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# First nests of Endangered Nordmann's Greenshank *Tringa guttifer* found in over 40 years indicate nesting plasticity

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## Short Communication

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### Summary

Knowledge of the breeding ecology of Endangered Nordmann's Greenshank *Tringa guttifer* is necessary to develop a comprehensive species-specific conservation plan. We found nine greenshank nests in Schaste Bay, Russian Far East during the summers of 2019–2021. These are the first nests found in over 40 years and the only discovered to date on mainland Russia. In contrast to previous nest descriptions, we found greenshanks do not exclusively nest in trees, but also place nests on the ground at the base of mature or sapling larches. Our results indicate greenshanks may be larch obligates during the breeding season, and protecting coastal larch forest ecosystems near bogs, meadows, and mudflats throughout the Russian Far East may be critical to the species' conservation.

### Резюме

Знание экологии размножения охотского улита, находящегося под угрозой исчезновения, необходимо для разработки комплекса мер его охраны. В период полевых исследований 2019-2021 гг. в заливе Счастья на Дальнем Востоке России мы нашли девять гнезд охотского улита; гнезда были обнаружены впервые за более чем 40 лет и впервые на материковой части гнездового ареала вида. Мы выяснили, что охотские улиты гнездятся не только на деревьях, но и устраивают гнезда на земле у стволов, как высоких, так и низких лиственниц. Мы предполагаем, что лиственницы являются необходимым условием для размножения охотских улитов, а защита экосистем прибрежных лиственничных лесов вблизи болот, лугов и илистых отмелей на Дальнем Востоке России может иметь решающее значение для его сохранения.

## Introduction

Nordmann's (or Spotted) Greenshanks (*Tringa guttifer*) (hereafter, greenshanks) are listed as Endangered on the IUCN Red List (BirdLife International 2020) and, with a small and declining population of 1,200–2,000 individuals, are considered one of the rarest shorebirds in the world (Maleko *et al.* 2021). Greenshanks are endemic to the East Asian–Australasian Flyway and are regularly observed staging and wintering at key coastal sites in China and South-East Asia during the non-breeding season (Peng *et al.* 2017, Zöckler *et al.* 2018, Li *et al.* 2019, Yu *et al.* 2019, 2020). However, to construct an effective, species-specific, and flyway-wide conservation plan, more knowledge about their breeding and distribution ecology is needed.

Greenshanks only breed in the Russian Far East where they inhabit remote bays and estuaries along the Sea of Okhotsk coast. Until 2019, the only description of greenshank nests was from one old and four active arboreal nests found during the summer of 1976 in Chaivo Bay, north-eastern Sakhalin Island, Russia (Figure 1A) (Nechaev 1978). Greenshank nesting habitat was described as the edge of semi-dry, boggy, and sparse or "thinned" larch forest stands, near small lakes, rivers, and other inland water bodies, 0.75–2.5 km from coastal intertidal flats. Consequently, a preliminary understanding of breeding habitat requirements can be summarised as Cajander larch (*Larix cajanderi*) forests and hummocky inland bogs along the Sea of Okhotsk for nesting, adjacent coastal meadows for brood-rearing, and intertidal mudflats for foraging (Nechaev 1978).

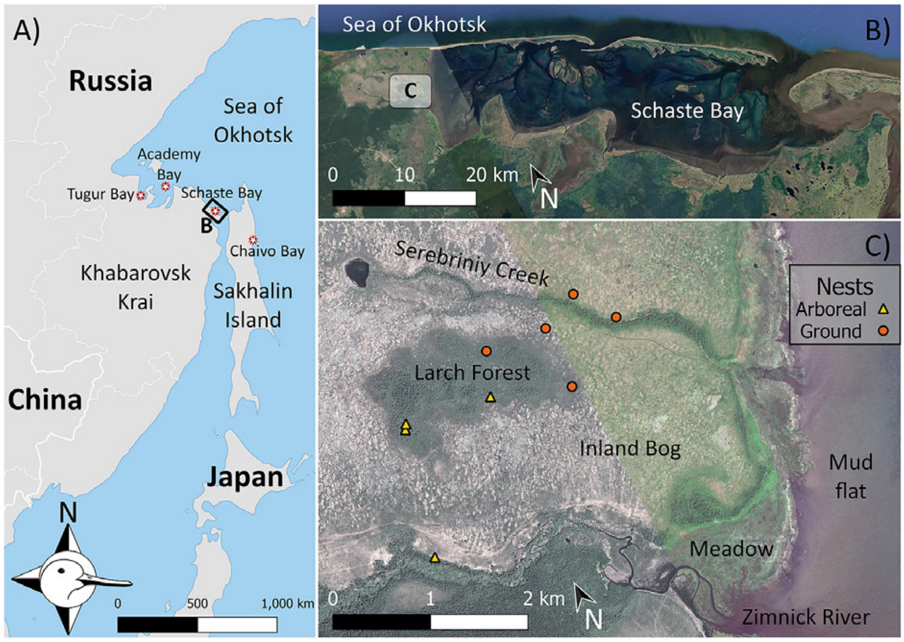


**Figure 1.** Nest-searching area. (A) A portion of the Russian Far East, China, and Japan, with Schaste Bay highlighted in B. (B) The entirety of Schaste Bay with our study area highlighted in (C). (C) Our study area in north-western Schaste Bay where greenshank nest searching took place during the summers of 2019–2021. Highlighted in (C) are the four habitat types greenshanks require for breeding (i.e. inland bogs, larch forest patches, coastal meadow, and intertidal mudflat) as well as Zimnick River and Serebriniy Creek. Orange dots represent ground nests and yellow triangles represent arboreal nests.

Since Nechaev's (1978) work, greenshank abundance throughout Sakhalin Island has declined drastically due to wildfires, hunting, reindeer herding, and habitat degradation related to the fossil fuel industry (Nechaev 1989, Blokhin 1998, Leonov 2000, Blokhin and Kokorin 2001, Tiunov 2016) and no more nests have been found. Despite greenshank-focused expeditions to other coastal sites along the Sea of Okhotsk with seemingly suitable habitat, including Sakhalin Island (Reviakina and Zikov 2011, 2018) and Magadan Oblast (Kondratyev and Andreev 1997, Bergmann 1998, Dorogoy 2013), no nests were found and the extent of suitable and occupied habitats throughout the rest of the species' breeding range remained uncertain.

In 2009–2013, a series of avian surveys conducted throughout the greater Academy, Schaste, and Tugur Bay regions in central Khabarovsk Krai revealed that Schaste Bay (mainland Russia, ~20 km west of Sakhalin Island) may be an important breeding area for greenshanks as numerous pairs were found displaying brood-rearing behaviours (Pronkevich and Oleinikov 2010, Pronkevich *et al.* 2011a, b, Pronkevich 2013, Pronkevich and Voronov 2013). During 2019–2021, we concentrated nest-searching efforts here and found a total of nine (six active and three inactive) greenshank nests. Herein, we describe these nests and the habitats in which they were found to inform nest searching for future studies and enhance understanding of greenshank breeding ecology.

## Methods

### *Study site*

We searched for greenshank nests in Schaste Bay, a shallow lagoon on the western coast of the Sea of Okhotsk (53.47°N, 140.91°E) (Figure 1B). The bay is relatively accessible compared with other potential greenshank breeding sites as it is near populated areas with adequate infrastructure. We focused nest-searching efforts between Zimnick River and Serebriniy Creek, an area of ~330 ha, 3 km south of the Sea of Okhotsk coast in north-western Schaste Bay. This site is characterised by isolated patches of larch forest, dispersed larches, and dwarf Siberian pines (*Pinus pumila*), and a strip of larch forest running along Serebriniy Creek, all on an elevated inland hummock bog. The area is bordered by a dense mixed-species forest to the south-west and a mixed-species forest band, coastal meadow, and intertidal estuarine mudflat to the south-east (Figure 1C).

### *Nest searching*

We searched for nests from the beginning or middle to the end of June, 2019–2021. Due to various site-related logistical constraints, as well as travel restrictions stemming from the Covid-19 pandemic, search effort varied among years (three days in 2019, six days in 2020, and four days in 2021). We used binoculars and spotting scopes to locate and observe greenshank activity within inland bogs and around forests. Typically, one bird incubated the nest while the other of the pair either foraged on the intertidal mudflat or perched on tall structures near the nest, acting as a sentinel (Maleko *et al.* 2021). We considered a location a potential breeding territory if we repeatedly observed a greenshank perched on a tree in the area, and if it stayed in the immediate vicinity even when flushed. After identifying a territory, we thoroughly searched the area within a 100-m radius by approaching any clumps of moss or twigs that resembled a nest and carefully scanning all larch trees hoping to spot an incubating bird. Although Nechaev (1978) found only arboreal nests, we did not exclude the possibility that greenshanks may nest elsewhere, thus, we also scanned the ground and checked under larches. If we did not find a nest within an hour, we returned to the area in the following days and watched, from afar, for the pair to switch incubation bouts and reveal the nest location. Our secondary approach was to trek throughout the inland bog checking under larches and low hanging branches. All nest searching was conducted following the guidance of Fair *et al.* (2010).

## Results

We found nine greenshank nests, six active (one each in 2019 and 2020, and four in 2021) and three inactive (all in 2020), in or around semi-dry, boggy, and sparse larch forest stands. Two nests were located at the edge of a larch forest (Figure 2-1a), four on an inland hummock bog surrounded by dispersed sapling larches (Figure 2-2a), and three within a sparse larch forest (Figure 2-3a). All nests were directly associated with larch trees and were underneath broad overhanging larch branches. The microhabitat where we found these nests can be separated into three broad categories: on a larch branch (one active and three inactive) (Figure 2-1a), on the ground underneath a sapling larch (four active) (Figure 2-2a), and at the base of a mature larch (one active) (Figure 2-3a). The flora community in the vicinity was a varying combination of Cajander larch, dwarf Siberian pine, Middendorf birch (*Betula middendorffii*), pussy willow (*Salix caprea*), alder shrubs (*Duschekia* spp.), wild rosemary (*Ledum palustre*), Lapland (*Carex lapponica*) and woolly (*C. pallida*) sedge, marsh reedgrass (*Calamagrostis langsdorffii*), bog myrtle (*Myrica gale*), crowberry (*Empetrum nigrum*), cloudberry (*Rubus chamaemorus*), bog cranberry (*Oxycoccus palustris*), lingonberry (*Vaccinium vitis-idaea*), bog bilberry (*V. uliginosum*), various lichens, and *Sphagnum* peat moss. Based on structural integrity, we concluded that inactive nests were likely from previous nesting seasons (2018 or 2019) as Schaste Bay's strong winds and heavy precipitation hasten nest disintegration (pers. obs.).

Arboreal nests ($n = 4$) (Figure 2-1b) were 17–23 cm in diameter (mean 19.8 ± 3.0) and 4.0–5.5 cm thick (mean 4.5 ± 0.1), with a nest cup 12–13 cm wide (mean 12.3 ± 0.6) and 2.5–4.0 cm deep (mean 3.0 ± 0.1). These nests were composed of small larch twigs, some with small cones attached, as the base (80%), with nests lined (20%) with speckled horsehair (*Bryoria fuscescens*), small pieces of larch bark, dwarf Siberian pine needles, and lichens such as melanelia (*Melanohalea olivacea*), rim (*Lecanora symmicta*), ring (*Evernia mesomorpha*), tube (*Hypogymnia sachalinensis*), Bering reindeer (*Cladonia cf. arbuscula*), and bearded (*Usnea* sp.). The light-coloured lichens (ring, tube, and Bering reindeer) were not found on the nest trees, indicating the birds brought them from elsewhere, likely to better camouflage their blue-green eggs (Figure 2). These nests were found in larches that were 12–15 m tall with a 20–46 cm diameter at breast height (dbh). Nests were placed on branches approximately 3.8–8.0 m off the ground, and 0.6–1.0 m from the tree trunk, with broad overhanging branches 7–40 cm above them. Arboreal nests generally faced south and were characterised by a wide (~50 cm) platform in front of the nest on the supporting branch.

Ground nests ($n = 5$) (Figure 2-2b and 3b) were 12–15 cm in diameter (mean 13.2 ± 1.1) with a nest cup 1–3 cm deep (mean 1.7 ± 01.2), and their composition differed based on location. Nests under sapling larches ($n = 4$) were 90% composed of *Carex* stems and 10% larch twigs, dry cloudberry leaves, and lichen thalluses. The lone ground nest found under a mature larch was 90% composed of larch twigs and bark, and 10% of wild rosemary, lingonberry leaves and crowberry stems, pinecone scales, *Sphagnum* peat moss, and various lichens. Ground nest lichens included striped Iceland (*Cetraria laevigata*), curled snow (*Nephromopsis cucullata*), cup (*Cladonia gracilis*), and Bering reindeer, with striped Iceland not found in the nesting area. Sapling larches were 0.6–1.9 m tall, with a 3–8 cm base diameter while the mature larch was 12 m tall with a 26 cm dbh. Ground nests were also underneath overhanging branches, with sapling larches providing 30–45 cm wide canopies 15–37 cm above the nests, while the mature larch provided a 1.5 m-wide canopy 1.4 m above the nest.

Active nests were found between 17 June and 22 June 2019–2021; five nests contained four eggs and the sixth had three eggs. Eggs ($n = 23$) were 46.4–51.0 mm long (mean 48.7 ± 1.2), 33.1–35.0 mm wide (mean 34.2 ± 0.6), and weighed 23.0–29.7 g (mean 26.2 ± 2.0). We were unable to regularly monitor nests, but in general eggs hatched between 25 June and 28 June. All ground nest eggs hatched; however, the only active arboreal nest was depredated. Given that incubation is ~25 days (Maleko *et al.* 2021), nest initiation probably occurred in late May or early June.

## Discussion

The nests we found at Schaste Bay were not only the first greenshank nests found in over 40 years, but also the first nests found on mainland Russia. Unlike Green (*Tringa ochropus*), Solitary (*T. solitaria*), or Wood (*T. glareola*) Sandpipers, which occasionally nest arboreally but inhabit old passerine nests (Oring 1966, Pulliainen and Saari 1991, Zwdarek 1999, Houston 2012), Nordmann's Greenshanks are the only shorebird known to build their own arboreal nests (Nechaev 1978). However, we discovered that greenshanks do not exclusively nest in trees, as expected based on the descriptions of Nechaev (1978), but exhibit nesting plasticity by also placing nests on the ground at the base of mature or sapling larches. We also found greenshanks alter nest composition depending on nest location (Figure 2b), and use materials obtained within and without the nesting area to match the surrounding environment and improve nest or egg camouflage.

It is possible that vegetation greening or snow cover at the time of nest initiation may influence nest-site selection (Cunningham *et al.* 2016, Ims *et al.* 2019). Larches are deciduous conifers; if larch needles have not emerged when greenshanks are establishing nest locations, an arboreal nest may be more visible to predators, primarily Large-billed (*Corvus macrorhynchos*) and Carrion (*C. corone*) Crows and Red Foxes (*Vulpes vulpes*), but also potentially Eurasian Hobbies (*Falco subbuteo*), Short-eared Owls (*Asio flammeus*), and Brown Bears (*Ursus arctos*), and also unduly exposed to wind and precipitation, ultimately influencing birds to nest on the ground instead. Similarly, if snow cover is abundant, the ground may be unavailable for nesting and influence greenshanks to nest in trees.

Of the nine nests we found, seven were located within 40 m of a Cajander larch forest or forest fragment, and two were 150 m from a larch forest but surrounded by sapling larches. Furthermore, all nest sites contained tall (12–15m) larch trees (live or dead), which greenshanks use as perches to watch for potential threats (Pronkevich *et al.* 2022). The arboreal nests found on Sakhalin Island were situated directly underneath broad overhanging larch branches, presumably to provide concealment from avian predators and to shield nests from strong winds and precipitation while allowing birds an unobstructed view of their surroundings (Nechaev 1978). Similarly, all the nests we found at Schaste Bay, arboreal and ground, were characterised by overhanging larch branches. These elements support the belief that greenshanks are

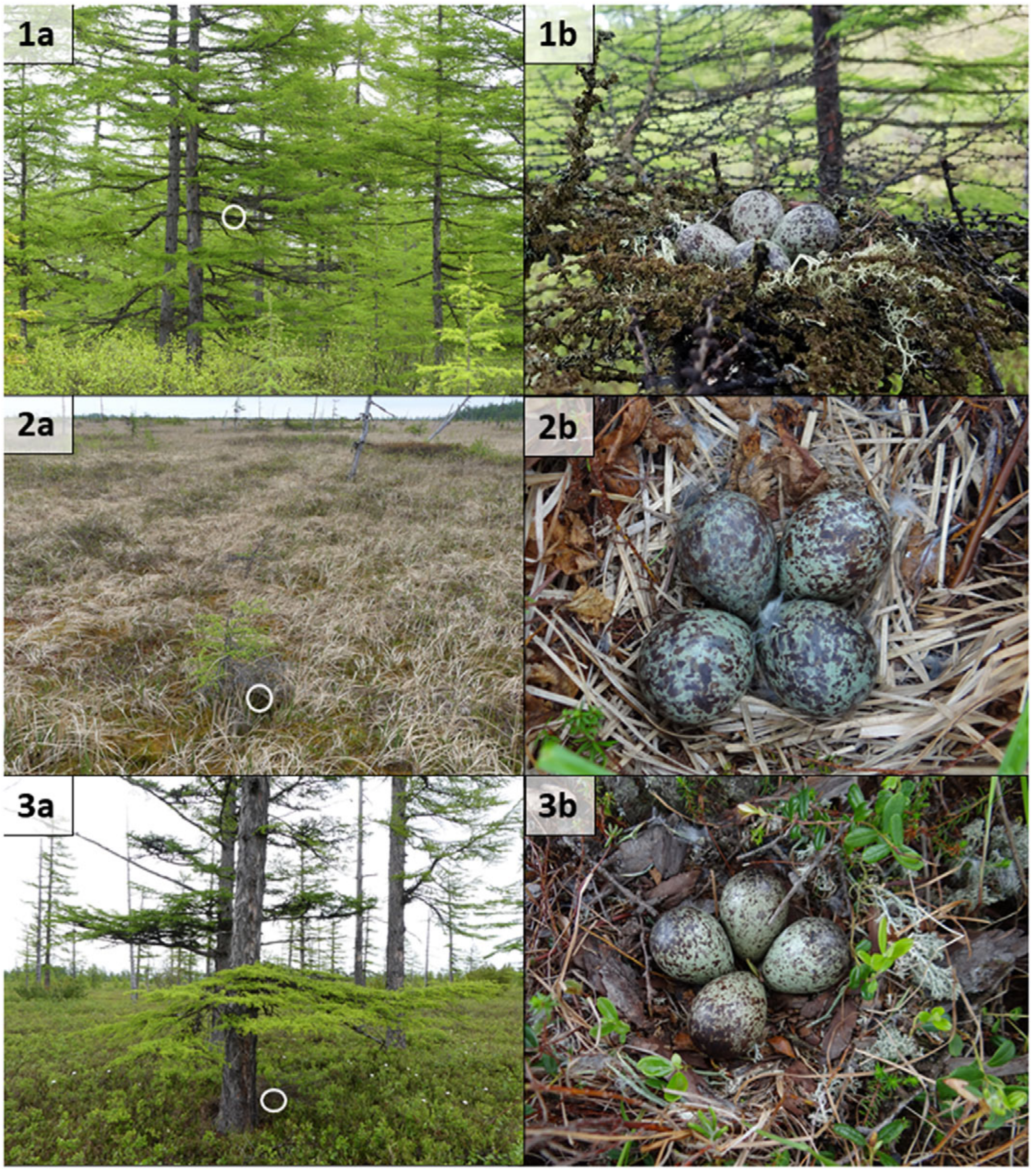


**Figure 2.** Nest microhabitat and composition. The three general habitat types (a) throughout north-western Schaste Bay in which we found greenshank nests during the summers of 2019–2021 and the corresponding nests (b) found in those habitat types. Exact nest locations are highlighted with white circles. (1a) Greenshank arboreal nesting habitat at the edge of a larch forest fragment. (1b) The arboreal nest situated on a larch branch, mostly composed of larch twigs and various lichens. (2a) Greenshank nesting habitat on the inland bog with abundant *Carex* sedges, many dispersed saplings, and live and dead trees in the vicinity with the nest situated under a sapling larch tree. (2b) A typical greenshank nest found on the inland bogs under sapling larch trees mostly composed of dry *Carex* sedge stems, various dry leaves, and small twigs. (3a) Greenshank nesting habitat on an inland bog that is close to a larch forest fragment with many live and dead tall trees in the vicinity, with flowering lingonberry bushes as the main ground cover feature and the nest situated at the base of a mature larch. (3b) The nest under the mature larch is composed mostly of small pieces of larch bark and twigs, some *Cladonia* spp. moss, with a few lingonberry seedlings around the outside.

obligates of coastal larch ecosystems during the breeding season (Nechaev 1978, Maleko *et al.* 2021). This reliance on larch trees for nesting presents an uncertain future for breeding greenshanks as possible climate change effects on coastal larch ecosystems remain unclear. Larch trees are very cold-climate adapted and a small increase in global air or ground temperatures may cause larch forests to shrink, retreat northward, or leave southern patches weak and unstable (Leng *et al.* 2008, Bai *et al.* 2019, Zhang *et al.* 2019). Likewise, unpredictable precipitation patterns may cause unstable wildfire regimes throughout boreal ecosystems, including in larch forests (Heim *et al.* 2019).

On Sakhalin Island, greenshanks nested near small lakes, rivers, and other inland water bodies (Nechaev 1978). Although there were plentiful pools and small inland lakes throughout Schaste Bay bogs, we did not find them to be prominent features of nest sites. While three nests were near small creeks, the channels were either subterranean or overgrown with larch trees and it is most likely the trees were the main attracting feature. Given that we never observed greenshanks loafing on the ground throughout the bogs, it is unlikely inland water bodies provide foraging habitat and may not be significant components of nesting areas in Schaste Bay.

Nechaev (1978) noted that greenshanks may breed in “loose nesting colonies” or “diffuse settlements” as the nests he found were relatively close together (minimal distance 70 m apart). Although the closest active nests we found were ~300 m apart, we likely did not find all the nests in the area in any year. Additionally, whenever we found a nesting territory, a sentinel bird would give an alarm call and draw in nearby greenshanks, which would either quietly perch on top of a tree or join the chorus of alarm calls. Perhaps this behavioural observation is anecdotal evidence of loose colonial or diffused breeding. It is more probable however that greenshanks nest relatively close together due to a patchy distribution of suitable nesting habitat rather than intraspecies social cohesion (Harwood *et al.* 2016).

Similarly to the findings of Nechaev (1978), we observed greenshanks using four different habitats: larch forests and hummocky inland bogs during nesting as well as adjacent coastal meadows and intertidal mudflats during foraging and brood-rearing. Given the extremely small number of greenshanks remaining, the protection of these habitats in the Russian Far East may be crucial for the conservation of this Endangered species. In addition, Schaste Bay is currently the only confirmed breeding site for Nordmann's Greenshank and thus can be a priority for protected area designation.

Our observations were biased to a small sample of mid-incubation or inactive nests. More research of tagged individuals and direct observations of birds during the breeding season are needed to determine greenshank breeding phenology, nest-site selection, and factors determining nest survival. Similarly, a detailed analysis is needed into the distributions of landscape features identified as important to greenshanks at various stages of the breeding season: coastal larch forests and hummocky inland bogs in close proximity to coastal meadows and intertidal mudflats. For example, remote sensing can be used to identify prospective areas along the Sea of Okhotsk coast with the confluence of possible suitable habitats (e.g. Academy and Tugur Bays), followed by targeted ground truthing and avian surveys. Furthermore, research is needed to determine whether habitat availability on the breeding grounds is limiting the global greenshank population, in addition to habitat reclamation, invasive species, and subsistence hunting throughout their non-breeding range (MacKinnon *et al.* 2012, Murray *et al.* 2014, Murray and Fuller 2015, Jackson *et al.* 2021).

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**Supplementary Materials.** To view supplementary material for this article, please visit http://doi.org/10.1017/S095927092200051X.

## References


Bai, X., Zhang, X., Li, J., Duan, X., Jin, Y. and Chen, Z. (2019) Altitudinal disparity in growth of Dahurian larch (*Larix gmelinii* Rupr.) in response to recent climate change in northeast China. *Sci.Total Environ.* **670:** 466–477.

Bergmann, H. H. (1998) Short report on a little known bird: Nordmann's Greenshank (*Tringa guttifer*). *Der Falke* **45:** 56–59. (In German).

BirdLife International (2020) Species factsheet: *Tringa guttifer.* Accessed online 28 January 2020 from http://www.birdlife.org.

Blokhin, A. Y. (1998) Breeding wader populations on the marine coasts of north-eastern Sakhalin. *Internatn. Wader Study* **10:** 221–224.

Blokhin, A. Y. and Kokorin, A. I. (2001) Current status of rare bird species in northeast Sakhalin. *Russ. Ornithol. J.* **22:** 2896–2898. (In Russian).

Cunningham, J. A., Kessler, D. C. and Lanctot, R. B. (2016) Habitat and social factors influence nest-site selection in Arctic-breeding shorebirds. *Auk* **133:** 364–377.

Dorogoy, I. V. (2013) Encounters with Ruff (*Philomachus pugnax*) and Nordmann's Greenshanks (*Tringa guttifer*) in southern Magadan Oblast. *Russ. Ornithol. J.* **872:** 1102–1106. (In Russian).

Fair, J. M., Paul, E., Jones, J., Clark, A. B., Davie, C. and Kaiser, G. (2010) *Guidelines to the use of wild birds in research*. Washington, DC, USA: Ornithological Council.

Harwood, C. M., Gill, R. E. Jr. and Powell, A. N. (2016) Nesting ecology of whimbrels in boreal Alaska. *Wader Study* **123:** 99–113.

Heim, R. J., Hölzel, N., Heinken, T., Kamp, J., Thomas, A., Darman, G. F., Smirenski, S. M. and Heim, W. (2019) Post-burn and long-term fire effects on plants and birds in floodplain wetlands of the Russian Far East. *Biodivers. Conserv.* **28:** 1611–1628.

Houston, C. S. (2012) Discovery of the world's first nest of the Solitary Sandpiper. *Blue Jay* **70:** 37–45.

Ims, R. A., Henden, J. A., Strømeng, M. A., Thingnes, A. V., Garmo, M. J. and Jepsen, J. U. (2019) Arctic greening and bird nest predation risk across tundra ecotones. *Nat. Clim. Chang.* **9:** 607–610.

Jackson, M. V., Fuller, R. A., Gan, X., Li, J., Mao, D., Melville, D. S., Murray, N. J.,. Wang, Z and Choi, C. Y. (2021) Dual threat of tidal flat loss and invasive *Spartina alterniflora* endanger important shorebird habitat in coastal mainland China. *J. Environ. Manage.* **278:** 1–9.

Kondratyev, A. B. and Andreev, A. (1997) Likely breeding of Nordmanns Greenshanks in Magadan Oblast. *Russ. Ornithol. J.* **26:** 3–4. (In Russian).

Leng, W., He, H. S., Bu, R., Dai, L., Hu, Y. and Wang, X. (2008) Predicting the distributions of suitable habitat for three larch species under climate warming in Northeastern China. *For. Ecol.Manage.* **254:** 420–428.

Leonov, A. (2000) Oil and gas development on the Sakhalin Island shelf: an assessment of changes in the Okhotsk Sea ecosystem. *Slavic Res. Cent. Occas. Pap.* **71:** 151–180.

Li, J., Hughes, A. C. and Dudgeon, D. (2019) Mapping wader biodiversity along the East Asian-Australasian Flyway. *PLoS One* **14:** 1–26.

MacKinnon, J., Verkuil, Y. I. and Murray, N. (2012) IUCN situation analysis on East and Southeast Asian intertidal habitats, with particular reference to the Yellow Sea (including the Bohai Sea). *Occasional Paper of the IUCN Species Survival Commission*. Gland, Switzerland and Cambridge, UK: International Union for Conservation of Nature (No. 47).

Maleko, P. N., Pronkevich, V. V. and Maslovsky, K. S. (2021) Nordmann's Greenshank (*Tringa guttifer*), version 2.0. In S. M. Billerman, P. G. Rodewald and B. K. Keeney eds. *Birds of the world*. Ithaca, NY, USA: Cornell Lab of Ornithology.

Murray, N. J., Clemens, R. S., Phinn, S. R., Possingham, H. P. and Fuller, R. A. (2014) Tracking the rapid loss of tidal wetlands in the Yellow Sea. *Front. Ecol. Environ.***12:** 267–272.

Murray, N. J. and Fuller, R. A. (2015) Protecting stopover habitat for migratory shorebirds in East Asia. *J. Ornithol.* **156:** 217–225.

Nechaev, V. A. (1978) On behavior and biology of the Nordmann's Greenshank (*Tringa guttifer*) on Sakhalin Island. *Zool. Z.* **57:** 727–737. (In Russian).

Nechaev, V. A. (1989) The status of Nordmann's Greenshank (*Tringa guttifer*) in the USSR. *Asian Wetland News* **2:** 2.

Oring, L. W. (1966) Vocalizations of the green and solitary sandpipers. *Wilson Bull.* **80:** 395–420.

Peng, H. B., Anderson, G. Q. A., Chang, Q., Choi, C. Y., Chowdhury, S. U., Clark, N. A., Gan, X., Hearn, R. D., Li, J., Lappo, E. G., Liu, W., Ma, Z., Melville, D. S., Phillips, J. F., Syroechkovskiy, E. E., Tong, M., Wang, S., Zhang, L. and Zöckler, C. (2017) The intertidal wetlands of southern Jiangsu Province, China: globally important for Spoon-billed Sandpipers and other threatened waterbirds, but facing multiple serious threats. *Bird Conserv. Internatn.* **27:** 305–322.

Pronkevich, V. V. (2013) New records of rare and poorly known birds from southern Priamurye and southwestern Priokhotye in 2012. *Amur Zool. Z.* **5:** 89–93. (In Russian).

Pronkevich, V. V., Maleko, P. N., Maslovsky, K. S. and Slaght, J. C. (2022) Trapping shorebirds using bow-net tables: an example with Endangered Nordmann's Greenshank. *Wader Study* **129:** 56–60.

Pronkevich, V. V. and Oleinikov, A. Y. (2010) New data on some water birds from the Khabarovskii Krai Province. *Amur Zool. Z.* **4:** 363–365. (In Russian).

Pronkevich, V. V., Roslyakov, V. I. and Voronov, B. A. (2011a) Results of registration of rare and insufficiently studied birds in Pri-Amurye and south-western Pri-Okhotye region in 2011. *Amur Zool. Z.* **3:** 381–385. (In Russian).

Pronkevich, V. V. and Voronov, B. A. (2013) Abundance of Nordmann's Greenshanks Tringa guttifer in Khabarovsk Krai. *Russ. Ornithol. J.* **28:** 1731–1735. (In Russian).

Pronkevich, V. V., Voronov, B. A., Atrokhova, T. A., Antonov, A. L., Adnagulov, E. V. and Oleinikov, A. Y. (2011b) New data on rare and seldom studied birds of Khrabarovsk Krai. *Russ. Ornithol, J*, **29:** 486–497. (In Russian).

Pulliainen, E. and Saari, L. 1991. Breeding biology of the Wood Sandpiper *Tringa glareola* in Eastern Finnish Lapland. *Ornis Fenn.* **68:** 127–128.

Reviakina, Z. and Zikov, V. (2018) Nordmann's Greenshank in Baikal Bay in Sakhalin Island. *The Second Meeting of Russian Nordmann's Greenshank Taskforce 2018*.

Reviakina, Z. V. and Zikov, V. B. (2011) Shorebird surveys in northeastern and western Sakhalin Island. *Russian Shorebird Working Group* **24**: 22–25.

Tiunov, I. M. (2016) Lagoons of the North-Eastern Shore of Sakhalin Island. Pp. 101–103 in *Marine important bird areas of the Russian Far East*. Moscow, Russia: BirdsRussia.

Yu, C., Ngoprasert, D., Round, P. D., Pierce, A. J., Savini, T. and Gale, G. A. (2019) Roost selection of the endangered Spotted Greenshank (*Tringa guttifer*) in critical habitat in the Inner Gulf of Thailand. *Avian Res.* **10:** 1–10.

Yu, C., Ngoprasert, D., Savini, T., Round, P. D. and Gale, G. A. (2020) Distribution modelling of the endangered Spotted Greenshank (*Tringa guttifer*) in a key area within its winter range. *Glob. Ecol. Conserv.* **22:** 1–10.

Zhang, X., Bai, X., Hou, M., Chen, Z. and Manzanedo, R. D. (2019) Warmer winter ground temperatures trigger rapid growth of Dahurian larch in the permafrost forests of northeast China. *J. Geophy. Res. Biogeosci.* **124:** 1088–1097.

Zöckler, C., Li, D., Chowdhury, S. U., Iqbal, M. and Chenxing, Y. (2018) Winter distribution, habitat and feeding behaviour of Nordmann's Greenshank *Tringa guttifer*. *Wader Study* **125:** 1–8.

Zwdarek, P. (1999) Report on nesting of the Green Sandpiper *Tringa ochropus* in central Europe. *Wader Study Group Bull.* **89:** 45–49.