

Movements and use of haul-out sites of radio-tagged Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) during the open-water season

Jouni T. Koskela¹, Mervi Kunnasranta, Esa Hämäläinen & Heikki Hyvärinen²

Department of Biology, University of Joensuu, P.O. Box 111, FIN-80101 Joensuu, Finland

¹⁾ *Present address: Metsähallitus, Nature Protection, Akselinkatu 8, FIN-57131 Savonlinna, Finland*

²⁾ *Correspondence author (e-mail: heikki.hyvarinen@joensuu.fi)*

Received 28 December 2000, accepted 23 September 2001

Koskela, J. T., Kunnasranta, M., Hämäläinen, E. & Hyvärinen, H. 2002: Movements and use of haul-out sites of radio-tagged Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) during the open-water season. — *Ann. Zool. Fennici* 39: 59–67.

The movements and use of haul-out sites of nine adult Saimaa ringed seals (*Phoca hispida saimensis*) were monitored by VHF-radiotelemetry during the open-water season. Saimaa seals exhibited a high degree of site fidelity. The home range of this subspecies is probably smaller than that of ringed seals living in the sea. The main living area of one male was about 3 km² and whole living area about 20 km². All seals used more than one haul-out site during the study periods. Maximum distances between different haul-out sites of studied seals ranged from 2.7 km to 13.0 km. Moreover, the wintering areas of five seals were the same as the summertime haul-out site of each seal. The first translocation experiment on the Saimaa ringed seal was made in this study. After translocation of 100 km, mature female moved 18 km and showed a high degree of site fidelity in her new environment.

Introduction

Lake Saimaa (61°05′–62°36′N, 27°15′–30°00′E) with surface area of 4380 km² is the largest lake

in Finland. The shoreline is about 15 000 km long and the lake is characterised by several areas of exposed water, which are connected to each other by narrow sounds. This labyrin-

thine water system is inhabited by subspecies of ringed seal (*Phoca hispida saimensis*), which has been living separated from other ringed seals for over 8000 years. Morphologically, the Saimaa ringed seal has already differentiated from the neighbouring subspecies in the Baltic Sea and in Lake Ladoga (Hyvärinen & Nieminen 1990). Nowadays this highly endangered subspecies is estimated to consist of 230–250 individuals.

Previous studies of diving behaviour, based on telemetric techniques, have shown that Saimaa seals spend even 80% of the total time submerged during the open water season. In addition, dive duration of the seals ranges 3 min to 7 min with maximum over 20 min and the seals are supposed to sleep during long duration resting dives (Hyvärinen *et al.* 1995, Kunnasranta *et al.* 2002). These studies also indicated that the Saimaa seal is quite stationary subspecies. Thus, it has been supposed that the breeding populations in northern and southern parts of the lake are separated from each other and that the population might be divided into several subpopulations (Sipilä *et al.* 1990). However, there has not been information about movements and habitat use of ringed seals in Lake Saimaa. Information concerning the movements, homing behaviour, home range and home fidelity is needed for better understanding ecology of the Saimaa seal and also for improving conservation strategies of this threatened subspecies.

In the present study, we examined the movements and use of haul-out sites of radio tagged Saimaa seals in an attempt to characterise the home range size of the seal. Further, we present data from the first translocation experiment on the Saimaa seal.

Materials and methods

The movements of radio-tagged Saimaa seals were monitored in different parts of Lake Saimaa in 1990–1997 (Fig. 1). A male (named Sulevi) was released back to his natural environment in northern Saimaa in August 1990 after being in captivity in a small lake for four years (*see* Hyvärinen *et al.* 1995, Kunnasranta *et al.* 1999).

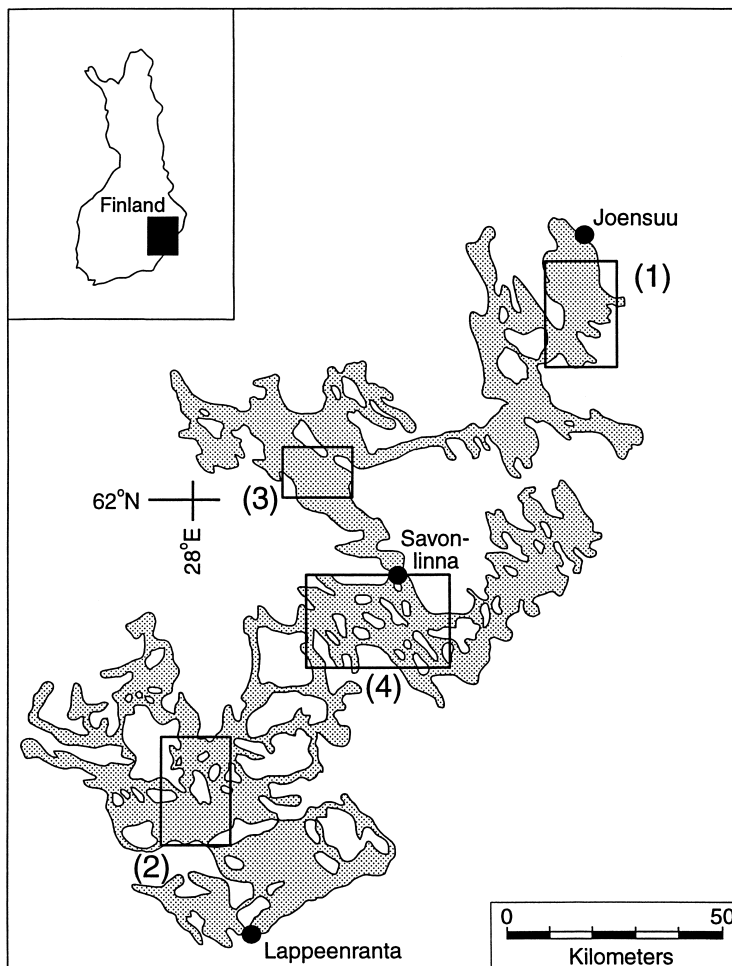
In 1992, an adult female (Venla) was captured in central Saimaa (Fig. 1: area 3) and transported about 100 km (Fig. 1: area 2) south of the capture site as part of an initiative to increase number of mature females in this low population area. The movements of these seals were monitored with an Argos satellite telemetry system with UHF transmitters (Toyocom T-2028 PTTs, Toyo Communication Equipment Co. Ltd, Tokyo, Japan). Locations (classes 1, 2 or 3) were approved with a minimum accuracy of 1 km in 66% of the results. Venla was also equipped with a VHF transmitter (Finntracker AML-465, Finland).

In 1993, two adult males (named Konsta and Osmo) and in 1994 a female (Orvokki) and Osmo for the second year in a row were captured in central Saimaa from Haukivesi area (Fig 1, area 3). In 1996, adult male (named Väinö) and adult female (Emma) and in 1997 two other females (Lyyli, Suvi) and Emma second time were captured from southern part of central Saimaa from Pihlajavesi area (Fig. 1: area 4). The seals were equipped with VHF-transmitters similar to those attached to Venla.

The seals were captured with nets from haul-out areas during the moulting season (middle of May to early June). Radio tags were attached with epoxy resin to the pelage between the scapulae of the seals (*see* Hyvärinen *et al.* 1995). In practice, tags transmitted for 3–8 months. In some cases only few weeks of movements were recorded as transmitter antennae were broken or batteries expired. Radio tags fell off at least at the time of next moulting. Additionally, all studied seals were tagged with a plastic tag (Dalton Jumbo Plastic Rototag) in the webbing of the hind flipper. After transmitters fell away, flipper tags as well as individual characteristic were used to identify the seals during the next few years.

A signal could be received from the transmitter only when the seal was surfacing. The locations of seals were determined with portable receivers (Finntracker AMV-466, Finland and AOR 8000, Japan) and animals were visually observed at least once a week. Transmitter signals were also monitored continuously with an omni-directional dipole antenna connected to a receiver with a chart recorder (Hioki 8201,

Fig. 1. Map of study areas of radio-tagged Saimaa ringed seals: (1) Sulevi, (2) Venla, (3) Konsta, Osmo, Orvokki, (4) Väinö, Emma, Lyyli and Suvi.



Japan). The range of recorder ranged from 3 km to 5 km, signal strength varying with the surrounding topography. The recorders were placed approximately in the middle of the living areas of the studied seals.

Additionally, habitat use of the seals was monitored in 1993 and 1994 by two computer-guided permanent stations located on the shore. VHF signals could be monitored from seals as far away as 10 km by directional antennae mounted on mast 5–15 m above the water surface. The exact range of the receivers varied between regions. Locations in 1993 were determined automatically when the seals were hauled out on the rocks. In 1994 from August to November we were able to locate also the majority of

surfacing places of Osmo with this cross-bearing method. Locations determined were compared in this way with locations obtained by visual observation. The cross-bearing method was accurate within a hundred meters. Data from chart recorders were used to confirm whether or not the seals travelled outside of the receiving range of the signal. Using these various methods we were able to find all haul-out sites of the seals and to designate the travelling dives of Osmo from other dives. If the location of surfacing was changed systemically, the dives were grouped as travelling dives. The other dives were subdivided into as resting dives and foraging dives (*see Hyvärinen et al. 1995, Kunasranta et al. 2002*).

Results

The movements of nine free ranging Saimaa seals were monitored during the open water season on Lake Saimaa. Maximum distances between the farthest observed locations of individual seals ranged from 3.4 to 18 km and between different haul-out sites from 2.7 to 13.0 km (Table 1). All seals used more than one haul-out site during the study periods (*see* Figs. 2–5).

After four years in captivity, Sulevi (male) released in 1990 back to the haul-out area, where was captured in 1986. Before that, it had been seen annually in the same area during moulting season since the end of the 1970s. After release it stayed close to the release site for about one week (Fig. 2). Then it moved to another group of islands, about seven kilometres to the east and stayed there for one and a half months. During one week, it travelled between these two areas and finally settled in the wintering area at the end of October and made a haul-out lair within same area (Fig. 2). During the radio tagging period (15 August 1990–7 January 1991) it used only two different haul-out sites. Moreover, Sulevi was observed hauled-out at his capture site during the moulting season every year since its release. At the end of May 1995 and 1996 he was seen hauled-out on a rock 13.0 km south (Fig. 2) of his main haul-out site but returned back in June.

The translocation experiment on the Saimaa seal was made in the summer of 1992. An adult female (Venla) was captured in central Saimaa and transported about 100 km to the south of the capture site. During the first week after release, Venla moved about 18 km south and settled down near some islands (Fig. 3). Venla used a group of islands as haul-out site and based on the signals received by the chart recorder, she remained over 95% of the whole time within the range of the receiver (diameter about 3 km) until the end of November when the transmitter batteries ran out. In addition, after the radio tagging period had ended, Venla was seen in the same area several times annually. In the springs of 1994 and 2000 she gave birth within this area (Fig. 3).

In 1993, males Konsta and Osmo were observed to use two haul-out sites each located 3 km and 2.7 km from each other, respectively (Fig. 4). A transmitter signal of Konsta was observed during the ice-covered period on 5 different days in December and 3 days in January close to the chart recorder in the same habitat as in summer. In January 1994, this seal was located hauled-out in the haul-out lair and in April his lair was found only 800 m away from his capture site (Fig. 4).

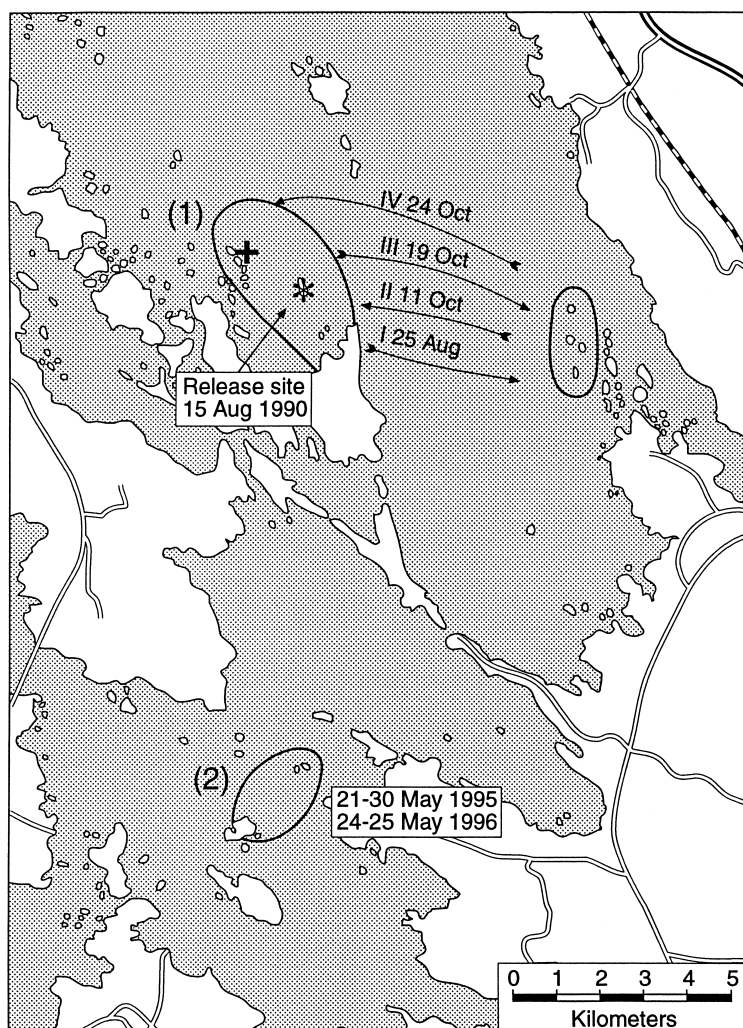
In 1994, Osmo used the group of islands where he was captured as haul-out site almost exclusively (Fig. 4). Once, at the end of November, was he located 4.0 km away from his main

Table 1. Maximum distances (km) between different haul-out sites and surface locations of nine adult Saimaa ringed seals.

Seal	Number of bearings	Haul-out sites	Surface locations	Study period
Sulevi ♂	106	13.0	13.0	15 August 1990–7 January 1991, 21 May–15 July 1995
Venla ♀	40	4.3	9.5 ¹	4 June–21 December 1992
Konsta ♂	50	2.9	3.4	20 May 1993–20 January 1994
Osmo ♂	63	4.5	6.8	11 May–4 August 1993, 25 May–30 November 1994
Orvokki ♀	17	3.3	7.5	25 May–8 September 1994
Väinö ♂	28	7.5	8.0	21 May–28 June 1996
Emma ♀	35	7.5	7.5	21 May–13 August 1996, 22 May–11 June 1997
Lyyli ♀	14	10	10	23 May–5 June 1997
Suvi ♀	44	6.5	7	5 June–12 November 1997

¹⁾ Excluding transition (about 18 km) from release site to new home range.

Fig. 2. Main haul-out sites of male Saimaa seal, Sulevi. (1) Movements 15 Aug. 1990–7 Jan. 1991 (24 Argos locations and 7 sightings) and haul-out lair (+) in winter 1991, (2) haul-out site in springs 1995 (7 sightings) and 1996 (2 sightings).



haul-out site. The location of Osmo's haul-out lair could not be determined precisely, but at the end of April 1995 he was seen hauled-out on his capture site. When all locations of Osmo during May–November in 1994 are taken in account, his living area was about 20 km² (Fig. 5). In addition, about 90% of locations of surfacing places ($n = 2594$) by automatically cross-bearing method in August to November in 1994 were situated in about 3 km² area, which Osmo used for foraging and resting during study period (Fig. 5). Osmo displayed quite established behavior patterns, and was typically at the same places daily (Fig. 5). In 1994 female Orvokki used two different haul-out sites at a distance of 3.3 km

from each other, preferring the place where she was captured (Fig. 4). Osmo and Orvokki were captured on rocks of the same island simultaneously in 1994 and they shared the same foraging area and haul-out site during study period. Twice, in August and in September, they were seen together in water about 2 km from their main haul-out site. According to visual observations and chart recorder records they had been hauling out at the same haul-out site together at least three different times.

The haul-out sites of the seals captured from Pihlajavesi, were different during the moulting time and later in summer (Fig. 4). Haul-out sites of Vainö and Emma were 7.5 km and 5.5 km

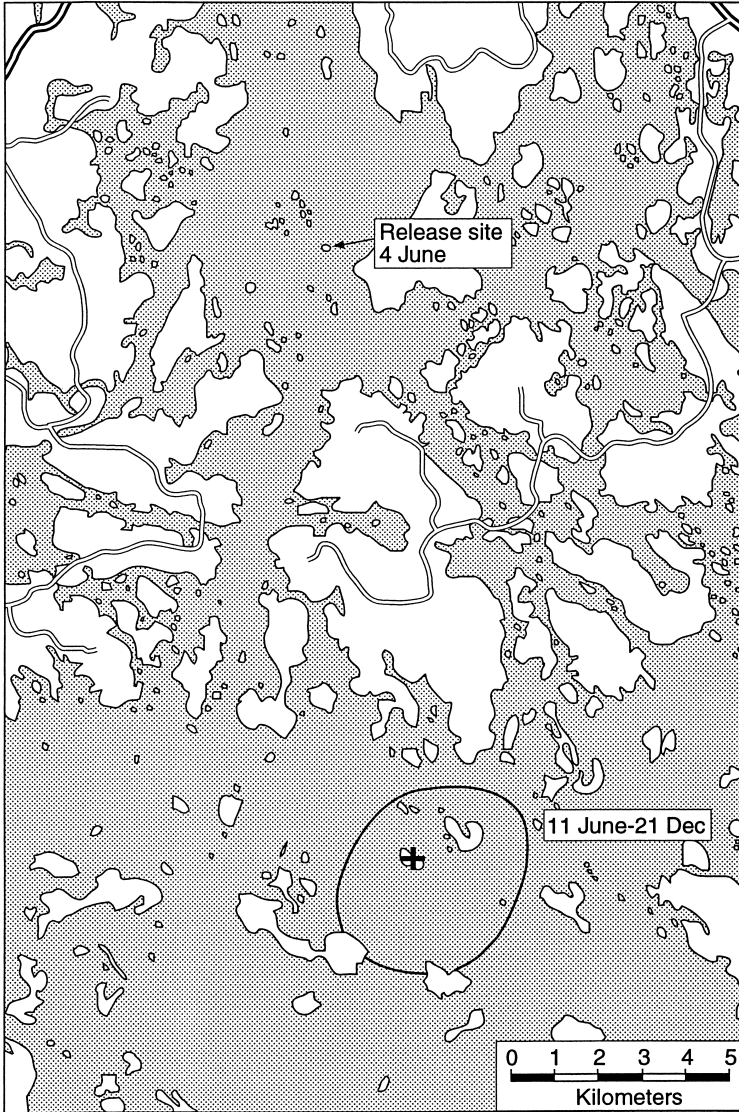


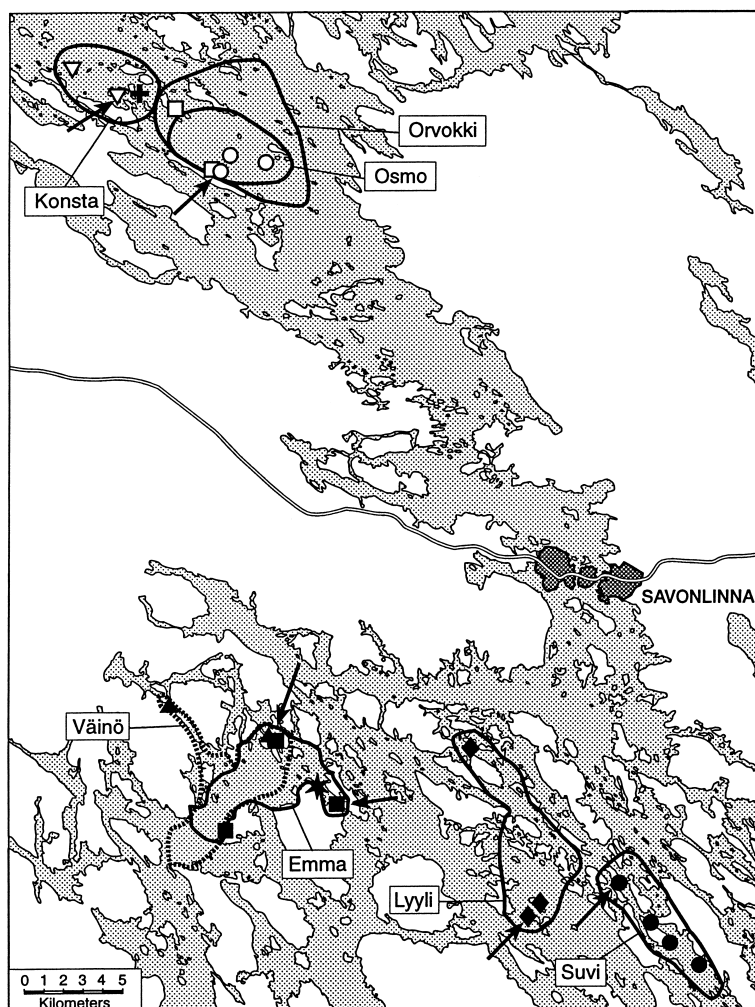
Fig. 3. Main haul-out sites and living area of translocated Saimaa seal female Venla in 1992 and its birth lair site (✚) in winters 1994 and 2000.

from capture site in 1996, respectively. Emma gave birth in 1997 and birth lair was situated about 2.5 kilometres from the capture site of 1996 (Fig. 4). The main haul-out area of Emma was same also in 1997, although the capture site in the moulting time was different 1997. The haul-out site of Lyyli soon after moulting was 11 km from the capture site. Suvi had at least 3 different haul-out sites and the maximum distance from her capture site was 6.5 km (Fig. 4).

Discussion

According to this study, movements of adult Saimaa seals seem to be small compared with that of ringed seals living in the sea. The maximum distances of individual Saimaa seals observed during the open water season ranged from 3.4 km to 18 km. In addition, the whole living area of one male during open water study period was only about 20 km² and it spent 90% of its time

Fig. 4. Haul-out sites and main living areas of radio-tagged Saimaa seals. Haukivesi area: Haul-out sites of Konsta (▽) in 1993, Osmo (○) in 1993–1994, Orvokki (□) in 1994 and haul-out lair of Konsta (✚) in 1994. Pihlajavesi area: Haul-out sites of Väinö (▲) in 1996, Emma (■) in 1996 and 1997, Lyyli (◆) and Suvi (●) in 1997 and pupping lair of Emma (✱) in 1997. Main living area of each seal during study period is marked by line with name-plate and captures sites by arrows.



within area of 3 km², which indicates quite small home range of adult Saimaa seals. In contrast, the seasonal movements of ringed seals in the Arctic Ocean usually vary from 10 to over 100 km, and long-distance migrations of more than 1000 km have been documented (Frost & Lowry 1981, Smith 1987, Heide-Jørgensen *et al.* 1992, Kapel *et al.* 1998, Teilmann *et al.* 1999). However, there are some evidences that adult marine ringed seals can also be sedentary (McLaren 1958, Smith & Hammill 1981, Kapel *et al.* 1998) and that subadults may have some fidelity to theirs area of birth (Teilmann *et al.* 1999). Young ringed seals may make extensive

travels (Frost & Lowry 1981, Ridoux *et al.* 1998) and juvenile Baikal seals (*Phoca sibirica*) have migrations of hundreds of kilometres in Lake Baikal (Stewart *et al.* 1996). According to preliminary observations, immature Saimaa ringed seals travel longer distances than adults (Kunnasranta 2001), but these migrations are not comparable with the marine ringed seals. So although, adult Saimaa seals seem to be very local, juvenile seals might improve gene flow between distribution areas in Lake Saimaa.

In the current study, all adult Saimaa seals showed high site fidelity and many seals have been observed to use same hauling-out sites

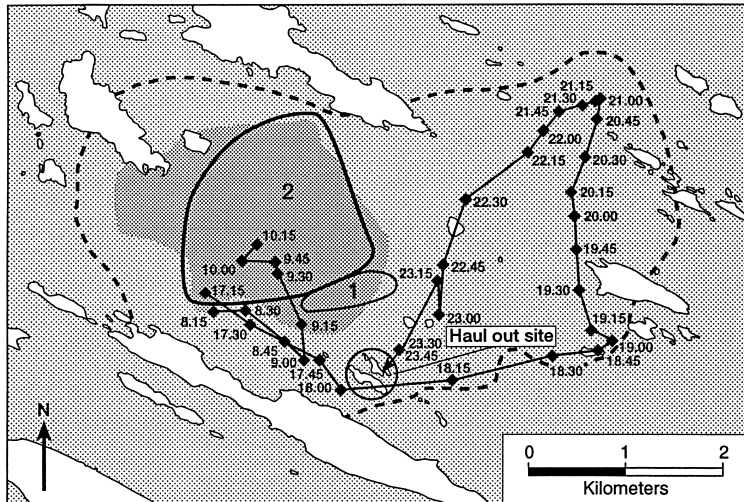


Fig. 5. Locations of different diving behavior of the automatically monitored Saimaa seal male (Osmo) during one day (17 August 1994) and the area of all locations ($n = 2594$) (broken line) and 90% of surfacing locations (dark grey area) of same seal between August to November. The locations are means of surfacing places between every 15 minutes: (1) area of resting dives during 00:00–02:45, (2) area of foraging dives during 03:00–08:00 and 10:15–17:00 and (♦) travelling route during 08:15–10:15 and 17:15–23:45.

year after year. In addition, all studied seals used more than one haul-out site during the study periods, but typically the haul-out sites were within a few kilometres of each other. The haul-out sites of some seals were different during the moulting time than later in summer and we assume that adult Saimaa seals may have short distance movements in the springtime during the moulting season. In addition, it could be connected with social behavior. At the moulting time several seal were often seen to be hauled out together, although later in summer they usually haul-out solitary. It has been suggested that the ringed seal is monogamous or nearly so (Stirling 1977, Frost & Lowry 1981). Smith and Hammill (1981) disagree and suggest that the ringed seal exhibit a limited form of polygyny. Further, Kelly and Quakenbush (1990) found female territories contained within male territories. In the case of studied male (Osmo) and female (Orvokki) Saimaa seal, there might have been a loose pair bond all year round. These seals used the same home range and were observed hauled-out or swimming together occasionally. In addition, the group of islands in the main haul-out site of these seals has long been annual birth lair site.

This study presents data from the first translocation experiment on the Saimaa ringed seal. The transported female seal has been observed in the same living area yearly since releasing and she has given birth in the same area and raised the pup successfully. This experiment indicates that in Lake Saimaa, translocation might be used to increase the number of seals in low population areas.

We monitored the movements of the seals primarily during the open water season, but we also found over-wintering areas of five seals, which were the same as their summertime haul-out sites. This indicates that Saimaa seals might have been site faithful all year round. However, additional information is needed about winter-time movements of the Saimaa seal. In the Arctic Ocean, there are obvious regional and seasonal differences in the distribution of the ringed seal (Frost & Lowry 1981). Long distance migrations of marine ringed seals are interpreted as the tendency of adolescent seals to move closer to the ice margin to winter in easier ice conditions (Helle 1980, Smith 1987). We propose that the high site fidelity of the Saimaa seal is due to the labyrinthine morphology and rapid freezing of Lake Saimaa. The whole lake

freezes over virtually at the same time, and the Saimaa seal has no possibility to follow the advancing edge of the ice.

Acknowledgements

We thank Janne Herranen, Jani Häkkinen, Terho Laitinen, Kaiku Marttinen, Tero Sipilä, Juha Taskinen and Pertti Tyni for helping with the fieldwork, and Matti Savinainen, Juha Hartikka, Heikki Jeronen and Aaro Kukkohovi for technical advice on telemetry equipment. The study was financed by the Academy of Finland, World Wide Fund for Nature (WWF), the Ministry of Agriculture and Forestry, the Finnish Ministry of the Environment and the Maj and Thor Nessling Foundation.

References

- Frost, K. J. & Lowry, L. F. 1981: Ringed, Baikal and Caspian Seals. — In: Ridgway, S. H. & Harrison, R. J. (eds.), *Handbook of marine mammals*. Vol. 2: 29–53. Academic Press, London.
- Helle, E. 1980: Age structure and sex ratio of the ringed seal *Phoca (Pusa) hispida* Schreber population in the Bothnian Bay, northern Baltic Sea. — *Z. Säugetierk.* 45: 310–317.
- Heide-Jørgensen, M. P., Stewart, B. S. & Leatherwood, S. 1992: Satellite tracking of ringed seal *Phoca hispida* off northwest Greenland. — *Ecography* 15: 56–61.
- Hyvärinen, H. & Nieminen, M. 1990: Differentiation of the ringed seal in the Baltic Sea, Lake Ladoga and Lake Saimaa. — *Finn. Game Res.* 47: 21–27.
- Hyvärinen, H., Hämäläinen, E. & Kunnasranta, M. 1995: Diving behavior of the Saimaa ringed seal (*Phoca hispida saimensis* Nordq.). — *Mar. Mamm. Sci.* 11(3): 324–334.
- Kapel, F. O., Christiansen, J., Heide-Jørgensen, M. P., Härkönen, T., Born, E. W., Knutsen, L. Ø., Riget, F. & Teilmann, J. 1998: Netting and conventional tagging used to study movements of ringed seals (*Phoca hispida*) in Greenland. — In: Heide-Jørgensen, M. P. & Lydersen, C. (eds.), *Ringed seals in the North Atlantic*: 211–228. North Atlantic Marine Mammal Commission (NAMMCO), Tromsø.
- Kelly, B. P. & Quakenbush, L. T. 1990: Spatiotemporal use of lairs by ringed seals (*Phoca hispida*). — *Can. J. Zool.* 68: 2503–2512.
- Kunnasranta, M. 2001: *Behavioural biology of two ringed seal (Phoca hispida) subspecies in the large European lakes Saimaa and Ladoga*. — Ph.D. thesis. University of Joensuu. 86 pp.
- Kunnasranta, M., Hyvärinen, H., Sipilä, T. & Koskela, J. T. 1999: The diet of the Saimaa ringed seal *Phoca hispida saimensis*. — *Acta Theriologica* 44(4): 443–450.
- Kunnasranta, M., Hyvärinen, H., Häkkinen, J. & Koskela, J. T. 2002: Dive types and circadian behaviour patterns of Saimaa ringed seals (*Phoca hispida saimensis*) during open water season. — *Acta Theriologica*. [In press].
- McLaren, I. A. 1958: The biology of the ringed seal (*Phoca hispida* Schreber) in the eastern Canadian arctic. — *Fish. Res. Board Can. Bull.* 118. 97 pp.
- Ridoux, V., Hall, A. J., Steingrimsdóttir, G. & Olafson, G. 1998: An inadvertent homing experiment with a young ringed seal, *Phoca hispida*. — *Mar. Mamm. Sci.* 14(4): 883–888.
- Sipilä, T. 1990: Lair structure and breeding habitat of the Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) in Finland. — *Finn. Game Res.* 47: 11–20.
- Sipilä, T., Helle, E. & Hyvärinen, H. 1990: Distribution, population size and reproductivity of the Saimaa ringed seal (*Phoca hispida saimensis* Nordq.) in Finland, 1980–84. — *Finn. Game Res.* 47: 3–10.
- Smith, T. G. 1987: The ringed seal, *Phoca hispida*, of the Canadian Western Arctic. — *Can. Bull. Fish. Aqu. Sci.* 216. Ottawa. 81 pp.
- Smith, T. G. & Hammill, M. O. 1981: Ecology of the ringed seal, *Phoca hispida*, in its fast ice breeding habitat. — *Can. J. Zool.* 59: 966–981.
- Stewart, B. S., Petrov, E. A., Baranov, E. A., Timonin, A. & Ivanov, M. 1996: Seasonal movements and dive patterns of juvenile Baikal seals (*Phoca sibirica*). — *Mar. Mamm. Sci.* 12(4): 528–542.
- Stirling, I. 1977: Adaptations of Weddell and ringed seals to exploit the polar fast ice habitat in the absence of presence of surface predators. In: Llano, G. A. (ed.), *Adaptations within Antarctic ecosystems*: 741–748. Proceedings of the 3rd Symposium on Antarctic biology. Gulf Publishing Co., Houston.
- Teilmann, J., Born, E. W. & Acquarone, M. 1999: Behaviour of ringed seals tagged with satellite transmitters in the North Water polynya during fast-ice formation. — *Can. J. Zool.* 77: 1934–1946.