The historical and contemporary status of the sea otter *Enhydra lutris* population on Urup Island, southern Kuril Islands

Igor Popov and Alexey Scopin

Abstract We describe the population of the Endangered sea otter *Enhydra lutris* on Urup Island, one of the main wildlife refuges in the southern Kuril Islands of Russia. We reviewed historical and local reports of the sea otter, identified its habitat around the island, and surveyed the coastal waters of the island in 2019. Sea otters were numerous on Urup Island in the past but were hunted excessively and almost exterminated by the 1950s. Since then, sea otter populations have increased, and as the island is almost uninhabited we expected otters to be numerous. This was not the case, and we estimated the total population to be 363 ± SE 126 individuals. Our observation of two skinned carcasses on the shore suggests the low numbers are a result of poaching for the illegal fur trade. The case of Urup Island demonstrates that sea otters require active conservation, as even on a remote island they remain threatened. Establishment of protected areas would be an effective conservation measure for this species, although the suppression of demand for sea otter fur is of the greatest importance.

Keywords *Enhydra lutris*, fur trade, Kuril Islands, poaching, population decline, Russia, sea otter, Urup Island

Introduction

The sea otter *Enhydra lutris* formerly occurred across the North Pacific rim, but extensive harvesting for its fur in the 18th and 19th centuries almost exterminated the species, which was saved by the International Fur Seal Treaty of 1911 (Doroff & Burdin, 2015). From < 2,000 individuals in 13 colonies, the species increased in numbers and range (Kenyon, 1969), but is nevertheless categorized as Endangered on the IUCN Red List (Doroff & Burdin, 2015). The current range of sea otters is from northern Hokkaido, through the Kuril Islands, Commander Islands, Aleutian Islands, and the coast of North America, to California. The populations in the eastern range and on the Commander Islands have been regularly monitored (Nikulin et al., 2008; Mamaev, 2018; Shelton et al., 2018), but those in the south-west of the range are poorly studied. There are reports the sea otter is declining on the Kamchatka Peninsula and Kuril Islands in Russia (Doroff & Burdin, 2015). Here we examine the species on Urup Island, one of the main wildlife refuges in the southern Kuril Islands. Our findings provide a basis for assessing the status of sea otter populations on the south-western extreme of their range, and illustrate the threats affecting the species.

Study area

The 116 km long Urup Island (Fig. 1) comprises mountainous and rocky terrain, and is unsuitable for large or permanent human settlements. The human population on Urup has historically been small. Land animals are few, and there are no large predators (Voronov, 1974). In 1958, the island was declared a reserve of regional importance by the local administration (Sakhalinskaya oblast). Unlike designation as a reserve of national importance, this status did not lead to the organization of a special institution that would deal with the protection and management of the island. However, the island is a refuge as a result of being rarely visited, and in 2003 this was underscored by the fact that the protective status was judged unnecessary, and removed (OOPT Rossii, 2021). There are two lighthouses on the island, on the extreme southern and northern tips, where a few people reside. Recently, mining for gold has begun at the southern end of the island, and a small temporary camp has been built. However, most of the island remains undeveloped, and because the harvesting of sea otters there ended in the early 20th century, we expected the species to be numerous.

Methods

We gathered records on the sea otters of Urup Island by examining the Russian Citation Index (2021) and Web of Science (Clarivate Analytics, Philadelphia, USA) databases, and by searching in the libraries of the Zoological Institute of the Russian Academy of Sciences, St Petersburg State University, and the Russian Institute of Game Management and Fur Farming.

We analysed the suitability of the coastal waters of the island for sea otters by using maps and aerial photographs, considering a seabed depth of 50 m as the boundary of any otter habitat. Although sea otters can dive deeper than this,

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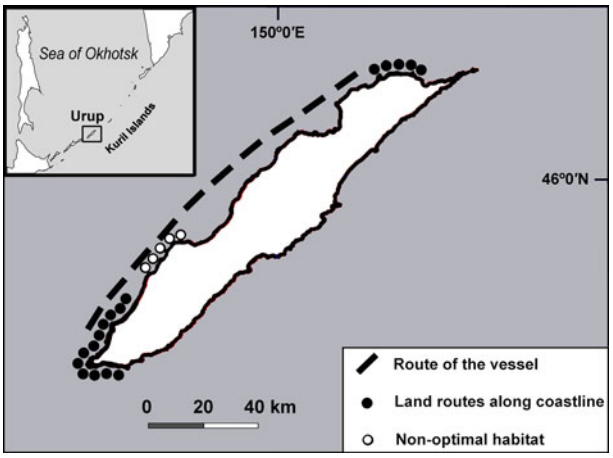

FIG. 1 Urup Island, in the Kuril Islands, with the areas of the coastline where we surveyed for the sea otter *Enhydra lutris* in 2019.

their principal habitats are in waters of < 30 m depth (Bodkin et al., 2004). We considered the sea otter habitat of Urup Island to be either optimal or suboptimal. In optimal habitats, the seabed depth reaches 50 m at a distance of at least 1 km from the coastline. Suboptimal habitats are those with a sharp increase in depth near the shore, and depths of ≤ 50 m occupying a strip of < 1 km. The coastline is irregular and we examined it in 1 km sections for this analysis.

In the summer of 2019, we surveyed sections of the island by travelling along the coastline on foot, for 15 km along the northern part of the island, and 25 km along the southern part. Each section was surveyed only once. The water surface was observed using binoculars, and the points of sea otter occurrences were recorded with a GPS, and photographed. We calculated the number of sea otters observed per km of coastline, and extrapolated abundance based on measurements of the coastline of the entire island. We moved from the northern to the southern sections of the island by boat. During this travel we searched for marine mammals but, as the vessel's route was not specifically adjusted for studying sea otters, observations from the vessel provided additional data for discussion but were not used in the calculations.

Results

The earliest historical information about sea otters on Urup dates from the 18th century, at which time they were already the subject of hunting trade between native people and the Japanese Empire (Taniguchi, 2019). At the end of the 18th

TABLE 1 Records of the harvest of sea otters *Enhydra lutris* on Urup Island from 1769 to the 1940s.

Years	No. of harvested individuals	Source	Comments
1769	600	Polonskij (1871)	
1775–1776	180	Sergeev (1947)	Harvest from one Russian ship
1777–1778	970	Sergeev (1947)	Harvest from one Russian ship
1779–1780	20	Sergeev (1947)	An earthquake affected the sea otter population
1794	Not known	Sergeev (1947)	Commercial harvesting recommenced
1828	1,000	Sergeev (1947)	
1829	800	Sergeev (1947)	
1830	Several hundred	Sergeev (1947)	800 with the harvest from Simushir Island
1842	50	Golovin (1862)	Official statistics of the Russian–American Company
1843	Not known	Sergeev (1862)	An earthquake affected the sea otter population
1847	6	Golovin (1862)	Official statistics of the Russian–American Company
1848	162	Golovin (1862)	Official statistics of the Russian–American Company
1849	104	Golovin (1862)	Official statistics of the Russian–American Company
1850	121	Golovin (1862)	Official statistics of the Russian–American Company
1852	77	Golovin (1862)	Official statistics of the Russian–American Company
1853	108	Golovin (1862)	Official statistics of the Russian–American Company
1855	327	Golovin (1862)	Official statistics of the Russian–American Company
1856	14	Golovin (1862)	Official statistics of the Russian–American Company
1857	38	Golovin (1862)	Official statistics of the Russian–American Company
1858	36	Golovin (1862)	Official statistics of the Russian–American Company
1859	408	Golovin (1862)	Official statistics of the Russian–American Company
1860	359	Golovin (1862)	Official statistics of the Russian–American Company
1896	35	Brass (1911)	
1901	7	Brass (1911)	Harvest by one Japanese ship
1910	0	Suvorov (1912)	Data from Japanese newspapers
1913	0	Barabash-Nikiforov et al. (1968)	An earthquake affected the sea otter population
1920–1930s	Several tens	Barabash-Nikiforov et al. (1968)	Hunting for scientific purposes was allowed
1940s	0	Barabash-Nikiforov et al. (1968)	Formerly legal hunting was banned

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century and in the first half of 19th century the hunting of sea otters expanded, and their numbers decreased (Table 1). In addition to killing by hunters, the negative effects of earthquakes and attendant tsunamis on the number of sea otters was also noted. In the 1850s, when Urup Island belonged to the Russian Empire, restrictions were placed on the sea otter harvest. In 1875, Urup Island was ceded to Japan. During the following 5 years, the sea otters on the island were almost exterminated, and commercial hunting ended (Nikolaev, 1969). Hunting by the native population of the Kuril Islands (the *Ainu*) also stopped, when the Japanese authorities evicted them, relocating them to a village on Shikotan Island, and prohibited them from hunting (Snow, 1897). Following this, the number of sea otters increased slightly but in the early 20th century, hunting by the Japanese resumed (Shin, 2014). By 1912 only c. 200 sea otters remained in the Kuril Islands. As a result of protective measures consequently adopted by the Japanese government, the number of sea otters increased to 800 individuals by 1939 (Nikolaev, 1969), but hunting for scientific purposes continued despite the small population (Barabash-Nikiforov et al., 1968). In 1945, the island became a Russian territory again, and regulated hunting of sea otters ceased. At that time, only a few individual otters, or the complete lack thereof, were reported on Urup Island (Uspenskij, 1955; Nikolaev, 1969).

An increase in the number of sea otters on Urup Island was reported in 1952 (Nikolaev, 1969); since then there have been various surveys and estimates of the status of the population (Table 2). The methods used have not been consistent (in some cases they were not described) and therefore it is difficult to analyse changes in the population. Nevertheless, these data facilitate estimates of the scale of abundance (Table 2) and the pattern of distribution of the sea otters around the island. Several researchers examined the entire coastline, or a significant portion (Nikolaev, 1958; Kornev, 2016). They showed that sea otters occurred around the entire island, with few differences between the western and eastern coasts, but that sea otters did not occur uniformly throughout the island's coastal waters: some otter groups contained a few dozen individuals, and sea otters were not recorded in some areas.

The total length of the island's coastline is 287 km. Most of its coastal waters are optimal for sea otters, except for a 13 km section on the western coast (Fig. 1), where the depth increases steeply to 20 m, at a distance of 200–300 m from

TABLE 2 Number of sea otters recorded on Urup Island from 1953 to 2017, with source and information on methods employed.

Years	Number	Source	Methods
1953	300	Voronov (1964)	Observation of a part of the island; estimate
1955	800	Voronov et al. (1956)	Number of visible individuals; survey by boat & from land
1955–1956	> 500	Klumov (1957)	
1956	Several hundred	Nikolaev (1958)	Number of visible individuals; survey by boat
1958	938	Nikolaev (1965, 1967)	Number of visible individuals
1958	1,179	Velizhanin (1967)	Number of visible individuals; survey by boat (19 May–10 August)
1961	1,700	Nikolaev (1965, 1967)	Number of visible individuals; survey by boat & ship
1962–1964	2,036	Belkin (1966)	
1963	1,566	Nikolaev (1965, 1967)	Number of visible individuals; survey by boat & ship
1963	1,840	Velizhanin (1967)	Number of visible individuals; survey by boat (19 May–10 August)
1964	1,870	Nikolaev (1965, 1967)	
1965	2,111	Nikolaev (1965, 1967)	Photography of habitats & analysis of pictures; survey by boat & ship
1967	2,300	Nikolaev (1968)	
1970–1971	1,619	Kuzin et al. (1984)	
1973	1,970	Kuzin et al. (1984)	
1975–1976	1,806	Kuzin et al. (1984)	
1978–1979	2,141	Kuzin et al. (1984)	
1980	2,082	Kuzin et al. (1984)	
2000	476	Kornev et al. (2001)	Number of visible individuals along western coast; survey by boat
2000	530	Kornev (2016)	
2006	2,010	Kornev & Korneva (2006)	
2012	867	Ovsyanikova (2015)	Survey by boat of several sections of coastline; extrapolation of numbers to whole island
2013	371	Kornev (2016)	Number of visible individuals along western coast; survey by boat
2014	539	Kornev (2016)	Number of visible individuals along western coast & southern tip
2015	1,106	Kornev et al. (2015)	Number of visible individuals along whole coastline; survey by boat
2016	1,061	Kornev (2016)	
2017	972	Kornev et al. (2017)	

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shore reaches 50 m, and thereafter increases steeply to 1,000 m. Hence the total length of the coastline that sea otters could potentially inhabit is 274 km.

We recorded 53 sea otters: 49 in the southern and four in the northern part of the island. Frequency of occurrence was 0–17 individuals per km, with a mean of 1.325 ± SE 0.461 per km. A naïve extrapolation to the 274 km of suitable coastline suggests a potential total of 363 ± SE 126 individuals. This is considerably lower than the population estimates from the recent past (Table 2).

We found one skeleton and one carcass of a recently-killed sea otter (i.e. it was not yet in a state of decay). The carcass had been decapitated and skinned. The skeleton did not have a skull (Plate 1). We did not see any sea otters from the boat, suggesting low abundance. The vessel's route passed near the length of coast that we identified as sub-optimal for sea otters, and we observed a family of killer whales *Orcinus orca* (3–5 individuals), a potential sea otter predator, there (Estes et al., 2005). We did not observe killer whales in other locations along the coast.

PLATE 1 The remains of sea otters *Enhydra lutris* on the shore of Urup Island (Fig. 1), in 2019.

Discussion

The dynamics of the sea otter population of Urup Island is an illustration of the species' ability to increase rapidly in numbers under favourable conditions, and also that declines can occur rapidly (Bodkin, 2015). Currently, the number of sea otters on the island appears to be low compared with historical numbers. A low number could partly be explained by migration and redistribution. However, it is unlikely that numbers would drop frequently for this reason alone, because the habitats of neighbouring islands are less suitable for sea otters. The islands to the north are smaller, and sea otters have historically been less abundant there (Snow, 1897). South of Urup lies the larger Iturup Island, with a relatively large human population and economic activity, it is less suitable for sea otters than Urup.

Several processes causing the decline of sea otter populations have been reported. It is believed that the decline in the Commander Islands occurred as a result of a lack of food (sea urchins, benthic crustaceans and molluscs) preceded by a sharp increase in the number of sea otters; i.e. fluctuations in numbers of sea otters as a result of predator–prey relationships (Mamaev, 2018). In the case of Urup, this is unlikely to have resulted in the low numbers of sea otters we observed because the small population is unlikely to have overexploited the available food resources. Decreasing numbers of sea otters in the Aleutian Islands were associated with predation by killer whales (Doroff et al., 2003). A similar situation has been reported in California, where predation by great white sharks *Carcharodon carcharias* has become more frequent (Tinker et al., 2016). Changes in predator behaviour that affect sea otters are associated with global declines of fish and other targets of human consumption (Ellis, 2004). Carcasses of sea otters displaying signs of predation have not, however, been observed on Urup Island.

In California, parasites also caused increased sea otter mortality (Thomas & Cole, 1996; Conrad et al., 2005; Johnson et al., 2009). At least some (*Sarcocystis neurona, Toxoplasma gondii*) were transmitted from land mammals: opossums *Didelphis virginiana* and felids. However, such mammals do not occur in Urup Island, although there are foxes *Vulpes vulpes*, American mink *Neovison vison* and rats *Rattus norvegicus* (Kostenko et al., 2004). We did not locate any sea otter carcasses on the shore that suggested death from disease. Attacks on sea otters by feral dogs have been reported on Urup Island (Voronov, 1964), but feral dogs have not been reported since at least the 1990s (Kostenko et al., 2004). Other potential threats to sea otters include oil spills, other environmental contaminants, entanglement in fishing gear, vessel strikes, human disturbance, and poaching (Fisheries and Oceans Canada, 2014; Doroff & Burdin, 2015; Mamaev, 2018). As Urup Island is largely uninhabited, most of these factors are probably insignificant, but the two dismembered, skinned carcasses that we found on the shore suggest poaching.

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Poaching is likely to be stimulated by illegal trade in otter fur. In 2005, selling of sea otter skins was reported in Moscow and Kamchatka, most of which later appeared in Chinese markets (Doroff & Burdin, 2015). In this case the sea otters were illegally hunted in the reserve on the Commander Islands. The same is now probably occurring in the southern Kuril Islands. The demand from China appears to be a potential driver of the poaching of sea otters because, unlike in other countries where fur is in use, in China otter fur is of particular value, prized not only for its decorative beauty but also for cultural superstitions and traditional medicine. It was believed that this tradition ended when the Dalai Lama criticized the use of wild animal fur in 2006 (Yongdan, 2018), but this action may have only had a temporary and insubstantial effect, as the trade of otter skins has continued (International Otter Survival Fund, 2014).

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Author contributions Both authors contributed equally to study design, fieldwork, data analysis and writing.

Conflicts of interest None.

Ethical standards This research abided by the *Oryx* guidelines on ethical standards.

References

Barabash-Nikiforov, I.I., Marakov, S.V. & Nikolaev, A.M. (1968) *Kalan—morskaya vydra*. Nauka, Leningrad, Russia.

Belkin, A.N. (1966) O sovremennoj chislennosti i sostoyanii populyacii kalanov na Kuril'skih ostrovah. *Izvestiya Tikhookeanskogo Instituta Rybnogo Khozyastva*, 58, 3–13.

Bodkin, J.L., Esslinger, G.G. & Monson, D.H. (2004) Foraging depths of sea otters and implications to coastal marine communities. *Marine Mammal Science*, 20, 305–321.

Bodkin, J.L. (2015) Historic and contemporary status of sea otters in the north Pacific. In *Sea Otter Conservation* (eds S.E.B. Larson, J.L. & G.R. van Blaricom), pp. 43–61. Academic Press, London, UK.

Brass, E. (1911) *Aus dem Reiche der Pelze*. Verlage der Neuen Pelzwaren-Zeitung, Berlin, Germany.

Conrad, P.A., Miller, M.A., Kreuder, C., James, E.R., Mazet, J., Dabritz, H. et al. (2005) Transmission of toxoplasma: clues from the study of sea otters as sentinels of *Toxoplasma gondii* flow into the marine environment. *International Journal for Parasitology*, 35, 1155–1168.

Doroff, A. & Burdin, A. (2015) *Enhydra lutris*. In *The IUCN Red List of Threatened Species* 2015: e.T7750A21939518. dx.doi.org/21939510.21932305/IUCN.UK.21932015-21939512.RLTS.T21937750A21939518.en [accessed 4 December 2020].

Doroff, A.M., Estes, J.A., Tinker, M.T., Burn, D.M. & Evans, T.J. (2003) Sea otter population declines in the Aleutian archipelago. *Journal of Mammalogy*, 84, 55–64.

Ellis, R. (2004) *The Empty Ocean*. Island Press, Washington, DC, USA.

Estes, J.A., Tinker, M.T., Doroff, A.M. & Burn, D.M. (2005) Continuing sea otter population declines in the Aleutian archipelago. *Marine Mammal Science* 21, 169–172.

Fisheries and Oceans Canada (2014) *Management Plan for the Sea Otter (*Enhydra lutris*) in Canada*. Fisheries and Oceans Canada, Ottawa, Canada.

Golovin, P.N. (1862) *Obzor russkih kolonij v Severnoj Amerike*. Morskoye ministerstvo, Saint Petersburg, Russia.

International Otter Survival Fund (2014) *The Shocking Facts of the Illegal Trade in Otters*. International Otter Survival Fund, Broadford, Isle of Skye, UK.

Johnson, C.K., Tinker, M.T., Estes, J.A., Conrad, P.A., Staedler, M., Miller, M.A. et al. (2009) Prey choice and habitat use drive sea otter pathogen exposure in a resource-limited coastal system. *Proceedings of the National Academy of Sciences of the United States of America*, 106, 2242–2247.

Kenyon, K.W. (1969) *The Sea Otter in Eastern Pacific Ocean*. U.S. Fish & Wildlife Service, Washington, DC, USA.

Klumov, S.K. (1957) Beregovye lezhbishcha kotikov i mesta obitaniya kalanov na Kuril'skih ostrovah i orientirovochnoe opredelenie ih chislennosti. *Doklady AN SSSR*, 117, 153–156.

Kornev, S.I. (2016) Monitoring of marine mammals on Urup island (southern Kuril islands) in 2013–2016. In *Sohranenie bioraznoobraziya Kamchatki i prilegayushchih morej* (eds V.F. Bugaev, V.V. Maximenkov, A.M. Tokranov & O.A. Cherniagina), pp. 334–338. Kamchatpress, Petropavlovsk-Kamchatskij, Russia.

Kornev, S.I. & Korneva, S.A. (2006) Some criteria for assessing the state and dynamics of sea otter (*Enhydra lutris*) populations in the Russian part of the species range. *Russian Journal of Ecology*, 37, 172–179.

Kornev, S.I., Truhin, A.M., Artyuhin, Y.B. & Purtov, S.Y. (2001) Rezul'taty ucheta morskih mlekopitayushchih na yuzhnoj Kamchatke i Kuril'skih ostrovah v iyune-avguste 2000 g. In *Rezul'taty issledovaniya morskih mlekopitayushchih Dal'nego Vostoka v 1991–2000 gg* (ed. V.A. Vladimirov), pp. 191–204. VNIRO, Moscow, Russia.

Kornev, S.I., Anikina, T.V. & Lopatin, A.V. (2015) Rezul'taty monitoringa morskih mlekopitayushchih na o.Urup (YUzhnye Kuril'skie ostrova) v 2014–2015gg. In *Sohranenie bioraznoobraziya Kamchatki i prilegayushchih morej* (eds V.F. Bugaev, E.G. Lobkov, V.V. Maximenkov, A.M. Tokranov & O. Cherniagina), pp. 383–387. Kamchatpress, Petropavlovsk-Kamchatsky, Russia.

Kornev, S.I., Marshuk, S.P. & Danilin, D.D. (2017) Several results of monitoring marine mammals and some species of predator birds on Urup island. In *Conservation of Biodiversity of Kamchatka and Coastal Waters: Materials of the XVIII International Scientific Conference, Dedicated to the 70th Anniversary of P. A. Khomentovsky's Birthday*, pp. 447-452. Kamchatpress, Petropavlovsk-Kamchatsky, Russia.

Kostenko, V.A., Nesterenko, V.A. & Truhin, A.M. (2004) *Mlekopitayushchie Kuril'skogo Arhipelaga*. Dal'nauka, Vladivostok, Russia.

Kuzin, A.E., Maminov, M.K. & Perlov, A.S. (1984) CHislennost' lastonogih i kalana na Kuril'skih ostrovah. In *Morskie mlekopitayushchie Dal'nego Vostoka* (ed. A.S. Perlov), pp. 54–72. TINRO, Vladivostok, Russia.

Mamaev, E.G. (2018) Present status of the sea otter (*Enhydra lutris* L.) population on the Commander Islands. In *Marine Mammals of the Holarctic, Vol. 2* (eds. O.V. Shpak, O.A. Filatova, D.M. Glazov, V.N. Burkanov, S.E. Belikov, N.V. Kryukova, O.A. Demidova et al.), pp. 32–39. ST Print Publisher, Arkhangelsk, Russia.

Nikolaev, A.M. (1958) Materialy po biologii kalana ostrova Urup. (In Russian. Data on biology of the sea otter of Urup island). *Soobshcheniya Sahalinskogo kompleksnogo nauchno-issledovatel'skogo instituta*, 6, 171–184.

https://doi.org/10.1017/S0030605320000812 Published online by Cambridge University Press

Nikolaev, A.M. (1965) Sostoyanie pogolov'ya Kuril'skih kalanov i kotikov i meropriyatiya po ih vosproizvodstvu. In *Morskie mlekopitayushchie* (ed. E.N. Pavlovsky), pp. 226–230. Nauka, Moscow, Russia.

Nikolaev, A.M. (1967) O perspektivah rasshireniya areala kalana v SSSR. *Trudy Polayrnogo Instituta Rybnogo Khozyastva i Okeanografii*, 21, 217–231.

Nikolaev, A.M. (1968) *Kalan Kuril'skih ostrovov—biologiya i voprosy hozyajstvennogo ispol'zovaniya. Avtoref.dis. na soisk.uchen step, kand.biol.nauk*. Abstract of PhD thesis, Voronezh, Russia.

Nikolaev, A.M. (1969) Voprosy ohrany i rasseleniya kalanov na ostrovah Kuril'skoj gryady. In *Morskiye mlekopitayushie* (ed. V.A. Arseniev), pp. 102–105. Nauka, Moscow, Russia.

Nikulin, V.S., Vertyankin, V.V. & Fomin, V.V. (2008) Sea otters (*Enhydra lutris* L.) of Commander Islands (brief story of development of population for 1957–2007). In *Research of Water Biological Resources of Kamchatka and of the Northwest Part of Pacific Ocean: Selected Papers KamchatNIRO, Vol. 10* (ed. Y.P. Diyakov), pp. 90–108. KamchatNIRO, Petropavlovsk-Kamchatsky, Russia.

Ovsyanikova, E.N. (2015) Results of the 2012 Kuril Island sea otter (*Enhydra lutris lutris*) survey. In *Marine Mammals of the Holarctic. 2015, Vol. 2* (eds. A.N. Boltunov, N.L. Remennikova & V.S. Semenova), pp. 63–70. Marine Mammal Council, Moscow, Russia.

OOPT Rossii (2021) *Protected areas of Russia*. oopt.aari.ru [accessed 21 January 2021].

Polonskij, A. (1871) Kurily. *Zapiski Imperatorskogo Russkogo geograficheskogo obshchestva. Otdel etnografii*, 4, 367–576.

Russian Citation Index (2021) elibrary.ru [accessed 21 January 2021].

Sergeev, M.A. (1947) *Kuril'skie ostrova*. Geografgiz, Moscow, Russia.

Shelton, A.O., Harvey, C.J., Samhouri, J.F., Andrews, K.S., Feist, B.E., Frick, K.E. et al. (2018) From the predictable to the unexpected: kelp forest and benthic invertebrate community dynamics following decades of sea otter expansion. *Oecologia*, 188, 1105–1119.

Shin, F. (2014) About the Kuril Islands in the mid-Meiji 30s. Development of the Ocean Fishing Industry. *Bulletin of Niigata University–Faculty of Education*, 7, 297–317.

Snow, H.J. (1897) *Notes on the Kuril Islands*. John Murray, London, UK.

Suvorov, E.K. (1912) *Komandorskie ostrova i pushnoj promysel na nih*. G.U.Z. i Z. Dep. zem tip. V.F. Kirshbauma, Saint Petersburg, Russia.

Taniguchi, M. (2019) *A Far-reaching Look at Menashi. What Made the Empire Rush. The Desire for Fur that Moved Japanese History*. kai-hokkaido.com/feature_vol44_sidestory1 [accessed 21 January 2021]. [In Japanese]

Thomas, N.J. & Cole, R.A. (1996) The risk of disease and threats to the wild population. *Endangered Species Update*, 13, 23–27.

Tinker, M.T., Hatfield, B.B., Harris, M.D. & Ames, J.A. (2016) Dramatic increase in sea otter mortality from white sharks in California. *Marine Mammal Science*, 32, 309–326.

Uspenskij, S.M. (1955) Proshloe rasprostranenie kotika (*Callorhinus ursinus* L.) i kalana (*Enhydra lutris* L.) na ostrovah Kuril'skoj gryady. *Byulleten' moskovskogo obshchestva ispytatelej prirody, otdel biologii*, 60, 9–16.

Velizhanin, A.G. (1967) Sovremennoe sostoyanie kuril'skoj populyacii kalana. In *Sbornik NTI VNIIZHP* (ed. V.F. Gavrin), pp. 26–31. Ekonomika, Moscow, Russia.

Voronov, V.G. (1964) Kalany na Kurilah. *Ohota i ohotnich'e hozyajstvo*, 1, 10–11.

Voronov, V.G. (1974) *Mlekopitayushie Kurilskikh Ostrovov*. Nauka, Leningrad, Russia.

Voronov, V.G., Nikolaev, A.M. & Pereleshin, S.D. (1956) Kalan ostrova Urup. *Soobsheniya Sakhalinskogo Kompleksnogo Nauchno-Issledovatel'skogo Instituta*, 4, 53–730.

Yongdan, L. (2018) Precious skin: the rise and fall of the otter fur trade in Tibet. *Inner Asia*, 20, 177–198.

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