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REPORT 158

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Preface

The Svalbard reindeer lives at the northern edge of the wild reindeer's range and is an endemic subspecies for Svalbard. Despite being studied for decades, there is limited information about their dispersal and movement patterns. In 2022, the Svalbard Environmental Protection Fund (SMF) granted the Norwegian Polar Institute (NPI) funds to study dispersal of calves and young animals.

An international team of researchers from the Norwegian Polar Institute (NPI) , Norwegian Institute for Nature Research (NINA), Norwegian University of Science and Technology (NTNU), Norwegian University of Life Sciences (NMBU) and the University Centre of Svalbard (UNIS) carried out the project. Here, we report on project results between April 2022 till the end of May 2024, including three field seasons of captures.

We thank SMF for funding the project and the Norwegian Research Council and the Climate-ecological Observatory for Arctic Tundra (COAT) for additional funding of GPS-collars. Further, we thank our institutions for the financial support of personnel for fieldwork and data analysis. We also thank Kamilla Buran and Fredrik Samuelsson for field assistance during several field seasons, Jan Ivar Pettersen, Svein Torgar Oland and Stein Tore Pedersen for logistic and field support, Oddveig Øien Ørvoll for topographic map and Ruben Dens for administrating and providing the GPS telemetry data at the NPI data center.

The study complies with current regulations in the Svalbard Environmental Protection Act and the necessary permissions from the Norwegian Food Safety Authority.

Tromsø, 26 February 2025

Åshild Ønvik Pedersen

Researcher and project leader

Content

Summary

Climate change is affecting biodiversity in all the Earth's ecosystems through habitat modifications. The Arctic is warming at an unprecedented rate, fueling the decrease of sea ice. The coastal areas of Svalbard are experiencing a massive loss of fast ice in the fjords especially on the western part of the archipelago, thus isolating peninsulas from each other. The Svalbard reindeer, a key species of the terrestrial ecosystem, inhabits these coastal habitats. The population dynamics are driven by foraging conditions and density-dependent effects. However, little is known about their current seasonal range displacement and dispersal abilities and how this is affected by environmental changes.

The purpose of the project was to explore how climate change may affect dispersal and range displacement among coastal semi-isolated populations. To do so, we GPS-marked 34 calves (2022-2024) on three neighboring peninsulas on the west coast of Svalbard in Forlandsundet (Brøggerhalvøya, Sarsøyra and Kaffiøyra). We also used two long-term datasets from the same area using GPS (2014-2024) and VHF collars (1998-2008) on adult females.

Only one of the GPS-marked calves moved between peninsulas; a newly marked male (10 months old) moved from Kaffiøyra to Sarsøyra in 2023, a year with a major population crash at Kaffiøyra (40 % decline between summers 2022 and 2023). The calf died just after dispersing. Of the six remaining calves equipped with GPS-collars in Kaffiøyra that spring, four died the same year. In our ongoing capture-mark-recapture study, only six marked reindeer (<2 %; n=4 males, n=2 females) out of 323 (n=237 females, n=86 males) are known to have moved between the peninsulas, either based on GPS-collar data or resightings. An earlier mark-resighting study (1998-2008) found that, in some years, up to 35 % of the adult females migrated seasonally between Sarsøyra and Brøggerhalvøya. In the early 2000's, fjord ice was normally present between the peninsulas in parts of winter, and high reindeer densities in Brøggerhalvøya seemed to favour winter migration to Sarsøyra. High densities and poor winter forage accessibility also triggered major dispersal events in the 1990's.

We suggest that the recent lack of movement between peninsulas, despite many severe winters, is due to the virtual absence of fjord ice as dispersal corridor. The reindeer sub-populations are increasingly isolated, which may cause inbreeding and loss of genetic diversity. The population genetics related to this are currently under study. Isolated populations are more at risk of extirpation under stochastic events, such as disease outbreaks or extreme weather events. The present study adds to our knowledge of changes in spatial distribution and population exchange of Svalbard reindeer, with implications for their long-term viability in a rapidly changing environment.

Capture of a reindeer during fieldwork in Svalbard. Photo: Trine Lise Sviggum Helgerud / Norwegian Polar Institute.

1 Introduction

The Svalbard reindeer is a key species in the Svalbard tundra ecosystem and an important resource for local hunting. Reindeer have been studied for decades in Svalbard (Pedersen et al. 2019), however, there is currently a knowledge gap related to the dispersal and exchange of individuals, particularly in semi-isolated, coastal subpopulations (Governor of Svalbard 2009). Demographic and genetic exchange, which is important for the viability of the reindeer population in the long-term, may be challenged because subpopulations are becoming increasingly isolated due to the absence of sea ice in recent years (Jenkins et al. 2016, Peeters et al. 2020). The coastal areas in the western part of Svalbard consist of isolated peninsulas, beach areas and islets (Figure 1). Without sea ice in the fjords, reindeer inhabiting these peninsulas, have few dispersal routes aside from crossing fjords by swimming or traversing large tide-water glaciers.

In Svalbard, continental populations, like those on Nordenskiöld Land, have increased by 50 % or more since temperatures began to rise in the 1990s (Hansen et al. 2019; MOSJ 2024 for population sizes in Adventdalen and Reindalen). This is related to changes in the foraging conditions with consequences for fitness – longer and warmer snow-free seasons overshadow the negative effects of rainy and icy winters (Albon et al. 2017, Hansen et al. 2019). On the north-west coast, on the other hand, the winters are particularly mild and wet, and pastures are frequently locked due to basal ice encapsulating the vegetation, thereby limiting access to forage (Hansen et al. 2011). Over time, small populations have higher extirpation risk due to demographic and environmental stochasticity, including extreme winters or other stochastic events, such as disease outbreaks (Reed 2004). Similarly, small, isolated populations are also more at risk of inbreeding and may experience inbreeding depression (Hedrick and Kalinowski 2000, Reed 2004).

For most ungulates, young animals are the ones that normally disperse and account for genetic exchange between populations. In Svalbard there is very limited knowledge about dispersal of reindeer, both in young and adult animals (but see Hansen et al. 2010, Stien et al. 2010, Loe et al. 2016). Around the turn of the millennium, when sea ice in the fjords was more widespread (Muckenhuber et al. 2016), up to 35 % of radio-collared adult females moved between the peninsulas in some years, with an apparent seasonal migration pattern (Hansen et al. 2010). More recently, observations have indicated little movement between the peninsulas (Pedersen et al. 2018; unpublished data). The sea ice (fjord ice) is probably the most important route for the exchange of individuals between the populations (Peeters et al. 2020), and lack of it in most recent winters challenges movements between peninsulas.

Here, we aimed to evaluate how the lack of sea ice in the fjords affects dispersal of calves and young Svalbard reindeer, by using GPS-telemetry and observational data from both ongoing and former capture-mark-recapture studies. Specifically, we quantified the degree of dispersal between the subpopulations, dispersal pattern and migration routes, and whether there are differences between areas, sex and season.

2 Methods

2.1 Study system

2.1.1 Study area

The high-Arctic Archipelago of Svalbard (74-81°N, 10-35°E; 62 700 km^2), Norway, comprises 60 % glaciers, 25 % barren and sparsely vegetated areas, and only 15 % vegetation covered land areas (Johansen et al. 2012). The coastal study area at the west coast of Spitsbergen consists of three peninsulas, Brøggerhalvøya, Sarsøyra and Kaffiøyra (Figure 1). These peninsulas are dominated by steep alpine mountains, reaching up to 700 m above sea level, and flat open coastal tundra plains in the lowlands. Large tidewater glaciers and fjords separate the peninsulas.

Figure 1. Study area for the capture-mark-recapture study of male/female calf/yearling and adult females during 2014-2024. Map: Norwegian Polar Institute.

2.1.2 Study species

The Svalbard reindeer is endemic to the archipelago, where it is the only large herbivore species. They occur alone or in small groups of typically 2-5 individuals, often but not always sexually segregated (Loe et al. 2006). Compared to other *Rangifer* subspecies, they have small seasonal and annual home ranges and are non-migratory (Tyler and Øritsland 1989). However, partial seasonal migration can occur when foraging conditions are bad due to the presence of basal ice, adverse snow-conditions, high reindeer densities or past overgrazing (Hansen et al. 2010, Stien et al. 2010, Loe et al. 2016). Both rainfall in winter and large amounts of snow can hinder access to pastures due to basal ice and deep/hard snowpack, thereby increasing the potential for competition over resources. Svalbard reindeer is not subject to significant predation (but see Derocher et al. 2000; and Pedersen et al., unpublished study by Svalbard Environmental Protection Fund), insect harassment or interspecific competition (Øritsland and Alendal 1986). Instead, annual population fluctuations are mainly driven by density dependence in interaction with winter weather variability, especially fluctuations in amount of rain and snow (e.g., Albon et al. 2002, Aanes et al. 2003, Albon et al. 2017, Hansen et al. 2019).

2.1.3 Study populations

In Brøggerhalvøya, reindeer were re-introduced in 1978 after being locally extinct for almost 100 years due to overharvest. After the reintroduction of 15 reindeer (six males and nine females, of which three males died soon after) from Adventdalen, central Spitsbergen, the population grew fast and reached 360 individuals in 1993 after just 15 years. In November 1993, large amounts of rain fell and covered the pastures with basal ice. In 1994, during the winter counts, only 78 animals were found alive (Aanes et al. 2000, Aanes et al. 2003). Since then, the population has fluctuated at a lower level of abundance, ranging between 52-228 during 2000-2024 (summer census).

During the 1994 population crash, reindeer from Brøggerhalvøya crossed over sea ice and established on Sarsøyra to the south. Thereafter, a third population established even farther to the south on Kaffiøyra during 1996–1997 (Aanes et al. 2000). The Sarsøyra population gradually increased and was the largest of the three populations until around 2014, ranging between 106-241 individuals during 2000-2024 (summer census). Kaffiøyra subsequently had the largest population size, ranging between 91-283 during 2002-2024 (summer census). The Kaffiøyra subpopulation had a major decline of approximately 40 % from summer 2022 to 2023. There is no hunting and very low human activity in these study locations.

2.2 Field protocol

2.2.1 Capture of reindeer and telemetry

We captured and deployed GPS-collars on 34 male and female calves in April and May for three field seasons (2022 – 2024; see Table 1 for sample sizes and sex of the GPS-collared calves). We used a net held between two snowmobiles as described by Omsjoe et al. (2009) to capture the animals (Figure 2). Animals were manually restrained, weighed to the nearest 0.5 kg and fitted with an expandable GPS-collar. Each collar had an automatic drop-off mechanism (released automatically after two years or via UHF) and sent data via the IRIDIUM satellite-link (Vectronic Aeropsace GMBH, Germany; 1 position per 23 h). Every individual was also marked with ear-tags. The GPS-collar weighs approximately 500 grams (~2 % of the calves' winter body weight). We also collected several biological samples (i.e., blood, hair, ear tissue and faeces).

This capture campaign is part of a decade long capture-mark-recapture time-series, initiated in 2014 with seed-money from the Svalbard Environmental Protection Fund. Currently, this time-series is part of the annual monitoring of the Climate-ecological observatory for Arctic tundra (COAT, www.coat.no) and consists of 323 individually tagged animals (n=237 females, n=86 males), most marked as calves (ca. 10 months old). Individuals are marked with unique ear tags and females are in addition equipped with either a GPS transmitter or a plastic collar. Males are not collared, except for the male calves equipped with expandable GPS-collars (listed in Table 1).

Figure 2. *Upper panel: Capturing of a reindeer with a handheld net from a pair of snowmobiles (left) and calf manually restrained after capture in the net (right). Lower panels: Calf with GPS-collar and with ear-tags and GPS-collar (left) and release of calf after approximately 15 minutes handling time (right). Photos: F. Samuelsson (upper panel left), T.L. Sviggum Helgerud (upper panel right), Å.Ø. Pedersen (lower panel left) and T.L. Sviggum Helgerud (lower panel right).*

2.2.2 Re-sighting data of reindeer initially marked as calves

During the annual population census in August (2022-2024), we re-sighted calves, yearlings and adults, identified with their unique ear-tags, in the three study locations. Sarsøyra and Kaffiøyra were covered in one day by foot while Brøggerhalvøya was covered in two days. We detected reindeer by systematic scanning of the study area, using hand-held binoculars (Swarowski/Zeiss binoculars; 10x42). For individual identification, we used a telescope (20x60 mm) after the initial detection of an individual or a group with marked individuals. Based on Le Moullec et al. (2017) we can assume detection rates to be close to 100 %. We recorded positions of the animals, checked whether individuals had moved between peninsulas and the status of the collar on the animal.

2.3 Pre-processing of GPS data

We downloaded GPS position data via a satellite-link to a local server at NPI. GPS positions were screened and filtered for erroneous positions (e.g., single points far away from the study site). The data was also filtered for the time the collar was on the animal. Prior to analysis we removed the day of capture of every individual and the subsequent 24 h.

2.4 Data analysis

We used data from captures, field observations (summer surveys) and GPS-collars to assess whether individuals moved between peninsulas. Here we defined dispersal as ‘permanent’ departure from natal area (i.e., where the calf at 10 months age was captured), and displacement as temporary departure from natal area (e.g., seasonal migration). We assessed the displacement and/or dispersal events based on observation quality, e.g., whether the animal was physically captured, seen by an observer, or whether only ear tags / a collar was found, in addition to evaluating the potential for identification errors (e.g., misidentification by observer).

To visualise the home ranges, or extracted 95 % minimum convex polygons (MCP) for each calf using the “mcp” function in the “adehabitatLT” package (Calenge 2006). MCP’s were determined for each individual every year, thus spanning between two annual capture events. In this sense, year 1 represents the first year of data collected (from capture in year t to capture in t+1), while year 2 represents the second year of data collected (from capture in year t+1 to capture in t+2) for a given individual.

For comparative purposes, we also took advantage of two other data sources to inform about patterns of dispersal and displacement and how this has changed over time; 1) the dataset from 29 collared (VHF or plastic bands) adult females in 1998, described in Hansen et al. (2010), and 2) the dataset (2014 until spring 2024) from 323 marked reindeer of both sexes, including 86 GPS-collared females (background information is described in Pedersen et al. 2018). We assessed the dispersal and displacement events as for the calves.

For all statistical analyses, we used R version 4.3.1.

The field team takes various samples from a reindeer during the short handling period.
Photo: Trine Lise Sviggum Helgerud / Norwegian Polar Institute.

3 Results

3.1 Capture and dispersal of calves during 2022–2024

During the study period (2022-2024), 86 Svalbard reindeer calves (females [n=50]; males [n=36]) were captured in April. Of these, we marked and equipped 34 calves with GPS satellite collars (female calves [n=14]; male calves [n=20]). Six calves were later confirmed dead. See Table 1 for an overview of GPS-collared calves and Appendix 1 for the duration of data collection per individual.

Based on GPS data, we identified only one dispersal event, i.e., a male calf (ID292) that moved from Kaffiøyra to Sarsøyra (Sarstangen) 38 days after its capture on 23 April 2023 (Figure 3). Based on the GPS positions upon arrival in Sarstangen, this animal was assumed dead. The 2022/2023 winter season, combined with high population density of reindeer in summer 2022, caused a population crash at Kaffiøyra (i.e., approximately 40 % population decline), and four out of the other six GPS-collared calves in Kaffiøyra died that year in late winter / early spring.

***Table 1**. Overview of reindeer calves equipped with a GPS-collar during the April field campaigns (2022-2024). The numbers in parentheses indicate the number of individuals that died. Asterix (*) denotes that one male was presumed but not confirmed dead (most likely died May 2023 after moving from Kaffiøyra to Sarsøyra). The nine calves marked in April 2024 was not included in the subsequent analyses due to short track duration.*

	2022		2023		2024		Total
Location/Sex	*F*	*M*	*F*	*M*	*F*	*M*	
Brøggerhalvøya	3 (1)	4	1	2	3	4	17 (1)
Kaffiøyra	1	-	2 (2)	4 (2*)		1	8 (4*)
Sarsøyra	2	3 (1)	2	1 (1)		1	9 (2)
All	6	7	5	7	3	6	34 (7*)

Reindeer are captured in a handheld net between two snowmobiles. The calf is manually restrained and handled during a short time-period while several measures and samples are taken. Photo: Trine Lise Sviggum Helgerud / Norwegian Polar Institute.

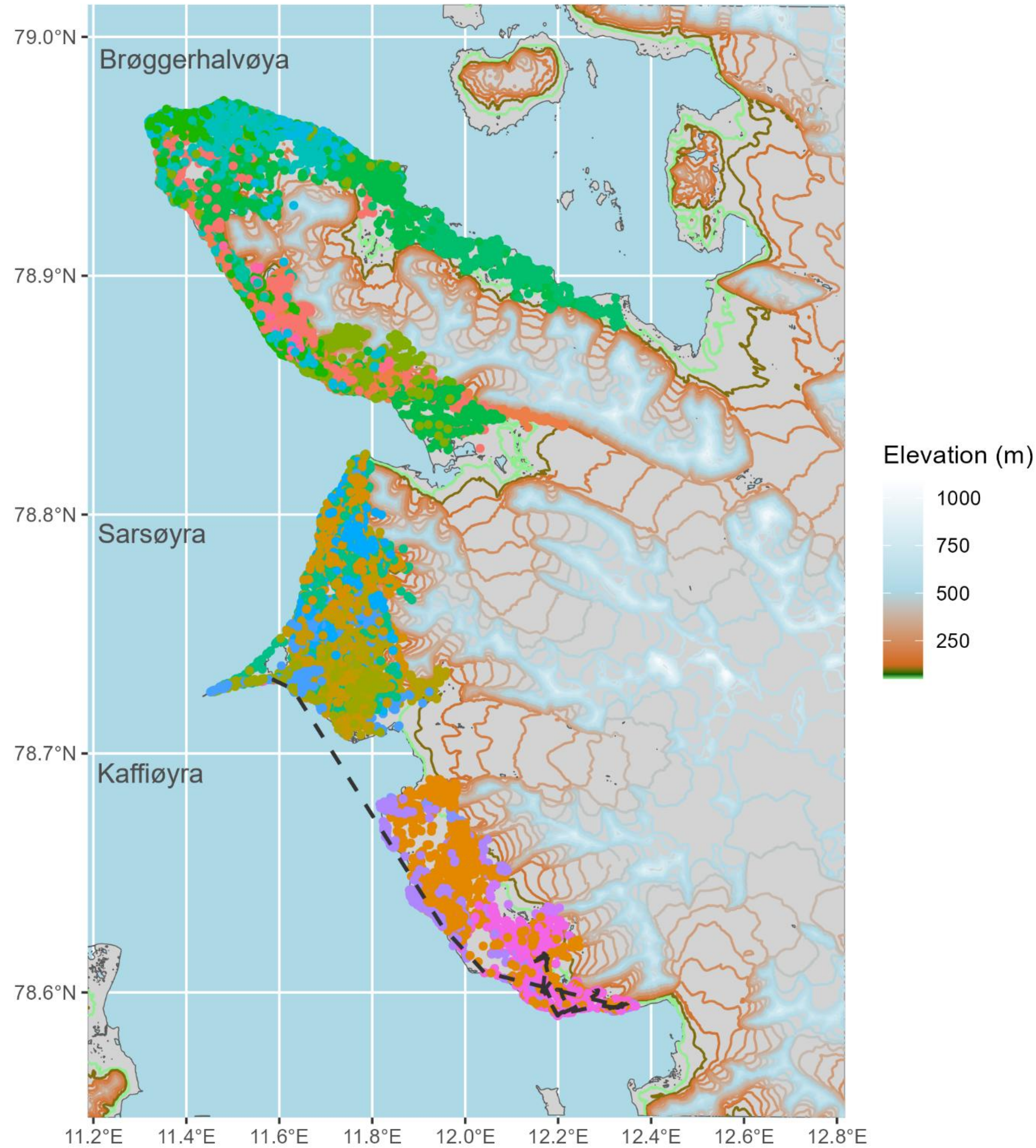

Figure 3. *All recorded GPS positions of 34 Svalbard reindeer calves equipped with a GPS-collar in April/May 2022 and 2023 (n=11 female calves, n=14 male calves). Individuals are represented by a unique colour. One male calf (dashed line) moved from Kaffiøyra (southern peninsula) to Sarsøyra (middle peninsula) and presumably died on May 31st in 2023.*

Movement patterns varied between individuals. Some individuals showed similar area use in their first and second year (e.g., IDs 231 and 239, Figure 4), while other individuals roamed larger areas in their second year compared to their first (e.g., IDs 234 and 236). There were large differences in the overall home range size between individuals on the same peninsula, with some covering the entire peninsula and others only a small area (e.g., ID 228 vs. ID 237 on Brøggerhalvøya, ID233 vs. ID239 on Sarsøyra; for an example see Appendix 2).

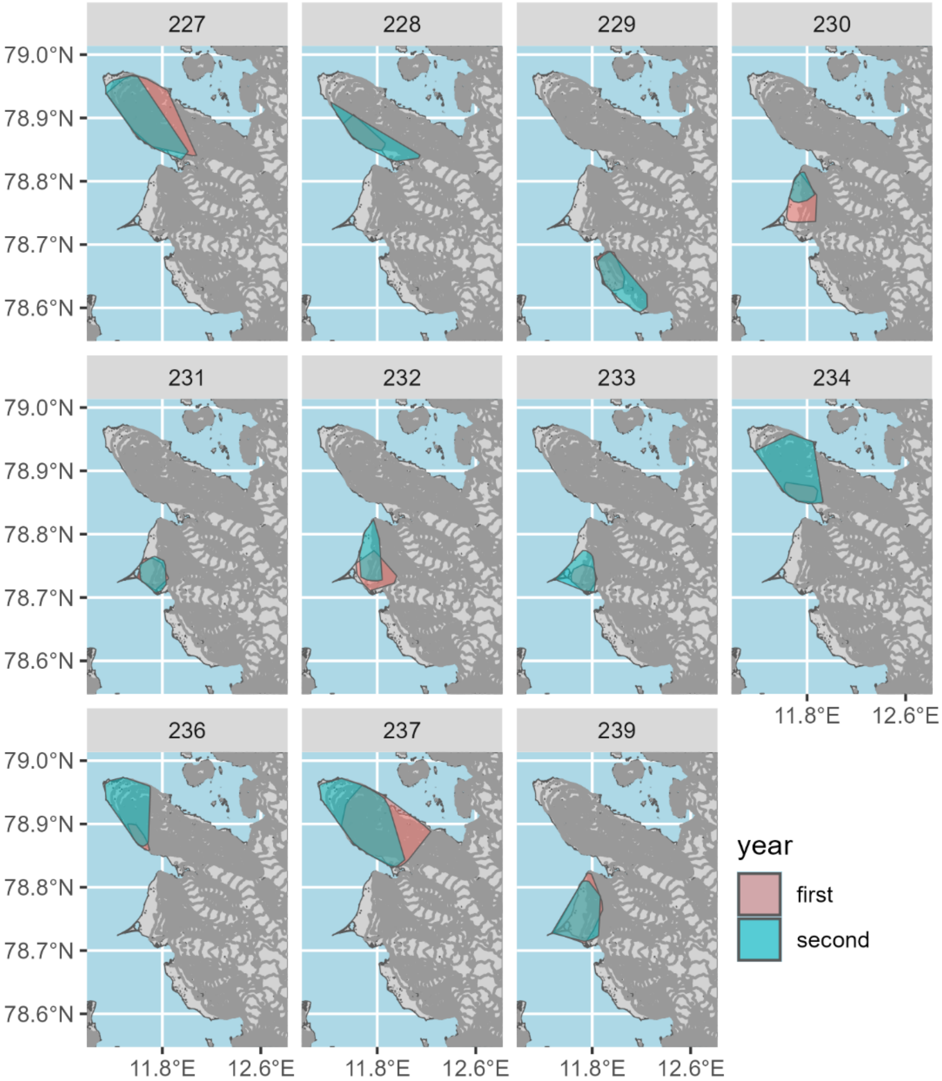

__Figure 4.__ Yearly home-range (95 % minimum convex polygon) for reindeer equipped with GPS-collar as calf (10 months old) in 2022 and 2023. The calves that died within the same year/season as they were marked or those with short track duration are not shown. See Appendix 1 for collar deployment dates and durations of transmitters.

3.2 Dispersal of reindeer during the capture-mark-recapture study in 2014–2024

We also quantified the rates of dispersal events using all capture-mark-recapture data between 2014-2024 (including the 34 calves tagged in this study). Out of 323 individually marked reindeer (n=237 females [40 adults, 197 calves], n=86 male calves), only six individuals were observed on a different peninsula than the one where they were captured (4 males and 2 females; Figure 5). Two individuals are known to have migrated back, two individuals have no later resighting or was found dead (i.e., they could potentially be true dispersers), and two individuals (female IDY64 and male ID7) have later been consistently resighted on the same peninsula, suggesting that these are true dispersal events (Figure 5). Female IDY64 moved from Kaffiøyra to Sarsøyra as an adult, while the male (ID7) moved from Sarsøyra to Brøggerhalvøya, but from the data it is not possible to determine the time of dispersal.

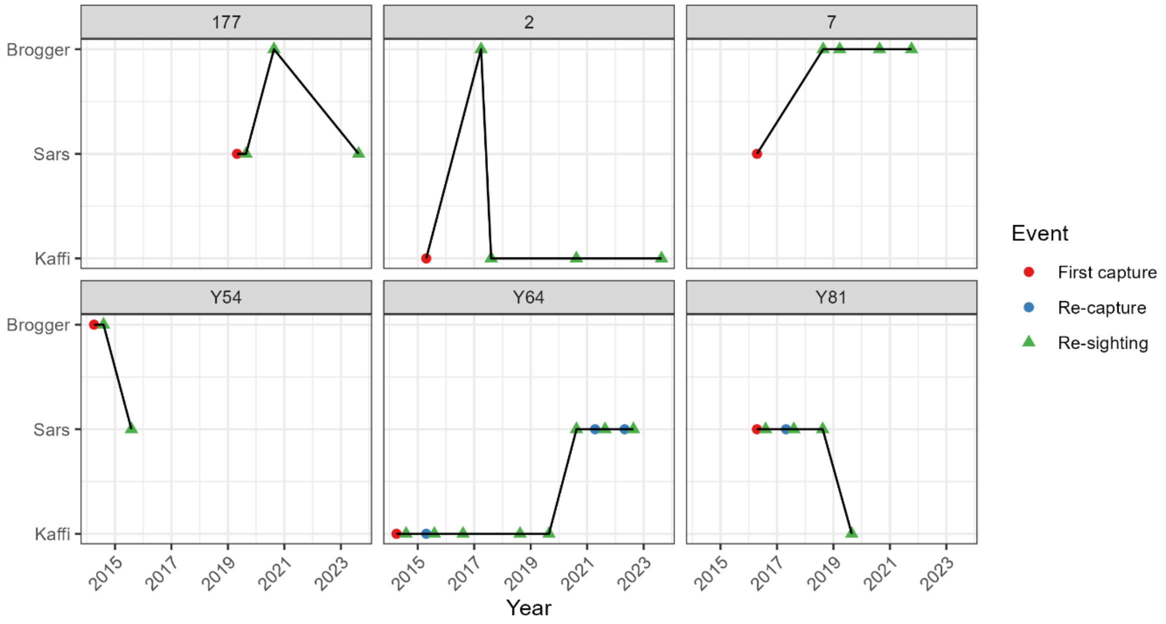

Figure 5. *Illustration of dispersal (male ID7 and female ID64) and displacement (male ID2 and male ID177) events from 2014 till 2024 in the capture-mark-recapture study. The Y-axis shows the location/peninsula where each animal has been observed, a point indicates a resighting or capture event, distinguished by different colours. Brogger = Brøggerhalvøya, Sars = Sarsøyra, Kaffi = Kaffiøyra. For male IDY54 there were no more resightings since it first moved between peninsulas. Female IDY81 was observed dead in Kaffiøyra. In principle, these two animals can also be categorized as true dispersers.*

3.3 Dispersal of reindeer in a former radio tracking study in 1998–2008

We also used data collected in the period 1998-2008 on Sarsøyra and Brøggerhalvøya, described in Hansen et al. (2010), to compare dispersal and range displacement rates over this period with the last ten years of data available for marked individuals. Hansen et al. (2010) analysed a total of 81 marked individuals. Of these, 30 individuals were resighted on a different peninsula from the one where they were first captured showing both seasonal displacement and true dispersal (see examples in Figure 6; Appendix 3)

A group of Svalbard reindeer. Photo: Trine Lise Sviggum Helgerud / Norwegian Polar Institute.

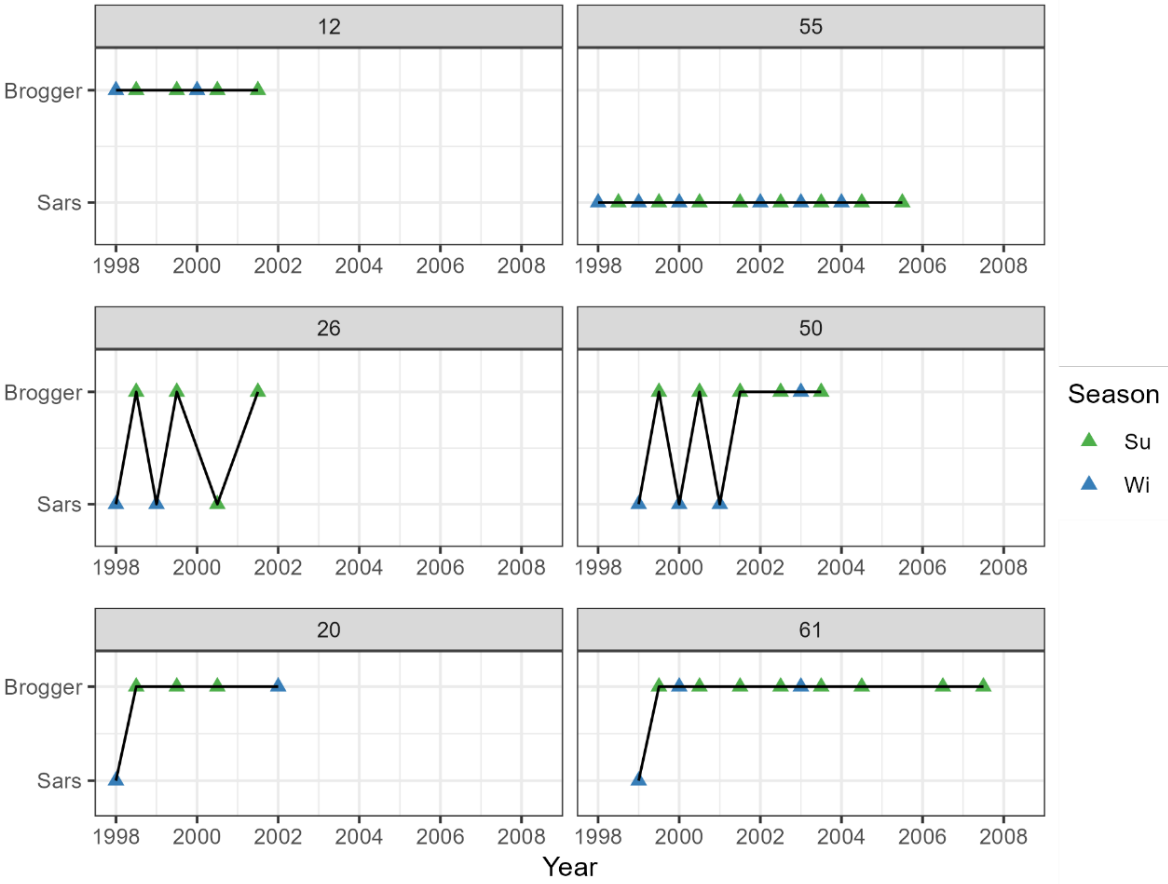

Figure 6. *Examples of movements based on radio-tracking of adult Svalbard reindeer females between 1998-2008 in Brøggerhalvøya and Sarsøyra. The Y-axis shows the peninsula where each animal has been observed, each triangle indicates an observation or capture event, colour-coded by season (Su = summer, Wi = winter). Upper panel = no observed displacement, middle panel = seasonal displacement, bottom panel = dispersal. Brogger = Brøggerhalvøya, Sars = Sarsøyra.*

4 Discussion

Our study suggests that dispersal and displacement patterns have changed drastically over the last decades (1998-2024). In the early study period (1998-2008), a large proportion (up to 35 %) of the adult females displaced seasonally, and some (apparently) dispersed permanently (Hansen et al. 2010). On the other hand, in the latest period (2014-2024), movement of individuals between peninsulas was rare (less than 2 % of the marked reindeer were confirmed to move). Drivers of the movements between the peninsulas are thought to be linked to severe winter foraging conditions combined with density-dependent effects. Indeed, the only GPS-collared calf in this study that moved, moved from Kaffiøyra during a major population crash (40 % decline between 2022-2023 and high mortality), most likely due to the combined effects of inaccessible food resources (i.e., encapsulated into basal ice and/or deep snow cover) and a high population density, causing competition for resources.

The limited dispersal and seasonal movements between the peninsulas could be attributed to the lack of sea ice and resultant loss of migration corridors in winter (Jenkins et al. 2016, Peeters et al. 2020). Previously, sea ice was used as a corridor between the peninsulas when winter foraging conditions were challenging (Hansen et al. 2010, Stien et al. 2010). The continuous decrease of sea ice on the west coast of Svalbard is increasingly isolating populations due to reduced connectivity between peninsulas. Although the reindeer can indeed swim, they appear to prefer not to in winter, i.e., the season when they experience dispersal triggers due to resource restriction. In practise, they therefore end up as more or less landlocked on the small peninsulas. Over time, this may have consequences for their genetic diversity (Peeters et al. 2020). The three populations already show signs of genetic differentiation (Burnett et al. 2023), which are expected to increase as sea ice continues to be absent in the fjords and bays. Our findings illustrate reduced spatial connectivity between peninsulas, which may threaten the persistence of coastal reindeer subpopulations and their genetic diversity.

The peninsulas in our study area share the same characteristics as many other parts of the coastal landscape in Svalbard, therefore our results are likely to be generalisable to other locations, particularly along the west coast of Svalbard. In this context, this long-term population monitoring of individuals using GPS-tracking, genetic analyses and collection of individual fitness data, will allow us to continue exploring the genetic consequences of limited dispersal and increasing isolation of Svalbard reindeer populations.

The results from this study are integrated within a larger research project (Adaptive capacity and population viability under rapid environmental change: a multi-scale eco-evolutionary approach, ADAPT) funded by the Norwegian Research Council for 2024-2027, as well as the Climate-ecological Observatory of Arctic Tundra (COAT). These projects/monitoring programmes will focus further on the dispersal of reindeer and the evolutionary consequences of a changing environment. Whether the apparently very low dispersal rates between the isolated peninsulas in our study area will be sufficient to avoid increased inbreeding and isolation is not yet known. In this context, our pilot study has yielded the first results and is an important basis for the continuation of increased understanding of the consequences of climate change for Arctic ecosystems.

5 Management recommendations

Our project suggests that environmental changes caused by global warming affect dispersal rates in Svalbard reindeer. This contributes to the current understanding of potential changes in Svalbard reindeer's future spatial distribution, large-scale population dynamics, genetics, and long-term population viability. Such knowledge was called for in the management plan for Svalbard reindeer (Sysselmannen på Svalbard, 2009) and is no less relevant today or in the near future. Finally, our study also demonstrates the value of long-term monitoring by investigating how a changing environment might affect the various aspects of life in long-lived organisms inhabiting highly stochastic Arctic environments.

This study suggests that environmental changes caused by global warming affect dispersal rates in Svalbard reindeer. Photo: Trine Lise Sviggum Helgerud / Norwegian Polar Institute.

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7 Appendices

Appendix 1. Deployment Table for calves equipped with GPS-collars (2022-2024).

Table A1*. Overview of the calves equipped with a GPS-collar (id_plat = individual identification and GPS platform number). Start_date = the day of first position in the GPS dataset, end_date = the day of last position in the GPS dataset, date_ON = date when calf was collared, date_OFF = date when collar was removed.*

id_plat	id	start_date	end_date	date_ON	date_OFF
227-86585	227	25.04.2022 02:00	16.04.2024 06:00	24.04.2022	2024-04-17
228-86577	228	26.04.2022 02:00	26.01.2024 18:00	25.04.2022	2024-01-27
229-86501	229	28.04.2022 02:00	20.03.2024 16:27	27.04.2022	2024-03-21
230-86500	230	01.05.2022 02:00	11.04.2024 16:26	30.04.2022	NA
231-86575	231	01.05.2022 02:00	21.03.2024 23:46	30.04.2022	2024-04-14
232-48590	232	01.05.2022 01:00	22.02.2024 14:00	30.04.2022	2024-02-23
233-86576	233	02.05.2022 02:00	14.04.2024 08:00	01.05.2022	2024-04-15
234-48588	234	02.05.2022 01:00	30.04.2024 15:00	01.05.2022	2024-05-01
235-86578	235	02.05.2022 02:00	06.01.2023 16:00	01.05.2022	2023-01-07
236-47926	236	03.05.2022 01:00	08.10.2024 15:00	02.05.2022	NA
237-47958	237	03.05.2022 01:00	16.04.2023 20:00	02.05.2022	2023-04-17
237-88593	237	18.04.2023 02:00	16.04.2024 18:28	17.04.2023	2024-04-23
237-99778	237	24.04.2024 02:00	18.10.2024 05:00	23.04.2024	NA
238-48597	238	03.05.2022 01:00	16.04.2023 20:00	02.05.2022	2023-04-17
239-86502	239	04.05.2022 02:00	22.02.2024 01:01	03.05.2022	2024-04-15
239-88603	239	13.08.2024 22:00	21.10.2024 15:40	15.04.2024	NA
261-88591	261	16.04.2023 02:00	17.10.2024 12:05	15.04.2023	NA
263-88602	263	16.04.2023 02:00	15.10.2024 20:46	15.04.2023	NA
266-86585	266	21.04.2024 01:00	10.05.2024 10:59	19.04.2024	NA
267-88592	267	18.04.2023 02:00	21.10.2024 18:18	17.04.2023	NA
268-88590	268	21.04.2023 02:00	10.05.2023 22:00	20.04.2023	2023-05-11
269-88601	269	21.04.2023 02:00	15.10.2024 18:48	20.04.2023	NA
273-88599	273	21.04.2023 02:00	14.04.2024 08:00	20.04.2023	2024-04-15
282-88594	282	24.04.2023 02:00	07.05.2023 22:00	23.04.2023	2023-05-08
283-48597	283	24.04.2023 04:00	12.04.2024 10:00	23.04.2023	2024-04-13
284-88603	284	24.04.2023 02:00	23.05.2023 22:00	23.04.2023	2023-05-24
290-88598	290	24.04.2023 02:00	10.05.2023 22:00	23.04.2023	2023-05-11
291-47958	291	24.04.2023 04:00	28.04.2024 17:01	23.04.2023	2024-04-29
292-88597	292	24.04.2023 02:00	24.05.2023 08:00	23.04.2023	2023-05-31
294-88590	294	12.08.2024 00:00	19.10.2024 10:18	13.04.2024	NA
306-88598	306	03.08.2024 09:00	17.10.2024 23:21	14.04.2024	NA
307-88594	307	11.08.2024 01:00	16.10.2024 15:43	15.04.2024	NA
308-88599	308	20.04.2024 02:00	17.10.2024 14:38	18.04.2024	NA
309-48597	309	20.04.2024 02:00	17.10.2024 16:04	18.04.2024	NA
310-99777	310	21.04.2024 02:00	19.10.2024 04:00	20.04.2024	NA
311-99786	311	21.04.2024 02:00	19.10.2024 04:00	20.04.2024	NA
313-86576	313	25.04.2024 20:00	30.04.2024 09:15	23.04.2024	NA
314-99773	314	24.04.2024 02:00	16.10.2024 07:00	23.04.2024	NA
315-99780	315	24.04.2024 02:00	19.10.2024 04:00	23.04.2024	NA

Appendix 2. Example of variation in spatial behaviour for a male calf (ID237).

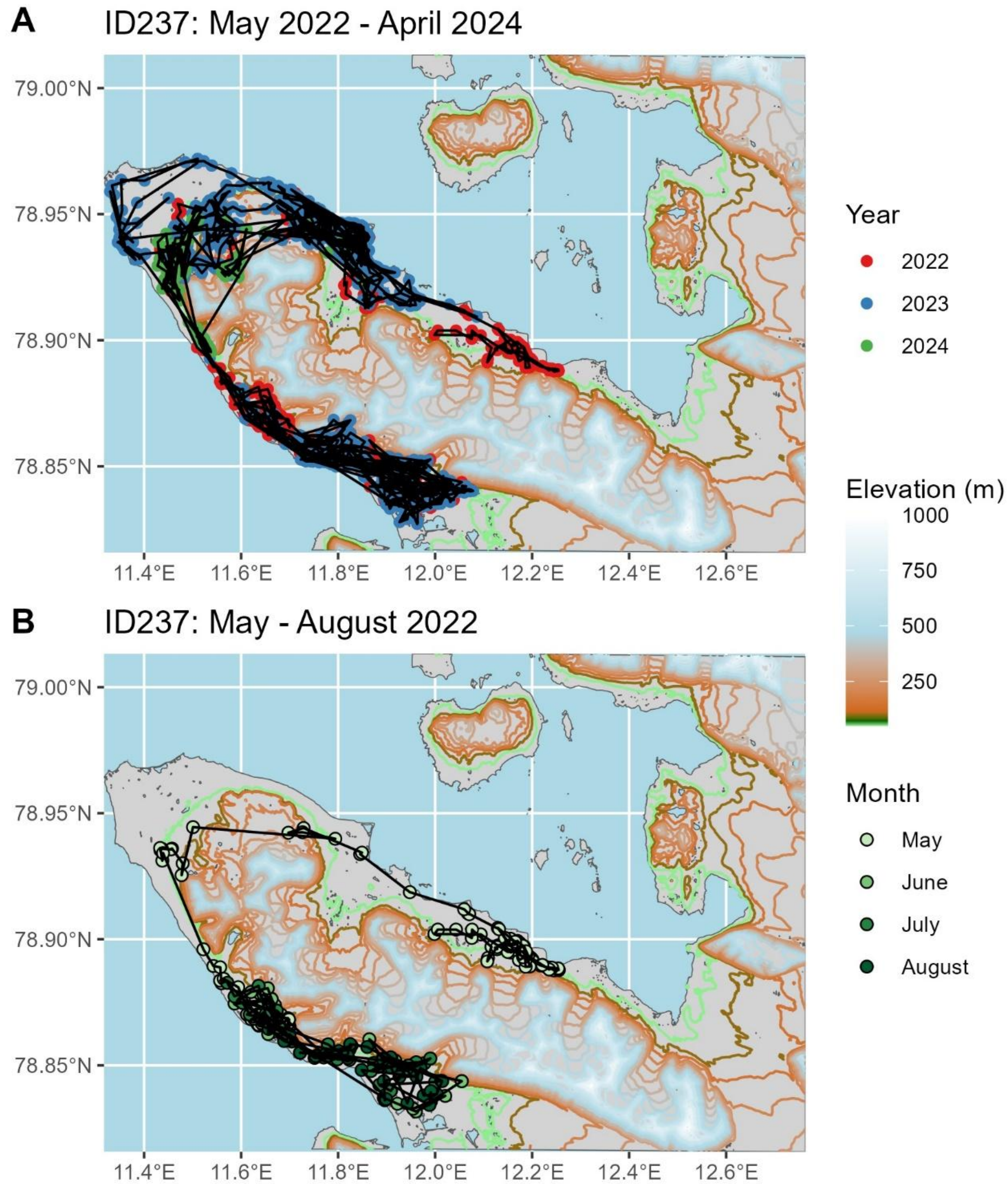

__Figure A2.__ Example of variation in spatial behaviour for a male calf (ID237). A) Annual space use by year and B) seasonal space use by month (5 = May, 6 = June, / = July) in 2022.

Appendix 3. Observed dispersal and displacement events in adult female Svalbard reindeer monitored.

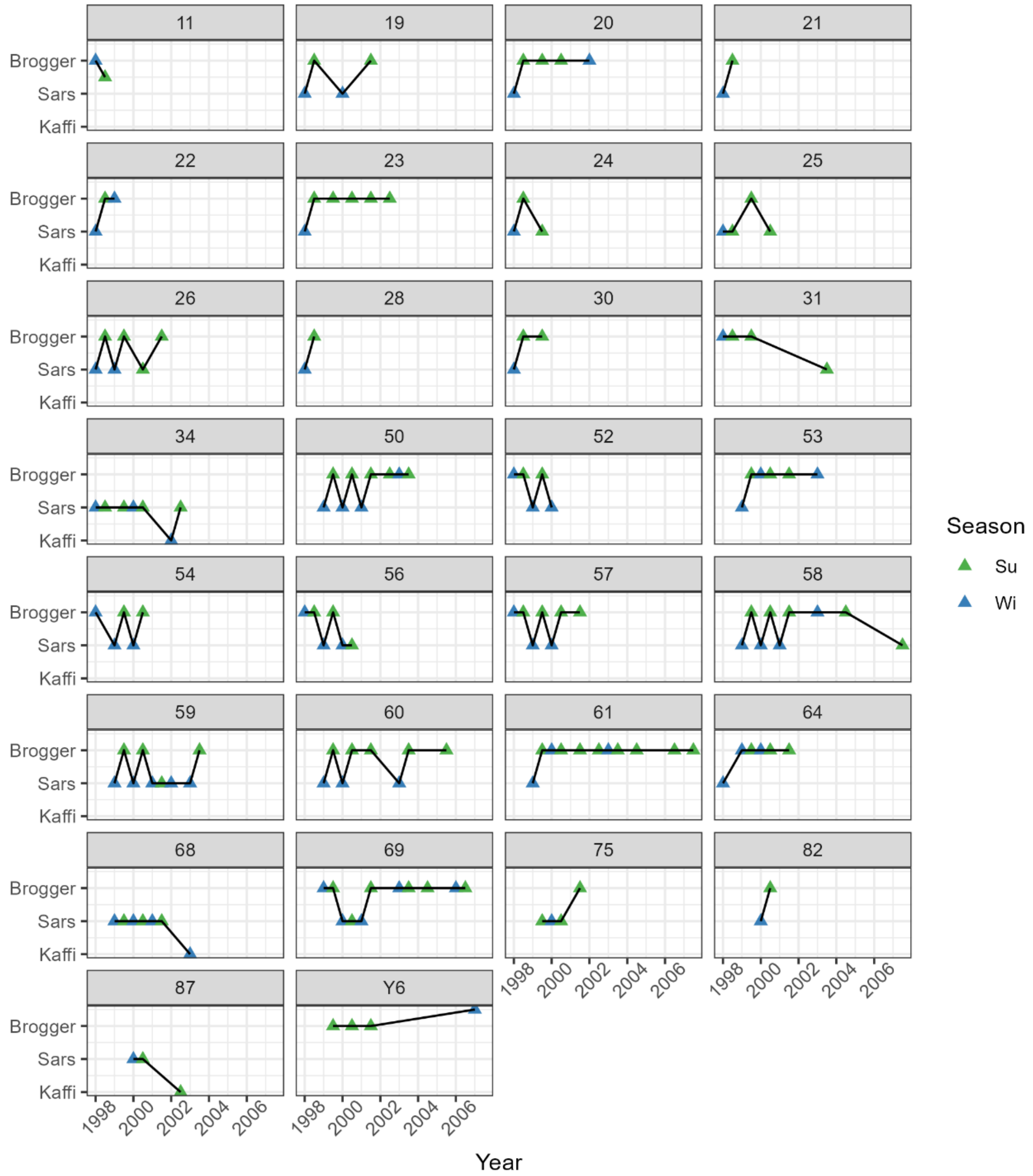

***Figure A3**. Observed dispersal / displacement events in Svalbard reindeer monitored between 1998 and 2008 on the peninsulas. Each point represents an observation of an animal each year, colour-coded by the period during which it was observed (su = summer, wi = winter). Each panel represents one individual with the ID given in the panel header. Two adult females moved to other locations than the peninsulas (ID Y6 – Garwoodtoppen and ID11 – Comfortlessbreen). Brogger = Brøggerhalvøya, Sars = Sarsøyra, Kaffi = Kaffiøyra.*