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Upward elevational shift of the Horned Lark *Eremophila alpestris* in alpine breeding sites at Dovrefjell, central Norway

Oscar Østvold*, Axel Brevig-Edfeldt & Svein Dale

Faculty of Environmental Sciences and Natural Resource Management, Norwegian University of Life Sciences, P.O. Box 5003, NO-1432 Ås, Norway.
* Corresponding author: o.ostvold@gmail.com

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Abstract
Climate change is expected to force species to move upwards and polewards. Mountain species are at particular risk because upward elevational shifts may be limited by the maximum height of mountain ranges. The Horned Lark *Eremophila alpestris* breeds in the high mountains of southern Norway. Two previous studies recorded the elevation of breeding territories of Horned Larks in two regions of Dovrefjell, central Norway. In mountains around Grimsdalen (Dovre municipality) territories had a mean elevation of 1329 m (range = 1200–1450 m, n = 15) in 1969, and in mountains around Einunndalen (Folldal and Oppdal municipalities) the mean was 1339 m (range = 1240–1430 m, n = 15) in 1992. The same mountain areas were resurveyed 30–53 years later in 2022. In Grimsdalen, mean elevation of lark territories was now 1426 m (range = 1260–1570 m, n = 23) and in Einunndalen 1415 m (range = 1196–1523 m, n = 42). Overall, the data suggested a mean upward elevational shift of 2.2 m/year. The shift in elevation suggests that climate change has influenced the elevational range of the Horned Lark in the mountains of central Norway, with potential population consequences if the upward shift continues.

INTRODUCTION

Global climate change is changing ecosystems worldwide, impacting wildlife and plant communities (Parmesan & Yohe 2003). The rise in temperatures is forcing species to adapt by shifting their distributions to higher elevations and latitudes (Walther et al. 2002, Chen et al. 2011). Elevated temperatures also drive increased primary production in alpine and arctic biomes, posing a threat to native species (Myers-Smith et al. 2020, Rumpf et al. 2022).

Wildlife populations have declined by an average of 69% between 1970 and 2018, primarily due to land use changes (WWF 2022). However, if global warming exceeds 1.5°C, climate change could become the dominant cause of biodiversity loss. Alpine regions are experiencing a warming rate twice the global average, impacting species at their upper latitudinal and elevational limits (Brunetti et al. 2009). Elevational shifts have been observed in vegetation zones (Theurillat & Guisan 2001, Batllori et al. 2009, Vanneste et al. 2017), plant and insect communities (Felde et al. 2012, Shah et al. 2020, Nicklas et al. 2021, Kerner et al. 2023), and also mountain birds (Popy et al. 2010, Pernollet et al. 2015, Chamberlain et al. 2016a, Scridel et al. 2018, Bani et al. 2019, Garcia-Navas et al. 2021, Hallman et al. 2022), potentially leading to population declines and extinctions (Thomas et al. 2004). Declines in mountain birds have been recorded in Fennoscandia (Lehikoinen et al. 2019), and whilst most declines are observed for common species (Byrkjedal & Kålås 2012, Lehikoinen et al. 2014), the specialists that only breed in mountain areas will also face population declines (Scridel et al. 2018). Declines in population numbers could be caused by elevational shifts and loss of habitat (Popy et al. 2010, Maggini et al. 2011, Pernollet et al. 2015), but not all studies show these trends (Archaux 2004). Recognizing climate change as a major threat to mountain bird abundance underscores the urgency for research and conservation efforts (Chamberlain et al. 2016b).

Mountain birds in the Alps in Central Europe have shown evidence of upward elevational shifts (Popy et

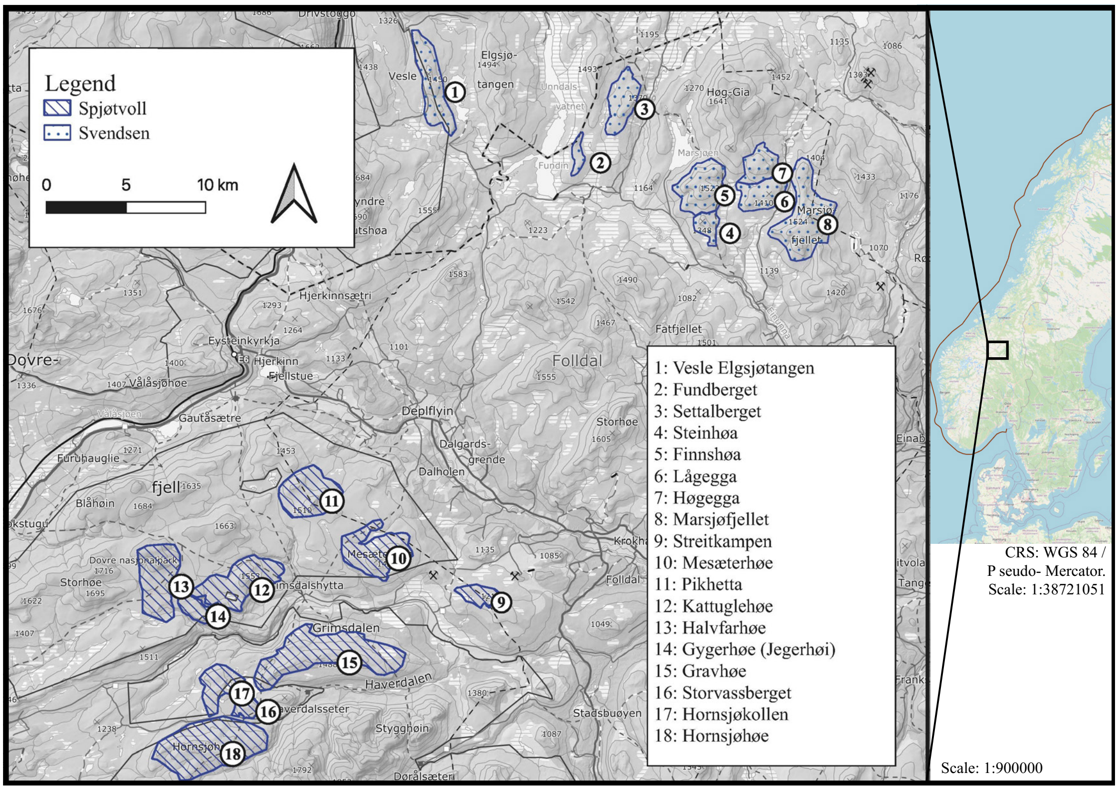

Figure 1. Map of areas surveyed for Horned Larks *Eremophila alpestris* during 1969 (sites 9–18, mountains around Grimsdalen; Spjøtvoll 1970) and 1992 (sites 1–8, mountains around Einunndalen; Svendsen 1997) and resurveyed in 2022 (the current study). Inset: the two study areas are located in the Dovrefjell mountains of central Norway (Innlandet and Trøndelag counties). Map prepared with QGIS 3.8.

al. 2010, Pernollet et al. 2015, Bani et al. 2019, but see Archaux 2004). Abundance of birds in the Scandinavian mountains has also shifted uphill over the past decade at an average speed of 0.9 m per year, with the fastest elevational shifts among short-lived species of cold-dwelling songbirds such as Bluethroat *Luscinia svecica*, Northern Wheatear *Oenanthe oenanthe* and Common Redpoll *Acanthis flammea* (Couet et al. 2022), although this study included high-elevation species only to a limited extent. The Horned Lark *Eremophila alpestris* breeds in the alpine zone of mountains in Norway. Due to specific habitat requirements and low breeding densities (Lien et al. 1974, Østbye & Framstad 1987), Horned Larks are only recorded in low numbers in existing monitoring projects in Norway, such as the Common breeding bird monitoring program (Lehikoinen et al. 2014, Øien et al. 2023). Thus, there is little information about the potential response of Horned Larks to climate change in Norway, such as changes in elevational distribution.

In the present study, line transects (ranging 1,000–1,700 m a.s.l.) were conducted to assess the elevational distribution of the Horned Lark in the Dovrefjell mountains, specifically around Grimsdalen in Dovre and Einunndalen in Folldal and Oppdal. The observed elevations were compared to earlier observations for Grimsdalen made by Spjøtvoll (1970) and for Einunndalen by Svendsen (1997). Human impacts are limited in these high-elevation areas, and changes in elevational range are likely to be related to climate change. We predicted that the elevational range of the Horned Lark should shift upwards if environmental change has affected the habitat conditions for mountain birds during the last 30–50 years.

METHODS

Spjøtvoll (1970) surveyed ten mountains around Grimsdalen in Dovre municipality, Innlandet county (61°59'–62°10'N, 9°26'–9°53'E), during the breeding seasons of 1967–1970 (Figure 1). Few observations were made in 1967–68 and 1970, whereas all sites were visited in 1969. We therefore used the data from 1969 because the author stated that the data for 1969 gave the most correct picture of the distribution of the Horned Lark in the Grimsdalen region. Spjøtvoll (1970) conducted systematic searches for Horned Larks on at least 14 days during June–August 1969. The exact routes followed were not specified, but birds were found on most mountain tops around Grimsdalen. Spjøtvoll (1970) referred to earlier descriptions of the species as preferring high, wind-swept mountains with sparse vegetation, so he likely also included the highest areas of the mountains during his searches.

Svendsen (1997) surveyed eight mountains around Einunndalen in Folldal and Oppdal municipalities, Innlandet and Trøndelag counties (62°18'–62°24'N, 9°43'–10°15'E), during the breeding seasons of 1989 and 1992 (Figure 1). We used the data from 1992

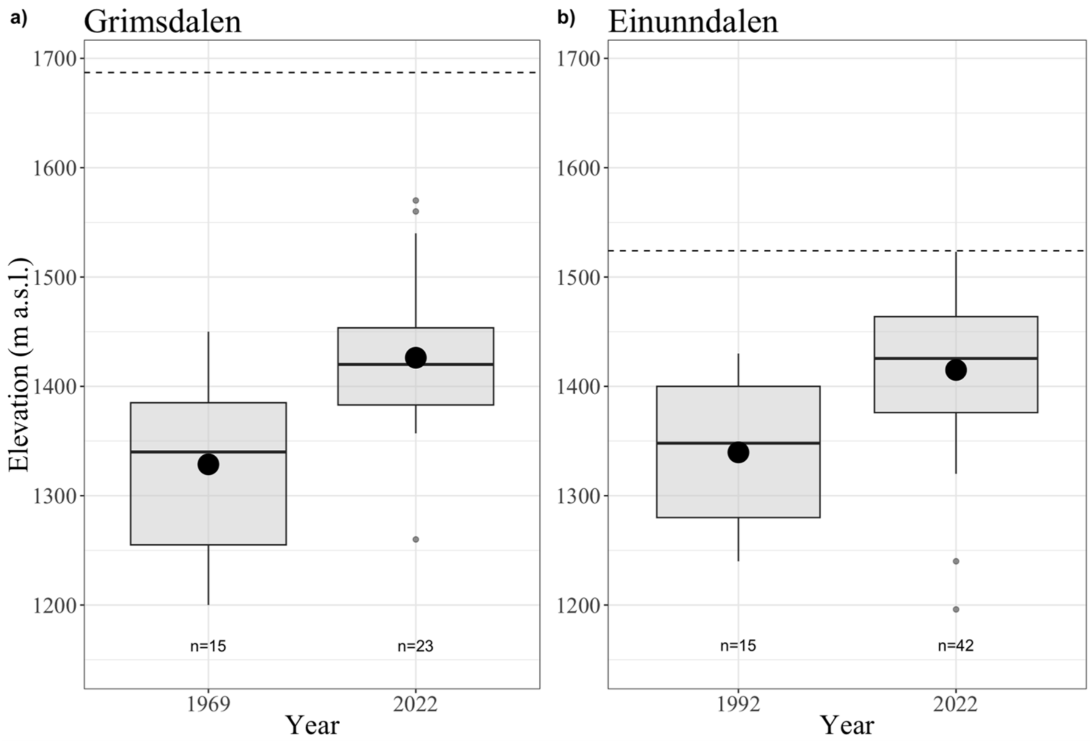

Figure 2. Boxplots comparing the elevational distribution of Horned Larks *Eremophila alpestris* in the Dovrefjell mountains at a) Grimsdalen in 1969 and 2022 and b) Einunndalen in 1969 and 1992. Black lines represent the median in the data, solid points are the mean, boxes are the interquartile range, whiskers are the 95% CI and grey points are outliers. The dashed line indicates the highest elevation of the mountaintops in the two survey regions.

because only a few sites were visited in 1989, whereas all sites were visited in 1992. Svendsen (1997) also conducted systematic searches for Horned Larks, on at least 10 days during June–July 1992. Again, the exact routes followed were not specified, but birds were found on most mountain tops around Einunndalen, and Svendsen (1997) referred to earlier descriptions of the habitat preferences of the species, including Spjøtvoll (1970), so he also likely included the highest parts of the mountains during his searches.

The same mountains areas were resurveyed in the current study during 12 days in June 2022. Line transect routes were followed to cover suitable habitat as described by previous authors, in particular by following ridges and wind-exposed slopes with sparse vegetation. In addition, full elevational gradients for each mountain were surveyed including the tops of mountains. Surveys were conducted in particular to cover areas above 1,200 m a.s.l. based on previous information on the elevational range of Horned Larks in central and southern Norway (Spjøtvoll 1970, Haftorn 1971, Stueflotten 1994, Svendsen 1997). Surveys of larger sites were also conducted following circular paths in order to cover as much ground as possible. Bird surveys also covered substantial areas below 1,200 m a.s.l. when approaching the mountains, often from treeline which was at about 1,000 m a.s.l. in the study area.

Each site was surveyed on one day only in 2022, usually from early morning until midday. In general, the timing of surveys in 2022 was somewhat earlier in the season than the earlier period of surveys which could increase detectability of birds by covering the singing period of Horned Larks better. On the other hand, the total number of field days was greater for the earlier surveys (a total of at least 24 days) compared to 2022 (12 days), and the earlier surveys also included visits on two different days to some of the sites, in particular in Einunndalen. Thus, the probability of detecting Horned Larks may have been fairly similar in the earlier and the present surveys.

Horned Lark territories were defined as observations of pairs, singing males, or single adult individuals. Neighbouring territories separated by short distances were differentiated based on simultaneous observations of individuals in each territory, mostly that there were two males singing at the same time.

We cannot assess whether our field effort may have been greater than the surveys of Spjøtvoll (1970) and Svendsen (1997). The habitat descriptions indicate that the previous surveys also covered the full elevational ranges of the mountains, and our data on elevation of recorded Horned Larks should therefore not be biased by any possible differences in search effort.

To assess differences in the elevational distribution of the Horned Lark between the time periods, Welch two-sample t-tests were conducted. Prior to conducting the t-tests, the assumptions of normality were checked visually with qq-plots and statistically using Shapiro-Wilk tests, where all four groups had p-values greater than 0.05, indicating normal distribution. However, we also included the results of non-parametric Mann-Whitney U-tests. The statistical analyses were performed using R Statistical Software, version 4.3.1 (R Core Team 2021).

RESULTS

The mean elevation of territories of Horned Larks increased from 1329 m in 1969 (range = 1200–1450 m, n = 15) to 1426 m in 2022 (range = 1260–1570 m, n = 23) at Grimsdalen ($t = -3.96$, $df = 28.77$, $p < 0.001$; U-test: $z = -3.41$, $p < 0.001$; Figure 2), and from 1339 m in 1992 (range = 1240–1430 m, n = 15) to 1415 m in 2022 (range = 1196–1523 m, n = 42) at Einunndalen ($t = -3.75$, $df = 25.86$, $p < 0.001$; U-test: $z = -3.34$, $p < 0.001$; Figure 2). The differences in elevation corresponded to yearly increases of 1.83 m and 2.53 m, respectively (averaged across sites: 2.18 m/year).

DISCUSSION

The analysis revealed a clear pattern of upward elevational shifts of two Horned Lark populations in the Dovrefjell area. The exact routes for the field surveys conducted by Spjøtvoll (1970) and Svendsen (1997) were unknown, but we believe that any differences in field methods should not necessarily cause differences in elevational records. Thus, we argue that an upward elevational shift has occurred, possibly as a response to climate-induced warming, providing valuable insights into the ecological consequences of changing environmental conditions. Our findings indicate a statistically significant difference in the mean elevational distribution of the Horned Lark and are consistent with elevational range shifts that have occurred in lower-elevation mountain birds in Norway (Couet et al. 2022). For both mountain areas, the width of the elevational distribution has become more narrow (Figure 2), indicating a shrinking of the preferred habitat.

The observed upward movement in elevational distribution aligns with the global trend of climate change, particularly in alpine regions where warming rates exceed the global average (Brunetti et al. 2009). The elevational shift has important implications for the spatial distribution of bird communities, as species tend to seek more suitable habitats in response to changing temperature regimes (Chamberlain et al. 2016a, Freeman et al. 2018).

The documented elevational shift may be attributed to several ecological factors, including changes in vegetation zones and alterations in food availability. Previous studies have reported similar trends in mountainous regions, with vegetation zones shifting upwards in response to climate warming (Pauli et al. 2012, Vitasse et al. 2021). The treeline has advanced in the Dovre area during the past century. According to Bryn and Potthoff (2018), the treeline advanced with 300 meters in a survey location in Grimsdalen between 1930 and 1993, while the treeline advanced in one out of two sampling sites at Hjerkinn. The variation shows the spatial differences in treeline advances, and it would be expected that the differences could also affect range shifts of other organisms. However, note that the treeline (ca. 1000 m a.s.l.) is still well below the elevational distribution of Horned Larks in the study area (above 1200 m a.s.l.), so the Horned Lark is more likely to be directly affected by any parallel shifts in the upper elevational distribution of the shrub zone (*Salix* spp.), given that the species prefers areas with short and sparse vegetation.

It is essential to acknowledge the potential consequences of the elevational shift, which may impact the composition and diversity of bird communities. Species that are constrained by specific elevational ranges may face challenges in finding suitable habitats, leading to potential population declines or shifts in community structure (Thomas et al. 2004, Şekercioğluet al. 2008), although the Horned Lark has shown evidence for population increases in some areas of Norway (Byrkjedal & Högstedt 2022). Future research should address the specific mechanisms driving the observed elevational shifts, considering factors such as resource availability, competition, and interactions with other species, which might be expected with other songbirds that overlap in elevation and diet such as the Snow Bunting *Plectrophenax nivalis* and Lapland Longspur *Calcarius lapponicus* (Byrkjedal et al. 2022). If competing species respond differently to climate change, elevational shifts could differ between species, and competition could both increase or decrease at different elevations. Additionally, long-term monitoring is crucial to track the persistence and stability of these changes over time.

In conclusion, our field study provides empirical evidence of an upward elevational range shift in Horned Lark populations. Our findings contribute to our understanding of the dynamic responses of species to environmental changes. We suggest that proactive conservation measures are needed to mitigate potential impacts on alpine ecosystems.

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REFERENCES

Archaux F. 2004. Breeding upwards when climate is becoming warmer: no bird response in the French Alps. *Ibis* **146**: 138–144. doi: 10.1111/j.1474-919X.2004.00246.x.

Bani L, Luppi M, Rocchia E, Dondina O & Orioli V. 2019. Winners and losers: How the elevational range of breeding birds on Alps has varied over the past four decades due to climate and habitat changes. *Ecology and Evolution* **9**: 1289–1305. doi: 10.1002/ece3.4838.

Batllori E, Blanco-Moreno JM, Ninot JM, Gutierrez E & Carrillo E. 2009. Vegetation patterns at the alpine treeline ecotone: the influence of tree cover on abrupt change in species composition of alpine communities. *Journal of Vegetation Science* **20**: 814–825. doi: 10.1111/j.1654-1103.2009.01085.x.

Brunetti M, Lentini G, Maugeri M, Nanni T, Auer I, Böhm R & Schöner W. 2009. Climate variability and change in the Greater Alpine Region over the last two centuries based on multi-variable analysis. International *Journal of Climatology* **29**: 2197–2225. doi: 10.1002/joc.1857.

Bryn A & Potthoff K. 2018. Elevational treeline and forest line dynamics in Norwegian mountain areas – a review. *Landscape Ecology* **33**: 1225–1245. doi: 10.1007/s10980-018-0670-8.

Byrkjedal I, Fjeldheim VB, Halvorsen LS & Lislevand T. 2022. Diet of three sympatric species of granivorous songbirds in a Norwegian high mountain area during the early breeding season. *Ornis Norvegica* **45**: 16–26. doi: 10.15845/on.v45i0.3639.

Byrkjedal I & Högstedt G. 2022. Numbers of Horned Lark *Eremophila alpestris* are increasing at high alpine and arctic breeding sites in Norway. *Ornis Norvegica* **45**: 10–15. doi: 10.15845/on.v45i0.3640.

Byrkjedal I & Kålås JA. 2012. Censuses of breeding birds in a South Norwegian arctic-alpine habitat three decades apart show population declines in the most common species. *Ornis Norvegica* **35**: 43–47. doi: 10.15845/on.v35i0.288.

Chamberlain DE, Brambilla M, Caprio E, Pedrini P & Rolando A. 2016a. Alpine bird distributions along elevation gradients: the consistency of climate and habitat effects across geographic regions. *Oecologia* **181**: 1139–1150. doi: 10.1007/s00442-016-3637-y.

Chamberlain DE, Pedrini P, Brambilla M, Rolando A & Girardello M. 2016b. Identifying key conservation threats to Alpine birds through expert knowledge. *PeerJ* **4**: e1723. doi: 10.7717/peerj.1723.

Chen I-C, Hill JK, Ohlemüller R, Roy DB & Thomas CD. 2011. Rapid range shifts of species associated with high levels of climate warming. *Science* **333**: 1024–1026. doi: 10.1126/science.1206432.

Couet J, Marjakangas EL, Santangeli A, Kålås JA, Lindström Å & Lehikoinen A. 2022. Short-lived species move uphill faster under climate change. *Oecologia* **198**: 877–888. doi: 10.1007/s00442-021-05094-4.

Felde VA, Kapfer J & Grytnes J-A. 2012. Upward shift in elevational plant species ranges in Sikkilsdalen, central Norway. *Ecography* **35**: 922–932. doi: 10.1111/j.1600-0587.2011.07057.x.

Freeman BG, Scholer MN, Ruiz-Gutierrez V & Fitzpatrick JW. 2018. Climate change causes upslope shifts and mountaintop extirpations in a tropical bird community. *PNAS* **115**: 11982–11987. doi: 10.1073/pnas.1804224115.

Garcia-Navas V, Sattler T, Schmid H & Ozgul A. 2021. Spatial heterogeneity in temporal dynamics of Alpine bird communities along an elevational gradient. *Journal of Biogeography* **48**: 886–902. doi: 10.1111/jbi.14045.

Haftorn S. 1971. *Norges Fugler.* Universitetsforlaget, Oslo.

Hallman TA, Guelat J, Antoniazza S, Kery M & Sattler T. 2022. Rapid elevational shifts of Switzerland's avifauna and associated species traits. *Ecosphere* **13**: e4194. doi: 10.1002/ecs2.4194.

Kerner JM, Krauss J, Maihoff F, Bofinger L & Classen A. 2023. Alpine butterflies want to fly high: Species and communities shift upwards faster than their host plants. *Ecology* **104**: e3848. doi: 10.1002/ecy.3848.

Lehikoinen A, Brotons L, Calladine J, Campedelli T, Escandell V, Flousek J, Grueneberg C, Haas F, Harris S, Herrando S, et al. 2019. Declining population trends of European mountain birds. *Global Change Biology* **25**: 577–588. doi: 10.1111/gcb.14522.

Lehikoinen A, Green M, Husby M, Kålås JA & Lindström Å. 2014. Common montane birds are declining in northern Europe. *Journal of Avian Biology* **45**: 3–14. doi: 10.1111/j.1600-048X.2013.00177.x.

Lien L, Østbye E, Hogstad O, Haande KM, Haande PS, Hagen A, Skar H-J, Skartveit A & Svalastog D. 1974. Bird surveys in the high mountain habitats of Finse and Stigstuv, Hardangervidda, South Norway, 1967-1972. *Norwegian Journal of Zoology* **22**: 1–14.

Maggini R, Lehmann A, Kéry M, Schmid H, Beniston M, Jenni L & Zbinden N. 2011. Are Swiss birds tracking climate change?: Detecting elevational shifts using response curve shapes. *Ecological Modelling* **222**: 21–32. doi: 10.1016/j.ecolmodel.2010.09.010.

Myers-Smith IH, Kerby JT, Phoenix GK, Bjerke JW, Epstein HE, Assmann JJ, John C, Andreu-Hayles L, Angers-Blondin S, Beck PSA, et al. 2020. Complexity revealed in the greening of the Arctic. *Nature Climate Change* **10**: 106–117. doi: 10.1038/s41558-019-0688-1.

Nicklas L, Walde J, Wipf S, Lamprecht A, Mallaun M, Rixen C, Steinbauer K, Theurillat JP, Unterluggauer P, Vittoz P, et al. 2021. Climate change affects vegetation differently on siliceous and calcareous summits of the European Alps. *Frontiers in Ecology and Evolution* **9**: 642309. doi: 10.3389/fevo.2021.642309.

Parmesan C & Yohe G. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* **421**: 37–42. doi: 10.1038/nature01286.

Pauli H, Gottfried M, Dullinger S, Abdaladze O, Akhalkatsi M, Alonso JLB, Coldea G, Dick J, Erschbamer B, Calzado RF, et al. 2012. Recent plant diversity changes on Europe's mountain summits. *Science* **336**: 353–355. doi: 10.1126/science.1219033.

Pernollet CA, Korner-Nievergelt F & Jenni L. 2015. Regional changes in the elevational distribution of the Alpine Rock Ptarmigan *Lagopus muta helvetica* in Switzerland. *Ibis* **157**: 823–836. doi: 10.1111/ibi.12298.

Popy S, Bordignon L & Prodon R. 2010. A weak upward elevational shift in the distributions of breeding birds in the Italian Alps. *Journal of Biogeography* **37**: 57–67. doi: 10.1111/j.1365-2699.2009.02197.x.

R Core Team. 2021. *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Available at: https://www.R-project.org/.

Rumpf SB, Gravey M, Bronnimann O, Luoto M, Cianfrani C, Mariethoz G & Guisan A. 2022. From white to green: Snow cover loss and increased vegetation productivity in the European Alps. *Science* **376**: 1119–1122. doi: 10.1126/science.abn6697.

Scridel D, Brambilla M, Martin K, Lehikoinen A, Iemma A, Matteo A, Jähnig S, Caprio E, Bogliani G, Pedrini P, et al. 2018. A review and meta-analysis of the effects of climate change on Holarctic mountain and upland bird populations. *Ibis* **160**: 489–515. doi: 10.1111/ibi.12585.

Şekercioğlu ÇH, Schneider SH, Fay JP & Loarie SR. 2008. Climate change, elevational range shifts, and bird extinctions. *Conservation Biology* **22**: 140–150. doi: 10.1111/j.1523-1739.2007.00852.x.

Shah AA, Dillon ME, Hotaling S & Woods HA. 2020. High elevation insect communities face shifting ecological and evolutionary landscapes. *Current Opinion in Insect Science* **41**: 1–6. doi: 10.1016/j.cois.2020.04.002.

Spjøtvoll Ø. 1970. Fjellerke i Rondane- og Dovrefjellområdet – og litt om dens forplantningsbiologi. *Sterna* **9**: 163–174.

Stueflotten, S. 1994. Fjellerke *Eremophila alpestris*. Pp. 318–319 in: Gjershaug JO, Thingstad PG, Eldøy S & Byrkjeland S (Eds) *Norsk fugleatlas*. Norsk Ornitologisk Forening, Klæbu. (In Norwegian)

Svendsen RS. 1997. *Fjellerkeobservasjoner fra Einunndalen*. Rapport til den lokale rapport- og sjeldenhetskomitéen (LRSK) i Norsk ornitologisk forening avd. Hedmark. (In Norwegian)

Theurillat J-P & Guisan A. 2001. Potential impact of climate change on vegetation in the European Alps: A review. *Climatic Change* **50**: 77–109. doi: 10.1023/A:1010632015572.

Thomas CD, Cameron A, Green RE, Bakkenes M, Beaumont LJ, Collingham YC, Erasmus BFN, de Siqueira MF, Grainger A, Hannah L, et al. 2004. Extinction risk from climate change. *Nature* **427**: 145–148. doi: 10.1038/nature02121.

Vanneste T, Michelsen O, Graae BJ, Kyrkjeeide MO, Holien H, Hassel K, Lindmo S, Kapás RE & De Frenne P. 2017. Impact of climate change on alpine vegetation of mountain summits in Norway. *Ecological Research* **32**: 579–593. doi: 10.1007/s11284-017-1472-1.

Vitasse Y, Ursenbacher S, Klein G, Bohnenstengel T, Chittaro Y, Delestrade A, Monnerat C, Rebetez M, Rixen C, Strebel N, et al. 2021. Phenological and elevational shifts of plants, animals and fungi under climate change in the European Alps. *Biological Reviews* **96**: 1816–1835. doi: 10.1111/brv.12727.

Walther G-R, Post E, Convey P, Menzel A, Parmesan C, Beebee TJC, Fromentin J-M, Hoegh-Guldberg O & Bairlein F. 2002. Ecological responses to recent climate change. *Nature* **416**: 389–395. doi: 10.1038/416389a.

WWF. 2022. *Living Planet Report 2022 – Building a nature-positive society*. Almond, R. E. A., Grooten, M., Juffe Bignoli, D. & Petersen, T. (eds). WWF, Gland, Switzerland.

Øien IJ, Stokke BG & Kålås JA. 2023. Det går litt bedre for fjellfuglene, men det blir stadig lengre mellom fuglene i jordbrukslandskapet - borte som hjemme. *Vår Fuglefauna* **46**: 12–19. (In Norwegian)

Østbye E & Framstad E. 1987. Spurvefuglenes habitatbruk i høyfjellet. *Viltrapport* **43**: 104–110. (In Norwegian)

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Appendix 1. Elevation (m a.s.l.) of Horned Lark *Eremophila alpestris* observations from study sites in Dovrefjell, southern Norway during 1969 (around Grimsdalen; Spjøtvoll 1970), 1992 (around Einunndalen; Svendsen 1997), and 2022 (Grimsdalen and Einunndalen; the current study). * indicates that surveys were conducted but no Horned Larks were observed at a site in the specific year..

Site	1969 or 1992 Elevation	2022 Elevation
Einunndalen		
Vesle Elgsjøtangen	1270	1396
	1280	1400
	1280	1435
	1290	
	1395	
	1430	
	1430	
Fundberget	1240	1240
	1258	
Settalberget	1365	1334
	1368	1350
Steinhøa	1330	1196
	1348	1323
		1342
Finnshøa	*	1405
		1422
		1432
		1440
		1448
		1465
		1480
		1484
		1490
		1523
Lågegga	1405	1320
	1405	1353
		1373
		1385
		1396
		1400
		1404
Høgegga	*	1372
		1456
		1476
		1485
		1491
		1495
		1498
Marsjøfjellet	*	1362
		1416
		1424
		1427
		1436
		1452
		1457
		1460
		1486
Grimsdalen		
Streitkampen	1200	*

Appendix 1. Continued.

Site	1969 or 1992 Elevation	2022 Elevation
Mesæterhøe	1230	*
Pikhetta	1320	1500
Kattuglehøe	1250	1260
	1390	1358
		1379
		1386
		1420
		1422
		1457
Halvfarhøe	1450	1400
		1400
		1400
		1400
		1420
		1440
		1488
		1570
Gygerhøe (Jegerhøi)	1370	1357
Gravhøe	1420	*
Storvassberget	1250	1368
Hornsjøkollen	1260	*
	1340	
Hornsjøhøe	1320	1380
	1350	1447
	1380	1450
	1400	1540
		1560