BREEDING BIRDS IN THE RAMSAR SITE HEDEN AND IN A PROPOSED RAMSAR REPLACEMENT AREA, JAMESON LAND, EAST GREENLAND

NERI Technical Report no. 822 2011

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Data sheet

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Abstract: In June 2009, breeding bird studies were performed in two different areas of Jameson Land, East Greenland. Breeding bird densities were obtained from four large study areas of 17-34 km^2 each in the Gurreholm area inside the Ramsar site Heden and in a proposed Ramsar replacement area, the Ørsted Dal. The purpose of the studies was to evaluate possible impacts from mining activities on the breeding birds in the Ramsar site and to examine if the Ramsar replacement area could protect similar species and numbers of breeding pairs. Densities are given for 15-26 breeding bird species in the two areas. The breeding period of 2009 was thought to be good mainly due to early snow melt. The densities of waders in both areas were, compared to other high Arctic study areas higher than expected from a direct comparison. From the present knowledge of the mining activities inside the Ramsar site and from a literature based disturbance distance of 300 m (1500 m for geese), we calculated the number of breeding pairs of each species that potentially would be affected by the mining activities. It is concluded that the replacement area fully can give protection under the Ramsar Convention to the number of breeding pairs that potentially can be affected in the Ramsar site for species found breeding in both areas. However, nine species were found breeding only in the Ramsar site. Three of these species, Sabine's gull, whimbrel and Eurasian golden plover, are considered near-threatened in Greenland and Jameson Land is the only known breeding area in Greenland for the latter two species. Moving the airstrip west or out of the Ramsar site would reduce the impact.

Keywords:	Ramsar site, mining, breeding tundra birds, disturbances, replacement area, Jameson Land, East Greenland
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Summary

The present report describes breeding bird studies performed in June 2009 in two different areas of Jameson Land in East Greenland (Fig. 1) in connection with planned mining activities. The purpose of the studies was to establish baseline knowledge of breeding bird densities and distributions in the Gurreholm area in the north-western part of the Heden Ramsar site and in the Ørsted Dal area proposed as a Ramsar replacement area to compensate for expected disturbances at Gurreholm. The derived knowledge was used to assess the likely impacts from mining activities on the breeding bird populations in the Gurreholm area and to evaluate, whether the proposed Ramsar replacement area would be able to give protection under the Ramsar Convention to similar species and numbers that potentially will be displaced from the impacted area.

In late 2008 the mining company, Quadra Mining Ltd., was granted an exploitation license. The license covers primarily a large molybdenum mineralization in the Malmbjerget area situated about 75 km north of the Ramsar site Heden (Fig. 1). To transport the molybdenum concentrate out of the area, the company plans to develop the north-western part of the Ramsar site, named Gurreholm. The planned activities include the construction of a port, a gravel road and a 2000 m long air strip. The Greenland Government has claimed the mining project of "urgent national interests". The Ramsar Convention Secretariat is in dialogue with the Greenland Government and has accepted that the project can proceed provided that the impact of the activities is monitored and that an appropriate replacement area is found in advance.

The Ramsar site Heden in high Arctic East Greenland (centre 71º00'N; 24º00'W) covers 2524 km^2 of the large Jameson Land lowland tundra area. It was designated in 1988, primarily to protect internationally important populations of moulting pink-footed geese *Anser brachyrhynchus* and barnacle geese *Branta leucopsis*. Of importance for the designation were also other breeding birds like divers, waders and skuas together with uncommon breeding birds like Sabine's gull *Larus sabini* and whimbrel *Numenius phaeopus*.

The present report gives an overview of the breeding bird studies performed in Jameson Land in 2009, presents in detail the distribution of all breeding species in the four different study areas and assesses the likely disturbance effects of the mining activities.

The studies were performed during the optimal period in high Arctic Greenland for performing a breeding bird census so the results represent realistic numbers of breeding pairs of that particular year. The breeding season in Jameson Land in 2009 is thought to have been good due to early snow melt, indicating that densities of breeding pairs were not suppressed by poor conditions. The densities of breeding pairs of waders in both Gurreholm and Ørsted Dal areas were rather high as compared to high Arctic study areas of similar size.

From our present knowledge of the mining constructions and activities inside the Ramsar site Heden and from a literature based ‘median avoidance distance’ of 300 m from human activities and structures, we have calculated the number of breeding pairs of each species that potentially will be displaced by the mining activities. Similarly, for breeding geese we have used a 1500 m avoidance distance. The numbers of birds displaced will always level off with increasing distance form a disturbance. Hence, the median avoidance distance from the different disturbances created by the mining activities is regarded as the distance where as many birds are displaced outside this distance as will remain inside the distance. Furthermore, we have chosen a precautionary principle, meaning that disturbances hardly will be more extensive than anticipated. However, this is on the precondition that a total ban on dogs is implemented at Gurreholm, and that no human access to areas outside roads etc. is allowed.

On the basis of the calculated numbers of potentially displaced breeding pairs at Heden and the number of breeding pairs calculated for the entire Ørsted Dal replacement area, we conclude that the replacement area fully can give protection under the Ramsar Convention to the number of breeding pairs that potentially can be displaced from the Ramsar site, as long as the species are found breeding in both areas.

However, nine species were found breeding only in the Gurreholm area. The total number of pairs of these species potentially affected by the mining activities was calculated to c. 50 with 2-10 pairs per species. This number seems low, but three of the species, Sabine’s gull, whimbrel and Eurasian golden plover *Pluvialis apricaria*, are considered near-threatened in Greenland and Jameson Land is the only known breeding area in Greenland for the latter two species.

Besides having no mining activities inside the Ramsar site, the impacts could be minimized by reducing the affected area as much as possible. Since the airstrip and belonging constructions and flight corridors are situated most easterly of the activities, it would reduce the impact, if these activities are moved as far west as possible or north of the Ramsar site. As mentioned, effects can also be reduced by avoiding any access to the Ramsar site outside the port, the airstrip area and the roads including a ban on dogs.

Sammenfatning

I denne rapport beskrives to ynglefugleundersøgelser, der blev udført i juni 2009 i to forskellige områder i Jameson Land i Østgrønland (Fig. 1) i forbindelse med planlagte mineaktiviteter. Formålet med undersøgelserne var at opbygge en baggrundsviden om tætheder og udbredelse af ynglefugle i Gurreholmområdet i den nordvestlige del af Ramsarområdet Heden og i Ørsted Dal-området i det foreslåede Ramsar erstatningsområde for de forventede forstyrrelser ved Gurreholm.

På baggrund af undersøgelsernes resultater vurderede vi de sandsynlige konsekvenser af forstyrrelser af arter og antal af ynglefugle i Gurreholmområdet som følge af planlagte mineaktiviteter. Desuden undersøgte vi, om det foreslåede erstatningsområde kan give et tilsvarende antal arter og ynglepar beskyttelse under Ramsarkonventionen.

I slutningen af 2008 fik mineselskabet Quadra Mining Ltd. en udvindingstilladelse i området til en stor forekomst af molybdæn i Malmbjerget, der ligger ca. 75 km nord for Ramsarområdet (Fig. 1). Men for at kunne transportere molybdænkoncentatet ud af området har mineselskabet planlagt at bygge en havn, en vej mod nord til minen og en ca. 2 km lang landingsbane i Gurreholmområdet i den nordvestlige del af Ramsarområdet. Grønlands Selvstyre har i dialog med Ramsarsekretariatet meddelt, at mineprojektet er af "vital national interesse", således at projektet kan fortsætte, forudsat at påvirkningerne af mineaktiviteterne moniteres, og at der udpeges et passende erstatningsområde inden minestart.

Ramsarområdet Heden ligger i højarktisk Østgrønland (centrum 71º00'N; 24º00'W) og omfatter 2524 km² af lavlandstundraen i Jameson Land. Heden blev udpeget som Ramsarområde i 1988 bl.a. for at beskytte de internationalt vigtige bestande af fældende kortnæbbede gæs *Anser brachyrhynchus* og bramgæs *Branta leucopsis*. I udpegningsgrundlaget indgik desuden andre ynglefugle som lommer, kjover og vadefugle, samt relativt sjældne ynglefugle som sabinemåge *Larus sabini* og lille regnspove *Numenius phaeopus*.

Undersøgelserne blev udført i den optimale periode for optælling af ynglepar i højarktisk Grønland, hvorfor resultaterne angiver et realistisk antal ynglepar det pågældende år. Snesmeltningen var tidlig dette år, hvilket betyder, at ynglefugletæthederne ikke var reducerede pga. ufavorable forhold. Sammenlignet med andre højarktiske studieområder af tilsvarende størrelse, hvor vadefugletæthederne er blevet bestemt, var tæthederne ganske høje i både Gurreholm- og Ørsted Dal-områderne.

På grundlag af den nuværende viden om mineaktiviteterne i Ramsarområdet Heden og en forstyrrelsesafstand på 300 m, fastsat ud fra litteraturstudier, har vi beregnet antallet af ynglepar, der potentielt kan blive fordrevet af mineaktiviteterne. Forstyrrelsesafstanden for ynglende gæs blev tilsvarende sat til 1500 m. Antallet af fugle, der bliver fordrevet af forstyrrelser, vil altid aftage gradvist med afstanden til forstyrrelsen. Vi har derfor valgt afstande, hvor lige så mange fugle bliver fordrevet udenfor den valgte afstand, som der vil forblive og reproducere sig indenfor denne afstand. Vi har tillige valgt et forsigtighedsprincip, hvilket betyder, at forstyrrelserne med stor sandsynlighed ikke vil være større end angivet. Dette er imidlertid under forudsætning af, at der ikke holdes hunde ved Gurreholm, og at menneskelig færdsel ikke bliver tilladt udenfor veje og andre anlæg.

Endvidere har vi beregnet antallet af ynglepar i Ramsar erstatningsområdet Ørsted Dal. På baggrund heraf kan vi konkludere, at erstatningsområdet fuldt ud kan give beskyttelse under Ramsar-konventionen til det antal ynglepar der potentielt bliver påvirket af mineaktiviteterne, så længe arterne findes både i Gurreholmområdet og i Ørsted Dal-området.

Imidlertid er der ni arter der kun er fundet ynglende i Gurreholmområdet. Samlet set drejer det sig om ca. 50 ynglepar med 2-10 par pr. art, der kan blive påvirket af aktiviteterne. Dette antal synes ikke højt, men det er vigtigt at bemærke, at tre af disse ni arter, nemlig sabinemåge, lille regnspove og hjejle *Pluvialis apricaria*, er vurderede som "næsten truet" i Grønlands rødliste. Endvidere er Jameson Land det eneste kendte yngleområde i Grønland for lille regnspove og hjejle.

Bortset fra helt at undgå mineaktiviteter i Ramsarområdet vil effekterne på ynglefuglene kunne minimeres ved at gøre det påvirkede areal så lille som muligt. Dette kunne opnås ved at flytte landingsbanen med tilhørende bygninger enten så langt mod vest som muligt eller ud af Ramsarområdet mod nord. Påvirkningerne indenfor Ramsarområdet kan som nævnt også minimeres ved at undgå adgang af enhver art udenfor havne- og lufthavnsområderne samt vejene inklusive et forbud mod hunde i området.

Photo 1. Red phalarope female feeding shortly after arrival on the breeding ground.

Eqikkaaneq

Nalunaarusiami uani timmissanik piaqqiortunik marlunnik Tunumi Jameson Landimi sumiiffinni assigiinngitsuni marlunni misissuinerit aatsitassarsiornissamik pilersaarutinut atatillugu 2009-mi junimi ingerlanneqartut nassuiarneqassapput. Misissuinerit Gurreholmimi Ramsareqarfiup Heden-ip avannamut kitaani Ørsteds Dal-imilu Guureholmimi akornusersuilernissanut ilimagisanut taarsiullugu Ramsareqarfissatut siunnersuutigineqartumi timmissat piaqqiortut qanoq eqimatiginerinut siaruarsimanerinullu tunngatillugu paasisimasaqarnermik pilersitsinissaq siunertaraat.

Misissuinerit inerneri tunuliaqutaralugit timmissanut sunut piaqqiortullu amerlassusiinut Gurreholmimi aatsitassarsiornertigut pilersaarutaasutigut akornusersuinerussangatitat kingunerisinnaasaat nalilersorpagut. Misissorparputtaaq timmissanik assigiinngitsunik piaqqiortunillu Ramsareqarfikkut illersuiffimmut taartissatut siunnersuutigineqartoq taamaaqataanik illersuiffiusinnaanersoq.

2008-p naalernerani aatsitassarsioqatigiit Quadra Mining Ltd. Malmbjergimi molybdæneqarferujussuarmi, Ramsareqarfimmiit 75 km missiliorlugit avannarpasinnerusumi iluaquteqarnissamut akuerineqarpoq (Fig. 1). Molydænilu piiagaq aallarussorneqarsinnaaqqullugu aatsitassarsioqatigiiffik umiarsualiviliorniarluni, avannamut piiaaviup tungaanut aqqusinniorniarluni Gurreholmimillu Ramsareqarfiup avannamut kippasinnerusortaani, 2 km missaanik takissusilimmik mittarfiliorniarluni pilersaaruteqarpoq. Namminersorlutik Oqartussat Ramsareqarnermut allaffeqarfiup oqaloqatiginerani nalunaarpoq aatsitassarsiornissaq "nunamut tamarmut soqutiginarluinnarmat" pilersaarut ingerlaqqissasoq aatsitassarsiornikkut ingerlatat sunniutissaat misissorneqarsimappata aammalu taartaasussamik naleqquttumik aatsitassarsiorneq aallartitsinnagu toqqaasoqarsimappat.

Ramsareqarfik Heden Tunup avannaarsuaniippoq (qeqqa 71°00'N; 24°00'W) Jameson Landimi narsaamanersuarmiilluni masarsoqarfiulluni qeriuaannartumi 2524 km² annertussuseqarluni. Heden 1988-imi Ramsareqarfissatut toqqarneqarpoq ilaatigut nerlerit siggukitsut *Anser brachyrhynchus* nerlernallu *Branta leucopsis* nunanut assigiinngitsunut pingaarutillit tamaani isasartut pissutigalugit. Toqqaanissamut toqqammavissamut ilaapputtaaq timmissat allat erniortartut, appat, isunngat naloraarusillillu aammalu timmissat qaqutigoornerusut, soorlu sabinemåge *Larus sabini* regnspovelu mikisoq *Numenius phaeopus*.

Misissuinerit Kalaallit Nunaata issittorsuartaani erniortut aappariikkuutaat kisikkuminarseruttorneranni ingerlanneqarput, taamaattumillu angusat tutsuiginartumik ukioq taanna aappaariikkuutaanik kisitanik pissarsivigineqarput. Ukioq taanna aput piaartumik aattorpoq taamaattumillu piaqqiortut akulikissusiat pissutsinit akornutaasinnaasunit akornusersorneqarnani. Issittorsuarmi misissuiffinnut allanut taamatut angissusilinnut naloraarusillit akulikissusiannik naliliiffiusimasunut saniliullugu akulikissuseq Guureholmimi Ørsted Dalimilu annertoqaaq.

Ramsareqarfimmut Hedenimut tunngatillugu ullumikkut ilisimasat tunngavigalugit akornusersuilersarnerullu 300 m atuakkanik misissuinerit tunngavigalugit ungasissusilerneratigut aappariit piaqqiortut, aatsitassarsiornermit qimaatinneqarsinnaasut amerlassusiat naatsorsorsimavarput. Nerlerit akornusersorneqalersarnerat aamma taamatut 1500 m ungasissusilersimavarput. Timmissat akornusersuinernit qimaatinneqartut ikiliartortarput akornusersuisoq ungasilliartortillugu. Taamaattumik ungasissutsit aalajangersimavagut timmissat taamatut amerlatigisut ungasissutsip taassuma avataanut nuuffigisinnaasaanni ungasissutsillu taassuma iluani piaqqiorlutik. Mianersuussinissartaaq qinersimavarput, tamannalu pissutigalugu akornusersuinerit ilimagineqartumit annertunerussangatinnanngillat. Aatsaalli taamaassinnaavoq Gurreholmimi qimmeqarnissaa inuillu aqqusernit sanaartukkallu avataanni angalaarnissaat inerteqqutaappata.

Ramsareqarfimmut taartissami Ørsted Dalimi timmissat aappariit piaqqiortut amerlassusissaat aamma naatsorsorsimavarput. Tamanna tunngavigalugu inerniliisinnaavugut taartaasussaq Ramsarimik isumaqatigiissutip illersuineratulli aappariit piaqqiortut aatsitassarsiornikkut akornusersuutinit nujuttitaasut amerlaqataannut illersuutaasinnaalluartoq Gurreholmi Ørsted Dalilu timmissanit taakkunannga najorneqartillugu.

Kisiannili timmissat assigiinngitsut allat qulingiluat aappariikkuutaarlutik Gurreholmiinnarmi piaqqiortartut paasineqarput. Ataatsimut isigalugit tassa aappariit 50-it missingi timmissat assigiit aappariikkuutaat 2-10 amerlassuseqartut ingerlatanit sunnerneqarsinnaasut. Taakkua amerlassusiat ingasagisassaanngikkaluarpormi kisiannili malugineqartariaqarpoq taakua assigiinngisitaartut ilaat pingasut, tassalu sabinemåge, regnspove mikisoq anngilillu *Pluvialis apricaria* Kalaallit Nunaanni aarlerinartorsiortut nalunaarsorsimaffianni "navianartorsiungajalluinnartutut" nalunaaqutaqarmata. Aammalumi Jameson Land tassatuaavoq regnspove mikisup anngillillu ilisimaneqartumik Kalaallit Nunaanni piaqqiorfituaat.

Ramsareqarfimmi aatsitassarsiornikkut ingerlatat pinngitsuuvisinnaanngippata timmissanut piaqqiortunut sunniutai annikillilerneqarsinnaapput nunap sunnerneqartup sapinngisamik minnerpaatinniarneqarneratigut. Tamanna anguneqarsinnaavoq timmisartunut mittarfissap illutassaasalu sapinngisamik kippasinnerpaafigisinnaasaannut, imaluunniit Ramsareqarfiup avataanut avannamut nunneqarneratigut. Ramsareqarfiup iluani sunniutit oqaatigineqartutut millisinneqarsinnaapput umiarsualiuviup, timmisartoqarfiup aqqusernullu avataannut pinissat suugaluartulluunniit pinaveersaartinnerisigut tamaanilu qimmeqarnissamut inerteqquteqarneratigut.

1 Introduction

The present report describes breeding bird studies performed in June 2009 in two different areas of Jameson Land in East Greenland (Fig. 1) in connection with planned mining activities. The purpose of the studies was to establish baseline knowledge of breeding bird densities and distributions in the Gurreholm area in the northwestern part of the Ramsar site Heden and in the Ørsted Dal area proposed as a Ramsar replacement area to compensate for disturbances at Gurreholm (Glahder et al. 2010a, b). On the basis of the derived knowledge it should be possible to evaluate the likely impacts from mining activities on the breeding bird populations in the Gurreholm area and to compare the quality of the proposed Ramsar replacement area with that of Gurreholm.

The reason for initiating these breeding bird studies in June 2009 and studies on numbers and distributions of moulting and breeding geese in July 2008 and 2009 (Boertmann & Nielsen 2010, Glahder et al. 2010a, b) was that the mining company Quadra Mining Ltd. was exploring an ore body in the area and in late 2008 was granted an exploitation license. The license covers primarily the Malmbjerget area about 75 km north of the Ramsar site Heden (Fig. 1). The company plans to exploit a large molybdenum mineralization and develop the northwestern part of Heden (Cessford 2007, Quadra Mining Ltd. 2008). The planned activities at Gurreholm in the Ramsar site (Fig. 1) include the construction of a port, a gravel road and a 2000 m long air strip. Trucks are planned to transport molybdenum concentrate to the port from where ships during the open water period in July-October will transport the molybdenum out of the area. About 100 flights with aircrafts of different sizes are planned to service the area per year. The Greenland Self-Government has claimed the mining project of “urgent national interests”. The Ramsar Convention Secretariat is in dialogue with the Greenland Self-Government and has accepted that the project can proceed provided that the impacts of the activities are monitored and that an appropriate replacement area is found in advance (Salathe 2009).

The Ramsar site Heden in high Arctic East Greenland (centre 71º00’N; 24º00’W) covers 2524 km^2 of the large Jameson Land lowland tundra area (Fig. 1). This is the southernmost lowland area on the generally rugged mountainous east coast of Greenland. It was designated in 1988 primarily to protect internationally important populations of moulting pink-footed geese *Anser brachyrhynchus* and barnacle geese *Branta leucopsis* (Greenland Home Rule 1990, Egevang & Boertmann 2001). At that time the area held 2% of the Iceland/Greenland flyway population of pink-footed geese and 7% of the Greenland flyway population of barnacle geese (Mosbech et al. 1989, Boertmann 1991). Of importance for the designation were also breeding birds like red-throated diver *Gavia stellata*, dunlin *Calidris alpina*, ruddy turnstone *Arenaria interpres*, long-tailed skua *Stercorarius longicaudus*, Arctic skua *Stercorarius parasiticus*, red phalarope *Phalaropus fulicarius* and red-necked phalarope *Phalaropus lobatus* together with uncommon breeding birds like Sabine’s gull *Larus sabini* and whimbrel *Numenius phaeopus*.

Besides these breeding bird studies, biological surveys performed during July 2008 by the National Environmental Research Institute (NERI), Denmark, covered the Ramsar site and other areas in Jameson Land (Glahder et al. 2010a, b). On the basis of different disturbance scenarios the number of possibly impacted geese and other bird species were assessed and a larger area around the Ørsted Dal was suggested as a replacement area. The present studies that were performed by NERI during June 2009 are supplementary to the 2008 studies. The results of the 2009 studies carried out in the Gurreholm area (Glahder & Walsh 2010) and in Ørsted Dal (Meltofte & Dinesen 2010) are presented in the two scientific papers attached to the present report. The report gives an overview of the breeding bird studies, presents in detail the distribution of all breeding species in four different study areas in the Gurreholm and Ørsted Dal areas, respectively, and assesses the likely disturbance effects of the mining activities.

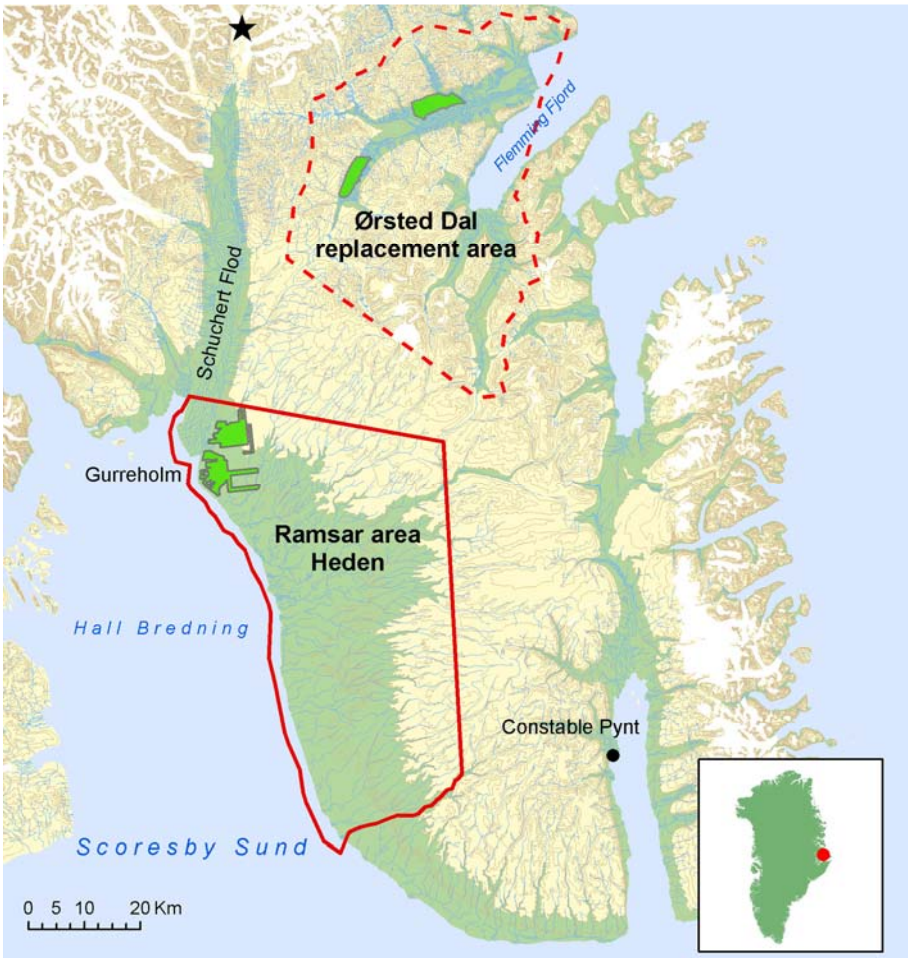

Figure 1. The four breeding bird study areas (bright green) at Gurreholm and in Ørsted Dal, Jameson Land. The Ramsar site Heden is shown together with the proposed Ramsar replacement area Ørsted Dal. Gurreholm is the area where the mining company plans to construct a port, roads and an airstrip; a road is planned to run up along the river Schuchert Flod to the mine (star).

2 Study areas

The Gurreholm area

The Gurreholm study area in the northwestern part of Jameson Land is a lowland area delimited to the west by Hall Bredning in Scoresby Sund (Fig. 1). In the northwestern part of the area a huge silty delta area is formed at the mouth of the 3-4 km wide Schuchert Flod. To the north and east the area gradually rises to drier areas. The study area can in general be classified as a wetland area with a high number of smaller and larger lakes and ponds, many marshes and smaller and larger rivers that drain the area. Mosses, cotton grasses *Eriophorum* spp., sedges *Carex* spp. and flowering plants dominate the wet areas along lakes and rivers and in the marsh areas. On higher ground in-between the wetlands the vegetation is dominated by dwarf scrub heath with species like Arctic blueberry *Vaccinium uliginosum*, Arctic bell-heather *Cassiope tetragona* and Arctic willow *Salix arctica*. The two study areas, Gurreholm South and Gurreholm North (Fig. 1, Appendix 1 (Fig. 2)) were chosen to cover as much as possible of the nortwestern corner of the Ramsar site Heden, which possibly could be affected by future mineral activities. The southern study area is more coastal than the northern, contains more wetland areas and is in general low-lying.

The Ørsted Dal area

Ørsted Dal is situated in the northeastern part of Jameson Land as the largest valley extending about 45 km towards southwest from Fleming Fjord (Fig. 1). The valley floor including lower slopes below 200 m a.s.l. is 4-7 km wide. Most of the valley floor has a relatively level or undulating terrain with more landscape profile of up to c. 20 m at moraines, raised delta terraces and river ravines. At the foot of the steep mountain bluffs surrounding most of the valley, scree slopes dominate together with extensive gravely and stony outwash fans from the many tributary rivers and rivulets.

Two study areas in the valley were selected from satellite images to represent different patterns of wet and dry tundra, one of 17.0 km^2 in the upper valley and one of 23.0 km^2 in the central part of the valley, the latter largely being the same as the area studied in 1974 (Green & Greenwood 1978). Both were demarcated by the main river to the south, by tributary rivulets to the east and west and by the 200 m contour to the north. The upper area had much wet fen vegetation together with large and small ponds. The central area had more mesic tundra and dry, almost barren lands. Yet, wet fens with ponds were found also here, particularly in areas irrigated well into the summer season by runoff from large snow-beds and ice-fields. The general habitat patterns of the valley were mapped by Ferns & Mudge (1976) and given in more detail for the central study area by Green & Greenwood (1978).

3 Methods

The two main areas, Gurreholm and Ørsted Dal, with a total of four study areas were censused during the same period and with the use of, in general, the same methods. The two teams, each of two persons, were transported by a Bell 222 helicopter from Constable Pynt (Jameson Land east) to the first camp site on 11 June, transferred by helicopter on 19 June to the second camp site and finally returned to Constable Pynt on 26 June.

The field method of our censuses was the "rapid assessment" described by Boertmann et al. (1991) and Meltofte et al. (2009). The aim of this method is to map all territories based on territorial behaviour performed by pairs and individuals during the early part of the breeding, i.e. before most of the waders are incubating. Meltofte (2001) recommends 12-20 June as the optimal period in high Arctic Greenland for a census with focus on waders. Besides geese, we found few nests, but judged from a few incomplete as well as complete clutches and the relatively late flowering and invertebrate emergence – the latter of decisive importance for initiation of egg-laying in waders (Meltofte et al. 2007) – we estimate that our timing approximated the ideal timing fairly closely. Furthermore, it was ideal for censusing geese, since all were incubating and easy to record.

We traversed the study areas in parallel transect lines that covered 100 m on each side of the observer and with a distance of c. 200 m between us. These transect lines were followed using GPS (Garmin Etrex & GPS Map 60CSX, UTM 27) and satellite images. We used small VHF radios to coordinate our coverage and to avoid double counts. Observations were verified by binoculars (Leica & Zeiss 10x42 magnifications and Swarovski 8.5x42).

All birds and other relevant observations were recorded on field maps (1:26,300) with 1000 m UTM grid lines and on tape, and later each day or early next day observations from each observer were merged onto a final map. According to the method, all pairs as well as single individuals uttering song, alarm calls or other indicative behaviour are considered as belonging to the local population, i.e. representing a pair/territory (Meltofte et al. 2009). Silent individuals are considered as uncertain pairs/territories, while overflying individuals are neglected. Pink-footed goose and barnacle goose ‘territories’ were in most cases determined by nest observations. Besides incubating female geese, territories were easily detected by observation of the vigilant gander. Observations of mammals and fox dens were also registered.

In total, the Gurreholm South area was covered in 104 man-hours, Gurreholm North in 90 man-hours, the Ørsted Dal upper area in 52 man-hours and the Ørsted Dal central area in 47 man-hours.

The total wader densities from 42 high Arctic study areas, including the present Gurreholm and Ørsted Dal study areas, were statistically analysed for the relationship between size of the study area and the study period. Study areas of less than 12 km^2 were grouped as “small”, larger areas as "large". Studies performed before 1 July were grouped as "early", while "late" studies were performed after 1 July. Density data was log-transformed to fulfil the assumptions for parametric tests of normality (Shapiro-Wilk normality test, $P>0.05$) and homogeneity of variances (Bartlett test, $P>0.05$). The relationship between area and period was tested by a 2-way analyses of variance (ANOVA).

Photo 2. A large wetland tundra is crossed in the Gurreholm area during the breeding bird census. The two observers walked in parallel transect lines 200 m apart and coordinated the coverage through VHF radios.

4 Results

4.1 The Gurreholm study areas

In total 26 bird species were recorded as breeding or possible breeding in the two study areas. The two areas were not different in breeding species diversity with 23 species in the southern area and 24 in the northern (Table 1). Densities (territories/km^2) of breeding waders in the southern area seemed higher (6.77-8.20) than in the northern area (5.71-6.43), and this was mainly due to a higher density of sanderling *Calidris alba* (1.14-1.29) and red phalarope (0.21-0.38) in the southern area (Table 1). Among other bird species than waders the southern area had higher densities of pink-footed goose (4.78-5.21), barnacle goose (0.79) and Sabine's gull (0.35-0.47), whereas Lapland bunting *Calcarius lapponicus* was recorded only in the northern area with a density of 0.48-0.62 territories/km^2. In the same study area the snow bunting *Plectophenax nivalis* density (6.60-6.88) was twice the density of the species in the southern area.

4.2 The Ørsted Dal study areas

The total number of breeding or possible breeding bird species was 15 in Ørsted Dal. In the Upper Valley 13 bird species and in the Central Valley 12 bird species held territories. Among these, five species were registered with only one or two territories in Ørsted Dal: northern pintail *Anas acuta* and rock ptarmigan *Lagopus mutus* were registered with one territory each and red-necked phalarope with two territories in the Upper Valley, while red-throated diver and king eider *Somateria spectabilis* both held one territory in the Central Valley (Table 2). Densities of breeding waders in the Upper Valley was higher (8.5-9.2 territories/km^2 for all species taken together) than in the Central Valley (5.2-5.8). This was mainly due to a much higher density of dunlin in the Upper Valley (Table 2). Among other bird species than waders, the Upper Valley had higher densities of long-tailed duck *Clangula hyemalis* (1.0-1.4), long-tailed skua (1.0-1.5) and snow bunting (1.2-1.7), while pink-footed goose and sanderling had higher densities in the Central Valley (3.7).

4.3 Comparison with other areas

The densities of wader territories in 42 high Arctic study areas, including our four study areas, were tested for relationships between size of the study area and the study period. Because the interaction effect was not significant (F=1.25, p=0.27) the ANOVA was re-run without this term. The ANOVA then showed that densities in the smaller areas were significantly higher than those of larger areas ($F_{1,39}$=12.4, p=0.002) and densities in earlier periods were significantly higher than in later periods ($F_{1,39}$=5.27, p=0.03) (Appendix 1, Fig. 3).

Table 1. Breeding bird numbers and densities (territories/km^2) in the two study areas at Gurreholm South and Gurreholm North, respectively, in 2009. Densities are not calculated where only uncertain territories were registered.

Species	**Gurreholm South** Area 34.13 km^2		**Gurreholm North** Area 29.09 km^2	
	Number	**Density**	**Number**	**Density**
Common ringed plover *Charadrius hiaticula*	7-10	0.21-0.29	1-2	0.03-0.07
Eurasian golden plover *Pluvialis apricaria*			2	0.07
Red knot *Calidris canutus*	38-49	1.11-1.44	32-33	1.10-1.13
Sanderling *Calidris alba*	39-44	1.14-1.29	4-5	0.14-0.17
Dunlin *Calidris alpina*	101-120	2.96-3.52	105-114	3.61-3.92
Purple sandpiper *Calidris maritima*	0-1			
Ruddy turnstone *Arenaria interpres*	32-36	0.94-1.05	21-23	0.72-0.79
Whimbrel *Numenius phaeopus*	3	0.09	1	0.03
Red phalarope *Phalaropus fulicarius*	7-13	0.21-0.38	0-3	
Red-necked phalarope *Phalaropus lobatus*	4	0.12	0-4	
Waders total	231-280	6.77-8.20	166-187	5.71-6.43
Red-throated diver *Gavia stellata*	2-5	0.06-0.15	3	0.10
Pink-footed goose *Anser brachyrhynchus*	163-178	4.78-5.21	110	3.78
Barnacle goose *Branta leucopsis*	27	0.79	7	0.24
Northern pintail *Anas acuta*	1-2	0.03-0.06	0-1	
King eider *Somateria spectabilis*	3-7	0.09-0.21	8-11	0.28-0.38
Long-tailed duck *Clangula hyemalis*	20-26	0.59-0.76	17-24	0.58-0.83
Rock ptarmigan *Lagopus mutus*	0-4		0-2	
Long-tailed skua *Stercorarius longicaudus*	9-32	0.26-0.94	18-27	0.62-0.93
Arctic skua *Stercorarius parasiticus*	6-14	0.18-0.41	1-5	0.03-0.17
Sabine's gull *Larus sabini*	12-16	0.35-0.47	0-1	
Arctic tern *Sterna paradisaea*	4-6	0.12-0.18	1	0.03
Raven *Corvus corax*	1-2	0.03-0.06	0-1	
Northern wheatear *Oenanthe oenanthe*			3	0.10
Common/Arctic redpoll *Carduelis flammea/C. hornemanni*	1-2	0.03-0.06		
Lapland bunting *Calcarius lapponicus*			14-18	0.48-0.62
Snow bunting *Plectophenax nivalis*	87-98	2.55-2.87	192-200	6.60-6.88

Table 2. Breding bird numbers and densities (territories/km^2) in the two study areas in Upper and Central Ørsted Dal, respectively, in 2009, together with the results from the Central Valley in 1974 (moderated from Green & Greenwood 1978 to better fit our delimitation of the central area).

Site	**Upper Valley 2009**		**Central Valley 2009**		**Central Valley 1974**	
Area (km^2)		17.0		23.0		21.2
	Number	**Density**	**Number**	**Density**	**Number**	**Density**
Red-throated diver *Gavia stellata*			1	+		
Pink-footed goose *Anser brachyrhynchus*	27	1.6	84	3.7		
Barnacle goose *Branta leucopsis*	8	0.5	7	0.3	+	+
Northern pintail *Anas acuta*	1	+				
King eider *Somateria spectabilis*			1	+		
Long-tailed duck *Clangula hyemalis*	17-23	1.0-1.4	2	0.1	1	+
Rock ptarmigan *Lagopus mutus*	1	+				
Common ringed plover *Charadrius hiaticula*	22-29	1.3-1.7	28-30	1.2-1.3	6	0.3
Red knot *Calidris canutus*	6	0.4	6-7	0.3	5	0.2
Sanderling *Calidris alba*	14-16	0.8-0.9	35-40	1.5-1.7	11	0.5
Dunlin *Calidris alpina*	88-94	5.2-5.5	39-44	1.7-1.9	11	0.5
Ruddy turnstone *Arenaria interpres*	13-15	0.8-0.9	12-13	0.5-0.6	26	1.2
Red-necked phalarope *Phalaropus lobatus*	2	0.1			2-3	0.1
Long-tailed skua *Stercorarius longicaudus*	17-25	1.0-1.5	9-18	0.4-0.8	+	+
Snow bunting *Plectophenax nivalis*	20-29	1.2-1.7	7-9	0.3-0.4	+	+
Waders total	145-162	8.5-9.2	120-134	5.2-5.8	61-62	2.9

5 Breeding bird disturbance distances

The numbers of birds displaced from a source of disturbance will always level off with increasing distance form a disturbance. Hence, we here aim for a delineation of the 'median avoidance distance' from the different disturbances created by the mining activities, i.e. birds refraining from establishing themselves upon arrival in spring in the area exposed to humen disturbance. This definition is regarded as the distance where as many birds avoid the area outside this defined distance as those remaining within the defined distance. This is equal to all birds being diplaced from inside the distance and none outside. Furthermore, we have chosen a precautionary principle, meaning that disturbances hardly will be more extensive than anticipated here. Finally, we have not calculated with the possibility that the birds will habituate to the disturbances resulting in reduced effects of the disturbances over time, but we note that this may take place under the precondition that no dogs are allowed at Gurreholm.

According to the plans for the development of a molybdenum mine in the Malbjerget area north of Jameson Land (Fig. 1) disturbances from aircraft, trucks, other vehicles, ships and persons can be expected in the Gurreholm area inside the Ramsar site Heden. The effects of these disturbances on moulting and breeding geese have been discussed in Glahder et al. (2010a, b). From studies on disturbance reactions of moulting pink-footed geese and barnacle geese to helicopters (Mosbech et al. 1989, Mosbech & Glahder 1991) it was anticipated that moulting geese would avoid areas that were closer than 5-10 km from the disturbances. Studies on the effects of disturbances from approaching humans on incubating pink-footed geese and family flocks of this species (Sigurdsson 1974, de Korte 1988, Mosbech et al. 1989, Mosbech & Glahder 1990, Madsen et al. 2009) indicated that breeding pink-footed geese largely would avoid areas closer than 1.5 km from disturbances.

5.1 Related breeding bird species in disturbance studies

Here we focus on the effects of human disturbanes on breeding birds, especially waders. Included are also studies on breeding terns, skimmers (related to gulls) and ducks. The studies are summarized in Appendix 5, where disturbance distances and types, species involved and remarks on breeding period etc. are given for each reference.

Most studies involve approaching persons with or without a dog, whereas fewer studies have described effects of all terrain vehicles (ATVs), 4WD cars, road traffic, canoes, boats and a pumping station. Most studied species are plovers (*Pluvialis apricaria*, *Charadrius alexandrinus, C. hiaticula, C. marginatus, C. obscurus* and *Thinornis rubricollis*), oystercatchers (*Haematopus bachmani, H. palliates* and *H. ostralegus*). Other species involve dunlin, northern and southern lapwing *Vanellus vanellus* and *V. chilensis*, black-tailed godwit *Limosa limosa*, least tern *Sterna antillarum*, black skimmer *Rhynchops niger*, northern shoveler *Anas clypeata*, tufted duck *Aythya fuligula* and greater scaup *Aythya marila* (Einarsson &

Magnúsdóttir 1993, Rodgers & Smith 1995, Reijnen et al. 1996, Lord et al. 1997, Ruhlen et al. 2003, Fernández-Juricic et al. 2005, Finney et al. 2005, Lafferty et al. 2006, McGowan & Simons 2006, Morse et al. 2006, Baudains & Lloyd 2007, Liley & Sutherland 2007, Pearce-Higgins et al. 2007, Weston & Elgar 2007, Sabine et al. 2008, Holm & Laursen 2009).

Eurasian golden plovers breed on tundra habitats similar to the breeding habitat of most waders studied in Jameson Land, whereas oystercatchers and the small plovers breed on sandy beaches and shorelines; these habitats are different from the tundra habitat, but they are similar to habitats in Jameson Land such as stony beaches, mud flats and barren grounds where e.g. the common ringed plover *Charadrius hiaticula* breeds. Dunlin is a common breeder in moist areas in Jameson Land, while wimbrel is an uncommon breeder in fens on the Jameson Land tundra heath. The genera *Vanellus* and *Limosa* are not found breeding in Greenland; they occupy open breeding habitats of meadows, salt marshes and more or less moist grasslands not very different from open habitats in Jameson Land. Least tern and black skimmer are not breeding in Greenland either, but they are representatives of the family *Laridae* to which also Arctic tern and Sabine's gull belong. All these larids are breeding in colonies in open habitats like beaches, vegetated islets, salt marshes and coastal tundra. To this group we include the Arctic and long-tailed skuas. The duck genera *Anas* and *Aythya* are representatives of the duck species found breeding in Jameson Land: northern pintail, king eider and long-tailed duck.

5.2 Disturbance distances

Some of the above cited papers have focused directly on the relationship between disturbance distances and effects (Rodgers & Smith 1995, Reijnen et al. 1996, Fernández-Juricic et al. 2005, Finney et al. 2005, Baudains & Lloyd 2007, Pearce-Higgins et al. 2007, Weston & Elgar 2007, Sabine et al. 2008, Holm & Laursen 2009). The disturbance distance is the distance from the disturbing source to the bird reacting on a specified effect. Such effects were: breeding birds leaving the nests, birds being alert and fleeing late in the breeding season, redistribution of adults and chicks away from the disturbance source, reduced reproductive success and reduced densities of territories or nests.

Disturbances come in most of these studies from walking persons that approach directly towards the nests or birds, pass tangentially in a certain perpendicular distance or walk on paths. In two of the studies the persons were accompanied by dogs and often these were unleashed (Baudains & Lloyd 2007, Weston & Elgar 2007). In two other studies canoes, boats and all terrain vehicles were also part of the study (Rodgers & Smith 1995, Sabine et al. 2008). One study evaluated the disturbance distances from traffic with varying car density (Reijnen et al. 1996).

Disturbance distances from the above cited studies varied between 45 and 277 m with most being between 100 and 277 m. Distances are given as mean or median values, but also as a *set-back distance*, which includes a buffer and is calculated as mean up-flight distance + 1.6495 SD (Standard Deviation) + 40 m (Rodgers & Smith 1995). The latter distance involves the *Sterna* and *Rynchops* genera. Distances from traffic were calculated on the basis of threshold values of noise load in dB(A) (Reijnen et al. 1996). In that study, densities of breeding Eurasian oystercatchers were affected at a disturbance distance of up to 1700 m from roads with medium traffic (5000 cars/day), which was much larger than observed in the other bird species studied (65-230 m).

The remainder studies have focused on a more general disturbance effect on breeding birds e.g. the number of people visiting a beach area during weekdays and weekends and the distribution of nests or survival of nests and chicks. Other effects involve breeding or not breeding, feeding behaviour of chicks, incubation behaviour and periods and diving distance from a pumping station. Most of these studies involve beaches used by walking humans with or without dogs, cars and all terrain vehicles or shorelines visited by kayakers who often camp on the beach. On some of the beaches the nesting areas are roped, so that people can not pass, or they can pass only in the wet zone near the sea. Beach widths were not given explicitly, but we could derive it from the papers or alternatively from Google maps; since such calculated distances would be perpendicular, they should be regarded as minimum distances. They varied between 17 and 200 m, with most around 50 to 100 m. In the study on feeding *Aythya* species, very few dives were observed within about 550 m of the pumping station (Einarsson & Magnúsdóttir 1993).

5.3 The chosen disturbance distance

According to the above studies on disturbance distances most mean or median distances varied between 100 and 300 m. Many of the studies focused on fleeing or nest leaving distances, while few also included alert reactions (Rodgers & Smith 1995, Fernández-Juricic et al. 2005). In the two latter studies alert distances were larger than flushing distances, as would be expected. These findings were incorporated in the minimum approaching distances (MAD) (Fernández-Juricic et al. 2005) or the setback distances (Rodgers & Smith 1995). In some of the studies of Reijnen et al. (1996), Finney et al. (2005), Pearce-Higgins et al. (2007), Sabine et al. (2008) and Holm & Laursen (2009), where disturbance distances were calculated as mean or median values, variations were given in maximum distances (319 m) and upper 90% confidence limits (560 m). In the study of Holm & Laursen (2009) one person that walked the same path seven times per day implied a c. 50% reduction in the density of black-tailed godwit territories within 200 m and c. 15% reduction within 300 m. In addition, duration of simultaneous flights by both birds of breeding pairs was greater when disturbed, leaving nests susceptible to predation, and no indication of habituation to human disturbance was found. The study period began before birds arrived on the breeding grounds. For the Eurasian oystercatcher the mean disturbance distance was 1700 m at medium traffic density (Reijnen et al. 1996). At this traffic density a 10-20% reduction in nest density of relevant species (Eurasian oystercatcher not included) was found inside a 0-500 m zone adjacent to the roads.

On the basis of the above studies, and especially the two studies on density reductions by Reijnen et al. (1996) and Holm & Laursen (2009), we have chosen a median avoidance distance of 300 m that covers waders, ducks, divers, gulls, terns and skuas. Despite variations in breeding species, disturbance sources, disturbance effects and study designs, the disturbance distances presented in the references are not that different.

Species like rock ptarmigan and passerines like northern wheatear *Oenanthe oenanthe*, snow bunting and Lapland bunting are not taken into account in this report, because disturbance distances are regarded small, e.g. for passerines 10-50 m (maximum 100 m) according to Reijnen et al. (1996) and Fernández-Juricic et al. (2005).

Photo 3. Goslings of pink-footed goose hatched on 22 June 2009 at Gurreholm.

6 Discussion

The birds that can be expected to be displaced by the mining activities at Gurreholm in the Heden Ramsar site will either go to another place or – if the habitats are already saturated – the populations will be reduced accordingly. Hence, the concept of a Ramsar replacement area is not that the birds will move from the disturbed area to the replacement area, but that similar species and numbers are given protection under the convention.

Hence, the aim of the studies in Jameson Land, East Greenland, in June 2009 was to assess the impact on the breeding bird populations in the area affected by mining activities and to evaluate, whether the proposed Ramsar replacement area would be able to give protection to similar species and numbers that are likely to be displaced from the impacted area.

To achieve this aim it is necessary to know: (1) which species are breeding in which densities in representative areas of the impacted area and the replacement area, (2) how many breeding birds are affected by the mining activities and (3) if the replacement area can protect a similar number of species and numbers that have been affected?

6.1 Species and densities in the Gurreholm and Ørsted Dal areas

The studies conducted in the Gurrehom area in the northwestern part of the Heden Ramsar site covered a large proportion of the area that can be affected by the planned mining activities (Fig. 1 & 2). The study period in the Gurreholm area was the optimal period in high Arctic Greenland to perform a breeding bird census. The observed breeding species and their densities (Table 1) are therefore regarded as representative for the possibly impacted area, at least for the year of study.

The studies performed in the Ørsted Dal area in the proposed Ramsar replacement area covered about 15% of the most important breeding areas in the Ørsted Dal area, which are the Ørsted Dal valley itself of about 300 km^2 (Fig. 1). The study period in the Ørsted Dal area was identical to the Gurrehom area study period and was likewise the optimal period to perform a breeding bird census. The observed breeding species and their densities (Table 2) are therefore regarded as representative for the replacement area, at least for the year of study.

A comparison with densities in other high Arctic census areas in the Nearctic showed that total wader densities both at Gurreholm and in Ørsted Dal were high, even when limiting the comparison to areas censused at the optimal time in June. Yet, they were not as high as densities found in optimal habitat in central Northeast Greenland such as Zackenberg (Glahder & Walsh 2010).

6.2 Breeding pairs affected in the Gurreholm area

Most breeding species in the studied areas were waders, ducks, geese, terns, gulls, skuas and passerines. Breeding and moulting geese have been dealt with by Glahder et al. (2010a, b), where a 1500 m avoidance distance was found for breeding geese. Passerines are regarded little sensitive to disturbancees compared to the above bird groups and therefore not included in detail in the present report. In the literature we have found relevant disturbance studies on breeding waders, ducks and terns and from these studies we have derived a median avoidance distance of 300 m.

Disturbances in the literature studies come from a broad variety of sources like walking persons with or without dogs, cars, all terrain vehicles, traffic, canoes, kayaks, boats and a pumping station. The expected disturbances from the possible mining activities show some similarities, but also marked differences; in the area we expect disturbances from cars, other vehicles and persons as covered by the literature, but also from aircraft, trucks and ships, which are disturbances not covered by the literature studies. Without studies of the effect of the latter disturbance sources on breeding birds it is not possible to assess whether disturbance distances will be larger or smaller than the chosen distance.

Also, the different literature studies focused on a variety of disturbance effects, but most of these effects could impact on the breeding success. The effects can be summarised in the following: breeding birds leaving the nests, birds being alert and fleeing late in the breeding season, redistribution of adults and chicks away from the disturbance source, feeding behaviour of chicks, reduced reproductive success and reduced densities of territories or nests. The two latter effects have a clear impact on breeding success of the local population, but also birds leaving the nests more often and for longer periods will expose the clutch to predators and thereby reduce the reproductive output of the breeding birds. Chick survival can be affected where feeding chicks are displaced from optimal feeding grounds.

Finally, some of the studies have introduced disturbances after the birds have established their nests, while others have studied the birds where the disturbance sources, like a foot path or a road, were well established. It could be expected that birds disturbed before they have established a territory would be more susceptible than birds already nesting, but we have no evidence for this assumption.

The 300 m median avoidance distance chosen is thought to be a conservative choice mainly due to the uncertainties in the effects of disturbances from different aircrafts, trucks and ships. Hence, we have used a precautionary principle in defining the disturbance distance. However, this is on the preconditions that a total ban on dogs is implemented at Gurreholm and that no human access outside roads etc. is allowed. Similarly, no food must be made available on dumps or anywhere else that can attract foxes and thereby increase to predation pressure on the bird populations.

With our present knowledge of the mining constructions and activities inside the Ramsar site Heden we have prepared Fig. 2, which includes a 300 m median avoidance zone around these constructions. Flight corridors in connection to the airstrip have been included, but these may cover a larger area than shown on Fig. 2.

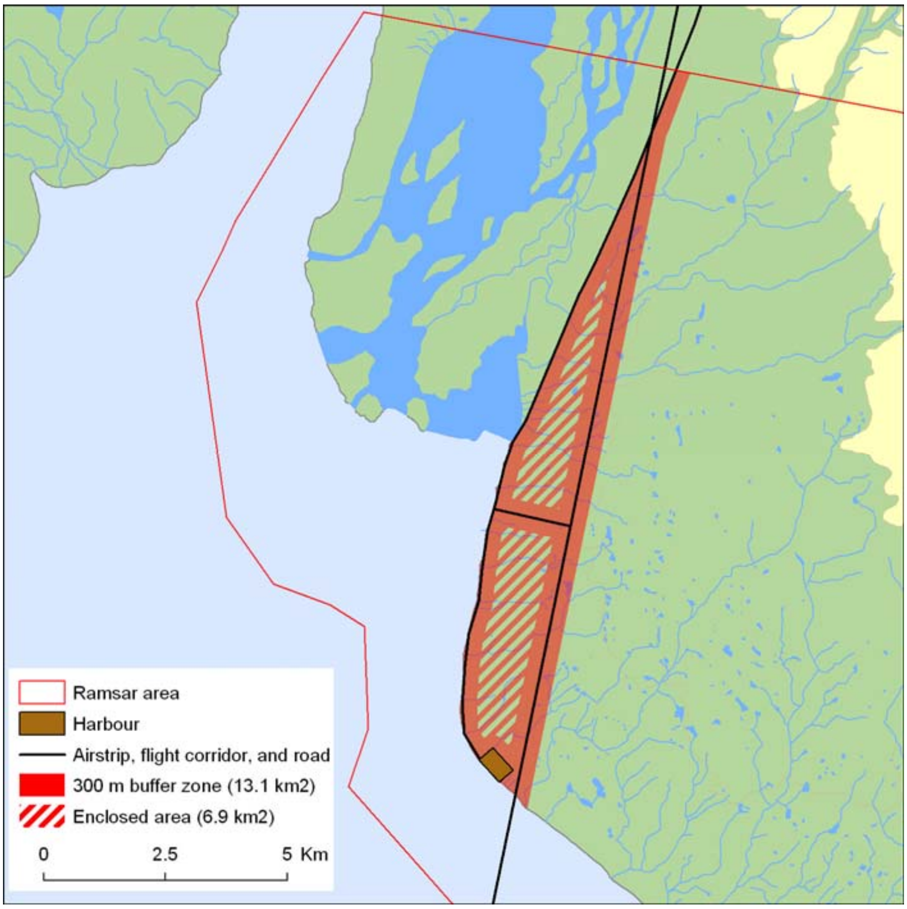

Figure 2. Disturbance zones in the Gurreholm area in the north-western part of the Ramsar site Heden. The median avoidance zones of 300 m follow the constructions of harbour, roads and airstrip including flight corridors north and south of the airstrip. The airstrip runs 1000 m north and south of the connecting east-west road. Total areas of directly affected areas (red) and possibly affected areas (hatched) are calculated in km^2.

The 300 m zone around the different constructions will cover an area of 13.1 km^2; this area is considered a minimum affected area. The enclosed area in between constructions and corridors represents a possibly affected area of 6.9 km^2. A maximum affected area is regarded as these two areas combined with a total of 20 km^2. On the basis of these affected areas, we can calculate the number of breeding pairs that potentially will be displaced by the mining activities; these numbers are given in Table 3.

In the minimum affected area of Gurreholm (13.1 km^2) it is calculated that the total number of breeding pairs displaced by the mining activities will be 96-160, while this number in the maximum affected area (20 km^2) is 146-244 (Table 3). A total of of 17 different species of breeding birds will be affected. On top of this about 149-204 pink-footed goose pairs and 8-31 barnacle goose pairs will be affected inside a 39.2 km^2 area at Gurreholm. For geese we have used a 1.5 km disturbance zone according to Glahder et al. (2010), which adds an extra 19.2 km^2 to the 20 km^2 area.

Table 3. Number of breeding bird pairs potentially displaced by mining activities inside two zones in the Gurreholm area, together with number of breeding pairs extrapolated for 300 km^2 of the Ørsted Dal itself. The 300 m zone area of 13.1 km^2 in the Gurreholm area is regarded the minimum affected area, wheras the 20 km^2 area is regarded the maximum affected area except for breeding geese, where a further 19.2 km^2 may be affected. Densities were derived from Tables 1 & 2.

Area name		**Gurreholm**		**Ørsted Dal**	
Area size (km^2)		**13.1**	**20.0**		**300**
Species	**Density**	**Number**	**Number**	**Density**	**Number**
Common ringed plover *Charadrius hiaticula*	0.1-0.3	1-4	2-6	1.2-1.7	360-510
Eurasian golden plover *Pluvialis apricaria*	0.1	1	2	-	0
Red knot *Calidris canutus*	1.1-1.4	14-18	22-28	0.3-0.4	90-120
Sanderling *Calidris alba*	0.1-1.3	1-17	2-26	0.8-1.7	240-510
Dunlin *Calidris alpina*	3.0-3.9	39-51	60-78	1.7-5.5	510-1650
Ruddy turnstone *Arenaria interpres*	0.7-1.1	9-14	14-22	0.5-0.9	150-270
Whimbrel *Numenius phaeopus*	0.1	1	2	-	0
Red phalarope *Phalaropus fulicarius*	0.2-0.4	3-5	4-8	-	0
Red-necked phalarope *Phalaropus lobatus*	0.1	1	2	0.1	30
Waders total	5.7-8.2	75-107	114-164	5.2-9.2	1560-2760
Red-throated diver *Gavia stellata*	0.1-0.2	1-3	2-4	-**)	2-4
Pink-footed goose *Anser brachyrhynchus*	3.8-5.2		149-204*)	1.6-3.7	480-1110
Barnacle goose *Branta leucopsis*	0.2-0.8		8-31*)	0.3-0.5	90-150
Northern pintail *Anas acuta*	0.1	1	2	-**)	-
King eider *Somateria spectabilis*	0.1-0.4	1-5	2-8	-**)	3-7
Long-tailed duck *Clangula hyemalis*	0.6-0.8	8-10	12-16	0.1-1.4	30-420
Long-tailed skua *Stercorarius longicaudus*	0.3-0.9	4-12	6-18	0.4-1.5	120-450
Arctic skua *Stercorarius parasiticus*	0.1-0.4	1-5	2-8	-	0
Sabine's gull *Larus sabini*	0.4-0.5	5-7	8-10	-	0
Arctic tern *Sterna paradisaea*	0.1-0.2	1-3	2-4	-	0

*) Inside an area of 39.2 km^2 due to a larger (1500 m) avoidance zone; **) One breeding pair was observed, but no density was calculated; instead an estimate was made for the entire valley based on information in the literature.

One breeding pair of red-throated diver and one pair of both northern pintail and king eider were observed in the Ørsted Dal area. No densities of these species were calculated for the valley. Instead, we have made an estimate for red-throated divers and king eiders in the entire valley based on information in the literature.

6.3 Can the Ørsted Dal replacement area protect similar species and numbers of breeding pairs that can be displaced from Heden?

For species found in both areas, the Ørsted Dal replacement area can fully protect the number of breeding pairs that can be affected by the planned mining activities in the Gurreholm area, as long as no dogs are allowed at Gurreholm. The two areas have eight breeding waterbird species in common. If we compare the largest number of breeding pairs that can be affected in the Gurreholm area (maximum number in the 20 km^2 area, Table 3) with the smallest number of breeding pairs in the Ørsted Dal valley area (minimum number in the 300 km^2 area) then the Ørsted Dal/Gurreholm ratio is between 1.9 (long-tailed duck) and 60 (common ringed plover).

However, a total of nine speices were only found in the Gurreholm area, and several more breeding pairs of red-throated diver, northern pintail and king eider were found at Gurreholm than in Ørsted Dal.

The total number of pairs that can be affected by the mining activities is not very high; in the minimum affected area the numbers of pairs are 17-31 and 26-48 in the maximum affected area. But three of the species, Sabine's gull, whimbrel and Eurasian golden plover, are considered near-threatened in Greenland (Boertmann 2007) and Jameson Land is the only known breeding area in Greenland for the two latter species.

Photo 4. A pair of barnacle geese flying over the Gurreholm area.

7 Conclusions

The two studies on breeding birds performed in the Gurreholm and Ørsted Dal areas have provided us with detailed knowledge on breeding bird species and their densities in those two areas of Jameson Land. The studies were performed during the optimal period in high Arctic Greenland for breeding bird censuses, so the results represent realistic numbers of breeding pairs at least of that particular year. The breeding season in Jameson Land in 2009 is thought to have been good due to early snow melt, indicating that densities of breeding pairs were not suppressed by poor conditions. Also, the collared lemming *Dicrostonyx torquatus* populations can vary considerably and thereby influence the populations of e.g. long-tailed skua and Arctic fox *Alopex lagopus.* Densities of lemmings were very low in 2009, causing low breeding activity of skuas and intensified fox predation on birds and their eggs. The densities of breeding waders in the relatively large study areas in the Gurreholm and the Ørsted Dal areas were rather high as compared to other high Arctic study areas of similar size.

From our present knowledge of the planned mining constructions and activities inside the Ramsar site Heden and from a literature based median avoidance distance of 300 m, we have calculated the number of breeding pairs of each species that potentially will be displaced by the mining activities. For breeding geese we have used a 1500 m avoidance distance (Table 3). In defining these distances, we have used a precautionary principle, meaning that it is unlikely that more birds will be displaced, provided that a ban on dogs at Gurreholm is implemented, and that no human access outside roads etc. is allowed. Also, it is possible that some habituation will take place over time meaning that disturbances will have less effect after some years, again provided that no dogs are allowed.

On the basis of the affected number of breeding pairs and the number of breeding pairs calculated in the Ørsted Dal replacement area, we conclude that the replacement area fully can give protection under the Ramsar Convention to the number of breeding pairs that potentially can be affected in the Ramsar site, as long as the species are found breeding in both areas.

However, nine species found breeding in the Gurreholm area were not found breeding in the Ørsted Dal replacement area. The total number of pairs of these species potentially affected by the mining activities was calculated to c. 50 with 2-10 pairs per species. This number seems rather low, but three of the species, Sabine’s gull, whimbrel and Eurasian golden plover, are considered near-threatened in Greenland, and Jameson Land is the only known breeding area in Greenland for the latter two species.

According to Glahder et al. (2010a) the replacement area held 60-80% af the moulting pink-footed geese expected to be displaced from the Gurreholm-area, and many more moulting barnacle geese than expeceted to be displaced.

Besides having no mining activities inside the Ramsar site, the impacts could be minimized by reducing the affected area as much as possible. Since the airstrip is situated most easterly of the activities, it would be important to move it as far west as possible or north of the Ramsar site. Also, effects can be reduced by avoiding any access to the Ramsar site outside the port, the airstrip area and the roads.

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Photo 5. A pair of king eiders.

Photo 6. Ruddy turnstone, a common breeder in Jameson Land

Appendix 1. Breeding bird densities in the Ramsar site Heden, Jameson Land, East Greenland

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Breeding bird densities in the Ramsar site Heden, Jameson Land, East Greenland

Christian M. Glahder and Alyn Walsh

(Med et dansk resumé: Tætheder af ynglefugle i Ramsarområdet Heden i Jameson Land, Østgrønland)

Abstract During 11-26 June 2009, territories of breeding birds were censused in two study areas (in total 63 km^2) in the north-western part of the Ramsar site Heden, Jameson Land, in high-arctic East Greenland. The purpose was to establish baseline knowledge on breeding bird densities in the area in order to evaluate possible impacts from proposed mining activities on these populations. Total densities of breeding waders varied between 5.7 and 8.2 territories/km^2 which are similar to the average density of 6.4 territories/km^2 (SD=4.1) of 42 other investigated high-arctic study areas in Northeast Greenland and Ellesmere Island. We discuss the correlation between densities, the chosen size of the study area and the study period. Important breeders were Sabine's Gull *Larus sabini* and Whimbrel *Numenius phaeopus* which both are considered near-threatened in Greenland. Pink-footed Goose *Anser brachyrhynchus* had densities of 4-5 nests/km^2 which indicate a much larger breeding population in Jameson Land than the 300-600 pairs estimated in the 1980s. We estimated the number of breeding pairs that may be displaced by the planned mining activities in the area and compared with the number of pairs in the proposed replacement Ramsar site Ørsted Dal, Jameson Land. The Ørsted Dal area can fully compensate the lost Ramsar status for most waders, Pink-footed Geese, Barnacle Geese *Branta leucopsis*, Long-tailed Ducks *Clangula hyemalis*, Long-tailed Skuas *Stercorarius longicaudus* and Snow Buntings *Plectophenax nivalis*, but no territories have been found in Ørsted Dal of Sabine's Gull, Red Phalarope *Phalaropus fulicarius*, Whimbrel and Lapland Bunting *Calcarius lapponicus*.

Introduction

The Ramsar site Heden in high-arctic East Greenland (centre at 71°00'N 24°00'W) covers 2524 km^2 of the large Jameson Land lowland tundra area (Fig. 1). This is the southernmost lowland area on the generally rugged and mountainous east coast of Greenland. It was designated in 1988, primarily to protect internationally important populations of moulting Pink-footed Geese *Anser brachyrhynchus* and Barnacle Geese *Branta*

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leucopsis (Greenland Home Rule 1990, Egevang & Boertmann 2001). At that time the area held 2% of the Iceland/Greenland flyway population of Pink-footed Geese and 7% of the Greenland flyway population of Barnacle Geese (Mosbech et al. 1989, Boertmann 1991). Of importance for the designation were also other breeding birds like Red-throated Diver *Gavia stellata*, Dunlin *Calidris alpina*, Ruddy Turnstone *Arenaria interpres*, Long-tailed Skua *Stercorarius longicaudus*, Arctic Skua *S. parasiticus*, Red Phalarope *Phalaropus fulicarius* and Red-necked Phalarope *Ph. lobatus*, as well as uncommon species like Sabine's Gull *Larus sabini* and Whimbrel *Numenius phaeopus* (50-100 pairs, Boertmann 2007). The Bureau of Minerals and Petroleum, Greenland Home Rule, designated the area an "area important to wildlife" (BMP 2000). Mineral exploration inside the area requires separate approval for specific periods.

Oil exploration was conducted by A/S ARCO Greenland in Jameson Land during 1985-1989, with an air strip and camp established at Constable Pynt in east Jameson Land as the basis for seismic winter and summer operations. In connection with these activities many studies were performed on the local environment, including the geese (Madsen & Boertmann 1982, Madsen et al. 1984a, 1984b, 1985, Madsen & Mortensen 1987, Mortensen et al. 1988, Mosbech et al. 1989, Mosbech & Glahder 1990, Mortensen 2000).

In 2008, the mining company Quadra Mining Ltd. was granted an exploitation license that covered the Malmbjerget area about 75 km north of the Ramsar site Heden. The company plans to exploit a large molybdenum ore body and develop the northwestern part of Heden (Cessford 2007, Quadra Mining Ltd. 2008). The planned activities inside the Ramsar site, around Gurreholm (Fig. 1-2), include the construction of a port, a gravel road and a 2000 m long airstrip. Trucks are planned to transport molybdenum concentrate to the port, to be shipped out of the area during the open-water period in July-October. About 100 flights per year with aircraft of different sizes are planned to service the area. At the moment (mid 2010) there is no information of a starting date. The Greenland Self-Government has claimed the mining project of "urgent national interests". The Ramsar Convention Secretariat is in dialogue with the Greenland Self-Government and has accepted that the project can proceed provided that the impact of the activities is monitored, and that an appropriate replacement area is found in advance (Salathe 2009).

In July 2008 the National Environmental Research Institute (NERI), Denmark, conducted bi-

Fig. 1. The Ramsar site Heden in north-western Jameson Land, East Greenland, with the two study areas indicated. Shown is also the the proposed Ørsted Dal replacement area with the study areas of Meltofte & Dinesen (2010). The star indicates the molybdenum site at Malmbjerget.
Ramsar-området Heden i det nordvestlige Jameson Land, med de to undersøgelsesområder angivet. Desuden er vist det foreslåede Ørsted Dal erstatningsområde med de to områder, der blev undersøgt af Meltofte & Dinesen (2010). Stjernen angiver stedet for molybdænforekomsten ved Malmbjerget.

ological studies in the Ramsar site and other areas in Jameson Land. On the basis of different disturbance scenarios the number of possibly impacted geese and other bird species were assessed and a larger area around Ørsted Dal was suggested as a replacement area (Fig. 1, Glahder et al. 2010). In June 2009 NERI performed breeding-bird studies in the Gurreholm area, which could possibly be affected by mineral activities, and in the proposed Ramsar replacement area of Ørsted Dal. These studies are regarded supplementary to the studies performed in 2008. The Ørsted Dal study was reported by Meltofte & Dinesen (2010), while the Gurreholm study is reported in the present paper.

The purpose of the present study was to establish baseline knowledge on breeding bird species and their densities in the Gurreholm area in order to evaluate possible impacts from proposed mining activities on these populations. In the paper we compare our results with those from Ørsted Dal in order to assess if the number of breeding pairs which are likely to disappear from the Ramsar site due to mining activities is similar to the number of pairs in the proposed replacement area, so that the number of pairs protected under the Ramsar Convention remains unchanged. Also, we wished to compare the richness in breeding waders in our study areas with those from other high-arctic study areas (Meltofte 1985, Boertmann et al. 1991, Mortensen 2000, Meltofte 2006 and Meltofte & Dinesen 2010). The results from these different areas are not directly comparable, both because densities of territories depend on the study period (Meltofte 2001) and because we anticipate that densities in small study areas are higher than in large areas because small study areas may be selected for their abundant vegetation and rich fauna (e.g., Boertmann et al. 1991). In the present paper we test these assumptions by a 2-way analysis of variance.

Study area

Jameson Land is situated around 71°15'N 23°30'W in East Greenland. It is a lowland area on the otherwise rugged and mountainous east coast of Greenland. The western and southern part is delimited by Scoresby Sund, the largest fiord system in the world, while the northern and eastern part is fringed by high mountains and open sea. The western part is covered by tundra and wetland areas. To the east the area gradually raises to drier tundra and low mountains of about 1000 m a.s.l. Jameson Land is intersected by many rivers and relatively lush valleys.

The Gurreholm study area in the north-western part of Jameson Land is a lowland area delimited to the west by Hall Bredning (Fig. 1-2). In the north-western part a huge silty delta area is formed at the mouth of the 3-4 km wide river Schuchert Flod. To the north and east the land gradually rises and become drier. Generally, the study area can

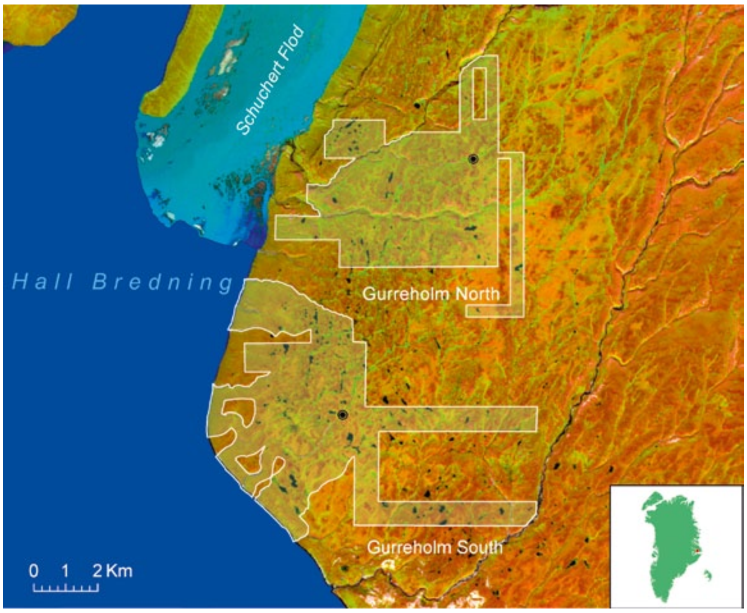

Fig. 2. The two study areas inside the Ramsar site Heden. Camp sites are indicated by circled dots. Hall Bredning is a part of the fjord Scoresby Sund. The satellite image is from 16 July 2004.
De to undersøgelsesområder i Ramsar-området Heden. Lejrene er vist med omcirklede prikker. Hall Bredning er en del af Scoresby Sund. Satellitbilledet er taget d. 16. juli 2004.

be classified as a wetland area with many marshes, ponds and lakes up to 500 m across, drained by streams of varying size. Mosses, cotton grass *Eriophorum* spp., sedge *Carex* spp. and flowering plants dominate the wet areas. On higher ground the vegetation is dominated by dwarf-scrub heath with species like arctic blueberry *Vaccinium uliginosum*, arctic bell-heather *Cassiope tetragona* and arctic willow *Salix arctica*. The two study areas, Gurreholm South and Gurreholm North (Fig. 2), were chosen to cover as much as possible of the northwestern corner of the Ramsar site Heden which possibly could be affected by future mineral activities. The southern area is the lower and wetter of the two areas.

The snow coverage within the study area was 30-35% at the time of arrival on 11 June 2009, rapidly decreasing to about 5% one week later. According to Meltofte & Dinesen (2010), snowmelt was very early in 2009. On average, the ice cover on 61 lakes and ponds in the Gurreholm South area was about 60% on 11 June and 35% on 18 June. Temperatures during the study period were 0-5 °C, visibility was good, and winds were light between south and west. It rained for 1-2 days. The first mosquitoes were encountered on 18 June, and on 20 June high numbers of larvae of the arctic woollybear caterpillar *Gynaephora groenlandica* had emerged and attracted a large flock of foraging Long-tailed Skuas. One arctic fox *Alopex lagopus* and one abandoned den were observed in Gurreholm South, and three foxes in Gurreholm North. No collared lemmings *Dicrostonyx groenlandicus* were seen, and neither were any summer burrows or winter nests.

Methods

The authors studied the Gurreholm South area during 11-18 June and the Gurreholm North area during 19-26 June 2009, being transported by helicopter between Constable Pynt and the two camp sites (Fig. 2). We censused the study areas using the same method as Boertmann et al. (1991) and Meltofte et al. (2009). This method aims at mapping all territories based on territorial behaviour during the early breeding period before incubation. Meltofte (2001) recommended 12-20 June as the optimal period for such a census in high-arctic Greenland.

We traversed the study areas along parallel transect lines separated by c. 200 m. On the first three days, we could use rivers and coast lines as guiding lines, but then changed to follow pre-chosen transect lines following the north-south and east-west UTM grid lines by use of handheld GPS receivers (Garmin Etrex & GPS Map 60CSX, UTM 27); the reason was the difficulties in following parallel transect lines in the rather featureless inland. Minor parts of the study areas were unintentionally left uncovered due to time constraints. Transect lines outside the core study area were drawn from the camp to randomly chosen points that were either 90 or 180° turning points. Routes were drawn on maps (1:26300) with 1000 m UTM grid lines, and observations were plotted on these maps in the field. We walked parallel transect lines simultaneously and communicated by small VHF radios, primarily to avoid double counts. All birds were recorded on the maps with notes on status and behaviour; birds in pairs, singing, giving alarm calls or other territorial behaviour, or (on rare occasions) connected with found nests were regarded as pair members holding a territory. Observed birds with no such indications of being local breeders were recorded as uncertain breeders, except that overflying birds were omitted from the census. For Pink-footed and Barnacle Geese most territories were determined by direct nest observations since these nest sites were easily detected, either because of the vigilant male or of the sitting female. In the few cases where we, against our intentions, flushed the geese we counted the number of eggs or, late in the period, goslings; eggs were covered after the count. Observations of mammals and fox dens were also recorded.

Observations from the field maps were transferred to a final map at camp shortly after each field session. Most observations were made between 10 am and 8 pm. In total we spent 104 man-hours in the field in the Gurreholm South area and 90 man-hours in Gurreholm North.

Total wader densities in the two Gurreholm study areas and in 40 high-arctic study areas reported in various papers, were statistically analysed for a relationship with the size of the study area and with the study period. Study areas less than 12 km^2 were grouped as "small", larger areas as "large"; similarly, studies performed before 1 July were grouped as "early", while studies performed from 1 July onwards as "late". Density data was log-transformed to fulfil the assumptions for parametric tests of normality (Shapiro-Wilk normality test, $P>0.05$) and homogeneity of variances (Bartlett test, $P>0.05$). The relationship between area and period was tested by a 2-way analysis of variance (ANOVA). Data were fitted to a logarithmic trend line.

Table 1. Breding bird number and densities in the two study areas at Gurreholm South and Gurreholm North. Density: territories/km².
Antal og tætheder af ynglefugle i de to undersøgelsesområder, Gurreholm syd og Gurreholm nord. Tætheder: territorier/km².

Species *Arter*	**Gurreholm South** Area 34.13 km²		**Gurreholm North** Area 29.09 km²	
	Number	**Density**	**Number**	**Density**
Common Ringed Plover *Charadrius hiaticula*	7-10	0.21-0.29	1-2	0.03-0.07
Eurasian Golden Plover *Pluvialis apricaria*			2	0.07
Red Knot *Calidris canutus*	38-49	1.11-1.44	32-33	1.10-1.13
Sanderling *Calidris alba*	39-44	1.14-1.29	4-5	0.14-0.17
Dunlin *Calidris alpina*	101-120	2.96-3.52	105-114	3.61-3.92
Purple Sandpiper *Calidris maritima*	0-1			
Ruddy Turnstone *Arenaria interpres*	32-36	0.94-1.05	21-23	0.72-0.79
Whimbrel *Numenius phaeopus*	3	0.09	1	0.03
Red Phalarope *Phalaropus fulicaria*	7-13	0.21-0.38	0-3	
Red-necked Phalarope *Phalaropus lobatus*	4	0.12	0-4	
Waders total *Vadefugle totalt*	231-280	6.77-8.20	166-187	5.71-6.43
Red-throated Diver *Gavia stellata*	2-5	0.06-0.15	3	0.10
Pink-footed Goose *Anser brachyrhynchus*	163-178	4.78-5.21	110	3.78
Barnacle Goose *Branta leucopsis*	27	0.79	7	0.24
Northern Pintail *Anas acuta*	1-2	0.03-0.06	0-1	
King Eider *Somateria spectabilis*	3-7	0.09-0.21	8-11	0.28-0.38
Long-tailed Duck *Clangula hyemalis*	20-26	0.59-0.76	17-24	0.58-0.83
Rock Ptarmigan *Lagopus mutus*	0-4		0-2	
Long-tailed Skua *Stercorarius longicaudus*	9-32	0.26-0.94	18-27	0.62-0.93
Arctic Skua *Stercorarius parasiticus*	6-14	0.18-0.41	1-5	0.03-0.17
Sabine's Gull *Larus sabini*	12-16	0.35-0.47	0-1	
Arctic Tern *Sterna paradisaea*	4-6	0.12-0.18	1	0.03
Raven *Corvus corax*	1-2	0.03-0.06	0-1	
Northern Wheatear *Oenanthe oenanthe*			3	0.10
Common/Arctic Redpoll *Carduelis flammea/ hornemanni*	1-2	0.03-0.06		
Lapland Bunting *Calcarius lapponicus*			14-18	0.48-0.62
Snow Bunting *Plectophenax nivalis*	87-98	2.55-2.87	192-200	6.60-6.88

Results

A total of 26 bird species were recorded as breeding or possibly breeding in the two study areas. The two areas were similar as regards the diversity of breeding species, with 23 species in the southern area and 24 in the northern (Table 1). Densities (territories/km²) of breeding waders in the southern area were higher (6.77-8.20) than in the northern area (5.71-6.43), mainly due to a higher density of Sanderling *Calidris alba* (1.14-1.29) and Red Phalarope (0.21-0.38) in the southern area (Table 1). Among other bird species, the southern area had higher densities of Pink-footed Goose (4.78-5.21), Barnacle Goose (0.79) and Sabine's Gull (0.35-0.47), whereas Lapland Bunting was recorded only in the northern area, with densities of 0.48-0.62; in the same area, Snow Bunting densities (6.60-6.88) were twice as high as in the southern area.

The first Pink-footed Goose goslings were observed on 22 June, two days earlier than the earliest goslings reported from Ørsted Dal (Ferns & Green 1975, Meltofte & Dinesen 2010) and 9-11 days earlier than the earliest observed by Cabot et al. (1984) and Madsen et al. (1984a), likewise from Ørsted Dal. The average size of observed egg clutches was 3.57 (SD=1.75, n=21), while the average brood size was 2.86 (SD=0.90, n=7).

Among the more unusual observations were a flock of about 160 Long-tailed Skuas in Gurreholm North on 20 June, with a Ring-billed Gull *Larus delawarensis* among them.

The relatively lush and low-lying tundra of Heden stands in marked contrast to the high mountains west of Hall Bredning. Photo: C. M. Glahder.

The relationship between densities of wader territories in the 42 high-arctic study areas and size of study areas and timing of study showed no indication of an interaction effect (F=1.25, P=0.27), so the 2-way ANOVA was re-run without this term. This test showed that densities in the smaller areas were higher than densities in larger areas ($F_{1,39}$=12.4, P=0.002), and that densities early in the season were higher than densities later in the season ($F_{1,39}$=5.27, P=0.03).

Discussion

The breeding bird study in the two Gurreholm areas was timed according to the recommendations by Meltofte (2001) concerning the optimal period for censusing breeding waders in the high Arctic. The number of recorded wader territories in the southern study area, studied during 11-18 June, may therefore be regarded as a maximum number, whereas the about 20% lower density of territories found in the northern study area could have been influenced by the later study period. This lower density was mainly a result of the few Sanderling territories found in the northern area, possibly because Sanderlings become very secretive when incubating, and probably even more so in case of double-clutching with both pair members incubating a clutch (Meltofte 2006).

The densities of wader territories in the two Gurreholm study areas were close to the average density per km^2 of 6.42 (SD=4.13) for 42 high-arctic study areas in Northeast Greenland and Ellesmere Island, compiled by Mortensen (2000) from Meltofte (1985) and Boertmann et al. (1991). To these we added the densities from Zackenberg (Meltofte 2006), Ørsted Dal (Meltofte & Dinesen 2010) and Gurreholm (present study) (Fig. 3). Total wader densities (territories per km^2) vary between 1.11 (Kap Stewart, Jameson Land) and 16.59 (Danmarks Havn). These densities are primarily based on five species: Common Ringed Plover, Red Knot *Calidris canutus*, Sanderling, Dunlin, and Ruddy Turnstone.

Because we anticipate that densities of wader territories are higher in smaller areas (<12 km^2) than in our study areas of about 30 km^2, we find it likely that the Gurreholm area actually is more important for breeding waders than the above comparison suggests. The idea of an area/density relationship was partly inspired by the wader study of Boertmann et al. (1991) in which the investigated areas on average were 6.1 km^2 (SD=2.8, n=14) and "were selected for their apparently abundant vegetation and consequently rich fauna." Criteria for selection of study areas were not given by Meltofte (1985) or Mortensen (2000); the two areas selected by Meltofte & Dinesen (2010) should represent different patterns of wet and dry tundra in a possible Ramsar replacement area, and the areas in the present study were mainly selected to cover a substantial part of the area inside the Ramsar site that will possibly be affected by mineral activities. The five common species mentioned previously "most often breed within 50-100 m of fertile wet or moist sites" (Meltofte 1985), while the two phalarope species need open water near the nest. We therefore suppose that such wetland areas are often chosen for studies of breeding waders, and the smaller the study area, the higher a percentage of such prime habitat area is likely to be included. Larger study areas will be more likely to include substantial proportions of less optimal wader habitat, such as dwarf scrub heath.

Our analysis of the 42 arctic study areas showed that densities of wader territories did indeed depend on the size of the study area, so that larger areas had significantly lower densities than smaller areas. The analysis also showed that densities depended on the study period so that densities were significantly higher in early than in late study periods, a relationship previously discussed by Meltofte (2001). The relative number of areas that were studied late in the breeding season was slightly higher for larger areas (35%) than for smaller areas (28%), but since the interaction between the size of the study area and the study period was not significant, this difference is thought to be of minor importance. On Fig. 3 we have plotted the number of wader territories (territory density × size of study area) against the size of the 42 study areas and fitted a logarithmic trend curve. It is noteworthy that the two Gurreholm areas had more territories than expected from the trend curve, most pronounced in case of the southern study area. This indicates that the Gurreholm area is a more important wader breeding habitat than the density figures alone suggest, because much higher densities reported from other – but smaller – areas have inflated our expectations of what may be found in "good wader habitat".

Below we compare our results from the possibly impacted area inside the Ramsar site Heden with those from Ørsted Dal (Meltofte & Dinesen 2010), in order to evaluate the quality of the proposed Ramsar replacement area. Densities of breeding waders in the two Ørsted Dal areas in June 2009 of 8.5-9.2 (Upper Valley) and 5.2-5.8 (Central Valley) were similar to the densities in the Gurreholm study areas (Fig. 3, Table 1). The major differences were that Common Ringed Plover and Dunlin had much higher densities in the Ørsted Dal areas than in the Gurreholm areas, and that densities of Red Knot were higher in the Gurreholm areas. Also, a total of 10 breeding wader species were found in the Gurreholm study areas, compared with only six in the Ørsted Dal study areas (Meltofte & Dinesen 2010). The additional species found only at Gurreholm were Eurasian Golden Plover *Pluvialis apricaria* (only a single non-territorial bird seen in Ørsted Dal), Purple Sandpiper *Calidris maritima*, Whimbrel and Red Phalarope. Four other bird species were found breeding in the Gurreholm study areas but not in the Ørsted Dal study areas: Arctic Skua, Sabine's Gull, Northern Wheatear *Oenanthe oenanthe* and Lapland Bunting.

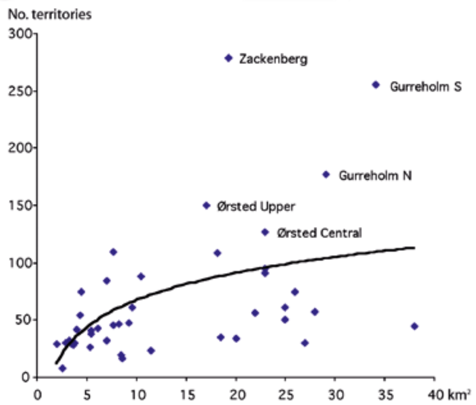

Fig. 3. The correlation between numbers of wader territories and the size in km^2 of 42 high-arctic study areas situated in Northeast Greenland and Ellesmere Island (Meltofte (1985), Boertmann et al. (1991), Mortensen (2000), Meltofte (2006), Meltofte & Dinesen (2010), present study). A logarithmic trend line is shown. Gurreholm S and N are the two areas in NW Jameson Land censused in the present paper. Ørsted Upper and Central are the two areas studied in NE Jameson Land (Meltofte & Dinesen 2010) and Zackenberg is the study area at the research station in central NE Greenland (Meltofte 2006).

Sammenhængen mellem antal af vadefugleterritorier og størrelsen i km^2 af 42 højarktiske undersøgelsesområder fra Nordøstgrønland og Ellesmere Island. Der er lagt en logaritmisk trendlinje ind på figuren. De to områder der er undersøgt i forbindelse med denne artikel er Gurreholm S og N beliggende i det nordvestlige Jameson Land, Ørsted Upper og Central er de to områder i det nordøstlige Jameson Land undersøgt af Meltofte og Dinesen (2010), og Zackenberg er undersøgelsesområdet ved forskningsstationen i det centrale Nordøstgrønland (Meltofte 2006).

Sabine's Gull, a prominent breeding species at Heden. Photo: C. M. Glahder.

The entire population of Pink-footed Geese in Jameson Land (9000 km^2) was estimated at 300-600 breeding pairs in the 1980s (Madsen et al. 1985, Mosbech et al. 1989). Since then, during the last 20 years, the Iceland/Greenland flyway population of Pink-footed Geese has increased by a factor 1.5 (Mitchell 2008), which, if applied to Jameson Land, would mean a population of less than 1000 pairs today. However, about 430 successfully breeding pairs were recorded within 236 km^2 of Jameson Land in July 2008 (Glahder et al. 2010), and in 2009 (present report) we counted 273-288 nests or pairs in the Gurreholm study areas (63 km^2 in total), while Meltofte & Dinesen (2010) found 111 nests in the Ørsted Dal study areas (40 km^2); combined, that is about 400 territories within 100 km^2. If we upscale to the present Ramsar site (2524 km^2) and the Ørsted Dal replacement area (1977 km^2), we get a population of roughly 18 000 pairs. The actual number is probably smaller, but the figures still suggest that it is considerable higher than 1000 pairs. This higher estimate apparently originates in the method used, detailed counts of nests and young broods, while the estimate from the 1980s was based on observation of goose families from the air in July, a method that is likely to underestimate the population.

From the present knowledge of the mining plans in the Gurreholm area of the Ramsar site (Cessford 2007) and the densities of breeding birds within the Gurreholm area (present study) and the proposed replacement area in Ørsted Dal (Meltofte & Dinesen 2010), it is possible to give a rough estimate of the number of pairs that will be displaced, and to assess if the future Ramsar status of the replacement area will protect at least a similar number of pairs. We estimate that mining-related activities at the port, the road along the coast, and the airstrip (including a flight corridor) will affect a roughly rectangular area of 2 by 15 km, i.e. 30 km^2. Based on this crude estimate, the proposed Ørsted Dal Ramsar replacement site can fully compensate the lost Ramsar status for most waders, Pink-footed Goose, Barnacle Goose, Long-tailed Duck, Long-tailed Skua and Snow Bunting. However, no territories were found in Ørsted Dal of Sabine's Gull, Red Phalarope, Whimbrel or Lapland Bunting, and only one King Eider pair was seen. Sabine's Gull and Whimbrel are considered near-threatened in Greenland (Boertmann 2007), with Jameson Land being the only known breeding area for Whimbrel.

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We wish to thank Hans Meltofte and Lars Dinesen who performed a similar study in Ørsted Dal, Jameson Land, for smooth collaboration during all phases of the study and for their useful comments on the manuscript. Ko de Korte and Kaj Kampp are thanked for their critical reviews and useful improvements of the manuscript. We had much help from the staff at Constable Pynt, especially from Henrik "Thy" Jensen, and excellent and safe support from Greenland Air Charter. Helene Schledermann, NERI, helped with data handling and figures, Mikkel Thamstorf, NERI, produced field maps and gave on-line help with GPS grid problems (UTM 27 grid), and Frank Riget, NERI, helped with statistical analyses of the data on wader territories. The present study was financed by the Bureau of Minerals and Petroleum, the Greenland Self-Government.

Resumé

Tætheder af ynglefugle i Ramsarområdet Heden i Jameson Land, Østgrønland
I juni 2009 undersøgte vi tæthederne af ynglefugle i to undersøgelsesområder i den nordvestlige del af Ramsarområdet Heden. Området ligger i Jameson Land i Østgrønland (Fig. 1) og er placeret sydligst i det højarktiske område. Baggrunden for undersøgelserne er, at et mineselskab har planer om at bryde en forekomst af molybdænmalm nord for Jameson Land og udskibe den fra den nordvestlige del af Ramsarområdet. Selskabet planlægger derfor at anlægge en vej, en havn og en landingsbane i dette område. Vore undersøgelser skulle dels give et grundlæggende kendskab til ynglefugletæthederne i området og dels give grundlag for at vurdere påvirkningen af mineaktiviteterne på områdets ynglefugle. På samme tid blev der af Meltofte & Dinesen (2010) udført lignende undersøgelser i Ørsted Dal i Jameson Land, der er foreslået som et erstatningsområde for det påvirkede område af Ramsarområdet Heden (Glahder et al. 2010).

Undersøgelserne blev udført i to delområder, Gurreholm syd (34 km^2, 11.-18. juni) og Gurreholm nord (29 km^2, 19.- 26. juni), jf. Fig. 2. Begge områder er dækket af tundra og indeholder mange større og mindre søer, damme, elve og kær. Det sydlige område ligger nærmere kysten end det nordlige og er generelt lavere og har flere vådområder. Ved vores ankomst 11. juni var 30-35% snedækket, men allerede en uge senere var der kun ca. 5% snedækkede områder tilbage. Områderne blev gennemvandret i parallelle linjer med en transektbredde på 100 m til hver side. For at undgå dobbeltregistreringer kommunikerede vi vha. små VHF-radioer. Par og individer, der sang eller på anden måde markerede et territorium, blev anset for at repræsentere et sikkert territorium, mens andre individer regnedes for at repræsentere et usikkert territorium. Alle fugleobservationer blev noteret på kort. I alt registrerede vi 26 arter som ynglende eller muligt ynglende (Tabel 1). Den fundne vadefugletætheder – 6,8-8,2 territorier/km^2 i det sydlige område og 5,7-6,4 territorier/km^2 i det nordlige område – ligger omkring gennemsnitet på 6,5 territorier/km^2 (SD=4,1) for 42 undersøgte områder i højarktis (Meltofte 1985, Boertmann et al. 1991, Mortensen 2000, Meltofte 2006, Meltofte & Dinesen 2010, denne undersøgelse). Tætheden af vadefugleterritorier var signifikant lavere i de store højarktiske undersøgelsesområder end i de små, hvilket skyldes, at små produktive vådområder ofte vælges som undersøgelsesområder, mens store områder som oftest vil inkludere dele med ringe ynglehabitat, som f.eks. dværgbuskhede. Både små og store områder optalt før 1. juli havde signifikant højere tætheder end tilsvarende områder talt efter denne dato. Da Gurreholm-områderne begge er store, er deres betydning for ynglende vadefugle større end den umiddelbare sammenligning med andre højarktiske undersøgelsesområder viser (Fig. 3).

Vadefugletæthederne i Gurreholm-områderne ligger nær tæthederne i de to områder i Ørsted Dal. De største forskelle mellem Gurreholm og Ørsted Dal er, at der i sidstnævnte område var langt højere tætheder af Stor Præstekrave og Almindelig Ryle, mens der var større tætheder af Islandsk Ryle i Gurreholm. Desuden blev der i Gurreholm registret fire ynglende vadefuglearter (Hjejle, Sortgrå Ryle, Lille Regnspove, Thorshane) og fire andre ynglefuglearter (Almindelig Kjove, Sabinemåge, Stenpikker, Laplandsværling), som savnedes i Ørsted Dal.

I 1980erne blev ynglebestanden af Kortnæbbet Gås i hele Jameson Land skønnet til 300-600 par (Madsen et al. 1985, Mosbech et al. 1989). En simpel fremskrivning, baseret på en registreret stigning i den islandsk-grønlandske bestand med en faktor 1,5 i de sidste 20 år (Mitchell 2008), giver knap 1000 ynglepar i Jameson Land, mens der i 2009 i Gurreholm blev talt 273-288 territorier (reder) på 63 km^2 og i Ørsted Dal 111 territorier på 40 km^2, eller i alt ca 400 reder på 100 km^2. Med samme tætheder ville der i hele Ramsarområdet Heden (2524 km^2) og det foreslåede Ørsted Dal erstatningsområde (1977 km^2) være 18 000 par, og selv om det faktiske antal formentlig er væsentligt mindre, må det formodes at ligge betydeligt over 1000 par. Dette højere estimat skyldes dels, at det bygger på detaillerede optællinger i yngleperioden og dels, at ynglebestanden

i 1980erne blev skønnet ud fra gåsefamilier observeret fra fly i juli måned, en metode som formodedes at ville underestimere bestanden.

På baggrund af vores nuværende kendskab til mineplanerne, og tæthederne af ynglefugle i Gurreholm og Ørsted Dal områderne, kan vi dels give et groft skøn over antallet af ynglepar, der bliver fordrevet, og dels anslå hvor mange fugle, hvis yngleområde vil miste henholdsvis få Ramsar status. Mineaktiviteterne inden for Ramsarområdet Heden antages at ville påvirke ca 30 km^2 ved Gurreholm. Ud fra dette skøn vil Ramsar kompensationsområdet ved Ørsted Dalen, med mindst 500 km^2 egnet ynglehabitat, fuldt ud kunne kompensere for de fordrevne ynglepar af de fleste vadere, Kortnæbbede Gæs, Bramgæs, Havlitter, Små Kjover og Snespurve, men Sabinemåge, Thorshane, Lille Spove og Laplandsværling tilsyneladende ikke yngler i Ørsted Dal området.

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Appendix 2. Population densities of birds in Ørsted Dal, NE Greenland, 2009

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Population densities of birds in Ørsted Dal, NE Greenland, 2009

Hans Meltofte & Lars Dinesen

(Med et dansk resumé: Bestandstætheder af fugle i Ørsted Dal, Nordøstgrønland, 2009)

Abstract During June 2009, the bird populations in two study areas in Ørsted Dal, northern Jameson Land in NE Greenland, were censused using the "rapid assessment" method where all "territory holding" pairs and individuals are considered part of the local population. The method provided significantly higher densities of waders (Charadrii) than found in the valley at censuses in July 1974. This is interpreted as a result of all non- and failed breeders having left their territories before the July census. Yet, numbers of Ruddy Turnstones *Arenaria interpres* may have decreased since then, while the nesting population of Pink-footed Geese *Anser brachyrhynchus* has increased quite considerably. Also, arrival and egg-laying in Barnacle *Branta leucopsis* and Pink-footed geese appears to have advanced as compared to previous decades, an advancement interpreted as the result of climate amelioration.

Introduction

In connection with possible molybdenum mining activities in Scoresby Land, the mining company is planning to establish an airfield together with a road, a container port and other facilities for the operations at Gurreholm in the north-western part of the Heden Ramsar Site in western Jameson Land, East Greenland (Cessford 2007, Glahder et al. 2010). To compensate for the loss of breeding and moulting habitat for birds in the Ramsar site, the Greenland authorities are considering the possibility to establish an alternative Ramsar site in the region. The National Environmental Research Institute (NERI), Aarhus University, put forward a preliminary proposal that the large valley of Ørsted Dal in north-eastern Jameson Land could make up such a compensation area (Glahder et al. 2010). To study the extent to which bird populations here match populations in the lost area, NERI conducted studies in the valley in July 2008, focusing on breeding and moulting geese, and in June 2009, focusing on population densities of all bird species. In parallel, similar studies were conduced in the Heden Ramsar Site (C.M. Glahder in litt.).

Prior to these studies, the birds of Ørsted Dal were described in a number of papers and reports following goose and wader studies in the 1960s, 1970s and 1980s (Marris & Ogilvie 1962, Hall & Waddingham 1966, Ferns & Green 1975, Ferns & Mudge 1976, Green & Greenwood 1978, Cabot et al. 1984). In 1974 the breeding waders of a 25 km^2 study area centrally in the valley were censused in connection with an extensive wader study in the Kong Oscar Fjord region (Green & Greenwood op.cit.). This area made up one of our two study areas in the valley in June 2009, although the delineation differed somewhat between the two study years.

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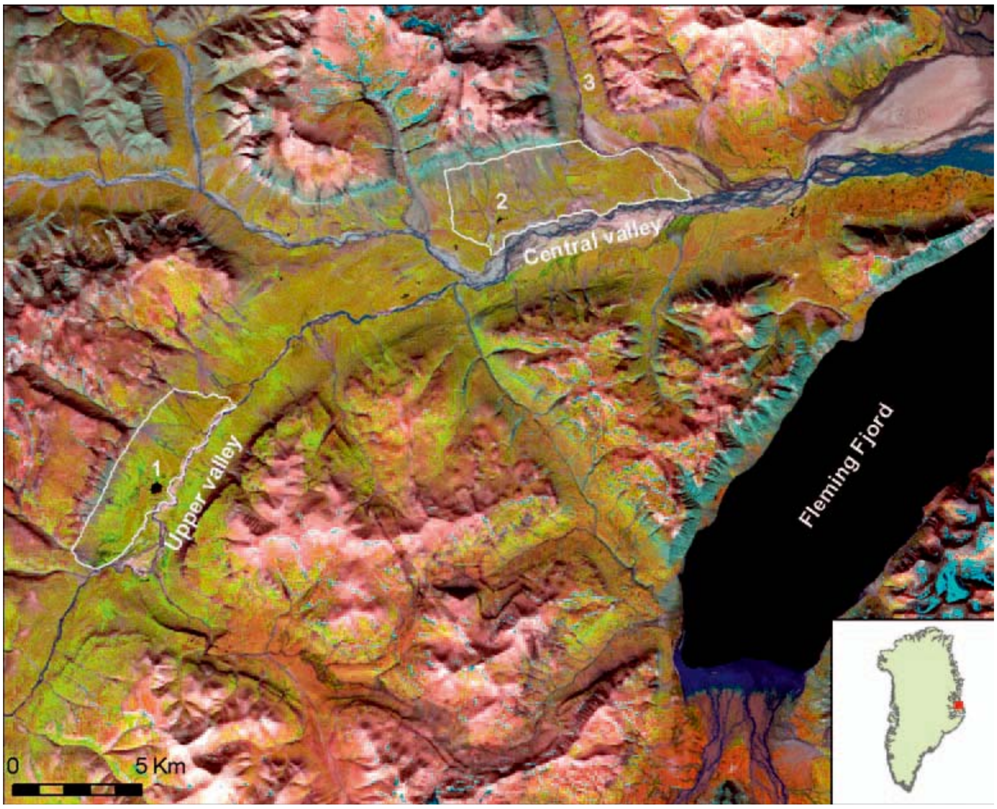

Fig. 1. Satellite image of Ørsted Dal from 16 July 2004 with the position of the two study areas. 1) Primula Pond, 2) Pinkfoot Pond, 3) Horsedal.
Satellitbillede af Ørsted Dal med undersøgelsesområderne vist. 1) Primula Pond, 2) Pinkfoot Pond, 3) Horsedal.

The study areas

Jameson Land is situated in the southernmost part of high-arctic NE Greenland. From relatively low-lying, undulating tundra in the south and west, Jameson Land rises to mountains reaching 800-1300 m a.s.l. in the north. Here, Ørsted Dal is the largest valley, extending about 45 km to the WSW from Fleming Fjord, a tributary of Kong Oscar Fjord (Fig. 1). The valley floor and lower slopes are 4-7 km wide and below 200 m a.s.l.

Most of the valley floor is relatively level or undulating terrain with more landscape profile (up to c. 20 m) at moraines, raised delta terraces and river ravines. At the foot of the steep mountain bluffs surrounding most of the valley, scree slopes together with extensive gravely and stony outwash fans from the many tributary rivers and rivulets dominate.

Two study areas in the valley were selected from satellite images to represent different patterns of wet and dry tundra, one of 17.0 km^2 in the upper valley and one of 23.0 km^2 in the central part of the valley, the latter largely being identical to the study area from 1974 (Fig. 1). Both were demarcated by the main river to the south, by tributary rivulets to the east and west, and by the 200 m contour to the north. The upper area had much wet fen vegetation and a large pond, Primula Pond, with adjacent smaller ponds to the east. The central area had more mesic tundra and dry, almost barren lands. Yet, wet fens with ponds were found also here, particularly in areas irrigated well into the summer season by runoff from large snow-beds and ice-fields. Besides the ankle-high vegetation typical of the high Arctic, knee-high *Salix* bushes typical of the low Arctic were found in a few places in the upper valley. The general habitat patterns of the valley were mapped by Ferns & Mudge (1976) and given in more detail for the central study area by Green & Greenwood (1978).

View over the upper Ørsted Dal study area seen from NW in mid June 2009. A part of Primula Pond is seen in the foreground, and breeding cliffs of Barnacle Geese on the southeast side of the valley are seen in the background. Photo: Lars Dinesen.
Udsigt over undersøgelsesområdet i øvre Ørsted Dal set fra nordvest. En del af Primula Pond ses i forgrunden, og klipperne med ynglende Bramgæs ses i baggrunden.

Snow melts earlier in Ørsted Dal than in adjacent parts of the Jameson Land, and snowmelt was particularly early in 2009. On a satellite image from 3 June the main part of the valley floor appeared largely snow free. The spring melt had apparently taken place already in the second half of May, and upon our arrival in the upper study area on 11 June, we estimated the snow cover to only 1% on the valley floor. Snowmelt in the central area was a little later – probably due to deeper snow – and snow cover was estimated at 5% upon our arrival on 19 June. No ice remained on the ponds except for the large and deep Primula Pond, which on 11 June only had open water along the shores, decreasing to about 70% ice cover when we left on 19 June. The snow cover on the mountain slopes above the study areas was 10% in the upper valley and 20% in the central valley, but with considerably more snow on some of the north facing mountain slopes on the south side of the valley.

For comparison, the snow cover was less than 5% in the central valley on 6 July 1974 (or about the same as we found 17 days earlier in 2009), and Meltofte (1985) estimated it to have been about 40% on 10 June when most birds in NE Greenland initiate egg-laying. 1974 was a particularly late year (Green et al. 1977, de Korte et al. 1981), but records from eight flights passing Ørsted Dal around 1 June in 1996-2005 indicate that snow cover in early June is quite extensive in most years (Table 1). Only the years 2000 and 2005 stand out as having been very early, as they were also at Zackenberg Research Station 300 km further north in NE Greenland (Hansen et al. 2009). Even the very early snowmelt in 2009 is in accordance with conditions at Zackenberg, where the river started to run on 22 May, eight days earlier than in any other year since 1996 and 29 days earlier than in the latest year (Sigsgaard et al. 2009, J. Hansen in litt.).

The south-western flat part of the upper valley study area had been flooded during the spring melt and held no breeding birds. The same was the case for the easternmost flat part of the central study area. The ecosystem phenology of the valley (plant growth and invertebrate emergence) appeared not to be particularly early, in spite of the early snow-

Table 1. Snow cover in central Ørsted Dal estimated from aircraft passing the valley each year around 1 June (H. Meltofte pers. obs.).
Snedækket i den centrale del af Ørsted Dal vurderet fra helikopter og fly under passage af dalen hvert år omkring 1. juni.

Year	Date	Central valley
1996	3 June	Predominantly snow covered
1997	27 May	Much snow
1998	26 May	Extensive snow cover
1999	1 June	80-90% snow cover
2000	3 June	Much snow-free ground
2003	2 June	More than 90% snow cover
2004	1 June	80-90% snow cover
2005	31 May	Very little snow left

melt. Purple saxifrage *Saxifraga oppositifolia* and snow whitlow-grass *Draba nivalis* were blooming extensively at our arrival in both areas, but very few other plants were flowering until some days into our stay. The upper valley, which we covered first, also had the earliest phenology – flowering of 11 common plants and emergence of two insects were 1-9 days later than at Zackenberg in the upper valley, and 3-15 days later in the central valley. Compared with Zackenberg in 1996-2009 (H. Meltofte pers.obs., J. Hansen in litt.), most dates of flowering and insect emergence in Ørsted Dal in 2009 were in the late end of the range.

We did not see a single collared lemming *Dicrostonyx torquatus;* neither did we see any active summer burrows, although there were several holes, particularly in the upper valley. Similarly, the number of winter nests was very limited, and only few were clearly from the previous winter. At Karup Elv, only 80 km from Ørsted Dal, the lowest number of winter nests were recorded in 2009 since monitoring began here in 1988, whereas lemmings had occurred in some numbers in 2008 (B. Sittler in litt.). Accordingly, arctic foxes *Alopex lagopus* bred in 2008, but although they were commonly seen in Ørsted Dal in 2009, there was no indication of breeding. We saw one or a few almost every day and estimated that about four different individuals occurred in each of the two study areas. Two fox dens, each with 12-33 entrances, were found in both of the study areas, but with no sign of occupation.

Methods

The field method of our censuses was the "rapid assessment" used by Boertmann et al. (1991) which follows the same procedure as used in the initial, all-covering census carried out at Zackenberg during several years (see Meltofte et al. 2009 for a manual). The method strives to cover all "territory holding" pairs and individuals during the period of territory establishment, pair formation and egg-laying – the period in which the birds most actively display territorial behaviour. Ideally, the census should be performed after dispersal of pre-breeding flocks and before initiation of incubation, when many birds become secretive and hard to record (Meltofte 2001). In NE Greenland, however, this period usually lasts for a few days only (between 10 and 20 June), so in practice a census will often have to be extended beyond this ideal period.

We covered the upper study area during 11-16 June and the central area during 19-25 June. Apart from Pink-footed Geese *Anser brachyrhynchus,* we found few nests, so we do not know the egg-laying phenology. But judged from a few incomplete as well as complete wader clutches (see the species accounts) and the relatively late flowering and invertebrate emergence – the latter of decisive importance for initiation of egg-laying in waders (Meltofte et al. 2007a) – we estimate that our timing approximated the ideal timing fairly closely. A census timed this early will produce much higher figures than censuses performed in July, when the failed breeders have left their territories (Meltofte 2001) – as were all previous studies in the area. This is further dealt with in the discussion. It should be noted that several rivulets within the study areas may have been hard to pass during peak spring snowmelt, and hence it would have been difficult to work in the area in mid June in a year where snowmelt was late.

Each study area was covered by transects walked in parallel by the two of us. According to the method, no part of the study area must be observed from a greater distance than 100 m, so we aimed to walk transects 200 m apart; in practice, however, the distance varied between 150 m and 225 m. The upper scree slopes towards the 200 m contour, and especially the extensive outwash fans, were observed from greater distances, while fens and other well vegetated areas were observed from shorter distances.

We used small radios to coordinate our coverage and to make sure that we did not record any birds twice. Furthermore, one of us used a GPS to track our positions, while the other carried a satellite image in order to make recognition of topographic features easier. Yet, due to lack of previous experience with the study areas, our coverage

Table 2. Census results ("territories"/nests) from the two study sites in Ørsted Dal, 2009, together with the results from the central area in 1974 (moderated from Green & Greenwood 1978 to better fit our delimitation of the central area).
Optællingsresultaterne ("territorier"/reder) fra de to undersøgelsesområder i Ørsted Dal, 2009, sammen med resultaterne fra det centrale område i 1974.

Site *Område*	Upper valley		Central valley		Central valley	
Census period *Optællingsperiode*	11-16 June 2009		19-25 June 2009		8-24 July 1974	
Area *Areal* (km²)		17.0		23.0		21.2
	n	Density	n	Density	n	Density
Red-throated Diver *Gavia stellata*			1	+		
Pink-footed Goose *Anser brachyrhynchus*	27	1.6	84	3.7		
Barnacle Goose *Branta leucopsis*	8	0.5	7	0.3	+	+
Northern Pintail *Anas acuta*	1	0.1				
King Eider *Somateria spectabilis*			1	+		
Long-tailed Duck *Clangula hyemalis*	17-23	1.0-1.4	2	0.1	1	+
Rock Ptarmigan *Lagopus mutus*	1	0.1				
Common Ringed Plover *Charadrius hiaticula*	22-29	1.3-1.7	28-30	1.2-1.3	6	0.3
Red Knot *Calidris canutus*	6	0.4	6-7	0.3	5	0.2
Sanderling *Calidris alba*	14-16	0.8-0.9	35-40	1.5-1.7	11	0.5
Dunlin *Calidris alpina*	88-94	5.2-5.5	39-44	1.7-1.9	11	0.5
Ruddy Turnstone *Arenaria interpres*	13-15	0.8-0.9	12-13	0.5-0.6	26	1.2
Red-necked Phalarope *Phalaropus lobatus*	2	0.1			2-3	0.1
Long-tailed Skua *Stercorarius longicaudus*	17-25	1.0-1.5	9-18	0.4-0.8	+	+
Snow Bunting *Plectophenax nivalis*	20-29	1.2-1.7	7-9	0.3-0.4	+	+
Waders total *Vadefugle totalt*	145-162	8.5-9.2	120-134	5.2-5.8	61-62	2.9

was hardly as accurate as at Zackenberg, but more in accordance with the study of Boertmann et al. (1991), in which HM participated.

All birds and other relevant observations were recorded on field maps and on tape, and later each day the observations were copied to census maps. According to the method, all pairs as well as single individuals uttering song, alarm calls or other indicative behaviour are considered as belonging to the local population, i.e. representing a pair/territory (Meltofte et al. 2009). Silent individuals are considered as uncertain pairs/territories, while overflying individuals are neglected.

We used approximately 52 man-hours to cover the upper area and 47 man-hours to cover the central area. In addition to this census time, we collected observations during many hours of hiking and at the camp, but these random observations were not used in the census.

The weather was rarely optimal for bird census work. Most of the time it was windy with "a strong and persistent easterly valley breeze" (Ferns & Mudge 1976) that sometimes blew dust from the flood plain high into the air. When this cold and humid wind was not blowing from the ice-covered Greenland Sea, a slightly milder, dry wind was blowing from inland. The easterly wind often brought fog and sometimes light precipitation, but this rarely hampered our work. Conditions on our arrival with helicopter on 11 June were windy and snowy, and on 22-23 June it was raining and blowing persistently for 24 hours during which the mountains above c. 400 m were covered with new snow. Otherwise, we could work on the tundra every day.

Maps with exact delineations of the study areas and the positions of nests and territories will be presented in a project report. When comparing with previous studies the different timing should be kept in mind (see the discussion), as should the different delimitation of the central study area in 1974 and 2009. Our area in the central valley included more land to the east and less to the west and north-east than the area used in 1974; the latter covered a total of 25 km², but only 21.2 km² was within the borders of our area. Finally, most population figures from 1963 are not comparable with either ours or those from 1974, since Hall & Waddingham (1966) only included actual finds of nests or young.

Species accounts

Red-throated Diver *Gavia stellata*
One pair nested on Pinkfoot Pond in the central study area, where one bird was seen on the nest on both 22 and 24 June. In 1963, two pairs and a single individual were recorded in the valley, including birds on both Pinkfoot Pond and Primula Pond (Hall & Waddingham 1966). Two pairs with chicks were seen in 1974 in lower Ørsted Dal and two pairs in tributary valleys (Ferns & Mudge 1976). In 1984, up to three birds were seen in the lower valley (Cabot et al. 1984).

Pink-footed Goose *Anser brachyrhynchus*
A total of 107 nests of Pink-footed Geese were encountered in the two study areas (Table 2), which is much more than anticipated. In 1961, no breeding records were made in the valley, but in 1963 a total of 25 goslings were seen in the entire valley (Hall & Waddingham 1966). In 1974, the number of goslings was three times higher, and 30 pairs were estimated to have nested successfully in the entire valley (Ferns & Green 1975, Ferns & Mudge 1976). In 1984, the entire valley was censused in June, resulting in 53 breeding pairs (Cabot et al. 1984). Of these, none were found in our upper study area, and only two in the central area. Since our study areas only covered a fraction of the valley (40 km^2 out of c. 260 km^2 lowland), the total today can be many hundreds. This considerable increase has happened in parallel with a tenfold increase in the entire Icelandic-Greenlandic population during the second half of the 20th century (Madsen et al. 1999, Mitchell 2008).

Nests were most often situated on small mounds in fens or on dry tundra, but avoiding the driest parts of the study areas. Several nests were predated by foxes during our stay, and we observed both robbing of single eggs and killing of incubating geese (followed by total depredation of the nest) – all unrelated to our presence (Dinesen 2010). We found 14 predated nests and seven killed adults.

The first goslings were observed on 24 June, when three pairs were encountered with 3, 4 and 4 young, respectively. This is among the earliest known in high-arctic Greenland, where hatching around this date has been recorded only once before (Ferns & Green 1975, Cabot et al. 1984, Madsen et al. 1984a). Allowing 1-2 days from hatching of the first egg until the goslings depart the nest, 26-27 days for incubation and one egg laid per day (typically 4-5 eggs) (Cramp & Simmons 1977), egg-laying must have been initiated shortly after 20 May.

Nowadays, the breeding birds in NE Greenland arrive in mid May (Meltofte 2006a). A mass immigration of more than 2000 Barnacle Geese *Branta leucopsis* and Pink-footed Geese passed the outer Scoresby Sund fjord on 13 May 2009 (C. Egevang in litt.); the proportion of Pink-footed Geese were estimated at c. 20%.

In addition to the breeding birds, 50-100 immature geese occurred in the upper study area and 50-80 in the central study area. The northward moult migration of immature Icelandic Pink-footed Geese, which nowadays mainly takes place during the second half of June (Meltofte 2006a), did not result in many birds passing over our study areas – we counted 283 between 14 June and our departure on 25 June, with a peak on 20 June. In 1983 and 1984, the moult migration did not commence until 24-25 June (Cabot et al. 1984). During the aerial surveys on 18 July 2008, 1310 Pink-footed Geese, including goslings, were counted in the entire valley (Glahder et al. 2010, D. Boertmann in litt.). This is 5.8 times as many as counted in 1963, when a total of 225 moulting birds were recorded in the valley (Hall & Waddingham 1966). Totals of 477 (including 83 young), 970, 456, 368, 912 and 699 were recorded in 1974, 1982, 1983, 1987 and 1989, respectively (Ferns & Green 1975, Madsen & Boertmann 1982, Mosbech & Glahder 1990). In 1984 numbers were low in July due to human disturbance, so totals of 520 were found in June and only 299 in July (Cabot et al. 1984).

In all of Jameson Land, 19 100 Pink-footed Geese were counted from the air in 2008, a threefold increase from 6640 in 1983 (Mosbech & Glahder 1990, Glahder et al. 2010) and a further manifestation of the outstanding increase of this population.

Canada Goose *Branta canadensis*
One individual, apparently of the subspecies *B. c. hutschinsii*, was encountered at Primula Pond in the upper study area on 14 June. There are only a few previous records of this species in NE Greenland (Boertmann 1994, Hansen et al. 2009).

Barnacle Goose *Branta leucopsis*
Ørsted Dal is well known for its large colonies of Barnacle Geese nesting at a height of up to 400 m on the mountain bluffs surrounding the valley. In both 1963 and 1974, in the order of 60-70 broods were recorded in the valley (Hall & Waddingham 1966, Ferns & Green 1975, Ferns & Mudge 1976), and in 1984 the population was censused to 201 pairs distributed on nine cliff colonies all around the valley (Cabot et al. 1984).

The Pink-footed Geese had a hard time defending themselves against the many arctic foxes in 2009. Photo: Lars Dinesen.
De Kortnæbbede Gæs blev konstant angrebet af de mange polarræve i Ørsted Dal i 2009.

We counted a minimum of eight pairs on the mountain bluff above our upper valley study area (colony no. 8 with 16 nests in Cabot et al. 1984) together with 106 individuals on the bluffs on the south side of the valley (nos 6 and 7 with 77 nests in Cabot et al. op.cit.). Both figures may include prospectors, but particularly on the south side, many individuals sitting on eggs may have been missed due to the large distance to the cliffs. Also on the eastern corner of Horsedal, near the central study area, where about 30 nest sites were counted in 1974 (Ferns & Green 1975, Ferns & Mudge 1976) and 50 nests in 1984 (no. 4 in Cabot et al. op.cit.), we saw birds on the mountain bluffs.

At the other end of the central study area, three pairs with 2, 2 and 3 goslings, respectively, were encountered at Pinkfoot Pond on 21 June. On 25 June, seven pairs were present here with four broods of one gosling, two of two, and one of four. At both occasions, the families abandoned the ponds at our appearance. Allowing 2-3 days from hatching until appearance in the lowland (Cabot et al. 1984), 24-25 days for incubation, and one egg laid per day (typically 4-5 eggs) (Cramp & Simmons 1977), these clutches must have been initiated around 20 May. This is the earliest ever recorded in Greenland (cf. Cabot et al. 1984, Madsen et al. 1984a, Meltofte 2006a), fitting well with the notion that the arrival of these birds to NE Greenland now takes place already in mid May, with massive immigration recorded over outer Scoresby Sund fjord during 13-16 May 2009 (C. Egevang in litt.; see above).

In addition to the formerly mentioned, flocks totalling 50-100 immatures were found daily in the upper study area and 15-30 in the central area. On 18 July 2008, 2275 Barnacle Geese (including young) were recorded in the entire valley (Glahder et al. 2010, D. Boertmann in litt.). This is a considerably increase from 1961, 1963, 1974, 1982, 1983, 1984, 1987, 1988 and 1989, when totals of 473, 736, 1231, 1688, 1402, 1238, 1480, 1753 and 1299 (some figures including goslings) were recorded, respectively (Ferns & Green 1975, Madsen & Boertmann 1982, Mosbech & Glahder 1990). In all of Jameson Land, a total of 16600 Barnacle Geese was counted from the air in 2008, which is

2.4 times as many as the 6820 recorded in 1983 (Mosbech & Glahder op.cit., Glahder et al. op.cit.). These increases parallel the 6-7-fold increase that occurred of the total NE Greenland population during the second half of the 20th century, so that the population now numbers about 70 000 individuals (cf. Madsen et al. 1999, Mitchell & Walsh 2008).

Northern Pintail *Anas acuta*
A pair was seen on Primula Pond on the upper study area between 14 and 18 June. The species is probably an annual summer vagrant to NE Greenland (Boertmann 1994), and occasional breeding cannot be excluded.

King Eider *Somateria spectabilis*
A pair was seen on the ponds east of Pinkfoot Pond in the central study area on 21 June, and a male was sitting on a pond west of the study area the following day. In 1961, three females were seen in the valley (Marris & Ogilvie 1962), and in 1963, a female with a brood was encountered off the delta of Ørsted Dal in addition to adult birds at Primula Pond and in the lower valley (Hall & Waddingham 1966). None were found in 1974 (Ferns & Mudge 1976), whereas in 1984 up to nine males and six females (including one with two ducklings) were seen in the lower valley and seven males and one female in Primula Pond (Cabot et al. 1984).

Long-tailed Duck *Clangula hyemalis*
In the upper valley study area, 17-23 pairs of Long-tailed Ducks were recorded, mainly on and around Primula Pond, but also at other ponds and water bodies in the study area (Table 2). This figure consists of 17 pairs actually seen and 6-8 males, which may have been unpaired or – less likely – already have had incubating mates. In the central study area, only two pairs were found in the eastern part of the area.

In July 1961, a female with a brood was seen in the valley together with a flock of 16 females (Marris & Ogilvie 1962). In July 1963, two nests/broods were encountered in the entire valley, as were groups of 10 and 12 (Hall & Waddingham 1966). In July-August 1974, 44 adult Long-tailed Ducks together with seven small ducklings were counted in Primula Pond, 1-2 females were found in the central study area and two broods on ponds in the lower valley (Ferns & Mudge 1976). In June 1984, 32 Long-tailed Ducks were counted in the entire valley, of which five pairs occurred in Primula Pond (Cabot et al. 1984).

Gyrfalcon *Falco rusticolus*
An adult Gyrfalcon was seen during the snowfall at our arrival in the upper study area on 11 June, where it was chased by a dozen Long-tailed Skuas *Stercorarius longicaudus*. In 1974, an adult was recorded near the mouth of the valley (Ferns & Mudge 1976), and in 1982, 1983 and 1984 a pair was occupying a nest site on the cliffs of the south side of the upper valley (Madsen & Boertmann 1982, Cabot et al. 1984).

Rock Ptarmigan *Lagopus mutus*
A territorial male was recorded in the upper study area on 15 June. Otherwise, the remains of a total of eight Rock Ptarmigans were found in the upper study area and seven in the central study area. All of them consisted of winter plumage feathers, and most likely the birds had been predated by foxes or Gyrfalcons during the previous winter or spring. No records of live birds were made in 1961, 1963 or 1974, whereas varying numbers were seen in 1982 and 1984 (Marris & Ogilvie 1962, Hall & Waddingham 1966, Ferns & Mudge 1976, Madsen & Boertmann 1982, Cabot et al. 1984).

Common Ringed Plover *Charadrius hiaticula*
Ringed Plovers were common in both study areas, with 22-29 territories in the upper area and 28-30 in the central area (Table 2). In the latter area, P.N. Ferns and G.P. Mudge only found seven pairs in 1974 (Green & Greenwood 1978), while in the entire valley they found 252 pairs (Ferns & Mudge 1976). [Note that figures on wader pairs for 1974 given in the text refer to the original census area of 25 km^2, while figures given in Table 2 refer to the reduced area of 21.2 km^2.]

On 15 June, we found a nest with one egg, and on 17 June one with four eggs, both in the upper study area. Except for one Ringed Plover flying high together with two Ruddy Turnstones *Arenaria interpres* on 15 June, we saw no flocks.

Eurasian Golden Plover *Pluvialis apricaria*
A Golden Plover stayed for a short while in the central study area on 20 June, whereupon it left, flying high towards west along the valley. A single bird also stayed briefly in the central valley in 1974 (Ferns & Mudge 1976). The species has been known to breed in southern Jameson Land, southern Liverpool Land and SW Scoresby Land for several decades (Boertmann 1994, Bennike 2007), and two pairs were found in western Jameson Land in 2009 (C. M. Glahder in litt.).

The high Arctic subspecies of Dunlin *Calidris alpina arctica* was a numerous wader breeding in Ørsted Dal. Photo: Lars Dinesen.
Den højarktiske race af Almindelig Ryle Calidris alpina arctica*, som er en talrigt ynglende vadefugl i Ørsted Dal.*

Red Knot *Calidris canutus*
Knots were not particularly numerous in the two study areas, since we only found six and 6-7 territories in the upper and the central study area, respectively (Table 2). Similarly, P.N. Ferns and G.B. Mudge found five "territories" in the latter area in 1974 (Green & Greenwood 1978), while they found 16 "territories" in the entire valley (Ferns & Mudge 1976).

On 14 June, we found a nest with one egg in the upper study area. In this area, up to three birds were feeding communally at Primula Pond, and two plus two were flying high together with Ruddy Turnstones. Also in the central study area, up to four knots were feeding communally at ponds and on the tundra, and up to two were seen in flocks with Turnstones.

Sanderling *Calidris alba*
Sanderlings were common in both study areas and particularly so in the central area, with 35-40 territories against 14-16 in the upper area (Table 2). P.N. Ferns and G.B. Mudge only found 11 "territories" in the central area in 1974 (Green & Greenwood 1978) and 37 in the entire valley (Ferns & Mudge 1976).

A nest found on 22 June in the central study area only held two eggs. Two Sanderlings were seen feeding together in the upper study area, while in the central study area up to four were feeding communally at ponds, in fens and on arctic heath, mainly together with Dunlins *Calidris alpina*.

At two occasions, Sanderlings with colour bands and flags were recorded in the central study area. Both had been marked in Ghana within the last two years (J. Reneerkens in litt.). Another Sanderling banded in Ghana was seen at Zackenberg in 2009, supporting the presumption that a significant proportion of the Greenland Sanderlings winters in West Africa (Meltofte 1985, Lyngs 2003).

Dunlin *Calidris alpina*
Dunlin was the most numerous wader in both study areas with 88-94 territories in the upper study area and 39-44 in the central (Table 2). P.N. Ferns and G.B. Mudge only found 13 "territories" in the latter area in 1974 (Green & Greenwood

1978) and 87 in the entire valley (Ferns & Mudge 1976), i.e. about the same as we found in the upper study area alone.

We found three nests each with four eggs in the upper study area on 17 June. Communally feeding flocks of Dunlin were found almost daily at Primula Pond, with 24 as the maximum and in addition a flock of 15 passing by on the same day (18 June). In the central study area up to 20 were feeding together at ponds and in fens, with up to seven passing by in flocks.

Ruddy Turnstone *Arenaria interpres*

13-15 Turnstone territories were recorded in the upper study area and 12-13 in the central study area (Table 2). In the latter, P.N. Ferns and G.B. Mudge found as many as 26 "territories" in 1974 (Green & Greenwood 1978), with 71 in the entire valley (Ferns & Mudge 1976).

No nests or eggs were found by us in the upper area (except for a predated egg 15 June). In both study areas up to four birds were seen feeding communally or passing over in flocks with Red Knots and Ringed Plovers.

Red-necked Phalarope *Phalaropus lobatus*

Up to two males and two females were present simultaneously on and around Primula Pond in the upper study area during our entire stay there. None were seen in the central area. In 1963, five adult Red-necked Phalaropes were seen at Primula Pond, and in the central study area one at Pinkfoot Pond, with an additional one in the lower valley (Hall & Waddingham 1966). In 1974, five adults were present at Primula Pond in July, including a pair with two almost fully grown chicks (Ferns & Mudge 1976). In 1982, 13 were seen at Primula Pond (Madsen & Boertmann 1982), while in 1984 up to six were seen here besides two in the lower valley (Cabot et al. 1984). The species is a scarce but regular breeder in southern NE Greenland north to Zackenberg (Meltofte 2006b).

Arctic Skua *Stercorarius parasiticus*

A single light-phase Arctic Skua was seen in the upper study area on 16 and 17 June, and one in the central valley on 24 June. In 1963, the species was found breeding in the central valley (Hall & Waddingham 1966), while none were recorded in 1974 (Ferns & Mudge 1976). In 1984, two birds were seen (Cabot et al. 1984). The species is a scarce breeder in southern NE Greenland, where it primarily breeds near seabird colonies.

Long-tailed Skua *Stercorarius longicaudus*

Long-tailed Skuas were common in both study areas in 2009, but no proof of breeding was obtained. We recorded 17-25 territories in the upper study area and 9-18 in the central study area (Table 2). The birds were often mobbing arctic foxes and Glaucous Gulls (and on 11 June a Gyrfalcon), and it cannot be excluded that a few pairs attempted to breed in spite of the very low lemming density (cf. Meltofte & Høye 2007).

The species was also common in 1961 and 1974, but no breeding was confirmed in these years either (Marris & Ogilvie 1962, Ferns & Mudge 1976). In 1963 and 1984 extensive breeding took place (Hall & Waddingham 1966, Cabot et al. 1984).

Glaucous Gull *Larus hyperboreus*

One or two Glaucous Gulls were seen almost daily in both study areas. Breeding colonies exist at the mouth of Ørsted Dal (Hall & Waddingham 1966, Cabot et al. 1984).

Snowy Owl *Nyctea scandiaca*

A few old pellets from this species were found, but no birds were seen. In 1963 a pair nested in the valley and another in a tributary valley, whereas single individuals were seen in 1961, 1974, 1982 and 1984 (Marris & Ogilvie 1962, Hall & Waddingham 1966, Ferns & Mudge 1976, Madsen & Boertmann 1982, Cabot et al. 1984). However, a pair nested unsuccessfully in the main valley in 1983, and a pair was seen in a tributary valley in 1984 during an aerial survey (Cabot et al. op.cit.; see also Madsen et al. 1984b).

Common Raven *Corvus corax*

Single Ravens were seen almost daily in both study areas. At a few occasions, Ravens were seen flying along the rock faces, where the Barnacle Geese nested. The species is a regular, but sparse breeder in NE Greenland (Boertmann 1994), and it was also recorded in Ørsted Dal at the earlier surveys (Marris & Ogilvie 1962, Hall & Waddingham 1966, Ferns & Mudge 1976, Madsen & Boertmann 1982, Cabot et al. 1984).

Redpoll/Arctic Redpoll

Carduelis flammea/hornemanni

Redpolls were seen on the ground or flying over the study areas at two occasions. A male on 14 June was identified as *flammea*. Both species are scarce breeders in the region, with *hornemanni* being common locally (Boertmann 1994). No records were made in 1974, whereas varying numbers were seen in 1961, 1963, 1982, 1983 and 1984 (Marris & Ogilvie 1962, Hall & Waddingham 1966, Ferns & Mudge 1976, Madsen & Boertmann 1982, Cabot et al. 1984).

Lapland Bunting *Calcarius lapponicus*
Male Lapland Buntings were seen flying over our study areas at two occasions. The species is a scarce breeder in the southern part of the region (Boertmann 1994). There are no previous records from Ørsted Dal.

Snow Bunting *Plectrophenax nivalis*
Totals of 20-29 Snow Bunting territories were recorded in the upper study area and 7-9 in the central area (Table2). Most were found on the scree slopes towards the upper limit of the study areas.

Discussion

The species composition and relative abundance found in our study resemble what was known from the valley and for southern high-arctic Greenland in general, but there are some notable exceptions. First of all, the numbers of Pink-footed and Barnacle geese have increased considerably. For the Pink-footed Goose this increase was especially pronounced in the case of the numbers of breeding pairs found in the study areas. These increases reflect the growth in the populations of both species during the second half of the 20th century, after improved protection from shooting combined with better feeding conditions on the wintering grounds (Madsen et al. 1999).

Secondly, our figures for some of the breeding waders were much higher than recorded in 1974, in case of the Dunlin even surpassing what was then estimated for the whole valley with tributaries. No doubt, this is due to the better timing of our censuses compared with those in 1974, when the census in the central valley took place in mid July and the remaining parts of the valley were surveyed in late July and early August. After early July, only successful breeders remain, whereas unsuccessful breeders leave their territories around 1 July to form post-breeding flocks, and they initiate their southbound migration early (Meltofte 1985). On top of this comes that the coverage of the valley outside the central census area must have been rather cursory, as most of the valley was surveyed by only two persons in a little more than two weeks.

On the other hand, numbers of Common Ringed Plovers and Ruddy Turnstones found in 1974 were surprisingly high, both in the central study area (Ruddy Turnstone) and in the entire valley (both species). It is possible that chick-tending adults giving alarm-calls far from their offspring may have inflated the estimate, a possibility also discussed by P.N. Ferns and G.B. Mudge (Green & Greenwood 1978). This might possibly explain the high figures for Ringed Plover in the general valley, but hardly all of the discrepancy between 1974 and 2009 for Turnstone in the central valley study area, where Ferns and Mudge found almost twice as many pairs as we did, so it would seem that Turnstone numbers have decreased. Interestingly, a similar decrease took place between the 1970s and the late 1980s at Danmarks Havn, 600 km further north (Boertmann et al. 1991), and the mid-winter counts of this population in NW Europe show decreasing numbers during the 1990s followed by an increase in recent years (Wetlands International 2008).

It should be stressed, that our methods are intended to cover all "territory-holding" pairs and individuals regardless of whether they actually breed or not (Meltofte 2001). In this connection, the many communally feeding waders (mainly Dunlins) seen by us are of interest, because all breeders as well as non-breeders ought to be dispersed on territories from mid June until around 1 July (Meltofte 1985). The question is then whether these birds were on feeding excursions away from their territories – a habit previously recorded by de Korte et al. (1981) in southern Jameson Land – or they were genuine non-breeders. Their highly fluctuating numbers might support the first possibility.

The only species missed among those we expected to see was the Wheatear *Oenanthe oenanthe,* but it is known to be scarce in NE Greenland, and only single pairs were found nesting in the valley in 1974 and 1983, although four pairs were recorded in the upper valley in 1982 (Ferns & Mudge 1976, Madsen & Boertmann 1982, Cabot et al. 1984).

Another change compared with pre-1980 visits is the earlier arrival of breeding and moulting Pink-footed and Barnacle geese today, and the correspondingly earlier egg-laying (Meltofte 2006a, this study). Most likely, this can be attributed to the marked climatic amelioration having taken place in NE Greenland during recent decades (cf. Dickey et al. 2008, Hansen et al. 2008), an amelioration resulting in significantly earlier flowering, invertebrate emergence, and egg-laying in waders at Zackenberg (Høye et al. 2007).

Population densities – and egg-laying phenology – of arctic-breeding waders appear to be governed by access to food resources early in the season (Meltofte 1985, Meltofte et al. 2007b). Hence, population densities in high-arctic Greenland are correlated with the ratio of snow-free vegetated ground in early June (Meltofte op.cit., Mortensen 2000). Total densities of waders in Ørsted Dal – 5-9 pairs per km^2 (Table 2) – were similar to other fairly good areas in Jameson Land (Mortensen 2000) and central NE Greenland (Meltofte op.cit., Boertmann et al. 1991), while optimal areas may support up to 14-18 pairs per km^2 (Boertmann op.cit., Meltofte 2006b). That Ørsted Dal does not reach such densities may at least in part be a result of a relatively late appearance of invertebrates in spring – in spite of the much earlier snowmelt compared with the surrounding valleys. Similarly, Long-tailed Skuas were found in densities typical for arctic tundra, but not as high as at Zackenberg (cf. Meltofte & Høye 2007).

For waders, the densities in Ørsted Dal were similar to densities found in the Heden Ramsar Site, where the mining infrastructure is planned to be built (C. M. Glahder in litt.). With the densities found, it is likely that the total wader populations in Ørsted Dal and adjacent valleys – the area proposed by Glahder et al. (2010) as a new Ramsar site instead of the anticipated reduction of the Heden Ramsar Site – number between 1000 and 2000 pairs. This is much more than the numbers supposed to be displaced by the planned infrastructure and associated activities at Gurreholm in the Heden Ramsar Site, provided that no dogs or hunting are allowed in that area.

However, the relative abundance of waders is markedly different between the two sites. Ørsted Dal, with much drier land than Heden, has much higher densities of Common Ringed Plover and Sanderling (the former being almost absent at Heden), whereas densities of Dunlin and Red Knot are several times higher at Heden, where also a few pairs of Golden Plover and Grey Phalarope *Phalaropus fulicarius* are breeding (C. M. Glahder in litt.).

For breeding and particularly for the moulting geese, much larger numbers of Pink-footed Geese are found in the Heden Ramsar Site than in the proposed Ramsar site of Ørsted Dal, implying that this will not fully make up for the likely reduction at the Heden site as a consequence of the planned mining activities. According to the aerial survey performed in July 2008 (Glahder et al. 2010) the proposed Ramsar site in and around Ørsted Dal held c. 3000 moulting Pink-footed Geese, which is only about 60-80% of the number expected to avoid the Gurreholm area after initiation of the mining activities. In contrast, the Ørsted Dal area has considerably more Barnacle Geese than the Gurreholm area.

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We are indebted to Christian Glahder, David Boertmann, Peter N. Ferns, David Cabot and Christian E. Mortensen for critical review of the manuscript and suggestions for several improvements, to Mikkel P. Tamstorf for production of field maps and to Helene Schledermann for digitizing the records from the field maps. The study was financed by the Bureau of Mineral and Petroleum, the Greenland Home Rule.

Resumé

Bestandstætheder af fugle i Ørsted Dal, Nordøstgrønland, 2009

I forbindelse med mineaktiviteter i Scoresby Land, Østgrønland, planlægges der en transportvej, en flyveplads, en havnemole og en række andre faciliteter i Ramsarområdet Heden i det vestlige Jameson Land. For at kompensere for de forringelser, som dette i så fald vil medføre for fuglene i Ramsarområdet, overvejes det at udpege et erstatningsområde omkring Ørsted Dal i det nordøstlige Jameson Land. I den forbindelse har Danmarks Miljøundersøgelser ved Aarhus Universitet gennemført undersøgelser af fuglelivet i Ørsted Dal i juli 2008 (Glahder et al. 2010) og juni 2009. Undersøgelserne i 2009 vedrørte primært ynglefuglene i dalen, og det er disse, der afrapporteres her.

To undersøgelsesområder på hhv. 17,0 km^2 i den øvre del af dalen og 23,0 km^2 i den centrale del af dalen blev dækket hhv. 11.-16. juni og 19.-25. juni. Det centrale område var overvejende sammenfaldende med et område, som blev undersøgt i 1974 (Green & Greenwood 1978).

Områderne blev gennemvandret ad transekter med 200 meters afstand, og alle fugleobservationer noteret på feltkort. Par samt enkeltindivider, der sang eller varslede, blev accepteret som repræsenterende et par/territorium, mens tavse enkeltindivider blev betragtet som usikre par/territorier.

Snesmeltningen var stort set overstået, da vi begyndte tællingerne, idet 2009 havde et usædvanlig tidligt forår (jf. Tabel 1). Vejrer var ikke optimalt under tællingerne, idet det ofte blæser i dalen, men egentligt dårligt vejr blev kun oplevet få dage.

Vi så ingen lemminger, og kun enkelte friske vinterreder blev fundet. Polarræve sås næsten dagligt i undersøgelsesområderne, og vi skønner, at der var 3-4 forskellige individer i hvert af områderne.

Som i andre højarktiske områder var fuglefaunaen domineret af vadefuglene – Stor Præstekrave, Islandsk Ryle, Sandløber, Almindelig Ryle og Stenvender – samt af et stort antal ynglende Kortnæbbede Gæs, især i den centrale del af dalen (Tabel 2). Havlit, Lille Kjove og

Snespurv var også talrige, ligesom Bramgæs ynglede på tilstødende fjeldvægge og siden bragte ungerne ned i lavlandet. De øvrige påviste og potentielle ynglefugle i undersøgelsesområderne var Rødstrubet Lom, Spidsand, Kongeederfugl, Fjeldrype og Odinshane, ligesom Jagtfalk, Almindelig Kjove, Gråmåge, Ravn og Grå/Hvidsisken formentlig ynglende i dalen eller dens omgivelser. Tillige sås Canadagås, Hjejle og Laplandsværling.

De fundne tætheder af vadefugle var væsentligt højere end fundet ved de tidligere undersøgelser, hvilket primært skyldes, at vi optalte fuglene på det optimale tidspunkt i juni, mens de tidligere undersøgelser blev foretaget i juli, hvor alle ikke-ynglende og fejlslagne ynglefugle har forladt territorierne. Dog synes bestanden af Stenvender at være reduceret siden tællingen i 1974 i det centrale område. Omvendt er der nu langt flere både ynglende og ikke-ynglende Kortnæbbede Gæs i dalen, end der var dengang, ligesom det samlede antal Bramgæs er steget kraftigt. Begge dele kan tilskrives den mangedobling af de totale bestande, som er sket i løbet af anden halvdel af de 20. århundrede som følge af bedre beskyttelse mod jagt og forbedrede fourageringsmuligheder om vinteren i Nordvesteuropa, hvor disse fugle overvintrer.

Mangelen på lemminger medførte, at vi ikke fandt sikre beviser for ynglen hos Lille Kjove, ligesom vi ingen Sneugler så. Polarrævenes prædation på de rugende gæs og deres æg var betydelig.

De første Bramgæs med gæslinger sås allerede den 21. juni, og de første klækkede Kortnæbbede Gæs den 24., hvilket er hhv. flere dage tidligere end fundet før og en tangering af den tidligere rekord. Disse datoer betyder, at æglægningen begyndte omkring den 20. maj. Også ankomsten af begge arter synes at ske tidligere nu – midt i maj – end den gjorde i 1950erne, 60erne og 70erne, og både dette og den tidligere æglægning kan formentlig tilskrives klimamildningen, som har været særlig følelig i arktiske områder.

De fundne tætheder af ynglende vadefugle – 5-9 par pr km^2 (Tabel 2) – svarer til relativt gode områder i resten af Jameson Land og til en række udvalgte områder længere nordpå i Nordøstgrønland, men større tætheder – op til 14-18 par pr km^2 – findes flere steder i det centrale Nordøstgrønland, hvor snesmeltningen og produktionen af smådyr starter tidligt (Meltofte 1985, 2006b, Boertmann et al. 1991, Mortensen 2000).

To Sandløbere blev set med farveringe fra Ghana, hvilket sammen med en tilsvarende observation fra Zackenberg dette år bekræfter, at en væsentlig del af Nordøstgrønlands Sandløbere overvintrer i Afrika (Meltofte 1985, Lyngs 2003).

Tæthederne af ynglende vadefugle i Ørsted Dal er fuldt på højde med eller overstiger tæthederne i Ramsarområdet Heden, men den relative hyppighed af arterne er meget forskellig i de to områder. Antallet af Bramgæs er langt større i Ørsted Dal end ved Gurreholm i det nordvestlige Ramsarområde på Heden, mens der er væsentligt flere Kortnæbbede Gæs på Heden end i Ørsted Dal (Glahder et al. 2010).

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Appendix 3. Breeding bird distribution in the Gurreholm area

Filled symbol: Certain territory
Circle around filled symbol: Nest (certain territory)
Open symbol: Uncertain territory

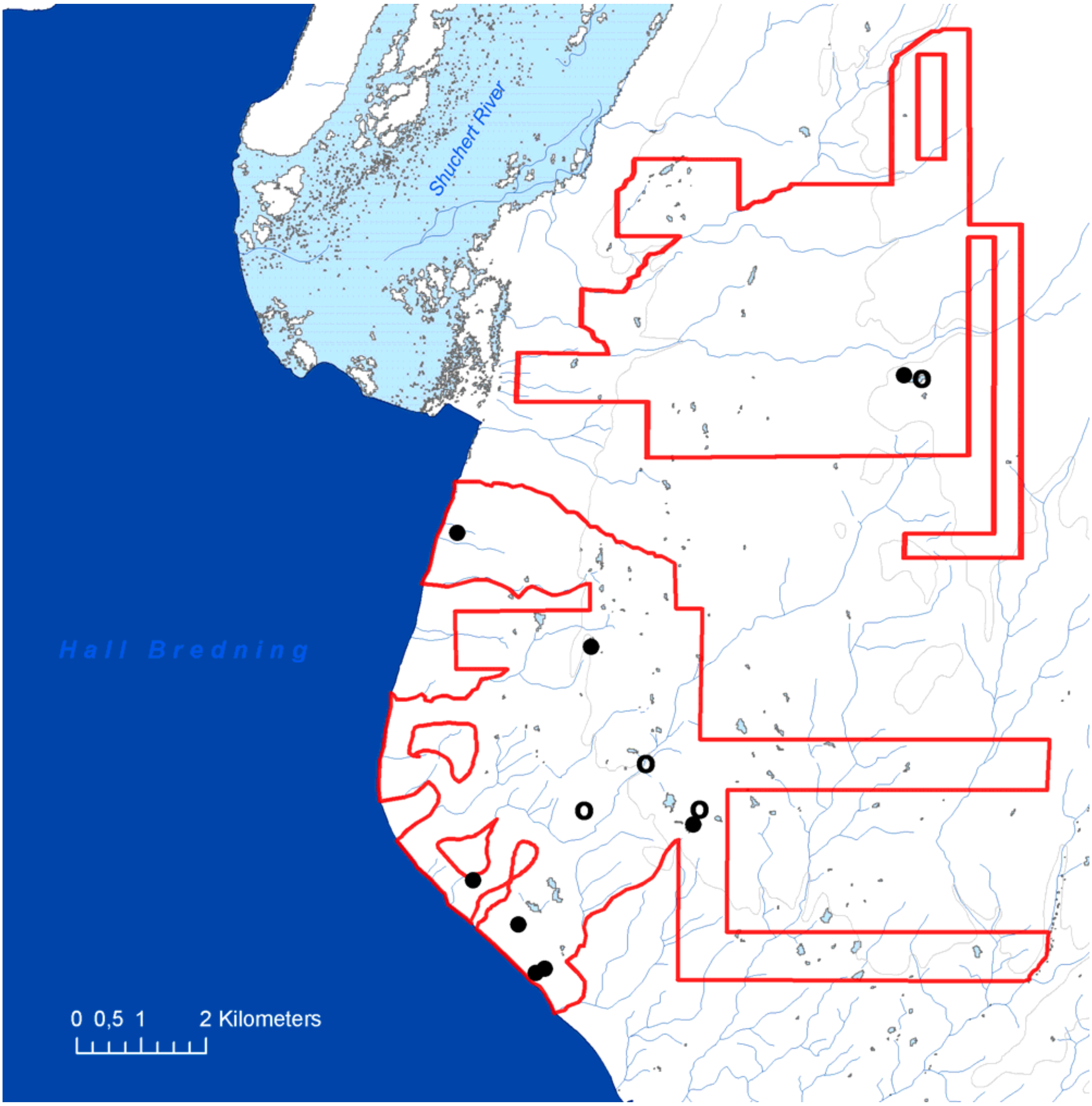

Figure 3. Common ringed plover *Charadrius hiaticula*.

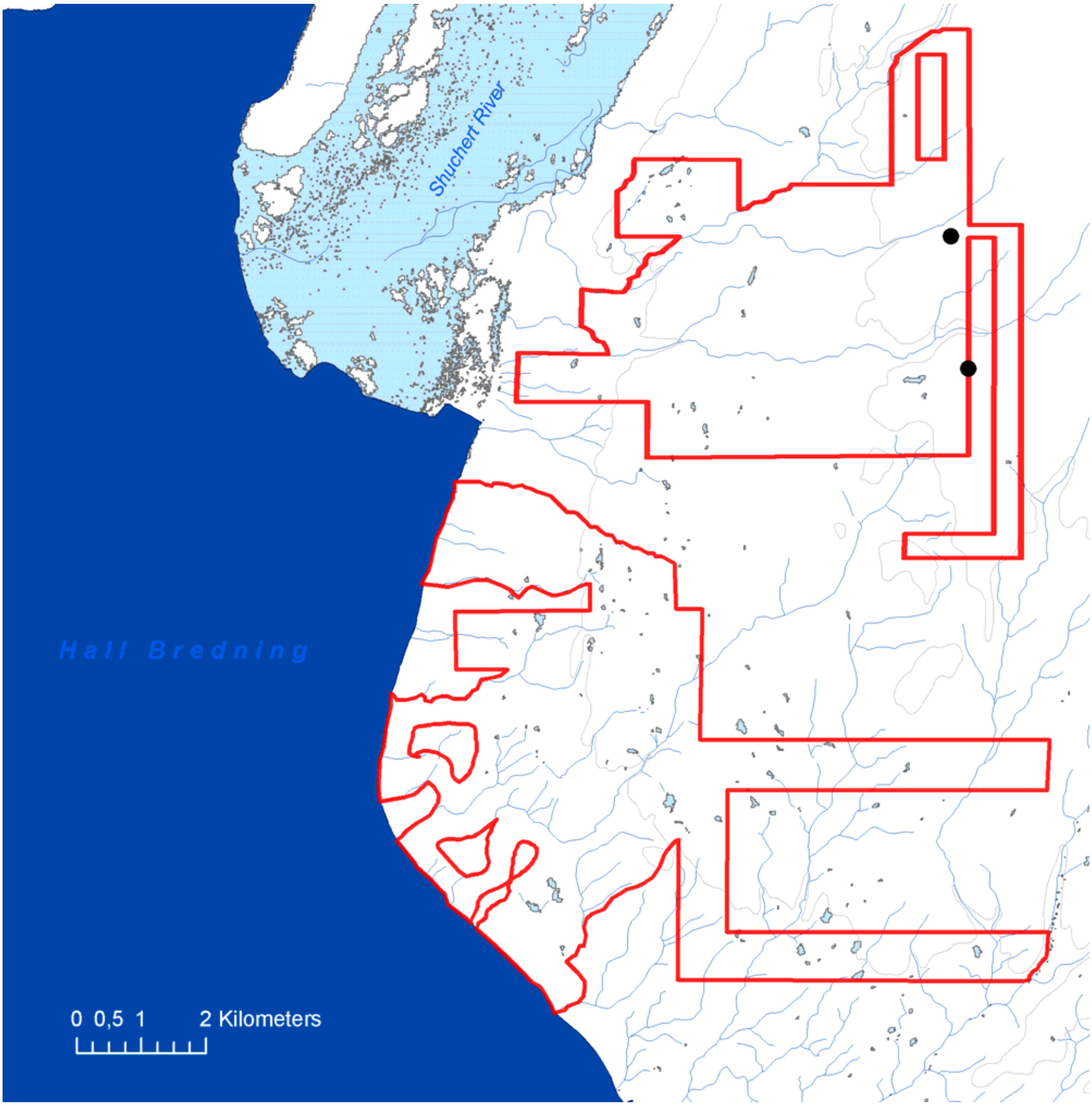

Figure 4. Eurasian golden plover *Pluvialis apricaria*.

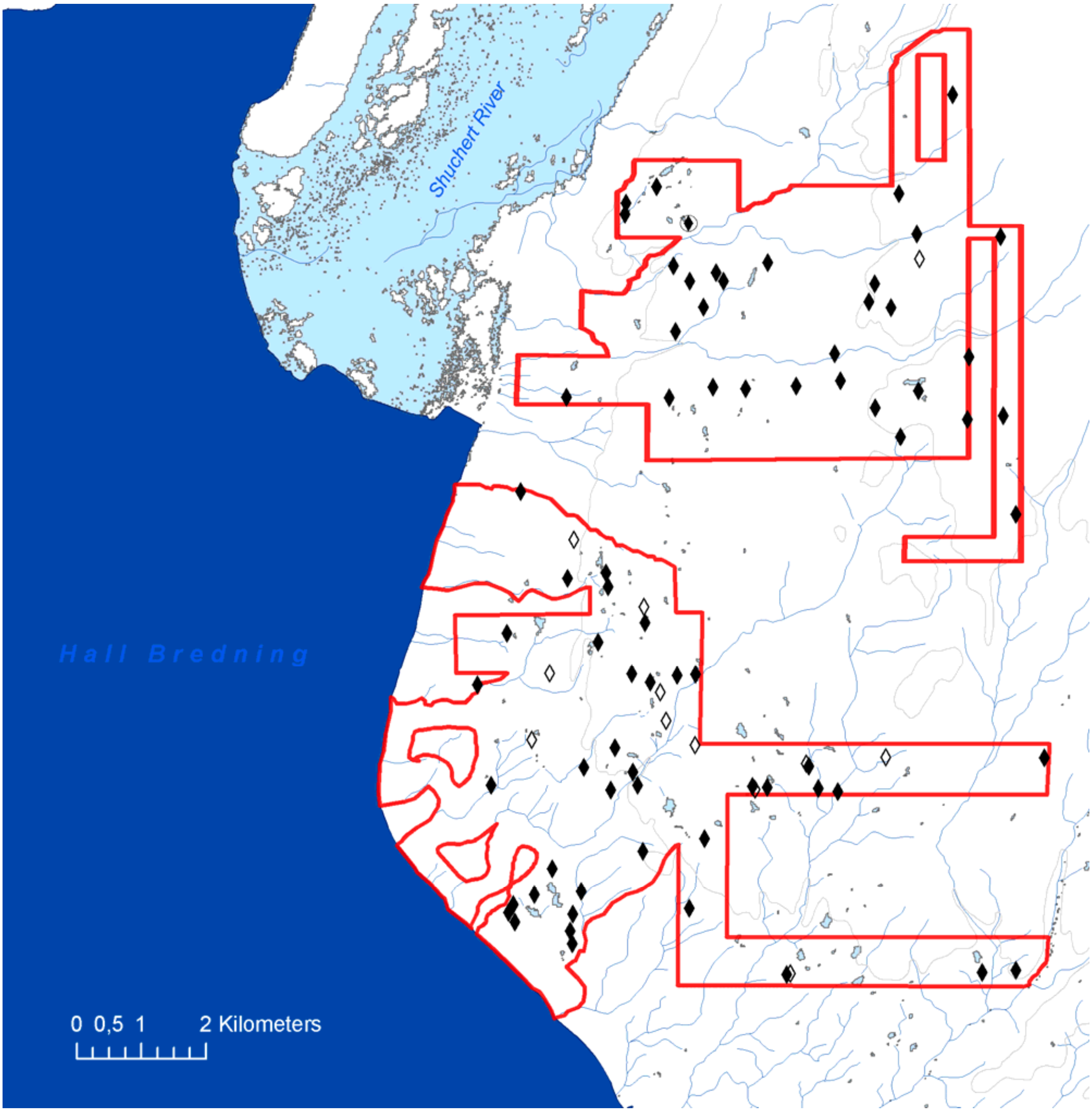

Figure 5. Red knot *Calidris canutus*.

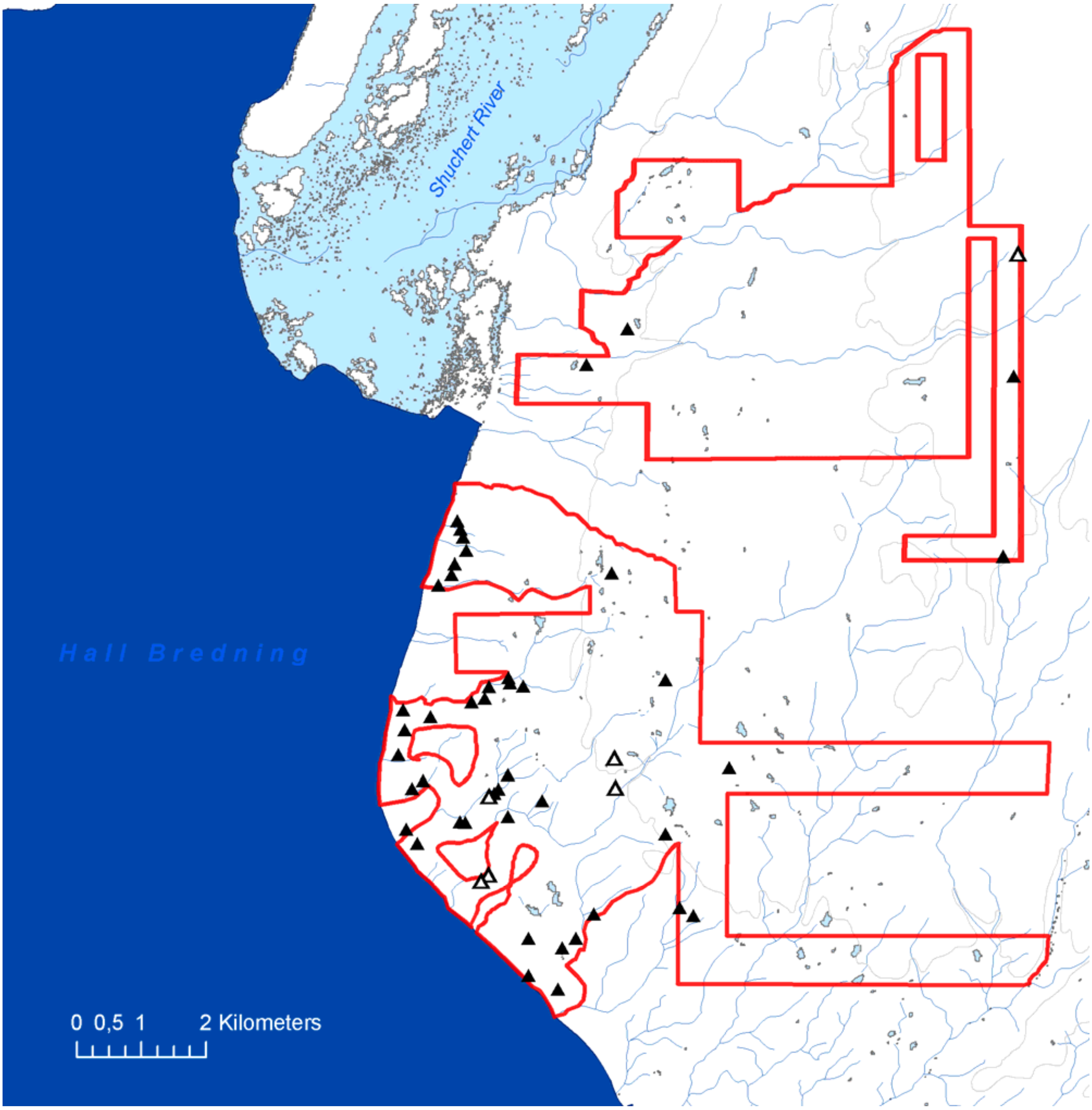

Figure 6. Sanderling *Calidris alba*.

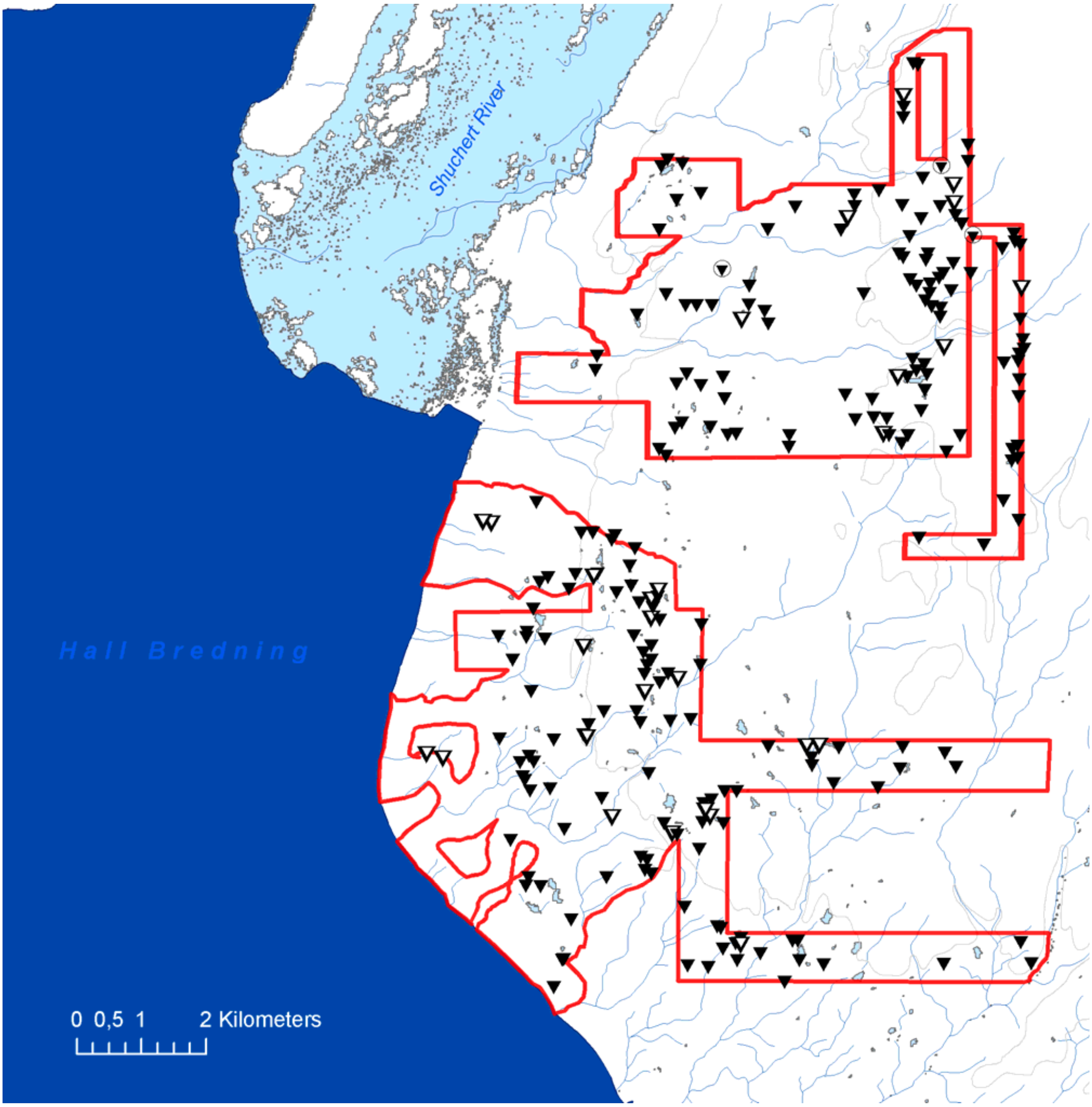

Figure 7. Dunlin *Calidris alpina*.

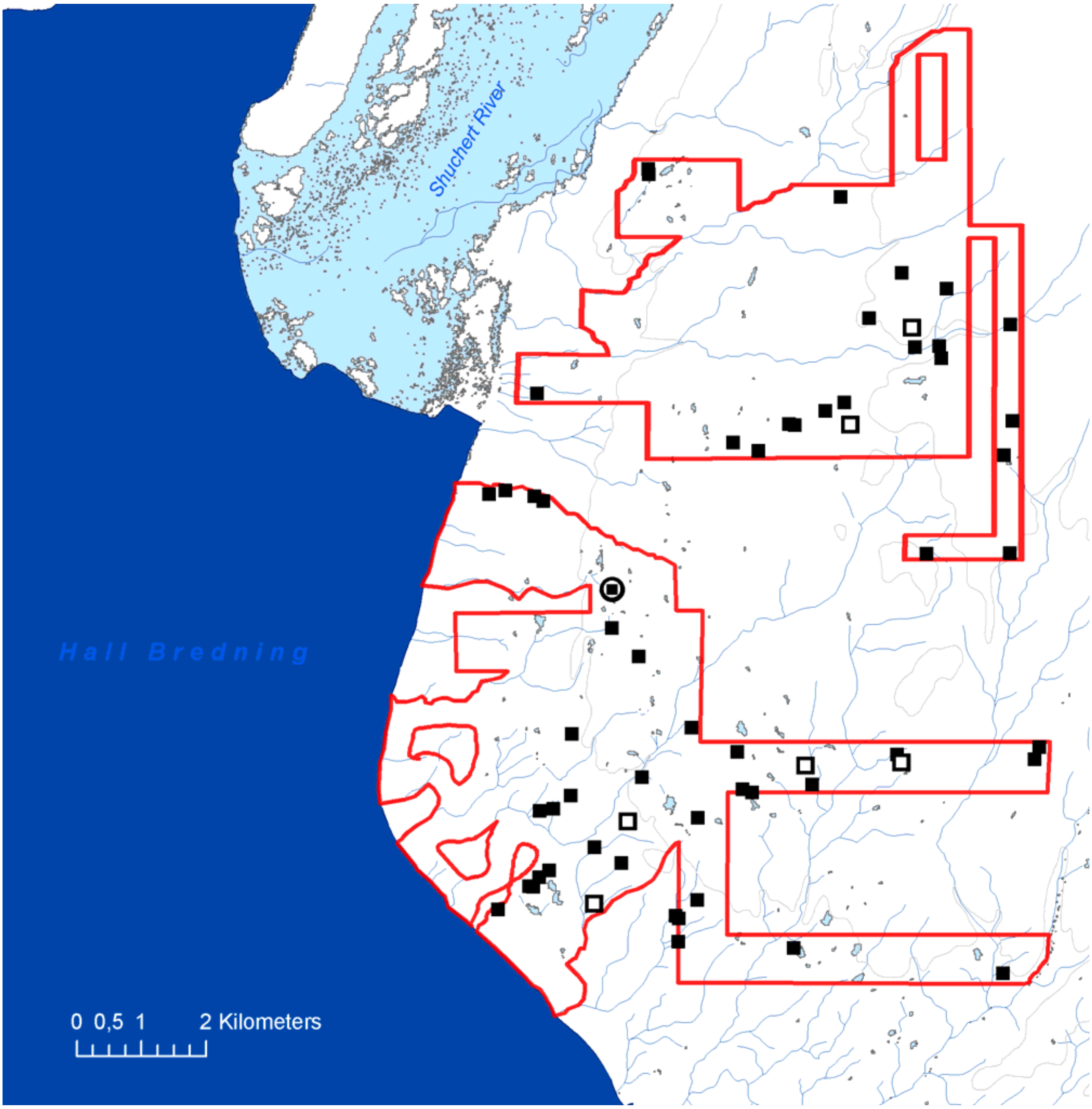

Figure 8. Ruddy turnstone *Arenaria interpres*.

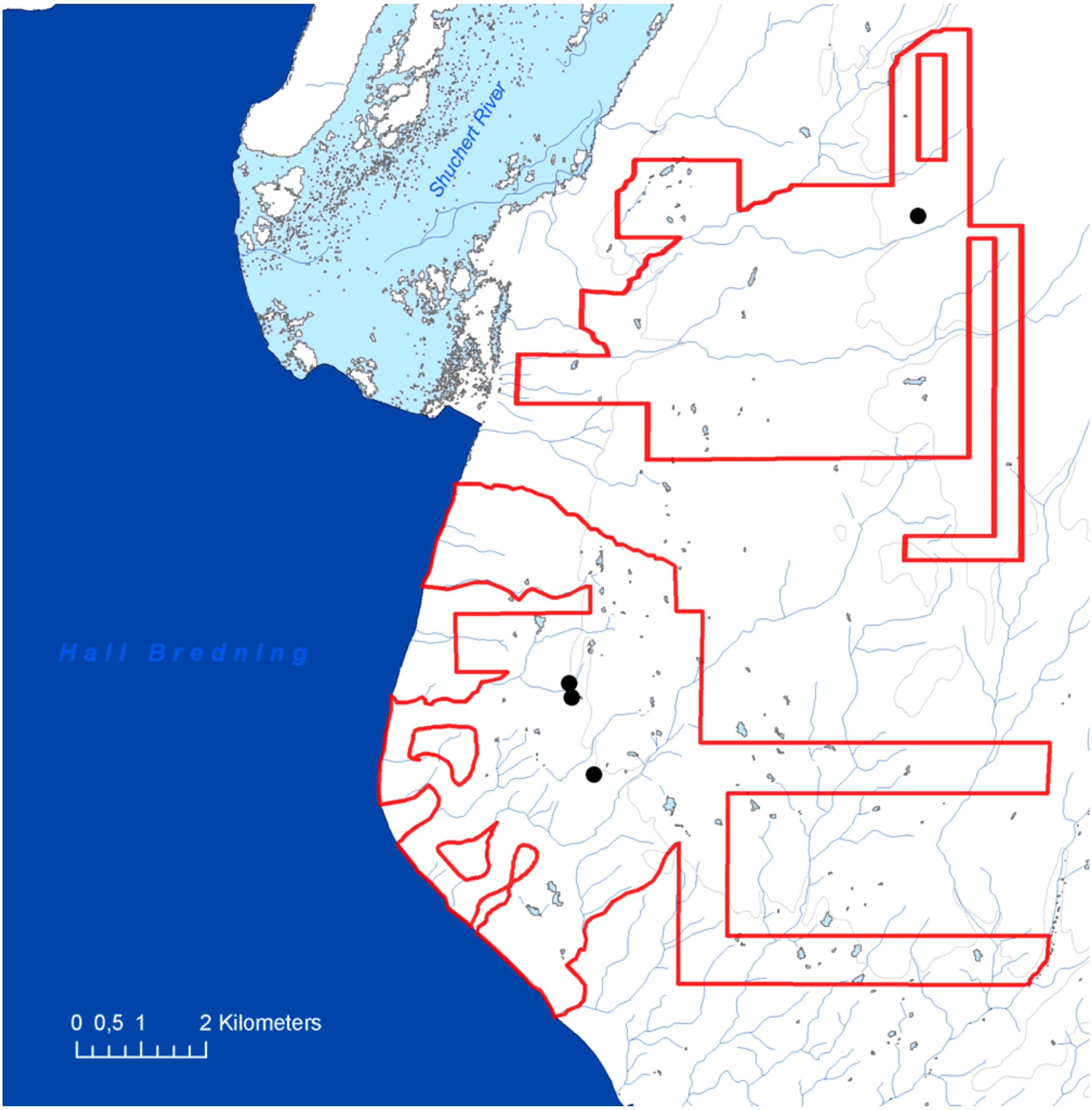

Figure 9. Whimbrel *Numenius phaeopus*.

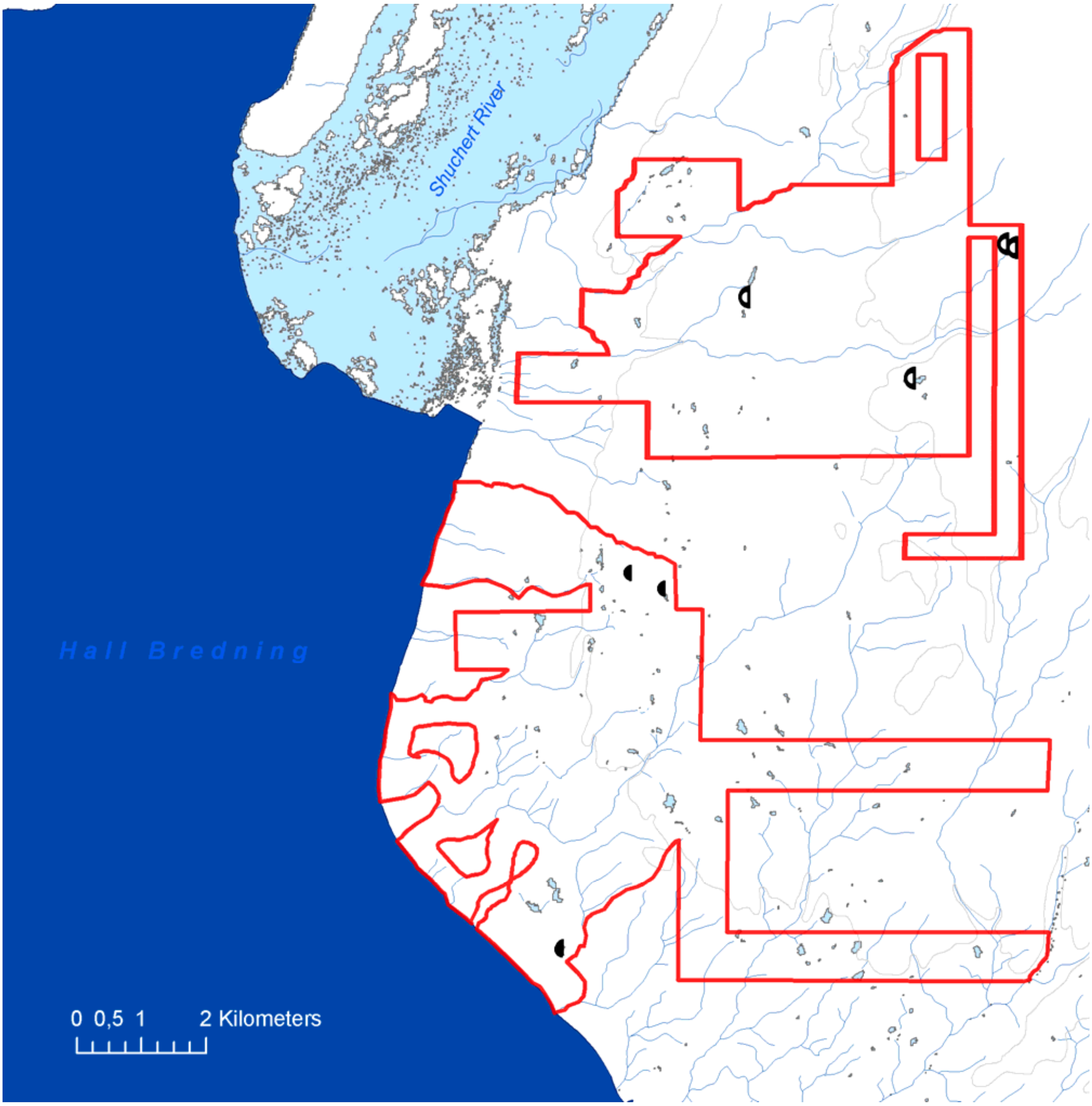

Figure 10. Red-necked phalarope *Phalaropus lobatus*.

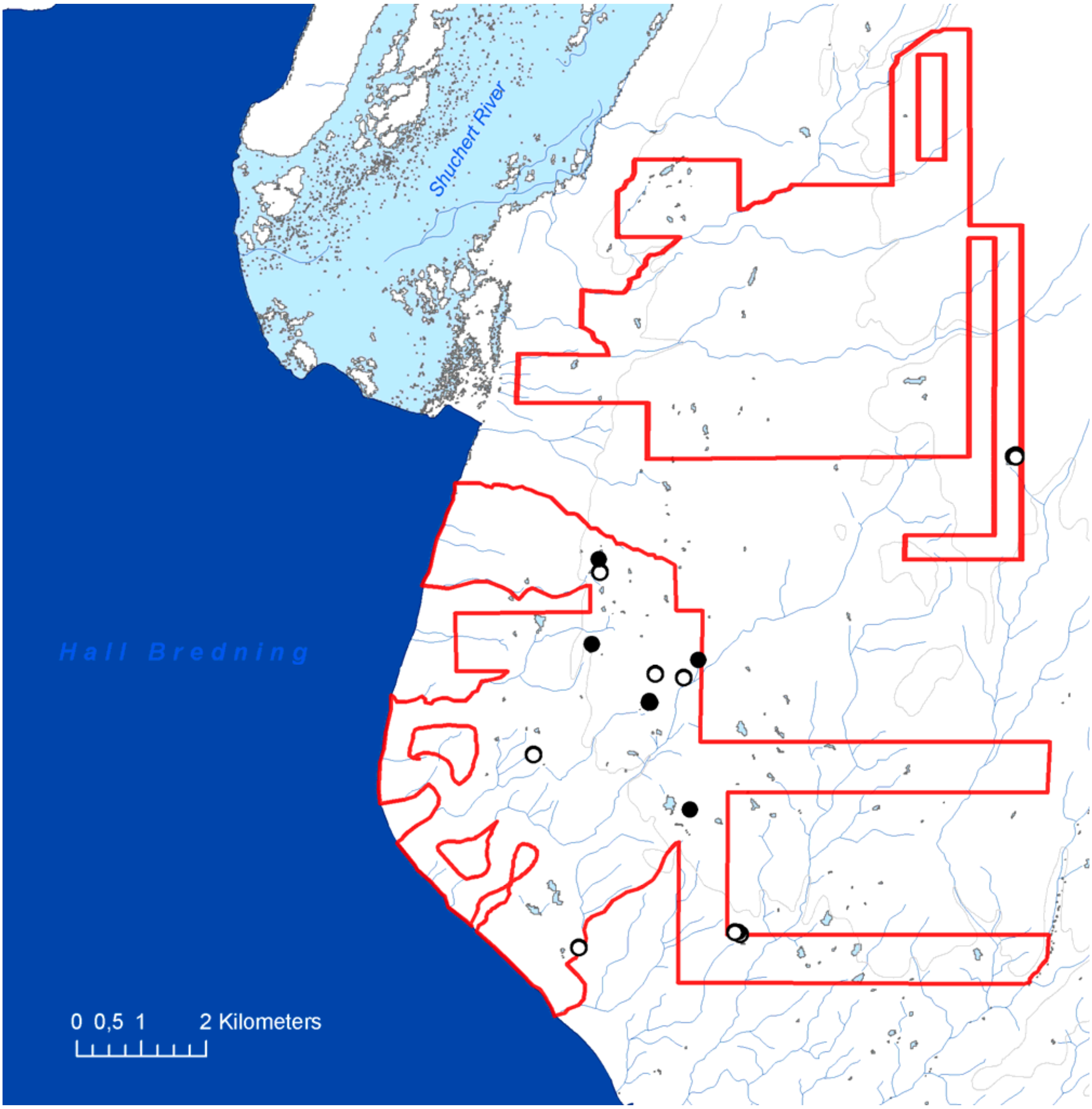

Figure 11. Red phalarope *Phalaropus fulicarius*.

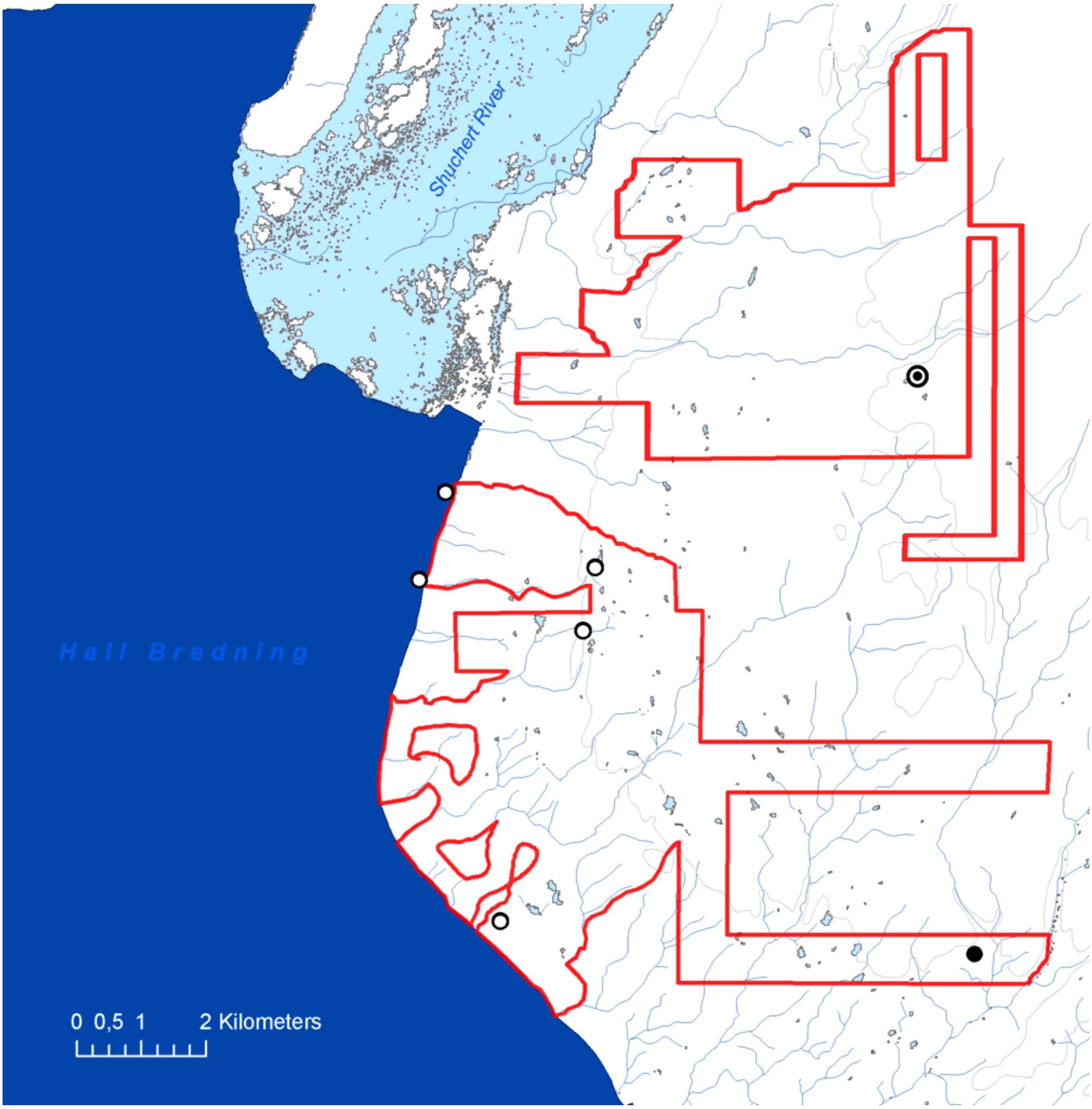

Figure 12. Red-throated diver *Gavia stellata*.

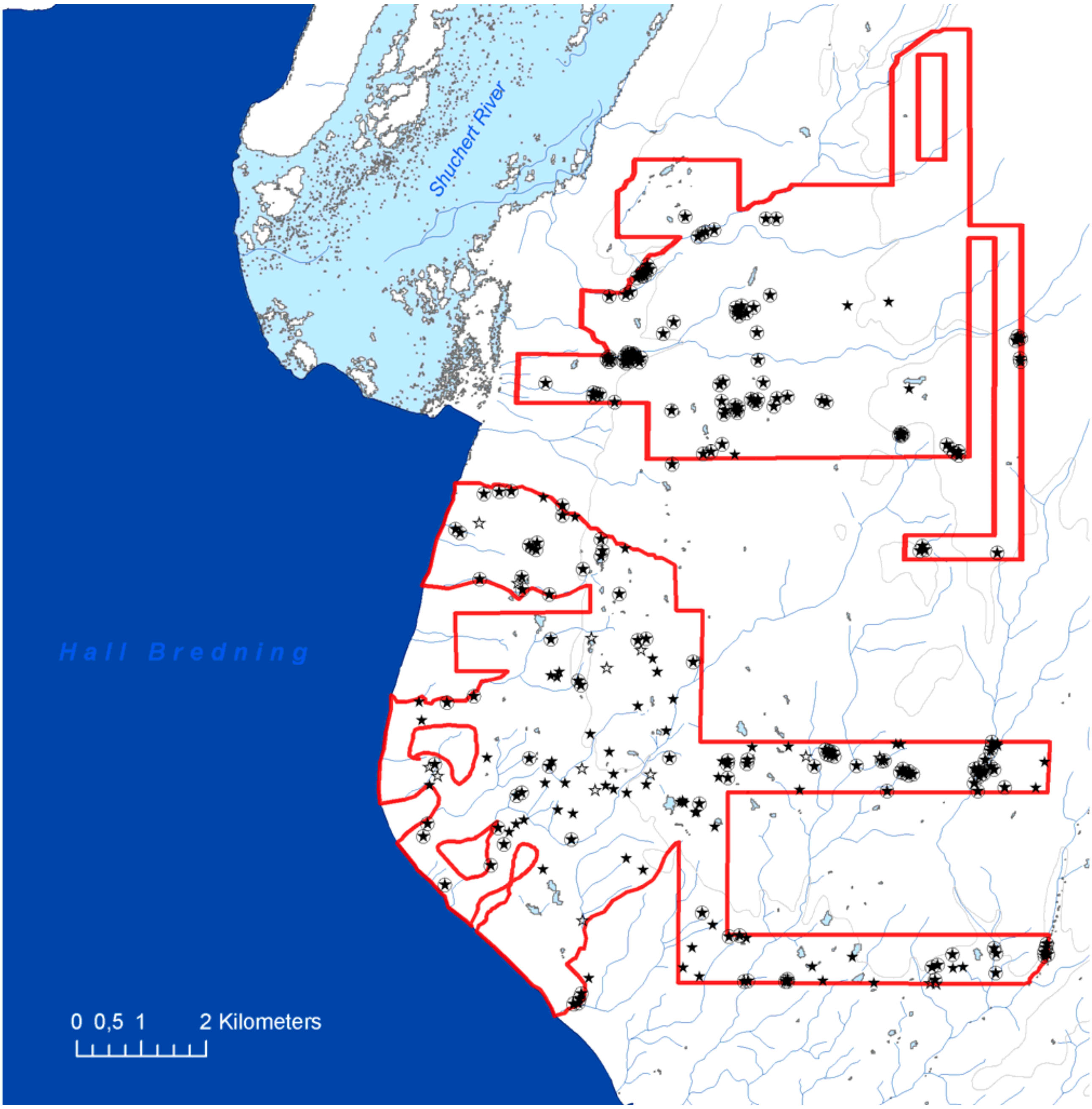

Figure 13. Pink-footed goose *Anser brachyrhynchus*.

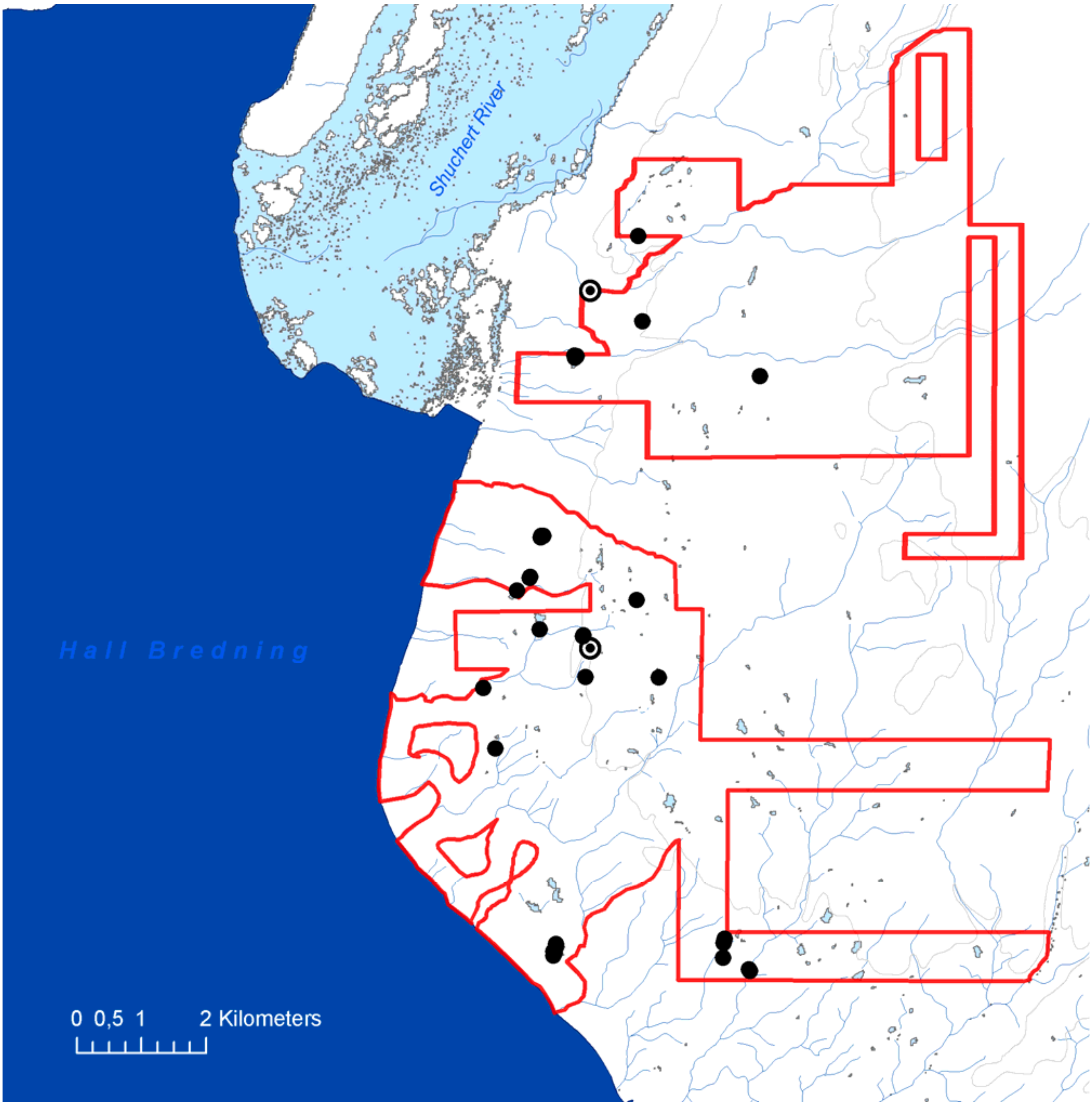

Figure 14. Barnacle goose *Branta leucopsis*.

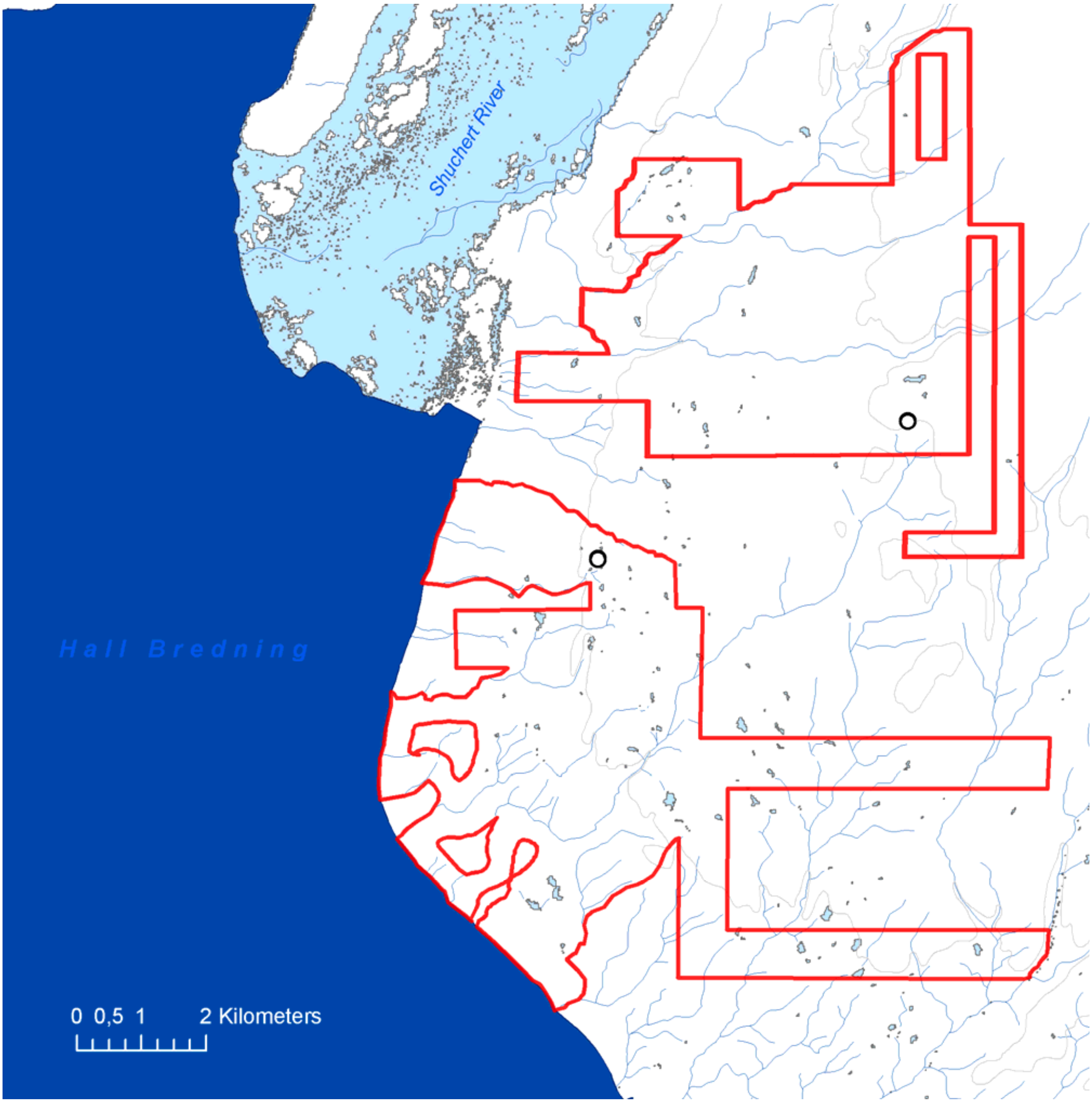

Figure 15. Northern pintail *Anas acuta*.

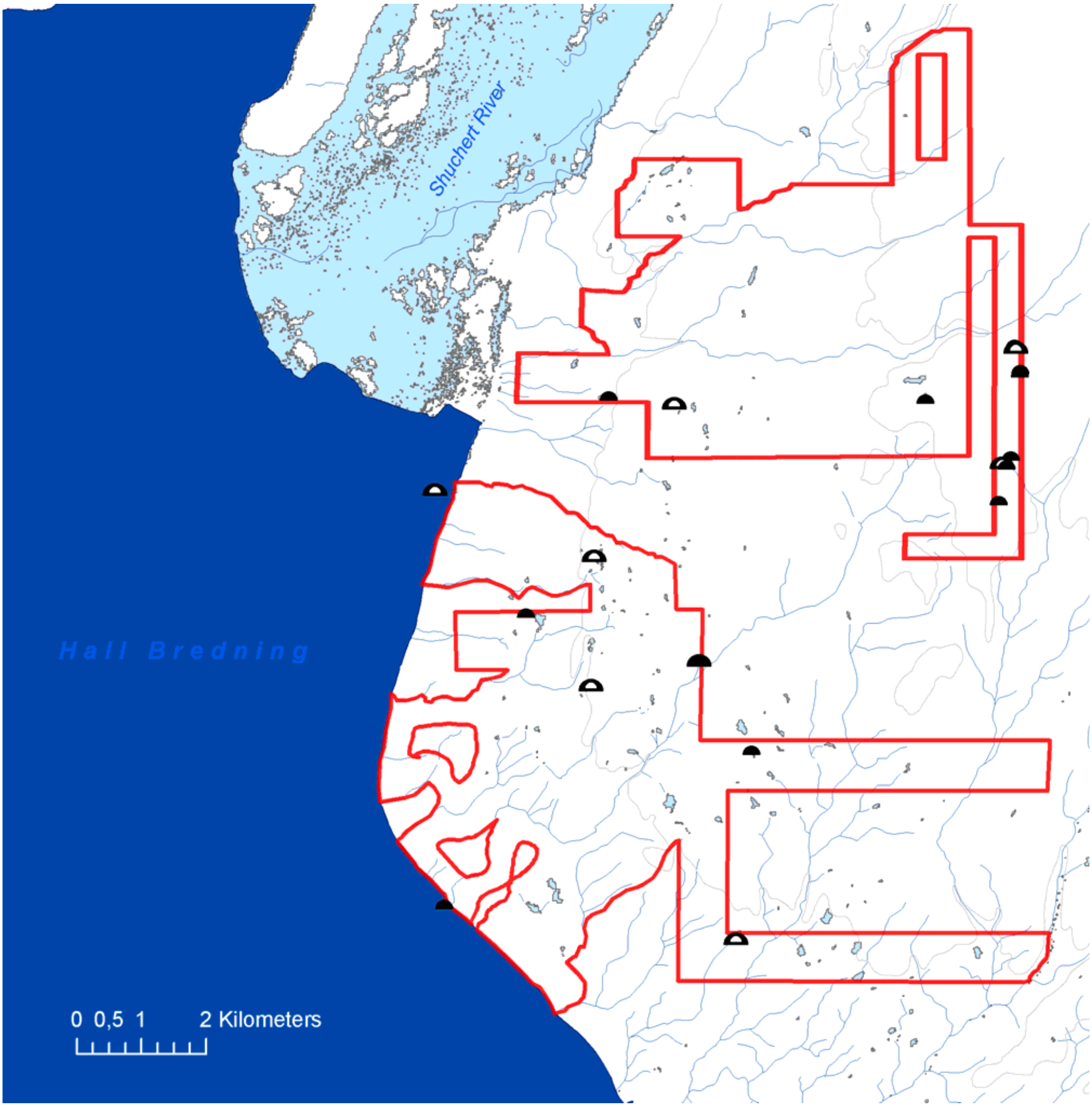

Figure 16. King eider *Somateria spectabilis*.

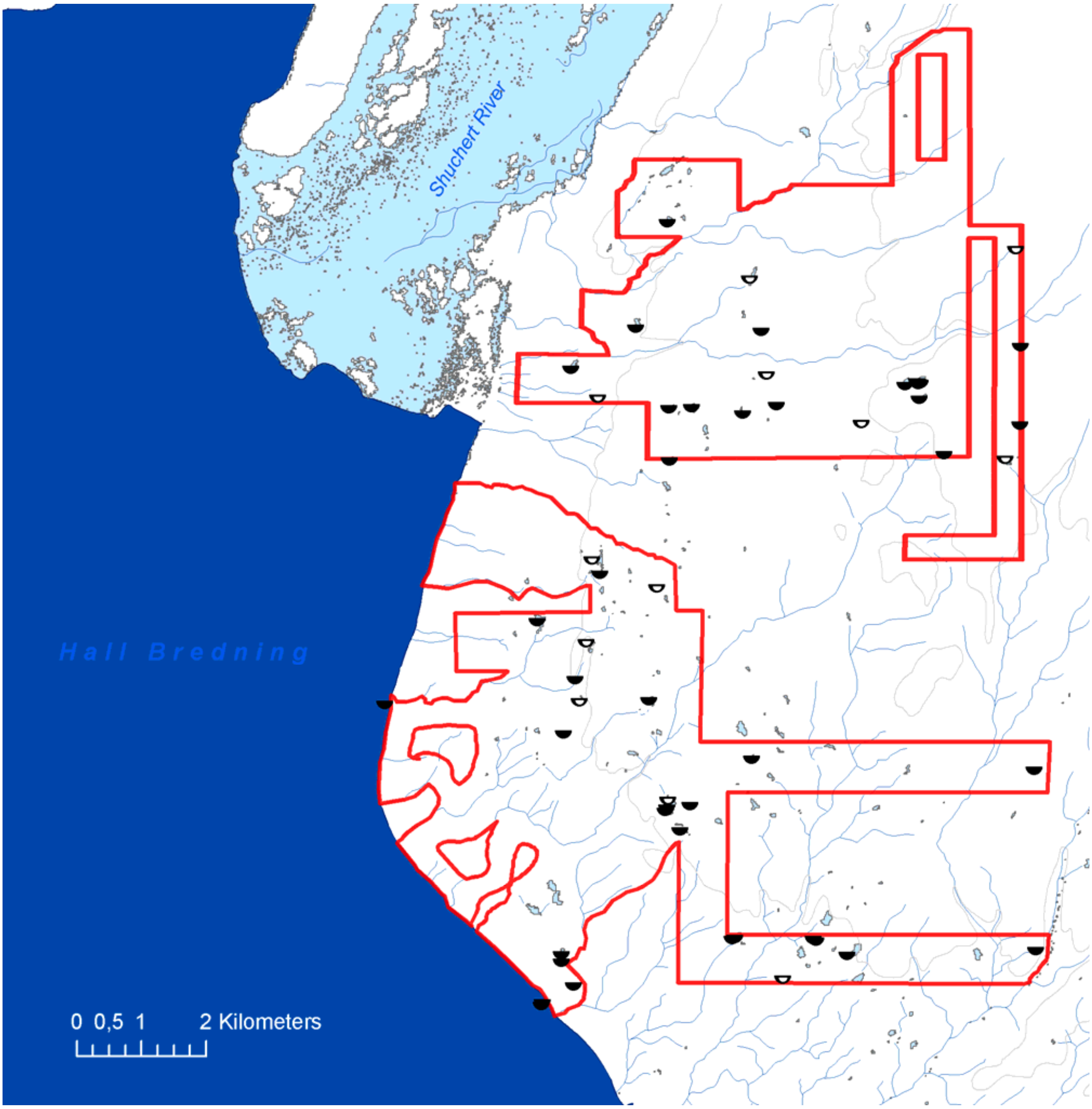

Figure 17. Long-tailed duck *Clangula hyemalis*.

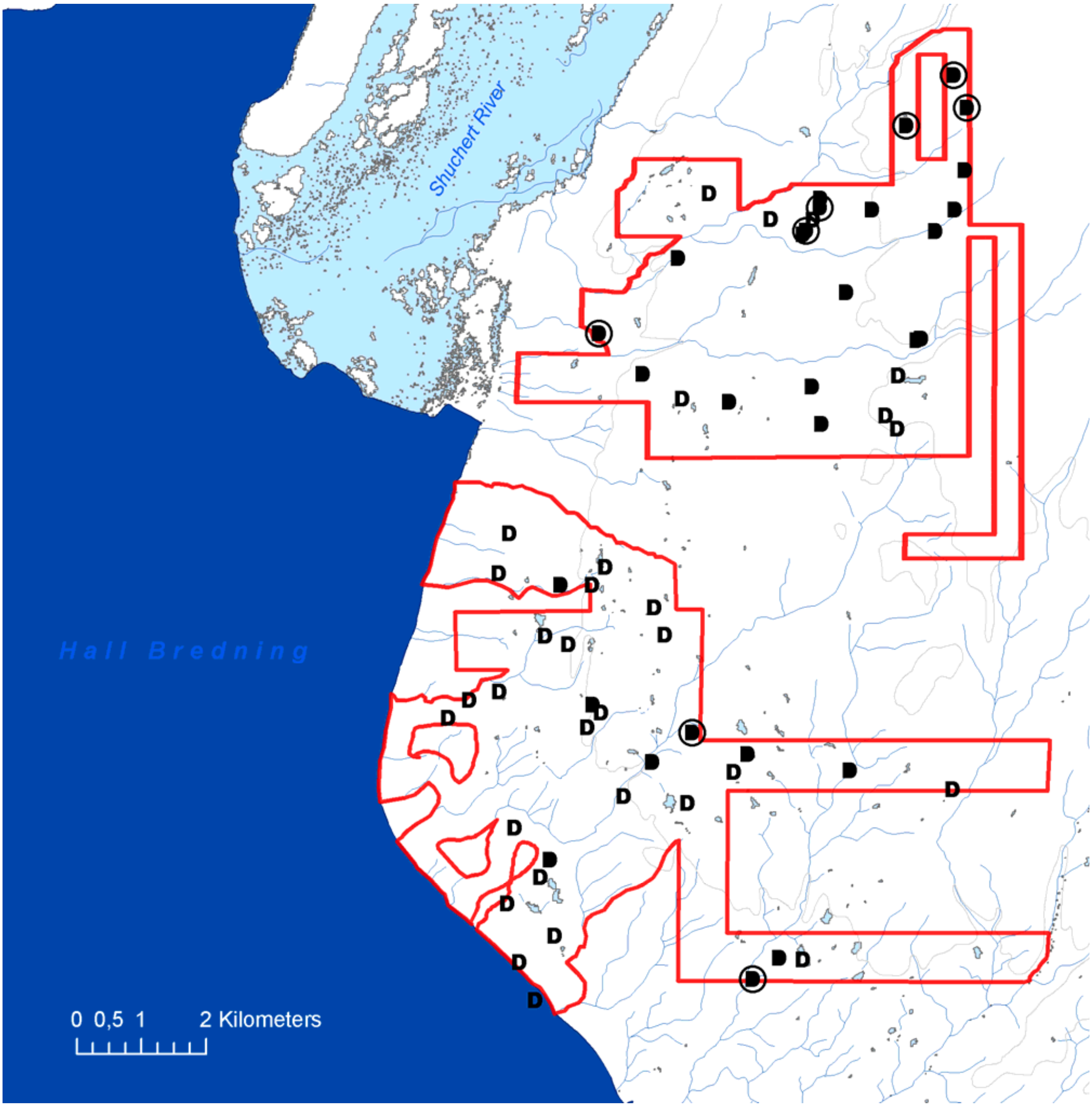

Figure 18. Long-tailed skua *Stercorarius longicaudus*.

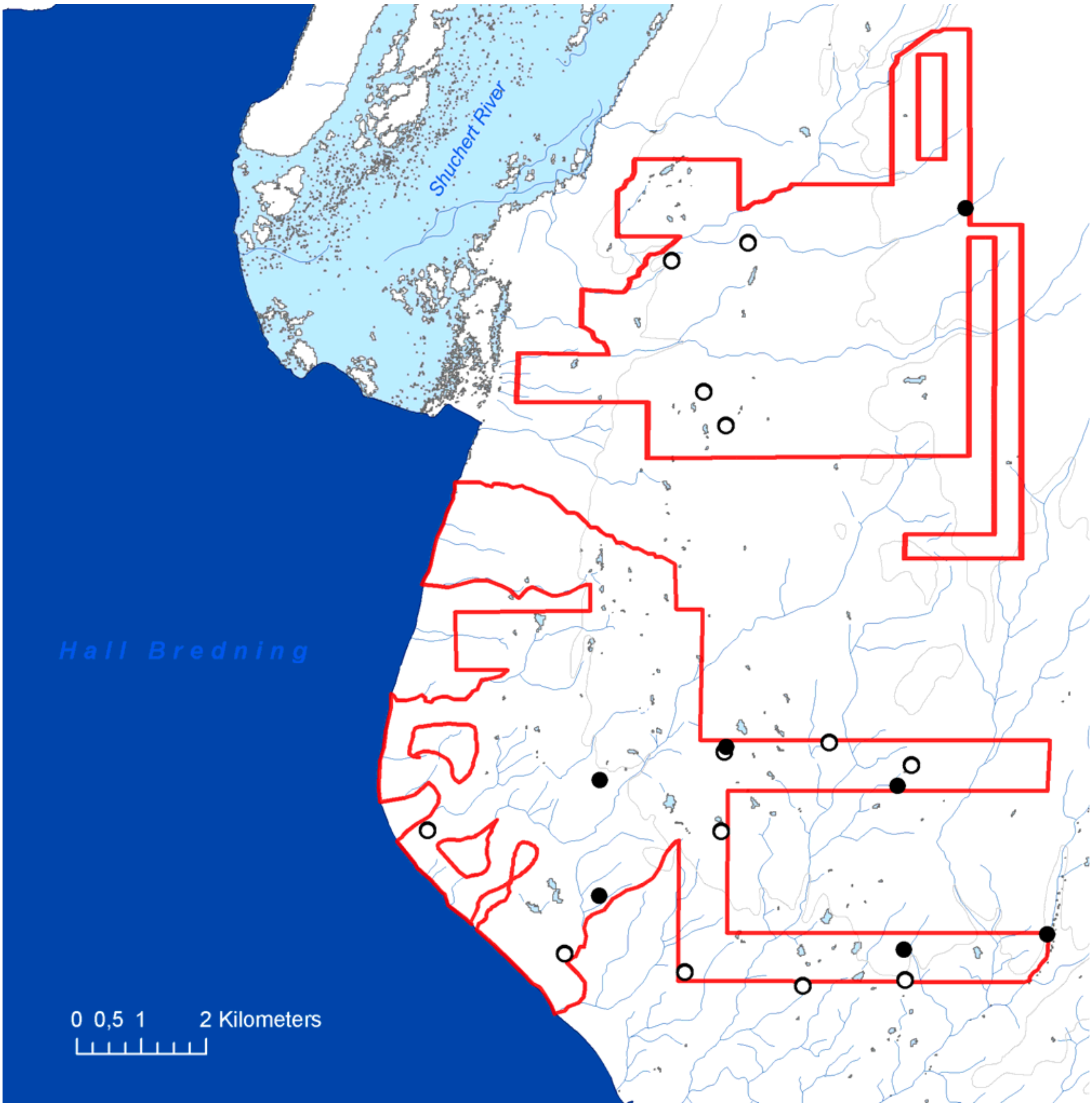

Figure 19. Arctic skua *Stercorarius parasiticus*.

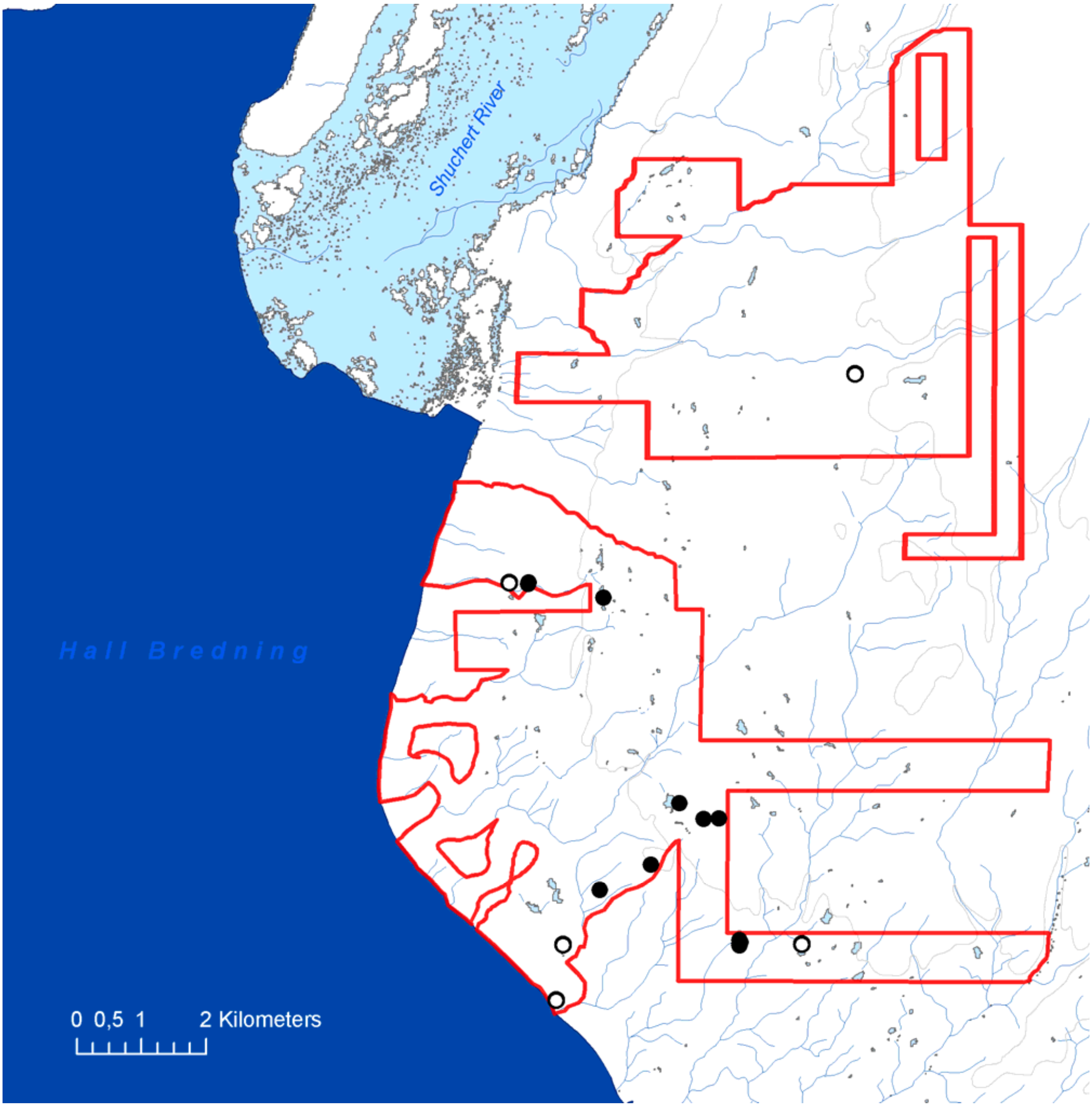

Figure 20. Sabine's gull *Larus sabini*.

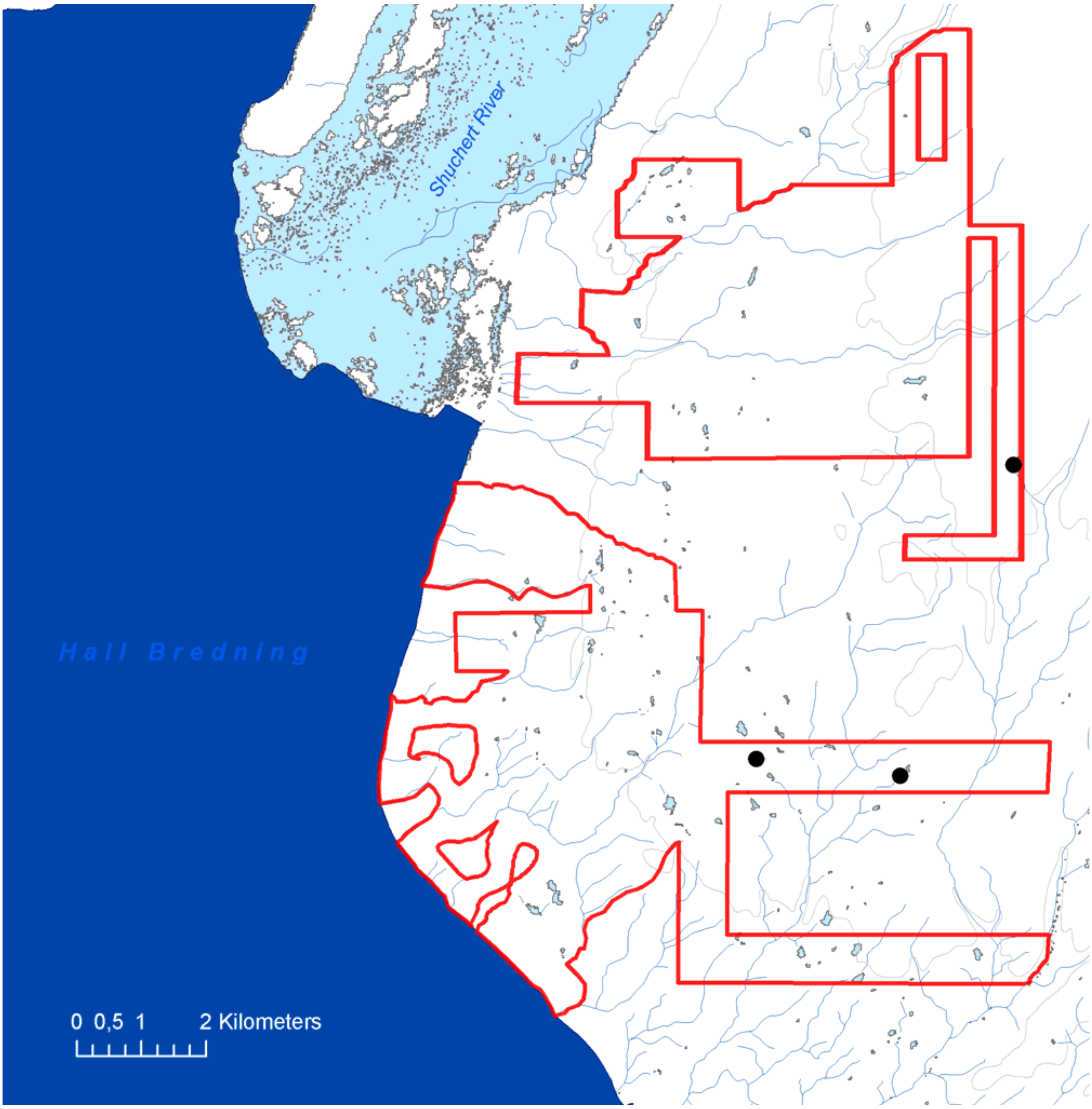

Figure 21. Arctic tern *Sterna paradisaea*.

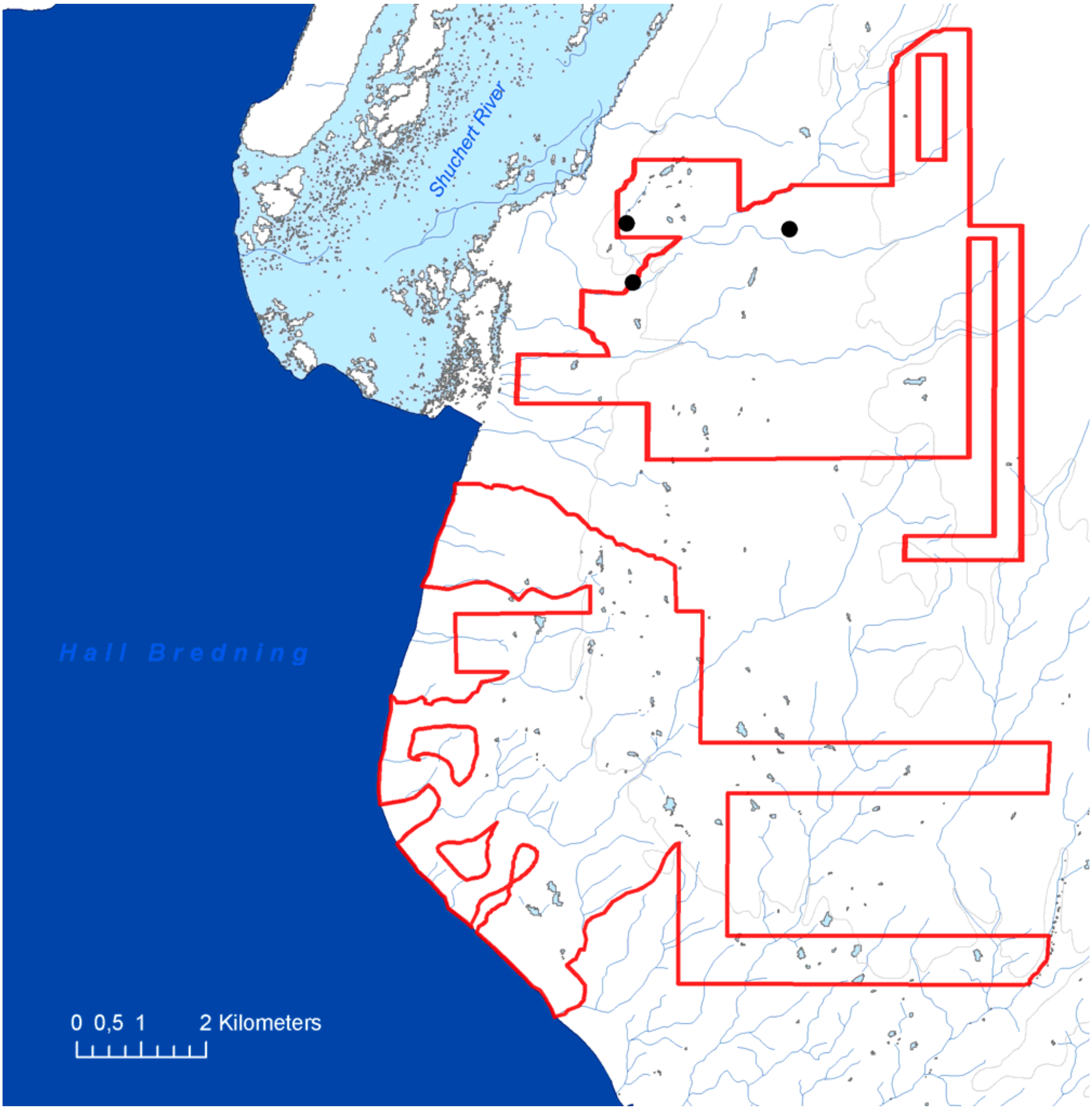

Figure 22. Northern wheatear *Oenanthe oenanthe*.

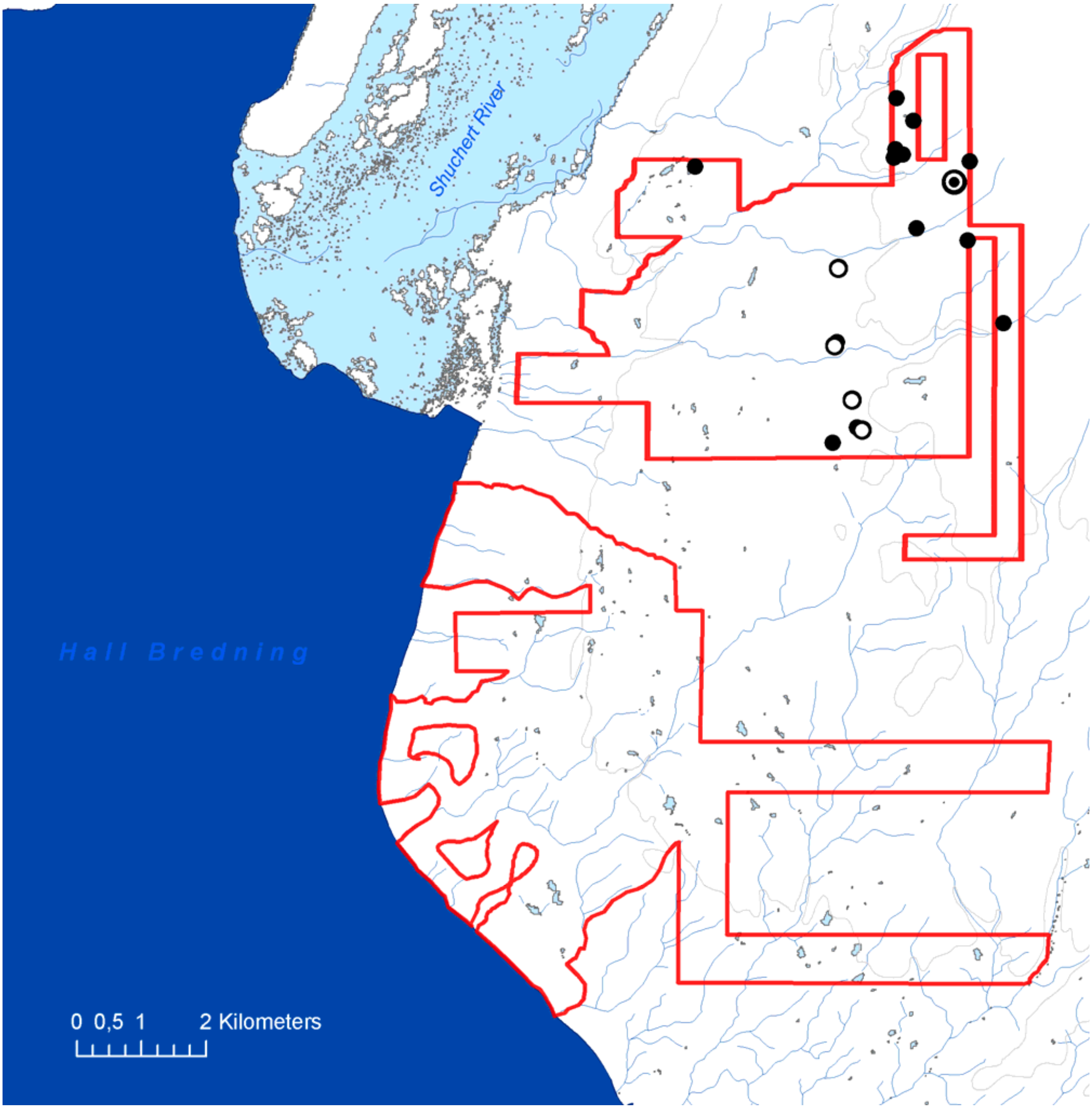

Figure 23. Lapland bunting *Calcarius lapponicus*.

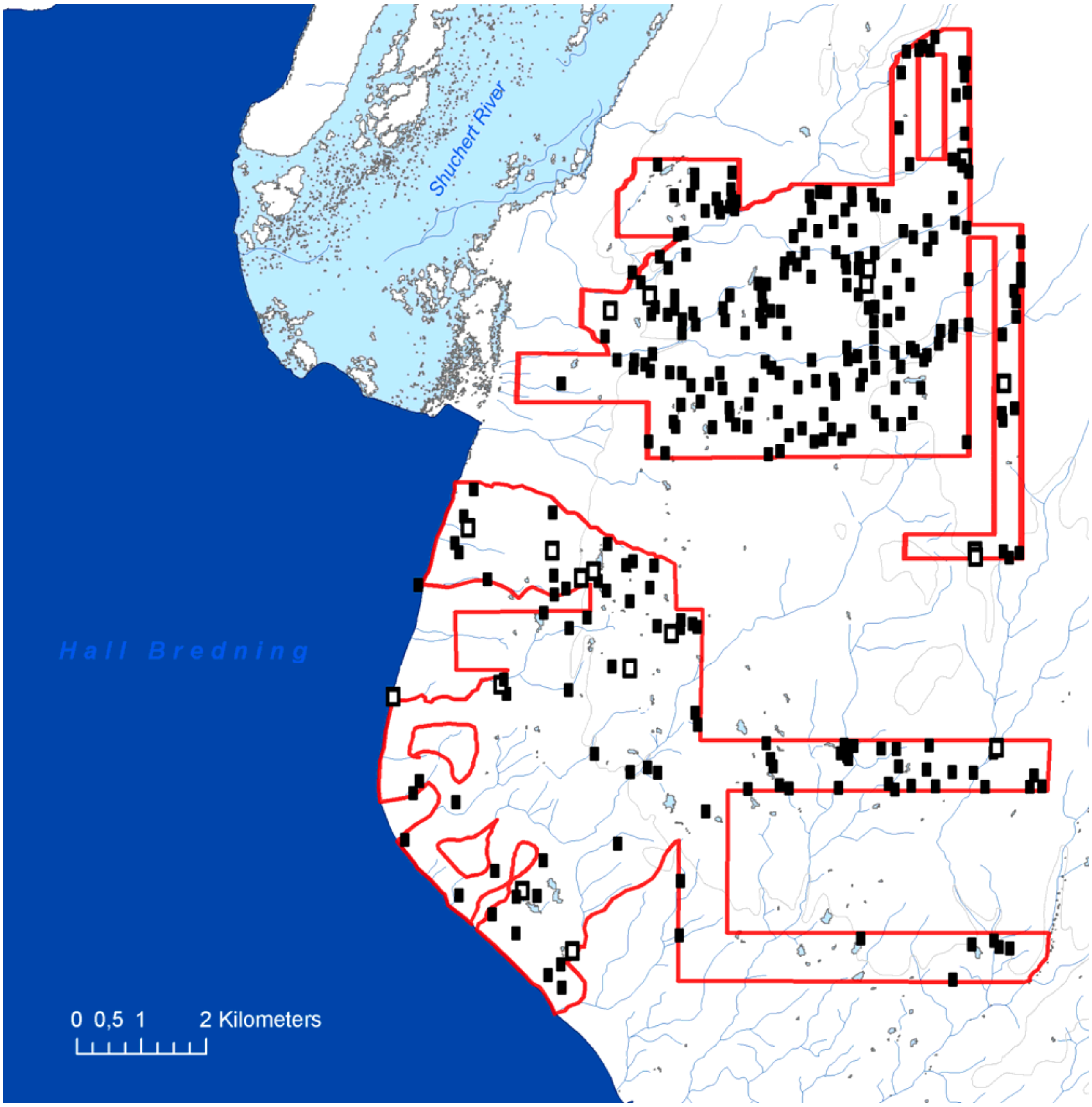

Figure 24. Snow bunting *Plectophenax nivalis*.

Appendix 4. Breeding bird distribution in Ørsted Dal

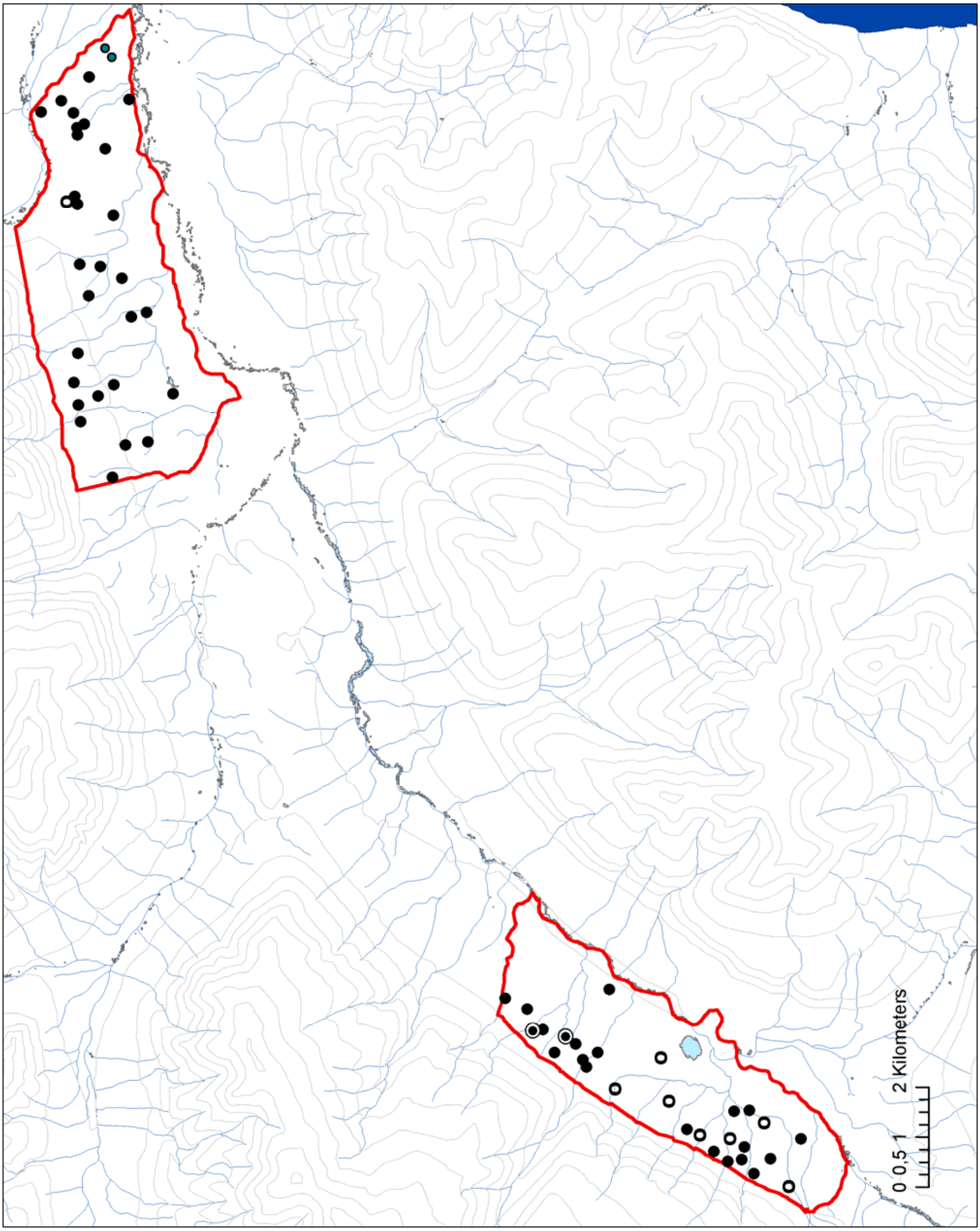

Figure 25. Common ringed plover *Charadrius hiaticula*.

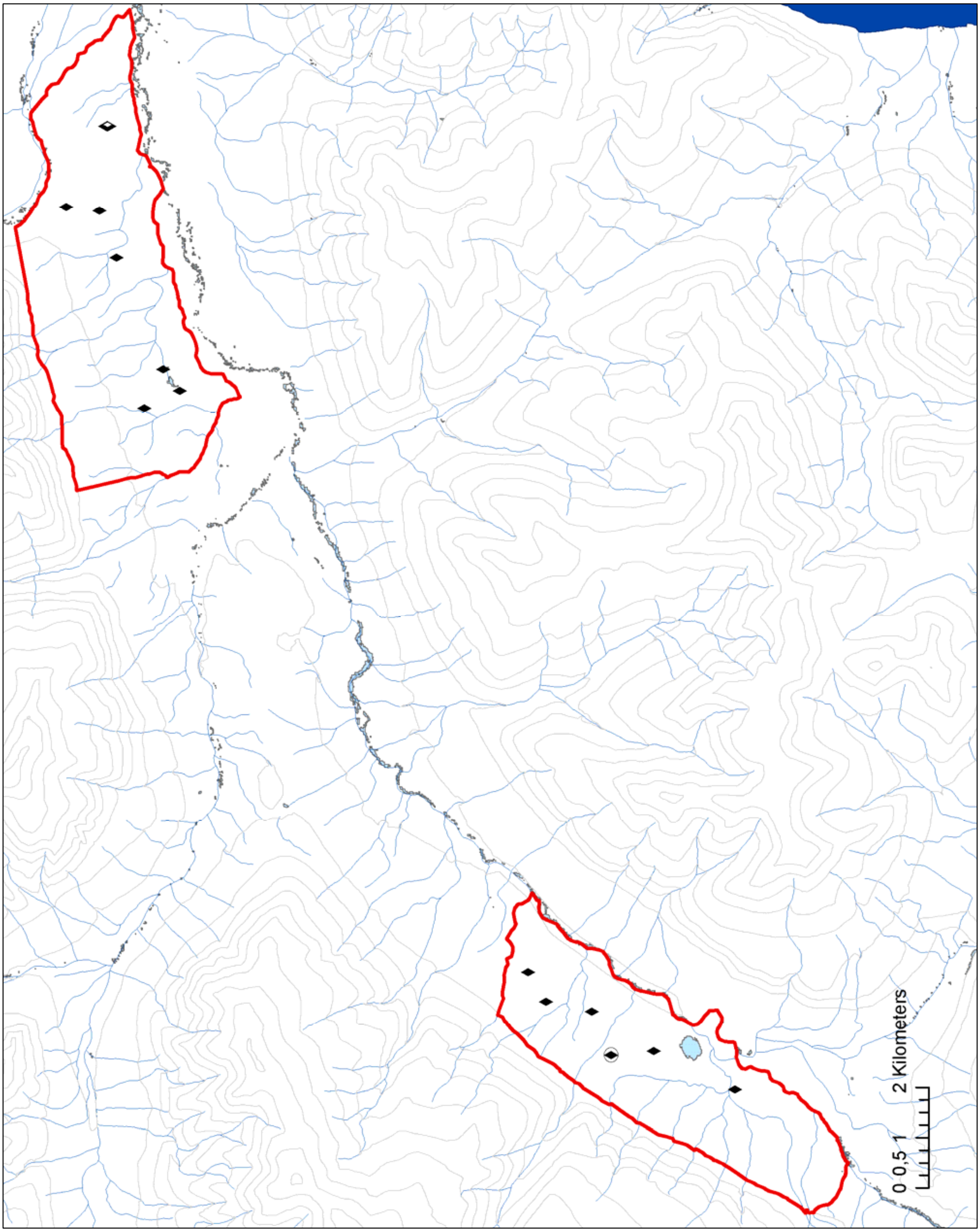

Figure 26. Red knot *Calidris canutus*.

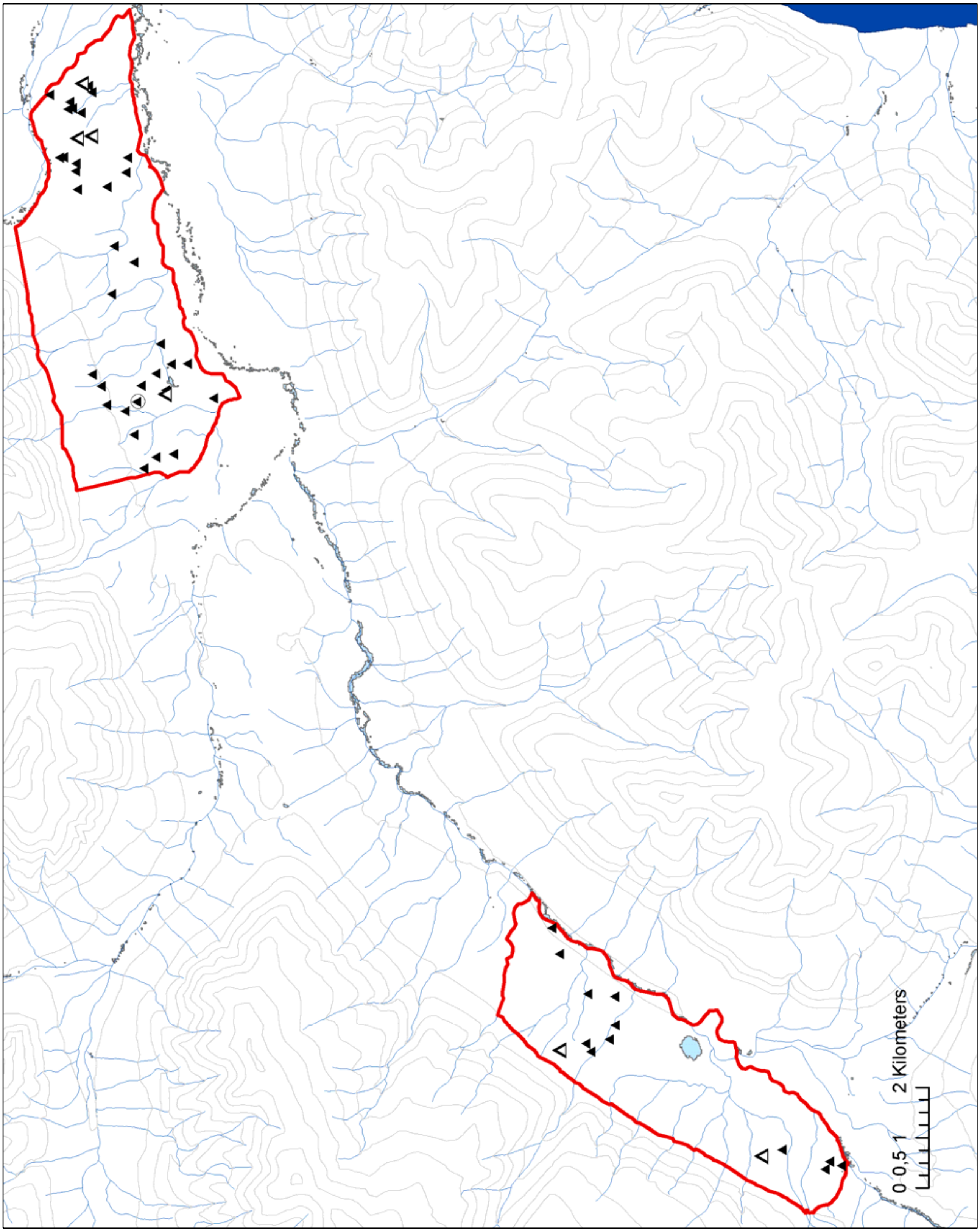

Figure 27. Sanderling *Calidris alba*.

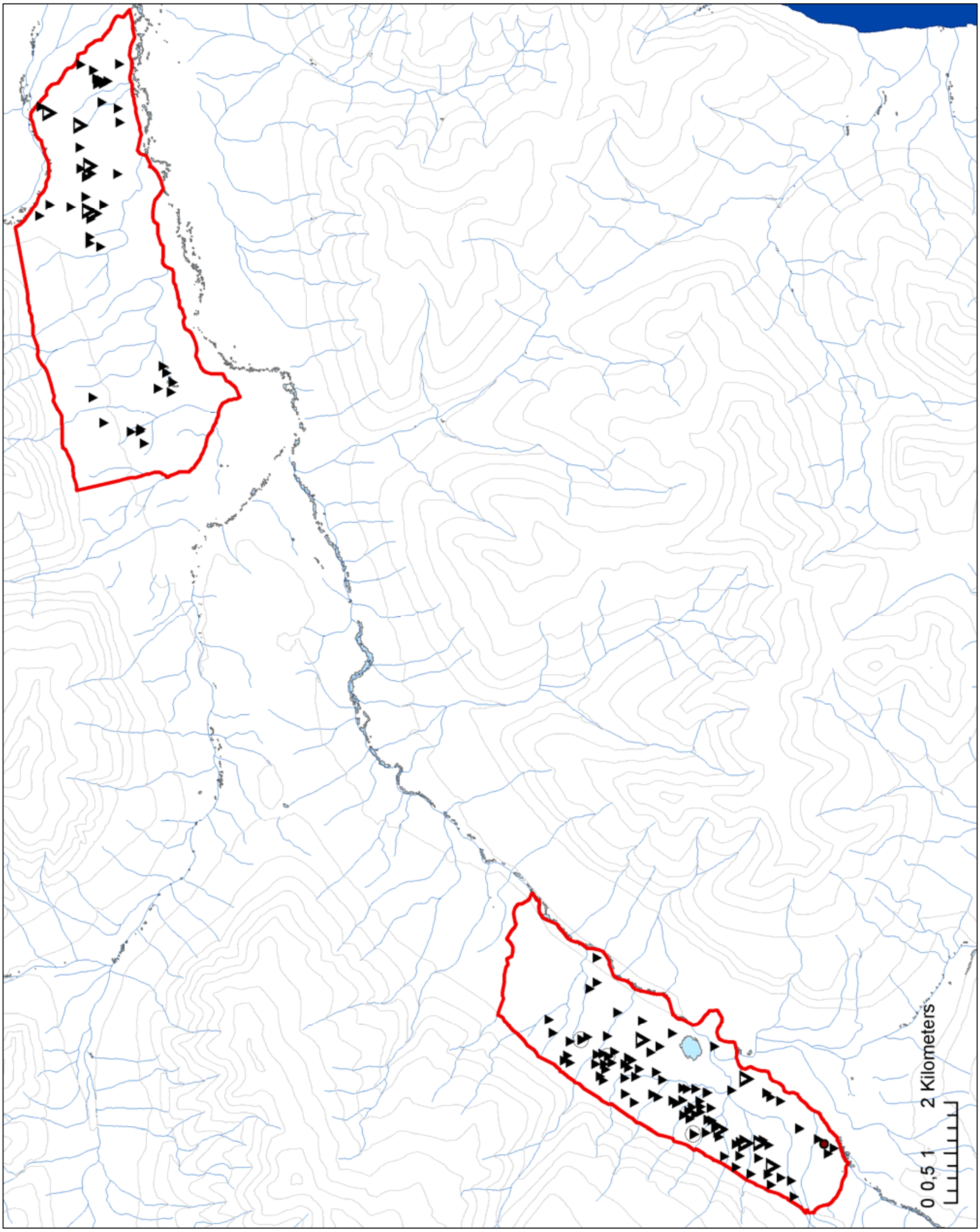

Figure 28. Dunlin *Calidris alpina*.

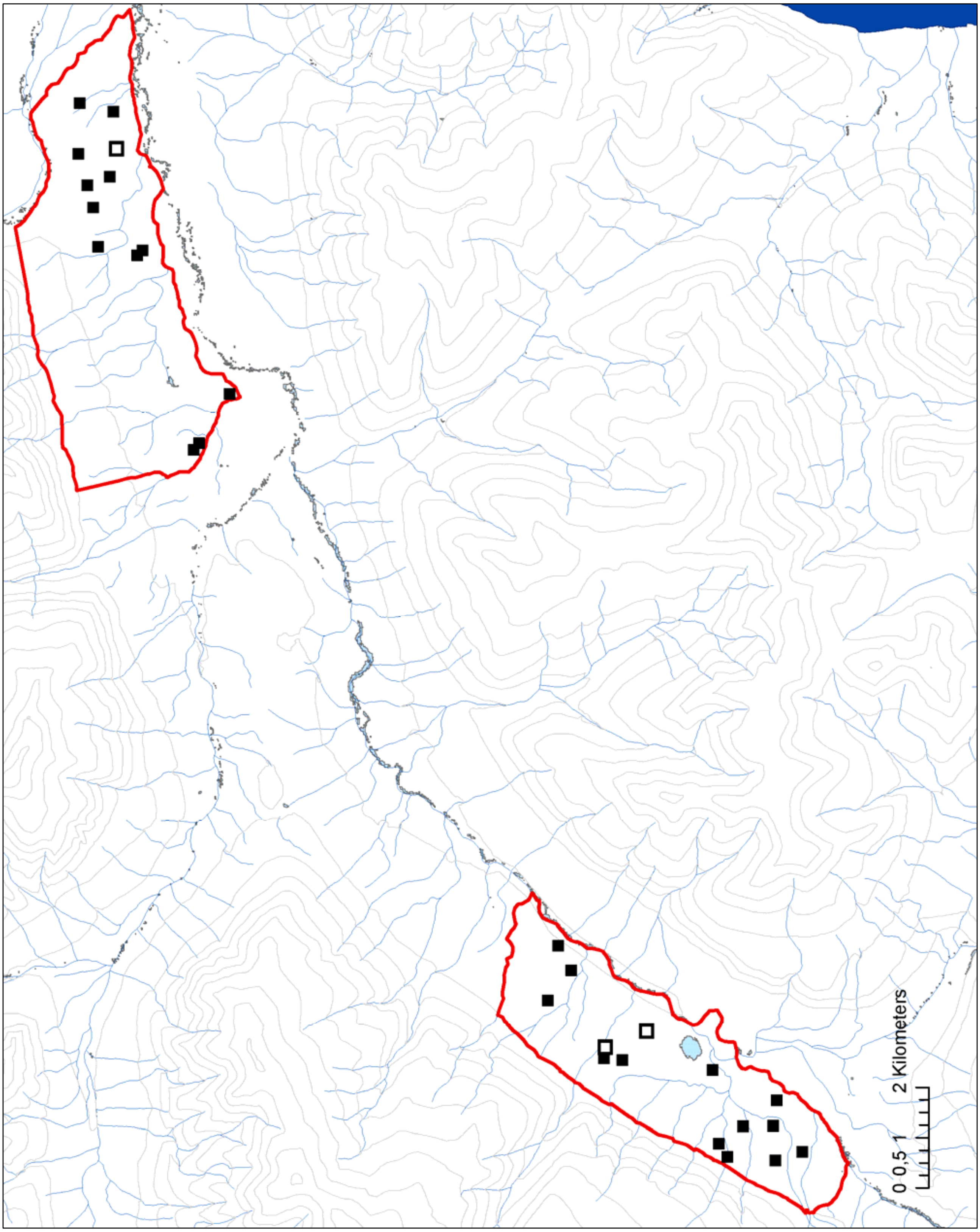

Figure 29. Ruddy turnstone *Arenaria interpres*.

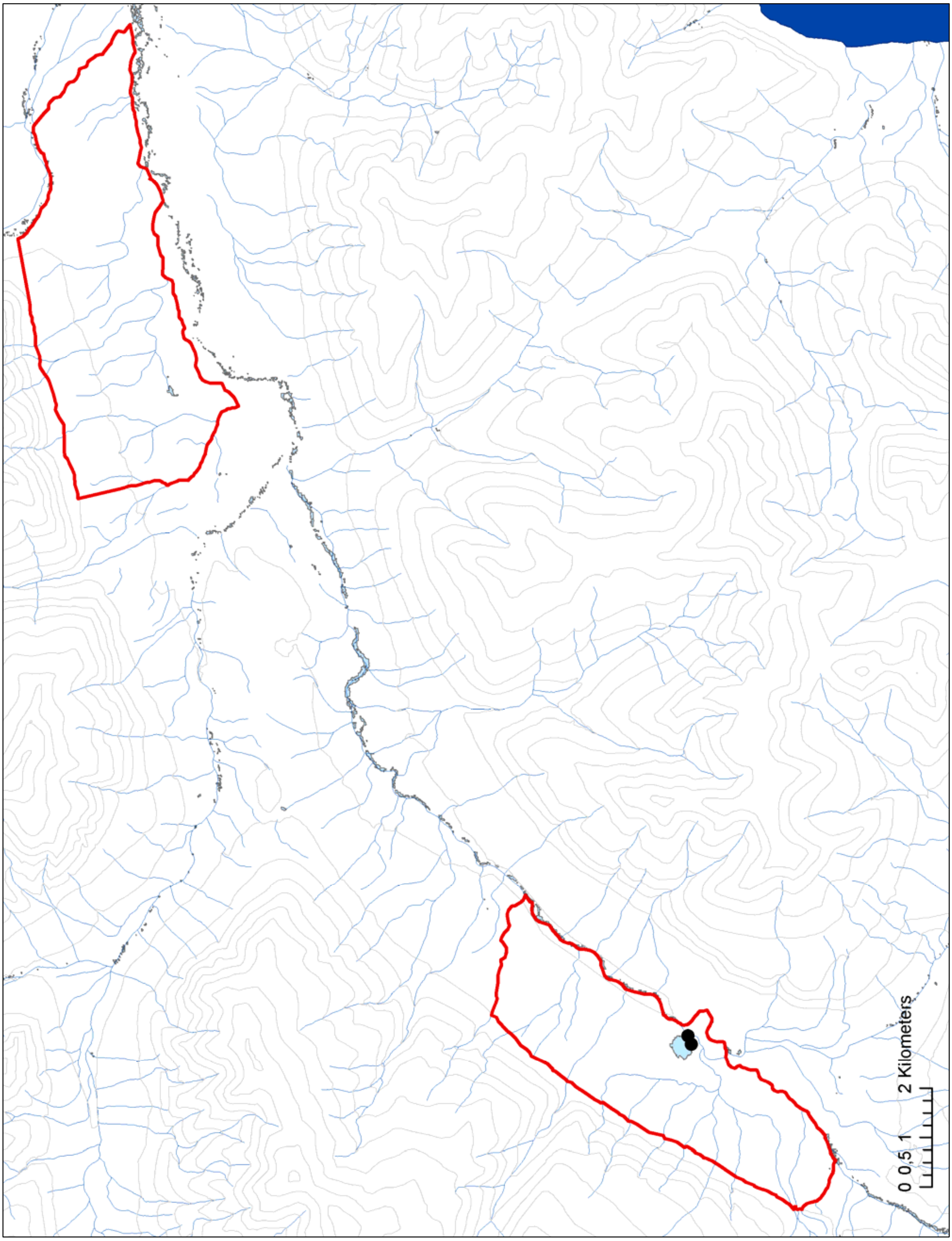

Figure 30. Red-necked phalarope *Phalaropus lobatus*.

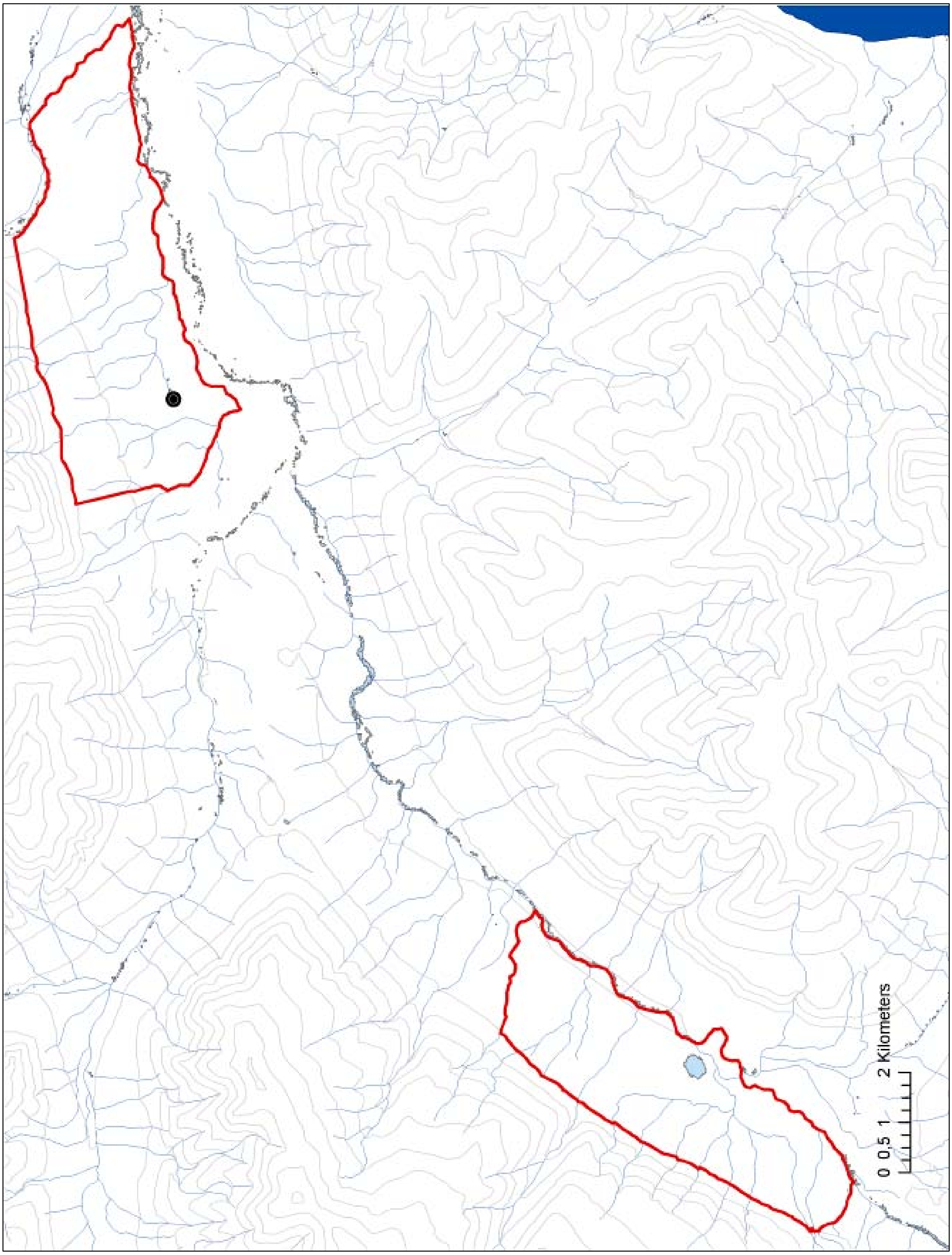

Figure 31. Red-throated diver *Gavia stellata*.

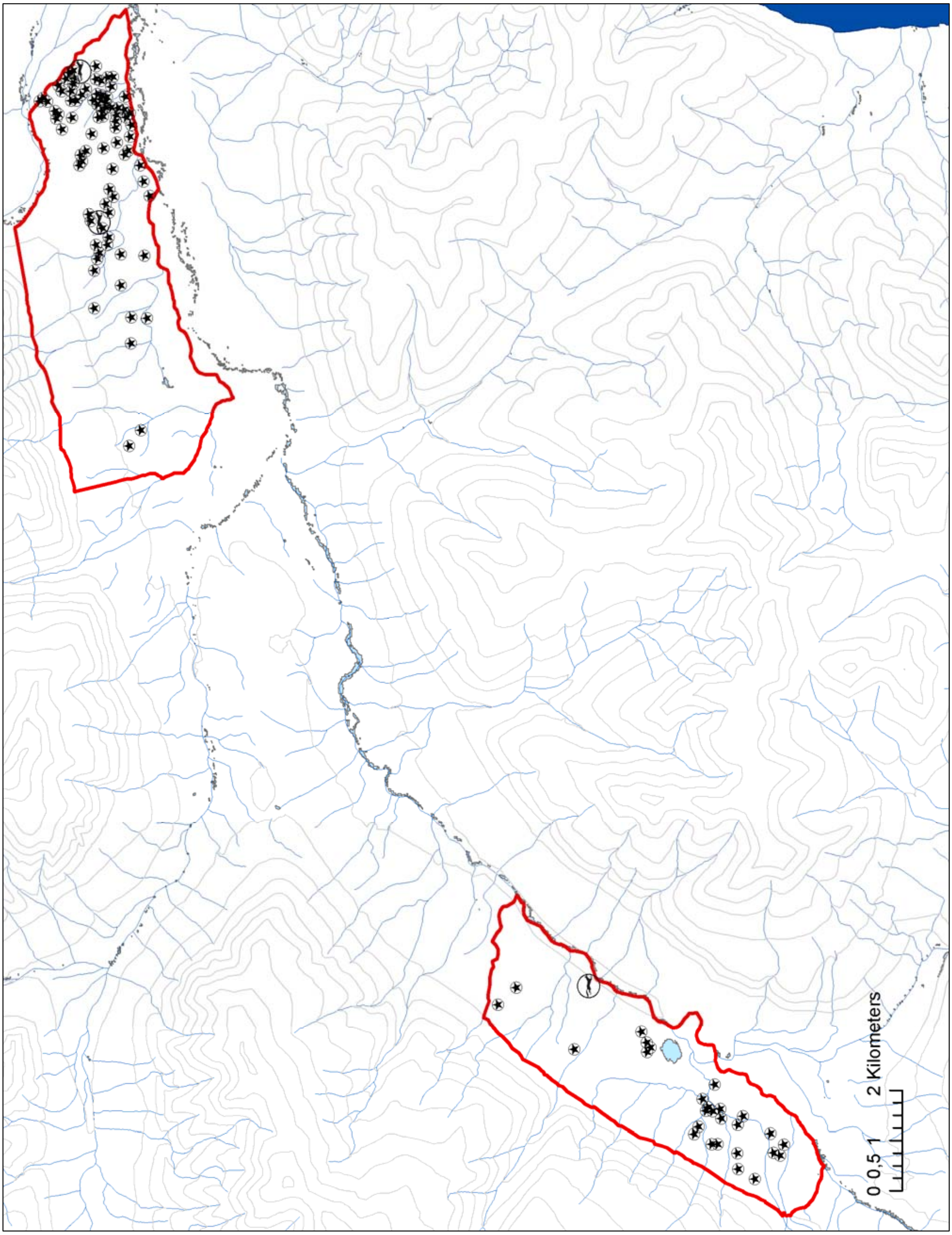

Figure 32. Pink-footed goose *Anser brachyrhynchus*.

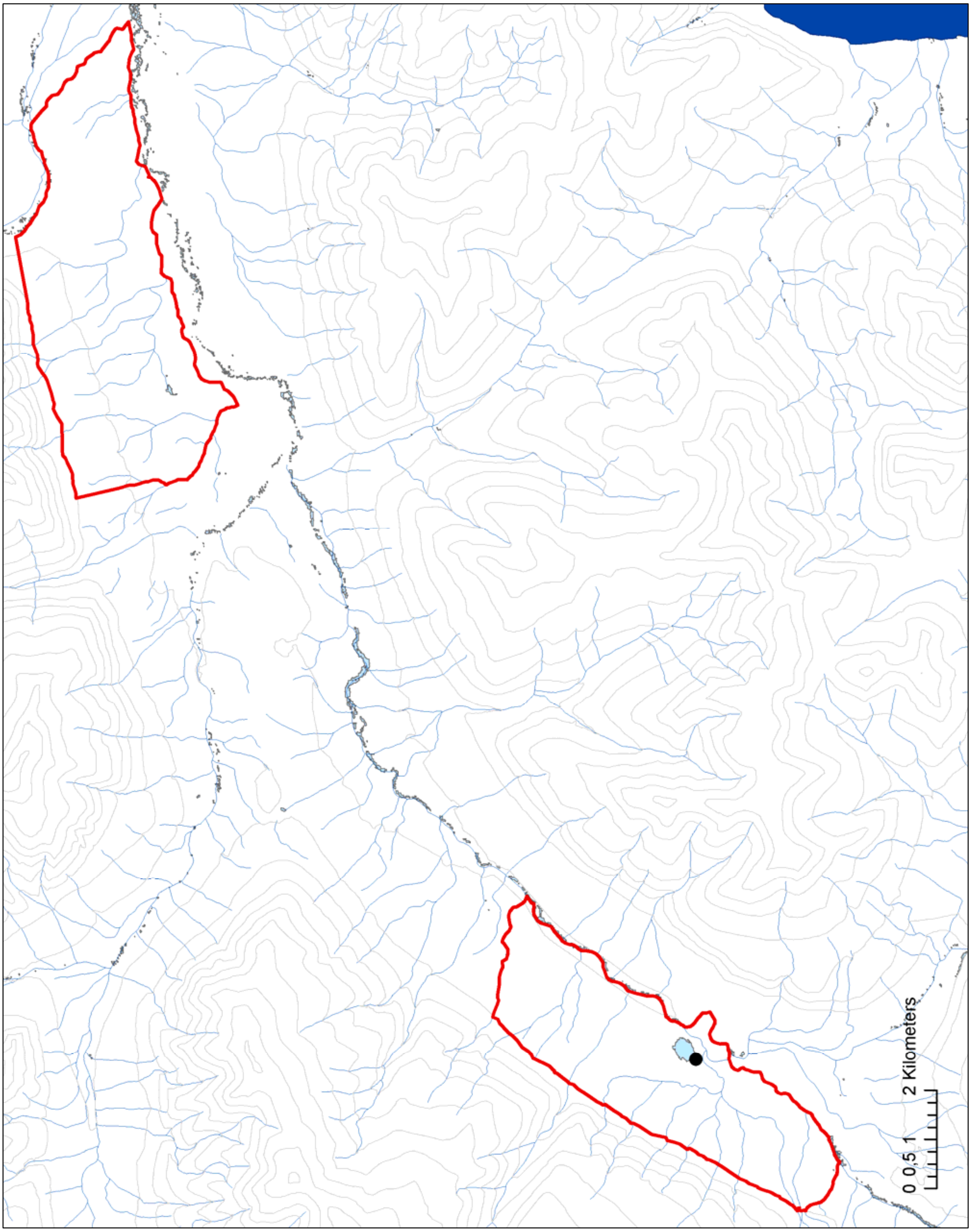

Figure 33. Northern pintail *Anas acuta*.

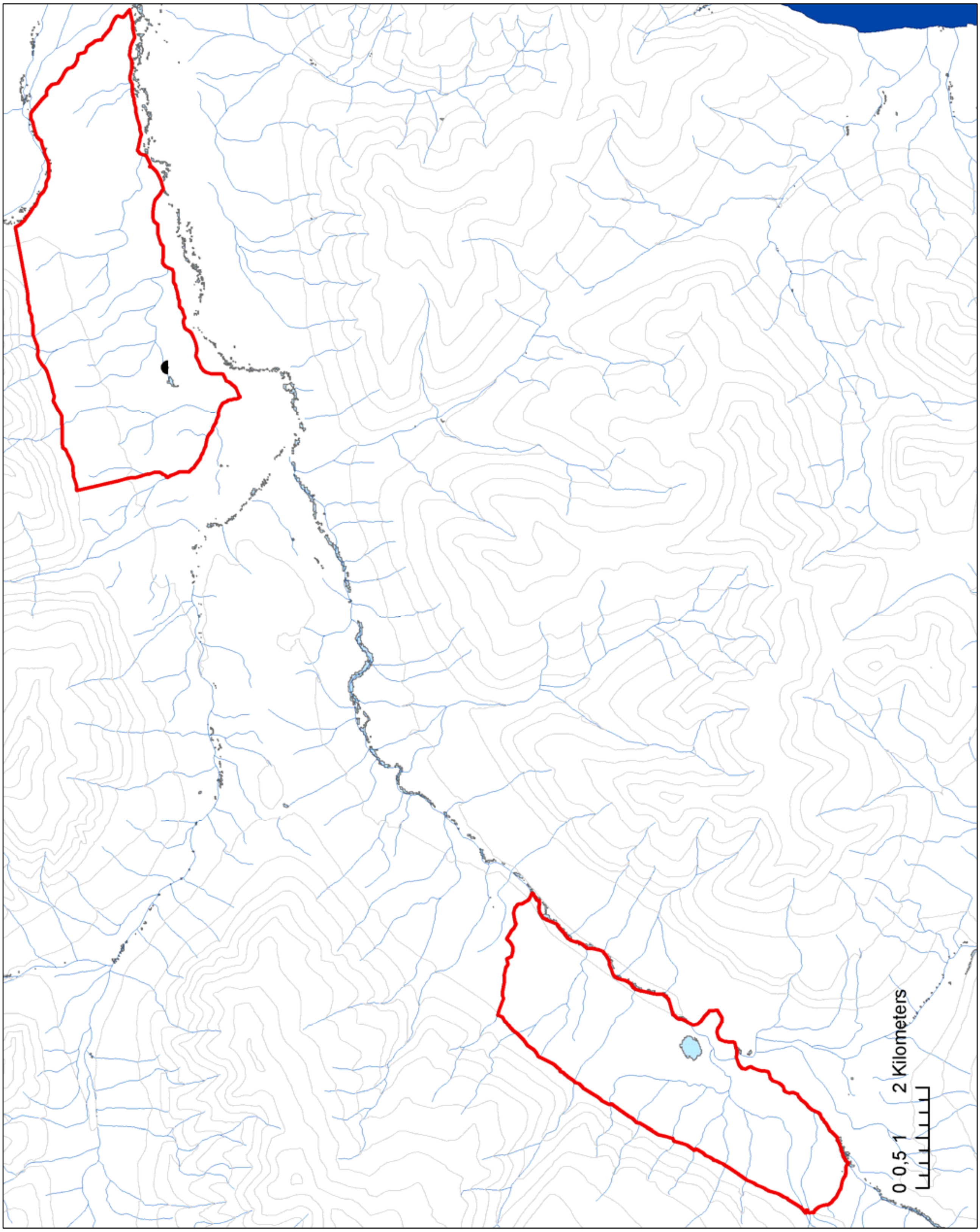

Figure 34. King eider *Somateria spectabilis*.

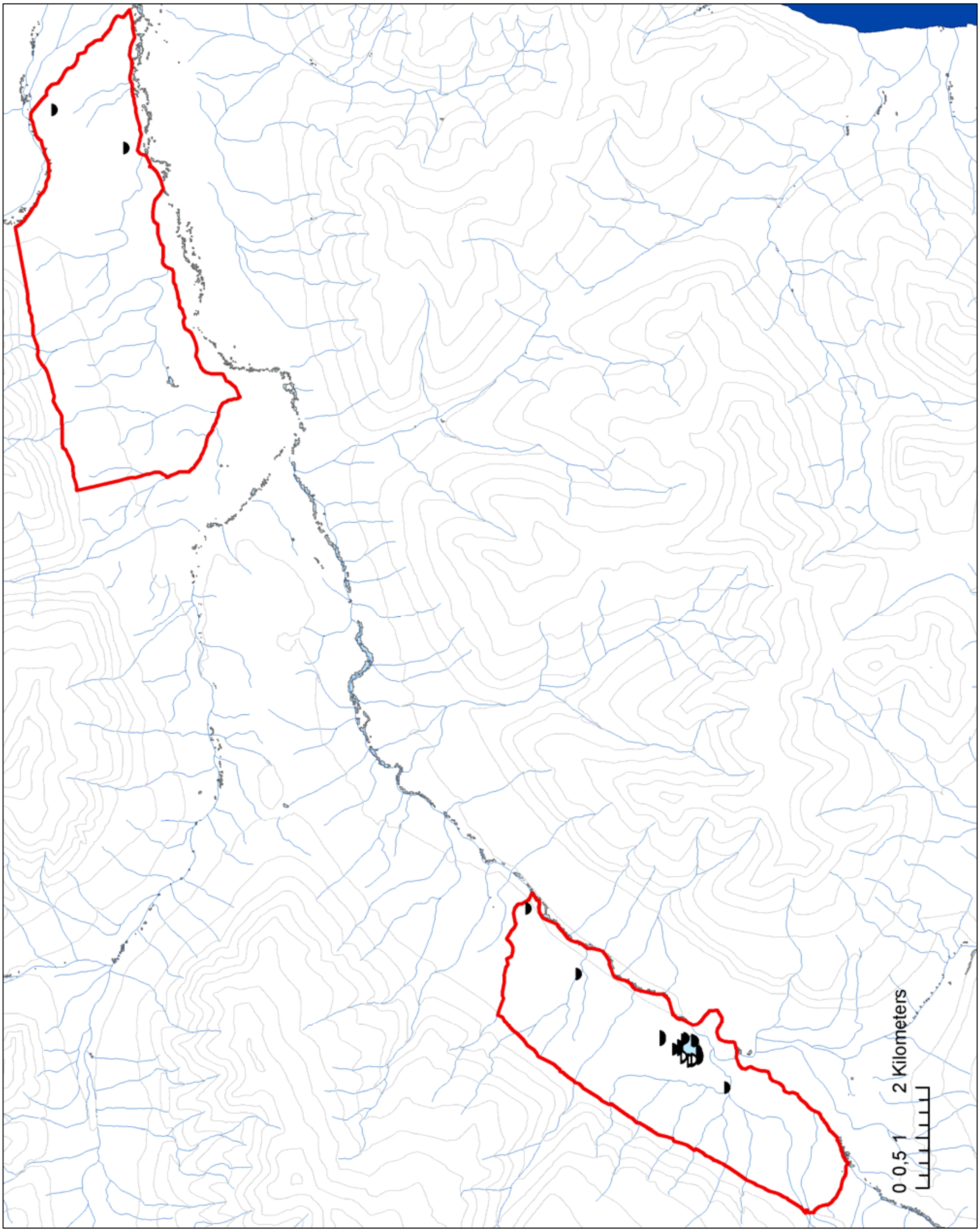

Figure 35. Long-tailed duck *Clangula hyemalis*.

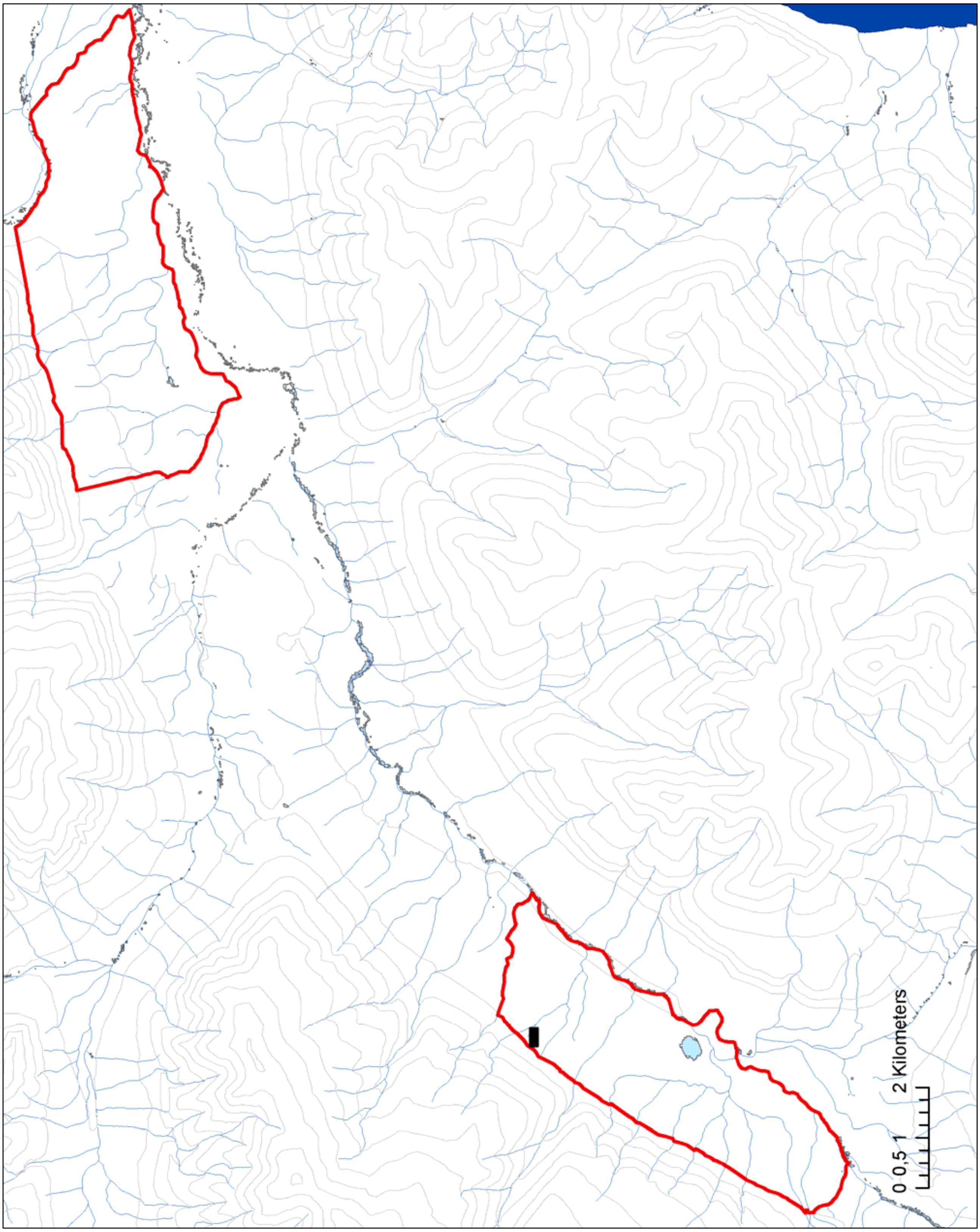

Figure 36. Rock ptarmigan *Lagopus mutus*.

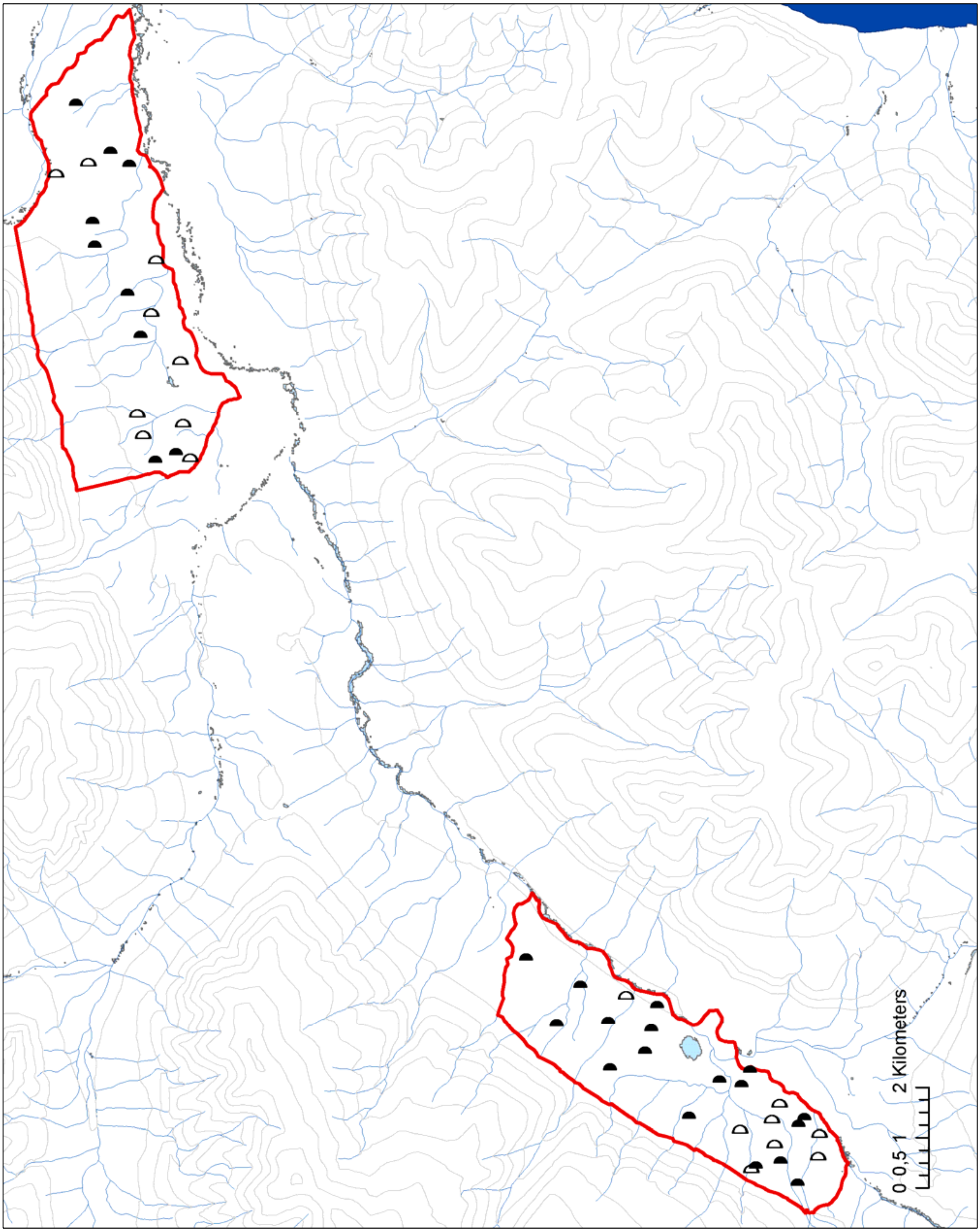

Figure 37. Long-tailed skua *Stercorarius longicaudus*.

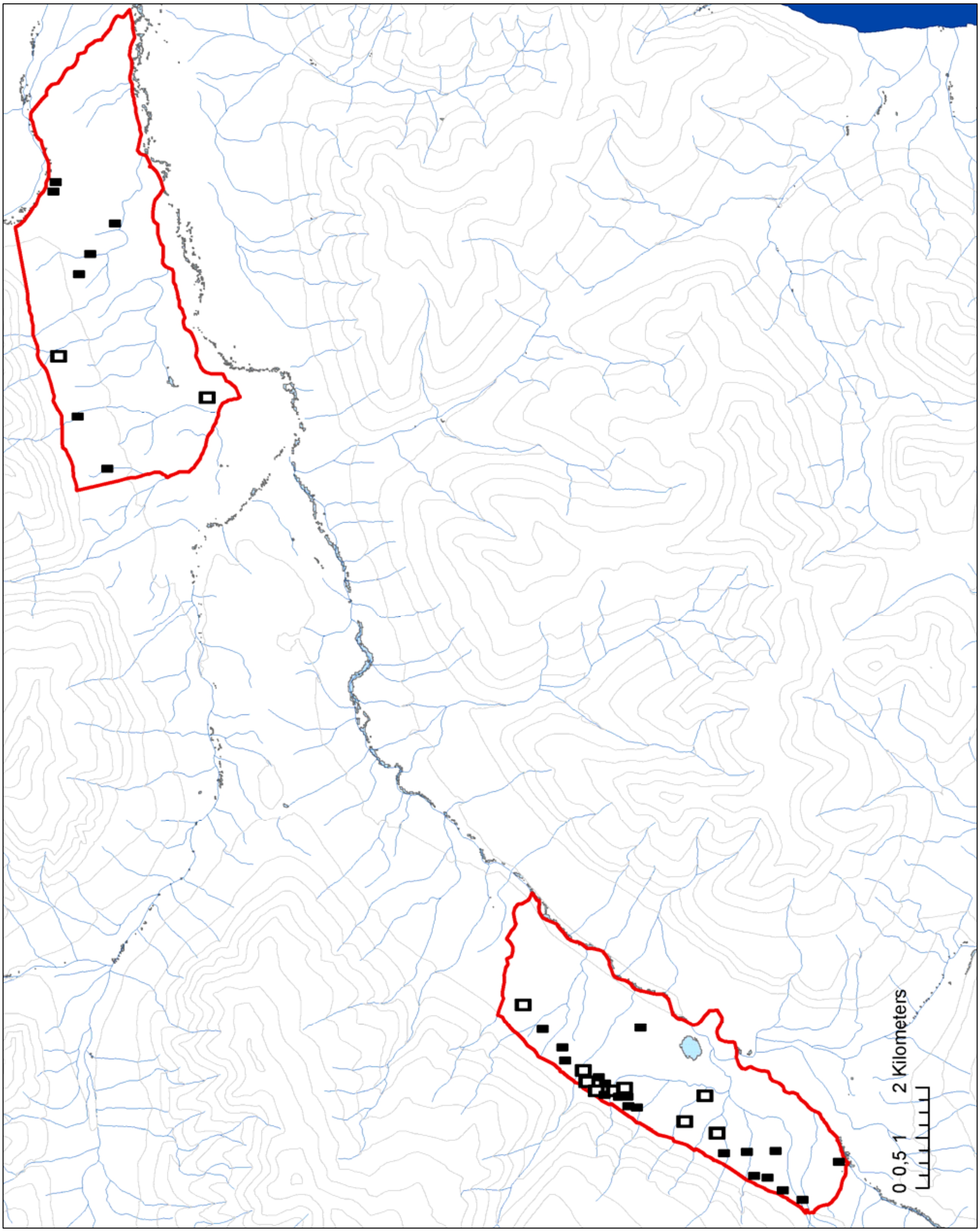

Figure 38. Snow bunting *Plectophenax nivalis*.

Appendix 5. Disturbance distances of breeding waders and ducks

Waders

Reference	Distance (m) adult	Distance (m) juvenile	Disturbance type	Species	Remarks
Baudains & Lloyd 2007	15-45	15-65	Human, walk Dogs, most unleashed	*Charadrius marginatus*	Nesting. Baboon predation more important at less disturbed site, so reduced fecundity here
Fernández-Juricic et al. 2005	30-100		Human, walk	*Vanellus chilensis*	Breeding season late. Distance in MAD: Min. app. dist.
Finney et al. 2004	191-277	191-277	Human, walk	*Pluvialis apricaria*	Chick-rearing. 277 m (median): 30% persons stray from path; 191 m: 4% stray. No detectable impact on reproduction.
Holm & Laursen 2009	72-95* 85-125**		Human, walk	*Limosa limosa*	Entire breeding season. Experimental disturbances from 2 & 7 walks/day. *= mean flush dist. **= mean territory displacement. Reduction of territory density (7 walks) within 300-500 m.
Lafferty et al. 2006	30-75	30-75	Human, walk Dogs, most unleashed	*Charadrius alexandrinus nivosus*	Breeding incl. chick-rearing. Distance =max. beach width (Google map). Breeding started following protection of beach
Liley & Sutherland 2007	17-c. 100	17-c. 100	Human, walk Dogs & vehicles	*Charadrius hiaticula*	Breeding incl. chick-rearing. Beach width 17-175 m. The more disturbance the less breeders.
Lord et al. 1997	0/40-65	0/40-65	Human, walk	*Charadrius obscurus aquilonius*	Chick-rearing. Shore 25 m, dry 80 m. Nesting dry area closed. Chicks prefer feeding on shore, but disturbed chicks feed in less favourable dry zone
McGowan & Simons 2006	0-200		Human, walk (4%), Truck (17%), ATV (25%)	*Haematopus palliatus*	Nesting. ATVs more disturbing: louder and faster than cars and humans walking. Beach up to 200 m wide (Google maps)
Morse et al. 2006	-	-	Kayakers camping	*Haematopus bachmani*	Breeding incl. chick-rearing. Low levels of disturbance have little effect. Breeding on beaches, width not given.
Pearce-Higgins et al. 2007	85/120-120/220		Human, walk	*Pluvialis apricaria, Calidris alpina*	Breeding incl. chick-rearing. Mean distances for *C. alpina* before and after foot-path. *P. apricaria* showed no disturbance due to few humans.
Reijnen et al. 1996	120 (560) *Vv* 230 (930) *Ll* 1700(3530) *Ho*		Car traffic	*Vanellus vanellus, Limosa limosa, Haematopus ostralegus*	Nesting. Medium traffic=5000 cars/day, (heavy=50,000 cars/day); both car speed=120 km/h. At medium traffic 10-20% density loss 0-500 m from roads.
Rodgers & Smith 1995	180 100		Human, walk Canoes	*Sterna antillarum, Rynchops niger*	Nesting. Distance + buffer: 180 m terns/skimmers; 100 m herons/storks *Set-back distance*= mean up-flight distance + 1.6495 SD + 40m
Ruhlen et al. 2003		0-200	Human, walk Dogs, most unleashed	*Charadrius alexandrines*	Chick-survival. Roped nesting area depends of beach width (20-200m). 3 x higher loss in weekends than in weekdays

Reference	Distance (m) adult	Distance (m) juvenile	Disturbance type	Species	Remarks
Sabine et al. 2008	137 (mx 319) 170	>150	Human, walk ATV, boat	*Haematopus palliates*	Nesting and chick-rearing. 137 m upper mean value of displacement from nest (319 max. value; no buffer). 170 m is mean disturbance distance from ATVs
Weston & Elgar 2007	100		Human, walk Dogs, most unleashed	*Thinornis rubricollis*	Nesting. Encounter defined as a person ≤100 m from nest. Effect: nest absence.

Ducks

Reference	Distance (m) adult	Distance (m) juvenile	Disturbance type	Species	Remarks
Einarsson & Magnúsdóttir 1993	550		Pumping station	*Aythya fu-ligula, A. marila*	Breeders foraging. Very few dives within 550 m of pumping station; reason unclear.
Reijnen et al. 1996	65 (20-265) M 320 (90-1030) H		Car traffic	*Anas clypeata*	Nesting. Medium traffic=5000 cars/day, (heavy=50,000 cars/day); both car speed=120 km/h. At medium traffic <10% density loss 0-500 m from road, c. 2% 0-1500 m

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BREEDING BIRDS IN THE RAMSAR SITE HEDEN AND IN A PROPOSED RAMSAR REPLACEMENT AREA, JAMESON LAND, EAST GREENLAND

In June 2009, breeding bird studies were performed in two different areas of Jameson Land, East Greenland. Breeding bird densities were obtained from four large study areas of 17-34 km^2 each in the Gurreholm area inside the Ramsar site Heden and in a proposed Ramsar replacement area, the Ørsted Dal. The purpose of the studies was to evaluate possible impacts from mining activities on the breeding birds in the Ramsar site and to examine if the Ramsar replacement area could protect similar species and numbers of breeding pairs. Densities are given for 15-26 breeding bird species in the two areas. The breeding period of 2009 was thought to be good mainly due to early snow melt. The densities of waders in both areas were, compared to other high Arctic study areas higher than expected from a direct comparison. From the present knowledge of the mining activities inside the Ramsar site and from a literature based disturbance distance of 300 m (1500 m for geese), we calculated the number of breeding pairs of each species that potentially would be affected by the mining activities. It is concluded that the replacement area fully can give protection under the Ramsar Convention to the number of breeding pairs that potentially can be affected in the Ramsar site for species found breeding in both areas. However, nine species were found breeding only in the Ramsar site. Three of these species, Sabine's gull, whimbrel and Eurasian golden plover, are considered near-threatened in Greenland and Jameson Land is the only known breeding area in Greenland for the latter two species. Moving the airstrip west or out of the Ramsar site would reduce the impact.

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