passes along the coast of northern Japan between April and June (Serventy 1953; Shuntov 1974; Degawa & Watabe 1983; Watabe et al. 1987). In this area, *Euphausia pacifica* is an abundant zooplankton species and is considered to be a key species in food web among marine organisms (Taki et al. 1996; Taki 1998). The distribution pattern and foraging ecology of the Short-tailed Shearwaters during their nomadic phase have been studied in the Bering Sea, where millions of these birds feed predominantly on euphausiids (Ogi et al. 1980; Schneider et al. 1986; Hunt et al. 1996), however, little is known about their ecology during the northward migration period. In the present paper, I discuss the foraging distribution of Short-tailed Shearwaters during this northward migration by analyzing the density and behavior of shearwaters in relation to prey availability.

METHODS

Observations were made from the wing deck (height: 7 m) of the 692 ton R/V *Wakataka-Maru* (Tohoku National Fisheries Research Institute:), from 13 to 23 April 1999 during daylight hours while the ship was underway at a speed of 12 knots (about 22 km/h). I identified, counted, and recorded the behavior of all seabirds seen within an area with a radius of 1,000 m from directly ahead of the ship to 90° off the side of

the ship with the best visibility using 8×56 mm and 20×60 mm image-stabilizer binoculars. Bird behavior was classified as either flying or sitting/foraging. The flight directions of flying birds were recorded as well as the time of each bird sighting. Ship speed and sea-surface temperature (SST) data were recorded at one minute intervals. The ship's position was recorded every 10 minutes. Abundance data were standardized to number of birds/km² every 10 minutes. The method used for observing the birds was the same as that described by Tasker et al. (1984).

Based on oceanographic data collected by the R/V *Wakataka-Maru* and the Japan Fishery Information Service Centre (JFISC) SST isothermal map (JFISC 1999; 15–18 April), the sampling area was divided into the following water masses: the Oyashio Area (OA), characterized by SST <10°C; Transition Area (TA), characterized by SST >11°C; a thermal front (TF) near the 10–11°C SST isothermal line, and a Warm-Core Ring (WCR), which formed from the Kuroshio Extension was characterized by a SST of 11°C, and the WCR remained at 39–40°N, 142–145°E (Fig. 1a).

RESULTS AND DISCUSSION

The total standardized number of all birds recorded during the 3,860 min of observation was 6,130.2 birds belonging to 32 species. The total standardized number of Short-tailed Shearwaters was 2,164.4, which was 35.4% of the standardized total of all birds observed. Thus, this shearwater was the predominant species in this survey area and period (Table 1). The densities of Short-tailed Shearwaters varied widely throughout the survey area, and were high within 50–100 km of the coast (Average±SD: 5.6±13.8 birds/km²; Maximum: 140.4 birds/km², Fig. 1b). Sitting/foraging shearwaters were found on the TF

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Table 1. Species composition and total number of seabirds recorded during the survey off Sanriku and Joban, northern Japan, in April 1999.

Species name	Total
Order Gaviiformes	
Family Gaviidae	
Pacific Loon <i>Gavia pacifica</i>	7.5
Yellow-billed Loon <i>Gavia adamsii</i>	2.0
Order Procellariiformes	
Family Diomedelidae	
Laysan Albatross <i>Diomedea immutabilis</i>	40.1
Black-footed Albatross <i>Diomedea nigripes</i>	17.2
Family Procellariidae	
Northern Fulmar <i>Fulmarus glacialis</i>	26.6
Streaked Shearwater <i>Calonectris leucomelas</i>	786.2
Flesh-footed Shearwater <i>Puffinus carneipes</i>	351.2
Sooty Shearwater <i>Puffinus griseus</i>	347.9
Short-tailed Shearwater <i>Puffinus tenuirostris</i>	2,164.4
Family Hydrobatidae	
Fork-tailed Storm-petrel <i>Oceanodroma furcata</i>	0.5
Leach's Storm-petrel <i>Oceanodroma leucorhoa</i>	14.4
Sooty Storm-petrel <i>Oceanodroma tristrami</i>	667.1
Madeiran Storm-petrel <i>Oceanodroma castro</i>	13.9
Order Pelecaniformes	
Family Phalacrocoracidae	
Temminck's Cormorant <i>Phalacrocorax filamentosus</i>	0.6
Pelagic Cormorant <i>Phalacrocorax urile</i>	4.7
Order Charadriiformes	
Family Phalaropodidae	
Red Phalarope <i>Phalaropus fulicarius</i>	345.0
Family Stercorariidae	
South Polar Skua <i>Catharacta maccormicki</i>	0.3
Pomarine Jaeger <i>Stercorarius pomarinus</i>	11.6
Long-tailed Jaeger <i>Stercorarius longicaudus</i>	33.8
Parasitic Jaeger <i>Stercorarius parasiticus</i>	0.8
Family Laridae	
Herring Gull <i>Larus argentatus</i>	20.0
Slaty-backed Gull <i>Larus schistisagus</i>	65.7
Glaucous Gull <i>Larus hyperboreus</i>	0.5
Black-tailed Gull <i>Larus crassirostris</i>	310.2
Black-legged Kittiwake <i>Larus crassirostris</i>	599.9
Common Tern <i>Sterna hirundo</i>	0.3
Family Alcidae	
Thick-billed Murre <i>Uria lomvia</i>	10.4
Marbled Murrelet <i>Brachyramphus marmoratus</i>	0.7
Ancient Murrelet <i>Synthliboramphus antiquus</i>	222.3
Crested Auklet <i>Aethia cristatella</i>	0.3
Parakeet Auklet <i>Aethia psittacula</i>	0.6
Rhinoceros Auklet <i>Cerorhinca monocerata</i>	53.6
Total	6,120.2

and OA waters. Only a few flying birds and no sitting birds were observed in the WCR (Figs. 1b & 1c). Higher proportions (82%) of birds flew northward were recorded during survey period suggesting that they were on migration to northern sea area as described by Ito and Ogi (1999) (Table 2). However at

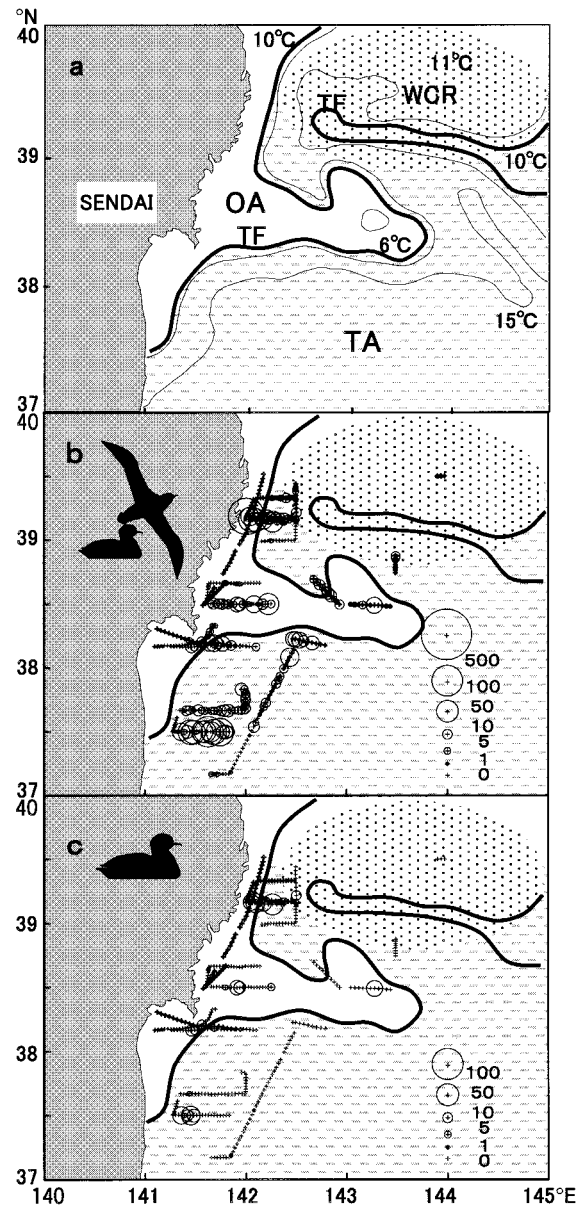


Fig. 1. Oceanographic features during 15–18 April and distribution of Short-tailed Shearwaters off Sanriku and Joban in April. (a) OA: Oyashio Area; TA: Transition Area; TF: thermal front; WCR: Warm-Core Ring; (b) flying and sitting/foraging shearwaters; (c) sitting/foraging shearwaters only. +: position where a 10 minute count was made; the size of the circle represents the abundance of birds at each position (birds/km²).

Table 2. Behavior of Short-tailed Shearwaters recorded for each sighting.

	N	(%)
Flying Northward	1,771.4	81.8
Flying Southward	14.0	0.6
Sitting/Foraging	378.9	17.5
Total	2,164.4	100.0

least five flocks consisting of 100–1,000 Short-tailed Shearwaters (including the birds foraging outside of the sampling radius) were observed on the water at 39°15'N, 142°00'E on 22 April 1999. In these flocks more than 80% of birds were actively diving into the water and they continued foraging until the ship approached closely. Some of them (at least 20 birds) vomited euphausiids before flying away from the ship. Taki et al. (1996), and Taki and Ogishima (1997) reported that *E. pacifica* adults are the most abundant zooplankton in April and they tend to occur in the Oyashio where the water is at 5–10°C (Kotani et al. 1996; Taki et al. 1996; Taki & Ogishima 1997). *E. pacifica* avoids areas of high SST and rarely occurs in the WCR (Taki 1998). In mid April, *E. pacifica* form daytime surface swarms in the coastal area off Sanriku (Endo 1984; Odate 1991) Thus, the distribution of some shearwaters during their northward migration is presumably related to the presence of adult euphausiids in cold water masses off the Sanriku and Joban district.

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