ABS ACTA BIOLOGICA SIBIRICA
A journal on the biodiversity of Siberia and the adjacent lands

Acta Biologica Sibirica 12: 1119–1134 (2026)
doi: 10.5281/zenodo.22708053
http://journal.asu.ru

RESEARCH ARTICLE

Winter and early spring records of the gyrfalcon *Falco rusticolus* on the Yamal Peninsula, Russia

Aleksandr A. Sokolov[1], Ivan A. Fufachev[1], Natalia A. Sokolova[1]

1 *Arctic Research Station of the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences, 21 Zelenaya Gorka St., Labytnangi, Yamal-Nenets Autonomous District, 629400, Russia*

Corresponding author: Aleksandr A. Sokolov (sokhol@yandex.ru)

Academic editor: A. Matsyura | Received 3 August 2026 | Accepted 2 September 2026 | Published 13 September 2026

http://zoobank.org/2EA71B17-5B76-4436-8348-8AC2B51A4463

Citation: Sokolov AA, Fufachev IA, Sokolova NA (2026) Winter and early spring records of the gyrfalcon *Falco rusticolus* on the Yamal Peninsula, Russia. Acta Biologica Sibirica 12: 1119–1134. https://doi.org/10.5281/zenodo.22708053

Abstract

Winter occurrence of the gyrfalcon *Falco rusticolus* in the Russian Arctic is known mainly from scattered observations and faunistic summaries, while repeated, dated records from the snow-covered season are scarce. We compiled gyrfalcon observations from the Yamal Peninsula during November–April 2024–2026 from field teams, railway personnel and local observers along the Obskaya–Karskaya railway and parallel road corridor. Ptarmigans *Lagopus* spp. were counted on fixed-width vehicle transects as an index of potential prey availability. We documented 58 gyrfalcon records involving 77 individuals; 33 records (43 individuals) occurred in November–February. Forty-eight records (67 individuals) were from 30 railway bridges between 193 and 563 km of the railway, up to 70.3°N. Thirteen bridges yielded records on more than one occasion, and ten did so in more than one snow-covered season, documenting recurrent use of particular bridge locations. At two bridges approximately 140–150 km north of Erkuta, gyrfalcons were observed feeding and departing with ptarmigans. Forty-three retained ptarmigan counts confirmed *Lagopus* presence in all three surveyed blocks, but no standardized counts were performed in the northern bridge sector. The bridge data are presence-only and cannot estimate abundance, detection probability, habitat preference, or individual residency. To our knowledge, they provide the first spatially referenced, repeated series of winter and early-spring gyrfalcon records across the northern Yamal railway corridor and show that artificial elevated structures form recurrent observation and use sites during the snow-covered season.

Keywords
Anthropogenic perches, Arctic tundra, *Lagopus* spp., non-breeding season, prey availability, railway bridges, snow-covered period

Introduction

The gyrfalcon *Falco rusticolus* is the largest falcon and one of the few diurnal raptors whose distribution is primarily associated with the Arctic and subarctic regions. It is a cold-adapted predator with a circumpolar breeding range and is widely recognized as a characteristic top predator of high-latitude ecosystems (Dementiev and Gladkov 1951; Cade 1982; Booms et al. 2020). Gyrfalcons and ptarmigan *Lagopus* spp. have also been identified as important parts (focal ecosystem components) of Arctic terrestrial biodiversity monitoring, reflecting both the conservation value of the species and the importance of predator–prey relationships in rapidly changing northern ecosystems (Christensen et al. 2018; Franke et al. 2020).

Despite this broad interest, the available knowledge of gyrfalcon ecology remains uneven across seasons and regions. Much of the published information concerns breeding distribution, territory occupancy, nest-site use, reproductive performance, diet during the breeding season, and the relationship between gyrfalcons and ptarmigan (Cade 1960; Poole and Bromley 1988; Barichello and Mossop 2011; Nielsen and Cade 2017; Franke et al. 2020; Slettenhaar et al. 2025). This emphasis is understandable: breeding territories are relatively fixed in space, adults are more detectable near nests, and breeding performance provides measurable demographic information. However, gyrfalcons occur at low densities, often in remote landscapes, and field data are difficult and expensive to collect throughout the year (Franke 2017).

The non-breeding season is much less documented. Winter field work in Arctic and subarctic regions is constrained by short daylight, low temperatures, frequent storms, snow cover, difficult access, and high logistical costs. As a result, winter occurrence and seasonal movements of gyrfalcons are often inferred from limited telemetry studies, occasional field observations, museum specimens, reports from local observers, or broad faunistic summaries rather than from repeated, dated, and spatially explicit records collected within a defined regional context.

Available studies show that gyrfalcons do not follow a single non-breeding movement strategy. Some adults may remain within or near breeding territories through winter when prey is available, whereas other birds, especially juveniles and some birds from high-Arctic populations, may undertake long-distance movements or seasonal migration (Nielsen and Cade 1990; McIntyre et al. 2009; Burnham and Newton 2011; Nygård et al. 2011; Eisaguirre et al. 2016; Booms et al. 2020). This variation has produced a widespread general expectation that many gyrfalcons, particularly from more northern populations, move southward or wander more widely during winter. However, such a generalization is difficult to apply directly across the circumpolar range because the same latitude may correspond to very different climatic conditions, snow regimes, prey availability and landscape structure in northern North America, Greenland, Fennoscandia, and the Russian Arctic.

This problem is especially important in the Russian Arctic. Russia contains a large part of the gyrfalcon's circumpolar range, but winter records from many regions remain scarce, scattered, and difficult to compare. Classical and regional sources have often combined faunistic observations, expert opinion, collection data, reports from people working in tundra landscapes, and occasional records accumulated over long periods (Dementiev 1947; Lobkov et al. 2007; Lobkov et al. 2011; Sorokin and Morozov 2021; Ryabitsev and Ryzhanovsky 2022). This information is valuable, particularly in remote areas where systematic winter ornithological work is rare. However, broad conclusions based on heterogeneous sources are hard to evaluate quantitatively when search effort, negative observations, dates, and exact localities are not reported consistently. Therefore, even relatively simple faunistic records can be important when they are dated, georeferenced, and interpreted with explicit limitations.

The Yamal Peninsula provides a useful region for documenting the winter occurrence of gyrfalcons in this way. It forms a long north–south Arctic landscape gradient in West Siberia and includes the transition from forest-tundra and the Polar Ural foothills in the south to open lowland tundra farther north. In southern Yamal and adjacent areas, gyrfalcons may use natural elevated substrates such as cliffs, trees, and nests built by other large birds. Far further north, natural elevated structures become scarce or absent, while large railway bridges of the Obskaya–Karskaya railway form conspicuous anthropogenic structures above otherwise flat tundra landscapes (Sokolov et al. 2017). These bridges are already known to be important in the regional breeding ecology of gyrfalcons (Sokolov et al. 2023), but their use by gyrfalcons outside the breeding season has remained poorly documented. Additional recent records from the lower Sabettayakha River and the Tiutey-Sale area indicate increased occurrence of gyrfalcon in northern Yamal during the snow-free and fall periods, although nesting was not confirmed there (Sokolova et al. 2024).

The winter occurrence of gyrfalcons should also be considered in relation to prey availability, especially in inland Arctic landscapes where alternative prey species are limited and ptarmigans remain the main available prey. Ptarmigans are a key prey group for gyrfalcons in much of the species' range. During late winter and early spring, when alternative avian prey species are limited and the pre-breeding period begins, ptarmigan may be especially important for sustaining gyrfalcons in inland Arctic landscapes (Nielsen and Cade 1990; Barichello and Mossop 2011; Nielsen and Cade 2017). At the same time, ptarmigan abundance can vary strongly among habitats, years, and snow conditions, and direct prey counts are rarely available for the same winter landscapes where gyrfalcons are recorded.

This study addressed three descriptive questions: (1) what spatial extent of gyrfalcon presence can be documented during the winter and early-spring snow-covered period; (2) were records repeated at the same railway bridge locations within and among snow-covered seasons; and (3) what context can available ptarmigan counts and direct prey observations provide for interpreting these records? The aim was to establish the evidence at a spatial and temporal resolution not available from previous regional sources, rather than to estimate gyrfalcon abundance, occupancy, or individual residency.

Materials and methods

Study area

The study was carried out on the Yamal Peninsula, north-west Siberia, Russia, and in the adjacent foothills of the Polar Urals (Fig. 1). Yamal is a low-relief peninsula in the northwest part of the West Siberian Plain, oriented from south to north and extending across a broad biogeographical gradient from the forest tundra and southern tundra landscapes to the open northern lowland tundra. The landscape is dominated by tundra vegetation, wetlands, lakes, river floodplains, and permafrost terrain (Walker et al. 2005; von Baeckmann et al. 2024). Our observations followed this gradient along the peninsula, from the Labytnangi–Obskaya area northward along the Obskaya–Karskaya railway and the parallel automobile-road corridor. The bridge-focused part of the study was restricted to the railway bridge corridor, where bridges form conspicuous elevated structures in otherwise open low-relief tundra.

The main observation axis ran north along the Yamal Peninsula from the town of Labytnangi in the south to the northern part of the Obskaya–Karskaya railway. Obskaya station was treated as 0 km of the railway corridor (66.72°N). From there, the route passed the Shchuchya River area (67.48°N; about 110 km), the Erkuta field station area (68.21°N; about 224 km) and continued northward along the railway to the northernmost bridge included in the study area (70.30°N; 563 km). The automobile road runs parallel to the railway from Obskaya station to the Erkuta field station area, which allowed road-based gyrfalcon observations and ptarmigan counts.

The Erkuta field station area was treated as a separate field block because repeated winter and early spring routes were conducted there. These routes covered the coastal sector to Cape Rok, the Yarono area approximately 50 km inland, and the Enzor routes. The block represents the central part of the road access study area and was used mainly for ptarmigan counts.

We considered the study area as a latitudinal and landscape gradient rather than as a set of formal bioclimatic subzones. For summarizing ptarmigan observations, we used three field blocks: (1) the automobile-road corridor from Obskaya station toward 222 km, dominated by open lowland tundra; (2) the Erkuta field-station block, including coastal, valley and shrub-rich tundra around Cape Rok, Yarono, and Enzor; and (3) the rocky piedmont landscapes of the Polar Ural foothills. The grouping reflects the geography and broad habitat context of the actual field routes, not a formal zonal classification.

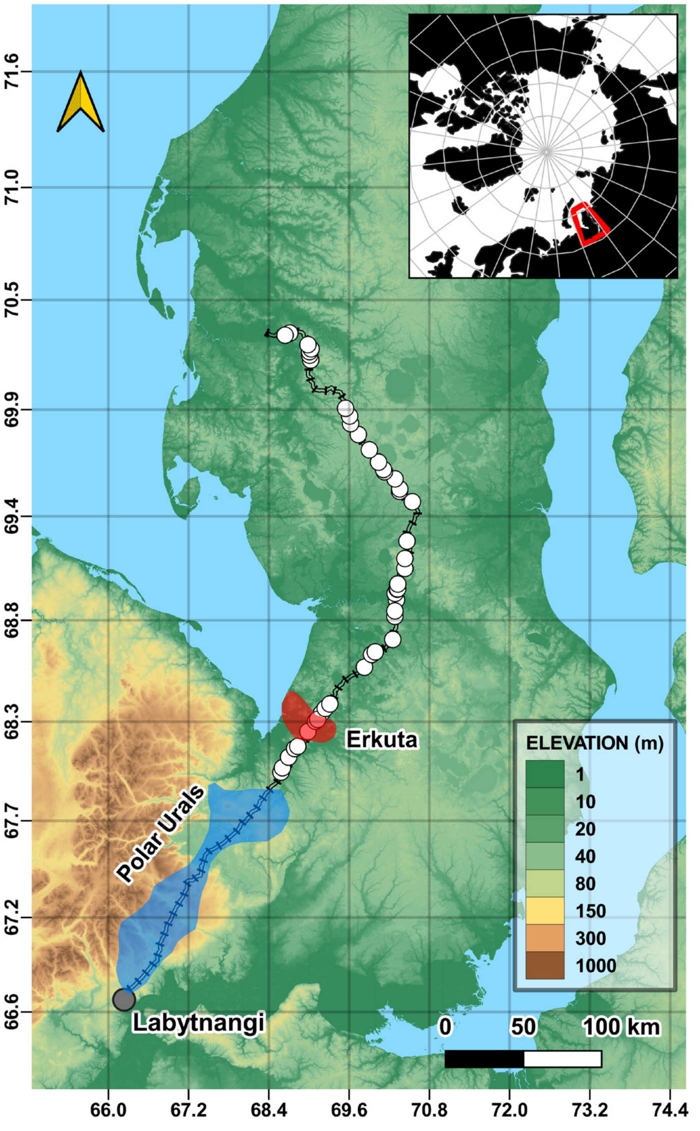

Figure 1. Study area on the Yamal Peninsula, northwestern Siberia, Russia. The map shows the main observation axis along the Obskaya–Karskaya railway and the parallel road corridor, and the three blocks used for the ptarmigan route counts: the road corridor from Obskaya station to 222 km, the Erkuta field station block (red shading), and the Polar Ural foothill block (blue shading). White circles indicate railway bridges included in the bridge-focused part of the study; because the gyrfalcon is protected, the bridge positions are shown schematically.

Railway bridges were considered separately. The bridge corridor used in this study included 43 bridges between 190 and 563 km of the Obskaya–Karskaya railway. Bridges rise approximately 10–15 m above the surrounding flat tundra and 10–20 m above the river and stream channels crossed by the railway. South of about 170 km, gyrfalcons can use natural breeding or perching substrates, including nests built by other bird species on cliffs or trees. North of this approximate limit, cliffs and trees are absent, and railway bridges are among the few elevated structures in the open tundra landscape. Previous information on the railway and its bridge structures is provided in Sokolov et al. (2017) and Sokolova et al. (2025).

Gyrfalcon records

We compile all documented records of gyrfalcons obtained during the winter and early spring snow-covered period. For the purposes of this article, 'winter' refers to November–February, whereas the 'snow covered period' refers to November–April. March and April were included because stable snow cover persists in the study area during this period and because these months correspond to the transition toward the pre-breeding period of gyrfalcons.

Gyrfalcon records came from three sources. First, the authors and field team members recorded gyrfalcons during winter field trips along the automobile road and in the Erkuta field station area. Second, railway staff recorded gyrfalcons observed on railway bridges in a dedicated observation log. The log was coordinated by V. F. Rudkovsky, who also made some of the bridge observations during rail trips. Third, we used detailed reports from experienced local observers, especially M. A. Kanev, who traveled along the winter road by car and reported bird observations after each trip. Observers were instructed to report only birds seen well enough to exclude Common Raven *Corvus corax*, the other large bird regularly encountered on bridges during the snow-covered period.

Because the gyrfalcon is a protected species, exact bridge locations are not disclosed. Bridge-specific records are reported using randomized identifiers of the form BRG-XX, which do not follow geographic order. Spatial patterns are summarized only by 100-km sections of the railway corridor. Non-bridge records are reported as broad localities or kilometer intervals.

Records made by railway staff and local observers were treated as confirmed presence records, not as standardized absence–presence surveys. Observers logged occurrences only; absences and the section of the corridor covered on each trip were not recorded. Numbers of bridges, records, and individuals are therefore minimum values and cannot be converted into occupancy, density, or detection rates. Railway trips depended on work schedules, visibility, stopping opportunities, and day length, and the absence of a record from a bridge was not interpreted as the absence of gyrfalcons.

Ptarmigan counts

Ptarmigans *Lagopus* spp. were counted from an off-road TREKOL vehicle by A. Sokolov, N. Sokolova, I. Fufachev, and V. Osokin, or from a UAZ vehicle by M. Kanev. Vehicle speed was approximately 30–50 km/h along the road corridor and 20–30 km/h in the Erkuta and Polar Ural blocks; generally two observers participated. All retained counts were made under snow-covered, precipitation-free conditions with good visibility, and counts were avoided during snowfall, blowing snow or other poor visibility. Three counts on 1 to 2 May 2025 were retained because snow cover persisted and characterized the early-spring period. The quantitative dataset comprised 43 counts.

We used a fixed-width strip-transect route count adapted from Romanov and Maltsev (2005). During movement along each route, all ptarmigans detected on both sides of the route line within a 0.2 km strip (100 m on each side) were recorded. No distance-based detection correction was applied because perpendicular distances to birds were not measured. The resulting values are therefore uncorrected observed density indices, may underestimate absolute density, and should not be interpreted as population-density estimates.

Ptarmigans were recorded as *Lagopus* spp. rather than identified as a species. Both Willow Ptarmigan *L. lagopus* and Rock Ptarmigan *L. muta* occur in the region, frequently in the same general landscapes, and reliable identification from a moving vehicle at winter count distances was not always possible. Both species are potential prey for gyrfalcons. The pooled genus-level index was used only to document the occurrence and broad spatial context of potential ptarmigan prey; it does not support species-specific habitat, abundance, or prey-selection inference. The three field blocks provide a broad habitat context, but do not substitute for verified species identification.

The Ptarmigan density was calculated for each route as:

$$N = X / (L \times h),$$

where N is the route-level observed-density index, individuals/km^2; X is the number of ptarmigans counted; L is route length, km; and h is strip width, km. For each block and period, we report the number of routes, cumulative route length and surveyed strip area, total ptarmigans, median with interquartile range, arithmetic mean with standard error, range and effort-weighted pooled density. Because the counts provide a descriptive faunistic context rather than a balanced temporal design, no inferential tests of temporal trends or differences among blocks were conducted. Primary route-level data are provided in the supplementary dataset.

The ptarmigan counts were used only as a documented index of potential winter prey occurrence in the surveyed parts of the study area. Standardized counts were not conducted north of the Erkuta area (approximately 224 km), where most northern bridge records of gyrfalcons were obtained. Accordingly, the route data cannot be used to test whether the gyrfalcon records tracked the local abundance of ptarmigan in the northern corridor.

Results

Gyrfalcon records

During November–February 2024–2026, we documented 33 gyrfalcon records that involved 43 observed individuals. Most of the winter records were associated with the railway bridges of the Obskaya–Karskaya railway: 24 records involving 34 individuals. Throughout the entire snow-covered period, including March–April, the data set included 58 records involving 77 individuals. The railway bridges accounted for 48 records and 67 individuals on 30 bridges.

The 48 bridge records were obtained between 193 and 563 km of the railway. Seventeen bridges yielded one record, eight yielded two records, and five yielded three records; thus, 13 of the 30 bridges (43%) produced records on more than one occasion. Ten bridges produced records in more than one snow-covered season. On 30 March–1 April 2024, 13 records were obtained at 12 bridges, involving 18 observed individuals; on 18–20 February 2025, 12 records were obtained at 12 bridges, involving 16 observed individuals (Table 1).

Table 1. Gyrfalcon records on the railway bridges of the Obskaya–Karskaya railway during the snow-covered period of 2024–2026

Dates	Bridge records	Single individuals	Records of two individuals	Total gyrfalcons
19–20 February 2024	7	3	4	11
28 February 2024	1	1	0	1
11 March 2024	7	6	1	8
30 March–1 April 2024	13	8	5	18
18–20 February 2025	12	8	4	16
4–5 March 2025	3	1	2	5
18 March 2025	1	0	1	2
22 November 2025	1	1	0	1
2–3 December 2025	3	1	2	5

Bridge records occurred in the four 100 km sections of the surveyed corridor, including five bridges in the northernmost 500–563 km section up to 70.3°N (Table 2). Because the section covered on each trip and negative observations were not logged, these values are minimum counts and cannot be converted into occupancy rates, densities, or a north–south occurrence gradient.

Table 2. Gyrfalcon records on the railway bridges of the Obskaya–Karskaya railway by corridor section during the snow-covered period of 2024–2026. Latitudes are approximate; values are minimum counts because absences were not recorded

Railway section, km	Approx. latitude	Bridges with records	Records	Individuals
190–299	68.0–68.7°N	7	12	18
300–399	68.7–69.3°N	7	8	11
400–499	69.3–69.9°N	11	19	27
500–563	69.9–70.3°N	5	9	11
Total	–	**30**	**48**	**67**

On 20 February 2025, two gyrfalcons were observed perched and feeding on BRG-22, and two at BRG-26; on departure from each bridge, a ptarmigan was carried away. Both bridges were approximately 140–150 km north of Erkuta, within the sector lacking standardized ptarmigan counts. These observations document ptarmigan use as prey in that northern sector on those occasions, but do not quantify local ptarmigan abundance.

Outside the railway bridges, 10 records of single gyrfalcons were obtained during the snow-covered period. Five were made in Labytnangi, four along the road corridor between approximately 80 and 120 km, and one in northern Yamal beyond the northern end of the railway. Nine of the 10 records were made in November–February. Some Labytnangi observations involved the pursuit or capture of synanthropic birds, including pigeons *Columba livia*, magpies *Pica pica* and ravens *Corvus corax*.

Ptarmigan counts

The ptarmigan dataset comprised 43 fixed-width route counts, 3385.9 km of routes, and 677.18 km² of cumulative surveyed strip area. In total, 4 044 ptarmigans were recorded, giving an effort-weighted pooled observed density index of 5.97 individuals/km². Counts were available for the road corridor, the Erkuta block, and the Polar Ural foothills, but not for the northern bridge corridor beyond approximately 224 km.

Route-level indices ranged from 0 to 191.36 individuals/km² and were strongly right-skewed (Table 3). The ptarmigans were recorded in each of the three survey blocks. The effort-weighted pooled indices were 1.83 individuals/km² along the road corridor, 10.77 in the Erkuta block, and 36.20 in the Polar Ural foothills. These values describe the retained route counts and are not interpreted as population estimates or temporal trends.

Table 3. Observation density indices at the route level of ptarmigan *Lagopus* spp. by survey block and period (0.2 km strip)

Block	Period	n	Route length, km	Surveyed area, km²	Ptarmigans	Median [IQR]	Mean ± SE	Range	Pooled density
Road corridor	January–February 2025	6	480.0	96.00	40	0.14 [0.00–0.55]	0.30±0.16	0.00–0.91	0.42
Road corridor	March–April 2025	8	886.0	177.20	22	0.00 [0.00–0.02]	0.12±0.11	0.00–0.89	0.12
Road corridor	February 2026	4	444.0	88.80	52	0.45 [0.00–1.03]	0.59±0.36	0.00–1.45	0.59
Road corridor	March–April 2026	6	574.0	114.80	760	3.28 [0.49–8.58]	5.74±2.88	0.00–17.95	6.62
Road corridor, all	**All periods**	**24**	**2384.0**	**476.80**	**874**	**0.00 [0.00–0.90]**	**1.65±0.84**	**0.00–17.95**	**1.83**
Erkuta	February 2024	2	130.0	26.00	110	4.23 [2.50–5.96]	4.23±3.46	0.77–7.69	4.23
Erkuta	January–February 2025	2	130.0	26.00	106	4.08 [2.81–5.35]	4.08±2.54	1.54–6.62	4.08
Erkuta	March–April 2025	6	283.0	56.60	1441	26.44 [8.17–47.16]	50.07±29.32	0.00–191.36	25.46
Erkuta	February 2026	2	130.0	26.00	25	0.96 [0.48–1.44]	0.96±0.96	0.00–1.92	0.96
Erkuta	March–April 2026	2	130.0	26.00	48	1.85 [0.96–2.73]	1.85±1.77	0.08–3.62	1.85
Erkuta, all	**All periods**	**14**	**803.0**	**160.60**	**1730**	**4.69 [0.96–13.46]**	**23.05±13.57**	**0.00–191.36**	**10.77**
Polar Ural foothills	March–early May 2025	5	198.9	39.78	1440	12.65 [5.80–24.55]	46.65±36.13	0.00–190.24	36.20
Total	**All counts**	**43**	**3385.9**	**677.18**	**4044**	**0.89 [0.00–6.21]**	**13.85±6.23**	**0.00–191.36**	**5.97**

Note: Values are individuals/km². The median [IQR] and mean ± SE are calculated from individual route-density values; pooled density is the total ptarmigans divided by the cumulative area of the surveyed strip. The survey area is the cumulative route length × 0.2 km and is not a unique geographic area. The summaries are descriptive.

Discussion

Spatial extent of snow-covered-season records

Winter occurrence and non-breeding movements of the gyrfalcon remain much less documented than its breeding ecology. Available telemetry and field studies show a spectrum from local winter use of breeding regions to long-distance movements, particularly among juveniles and birds from some high-Arctic populations (McIntyre et al. 2009; Burnham and Newton 2011; Nygård et al. 2011; Eisaguirre et al. 2016; Booms et al. 2020). Therefore, the Yamal records should be interpreted within this range of possible strategies rather than against a simple expectation that all northern gyrfalcons leave the Arctic in winter.

For Yamal and adjacent regions, previous winter information consists mainly of isolated observations, faunistic summaries, and expert interpretation (Dementiev 1947; Sorokin and Morozov 2021; Ryabitsev and Ryzhanovsky 2022). The novelty of the present material is not the first winter record of the species on Yamal and is not evidence that occurrence has become more frequent. To our knowledge, it is the first dated, spatially referenced and repeated series spanning the northern railway corridor from 193 to 563 km, including records up to 70.3°N.

The records are presence-only and do not estimate abundance, occupancy, detection probability, or individual residency. Records in the four corridor sections demonstrate spatial extent within the observed corridor, but unequal and unrecorded effort prevents comparison among sections. The smaller number of January records is also compatible with reduced daylight and detection opportunities and should not be interpreted as a lower biological occurrence.

Recurrent observations at railway bridges

The concentration of observations on bridges has both methodological and ecological components. Methodologically, the railway personnel traveled only along the corridor and did not survey the surrounding tundra. Consequently, the bridge records partly reflect the observer distribution, and the present data cannot demonstrate preference for bridges over unmonitored tundra.

Ecologically, railway bridges are prominent elevated structures in the flat northern landscape. Beyond approximately 170 km, cliffs and trees become rare or absent, whereas bridges provide potential perches, hunting posts, and resting sites 10–20 m above river channels and surrounding tundra (Sokolov et al. 2017). They are therefore best regarded as an anthropogenic structural addition to the winter landscape, not as a food subsidy in itself.

Repeated observations on 13 bridges, including records in more than one snow-covered season at ten bridges, are consistent with the recurrent use of particular structures. They do not show that the same individuals returned: a bridge could have been used repeatedly by one bird, by a pair, or by different transient birds.

Similarly, observations of two birds do not establish a breeding pair. Confirming bridge preference, site fidelity, or winter residency would require standardized off-corridor surveys and individual identification or telemetry.

Ptarmigan occurrence and limits of prey inference

The retained route counts establish the occurrence of ptarmigans during the snow-covered period in the road corridor, the Erkuta block, and the Polar Ural foothills. The wide route-level range and the contrasting pooled indices show that the observed ptarmigan encounter rates were heterogeneous. Because sampling was not balanced among blocks and periods and detection was not corrected, these data serve as a descriptive prey context rather than a test of habitat-specific abundance or temporal change.

Most bridge records occurred north of the standardized ptarmigan routes. Therefore, we cannot state that the gyrfalcon records tracked locally high ptarmigan abundance or that the northern corridor supported a quantitatively adequate prey base. The two observations at BRG-22 and BRG-26 are nevertheless direct evidence that gyrfalcons used ptarmigans as prey approximately 140–150 km north of Erkuta on 20 February 2025. They document prey use on those occasions, not prey abundance throughout the sector or winter.

Other explanations or additional strategies remain possible. Gyrfalcons may move through the corridor transiently, use carrion (Nielsen 2002), or exploit alternative birds where available. The Labytnangi records show pursuit or capture of pigeons, magpies, and ravens in a human-associated setting. These observations indicate winter foraging flexibility, but the available data cannot determine whether settlements provide an important energetic subsidy during periods of low availability of tundra prey.

Published observations from the Sabettayakha River and autumn aerial surveys also show that ptarmigans occur farther north on Yamal (Kiryakov et al. 2024; Sokolova et al. 2025). These records support the plausibility of a northern prey base, but cannot replace standardized winter counts in the same bridge sector.

Snow conditions and the change of Arctic ecosystems

Along the road corridor, the pooled observed density of ptarmigans index was 0.12 individuals/km^2 in March–April 2025 and 6.62 individuals/km^2 in March–April 2026, more than a fifty-fold difference between the same seasonal period in consecutive years. This contrast is descriptive and may reflect abundance, aggregation, detectability, or their combination. Winter snow regimes are a plausible contributor: rain-on-snow and ice-crust events have strongly affected Yamal tundra ecosystems (Sokolov et al. 2016), and snow conditions can influence gyrfalcon feeding behavior and breeding performance through access to ptarmigans (Slettenhaar et al. 2025).

We did not measure route-specific snow conditions and therefore cannot attribute the observed contrast or gyrfalcon occurrence to any particular snow process.

The main contribution of this study is a structured evidence base for a season and region that have been poorly documented. Future work should combine standardized bridge and off-corridor surveys, recorded search effort and absences, winter ptarmigan counts north of Erkuta, and individual marking or telemetry. Such data would allow tests of whether the pattern reflects local winter residency, recurrent use by different birds, seasonal movements, or a combination of these processes.

Conclusion

This study documents the presence of gyrfalcon during the winter and the snow covered period of early spring of 2024–2026 along a wide Yamal gradient, including the Obskaya–Karskaya railway corridor from 193 to 563 km and records up to 70.3°N. To our knowledge, it provides the first dated, spatially referenced, and repeated series at this resolution for northern Yamal.

Most records were obtained at railway bridges, and repeated observations at particular bridges are consistent with recurrent use of these artificial elevated structures as perches, hunting posts, or resting sites. However, the distribution of observers was concentrated along the railway, and the records do not establish bridge preference, local abundance, individual site fidelity, or year-round residency.

Ptarmigans occurred in the three surveyed southern and central blocks, and direct observations on two northern bridges documented ptarmigan use as prey approximately 140–150 km north of Erkuta. Ptarmigan abundance in the northern bridge sector remains unmeasured, and carrion, alternative prey, and transient movements cannot be excluded. Standardized winter surveys and individual tracking are needed to resolve these alternatives.

Acknowledgments

We are grateful to Valeriy Rudkovsky, Mikhail Kanev, Sergey Chizhik, and several railway locomotive crews for providing carefully documented observations of gyrfalcons during the snow-covered period. The study was funded by the Russian Science Foundation grant No. 24-44-00094. We also acknowledge institutional support provided within the state assignment of the Ministry of Science and Higher Education of the Russian Federation, project No. FUWU-2022-0009.

References

Barichello N, Mossop D (2011) The overwhelming influence of ptarmigan abundance on Gyrfalcon reproductive success in the central Yukon, Canada. In: Watson RT, Cade TJ, Fuller M, Hunt G, Potapov E (Eds) Gyrfalcons and Ptarmigan in a Changing World. Volume 1. The Peregrine Fund, Boise, 307–322.

Booms TL, Cade TJ, Clum NJ (2020) Gyrfalcon (*Falco rusticolus*), version 1.0. In: Billerman SM (Ed.) Birds of the World. Cornell Lab of Ornithology, Ithaca. https://doi.org/10.2173/bow.gyrfal.01

Burnham KK, Newton I (2011) Seasonal movements of Gyrfalcons *Falco rusticolus* include extensive periods at sea. Ibis 153(3): 468–484. https://doi.org/10.1111/j.1474-919X.2011.01141.x

Cade TJ (1960) Ecology of the Peregrine and Gyrfalcon populations in Alaska. University of California Publications in Zoology 63: 151–290.

Cade TJ (1982) The Falcons of the World. Comstock/Cornell University Press, Ithaca, 192 pp.

Christensen T, Longan S, Barry T, Price C, Lárusson KF (2018) Circumpolar Biodiversity Monitoring Program Strategic Plan 2018–2021. CAFF Monitoring Series Report No. 29. Conservation of Arctic Flora and Fauna, Akureyri, 25 pp. http://hdl.handle.net/11374/2118

Dementiev GP (1947) Sezonnoe razmeshchenie i migratsii krecheta *Falco gyrfalco* Linnaeus [Seasonal distribution and migrations of the Gyrfalcon *Falco gyrfalco* Linnaeus]. Trudy Tsentralnogo Byuro Koltsevaniya 6: 68–75. [In Russian]

Dementiev GP, Gladkov NA (Eds) (1951) Ptitsy Sovetskogo Soyuza. Tom 1 [Birds of the Soviet Union. Volume 1]. Sovetskaya Nauka, Moscow, 652 pp. [In Russian]

Eisaguirre JM, Booms TL, Schempf PF, Lewis SB (2016) Gyrfalcon home ranges and movements on the Yukon–Kuskokwim Delta, Alaska. Journal of Raptor Research 50(1): 109–114. https://doi.org/10.3356/rapt-50-01-109-114.1

Franke A (2017) Priorities for Gyrfalcon research: food, weather, and phenology in a changing climate. In: Anderson DL, McClure CJW, Franke A (Eds) Applied Raptor Ecology: Essentials from Gyrfalcon Research. The Peregrine Fund, Boise, 11–32. https://doi.org/10.4080/are.2017/001

Franke A, Falk K, Hawkshaw K, Ambrose S, Anderson DL, Bente PJ, Booms T, Burnham KK, Ekenstedt J, Fufachev I, Ganusevich S, Johansen K, Johnson JA, Kharitonov S, Koskimies P, Kulikova O, Lindberg P, Lindström BO, Mattox WG, McIntyre CL, Mechnikova S, Mossop D, Møller S, Nielsen ÓK, Ollila T, Østlyngen A, Pokrovsky I, Poole K, Restani M, Robinson BW, Rosenfield R, Sokolov A, Sokolov V, Swem T, Vorkamp K (2020) Status and trends of circumpolar peregrine falcon and gyrfalcon populations. Ambio 49(3): 762–783. https://doi.org/10.1007/s13280-019-01300-z

Kiryakov AA, Sokolova NA, Fufachev IA, Sokolov AA (2024) Bioraznoobrazie v arkticheskoi tundre poluostrova Yamal v zimnii period [Biodiversity in the Arctic tundra of the Yamal Peninsula in winter]. In: Fundamentalnye i prikladnye aspekty adaptatsii zhivykh organizmov k izmenyayushchimsya usloviyam okruzhayushchei sredy Severa:

issledovaniya, innovatsii, perspektivy. Abstracts of the All-Russian Scientific Conference with International Participation and School for Young Scientists (Petrozavodsk, 9–13 September 2024). Karelian Research Centre of the Russian Academy of Sciences, Petrozavodsk, 131. [In Russian]

Lobkov EG, Gerasimov YN, Gorovenko AV (2007) On the status of the Gyrfalcon (*Falco rusticolus*) population in Kamchatka, the Russian Far East. Ornitologiya 34: 5–35.

Lobkov E, Gerasimov Y, Gorovenko A (2011) Status of the Kamchatka Gyrfalcon (*Falco rusticolus*) population and factors affecting it. In: Watson RT, Cade TJ, Fuller M, Hunt G, Potapov E (Eds) Gyrfalcons and Ptarmigan in a Changing World. Volume 2. The Peregrine Fund, Boise, 280–290.

McIntyre CL, Douglas DC, Adams LG (2009) Movements of juvenile Gyrfalcons from western and interior Alaska following departure from their natal areas. Journal of Raptor Research 43(2): 99–109. https://doi.org/10.3356/JRR-08-43.1

Nielsen ÓK (2002) Some observations on carrion feeding by Gyrfalcons in Iceland. Náttúrufræðingurinn 71: 4–7. [In Icelandic with an English summary]

Nielsen ÓK, Cade TJ (1990) Annual cycle of the Gyrfalcon in Iceland. National Geographic Research 6: 41–62.

Nielsen ÓK, Cade TJ (2017) Gyrfalcon and ptarmigan predator-prey relationship. In: Anderson DL, McClure CJW, Franke A (Eds) Applied Raptor Ecology: Essentials from Gyrfalcon Research. The Peregrine Fund, Boise, 43–74. https://doi.org/10.4080/are.2017/003

Nygård T, Falkdalen U, Engström H (2011) The dispersal of satellite-tagged juvenile Gyrfalcons from an area of wind-farm development in the Swedish mountains. In: Watson RT, Cade TJ, Fuller M, Hunt G, Potapov E (Eds) Gyrfalcons and Ptarmigan in a Changing World. Volume 2. The Peregrine Fund, Boise, 161–170. https://doi.org/10.4080/gpcw.2011.0216

Poole KG, Bromley RG (1988) Natural history of the Gyrfalcon in the central Canadian Arctic. Arctic 41(1): 31–38. https://doi.org/10.14430/arctic1689

Potapov E, Sale R (2005) The Gyrfalcon. Yale University Press, New Haven, 288 pp.

Romanov VV, Maltsev IV (2005) Metody issledovanii ekologii nazemnykh pozvonochnykh zhivotnykh: kolichestvennye uchety [Methods for studying the ecology of terrestrial vertebrate animals: quantitative counts]. Vladimir State University Press, Vladimir, 79 pp. [In Russian]

Ryabitsev VK, Ryzhanovsky VN (2022) Ptitsy poluostrova Yamal i Priobskoi lesotundry. Tom 1. Nevorobinye [Birds of the Yamal Peninsula and the Ob forest-tundra. Volume 1. Non-passerines]. Moscow–Ekaterinburg, 624 pp. [In Russian]

Slettenhaar AJ, Østnes JE, Moen BC, Kroglund RT, Nygård T, Nilsen EB (2025) A picky predator and its prey: how snow conditions and ptarmigan abundance impact Gyrfalcon feeding behaviour and breeding success. Ecology and Evolution 15(4): e71228. https://doi.org/10.1002/ece3.71228

Sokolov AA, Sokolova NA, Ims RA, Brucker L, Ehrich D (2016) Emergent rainy winter warm spells may promote boreal predator expansion into the Arctic. Arctic 69(2): 121–129. https://doi.org/10.14430/arctic4559

Sokolov AA, Fufachev IA, Sokolov VA, Sokolova NA, Golovatin MG, Dixon A (2017) Krechet v tekhnogennom landshafte Yamala (Yamalo-Nenetskii avtonomnyi okrug) [Gyrfalcon in a technogenic landscape of Yamal, Yamalo-Nenets Autonomous Okrug]. Fauna Urala i Sibiri 2: 180–185. [In Russian]

Sokolov AA, Sokolov VA, Fufachev IA (2023) Gyrfalcon. In: Red Data Book of the Yamalo-Nenets Autonomous Okrug: Animals, Plants, Fungi. 3rd edn. Department of Natural Resources and Ecology of the Yamalo-Nenets Autonomous Okrug, Salekhard, 63–64. [In Russian]

Sokolova NA, Fufachev IA, Kiryakov AA, Sokolov AA (2024) Novye vstrechi krecheta na severe poluostrova Yamal (Yamalo-Nenetskii avtonomnyi okrug) [New records of the Gyrfalcon in the north of the Yamal Peninsula, Yamalo-Nenets Autonomous Okrug]. Fauna Urala i Sibiri 2: 94–97. https://doi.org/10.5281/zenodo.14556016

Sokolova NA, Fufachev IA, Sokolov AA (2025) Otsenka plotnosti kuropatok (*Lagopus* spp.) kak osnovnogo pishchevogo resursa krecheta (*Falco rusticolus*) v osennii period na Yamale [Assessment of ptarmigan (*Lagopus* spp.) density as the main food resource of the Gyrfalcon (*Falco rusticolus*) in autumn on Yamal]. Yug Rossii: ekologiya, razvitie 20(3): 82–92. https://doi.org/10.18470/1992-1098-2025-3-7

Sorokin AG, Morozov VV (2021) Gyrfalcon. In: Red Data Book of the Russian Federation: Animals. 2nd edn. VNII Ekologiya, Moscow, 651–653. [In Russian]

von Baeckmann C, Bartsch A, Bergstedt H, Efimova A, Widhalm B, Ehrich D, Kumpula T, Sokolov A, Abdulmanova S (2024) Land cover succession for recently drained lakes in permafrost on the Yamal Peninsula, Western Siberia. The Cryosphere 18: 4703–4722. https://doi.org/10.5194/tc-18-4703-2024

Walker DA, Raynolds MK, Daniëls FJA, Einarsson E, Elvebakk A, Gould WA, Katenin AE, Kholod SS, Markon CJ, Melnikov ES, Moskalenko NG, Talbot SS, Yurtsev BA, Bliss LC, Edlund SA, Zoltai SC, Wilhelm M, Bay C, Guðjónsson G, Ananjeva GV, Drozdov DS, Konchenko LA, Korostelev YV, Ponomareva O, Matveyeva NV, Safranova IN, Shelkunova R, Polezhaev AN, Johansen BE, Maier HA, Murray DF, Fleming MD, Trahan NG, Charron TM, Lauritzen S, Vairin BA (2005) The Circumpolar Arctic vegetation map. Journal of Vegetation Science 16(3): 267–282. https://doi.org/10.1111/j.1654-1103.2005.tb02365.x