Review of the distribution and conservation of Far Eastern Curlew *Numenius madagascariensis* in the River Lena and River Yana basins, East Siberia

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Abstract

The catchments of the River Lena and River Yana are the least known parts of the nesting grounds of the endangered Far Eastern Curlew *Numenius madagascariensis*, despite accounting for almost half of its known breeding range. This analysis reports on the current distribution of the Far Eastern Curlew, delineates the northern and western extent of its breeding range and describes distribution patterns and threats to the species, based on field research, reports from local people, and a review of historical and most recent publications. The breeding grounds extend to 63°17'N–67°31'N latitude north and 112°27'E–135°11'E longitude west, with the western bow-shaped limit extending to the middle reaches of the River Aldan. The only non-mountainous part of its breeding range within the Lena and Yana River basins is in a 700 × 300 km area west of the Verchoyanskiy Range (63°–66°N), which suggests that the Far Eastern Curlew is a species of mountainous and sub-montane areas. Depending on habitat mosaics, breeding curlews are sparsely distributed in solitary pairs, concentrated in mountains and their foothills. Data are lacking to support the estimation of regional trends in the abundance and distribution of Far Eastern Curlews. Annual hunting of the species does not appear to be critical, and the species is not susceptible to any other obvious threats. The Far Eastern Curlew is able to breed successfully in wetlands subject to human disturbance, but the pristine state of the majority of the breeding grounds and the low-level human activities within its core range suggest predominantly favourable conditions and a general lack of critical direct threats to the species in the River Lena and River Yana catchment areas.

Keywords: breeding distribution, breeding range, endangered species, wader.

The Far Eastern Curlew *Numenius madagascariensis* is a wader species which breeds in northeast Asia and migrates along the East Asian-Australasian Flyway. Annual counts on the wintering grounds across Australia show that numbers have decreased since the 1970s–1980s, with a dramatic decline by the 2010s (Cooper *et al.* 2012;

Studds *et al.* 2017; Dhanjal-Adams *et al.* 2019), stimulating the development of an action planning process to achieve a stable or increasing population of this species. This information indicated that the curlew was undergoing a very rapid population decline, and in 2015 the Far Eastern Curlew was uplisted to "Endangered" in the IUCN Red List and to "Critically Endangered" in the Australian Environment Protection and Biodiversity Conservation Act List of Threatened Fauna. In 2017, an International Single Species Action Plan for the Far Eastern Curlew was adopted by the East Asian-Australasian Flyway Partnership (EAAFP), which identified priorities and short- and long-term activities for conservation of the species. Actions relating to the breeding range, listed as being essential or of medium priority within the Action Plan, are: (1) to initiate research to obtain an accurate measure of population structure, trends and density; (2) to quantify the effects of disturbance on the species during the breeding season and assess its likely impact on the population; (3) to quantify and predict changes in important breeding habitats; and (4) to identify potential shifts in distribution (BirdLife International 2017; EAAFP 2017; Department of the Environment 2019).

The least known part of the Far Eastern Curlew's breeding range is the basins of the River Lena and River Yana in eastern Siberia. This area accounts for almost half of the breeding grounds described for the species, but we lack both a robust monitoring programme in the region and baseline data against which to judge the progress of conservation initiatives. Antonov (2016) notably but somewhat arbitrarily mapped four widely separate areas east of 110°E in basins of the upper reaches of the River Lena and River Yana where the curlews were thought to occur, as well as sites in the upper reaches of the River Vilyui, where they were known to occur and thought to breed. Meanwhile, Vinokurov (2019) illustrated the species as breeding across a large part of the River Vilyui basin, and indicated that the breeding range extended from the basin of the River Yenisei, situated west of 105°E, with a discrete outlier in the upper reaches of the River Yana. Following guidance from the IUCN SSC (IUCN 2001) on delineation of range extent as a minimum convex polygon, BirdLife International (2017) defined the north-western part of the extant breeding range as including almost the entire River Lena basin outside the Arctic region. There were no estimates of breeding numbers and population trends in this area.

In recent years, fieldwork has permitted verification of the northern and western limits of the Far Eastern Curlew's breeding range, filling of gaps in knowledge of their distribution, and assessment of population trends in the north-western section of its range. Moreover, two biogeographical subpopulations have been described, defined according to the different moulting strategies of Far Eastern Curlews passing through north-eastern China (EAAFP 2017), so whether these groups exploit separate breeding areas is of particular interest. This study therefore aims to use field surveys, reports from local people, and a literature review (including historical and more recent publications) to describe

Table 1. Data on Far Eastern Curlew nest sites in the basins of the River Lena and River Yana, eastern Siberia.

Code[a]		Location	Coordinates	Observation date	No. of pairs
A	1.	The middle reaches of the River Kyebyeryen (Vartapetov *et al.* 2019)	63°16'50"N 112°27'23"E	23 June 2012	1
	2.	The upper reaches of the River Syuldjikar (Andreev 1987)	63°25'37"N 113°50'54"E	June 1966	1
	3.	Lake Syugjer[b]	64°18'19"N 114°46'27"E	June 1999	13
	4.	Lake Kyukyay (Egorov & Secov 2018)	62°44'38"N 117°45'12"E	7–10 July 2017	1
	5.	Lower reaches of the RiverDyanyischka[b] (Labutin *et al.* 1988)	65°1'33"N 125°9'32"E	July–August 1975	~ 3–4
	6.	Lake Kustakh[b] (Vinokurov 2019)	65°46'N 122°5'37"E	June 2008–2009	7
	7.	The upper reaches of the River Dulgalakh (Nakodkin & Isaev 1991)	66°1'17"N 131°32'6"E	June 1990	3
	8.	Lake Ulakhan Kyuel (Shemyakin 2019)	67°31'29"N 136°30'38"E	July 2010	1[c]
	9.	The lower reaches of the River Maya	59°50'47"N 134°49'E	May 2019	1
	10.	The lower reaches of the River Maya	59°24'22"N 135°2'45"E	May 2009–2014	5
	11.	The lower reaches of the River Uchur	58°45'46"N 130°43'15"E	August 2009	2
	12.	The middle reaches of the River Algama[b] (Egorov *et al.* 2002)	56°22'11"N 130°12'48"E	July–August 2000	2
	13.	The upper reaches of the River Tyirkanda (Shemyakin 2019)	57°48'37"N 128°07'11"E	June 2014	1
	14.	The upper reaches of the River Tit (Shemyakin 2019)	57°34'5"N 125°20'42"E	June 2012	1
	15.	The middle reaches of the River Bol'schoe Khatyimi[b] (Shemyakin 2019)	57°11'33"N 125°08'26"E	June 2012	1
	16.	The middle reaches of the River Ungra[b] (Shemyakin 2019)	57°19'52"N 124°13'50"E	June 2009–2010	1

Table 1 (*continued*).

Code[a]		Location	Coordinates	Observation date	No. of pairs
	17.	The upper reaches of the River Durai (Shemyakin 2019)	57°16'20"N 124°14'5"E	August 2013	1
	18.	The upper reaches of the Gonam River	55°56'45"N 126°15'10"E	June 2010	1
	19.	The upper reaches of the River Chara (Pavlov 1976; Tolchin *et al*. 2014)	56°55'29"N 118°18'24"E	May–June 1963, May–June 1975	~ 10s
	20.	The upper reaches of the River Vitim (Tolchin *et al*. 2014)	56°25'41"N 115°43'24"E	May–June 1976	~ 10s
B	1.	The area of the mouth of the Rivers Viyuy and Lungkha[b] (Maack 1886)	~ 64°13'N 126°38'E	June–July 1854	~ 10s
	2.	The upper reaches of the River Chilli (Maack 1886)	~ 65°N 118°2'E	August 1854	1
C	1.	The basin of the middle reaches of the River Tyung (Borisov 2014)	~ 64°49'N 120°54'E	2010–2012	~ 1[d]
	2.	The basin of middle reaches of the River Tyung (Borisov 2014)	~ 64°31'N 121°3'E	2010–2012	~ 1[d]
	3.	The middle reaches of the River Linde[b]	~ 65°37'N 122°9'E	1970s	~ 10s
	4.	The middle reaches of the River Kele[b]	~ 63°38'N 130°54'E	1981–1984	~ 10
	5.	The middle reaches of the River Tukulan[b]	~ 63°37'N 132°22'E	1975–1978	~ 5
	6.	The middle reaches of the River Aldan[b]	~ 60°31'N 135°11'E	2016–2015	1
	7.	The middle reaches of the River Aldan	~ 58°57'N 131°41'E	2013	1
	8.	The lower reaches of the River Yudoma	~ 59°20'N 135°22'E	2017–2019	1
	9.	The lower reaches of the River Yudoma	~ 59°30'N 135°44'E	2017–2019	1
	10.	The middle reaches of the River Maya	~ 57°33'N 135°53'E	2014	1
	11.	The upper reaches of the River Maya	~ 57°36'N 136°7'E	2013–2014	1
	12.	The upper reaches of the River Maya	~ 57°52'N 136°22'E	2013–2014	1

[a]Breeding site codes are for areas illustrated in Fig. 1. A = located during the 1960s–2010s; B = located in the 19th century; C = reported by local people.
[b]Breeding sites are situated in a protected area.
[c]In addition, ~ 20 non-breeding Far Eastern Curlews were counted.
[d]Verbatim citation: "fairly noticeable numbers".

the current distribution of the Far Eastern Curlew, in order to delineate the western and northern extent of the breeding range, outline distribution patterns and identify threats to the species.

Methods

Data on Far Eastern Curlew distribution were collated for the wetlands of the Central Yakutian Plain (lowlands), the Aldan and Yudoma-Maya highlands, and the Vilyuiskoe and Prilenskoe plateaux within an area ranging from 56°–66°N and 108°–135°E. Representative and widespread wetland types were surveyed along the River Lena in 1979–2021 (Degtyarev 2007, 2016), including breeding habitat considered typical for Far Eastern Curlew located on plateaux, mountains, foothills and sub-montane depressions, along wide river valleys, and in other potentially suitable habitats widely distributed across the plains. The latter includes the "alas", a term used here to designate a small cryogenic type of landform specific to but widespread in the Central Yakutian Plain, which usually consists of a meadow and lake unit, of varying size, resulting from a hydrological depression without outflow, embedded in the taiga (Degtyarev 2016). The survey covered Far Eastern Curlew breeding areas identified by Maack (1886), the only ones reported in the 19th century (B1 and B2 in Table 1, Fig. 1). Evidence of breeding included nests with eggs, nest building, recent fledglings, courtship display, permanent territory, and territory defence. Breeding sites located were surveyed in the middle May–early June for several days by 1–3 researchers, during which time the numbers of pairs in the separate wetlands were recorded, the limits of their nesting territories were observed, and the distances between them were determined. Additionally, acoustic playbacks were used to detect the presence of curlews within a wetland. These data were not extrapolated to similar wetlands in the vicinity, because the patchy distribution of the birds (even in a uniform habitat) would invalidate any calculation of curlew densities. In the intermountain regions of the Verkhnecharskaya (A19) and Muiskaya (A20) depressions, however, Tolchin *et al.* (2014) reported Far Eastern Curlew as being common in suitable habitats, and calculated its density, which enabled us to obtain a rough estimate of the local breeding population for these two areas.

In addition to the breeding surveys, visible spring migration data were collected at four locations: at points in D1 in 1996, in D2 during 1989–1990, in D3 in 1978–1983 and in D6 between 2006 and 2021 (Fig. 1). Observations were made in 10–30 May throughout daylight hours at separate lakes or lake systems surrounded by marches, bogs and tussock bushlands, in habitat typically used by curlew in the study area. As all of these wetlands are embedded in the continuous taiga zone, our observations covered bird migratory movements and landing at ≤ 1 km from the observation point, depending on the size of the treeless area around the wetland.

An important source of information included interviews with local people made during the 1979–2021 study period. Their reports were verified by observations made of curlews during fieldwork, and this kind

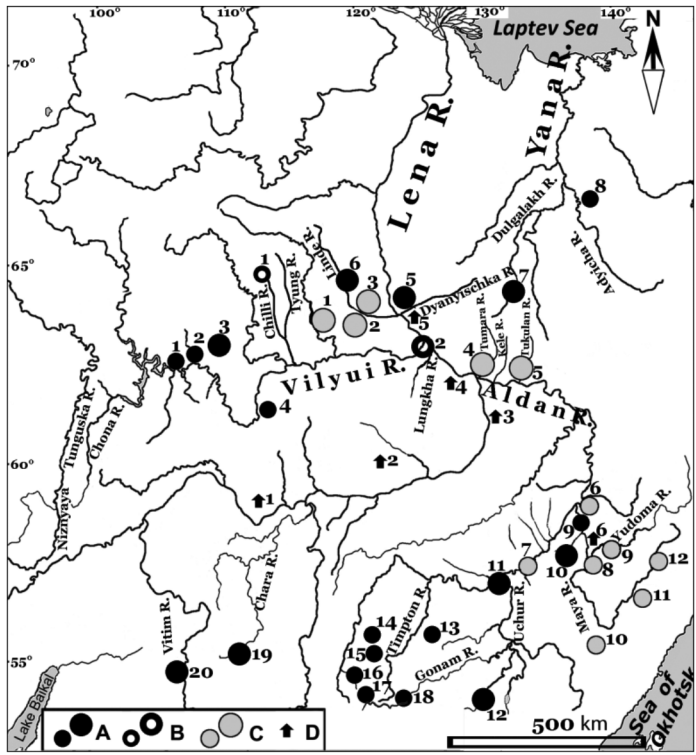

Figure 1. Distribution of Far Eastern Curlew in the basins of the River Lena and River Yana, in eastern Siberia. **A** = breeding sites located during the 1960s–2010s; **B** = breeding sites located in the 19th century; **C** = breeding sites reported by local people; **D** = location points for observers monitoring migration. For points **A**–**C**: small symbols = sites occupied by a single breeding pair; large symbols = sites occupied by several breeding pairs; and numbers refer to the sites listed in Table 1.

of information is considered trustworthy in studies made of other rare species (Degtyarev 2007, 2020). Reports from local observers of annual repeat occurrences of Far Eastern Curlew seen at the same locations, indicative of fidelity to wetlands during the breeding season, were taken into consideration. However, estimates by local residents of the numbers of Far Eastern Curlew were rough and thought to be biased.

Nesting locations derived from published information and the reports of people living in the area were examined using freely available medium- and high-resolution Google Earth satellite images to verify landscape composition and the habitat used by the birds. These images were also used to identify any human-induced changes in habitat over time.

As Antonov (2010) considered predation to be the main cause of egg and nestling mortality in the southern part of the species' range, any potential predators of nesting curlews were listed based on their raptorial

behaviour and their occurrence in or near the curlews' nesting territory. Any traces of the presence of potential predators (*e.g.* scats, sightings), as well as their activity in Far Eastern Curlew nesting territories (*e.g.* waterbirds being pursued, or remains of eaten birds and mammals) were recorded.

Hunting data in relation to Far Eastern Curlew were collected through an anonymous survey and hunter bag examinations, conducted during the interviews with local people mentioned above. The same kind of data were obtained from A.Y. Valeev, who, as a game warden, examined the birds shot by hunters or poachers during patrols of the wetlands from 1984–2015. Information on the occurrence and hunting of Far Eastern Curlew was also obtained from the local and regional hunter internet forums, surveyed for images and online discussions.

Results

Distributional records

Between the 1850s and the 2010s, 22 Far Eastern Curlew nesting areas were located in the River Lena basin, and the positions of 12 more were proposed by local people. Additionally, two nesting areas were found in the River Yana basin (A7 and A8; Fig. 1, Table 1). Wetland A9, which was monitored from 2007 onwards, was first occupied by a Far Eastern Curlew pair in 2019.

There are no recent observations of Far Eastern Curlew close to B1 and B2, recorded by Maack (1886) as nesting areas in the 19th century (Fig. 1, Table 1). It seems that the species now only occurs regularly *c.* 100 km further to the northwest of B2 in the River Lena valley, the basin of the lower reaches of the River Dyanyischka, and at the interfluve of the Rivers Vilyui, Tyung and Linde (A5, A6 and C1–C3, Fig. 1, Table 1; Labutin *et al.* 1988; Borisov 2014).

Breeding distribution

Far Eastern Curlews bred along the mountainous fringe of the eastern and south-eastern basin of the River Lena and the adjacent River Yana watershed (A7–A20, C6–C12, Fig. 1). The entire area is one of mountain ranges with highlands and piedmont plateaux, formed along the orogenic belt, which runs from Lake Baikal to the Arctic Ocean, where wetlands occupied by Far Eastern Curlews were situated at 216–1,115 m a.s.l.

Between 63° and 66°N, Far Eastern Curlew nesting sites occurred between 55–354 m a.s.l. (A1–A4, B1–B2, C1–C3) in an area extending 600–700 km westward from the Verchoyanskiy Range. Here, the breeding range extends along a section of up to 300 km width, to the point where the Central Yakutian Plain meets the Nizhnelenskaya lowlands, and from there to the eastern end of the Vilyuiskoe Plateau (Figs. 1 & 2).

Most nesting sites were situated in a valley or at the headwaters of small (A1, A2, A5, A9–A11, B2), medium-size (A12, A18–A20) and large (A4, A7, A9–A11, A13–A17, B2, C7–C12) rivers. The topography at A19 and A20 comprises large U-shaped, flat-bottomed valleys sandwiched between mountain blocks. With the exception of A4, nesting Far Eastern Curlews typically occupied an area along lake shores or on quaking bogs among sparse larch or larch-tussock forests and bushlands. The A4 area is a typical alas embedded within dense taiga.

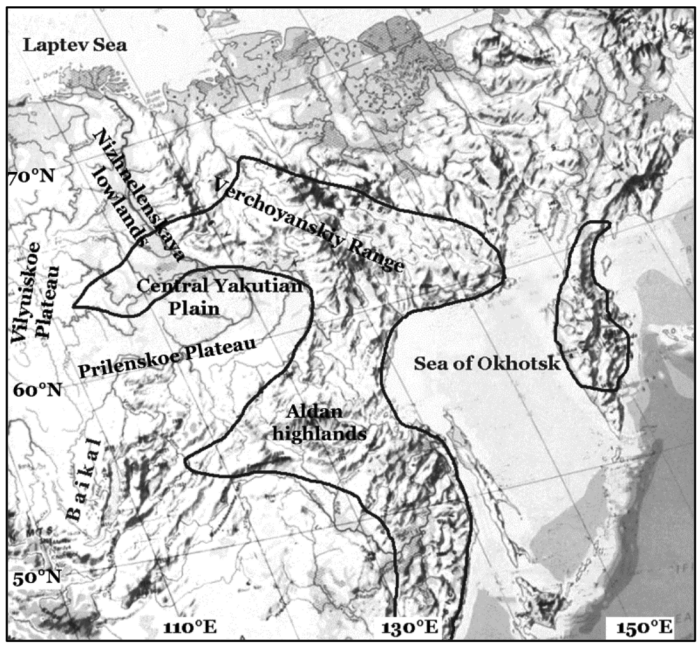

Figure 2. The breeding range of Far Eastern Curlew (outlined by the black line), superimposed on a relief map of northeast Asia.

Other nesting sites were located on interfluves and plateaux blocks between adjacent valleys. In A3, these consisted of large peat-filled depressions on a plateau with numerous lakes and quaking bogs among sparse larch trees *Larix* sp. and dwarf-shrub tundra, while in A8 Far Eastern Curlew bred in a large and deep intermountain depression at 216 m a.s.l. with typical alas formations. A6 and C1–C6 comprised flat whaleback watersheds, where nesting birds associated with lakes surrounded by quaking bogs or tundra vegetation embedded in the taiga.

Nesting numbers

In total, 100–200 Far Eastern Curlew pairs bred in the nesting areas located, excluding those in areas A19 and A20. Tolchin *et al.* (2014) reported a density of 0.2–0.5 curlews km^{-2} in suitable habitats of the intermountain Verkhnecharskaya depression (A19) in 1975 and 1.5 curlews km^{-2} in the Muiskaya depression (A20) in 1976. Given that the total area of depressions with habitat suitable for Far Eastern Curlew in A19 and A20 is estimated at *c.* 10,000 km^2, these densities imply a local breeding population of a few thousand pairs, which would constitute the largest known breeding assemblages in the entire region.

Away from A19 and A20, the nesting areas surveyed were usually occupied only by single or relatively few pairs (Fig. 1, Table 1). For instance, aggregations of five, three, three and two pairs in areas extending

up to 5 × 2.5 km (12 km^2) of lake shore were spaced < 1 km apart in area A3. Five pairs were found in an area 30 × 5.5 km (90 km^2) in A10 and two pairs within 7 × 3 km (16 km^2) in segments of a river valley within A11, with distances of at least 1–3 km between pairs. Wetlands supporting single nesting pairs were located in A4 (25 km^2), in plateau (A1, 5 km^2), sub-montane (A9, 0.5 km^2) and mountainous areas (A13–A16, ranging from 0.5 to 3 km^2) as well as within a patch of 0.03 km^2 (A17, 300 × 120 m) embedded in the taiga.

Possible predators

Potential predators of ground-nesting birds including curlews, seen in open habitat near nesting Far Eastern Curlews, included Brown Bear *Ursus arctos*, Red Fox *Vulpes vulpes*, Wolf *Canis lupus*, three Mustelidae species, ten Accipitriformes species and Common Raven *Corvus corax*. In the Central Yakutian Plain, in areas with alases (*i.e.* potential habitat for Far Eastern Curlew), the Eastern Marsh Harrier *Circus spilonotus* was also common. During fieldwork, however, no traces were found of the curlews having been predated or attacked by predators, nor were direct intrusions of predators observed in the curlews' nesting territories.

Hunting

Labutin & Larionov (1976) quoted two records of Far Eastern Curlew being shot by local hunters, in May 1961 and July 1970. The survey of 325 anonymous respondents and examination of 974 wildfowl harvested between 1979–2021 revealed nine cases of Far Eastern Curlew having been shot illegally (a total of about 15 individuals). A game warden (A.Y. Valeev, pers. comm. 2021) identified no waders in his examination of birds (several thousand) shot by hunters or poachers in the middle reaches of the River Aldan during 1984–2015, but a survey of the regional hunter internet forum gave evidence of Far Eastern Curlews occasionally being shot – either unknowingly or out of curiosity – in the 2010s. There were a few forum members who praised the flavour of curlew meat and claimed to hunt waders including the Far Eastern Curlew wherever possible. None of the respondents and forum members reported on special efforts and techniques being made to target waders, in a manner comparable with those (*e.g.* decoys, hides) used for legal hunting of duck and geese, which they practised annually.

Human impacts on wetlands

Only wetlands in areas A4 and A8 were grazed by livestock or cut for hay, and this activity was mostly outside the wettest areas of the alases occupied by Far Eastern Curlew. These alases are however accessed for duck hunting (May, August–September) and for open-water fishing (May–September). Sites A12–A14 were situated in a gold-mining area, with A13 in particular being situated in a small river valley heavily disturbed by an open-pit gold mining facility. Based on medium- (31 December 1985) and high-resolution (18 July 2019) satellite images, in the latter area, at least from 1985, about 7 km along the river has been denuded of vegetation and is almost entirely transformed by the existence of waste dumps and settling ponds. In contrast,

all other nesting areas were located in areas extremely hard to access by humans. They are mostly far from transport networks and can be reached only by using special transport vehicles (snowmobiles, water-jet propellers, cross-country vehicles, helicopters, *etc*.). The wetland types preferred by the Far Eastern Curlew are generally of little interest to hunters or fishermen during the entire breeding period.

Protected areas

Eleven breeding sites for Far Eastern Curlews are located within regional and municipal protected areas (Table 1). These include the "Ust-Vilyuisky" Nature Park (A5, the River Dyanyischka), and the "Lake Syugjer" (A3, Lake Syugjer), "Kitchan" (B1, the mouth of the Rivers Viyuy and Lungkha), "Linde" (A6, Lake Kustakh, C3, the River Linde), "Kele" (C4, the River Kele), "Tukulan" (C5, the River Tukulan), "Kyupsky" (C6, the River Aldan), "Bol'schoe Toko" (A12, the River Algama), "Ungra" (A16, the River Ungra), and "Khatyimi" (A15, the River Bol'schoe Khatyimi) Resource Reserves (Map of Protected Areas 2021). The largest known breeding assemblages, in the intermountain Verkhnecharskaya (A19) and Muiskaya (A20) depressions, however, are not covered by Russia's protected area system.

Discussion

This survey is the first to provide good coverage of representative types of wetlands and patches of terrain within the western River Aldan basin, the Central Yakutian Plain, the Prilenskoe Plateau, and the Aldan and Yudoma-Maya highlands, in relation to the presence and abundance of Far Eastern Curlew. Notwithstanding the fact that its entire population has still yet to be mapped, the data pooled to date provide a reliable basis for defining the western and northern extent of the species' breeding range, and also on the relative abundance and distribution of Far Eastern Curlew. However, the wetlands in the eastern River Aldan basin, from its mouth to the River Maya, remain unsurveyed in an area where we also have few reports from local people.

Breeding range limits

The aggregated data verify the view that the south-westernmost edge of the Far Eastern Curlew's breeding range is the Muiskaya intermountain depression in the upper reaches of the River Vitim (A20; Table 1, Fig. 1). From here, the western bow-shaped limit of the range extends eastward to 135°E across the upper reaches of the River Chara to the riverhead of the Aldan, and runs along it towards its mouth, then along the River Lena to the mouth of the River Vilyui. Then, the boundary of the range heads sharply westwards, almost reaching 112°E (A1; Table 1, Figs 1 & 2). Site A1 was confirmed as being at the westernmost point of the range, after which the boundary draws back to the River Lena, *c.* 300 km north of the mouth of the River Vilyui. Further north, the limit extends to the River Yana basin, crosses the Arctic Circle and reaches its northernmost point (A8) at just beyond 67°N. Towards the east from A8, the breeding range of Far Eastern Curlew nowhere extends above 61°–63°N (Lappo & Syroechkovski 2018; Sleptsov 2019) (Fig. 2).

Andreev (1987) and later Antonov (2016), both relying exclusively on reports from locals, defined the western edge of the species' distribution as being across the River Chona basin (~110°E). Also, seven Far Eastern Curlews were reported in late July 1970 at the mouth of the River Chona (~62°53'N, 111°4'E) by Labutin & Larionov (1976). These observations require verification of species identification, however, because other records of curlews made close to this area since 1926, in the basins of the River Nizhnyaya Tunguska and the River Chirkuo, and also along the River Chona, were all of Eurasian Curlew *N. arquata* (Tkachenko 1929; Mel'nikov 2000). In addition, no Far Eastern Curlews were observed during a survey of the central part of the River Chona basin in 2002 (Isaev *et al.* 2005).

Breeding distribution pattern

The Far Eastern Curlew is a species of mountainous and sub-montane areas (Fig. 2), breeding at altitudes of > 1,000 m a.s.l. The only non-mountainous section of its breeding range, in the basins of the River Lena and River Yana, was within a 700 × 300 km area west of the Verchoyanskiy Range. Other breeding sites located, along with those outside the study area, for the most part occurred in mountains and piedmont plateaux. Mountains provide a uniform terrain between the Rivers Aldan and Yana, the lower reaches of the River Lena, and the Sea of Okhotsk. Hence, there are no ecological barriers isolating the species' breeding grounds in the catchment of the River Lena from those located on the coast of the Sea of Okhotsk (Tokanov 2018; Kondrat'ev 2019), in the upper reaches of the Kolyma River (Sleptsov 2019), and in the Amur River basin (Mikhailov & Shibnev 1998; Driscoll & Ueta 2002; Antonov 2016) (Fig. 2). On the contrary, based on the species' distribution patterns in the Aldan and Yudoma-Maya highlands, all the mountainous blocks, including those within the basins of the Rivers Lena, Yana, Idigirka and Kolyima, and the Sea of Okhotsk below 66°–68°N, constitute potential continuous habitat for the Far Eastern Curlew. This is especially the case given that solitary pairs can be scattered in very low densities over vast areas, associated with the mosaics of countless small habitat patches associated with dense river networks. Nevertheless, there can be some clumping of breeding birds associated with a number of small intermountain depressions and in large piedmont plateaux along the Verchoyanskiy Range.

The intermountain Verkhnecharskaya and Muiskaya depressions are likely to hold the largest known assemblages of breeding Far Eastern Curlews in the region. However, it is not known whether their status here has been unchanged since 1975–1976 when the River Lena valley, 300 km north of the mouth of the River Vilyui with its adjacent interfluves and piedmonts, was considered to be the location of large numbers of breeding curlews.

The Far Eastern Curlew does not appear to have discrete separated breeding areas that could correspond to the different moulting strategies revealed among Far Eastern Curlews passing through northeast China (EAAFP 2017). Further information on this matter could be obtained by

examining Far Eastern Curlews in the northernmost and southernmost parts of their breeding range separated by about 20° latitudinally, or on the continental and coastal breeding grounds where the birds would encounter different climatic conditions that could account for different moulting strategies (Summers *et al.* 1989, 2004; Remisiewicz 2011).

Trends

Comprehensive data on historical numbers and distribution of Far Eastern Curlew are lacking, which makes it difficult to confirm trends over time. Fig. 1 and Table 1 show two nesting sites located by Maack (1886) in the 19th century where, more than 150 years later, the Far Eastern Curlew no longer occurs. Maack's site B2 was a large area at the mouth and lower reaches of the River Vilyui where Far Eastern Curlews were abundant and widespread. Based on the occurrence of migratory Far Eastern Curlews (Labutin *et al.* 1988), and also of the nesting sites found or reported in A5, A6 and C1–C3 (Fig. 1, Table 1), it is most likely that large numbers of Far Eastern Curlew are now slightly to the north of the mouth and lower reaches the River Vilyui.

No field surveys of Far Eastern Curlew breeding in the Verkhnecharskaya (A19) and Muiskaya (A20) depressions have been carried out since those made in 1976. Following the first reports of Far Eastern Curlew in the Verkhnecharskaya depression in 1963 (Pavlov 1976), it was confirmed as being abundant there in 1975 (Tolchin *et al.* 2014), and hopefully the site may continue to sustain breeding curlews to the present day. The current status of these two areas, the largest previously known breeding assemblages of the species, however remains unclear.

In spite of declining trends in its global population (BirdLife International 2017), the Far Eastern Curlew has occupied new nesting sites in recent years. Breeding Far Eastern Curlews were not known to occur in the alas landscapes of the Central Yakutian Plain (Andreev 1987; Degtyarev 2007), so the record of a breeding pair in alas habitat at A4 in 2017 (Egorov & Secov 2018) represented the first known colonisation of alas by the Far Eastern Curlew in the River Lena basin. This site, along with A7 in the River Yana basin, is unlikely to reflect the wider habitat preferences shown by Far Eastern Curlews in the major part of its breeding range. Single cases of nesting in a marsh and a meadow in agricultural landscapes have only been reported from the lower reaches of the River Amur and the upper reaches of the River Kolyma (Antonov 2010; Sleptsov 2019). Groups of Far Eastern Curlews that could consist of broods with parents reportedly occur in alases along the lower reaches of the River Vilyui in August. The colonisation of alas as nesting habitat is of particular note because, regionally, this is the favoured nesting habitat type for many other wader species (Degtyarev *et al.* 2006; Degtyarev 2007). Some of the best alas habitat (potentially suitable for the Far Eastern Curlew) occurs in the Central Yakutian Plain, suggesting that there is potential for the Far Eastern Curlew to spread to this area and to the Prilenskoe Plateau if its population increases.

Threats

Shorebirds, as distinct from geese and ducks, are not traditionally hunted in Yakutia. In contrast to the Kamchatka Peninsula (Gerasimov *et al.* 1997; Klokov *et al.* 2019), there has never been any specialist wader hunting in Yakutia, where wader hunting has been forbidden and waders were not legally declared game species until the 2010s. Since 1987, Far Eastern Curlew has been listed in the regional, and since 1997 in the national Red Data Book (Danilov-Danil'an *et al.* 2001; Vinokurov 2019). Nevertheless, because it is a duck-sized waterbird, the Far Eastern Curlew is shot occasionally whilst on migration during the spring duck hunting season. Its annual harvest in the region is unlikely to exceed several tens of mature individuals, however, as the majority of the waterfowl hunting occurs away from the curlews' core breeding grounds and prime migratory routes. All observations of avian spring migration throughout the Central Yakutian Plain and the Prilenskoe Plateau (D1–D4, D6, Fig. 1) are of small numbers, typically only solitary individuals, pairs or small flocks of Far Eastern Curlew (Degtyarev 2007; Vinokurov 2019). Unusually a group of almost 100 curlews were counted at a breeding site near the River Vilyui mouth in 1976, the only such report on record (D5, Fig. 1) (Labutin *et al.* 1988). Formal listing of waders as autumn game birds since 2010 could, to some extent, have increased hunting of waders in Yakutia, where formerly it was not widely practised. While this might increase the risk of Far Eastern Curlew being shot, there has been no apparent rise in the level of interest in this new bird category for hunting (Hunting and fishing. Forum at Ykt.ru. 2021). Sporadic reports praising curlew meat on the regional hunter internet forum may simulate a rise in the rate of incidental shooting of Far Eastern Curlews during the duck hunting season. However, the species remains legally protected from hunting, and illegal hunting carries criminal liability according to the species' conservation status and under Russian Law (The Criminal Code of the Russian Federation 1996; Danilov-Danil'an *et al.* 2001). This, along with the birds' breeding distribution, makes it unlikely that hunting curlew will become common practice in the region.

Other threats are not obvious. Far Eastern Curlew breeds in alases subject to hay-cutting or grazing by livestock and the species does not abandon areas in the vicinity of open-cast mining. The entire breeding range is almost completely restricted to pristine and (for humans) inaccessible areas. These pristine areas are progressively becoming more accessible for humans with increasing availability and use of special transport vehicles (*e.g.* hovercraft, water-jet propellers and cross-country vehicles). Nevertheless, there appear no real evident threats from humans for as long as the Far Eastern Curlew's habitats remain largely out of reach of human activity.

In recent decades, Brown Bear, Wolf and American Mink *Neovison vison* (the latter introduced to the River Aldan basin to 62°N) have been increasing throughout almost all of Yakutia (Mordosov 2006; Stepanova & Okhlopkov 2020). However, it seems unlikely that the Far Eastern Curlew, typically present at very low nesting

densities, would especially fall prey to these predators, which mainly forage on ungulates, Muskrat *Ondatra zibethicus*, other rodents, and fish. The risk of falling prey to predation may increase if Far Eastern Curlew continues to expand into the Central Yakutian Plain, where the Eastern Marsh Harrier normally occurs and the Red Fox population increased 4–5 fold during 2000–2011 and continues to grow (Zakharov *et al.* 2016). In the River Amur basin, the Red Fox along with the European Badger *Meles meles* and the Common Raccoon Dog *Nyctereutes procyonoides* accounted for 41% of mortality of Far Eastern Curlew eggs, while nestlings also often fell prey to them (Antonov 2010).

On the whole, the predominantly pristine state of the nesting habitat, the low-level of human activity and the absence of specific wader hunting at Far Eastern Curlew in areas included in this study, all suggest that the conservation status of the breeding grounds is favourable and that hunting in this part of the breeding range is not a major threat to the species. Together, this implies that the reasons for the rapid population decline observed on the winter quarters should largely be sought outside of this main part of the breeding range, and potentially suggests that factors operating at other points in the annual cycle (*e.g.* loss and deterioration of staging habitat in the Yellow Sea) are more likely responsible (BirdLife International 2017).

Although we lack contemporary breeding density estimates, Far Eastern Curlew numbers in two intermountain depressions at the south-westernmost edge of the range (the Verkhnecharskaya and Muiskaya) were formerly estimated to comprise a few thousand pairs, the rest of the nesting sites located are currently occupied by a few hundred pairs at maximum. On including the River Amur basin and the Kamchatka Peninsula we are, at best, aware of the breeding distribution of about one-third or half of the species' wintering population. This underlines the urgent need to focus on gaining a better understanding of the distribution and abundance of Far Eastern Curlew throughout its entire breeding areas. Particular emphasis is required on understanding the current status of suitable habitat, the population dynamics of the species and the protection status of the largest breeding concentrations reported here, as well as the identification of other sites of similar significance.

Additional important breeding sites for Far Eastern Curlew may be found in a number of intermountain depressions not yet surveyed within the delineated breeding range, and also in the large piedmont plateaux that can easily be identified in high-resolution satellite images. Following experience gained on ground-truthing wetland habitats as potentially suitable for nesting curlew, it is thought that areas totalling up to 2,000 km^2 in the interfluves of Rivers Urak, Okhota and Kukhtuy (59°47'N, 142°57'E), the areas surrounding Lake Bol'shoe Toko (56°N, 131°E) and Lake Mar-Kuel' (57°30'N, 132°32'E), and the interfluves of the Rivers Tumara, Kele and Tukulan (63°48'N, 131°21'E) may also be of interest for the species. The River Yudoma and River Ketanda headwaters (60°20'N, 140°42'E), and Lake Labynkyr and its environs (62°38'N, 143°22'E), encompass large aggregations of lakes, all of which

would merit further survey. If the Far Eastern Curlew expands into the Central Yakutian Plain in notable numbers, further monitoring to assess predation and human impacts will be required, which are probable in typical alases. Other important conservation efforts in the region should aim to prevent the level of incidental shooting, through stringent prosecution of such cases, combined with initiatives to ensure that hunters are aware that shooting the Far Eastern Curlew is illegal.

Acknowledgements

I gratefully acknowledge the assistance of A.K. Antonov, I.D. Pavlov, A.G. Takhvatulin, and A.Y. Valeev during the field studies. I also thank N.N. Egorov and E.V. Shemyakin who kindly clarified (verbally, in 2021) details of Far Eastern Curlew observations, which they had previously published. I thank Dr E. Rees and Prof. A. Fox and the two anonymous reviewers for their careful reading of the manuscript and their insightful comments and suggestions. The research was carried out within the state assignment of Ministry of Science and Higher Education of the Russian Federation (No. 0297-2021-0044, reg. No. 121020500194-9).

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Photograph: A mature Far Eastern Curlew, by V. Okonechnikov.

Photograph: Typical nesting habitat of the Far Eastern Curlew in May, by V. Degtyarev.