

## Short Communication

### Seasonal change in habitat use in Steller's sea eagles

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**Abstract** Habitat-use by Steller's sea eagle *Haliaeetus pelagicus*, categorized as Vulnerable on the 2002 IUCN Red List, was studied using satellite-tracking. This migratory species breeds in eastern Russia and mostly overwinters in Hokkaido, Japan, and the southern Kuzil islands. Locations of eagles were classified as being river, sea, lake, or other habitat. In autumn, eagles mainly used river habitats, probably because of the availability of abundant post-spawn dead salmon. In winter about one third of eagles continued to be located on rivers, with others on sea coasts and lake sides. During the spring migration and breeding season habitat use by adult eagles probably reflected the variety of habitats in which breeding occurs. At that time, sub-adult eagles were

located mainly on the sea coast, probably in places where food supply was sufficient and there were few territorial eagles. In Hokkaido 35% of overwintering eagles used mountain areas for at least some time. It is known that eagles using mountain areas in Japan in winter scavenge upon the carcasses of sika deer *Cervus nippon* killed by hunters, and are thus exposed to possible lead poisoning. The satellite tracking highlights the importance of several habitats within the range of this species, changes in which could affect its conservation status.

**Keywords** Habitat use, *Haliaeetus pelagicus*, Hokkaido, Kamchatka, lead poisoning, migration, satellite-tracking, Steller's sea eagle.

Steller's sea eagle *Haliaeetus pelagicus*, one of the largest eagles, is migratory. It breeds in eastern Russia on the Kamchatka peninsula and on the northern and western coasts of the Sea of Okhotsk, and overwinters in the southern Kuril islands and Hokkaido, Japan, and to a lesser extent on the Kamchatka peninsula (Fig. 1). The species is categorized as Vulnerable on the 2002 IUCN Red List (BirdLife International 2000, 2001; IUCN, 2002).

In order to be able to design an effective management plan for the species, knowledge of habitat use through-

out the year is required, but this is difficult to ascertain for a migratory species. In recent years tracking via satellite has been used to investigate the movement of animals, including Steller's sea eagle (Ueta *et al.*, 2000; McGrady *et al.*, 2003). In this paper we use data from satellite-tracked Steller's sea eagles to describe their use of habitat throughout the year, and we discuss the conservation implications of our findings. Forty-one Steller's sea eagles were fitted with satellite-received transmitters (PTTs, Platform Transmitter Terminals), either as nestlings or at overwintering grounds in Hokkaido, Japan. The PTTs were attached as backpacks using Teflon-treated ribbon. As a result of some transmitter failures and the deaths of some newly fledged eagles only 32 of the PTTs provided usable data.

Location data were received through the Argos satellite system, which estimates location and assigns a class that estimates accuracy. Our analyses used only location estimates whose accuracy was calculated to be <1 km. Individual and clusters of location estimates were used to identify sites used by eagles. In places where location estimates were clustered, we defined the site as the mean of the estimates. We defined the period of time that an eagle used each site as the number of days between the first and last dates on which the eagles were recorded there. A single location was assumed to represent a single day's stay. We excluded data from

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Received 4 June 2001. Revision requested 13 February 2002. Accepted 8 October 2002.



**Fig. 1** The main migration route of Steller's sea eagles between the eastern coast of Russia, where they breed, and the main overwintering grounds in Hokkaido, Japan, and the southern Kuril Islands.

the sites where the PTTs were attached. Locations were classified as occurring in one of four habitat types: 'River', 'Sea', 'Lake', or 'Other', which were delineated using ONC Maps (Defense Mapping Agency Aerospace

Center, USA). Locations were classified as River or Lake if they were within 1 km of these features, and as Sea if the location was within 1 km of sea coast or over the sea. Locations outside these definitions were classified as Other. River mouths were classified as River and coastal lakes and brackish lagoons were classified as Lake.

The year was divided into three 'seasons', which corresponded to eagle behaviour rather than to calendar date: spring migration and 'over-summering', pre-migration and autumn migration, and overwintering. Timing of spring migration is different for adult and sub-adult eagles; adults undertake the migration in April and sub-adult eagles in May (Ueta *et al.*, 2000). Thus, for our analyses, timings of the seasons for adults were different from those of sub-adults. For any given season we used data only from PTTs that transmitted for at least 20 days of that season. Given this constraint, and because most birds were marked as nestlings (some of which died during their first winter) and because PTTs had a limited battery life, there were fewer data for spring migration and over-summering. When referring to overwintering grounds 'Hokkaido' includes that island and the southern Kuril Islands, and 'Kamchatka' refers to that peninsula and the northern Kuril Islands. Because exposure to potential lead poisoning in Hokkaido is greatest in the mountain areas, we also examined the use of these areas by eagles. The main habitat used by an individual eagle in a particular season was defined as that habitat in which it was tracked for the longest period of time.

During the pre-migration and autumn migration period all eagles used mostly river habitat (Tables 1 & 2). All individuals spent >40% of their time in river habitats, and 60% were located on rivers >80% of the time. Two eagles that were tracked for more than 1 year used mainly river habitats during both their first and second

**Table 1** Number of Steller's sea eagles tracked and their main use of four habitat types during three 'seasons' (see text for further details).

Location	Number of eagles tracked	% of eagles tracked in each habitat type			
		River	Sea	Lake	Other
Pre-migration and autumn migration					
Hokkaido	16*	100	6	0	0
Kamchatka	4	100	0	0	0
Overwintering					
Hokkaido	25	28	40	20	12
Kamchatka	4	75	25	0	0
Spring migration and 'over-summering'					
Hokkaido	12	8	67	17	8
Kamchatka	0	0	0	0	0

\*One eagle was tracked for equal lengths of time on both river and sea

**Table 2** Mean percentage ( $\pm$ SD) use of habitat types by sub-adult and adult Steller's sea eagles tracked by satellite during three 'seasons' (see text for further details).

	Mean % ( $\pm$ SD) use of habitat type				No of individuals
	River	Sea	Lake	Other	
Non-adult eagles					
Pre-migration and autumn migration	81.7 $\pm$ 15.6	11.1 $\pm$ 12.4	3.3 $\pm$ 4.9	3.9 $\pm$ 4.2	19
Overwintering	42.1 $\pm$ 44.9	34.1 $\pm$ 37.3	10.2 $\pm$ 20.8	13.6 $\pm$ 23.0	24
Spring migration and over-summering	9.5 $\pm$ 9.2	68.2 $\pm$ 12.9	8.7 $\pm$ 12.7	13.7 $\pm$ 12.5	6
Adult eagles					
Pre-migration and autumn migration	90.0	10.0	0.0	0.0	1
Overwintering	6.9 $\pm$ 13.1	42.1 $\pm$ 34.4	20.5 $\pm$ 44.5	30.6 $\pm$ 35.2	5
Spring migration and over-summering	17.4 $\pm$ 38.7	34.8 $\pm$ 43.0	27.5 $\pm$ 43.7	20.4 $\pm$ 36.8	6

autumns. One used river 65% of the time in its first autumn and 100% in its second autumn, the other's use of river habitats in its first two autumns was 94 and 100%. During the overwintering period 72% of eagles in Hokkaido used mainly lake, sea and other habitat, whereas in Kamchatka 75% of eagles still used mainly river habitat, and 25% used mainly sea (Table 1). Thirty-five percent of the eagles overwintering in mainland Hokkaido used habitats in mountain areas. During the spring migration and over-summering period (data for Hokkaido only) sub-adult eagles used mainly sea habitat, whereas adult eagles used all four habitat types in relatively equal proportions (Table 2).

These results indicate that river habitat is important for eagles of all age classes in the autumn. At this time, the main food source for Steller's sea eagles is the ephemeral supply of post-spawn dead salmon in Kamchatka (Lobkov & Neifeldt, 1986) and Hokkaido (Ueta *et al.*, 1999), the availability of which affects the distribution of the eagles (Ueta *et al.*, 1999).

Three quarters of eagles overwintering in Kamchatka continued to use river habitats throughout the winter, whereas most eagles in Hokkaido that were initially found on rivers changed to sea coasts or lakes sometime during the winter. The same change was also recorded in white-tailed sea eagles *Haliaeetus albicilla* overwintering in Hokkaido (Ueta *et al.*, unpub. data). The change in habitat use by eagles during this time is probably a response to the declining availability of salmon as rivers become covered by snow and ice. In northern and eastern Hokkaido most rivers are covered by ice, and the main overwintering sites of eagles are along the coast at Rausu and on Furen Lake (a brackish lagoon). On the latter, eagles mainly feed upon abandoned by-catch fish discarded on the ice, and in Rausu mainly upon fish that fall from nets (WGWS, 1996). In contrast, rivers and lakes in Kamchatka have at least some open

water, and some of these have winter-spawning salmon. Work by Shiraki (1996) in Hokkaido supports this hypothesis, with winter observations of relatively large numbers of eagles on rivers that have open water with dead salmon, and few or no eagles on rivers covered by ice or snow. Also, on Kuril Lake in south Kamchatka, 650–700 Steller's sea eagles annually overwinter, feeding upon dead salmon where portions of the lake and river remain clear of ice (Ladygin *et al.*, 1991).

During the summer individual adult eagles used various habitats, but all sub-adult eagles that we tracked used seaside habitats. Steller's sea eagles nest along sea coast, rivers, on small islands, lakes and in wetlands (BirdLife International, 2001). Because within their breeding range few if any adult Steller's sea eagles are seen that are not holding a breeding territory (E. Potapov & I. Utekhina, unpub. data), and because territory-holding eagles forage near the nest (V. B. Masterov, unpub. data), habitat used by adult eagles during the breeding season reflected nest site location. In general, the breeding density of Steller's sea eagles is relatively low in sea coast habitats compared to rivers and lakes (Ueta & McGrady, 2000), and in places may be affected by nest site and prey availability. It seems likely therefore that sub-adult eagles used mainly sea coast in summer because food may have been sufficient and these areas may not have been occupied by breeding adults.

Although about one-third of eagles that visited Hokkaido used mountain areas, this may underestimate the real importance of mountain habitats because moves to the mountains occur in late winter (McGrady *et al.*, 2003) and only 60% of eagles were tracked throughout the whole of the winter period. Our analysis may also underestimate the importance of the mountains because the actual migration of some birds did not follow exactly the periods that we defined, with some

birds visiting mountain areas during the pre-migration and autumn migration period.

Until 1990, Steller's sea eagles congregated on the sea coast at Rausu (c. 90% of the overwintering population in Hokkaido) throughout the winter, and fed on cod *Theragra chalcogramma* that fell from fishnets (WGWS, 1996). As the cod catch declined, the number of eagles overwintering in Rausu decreased, and they dispersed to other sites (WGWS, 1996). At the same time the number of sika deer *Cervus nippon* killed by hunters, both for sport and in an effort to control their numbers, increased from c. 15,000 in 1990 to >45,000 in 1996 (Otaishi & Honma, 1998), resulting in an increase in the amount of deer remains in mountain areas (N. Kurosawa, per. comm.). Our data support the hypothesis that a large proportion of Steller's sea eagles overwintering in Hokkaido may disperse from Rausu and other coastal sites to mountain areas as the winter progresses (WGWS, 1996).

Steller's sea eagle's Vulnerable Red List status is due to its relatively small population size, and its restricted breeding range along the coasts and on the large rivers of eastern Russia. The results of the satellite tracking highlights the importance of several habitats within the range of this species, changes in which could affect its conservation status. In addition, our data illustrates the importance, in recent years, of mountain habitats to individuals overwintering in Hokkaido. This apparent change in winter foraging has coincided with an apparent increase in mortality due to lead poisoning (Kurosawa, 2000). Since at least the winter of 1995–96, Steller's and white-tailed sea eagles have been poisoned by consuming lead bullets and bullet fragments from deer carcasses, and the number of dead eagles located increased over 1995–2001 (Kurosawa, 2000). Increases in mortality rate in Steller's sea eagles, especially breeding adults, could cause population declines (Ueta & Masterov, 2000). It is important that continued research and conservation action is focused upon the relationship between Steller's sea eagles and their prey. In addition, although in Hokkaido the use of lead bullets for deer hunting has been illegal since autumn 2000, enforcement appears to be lacking (K. Saito, pers. comm.), and further efforts need to be made to reduce exposure of eagles to the risk of lead poisoning.

### Acknowledgements

We would like to thank the following people for assisting in the field, managing the ARGOS data and with map production: N. Aoki, M. Bramer, S. Caquelin, J. Cibor, M. Fuller, H. Hashimoto, Y. Hayashi, K. Hieda, Y. Kanai,

Y. Kato, M. Kikuchi, N. Kurosawa, A. Ladyguine, E. Lobkov, T. Matsuo, J. Minton, N. Mita, H. Miyazaki, M. Morita, E. Potapov, M. Sato, K. Saito, L. Schueck, W. S. Seegar, S. Shiraki, M. Sugano, M. Takada, R. Takada, S. Takada, I. Utekhina and V. Zykov. The research in 1995–1996 was funded by the Environment Agency of Japan, and supported by NTT and TOYOCOM. The research in 1997–1998 was funded by NEC Corporation, Chugach National Forest, and the US Department of Defense.

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### Biographical sketches

The authors have been studying the ecology and promoting the conservation of Steller's sea eagles for over 10 years. Mutsuyuki Ueta, Hajime Nakagawa and Fumio Sato have conducted studies mainly in Hokkaido, Japan, where eagles winter. Michael J. McGrady and Vadimir B. Masterov have studied eagles primarily on the breeding grounds in the Magadan and Amur Regions of Russia.