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Migration and wintering of juvenile and immature Steller's Sea Eagles

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Abstract. Twenty-nine nestling Steller's Sea Eagles *Haliaeetus pelagicus* were fitted with satellite-received transmitters (PTTs) in the summers of 1997 and 1998. Twenty-four provided data useful in understanding post-fledging movements, 12 from Magadan, 7 from Amur, four from Kamchatka, and one from Sakhalin. At this time (27 January 1999), we are still receiving information from six birds. Fledging occurred in August and early September. At least 20 fledglings moved to pre-migration sites for 1-4 weeks. This behavior was most obvious for birds whose natal ranges were coastal. Eagles raised on large rivers and lakes tended to wander along rivers prior to the onset of a definite migratory push. Nineteen birds were followed south, 16 made it to wintering areas. Eagles took 5-116 days to reach their initial wintering destinations. Migration rate averaged 51.3 km/day (SD = 56.0). Most birds from Magadan and Amur migrated down the western edge of the Okotsk Sea, and birds reared in Kamchatka eventually moved onto the Kuril Islands. Two birds were tracked from fledging into their second autumn migration. They moved northward from the wintering grounds in the second and third week of April. Summering areas were south of natal areas, and both had early and late summering areas.

INTRODUCTION

The Steller's Sea Eagle *Haliaeetus pelagicus* occupies a limited breeding range along the seacoasts and on islands and rivers of eastern Siberia from Koryakland south to northern

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Table 1. Details of PTTs fitted to Steller's Sea Eagle nestlings in 1997 and 1998.

Year	Region	No. of PTTs	Manufacturer	Duty cycle	Life expectancy
1997	Magadan	4	Microwave	8 hrs on 48 hrs off	1.5 yrs
		10	Toyocom	6 hrs on 12 hrs off	6 months
	Kamchatka	1	Toyocom	6 hrs on 48 hrs off	1 year
	Amur	3	Toyocom	6 hrs on 12 hrs off	6 months
1998	Kamchatka	3	Toyocom	5 hrs on 19 hrs off	9 months
		2	Toyocom	6 hrs on 42 hrs off	1 year
	Amur	4	Toyocom	5 hrs on 19 hrs off	9 months
		1	Toyocom	6 hrs on 48 hrs off	1 year
	Sakhalin	1	Toyocom	5 hrs on 19 hrs off	9 months

Korea. Part of the population over-winters in the breeding range, concentrating around ice-free portions of lakes, rivers and the sea (Nakagawa *et al.* 1987, Lobkov & Neufeldt 1986). Others move south to Hokkaido, the Kuril Islands, Korea, and the coast of the Russian mainland (Babenko *et al.* 1988, Lobkov 1988, Nakagawa & Fujimaki 1988).

Details of post-fledging dispersal and migration of *Haliaeetus* eagles have been studied elsewhere using conventional (e.g. Hunt *et al.* 1992, McClelland *et al.* 1996) and satellite telemetry (e.g. Grubb *et al.* 1994, Ueta *et al.* 1998). Steller's Sea Eagles movements have been studied using direct observations (WGWS 1996), color marks (Ueta and Utekhina unpubl. data), and satellite-received transmitters (PTTs) (Meyburg & Lobkov 1994, Ueta *et al.* 2000). The use of radio tracking via satellites is particularly appropriate given the remoteness of areas in which the Steller's Sea Eagle lives (Fuller *et al.* 1995). We report upon the results of tracking Steller's Sea Eagle nestlings fitted with PTTs in Magadan, Kabarovsk, Amur, and Sakhalin Regions and on the Kamchatka Peninsula of Russia.

MATERIALS AND METHODS

Two types of PTT were used, Toyocom (25) and Microwave (4). Some PTTs were programmed for longer life (and a slower rate of data collection). Table 1 summarizes PTT characteristics. All transmitters weighed about 65g, and were attached in backpack fashion using Teflon ribbon (e.g. Dunstan 1972), incorporating a sewn link at the breast. The link should degrade after some time, allowing the backpack to fall free of the bird. Two eagles were tracked for more than 16 months. Data on these birds included location estimates collected during the first spring migration, the second summer and the second autumn migration.

When analyzing movement, we used only ARGOS location classes 1, 2 or 3. Location classes 1, 2 and 3 mean that 68% of location estimates would lie within a radius of 1 km, 350 m and 150m, respectively.

Table 2. Summary of migration by juvenile Steller's Sea Eagles from Russia in 1997-1998.

PTT ID	Initiation of migration	No. of locations on migration	Date arrived on wintering grounds	Duration of migration	km traveled	Rate (km/day)	Degrees of Latitude to Wintering grounds
1997							
11986	– 10 Oct.	16	15 Jan.	97	2774	28.6	16.3
11987*	– 13 Oct.	4	14 Nov.	31	2216	71.5	14.6
11988	– 25 Oct.	1	15 Nov.[+]	21	2500	129.0	17.0
11989	– 27 Oct.	1	08 Dec.	42	2550	60.7	16.0
23372	– 24 Sep.	69	05 Dec.	72	2600	36.1	17.0
23374	– 1 Nov.	97	20 Nov.[+]	5	1140	228.0	6.2
28509	– 2 Oct.	51	20 Nov.	49	2408	49.1	14.0
28510	– 15 Oct.	38	16 Nov.[+]	32	1450	45.3	6.6
28512	– 4 Oct.	48	14 Jan.	97	200	2.1	1.0
28513*	– 19 Oct.	25	09 Dec.[+]	46	2344	50.9	13.0
1998							
04131	– 26 Sep.	28	22 Nov.	57	781	13.7	7.0
06749	– 25 Oct.	83	04 Jan.[+]	71	407	5.7	2.8
06755	– 14 Oct.	0	06 Nov.[+]	23	260	11.3	4.0
06762	– 18 Aug.	4	08 Nov.	82	1467	17.9	1.9
07018[#]	– 24 Sep.	9	04 Oct.	11	135	12.3	0.5
07101	– 4 Oct.	11	15 Nov.[+]	42	1288	30.7	7.7
07102	– 5 Nov.	69	14 Jan.[+]	70	1698	24.3	9.8
07317	– 6 Dec.	29	28 Dec.	22	475	21.6	3.4

*Left on migration from natal area, no pre-migration staging area noted (11987, 28513).
[+]More than one wintering area noted (11988, 23374, 28510, 28513, 06749, 06755, 07101, 07102).
[#]Wintering area north of natal area (7018).

RESULTS

Twenty-nine, nestling Steller's Sea Eagles were fitted with PTTs in the summers of 1997 and 1998. Twenty-four provided data useful in understanding post-fledging movements, twelve from Magadan, 7 from Amur, 4 from Kamchatka and 1 from Sakhalin. We are still (27 January, 1999) receiving information from six birds.

Fledging to Dispersal

Fledging occurred in August and early September for most eagles. Nestling dispersal (when the eagle moved permanently more than 5 km from the nest site) occurred 9 September to 6 December (N = 24). Twenty-two nestlings dispersed 14 September - 21 October. Dates of dispersal did not differ between years or regions.

Pre-migration and Migration

At least 20 fledglings moved to pre-migration sites for 1-4 weeks. This behavior was most obvious for birds whose nesting sites were coastal. Pre-migration sites were on the lower reaches of rivers and might be areas where dead (post-spawning) salmon are found in abundance. Eagles raised on large rivers and lakes tended to wander along rivers prior to the onset of a definite migratory push.

Nineteen birds were tracked on southward migration during their first autumn (Fig. 1).

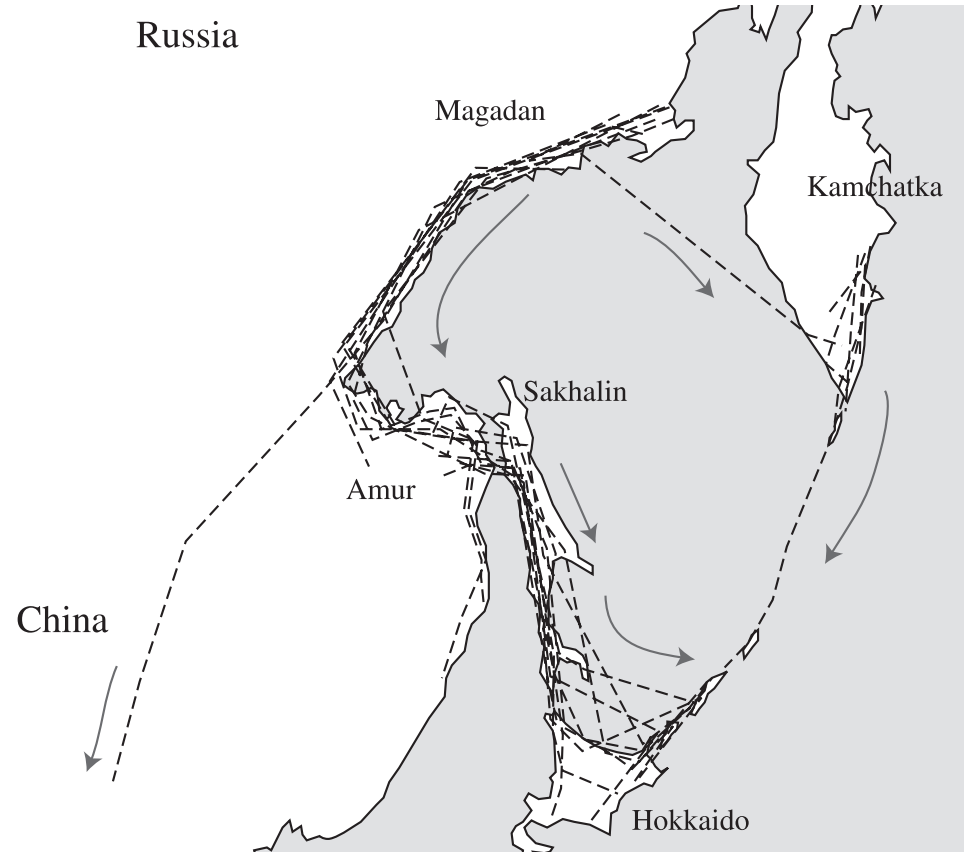

Fig. 1. Autumn migration routes of Steller's Sea Eagles from Magadan, Amur, Sakhalin and Kamchatka.

Table 2 summarizes the data. Birds initiated migration between August 18 and November 15. Birds marked in 1997 migrated earlier than those marked in 1998. Migration occurred between August 18 and January 14. All but one followed established migration routes. The pace of migration varied considerably. Birds took 5 to 116 days to reach their initial wintering destinations. Migration rate averaged 51.3 km/day (SD = 56.0). Most birds from Magadan and Amur migrated down the western edge of the Okhotsk Sea, and birds reared in Kamchatka moved down the Kuril Island chain. The eagle whose migration patterns was ‘atypical’ (ID 23374) was marked in Magadan region. It made an initial move west, then turned east, and migrated to the Kamchatka Peninsula. Only one location between the breeding and wintering grounds was estimated for this bird. This was of relatively low quality, but was located in the middle of the sea, and suggests that the bird may have made a sea crossing. The shortest crossing would be about 730 km.

For two birds, no wintering grounds could be identified. Either they did not settle in one wintering area or the transmitter stopped working before this occurred. Mortality was confirmed for one bird and strongly suspected for another. ID 11987 was collected in China

Table 3. Summary of second summer movements by Steller's Sea Eagles.

ID	Date of N. Migration	Date of Arrival	Date of Departure	Median Location	Date of Arrival	Date of Departure
11986	10 Apr	25 Jun	17 Jul	55.069N, 137.903W	01 Aug	10 Sep
11988	26 Apr	24 Jun	10 Jul	53.894N, 142.346W	25 Aug	24 Sep

with a broken wing (apparently from hitting electricity lines) on 10 November in the Xiang Hai Nature Reserve. It died in captivity on 30 November. ID 28512 probably died on the Okhota River. The pattern of location estimates suggests that this bird survived until 5 January at least. It was last received on 25 January.

Wintering areas

Seventeen birds were followed through the autumn to relatively well-defined areas where they spent > 2 weeks during the winter. By and large these were located on Hokkaido, Sakhalin and the Kuril Islands. In winter 1997-1998, six birds used only one area, and four used up to three distinct wintering areas. One eagle tagged in 1997 wintered on the Kamchatka peninsula. Data gathering for 1998-1999 is not yet complete.

Northward migration, second summer and second autumn migration

Two birds, IDs 11986 and 11988, were tracked from fledging into the second autumn migration. They moved northward from the wintering grounds in the second and third week of April, respectively. Summering areas were south of their natal areas. Both birds had early and late summering areas. Median location estimates for IDs 11986 and 11988 in their early summering areas were 4.2 and 5.6 degrees south of their respective natal areas, and 12 and 10.5 degrees N of their respective wintering areas. Late summering areas were 2.3 degrees south of nests and 14 degrees N of wintering area for ID 11986 and 5.0 and 11.2 degrees for ID 11988. IDs 11986 and 11988 initiated their second autumn migration on 10 and 24 September, respectively. Table 3 summarizes second summer movements by IDs 11986 and 11988.

DISCUSSION

Because location estimates calculated by the ARGOS system are of variable accuracy gross movements can be interpreted with more confidence than small ones. There are a number of limitations to PTT data, and sources of potential error in location estimates. Additionally, some behaviors (like staging by eagles) might not be documented because the PTT duty cycles may not be appropriate. Because high quality data are only a proportion of all location estimates, small sample size is often encountered. Because we excluded lower quality data, the dates of movement we report are not necessarily precise, and should be interpreted as accurate to within ± 2 duty cycles.

Food supply plays a large part in determining whether birds migrate, and where they

spend the non-breeding period (Newton 1979). We estimate that dispersal from natal areas could have occurred as early as 2 weeks or as late as 15 weeks post-fledging and was probably linked to declining prey availability (decreased numbers of prey or increase in ice cover). Dispersal of a nestling chick in Kamchatka from another study occurred on 16 October (Meyburg & Lobkov 1994), within the range of dates over which the birds we studied dispersed. The nestling whose natal area was furthest south (Sakhalin) initially moved north. Presumably, this is because food was available to the north, and early winter weather was not as harsh as in other areas where eagles were radio-tagged. Dispersal in Bald Eagles *H. leucocephalus* coincides with declines in prey availability, and may be related to physical condition of the fledgling (Wood *et al.* 1998), and Bald Eagles breeding in southerly parts of their range, migrate northward after nesting (Hunt *et al.* 1992).

Because of the duty cycles to which the PTTs operated, we may not have documented stopovers for all birds that staged. When staging occurred on rivers, these were in areas located somewhat inland where the river was not affected by tides, and where the speed and clarity of the water was relatively high appeared to be used.

Although we saw no significant variation in the timing of migration between regions, within-year sample size was low. However, eagles reared in areas where ice forms earlier in the year migrated earlier. Southward migration by Steller's Sea Eagles marked in Kamchatka followed the route used by a nestling eagle tagged with a PTT in 1991 (Meyburg & Lobkov 1994) and adult White-tailed Sea Eagles *H. albicilla* in 1995 (Ueta *et al.* 1998). Further, the behavior of ID 23374 suggests that not all birds wintering in Kamchatka are from there. Migration routes used by the eagles tracked for more than one migration (IDs 11986 and 11988) were similar, and agree with data collected by Ueta *et al.* (2000).

Distribution of Steller's Sea Eagles in autumn and winter in Hokkaido has been linked to distribution of prey and prey availability. Fish species of importance include salmon *Oncorhynchos keta* (Ueta & Kiota 1996, Shiraki 1996, Ueta *et al.* 1999), Walleye Pollock *Theragra chalcogramma*, *Hypomesus olidus*, *Eleginus gracilis*, *Myoxocephalus brandti*, *Tribolodon hakonensis*, and *Plaficntys stellatus* (WGWS 1996, Ueta *et al.* 1996a). Human activities and constructions often affected prey availability (Ueta *et al.* 1996a, b, WGWS 1996). Open water was related to eagle distribution on large rivers in Hokkaido, but suitable habitat and feeding places are also important (Shiraki 1996). Wintering eagles in Kamchatka were found on large rivers with areas of open water and along the coast where open water occurred (Lobkov & Neufeldt 1986, Nakagawa *et al.* 1987). The largest concentration of wintering sea eagles was near Rausu and on Furen Lake (Nakagawa *et al.* 1987, WGWS 1996), and the largest counts were in February (WGWS 1996). Our results agree with these studies.

By late March most eagles have left the wintering grounds in Hokkaido (Nakagawa et al. 1987). The path of northward migration by juveniles Steller's Sea Eagles followed by us mimics part of the migration route followed by adult White-tailed Sea Eagles (Ueta *et al.*

1998).

The fact that juvenile eagles did not return to their natal areas is not surprising. Other raptor species that mature only after a number of years do not show fidelity to their natal areas prior to maturation (e.g. Golden eagle *Aquila chrysaetos* (Haller 1996)).

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