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Winter migration of female northern fur seals *Callorhinus ursinus* from the Commander Islands

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Three female northern fur seals (*Callorhinus ursinus*), two adults and one sub-adult tagged on November 12, 1996, were tracked from the Commander Islands using satellite telemetry. The cumulative distance traveled by each female was 732-2,744 km during 26-67 days and the estimated average traveling speed was 1.1-1.7 km/h. The sub-adult female moved south along the Kamchatka Peninsula and traveled near the Subarctic Boundary in the western North Pacific to a location 1,463 km east of Hokkaido by January 18, 1997. One of the adult females moved to the Northwest Pacific Seamount Chain, to a location that was 592 km southwest of Attu Island, Aleutian Islands by December 8, 1996. The other adult female moved to the Bering Sea, passed through the Amukuta Pass in the eastern Aleutian Islands during December 15 and 16, and traveled near the Eastern North Pacific to a location 518 km southeast of Unimak Island, Aleutian Islands by January 17, 1997, where northern fur seals from the Pribilof Islands commonly occur during their winter migration. This study presents new information on the winter migration patterns of northern fur seals from the Commander Islands and demonstrates the movements overlapping with northern fur seals from the Pribilof Islands. These results also suggests previous studies indicating that northern fur seals from the Commander Islands use areas of the central and eastern North Pacific during their winter migration.

Key words: northern fur seal, migration, satellite telemetry

Introduction

The Commander Islands, including Bering Island and Medny Island, are located at the western edge of the Aleutian Islands. Approximately 22,000 northern fur seals (*Callorhinus ursinus*) occur on the Commander Islands during the summer breeding season and they migrate south to warmer waters in the North Pacific Ocean during the winter (Reijnders et al., 1993; Lander and Kajimura, 1982). Although several studies have investigated the winter distribution of northern fur seals (Bigg, 1990; Kajimura, 1984; Tsuboi, 1980; Wada, 1971), relatively little is known about their winter migration patterns from the Pribilof Islands (Loughlin et al., 1999; Ragen et al., 1995; Baba et al., 1991) and nothing is known about their winter movements from the Commander Islands. One reason for this lack of information is that no reliable techniques have existed for tracking marine mammals at sea.

The recent development of miniaturized satellite tracking devices has greatly improved the ability to document movements and activities of wild animals (Fancy et al., 1988). In marine mammal studies, satellite tracking has recently provided detailed information on movement patterns and foraging behaviors of harbor seals (Stewart et al., 1989), elephant seals (Stewart and DeLong, 1994), northern fur seals (Loughlin et al., 1999; Baba et al., 1991), Antarctic fur seals (Boyd et al., 1998), Steller sea lions (Merrick et al., 1994) and humpback whales (Mate et al., 1998). Satellite tracking has also provided information on the survival of marine mammals that have been rehabilitated and released in the wild (Wells, et al., 1999).

Northern fur seals that were tagged on the Commander Islands have been captured in the Sea of Japan, Sea of Okhotsk, North Pacific Ocean and Bering Sea (NPFSC, 1969, 1975). They have also been observed during the breeding season on the Pribilof Islands, San Miguel Island, Kuril Islands and Robben Island (NPFSC, 1969, 1975). These results suggest that northern fur seals from the Commander Islands migrate great distances from their breeding Islands to the North Pacific Ocean (Fig. 1). The purpose of this study is to examine the migration patterns of female northern fur seals from the Commander Islands using satellite telemetry.

Materials and Methods

On November 10 and 12, 1996 we attached Toyocom 2038 Platform Transmitter terminals (PTTs) to the dorsal pelage of five female northern fur seals at Northern rookery on Bering Island, Commander Islands. The PTTs were attached with epoxy glue (Quick 5, Konishi Co. Ltd., Osaka, Japan). On the basis of standard body length, one of the females was estimated to be 2 years of age (sub-adult, Table 1) and two were estimated to be at least 6 years of age (adult, Table 1).

Total weight of each PTT was 265 g in air, which represents about 1% of a female northern fur seal's body weight. The size of each PTT was 3.5 cm in diameter and 19 cm in length. The satellite transmitters emitted a signal every 60 seconds until the batteries were exhausted. The power output of the PTT transmission signal was 0.5 W and the transmission signal was programmed to transmit continuously.

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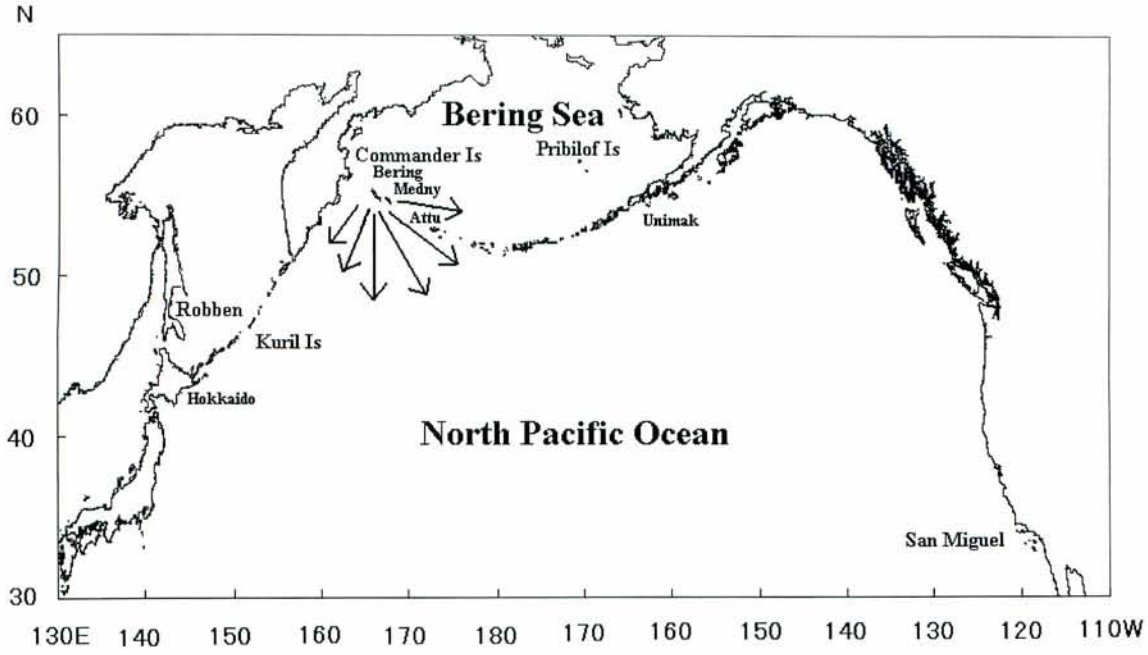

Fig. 1. Migrating routes of northern fur seals from the Commander Islands to the North Pacific Ocean estimated by past distribution and tag recovery data.

Locations were collected through the ARGOS system (CLS/Service Argos Processing Center, Toulouse, France). Data obtained from these PTTs included time of day, latitude and longitude. Indicators of the precision of the location (latitude and longitude) were also obtained and were based on signal quality (Class 3 = <150 m SD, Class 2 = < 250 m SD, Class 1 = <1000 m SD, Class 0 = > 1000 m SD, and Class 0 locations were further subdivided into Class A, B and Z levels of precision). Location data were evaluated to identify and remove unreasonable locations based on the estimated traveling speed between two locations. Locations that resulted in average speed >10 km/h were eliminated and the average speed recalculated between previous and subsequent points. Class A locations (error + 2 km) were used to calculate swimming speed and cumulative distances traveled, but Class B and Z locations were not used because of the high degree of error associated with these data.

Results and Discussion

Transmitter data

Two of the five PTTs malfunctioned soon after they were deployed and were not used in this analysis. The remaining three PTTs provided 165, 51, and 222 locations, for seals #1, #2 and #3, respectively. Location qualities that were analyzed for distance and swim speed ranged from Class A to Class 3 and numbered 45, 3, and 45 for seals #1, #2, and #3, respectively. A small number of locations were attributed to the lack of a saltwater

Table 1. Biological data, tracking period, and traveling speed of female northern fur seals.

Seal	PTT ID	Age (est)	Body length	Body weight	(GMT) Tagging date (tracking start)	(GMT) Tracking end	Tracking period	Traveling distance	Traveling speed
			(cm)	(kg)		(GMT)	(hours)	(km)	(km/h)
#1	18645	2	114	22.0	1996.11.12	1997.1.18	1627	2229	1.4
#2	18643	7	123	32.6	1996.11.12	1996.12.8	639	732	1.1
#3	18644	6+	129	37.0	1996.11.12	1997.1.17	1600	2744	1.7
#4	18640	3-4	118	22.6	1996.11.10	-	-	-	-
#5	18641	6+	122	40.1	1996.11.10	-	-	-	-

switch, which prevented transmissions when the animal was submerged, on the PTTs (Nakamura et al., 1985).

Individual movements

Seal #1 (sub-adult female) was tracked for the longest period (Table 1) and moved southwest along the Kamchatka Peninsula in the East Kamchatka Current, and then changed course to the southeast off the Kuril Islands, and arrived near the Subarctic boundary (Favorite et al., 1976) in the western North Pacific (Fig. 2). Her southeast change in direction off the Kuril Islands may have been influenced by the current flow of Bussol's Strait from the Okhotsk Sea (Talley, 1991). The last location of seal #1 was recorded 1,463 km east of Hokkaido on January 18, 1997.

Seal #2 (adult female) moved south along the Northwest Pacific Seamount Chain and entered the Western Subarctic Gyre (Fig. 2). Her last reported location was 592 km southwest of Attu Island, Aleutian Islands on December 8, 1996.

Seal #3 (adult female) moved east to the Bering Sea and to the Aleutian North Slope Current (Reed and Stabeno, 1999), and went through the Amukuta Pass, Aleutian Islands on December 15 and 16. The seal then entered the eastern North Pacific, and moved to a location of 518 km southeast of Unimak Island, Aleutian Islands by January 17, 1997 (Fig. 2).

Table 2. Monthly traveling speed (km/h) of Commander female fur seals.

Seal	November	December	January
#1	2.1	1.2	1.1
#2	-	-	-
#3	2.3	1.6	1.5

The traveling speed of seal #2 could not be calculated because of the few data (only two).

The results from this study were not unexpected because it is known that some northern fur seals from the Commander Islands travel great distances in the North Pacific Ocean during their winter migration (Bigg, 1990). However, the direction and pattern of movement of the three seals in this study were notably different. Although seals #2 and #3 were adults of the same sex, the former migrated to the western North Pacific and the latter moved to the eastern North Pacific. Both of these females were probably mature since most females reach sexual maturity after 6 years of age (York, 1983). Although the occurrence of tagged juvenile northern fur seals from the Commander Islands has been reported in the eastern North Pacific (Baba et al., 1993), the migration of adult females to this region was rare (NPFSC, 1975). Seal #3 migrated to an area commonly used by northern fur seals from the Pribilof Islands (Bigg, 1990) and adult males and females are known to use this area during their winter migration from the Pribilof Islands (Kiyota et al., 1992; Loughlin et al., 1999). Northern fur seal pups have also been reported to occur in this region, and travel through several passes (Unimak, Akutan, Umnak and Samalga) in the eastern Aleutian Islands before entering the North Pacific Ocean (Ragen et al., 1995). The migration path of seal #3 demonstrates the likely timing and location where northern fur seals from the Commander and Pribilof Islands occur simultaneously.

Monthly mean traveling speed of seals #1 and #3 decreased from November to January (Table 2) and

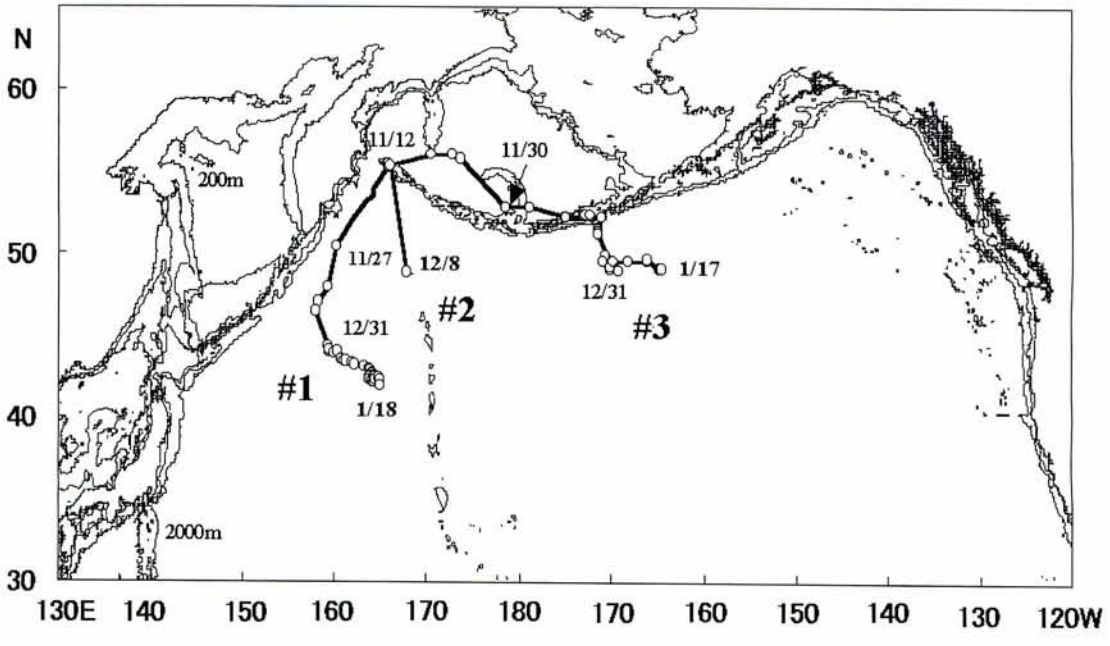

Fig. 2. The tracking courses of three female northern fur seals determined by the satellite telemetry. Circle shows the location of seal. Number shows Month/Day.

the seals tended to remain in the same general area in the North Pacific Ocean during the month of January (Fig. 2). These females probably remained in this region of the North Pacific Ocean to forage on abundant prey resources such as myctophids, gonatid squid (*Berryteuthis anonychus*), and juvenile salmon which are known important food of northern fur seals in the eastern and western North Pacific in January (Kajimura, 1984; Nagasawa et al., 1997; Ueno et al., 1997). These results suggests previous studies (e.g., Bigg, 1990) and provide new evidence that female northern fur seals from the Commander Islands use the central and eastern North Pacific Ocean for foraging during winter.

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冬季におけるコマンダー諸島雌オットセイの回遊

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摘　要

1996年11月12日にコマンダー諸島で標識したオットセイ雌３頭(成獣２頭，亜成獣１頭)を衛星テレメトリーにより追跡した．これらの個体は26～67日の間に732～2,744km(推定平均時速1.1～1.7km/h)移動した．亜成獣雌はカムチャツカ半島沿いに西部北太平洋の亜寒帯境界付近まで移動し，1997年１月18日までに北海道の東1,463km沖に至った．成獣雌は北西太平洋海山に沿って移動し，12月８日までにアッツ島の南西592km沖に至った．もう１頭の成獣雌はベーリング海に出た後12月15～16日の間に東部アリューシャン列島のアムクタ海峡を通過し，プリビロフ諸島のオットセイが分布する東部北太平洋に入り，１月17日までにウニマック島の南東518km沖に至った．これらの結果は，コマンダー諸島オットセイの移動経路がプリビロフ諸島オットセイの分布域と重なることを実証すると同時に，冬季コマンダー諸島のオットセイが中央及び東部北太平洋に分布するというこれまでの知見を支持している．

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