

## Population trends of the Kuril harbour seal *Phoca vitulina stejnegeri* from 1974 to 2010 in southeastern Hokkaido, Japan

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### Supplements 1 to 5. Additional data

#### Supplement 1. Descriptions of haul-out sites in each Hokkaido study area.

##### 1. Nemuro area

There are 2 haul-out sites on the Yururi and Moyururi islands, with perimeters of approximately 8.0 km and 3.0 km, respectively, in the Nemuro area. These 2 islands are located ~3 km off the Nemuro Peninsula. The distance between Yururi and Moyururi islands is ~800 m. Both islands are designated as protected sites of Hokkaido for important habitats of sea birds and mammals. Hence, people cannot enter the islands without permission (Nemuro City Board of Education 2005). Some individual Kuril harbour seals have used the haul-out sites on both islands (Marine Mammal Research Group 1982, Chishima 1995, Takama 1995). On Moyururi Island, seals were classified into 3 behaviour patterns: (1) landing during all seasons, (2) landing during pupping or moulting seasons only, or (3) rare and irregular landing, by individual identification (Chishima 2005).

## 2. Hamanaka area

There are 4 haul-out sites in the Hamanaka area: Hamanaka A and Hattaushi (called *Futatsu-iwa* by Niizuma et al. 1980) are on reeds along the coastline; Hamanaka B and Kenbokki are located in the islet and on an island. Hamanaka A is located in Hamanaka Bay, and there are dozens of shore reefs and rocks. The survey points for Hamanaka A and Hattaushi are in a demesne. Hence, we needed the landowner's permission to enter. Hamanaka B is ~5 km away from Hamanaka A and includes an islet and 2 rocks. Hattaushi is ~12 km west of Hamanaka A and ~23 km east of Yururi Island, Nemuro. Kenbokki is an uninhabited island with a perimeter of ~4.5 km. It lies 1 km off the coast. Kenbokki Island is ~7 km west of Hamanaka B. Only a few seals were observed in the early 1980s at 2 haul-out sites: Hattaushi and Kenbokki Island. Hence, we stopped the seal counts in Hattaushi in 1989 and stopped the counts on Kenbokki Island in 1984. Recently, some day and time counts were again conducted at Hattaushi.

## 3. Akkeshi area

There are 4 haul-out sites in the Akkeshi area: one is Daikoku Island, and the other 3 are Akkeshi A, B, and C along the coast of Hokkaido. Daikoku Island is an uninhabited island with a 6 km perimeter, located near the entrance of Akkeshi Bay. A part of Daikoku Island was designated as a protected site in 1951 as an important breeding place for sea birds. Hence, we needed the permission of the Japanese Agency for Cultural Affairs to enter this site (Japanese Agency for Cultural Affairs 2013). Daikoku Island is the second largest haul-out site in Japan, following Cape Erimo (Niizuma et al. 1980, Itoo & Shukunobe 1986). Akkeshi A, B, and C are located ~7.5 km west of Daikoku Island, ~7.5 km east of Daikoku Island, and ~2 km east of Akkeshi B, respectively. Akkeshi C is located ~18 km west of Kenbokki Island in Hamanaka. Questionnaires administered to the local people and field survey suggested that Akkeshi B and Akkeshi C existed until the 1970s (Itoo T., deceased, 1970s unpubl. data). Through intense searching for haul-out sites along the coastline of the Akkeshi area in the mid-1990s (Uekane Y., deceased, 1990s unpubl. data), landing and swimming seals were confirmed until the late 1990s at the Akkeshi B and Akkeshi C. Some seals used Akkeshi B during the pupping season but used Akkeshi C during the moulting season (Uekane et al. 2012).

Niizuma et al. (1980) reported the results of a questionnaire survey, which stated that the seal landing at the shore reef was located ~15 km west of the Akkeshi area, but there has been no information on that haul-out site since the latter part of the 1970s.

## 4. Cape Erimo area

Cape Erimo is located ~200 km west of the Akkeshi area. Cape Erimo is the southwest limit of the Kuril harbour seal distribution in the Pacific Ocean (Inukai 1942). The area is the largest habitat among those in Japan (Hayama 1985, Itoo & Shukunobe 1986). More than 10 reefs are located ~1.5 km offshore, and seals land on many places on these reefs (Itoo & Shukunobe 1986). Mitochondrial DNA analysis (Nakagawa et al. 2010), tagging records (Fujii et al. 2005, Kobayashi et al. 2012), epidemiologic research (Fujii et al. 2006a, 2007a,b) and tracking using telemetry (Fujii et al. 2006) suggest that a few Kuril harbour seals have moved from the Cape Erimo area to other eastern areas of Hokkaido.

Some reports have suggested that our volunteer researchers overlooked pups during the short observation periods because the haul-out sites at Cape Erimo are far from the survey points on land (Niizuma et al. 1980, Association for Protection of Kuril Seals 1984b, Hayama 1985). To determine the seal landing numbers, we compared data from population counts with those from aircraft-based surveys, which showed ~20% larger counts (Ishikawa 1999). A new method for estimating population size would therefore be helpful at this site.

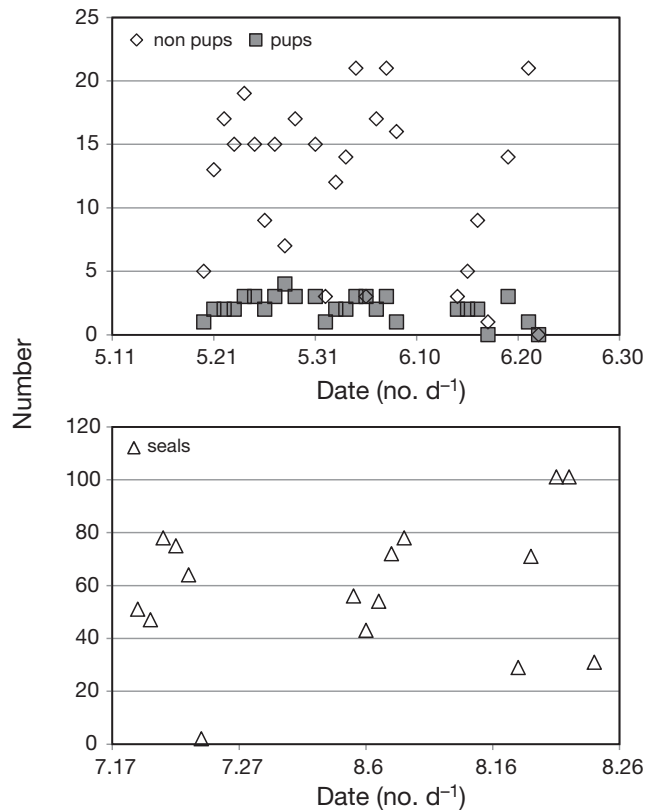
## Supplement 2

Disturbance factors and seals' re-haul-out time during intensive surveys from 2003 to 2005

Cause		Re-haul out time					Counts (%)
		≤30 min	≤60 min	≤5 h	>5 h	Unclear	
Artificial factors	Coastal fisheries	10	7	2	0	23	42 (30.2)
	Tourist (sightseeing)	1	1	0	1	5	8 (5.8)
	Investigators	1	0	0	0	0	1 (0.7)
	Others	1	0	2	0	0	3 (2.2)
Natural factors	Sea birds	2	0	0	0	1	3 (2.2)
	Wave (due to another seal)	7	2	1	0	5	15 (10.8)
Unclear		19	13	2	0	33	67 (48.2)
Total (%)		41 (29.5)	23 (16.5)	7 (5.0)	1 (0.7)	67 (48.2)	139 (100.0)

## Supplement 3

The maximum number of Kuril harbour seals per day in Hamanaka A in 2005 during the pupping period (May–June) and moulting period (July–August). There were no significant differences between the maximum population counts and counting effort, date, and tidal level (GLMM, Poisson distribution,  $p > 0.05$ )



### Supplement 4

The numbers of Kuril harbour seals reported are for 11 haul-out sites in southeastern Hokkaido during the pupping periods from 1974 to 2010. The numbers are the maximum counts during the May to June pupping season, conducted every year for 1 wk and every 30 min between sunrise and sunset, except for 1977, 1978, and 2010. In Yururi, Moyururi, and Daikoku uninhabited islands, the survey period was 5 d and omitted the first and last survey days, which were needed for transportation to and from these isolated sites. Hamanaka B was surveyed once for ~30 min to 1 h from a small ship, during the survey period of 1 wk. An empty column indicates that the site was unsurveyed. During the pupping period, the maximum counts of pups, non-pups, and the total number of seals were 151 in 2007, 718 in 2002, and 864 in 2007, respectively. \*In 1978, survey periods were short and unplanned for Moyururi Island: 12–15 June; Yurui Island: 15–16 June; Hattaushi 12–17 June; Daikoku Island: 13–20 June; and Cape Erimo: 12–15 June. \*\*In 2010, Moyururi and Yurui Island: 7–12 June; Daikoku Island: 10–14 June; others: 28 May–1 June

area	year		1974	1975	1976	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010		
	haul-out site	Date	23 May-31 Jun	16-21 Jun	10-16 Jun	Jun *	10-18 Jun	8-15 Jun	8-14 Jun	14-20 Jun	7-12 Jun	3-9 Jun	2-8 Jun	4-9 Jun	27 May-2 Jun	30 May-5 Jun	2-8 Jun	25-31 May	26 May-1 Jun	30 May-5 Jun	3-9 Jun	22-28 May	29 May-3 Jun	30 May-5 Jun	3-9 Jun	7-11 Jun	30 May-5 Jun	1-7 Jun	4-10 Jun	6-12 Jun	29 May-4 Jun	31 May-6 Jun	4-10 Jun	8-14 Jun	29 May-4 Jun	31 May-6 Jun	5-11 Jun	May- Jun **		
Nemuro	Moyururi Is.	pup	5	3	1	2	1	1	0	0	1	0		0				0	2	2	1	2	2	2	6	4	6	3	4	6	4	1	6	4	2	4	3	4		
		non pup	10	20	5	5	4	2	1	1	7	1		2					2	2	6	12	7	11	11	18	20	11	17	32	56	30	19	28	34	29	20	12	23	
	Yururi Is.	pup	3	4	0	2	3	2	4	3	3	3	4	2	2	2	3	4	4	4	3	2	2	3	2	3	3	1	2	4	0	1	4	1	2	5	2	6	0	
		non pup	16	16	8	7	5	8	10	19	9	14	13	15	11	6	9	8	12	4	2	3	6	2	4	4	1	7	6	4	2	12	3	2	7	11	16	1		
Hamanaka	Hattaushi	pup	4	4	4	3	5	0	1	0	0					0												0	0	0	0		0	0	0	0	0	0		
		non pup	17	23	27	25	14	5	4	3	2					1												0	1	0	0		0	0	0	0	0	0		
	HamanakaA	pup	2	5	7		5	8	4	6	7	5	6	6	4	3	3	2	6	3	2	1	3	4	4	2	3	3	2	3	1	3	3	4	4	4	4	6	1	
		non pup	6	16	13		13	19	28	30	27	27	39	41	24	21	22	13	15	9	7	3	6	9	11	9	4	13	7	9	4	6	21	12	15	26	23	25		
	HamanakaB	pup	0	0	1						5	2	0		1	0											8	3		20	8		5	10	4	5	3	2	5	
		non pup	50	9	9						17	20	8		23	15											60	48		100	95		60	82	40	50	50	41	50	
Kenbokki Is.	pup	3	0	0					0	2	0																													
non pup	non pup	7	2	2					1	2	0																													
Akkeshi	Daikoku Is.	pup	4	4	17	12	18	15	14	8	16	9	15	22	20	22	27	20	28	28	27	18	25	23	28	32	38	46	45	25	27	15	24	19	43	48	16	10		
		non pup	30	30	57	43	45	57	62	58	55	57	86	81	79	84	91	73	94	89	92	99	123	145	146	148	163	134	162	173	161	167	154	156	159	127	161	159		
	AkkeshiA	pup		2	0				0	2	1	2	1	1	1	2	2	1	2	2	1	3	2	3	1	5	4	3	2	3	2	2	2	1	1	2	0	1	0	
		non pup		10	2				4	7	8	6	2	4	2	3	5	2	4	3	2	5	2	4	3	8	6	4	6	4	7	4	5	3	2	5	0	3	2	
	AkkeshiB	pup																									17	22	17	14	7	12	9	12	12	9	10	10	13	12
		non pup																									33	43	29	40	31	33	28	45	58	59	60	55	63	62
	AkkeshiC	pup																									1	4	0	5	0	0	1	0	1	0	0	0	0	
non pup																										3	7		8		0	2	2	1	0	0	0	0		
Erimo	Cape Erimo	pup	7		10	5	5	5	12	28	8	7	11	19	22		11	14	36	37	21	35	49	46	52	26	36	17	29	30	24	6	12	18	80	29	81	53		
		non pup	50	59	70	68	10	50	75	85	112	75	101	124	132	125	137	160	194	192	198	129	253	177	230	304	231	254	257	341	204	280	223	317	388	277	378	350		
pup total			28	22	40	24	37	31	37	53	39	25	37	51	50	30	46	42	78	74	56	60	85	78	115	102	111	87	119	86	68	49	69	62	151	100	128	85		
non pup total			186	185	193	148	91	145	188	223	238	184	243	288	264	242	261	260	320	302	316	243	403	347	450	597	498	471	608	718	433	596	574	623	713	566	697	672		
total			214	207	233	172	128	176	225	276	277	209	280	339	314	272	307	302	398	376	372	303	488	425	565	699	609	558	727	804	501	645	643	685	864	666	825	757		

### Supplement 5

The number of Kuril harbour seals for the 11 haul-out sites in southeastern Hokkaido during moulting periods for the years 1983 to 2010. The numbers are the maximum counts in the July–August period, conducted every year for 1 wk and every 30 min between sunrise and sunset, except 2007 and 2010. The Yururi, Moyururi, and Daikoku islands are uninhabited. Hence, the survey period was 5 d, omitting the first and last survey days because of transportation to the sites. Hamanaka B was surveyed once for ~30 min to 1 h from a small ship during the week’s survey period. An empty column indicates that the site was unsurveyed. The maximum counts of seals were 1089 in 2007. \*In 2007, at Yurui and Moyururi islands, we did not need permission. Hence, we were able to count once from a small boat for 30 min during the survey period. \*\*In 2010, Daikoku Island survey period: 16-20 August

Year		'83	'84	'85	'86	'87	'88	'89	'90	'91	'92	'93	'94	'95	'96	'97	'98	'99	'00	'01	'02	'03	'04	'05	'06	'07	'08	'09	'10
Area	Haul-out site	D a t e Aug	5- 2-9 Aug	28 Jul- 3 Aug	4-9 Aug	1-6 Aug	27 Jul- 2 Aug	28 Jul- 3 Aug	21- 27 Jul	24- 30 Jul	26 Jul- 1 Aug	29 Jul- 4 Aug	24- 30 July	27 Jul- 2 Aug	29 Jul- 4 Aug	31 Jul- 6 Aug	6- 12 Aug	28 Jul- 3 Aug	15- 21 Aug	16- 22 Aug	9-15 Aug	7- 13 Aug	14- 20 Aug	5- 11 Aug	5- 11 Aug	10- 16 Aug	12-18 Aug	5-11 Aug	8-14 Aug
Nemuro	Yururi Is.	11	18	15	21	8	6	23	18	20	14	1	1	3	0	4	10	3	2	4				14	8	1*	14	10	13
	Moyururi Is.		4		3			9		9	25	37	23	48	50	54	24	48	23	79	74	78	69	72	68	20*	87	45	73
Hamanaka	Hattaushi																			0	0			0	0	0	0	0	0
	HamanakaA	60	59	65	66	55	61	51	59	64	60	62	46	60	80	64	101	80	77	86	95	71	91	78	73	96	96	98	46
	HamanakaB	47	9													24	3	40		25	7	22	34	15	22	21	35	3	30
Akkeshi	Daikoku Is.	95	101	114	117	104	148	121	96	95	88	143	139	139	161	155	175	155	135	169	179	189	233	206	181	139	202	203	204**
	AkkeshiA	3	14	6	3	19	9	6	25	57	36	35	45	50	33	41	59	44	46	50	79	56	68	64	48	77	85	69	44
	AkkeshiB																3	0	3	1	1	2	1	0	0	0	0	0	
	AkkeshiC																24	32	33	32	7	41	27	46	52	34	71	46	27
Cape Erimo		128	141	153	141	184	194	141	229	256	172	288	271	217	231	259	378	241	344	241	439	268	383	309	323	262	524	365	239
Total		344	346	353	351	370	418	351	427	501	395	566	525	517	555	625	785	644	662	662	915	713	925	810	757	687	1089	820	707

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