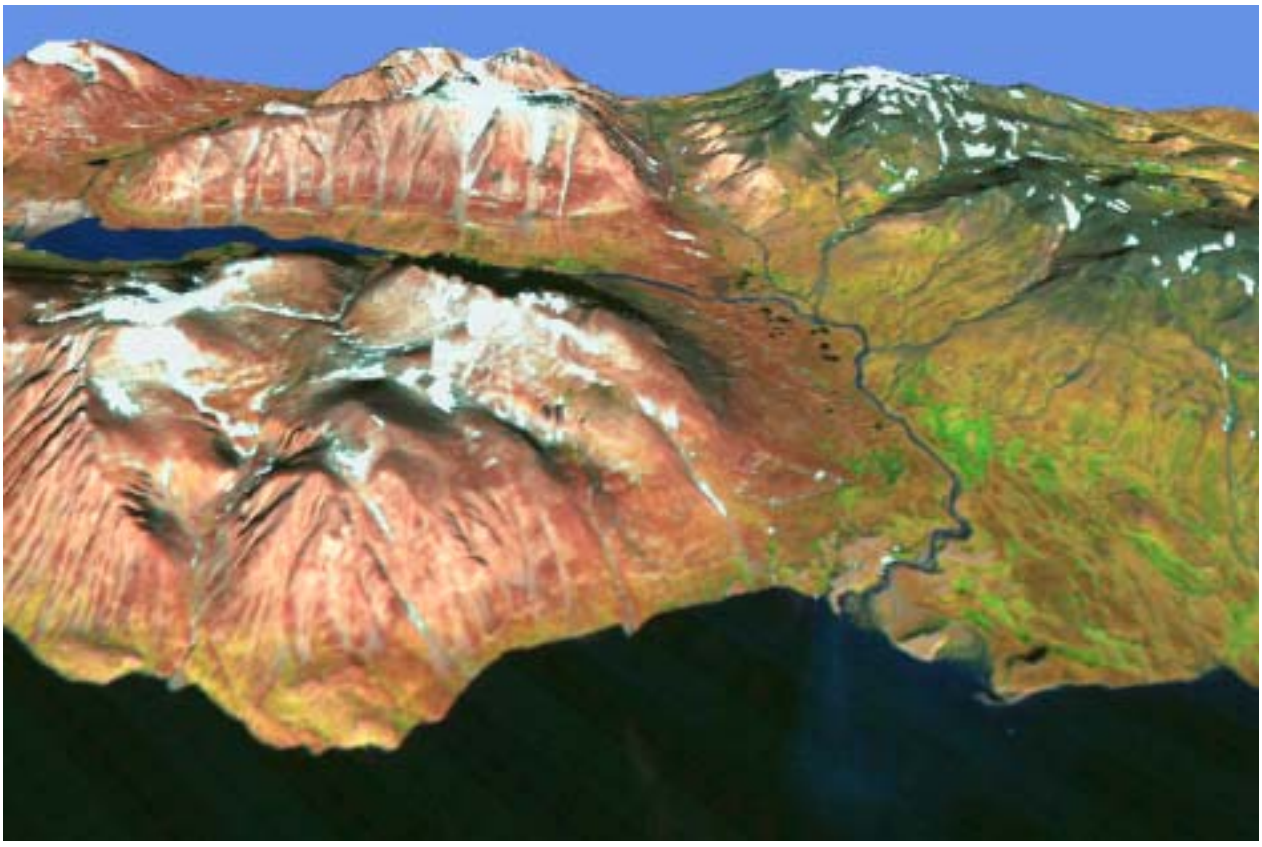
Zackenberg Ecological Research Operations

BioBasis

Conceptual design and sampling procedures of the biological programme of Zackenberg Basic

7th edition



National Environmental Research Institute

Department of Arctic Environment

2004

BioBasis: 7th edition, 2004

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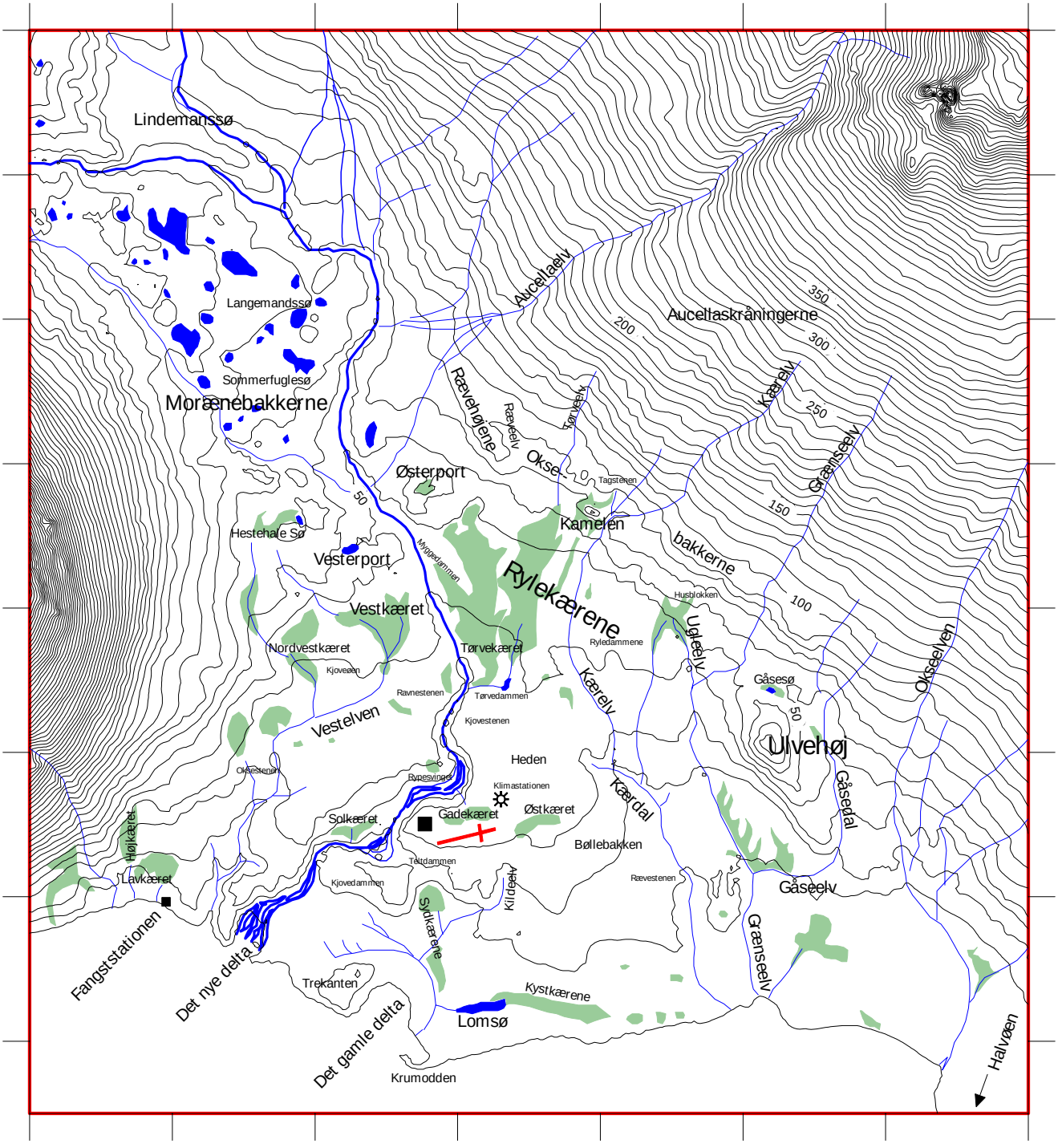
Published by: ©National Environmental Research Institute
Department of Arctic Environment
Frederiksborgvej 399
DK-4000 Roskilde
DENMARK

Front cover illustration

Manipulated satellite image of the Zackenberg mountain (front left) adjacent to the valley Zackenbergdalen, where most of the BioBasis monitoring takes place. (Photo courtesy by the Geographical Institute, University of Copenhagen.)

Content

Map of Zackenbergdalen with local site names usen by BioBasis



Scale: 1 km between grid markers.
Contours at 10 m intervals.

Superior notice on data handling and quality

It is of decisive importance that data obtained by BioBasis are handled with the greatest care. They all cost a lot of time, money and effort, and in many cases they can not be regenerated if lost.

While at Zackenberg, data files must be copied onto a floppy disc each time new data have been added. Use two alternate discs, so that any transfer error does not destroy the copy already worked up.

At the end of the season, the entire set of data files must be copied on two separate sets of floppy discs. Each set is kept separate during the homeward travel, so that one e.g. goes with the shipped goods, one with the personal luggage and the computer itself is kept with the hand baggage.

The same apply to hand written material such as plot maps etc.: Carry them home with the hand baggage, and photocopy them after arrival at the National Environmental Research Institute for storage in another place than the originals. Bring the copies to Zackenberg next year, so that a complete set is kept here as well.

At home with the National Environmental Research Institute, all data files are immediately copied to the main server, and these copies are updated each time the files have been supplemented or edited. The original floppy disc copies from the field season are kept in separate places until the annual data set is copied on a cd and delivered to the Danish Polar Center in accordance with the contract. Finally, all data files are printed out and kept as hard copies.

The quality of the data must be checked each year in connection with the final editing and preliminary analysis following each season. Any data diverging from expected values must be checked carefully and discussed with the observer.

BioBasis
Conceptual design and sampling procedures of the biological programme of Zackenberg Basic

General outline of BioBasis

The long-term 'baseline studies' of BioBasis embrace the 40 elements listed below. They have been selected to cover a wide variety of trophic levels in the local ecosystem as well as for their suitaibility for standardised monitoring. Together, they aim to produce a coherent set of numerical and phenological data facilitating the understanding of the intricate dynamics of a terrestrial High Arctic ecosystem. In combination with the parallel climatological and physical geographical parts of Zackenberg Basic, ClimateBasis and GeoBasis, it will be possible to evaluate the effects of long-term changes that may emerge in the future.

Overview of monitoring elements

1. Plants

1.1. In 29 plots, ranging from early to late snow-free plant communities, reproductive phenology (flowering) is recorded for *Cassiope tetragona* (6 plots), *Dryas* spp. (8), *Papaver radicatum* (4), *Salix arctica* (4), *Saxifraga oppositifolia* (3) and *Silene acaulis* (4) on a weekly basis during the growing season (late May - early September).

1.2. In the study plots mentioned under 1.1, the number of flowers is recorded at a fixed time during the summer season. The same applies to four study plots with *Eriophorum scheuchzeri*.

1.3. A 8.8 km transect - the 'ZERO line' - running from sea level to 1040 m a.s.l. was established in 1992 and 1994. In connection with the establishment, all significant vegetation pattern changes along the line were recorded and marked, using numbered pegs. Future changes between competing plant communities can be measured by referring to these pegs. The transect will be re-examined by a specialist at 5-10 year intervals.

1.4. One plant community plot (20 m x 20 m) is situated on a Dryas heath north of the east end of the airstrip along the ZERO line (see element no. 1.3). Within this plot, the distribution of plant species has been mapped in detail, so that even minute changes can be detected. The checking of each plot will be done by a specialist at 5-10 year intervals, in connection with no. 1.3.

1.5. In each plot, mentioned under element no. 1.1, weekly Relative Vegetation Indexes (RVI) are measured.

1.6. Fourteen study plots to test changes in the cryptogamic vegetation were established in 1994. The plots will be re-examined by a specialist at 5-10 year intervals.

1.7. The number of berries etc. are recorded annually in three study plots with *Arctostaphylos alpina*, *Vaccinium uliginosum* and *Empetrum nigrum*, respectively.

1.8. In 1998, nine ITEX point frame study plots, each with five frame plots in typical plant communities, were established. These are planned to be reanlysed at 5-10 year intervals.

1.9 Five northern range plant species are monitored every fifth year. *Salix herbacea*, *Campanula giesekiana*, *Carex glareosa*, *C. lachenalii*, and *C. norvegica*

1.10. Annual Normalised Difference Vegetation Index (NDVI) analyses from satellite images are made for 10 sections of the study area in Zacken-bergdalen.

2. Arthropods (leddyr)

2.1. Faunistic and phenological collections are carried out by means of yellow pitfall traps placed in five different plant communities. The traps are emptied on a weekly basis throughout the summer season (early June-late August/early September). The catches are sorted into taxonomic groups, counted and preserved at the Zoological Museum, University of Copenhagen.

2.2. Two 'window traps' are placed at a pond near the station to monitor limnitic insect production and aerial activity. The traps are emptied on a weekly basis throughout the summer season (early June-late August/early September), and the catches are sorted into taxonomic groups, counted and preserved at the Zoological Museum, University of Copenhagen.

2.3. Predation by larvae of the moth *Sympistis zetterstedtii* on *Dryas* flowers is recorded weekly in six study plots (see element no. 1.1) during the summer season.

2.4. The occurrence of woolly-bear caterpillars *Gynaephora groenlandica* is recorded weekly in four Arctic willow *Salix arctica* study plots (see element no. 1.1) and generally during fieldwork during the summer season.

2.5. Predation by larvae of sawflies Tenthredinidae on *Salix arctica* ovules is recorded weekly in four study plots (see element no. 1.1) during the summer season.

2.6. The occurrence of bumble bees *Bombus* sp. is recorded.

3. Birds

3.1. Populations of all breeding bird species (12-15) are mapped annually during June-July in a 19 km^2 census area in Zackenbergdalen (0-600 m a.s.l.). More intensive studies are carried out on 3.4 km^2 of the census area west of Zackenbergelven.

3.2. Breeding phenology (first egg dates, hatching, fledging) is monitored annually in the census area mentioned under element no. 3.1.

3.3. Annual fledging success of waders (shorebirds) is monitored by counts of juveniles in the deltas of Zackenberg-elven every third day during 20 July - 31 August.

3.4. Barnacle goose broods in Zacken-bergdalen are monitored during the fledging period.

3.5. Each year in mid/late July, birds are recorded along a transect from Dane-borg to Zackenberg and through the adjacent valley, Store Sødal.

3.6. Breeding common eiders, Sabine's gulls and Arctic terns are censused on Sandøen in late July.

3.7. Other bird observations are recorded throughout the entire field season, including flocks of moulting geese.

4. Mammals

4.1. Winter nests of collared lemmings are mapped annually in a 2.08 km^2 study area. Nest size, placement, and amounts of faeces together with predation are recorded for each nest.

4.2. Musk oxen in Zackenbergdalen are counted each day from a fixed point at the research station, and the position of the individual groups are mapped.

4.3. A complete census of muskoxen is performed within 40 km^2 in Zackenbergdalen on a weekly schedule between 1 July - 30 August. All musk ox groups within this area are identified for age and sex composition.

4.4. Fresh musk ox carcasses are recorded each year, tooth and tissue samples are taken, and leg bones are checked for marrow characteristics.

4.5. All Arctic fox dens in Zackenbergdalen are checked regularly during the summer field season for occupation and pups.

4.6. Arctic hares occuring on the east facing slopes of Zackenberg mountain are recorded each day.

4.7. As long as the fjord is ice covered, the number of seals hauled out on the ice is recorded each day.

4.8. Each year in mid/late July, mammals (incl. offspring, winter nests of lemmings, musk ox droppings and mammalian carcasses) are recorded along a transect line from Daneborg to Zackenberg and through the adjacent valley, Store Sødal.

4.9. Walrusses hauled out on Sandøen are counted, sexed and aged in mid/late July if appropriate.

4.10. Faeces from stoat, Arcitc fox and Arctic wolf together with casts from long-tailed skua and snowy owl are collected at 29 selected perches at the end of each season. The material is dried and kept available for later examination (e.g. for annual variation in contents of lemming bones).

4.11. Other observations of mammals are recorded throughout the entire fieldseason.

5. Lakes

5.1. Physical-chemical parameters, phytoplankton and zooplankton are each monitored 1-3 times per season in two lakes in Moræne bakkerne, one with and one without Arctic char.

5.2. Fish (to be developed).

6. Microclimate temperatures in ITEX and arthropod study plots, snow and ice melt in study plots, etc.

6.1. TinyTag/TinyTalk dataloggers are recording microclimate temperatures in ITEX flowering and arthropod study plots (see elements 1.1 and 2.1) 5-12 times per day, year round.

6.2. In each plot, mentioned under elements no. 1.1, 1.2, 1.4 and 2.1, the snow-cover is estimated at weekly intervals during snow melt.

6.3. Records are kept on snow and ice melt in the study area, particularly on ponds and lakes (see also section 5.1) and on the fjord, together with the start of running water in streams and rivers.

7. Disturbance

7. Records are kept of activities (man-days and ATV trips) in the different sectors of the study area, particularly in the 'low-use' study area east of Grænseelv and in the goose moulting area along the coast east of the old delta of Zackenbergelven. Records are also kept of aircraft operations in and around Zackenbergdalen, and of waste water and other discharges into Zackenberg-elven etc. Finally, records are kept of all manipulative research projects and of all studies involving take of organisms.

Detailed manual for BioBasis

1. Plants

1.1. Reproductive phenology and relative vegetation index (RVI)

1.1.1. Species to be monitored

White Arctic bell-heather *Cassiope tetragona* (kantlyng)

Mountain/Arctic avens *Dryas integrifolia / octopetala* (fjeldsimmer)

Arctic poppy *Papaver radicatum* (fjeld-valmue)

Arctic willow *Salix arctica* (polar-pil)

Purple saxifrage *Saxifraga oppositifolia* (purpur-stenbræk)

Moss campion *Silene acaulis* (tue-limurt)

1.1.2. Frequency of sampling

At weekly intervals during late May / early June - late August / early September (see fixed dates in table 1.1.2). If inclement weather prohibits sampling, the work may be postponed to the following day.

Table 1.1.2. Sampling dates for reproductive phenology (flowering etc.). The plots on the slope of Aucellabjerg are sampled two days later, in connection with the muskox censuses (see 4.3.3).

27 May	01 July	05 August
3 June	08 July	12 August
10 June	15 July	19 August
17 June	22 July	26 August
24 June	29 July	3 September

1.1.3. Equipment to be used

Map with position of study plots (+GPS)

Dictaphone

Knee pads

RVI meter with sensor

Boardwalks at Cassiope plots

Dataloggers

1.1.4. Location and marking of study plots

The position of the 29 study plots in the lowland is shown on Fig. 1.1.4, and the numbering follows the most practical route between them. Four more plots are situated on the slopes of Aucellabjerg, at c. 120 m a.s.l. (see table 1.2.2 and Fig. 4.3.4). Each plot is marked with angular aluminium bars in the corners and provided with a number plate. The plots are divided into four sections (quarters A, B, C and D separated by steel pegs) starting from the number plate and running either straight from there or clockwise around the centre. UTM co-ordinates, dimensions etc. appear from table 1.2.2.

1.1.5. Sampling method

During snow melt in June, per cent snow cover in each plot section is estimated at each sampling trip (including *Eriophorum* plots and Veg 1; see sections 1.2 and 1.4). If any plant part is visible above the snow layer, the cover is given as 99%. If any ground/vegetation cover is free, no more than 98% can be stated.

When the snow is gone, boardwalks are used at all Cassiope plots. Carry the boardwalk some metres away, when not used and place it 10-20 m downwind (to the south) at the end of the season.

At each visit, samples of a total of at least 50 flower buds, flowers and senescent flowers (or capsules with exposed seeds) are recorded within each plot section. This is done by counting the different phenological stages within appropriate group sizes of individuals and dictating subtotals to the dictaphone concomitantly until a total of over 50 is achieved. Check now and then that the dictaphone is recording (i.e. running and showing red light).

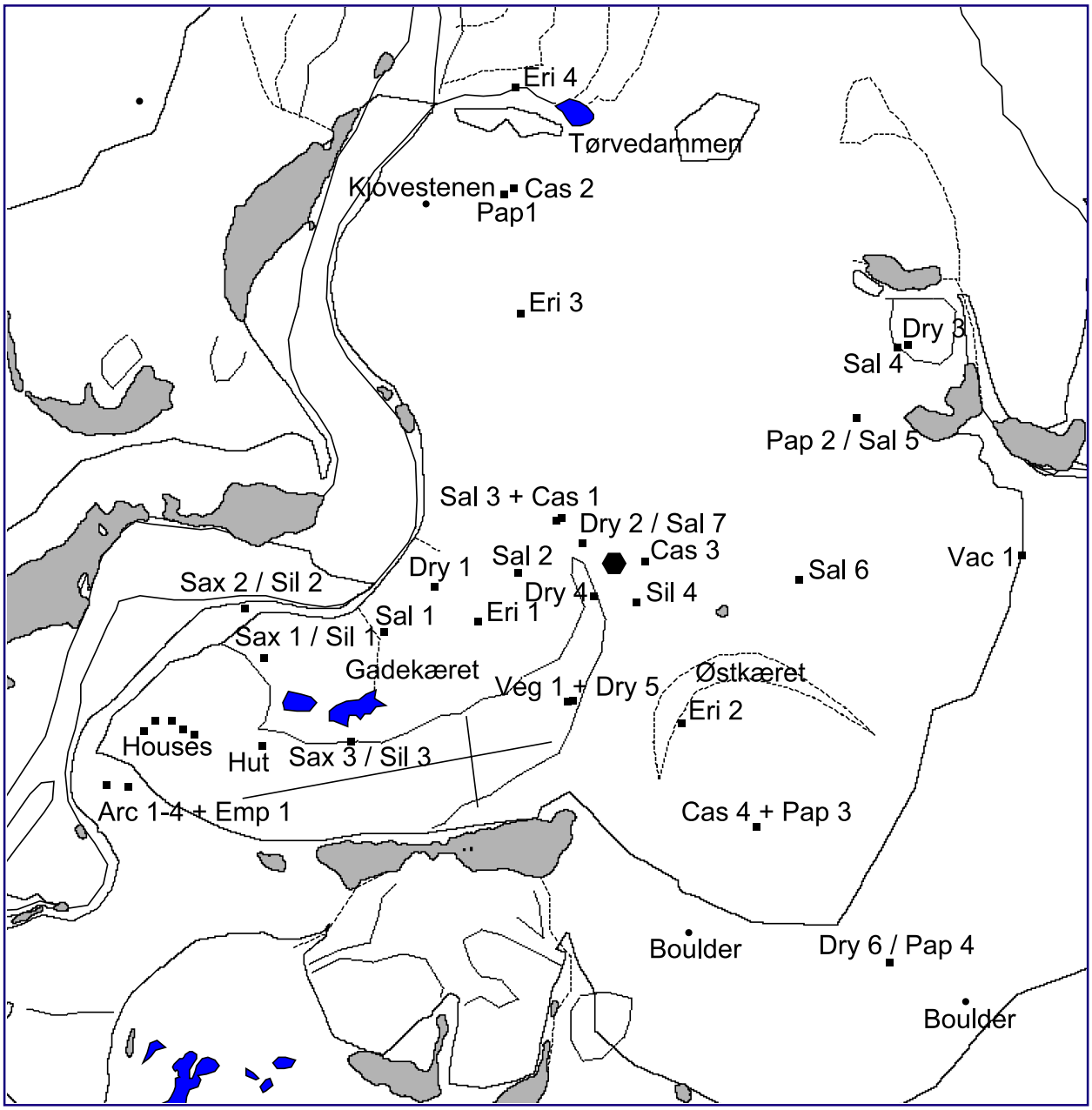


Fig 1.1.4. Position of the flowering study plots and plant community plot 1 together with the climate station (dot).

In general, flower buds are defined as flowers not yet open, flowers are open giving insects access to the reproductive organs, and senescent flowers as flowers that have lost all petals or with all petals almost or fully faded or brown. In some of the final stages, flower stems from the preceding year may interfere with the counts. However, such old stems are always dry and stiff, stems of this year are soft and fleshy.

For each species, the following sampling procedure apply in particular:

Cassiope: Most petals fall off as one unit before they wither. The ovules are still counted as senescent flowers.

Dryas: Apart from sampling of buds, flowers and senescent flowers, record also the number of flowers where the reproductive organs have been

partly or fully eaten by larvae (of *Sympistis zetterstedtii*). Such flowers must still be counted among the flowers. Also, the number of caterpillars in the sampled flowers must be recorded.

Papaver: Petals either fall off or turn dark green and fold around the capsule (late in the season). Both types are recorded as senescent flowers. Open capsules with exposed seeds must also be recorded. In cases where the petals are folded around the capsule, it may be necessary to remove the top of these to check if the capsule is open. Finally, the capsules may fall off. Such 'flowers' can still be separated from last year's stems by their hairy appearance, and they must still be recorded among the 'senescent flowers with exposed seeds'.

If the plot has been grazed by e.g. muskox, the ratio of missing capsules (represented by a flower stem from this year without a capsule) must be recorded together with the sampling of flowers etc. This only happens while the capsules are still green.

Salix: The sampling unit is catkins, not individual flowers.

Most flowers from one catkin emerge the same day, and they also wilt at the same time. Hence, catkins are recorded as buds when no stigmas or anthers are visible, and as flowers as soon as stigmas or anthers are visible (they are both red in the early stages). Buds can not be sexed, so male and female buds are pooled.

The transition to senescent flowers is not recorded, but female catkins must further be recorded as having exposed cutton from the time of exposure of the first seed hairs on top of the splitting capsules. Notice that fruits affected by sawfly Ten-thredinidae larvae expose seed hairs from the bottom of the capsules (excreta from the larvae are often visible among the seed hairs). These capsules must not be recorded as having seed hairs exposed, but should be recorded separately (however, still included in the number of flowers).

Fruits infected by sponges (yellow and twisted) should be recorded separately (yetstill included in the figure for 'flowers').

Also, the number of woolly-bear caterpillars *Gynaephora groenlandica* in the plots must be recorded (only for the part of the plot that is included in the sample).

If the plot has been grazed by e.g. muskox, this must be recorded as well (just yes or no).

Silene: A problematic species, since one or a few individuals may dominate the sample. Therefore, several individuals (preferably the same) must be sampled each week. Flower buds are reddish. Senescent flowers are defined as flowers with faded petals and empty pollen anthers.

Saxifraga: Flower buds are reddish. Senescent flowers are defined as flowers with faded petals. The ratio of open capsules (seeds exposed 5-8 weeks after senescense) is part of the sampling. New buds and even flowers may devellop in late autumn. These are counted, but not included in the calculation of reproductive phenology.

Finally, eight RVI measurements are taken in each plot (only four in the small *Dryas* and *Cassiope* plots). Two measurements are taken in each quarter (section) of the plot: one at the corner of the first quarter starting at the plot no. sign, and the next at the first corner of the next quarter - and so on. In the small *Dryas* and *Cassiope* plots, measurements are only taken at each corner - or start of each quarter, when they are on line.

Put the meter in the mode 'Ratio' and hold the sensor as horizontally as possible in a straight arm in over the plot and about one metre above the ground. Avoid measuring over your own shade. Read the value onto the dictaphone. The values should vary between 0.1 and 1+, with the highest values for the least vegetated areas. Do not take measurements over open water. If the vegetation is wet on sampling days in late July and early August, measurements should be repeated the next day. Switch off the meter between each plot.

1.1.6. Handling of dataloggers (see 5.1)

1.1.7. Laboratory work

Writing out the dictaphone recordings (see data forms in Appendix).

1.1.8. Input of data into database

The data from the weekly checks of the plots are entered into Excel data files with columns relevant for each species. The basic data are: Year, Month, Day, Observer, Plot (e.g. Dry1), Sample (sector A, B, C and D), Snow (per cent per sector), RVI (see below), Buds (give true numbers counted, not per cent), Flowers, Senescent (flowers), Total (sum of buds, flowers and senescent flowers at the annual count), and Remarks. Specific columns for individual species appear from the database files.

For RVI measurements, the ratios recorded in the field must be transformed into indeses by calculating the reciprocal values at the end of the season. For presentation in the annual reports, the RVI-values are transformed into NDVI-values by the equation NDVI= (RVI-1)/(RVI+1).

1.2. Total flowering

1.2.1. Species or taxonomic groups to be monitored

As in 1.1 plus Arctic cotton-grass *Eriophorum scheuchzeri* (polar-kæruld) and 'dark' cotton-grass *Eriophorum triste* (mørk kæruld).

1.2.2. Frequency of sampling

Once per season (table 1.2.2). The optimal time is when most or all flower buds have bursted.

1.2.3. Equipment to be used

Map with position of study plots

Pieces of cord totalling 100 m

Flower sticks

Dictaphone

Knee pads

Dataloggers

1.2.4. Location and marking of sampling plots

See map Fig. 1.1.4 and table 1.2.2. Each plot is divided into four sections, denoted A-D clockwise or straight, starting from the number plate.

1.2.5. Sampling method

Tighten a cord around each section of the plot. In large plots, subsections are established by placing two additional cords with about 1 m intervals from one end of each section, whereupon the lumped number of flower buds, flowers and senescent flowers are counted between each cord. Move one cord at a time and repeat the process until the entire plot is covered. In small plots, sticks may be used instead of cords. Dictate the results to the dictaphone at least for every 100 recordings.

In *Pavaver* plots, white flowers shoud be counted and given under Remarks, but still included in the totals. In the *Salix* plots, catkins that have been grazed, but can still be sexed, are included.

In the *Eriophorum* plots, both the number of *Eriophorum scheuchzeri* and *Eriophorum triste* inflorescenses must be recorded. Furthermore, in *Eriophorum scheuchzeri* they must be separated into fertile and infertile flowers. Infertile flowers have poorly develloped white hairs and the stem turns brown long before the stems of the fertile flowers.

1.2.6. Laboratory work

Writing out the dictaphone recordings.

1.2.7. Input of data into database

See section 1.1.8.

Table 1.2.2. Position, dimensions, orientation and approximate counting period for flowering study plots. The different counting periods within the species are determinded by snowmelt.

Plot no.	UTM-co-ordinates		Dimensions	A corner	Counting period
	Easting	Nording	(m)		
Cassiope 1	513,300	8,264,809	1x2	SE	mid/late July
Cassiope 2	513,230	8,265,290	1x3	SE	mid/late July
Cassiope 3	513,420	8,264,746	1x2	E	mid/late July
Cassiope 4	513,583	8,264,358	1x3	NE	mid/late July
Cassiope 5	514,239	8,267,196	1x2.5	SW	mid/late July
Cassiope 6	514,240	8,267,180	1x2	SW	mid August
Dryas 1	513,116	8,264,708	1x4	N	early July
Dryas 2	513,330	8,264,771	6x10	E	late July/August
Dryas 3	513,802	8,265,062	1x2	N	early/mid July
Dryas 4	513,348	8,264,694	2x3	N	early/mid July
Dryas 5	513,317	8,264,541	2x3	NW	early/mid July
Dryas 6	513,776	8,264,161	7x13	S	late July/August
Dryas 7	514,179	8,267,195	3x4	W	early/mid July
Dryas 8	514,203	8,267,167	3x4	S	early/mid July
Papaver 1	513,215	8,265,280	7x15	W	late July/early Aug
Papaver 2	513,729	8,264,955	10x15	E	late July/early Aug
Papaver 3	513,575	8,264,353	9x10	W	late July/early Aug
Papaver 4	513,776	8,264,161	7x13	S	late July/early Aug
Salix 1	513,041	8,264,643	6x10	W	mid/late **June**
Salix 2	513,237	8,264,729	15x20	W	mid/late July
Salix 3	513,294	8,264,805	6x6	S	late **June**/mid July
Salix 4	513,788	8,265,058	10x15	E	early/mid July
Salix 5	513,729	8,264,955	10x15	E	early/mid July?
Salix 6	513,645	8,264,718	?	?	early/mid July?
Salix 7	513,330	8,264,771	6x10	E	early/mid July?
Saxifraga 1	512,867	8,264, 603	2x3.5	W	mid **June**
Saxifraga 2	512,839	8,264,677	2x3	NE	mid **June**
Saxifraga 3	512,994	8,264,433	2x5	NW	mid/late **June**
Silene 1	512,867	8,264, 603	2x3,5	W	early/mid July
Silene 2	512,839	8,264,677	2x3	NE	early/mid July
Silene 3	512,994	8,264,433	2x5	NW	mid/late July
Silene 4	513,409	8,264,686	1x1	NW	early/mid August
Eriophorum 1	513,179	8,264,657	3x5	N	late July/late August
Eriophorum 2	513,475	8,264,510	3x5	NW	late July/late August
Eriophorum 3	513,241	8,265,106	2x3	E	late July/late August
Eriophorum 4	513,232	8,265,437	2x4	SE	late July/late August
Arctostaphylos 1	512,638	8,264,418	1x1.5	W	late June/late August
Arctostaphylos 2	512,669	8,264,408	1x1.5	NW	late June/late August
Arctostaphylos 3	512,646	8,264,407	1x1.5	NW	late June/late August
Arctostaphylos 4	512,665	8,264,402	1x1.5	NW	late June/late August
Vaccinium 1	513,968	8,264,753	1x4	N	early July/late August
Empetrum 1	512,669	8,264,416	1x5.2	W	mid June/late August

1.3. The ZERO-line

1.3.1. Species or taxonomic groups to be monitored

All vascular plants species. The nomenclature is according to Böcher et al., Grønlands Flora, P. Haase & Søns Forlag, 1978. Species of mosses and lichens are referred to as "moss" or "lichen".

1.3.2. Frequency of sampling
Every 5th year during the peak season from mid July to mid August.

1.3.3. Equipment to be used

A Raunkiær circling stick (metal angle)

List of peg positions (plus a GPS)

Data sheets

Knee pads

Camera with films

A hammer and extra aluminium tubes

1.3.4. Location and marking of the transect line

The ZERO-line consists of 130 numbered pegs running from the edge of the old delta to the top of Aucellabjerg. Each peg is placed at the borderline between distinct plant communities. Between each peg, 10 uluminium tubes denote the cetres for Raunkiær circles. Five tubes (nos 1-5) are situated with two metre intervals upwards from the peg and the last similarly before the next peg and again numbered upwards along the line (6-10). In plant communities less than 22 m wide, some tubes are placed on a right angle to the line, midway in the community and beginning on the western side. The exact location of all pegs are given in the Excel data file named Plot positions and stored at DMU (to be established).

1.3.5. Description of the sampling method

The Raunkiær circling stick with marks indicating the radius of the three circles is placed in the tube and all vascular plant species within the three circles are recorded . A species gets 1 point if rooted (or if a dwarf shrub has its buds within) only the 1/10 m^2, 2 if found within the 1/100 m^2, and 3 if found within the 1/1000 m^2 circle. Thus, the maximum score in 10 circles is 30. In addition it is recorded if the species is sexually reproductive (buds, flowers or fruits) within the 1/10 m^2 circle. Photos are taken of all plots from the eastern side of the line and along the borderline between the plant communities. Specimens, which are impossible to identify due to lack of flowers, fruits or other diagnostic characters are given by the genus name or by cfr. (e.g. Draba cfr. lactea). Later recordings during summers with better conditions will reveal the species.

1.3.6. Description of laboratory work

None.

1.3.7. Input of data into databases
Data from the plots are entered into an Excel data file with the columns Peg no., Tube no., Year, Month, Day, Observer and species names given as the three first letters of the scientific genus name followed after a dot by the first three letters of the species epithet. Uncertain species identifications have cfr. (=confer) added to indicate the need for further confirmation at next survey. Fertility is given by an "f" in a separate column after the species column.

See also: Fredskild, B. & Mogensen, G. 1997. ZERO line. Final Report 1997. A description of the plant communities along the ZERO line from Young Sund to the top of Aucellabjerg and the common plant communities in the Zackenberg valley, Northeast Greenland. - Greenland Botanical Survey & Botanical Museum, University of Copenhagen (36 pp.) and Bay, C. 1998. Vegetation mapping of Zackenberg valley, Northeast Greenland. Danish Polar Center & Botanical Museum, University of Copenhagen (29 pp. + 46 pp. appendix).

1.4. Plant community plots

Originally, four 20x20 m plant study plots were established in 1992, but only one

(Veg 1) was analysed (see Fredskild, B. & C. Bay 1993: Greenland Botanical Survey 1992. - Batanisk Museum, Copenhagen). Since then, only snowmelt has been recorded each spring, until Veg. 2-4 were closed down in 2001. Now, only snowmelt in Veg. 1 is recorded annually (see section 1.1.5).

1.5. RVI measurements in flower plots

See section 1.1.

1.6. Cryptogam study plots

Text is still in progress

1.6.1. Species or taxonomic groups to be monitored

1.6.2. Frequency of sampling

1.6.3. Equipment to be used

1.6.4. Location and marking of sampling plot(s)/transect line(s)

1.6.5. Description of sampling method

1.6.6. Description of laboratory work

1.6.7. Input of data into databases. To be produced

1.7. Production of berries

1.7.1. Species or taxonomic groups to be monitored

Alpine bearberry *Arctostaphylos alpina* (bjerg-melbærris)

Arctic blueberry *Vaccinium uliginosum* (mosebølle)

Crowberry *Empetrum nigrum* (revling)

1.7.2. Frequency of sampling

Twice per season, i.e. flowers in June-July and berries in late August.

1.7.3. Equipment to be used

Same as in 1.2.3.

1.7.4. Location and marking of sampling plots

See map Fig. 1.1.4 and table 1.2.2. Each plot is divided into four sections, denoted A-D.

1.7.5. Description of sampling method

As in 1.2.5. Besides berries, buds, flowers and senescent flowers are recorded separately.

1.7.6. Description of laboratory work

Writing out the dictaphone recordings.

1.7.7. Input of data into databases

As in 1.2.7 except that buds, flowers, senescent flowers and berries are given separately.

1.8. ITEX point frame plots

1.8.1. Species to be monitored

All vascular plants species. The nomenclature is according to Böcher et al. (1978). Species of mosses and lichens are referred to as moss or lichen.

1.8.2. Frequency of sampling

Every 5th year.

1.8.3. Equipment to be used

Map of plot positions (plus GPS)

An ITEX point frame (stored at the Zackenberg Research Station).

Data sheets

A xx cm ruler

Knee pads

Camera with films

1.8.4. Location and marking of sampling plots

The position of the plots appears from table 1.84. Each plot consists of five point frame analyses of 70x70 cm, each marked by an aluminium tube and three large spears.

Table 1.8.4.

Plot	UTM E	UTM N
1	513,346	8,265,008
2	513,612	8,264,732
3	513,219	8,264,605
4	?	?
5	514,042	8,265,177
6	?	?
7	514,063	8,266,478
8	512,636	8,263,613
9	515,037	8,266,857

1.8.5. Description of sampling method

The frame is placed horizontally above the plot fixed with the four legs in the tube and on the spear heads marking the plot. The distance from the soil surface to the underside of the frame should be checked after Bay 1998: Vegetation mapping of Zackenberg valley, Northeast Greenland. Danish Polar Center & Botanical Museum, University of Copenhagen. For each of the 100 hits per plot the vascular species are identified and recorded and mosses and lichens is given as moss or lichen. In addition the distance to the plant is measured (± 0.5 cm).

1.8.6 Description of laboratory work

None.

1.8.7. Input of data into databases

Data from the plots are entered into an Excel data file named ITEX plots and holding the columns Plot, Analysis, Year, Month, Day, NS location (1-10), WE location (1-10), Layer, Species, Status, Height and Remarks.

1.9. Northern range species

1.9.1. Species to be monitored

Salix herbacea (S. her.)

Campanula giesekiana (C. gie.)

Carex glareosa (C. gla.)

Carex lachenalii (C. lac.)

Carex norvegica (C. nor.)

1.9.3.Frequency of sampling
Every 5th year.

1.9.4. Location and marking of sampling plots

The positions are given in table 1.9.4. The plots are marked by aluminium tubes in each corner.

1.9.5. Description of sampling method

The species are low arctic species with their known northern distribution limit within the study area or the neighbouring areas just north of. In each plot, the number of buds, open flowers, senescent flowers and fruits are counted.

1.8.6 Description of laboratory work

Photos are stored in a file giving year, plot no and photo no.

1.9.7. Description of laboratory work

Data from the plots are entered into an Excel data file named Northern range species and holding the columns Species, Year, Month, Day, UTM E, UTM N, Buds, Flowers, Senecent and Photo.

1.10. Normalised Difference Vegetation Index (NDVI) analyses from satellite images

See special reports (e.g. Bøcker, C.A. 1999: Detaljeret analyse af NDVI for udvalgte vegetationszoner, Zackenberg 1998. - Asiaq.) and the map of the zones (Fig. 1.10; see next page).

Table 1.9.4.

Plot no.	UTM E	UTM N	Diment.
S. her. 1	512,652	8,266,331	25x30
S. her. 2	512,652	8,266,331	25x30
S. her. 3	514,220	8,266,309	30x50
S. her. 4	515,036	8,264,993	30x40
C. gie. 1	515,444	8,264,398	0.75 m^2
C. gie. 2	515,582	8,264,411	0.75 m^2
C. gie. 3	515,582	8,264,411	1.0 m^2
C. gie. 4	515,582	8,264,411	0.5 m^2
C. gie. 5	515,582	8,264,411	1.0 m^2
C. gie. 6	515,395	8,265,473	40x60
C. gie. 7	515,400	8,265,475	40x100
C. gie. 8	514,255	8,266,202	40x50
C. gie. 9	514,255	8,266,202	40x50
C. gla. 1	512,716	8,263,667	35x30
C. gla. 2	512,691	8,263,674	50x50
C. gla. 3	512,691	8,263,674	30x40
C. lac. 1	515,212	8,264,756	30x30
C. lac. 2	514,223	8,266,285	1.0 m^2
C. lac. 3	514,793	8,267,180	0.8 m^2
C. nor. 1	515,384	8,265,018	15x20
C. nor. 2	515,378	8,265,058	20x50
C. nor. 3	515,283	8,265,398	20x50
C. nor. 4	514,309	8,266,081	40x120
C. nor. 5	514,309	8,266,081	120x120

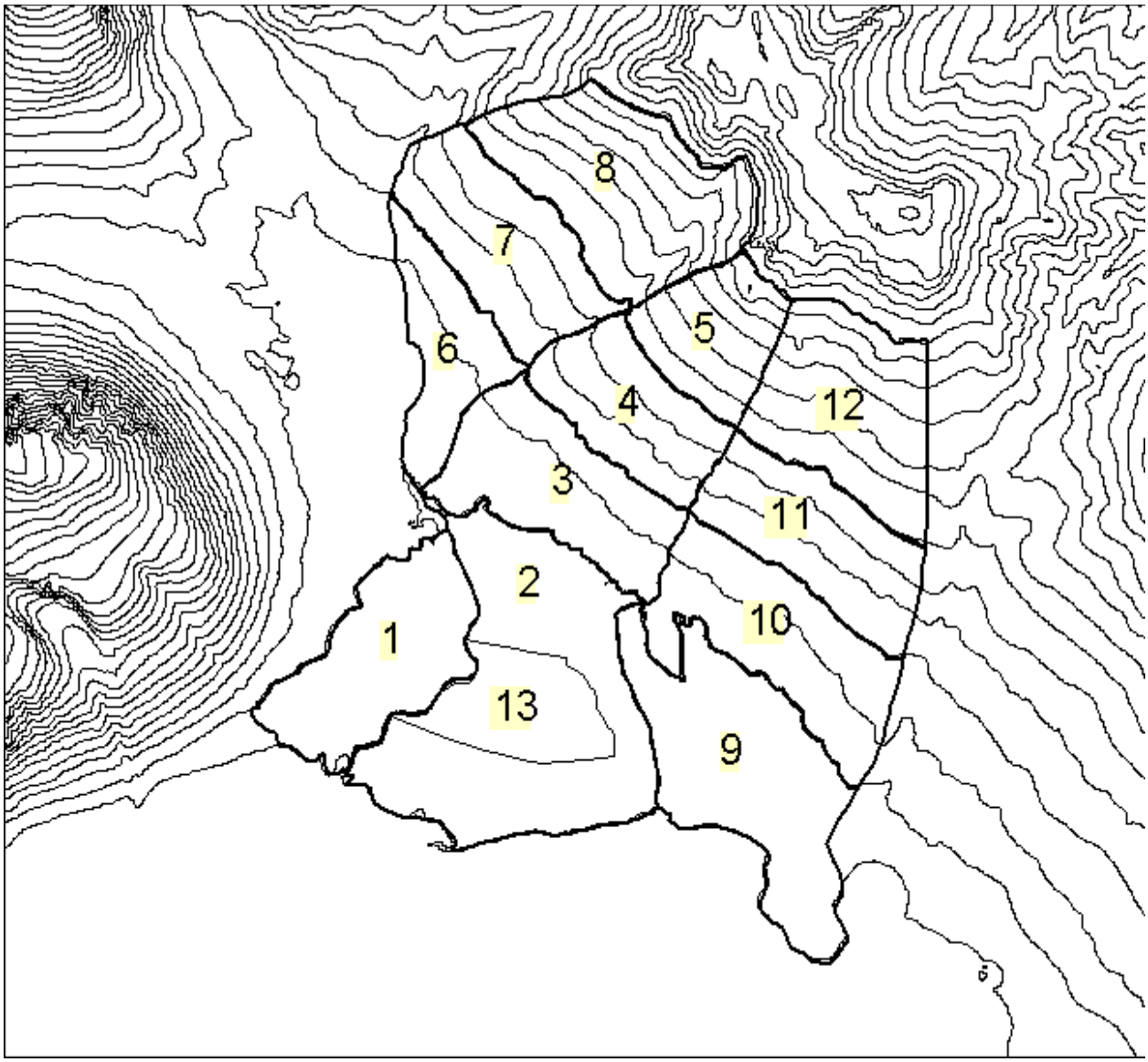


Fig 1.10. Map of Zackenbergdalen with 13 snow-cover and NDVI-zones demarkated.

2. Arthropods (leddyr)

2.1. Yellow pitfall traps

2.1.1. Species to be monitored

All taxonomic groups of arthropods

2.1.2. Frequency of sampling

The traps are emptied weekly on fixed dates (see table 1.1.2). If bad weather prohibits proper handling of the samples, the traps may be emptied on the following day.

2.1.3. Equipment to be used

For field work:

Map showing position of study plots

100 yellow (Pantone no. 108U) plastic cups, 10 cm in diameter and 8 cm deep

A thermos

A garden trowel with sharp edge

1, 5 and 10 l containers for water

Odourfree detergent (Tween 20 from Merck Eurolab, 43868788, info@merckeurolab.dk, www.merckeurolab.dk)

Salt (NaCl) - not from the kitchen!

50 metal pegs

Knee pads

A small aquarium net with the outer 10 cm of a lady's stocking as bag (make a new one each year and clean it in fresh water after each sampling day)

A pair of pointed and angled tweezers

500 ex. 10 cl plastic containers with lids

75 l of 70% alcohol

An ear syringe (with a rubber bulb and tube)

Alcohol resistant labels

Alcohol resistant pens

Alcohol resistant speed marker

Dataloggers

For sorting:

Binocular microscope

Pointed tweezers

Alcohol resistant pens

Preprinted alcohol resistant labels from the Zool. Museum, Univ. of Copenh.

70% alcohol

Data sheets (see Appendix)

and the following literature:

Böcher, J. no year: Insekter og andre smådyr - i Grønlands fjeld og ferskvand. - Forlaget Atuagkat.

Chinery, M. 1993: Vesteuropas insekter - en felthåndbog. - Gad.

Goulet, H. & J.T. Huber (eds.) 1993: Hymenoptera of the world: An identification guide to families. - Agriculture Canada.

MacAlpine et al. 1981, 1987 & 1989: Manual of nearctic Diptera. Vol. 1, 2 & 3. - Research Branch Agriculture Canada.

2.1.4. Location and marking of sampling plots

The position of the study plots appear from Fig. 2.1.4 (nos 2-7 and table 2.1.4). Each plot measures 10 x 20 m^2 and is made up of eight 5 x 5 m^2 squares marked with a white nylon stick (15 in total) in each corner. Each plot is identified with a number plate, and each section (with one trap each) is denoted A-H clockwise from the number plate.

On Station 2, the traps are marked with a nylon stick at each trap. Each stick is further marked with metal bands around the top (A-D) or the middle (E-H):

One band: A and E
Two bands: B and F
Three bands: C and G
Four bands: D and H

The vegetation types in pitfall plots are:

Art 2: Wet fen dominated by mosses and grasses/sedges (incl. Arctic cotton grass *Eriophorum scheuchzeri*), and with Arctic willow *Salix arctica* on the turfs.

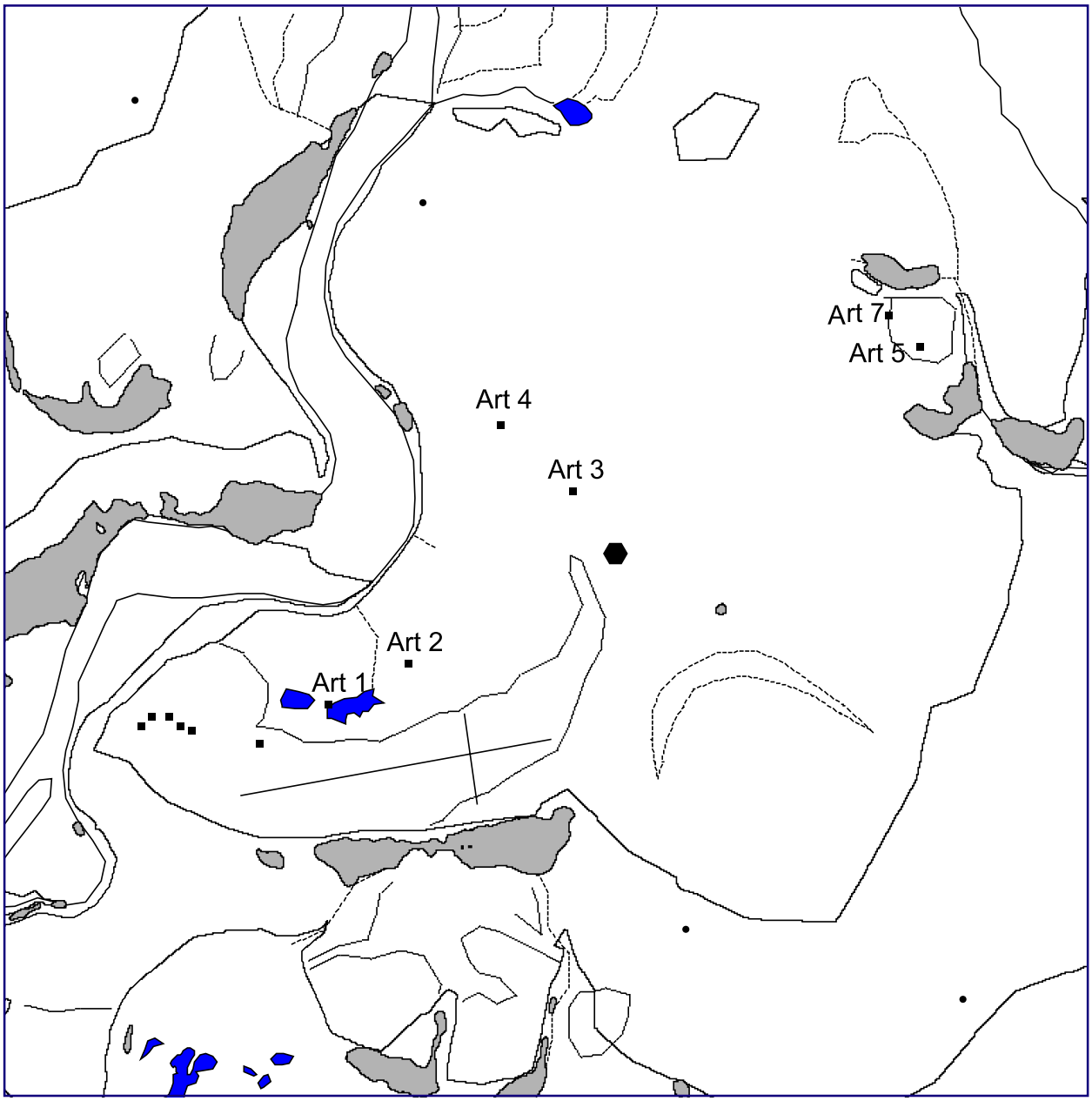


Fig. 2.1.4. Position of arthropod sampling plots 1-6 (1 = window traps, 2-7 = pitfall trap station) and the climate station (dot).

Table 2.1.4. UTM-coordinates of arthropod sampling plots.

Plot no.	Easting	Nording	A-corner
1	512,966	8,264,532	-
2	513,083	8,264,591	-
3	513,320	8,264,844	SE
4	513,215	8,264,941	E
5	513,825	8,265,055	S
6	513,545	8,264,747	W
7	513,780	8,265,100	W

Art 3: Mesic heath dominated by lichens (an almost complete cover of organic crust) and white Arctic bell-heather *Cassiope tetragona*, and with scattered individuals of Arctic willow and Arctic blueberry *Vaccinium uligonosum*.

Art 4: Mesic heath dominated by lichens (an almost complete cover of organic crust) and with scattered individuals of white Arctic bell-heather, Arctic willow, mountain avens *Dryas* sp., grasses/sedges and Arctic blueberry.

Art 5: Arid heath dominated by lichens (an almost complete cover of organic crust) and mountain avens and with scattered individuals of Arctic willow and Bellard's kobresia *Kobresia myosuroides*.

Art 6: Snow-bed covered in a thick mat of

lichens (an almost complete cover of organic crust) and poorly performing Arctic willow. The plot was colsed in 1999.

Art 7: Highly exposed and arid heath dominated by lichens (an almost complete cover of organic crust) and mountain avens, and with scattered individuals of Arctic willow and Bellard's kobresia (more mountain avens and less Arctic willow than Art 5, which often is snow-covered in winter).

2.1.5. Sampling method

2.1.5.1. Establishment of the traps

New traps for the following season are established late each summer, when a set of eight pitfall traps are established in each plot. Each trap is composed of two plastic cups fitting into each other, so that the upper one can be lifted and emptied without disturbing the surrounding soil. The traps are positioned randomly within each of the 5 x 5 m^2 squares by turning your back to the square and throwing an item over your shoulder. The trap is then dug down on the nearest reasonably level and 'elevated' site (so that it is not flooded during the snow melt) and carefully sunk into the soil, so that the upper rim levels exactly with the soil surface. Place the turf and the removed soil about a meter away from the trap. Do not disperse it, since it must be repositioned after the season, when the traps are removed.

The new traps are covered with a plastic lid and a stone during the winter. At the start of the season (i.e. on the round when the traps have appeared from the snow), new clean (washed with a little Tween 20) upper cups replace the 'wintering' ones. Bring hot water in a thermos in case the two cups are frozen solid.

If there is any risk that cups will float up due to water in the lower cup, two metal pegs must be placed along each cup to keep them in position.

The upper cup of the trap is then filled 2/3-3/4 with water (2 l needed per station) added three drops of detergent and a spoonful of salt as killing agent, preservation and to prevent freezing.

The traps on Station 2 are not removed from year to year as they are positioned on the only 'elevated' mounds on the site that are not flooded during spring. The traps on this station are only made up of one cup, as they otherwise would float during the snow-melt. Still, they may need pegs to keep them in position.

2.1.5.2. Emptying the traps

Catches from each of the eight traps are kept separate. Prepare 50 ex. 10 cl containers in advance by filling them 4/5 with 70% alcohol. Alcohol resistent labels with date, plot numbers and sections (A-H) written with an alcohol resistant pen are prepared from home and kept in order by a paper clip. Do not write on the con-tainers.

When the traps are emptied, the trap liquid is poured through the aquarium net into a spare cup, whereupon the liquid is poured back into the repositioned upper cup. Check the cup carefully for small arthropods before repositioning it. Mites, especially, often remain in the cups. Take care that liquid from the net does not fall on the soil around the trap by keeping the net over the cups all the time. The catch is then emptied into the 10 cl container with alcohol by turning the net inside out in the container. All remaining invertebrates must be removed carefully from the aquarium net by the tweezers and put into the container.

Note the full hour of the day, when the traps in each plot are emptied. After emptying all traps, extra water must be added to the traps to compensate for evaporation since last round (up to 1 l needed per station). In the middle of each season, a little salt and detergent must be added to compensate for loss during the season.

Bring an extra pair of cups on each round, together with equipment for setting up traps, in case a trap has been destroyed, e.g. by a fox or muskox. Any failures such as flooded or floating cups, fox faeces etc. must be recorded. This includes occurrence of fungi in the water. In that case a new cup and new water must be established.

At all visits at the arthopod stations during snow melt, the snow cover (%) is estimated for each section of the plot (see 1.1.5). At station 2,

this only apply to the individual traps (i.e. the trap covered = 100%, the trap snow-free = 0%).

Never touch the traps with mosquito repellent or suntan oil on you fingers!

2.1.5.3. Ending the season

At the termination of the catching season on 26 August or 3 September, the trap liquid must be collected from all the traps and poured into Zackenbergelven. All the 'old' traps are gathered, and the turfs put back into the hollows.

2.1.6. Handling of dataloggers

(see section 6.1).

2.1.7. Laboratory work

Specimens are sorted to different taxonomic levels (see data sheets in Appendix and section 2.1.3 for relevant literature) using a binocular microscope with a magnifying range of 6 to 40. Specimens from each taxa from each trap and date are kept in separate glass tubes with 70% alcohol. A pre-printed label written with an alcohol resistant pen stating date and year of collection, station and section no., and taxa (latin only) must be located inside the tube. Glass tubes with specimens sorted in Zackenberg are closed with a plastic stopper, and brought back to the Zoological Museum in Copenhagen. Here the stopper is removed, and the tubes are closed with a cotton stopper and kept in glass containers with 70% alcohol together with the samples sorted at the museum. Each glass must only contain samples of one taxon and year. The collection is organised in accordance with the instructions from the curator at the museum. After emptying the plastic containers, clean them with water to get rid of alcohol and dirt.

2.1.8. Input of data into database

After sorting, the total number of individuals per group is entered into Excel data files named Art2-7 and holding the following columns: Year, Month, Day, Hour, Plot, Fieldwork, Sorting, Snow A (per cent in the sector), Snow B, Snow C, Snow D, Snow E, Snow F, Snow G, Snow H, Days A (trap days for the trap in the sector), Days B, Days C, Days D, Days E, Days F, Days G, Days H, Taxon, A (no. of individuals in trap A), B, C, D, E, F, G, H and Remarks. Under Remarks, date of opening and closing together with relevant observations on the traps are stated. This include any disturbance that may influence the efficiency of the traps such as flooding, drying out, ice, dirt, faeces and vandalism by foxes.

2.2. Window traps

2.2.1. Taxonomic groups to be monitored

Same as in section 2.1.

2.2.2. Frequency of sampling

Same as in section 2.1.

2.2.3. Equipment to be used

Two window traps each with a 'window' of 20 x 20 cm^2

A cloth

A bucket

Otherwise same as 2.1.3

2.2.4. Location and marking of sampling plot

On an islet in the eastern pond of Gadekæret (station 1 on Fig. 2.1.4), two angular aluminium bars make up the holders for each trap. The traps are positioned with the windows in a right angle to each other, so that they catch in 'all' wind directions.

2.2.5. Sampling method

The two 'basins' of each trap must be filled 3/4 with water, detergent (one spoonful in each of the four basins) and salt (12 spoonfuls in each of the four basins).

At each visit during ice melt in spring the ice cover (per cent) on the pond must be estimated.

When emptying the traps, the aquarium net is used to 'fish' the catch from each basin. The catch from the two traps is pooled in one 10 cl plastic container. Refill the traps at each visit (5 l of water needed), and add a little salt in the middle of the season to compensate for loss. Keep the windows absolutely clean from salt water and salt.

Empty them together with the other traps on 26 August or 3 September. Use a bucket when you empty them. The traps must be stored in-house during winter.

2.2.6. Laboratory work

The samples are handled in the same way as described in 2.1.7.

2.2.7. Input of data into database

After sorting, the total number of individuals per group is entered into an Excel data file named Art1 and holding the following columns: Year, Month, Day, Hour, Plot, Fieldwork, Sorting, Ice (per cent cover on surrounding pond), Days A+B (sum of trap days for both traps), Taxon, No. (of individuals in both traps combined), and Remarks. Under Remarks, date of opening and closing together with relevant observations on the traps are stated. This include any disturbance that may influence the efficiency of the traps such as ice, dirt and vandalism by muskoxen.

2.3. Predation by larvae of *Sympistis zetterstedtii* on *Dryas* flowers

See section 1.1.5: *Dryas*.

2.4. Occurrence of woolly-bear caterpillars *Gynaephora groenlandica*

See sections 1.1.5: *Salix*, and 3.7: 'Random' observations.

2.5. Predation by larvae of sawfly Tenthredinidae on *Salix arctica* ovules.

See section 1.1.5: *Salix*.

2.6. Occurrence of bumble bees *Bombus* sp. and butterflies

See sections 3.7 and 4.7.

Text of preprinted labels:

NE GREENLAND, Zackenberg,

74°28'N, 20°34'W

Station: Date:

NATIONAL ENV. RES. INSTITUTE

ZOOLOGICAL MUSEUM, COPENHAGEN

3. Birds

3.1. Breeding bird census

3.1.1. Species to be monitored

Red-throated diver *Gavia stellata* (rødstrubet lom)

King eider *Somateria spectabilis* (kongeederfugl)

Long-tailed duck *Clangula hyemalis* (havlit)

Rock ptarmigan *Lagopus mutus* (fjeldrype)

Common ringed plover *Charadrius hiaticula* (stor præstekrave)

Red knot *Calidris canutus* (islandsk ryle)

Sanderling *Calidris alba* (sandløber)

Dunlin *Calidris alpina* (almindelig ryle)

Ruddy turnstone *Arenaria interpres* (stenvender)

Red-necked phalarope *Phalaropus lobatus* (Odinshane)

Long-tailed skua *Stercorarius longicaudus* (lille kjove)

Northern wheatear *Oenanthe oenanthe* (stenpikker)

Snow bunting *Plectrophenax nivalis* (snespurv)

Plus other species that may breed in the census area.

3.1.2. Frequency of sampling

Annually during June and July

3.1.3. Equipment to be used

Binoculars

Topographic maps of sections of the census area mounted on a clip-board

Dictaphone

Altimeter

Skis

Snowshoes

3.1.4. Location and marking of sampling plots

The borders of the census area in Zackenbergdalen is marked on the field maps (Fig. 3.1.4), and they generally follow visible features in the landscape. Sub-area 1 makes up an intensive study area of 3.4 km^2 west of Zackenbergelven, while Sub-area 2 is the 15.4 km^2 area east of the river, which is more extensively covered.

3.1.5. Sampling method

During mid-late June, both sub-areas must be surveyed. At that time, territories are being established, egg-laying is initiated, and the birds are concentrated on the relatively limited areas of snow-free ground.

During the survey trips, the area must be covered in such a way that no snow-free spot is passed by the observer at a distance exceeding 100 m. Minor snow free spots may be searched carefully with the binoculars at a little more distance. The surveys must be performed in fine weather. Avoid overcast with low clouds and windy days. Use the first days with good weather to cover Rylekærene, Oksebakkerne and the slopes of Aucellabjerg, as a minimum of four days is needed to cover these. Start with the most important areas below 300 m a.s.l.

On each survey trip, all bird observations are marked on the maps using specific symbols for each species and type of behaviour (see table 3.1.5).

On the slopes of Aucellabjerg it may be somewhat difficult to plot the observations on the right positions on the map. The combination of rivulets, snow drifts and the altitude provided by an altimeter gives the best clues. Remember to adjust the altimeter before leaving the station (35 m).

In the intensive study area west of Zackenbergelven (Sub-area 1), registrations continue during the rest of June and

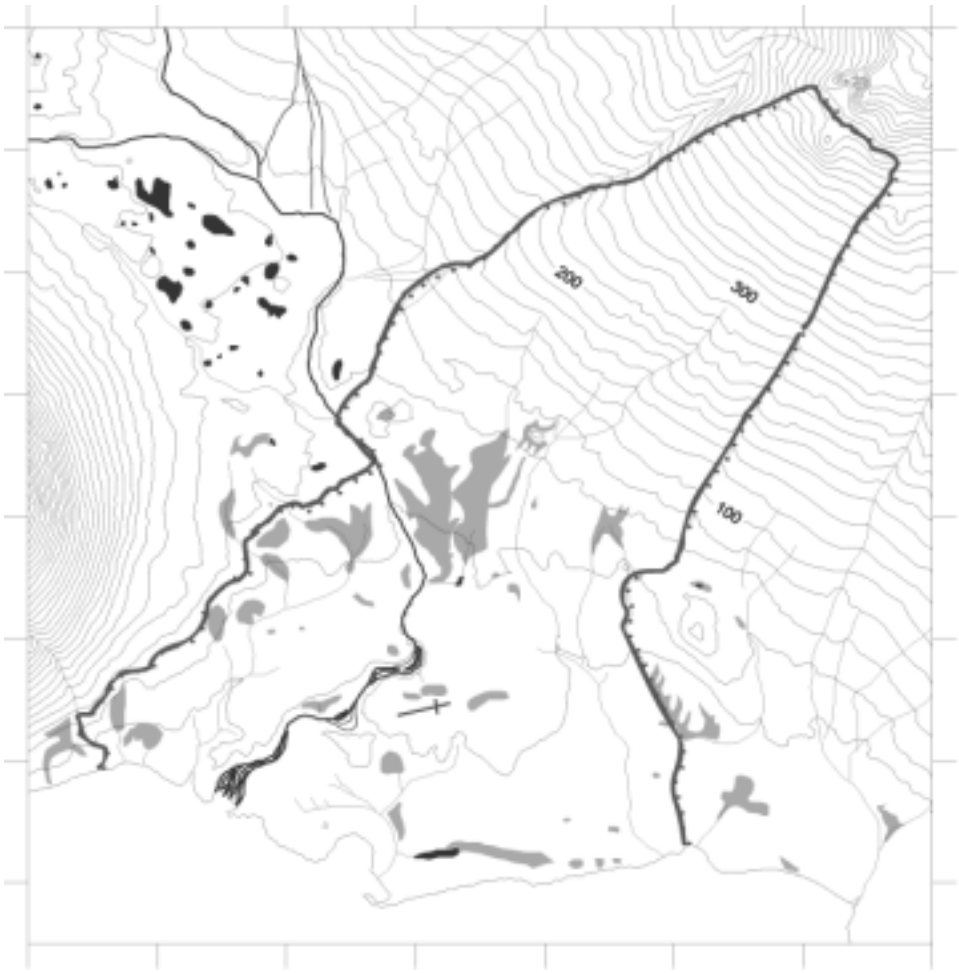


Fig. 3.1.4. Map of the breeding bird census area in Zackenbergdalen.

early-mid July, so that the area is covered at least once every 10-day period.

Until late June or early July (varying from year to year), it is advantageous to use skis in most of the lowland, and snowshoes may be used to pass large snow drifts. During mid June, Rylekærene may be difficult to pass due to extensive water-soaked snow. The watershed south of Kamelen, along the western side of Kærelv, is then the best place to pass.

Observations of single individuals are plotted as open symbols, while pairs are filled. Nests are shown as a pair/individual (dependent on the presence of the parents) with a circle around, while broods are marked as a pair/individual with a dashed circle around. The number of eggs/young is stated at the symbol.

Breeding behaviour is given a symbol as follows:

s Singing individual (or individual in a pair)

ag Aggressive individual/pair (towards conspecifics, other species or predators)

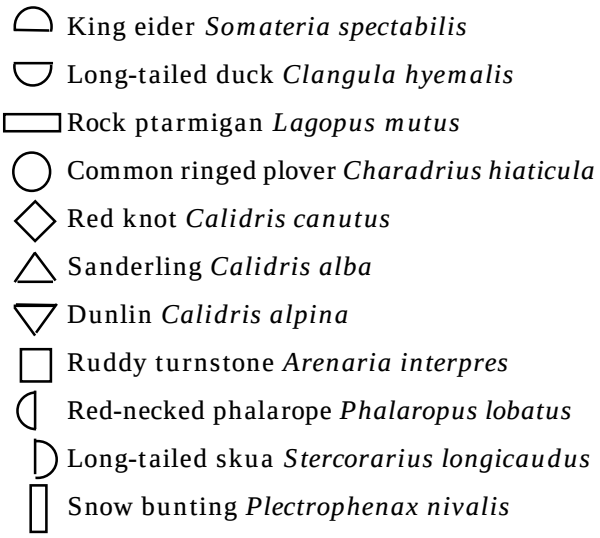
v Vocalisation other than song (e.g. alarm calling individual/pair)

y Distraction behaviour or other display that clearly indicate breeding (incl. nest building and food collecting in passerines)

Purs Flight pursuit between two or more birds.

Remember to estimate the ice cover on Langemandssø and Sommerfuglesø at

Table 3.1.5. Symbols for marking of bird observations on field maps.



Other species are written i full.

each visit on the upper slopes of Aucellabjerg (see section 5.1.2).

3.1.6. Laboratory work

After each season the results of the field records are evaluated and concluded by a map of all territories found in the census area. All site claiming pairs/individuals are considered full members of the population, whether breeding or not. Hence, all records of pairs, singing (or otherwise territorial) and alarm calling individuals are considered as 'territories'. Records that do not fulfil these criteria, but still may indicate the presence of a territory (e.g. stationary single but silent individuals), are plotted as additional territories with a question mark. The same is done with possible double registrations. In the area west of the river, the maximum number of territories recorded *simultaneously* in appropriate parts of the area are accepted.

The initial census in mid-late June is considered the basis for the evaluation, and an initial evaluation is made after this survey. Pairs may be added to these results if they are found in areas where no pairs were recorded nearby or in areas that were poorly covered during the initial census, or territories may be upgraded from a question mark if better records at the site are obtained later. Otherwise, later records of nests and small young together with stationary and clearly breeding pairs are just counterbalanced by repositioning a nearby 'territory' from the initial census. For the red knot, even pairs and singing individuals recorded during early June are included in the evaluation. In both sub-areas, great care should be taken not to double record pairs and individuals that move from one areas to another following snow melt. Territories, in which nests or broods have been found, are specifically marked (see 3.1.5).

3.1.7. Input of data into database

The position of each territory is entered into an Excel data file named 'Bird territories' and holding the following columns: Species, Year, Serial no., UTM East, UTM North, Status, and Remarks.

Territories in which nests or young have been found, must be allocated the same serial number as in the bird nest and bird brood data files, respectively (see 3.2.7). Such territories are given status as N for nest found or B for brood found. Other territories are given status T for territory or ? for uncertain territory.

For territories in which nests have been found, the UTM co-ordinates must be the same as in the bird nest database. For territories with broods this only apply to brood finding places that are considered representative for the actual territory (and hence, the UTM co-ordinates of the finding place of the brood is given in both databases). Others are given separate UTM co-ordinates for territory and finding place, and the B in status is given in brackets.

Under remarks, you may note e.g. that this brood may originate from nest no. x, ect.

3.2. Breeding phenology of birds in Zackenbergdalen

3.2.1. Species to be monitored

Same as in section 3.1, but with emphasis on sanderling, dunlin, ruddy turnstone and long-tailed skua, of which minimum samples of 10 nests/broods are aimed for.

3.2.2. Frequency of sampling

Annually during June, July and August

3.2.3. Equipment to be used

A clapsack chair

White nylon sticks

A thermos

A 0.5 l vessel with a mm scale on the side

Paper towels

30, 100 and 500 g Pesola spring scales

Fabric bags

Bird rings from the Zoological Museum, University of Copenhagen

Tongs for bird rings

Notebook

Otherwise same as 3.1.3

3.2.4. Marking of sampling plots

Each nest found must be marked with a white nylon stick or a small stone cairn situated 10 metres from the nest in the direction away from the tall antenna of the Zackenberg station.

3.2.5. Sampling method

During the second half of June and the first half of July wader nests are spotted by keeping an eye on birds lifting from nests and by 'walking back' from intensively alarm calling or distraction displaying individuals. From a point with good overview (use the clapsack chair in flat areas), the bird is watched moving back to the nest. If both individuals of a pair are alarm calling, keep track of the least vocative bird usually located in the periphery of alarming individuals. It may also be productive just to sit down and search an area with your binoculars. Nests of other species are located opportunistically.

Spend every second or third day west of the river, so that the effort per area is largest in Sub-area 1.

Eggs of waders and skuas are checked for incubation stage by floating two eggs of the clutch in the 0.5 l vessel 2/3 filled with 20ºC-30ºC water from the thermos. The angle between the egg axis and the bottom of the vessel or the extent of the egg that is above water and the angle towards the water surface is recorded. Use your watch to estimate angles. The eggs must be carefully dried with the paper towels before repositioned in the nest.

Do not visit nests again until about thre days before the estimated date of hatching, as tracks to and from nests may guide predators to the nest. From then on, eggs are checked for cracks in the shell at each visit- i.e. whether they are 'starred' or 'pipped'. An egg is recorded as 'starred' when there are small hatching cracks in the shell, and as 'pipped' when there is a hole in the shell. An egg is starred 2-4 days prior to hatching and pipped within 1-2 days before hatching.

Nests found empty must be checked for signs of hatching (shell fragments in the bottom nest material) or predation (predated shells, smell of fox, faeces). Nest cups, from which pulli have left, are often broad and flat as compared to depredated nests. Cold unhatched eggs are opened to check for dead embryos.

All wader and skua chicks found must be weighed to enable ageing. Furthermore, in skua young the wing is measured flattened and straightened on a ruler. Newly hatched wader chicks are weighed after they have been ringed by 'hanging' them

Table 3.2.6.1. Records of angle and float height of wader and skua eggs in relation to stage of incubation (given as days after start of incubation, but calculated from day of hatching).

Angle (º)	Floating above surface (mm)	Common ringed plover	Red knot	Sander-ling	Dunlin	Ruddy turn-stone	Long-tailed skua
Bottom							
0-10		0			0		0
10-20		3		0	0-1	0-2	2
20-30		2		2-4	2	1-4	2-4
30-40		3-4		2-4	3-4	1-5	3-6
40-50		4	5	4	3-5	6	3-6
50-60		4	5		4-6		6-9
60-70		5			6	4	5
70-80				6	6-8	6-8	5
80-90		9		6	8	5-9	10
Weightless				8		9	
Floating							
90	0-0.5	12		8	10	9	
80-90	0.5-1	12				9-11	13
70-80	1-2			12-15	13-16	10-16	15-17
70-80	2	14			15-17	14-16	
60-70	2-3			17	16-17	14-19	
60	3			19		19	
45	>3					18	

in the ring from the spring balance. Larger chicks are weighed in a fabric bag (remember to weight the bag immediately afterwards and subtract the weight from the weight of the young). Keep all young of a brood in a fabric bag until they can be released simultaneously. Avoid handling eggs and chicks with mosquito repellent or sun lotion on your hands.

Chicks that are only observed at a distance, are 'aged' by comparing them with the state of development of chicks experienced at previous occasions. Newly fledged wader and skua young, still with downy head and neck and still accompanied by an adult, are recorded too. These can only by aged (cf. Table 3.2.6.2) if no periods of inclement weather have prevailed during the possible fledging period.

Nests of divers, ducks and ptarmigan are checked from a distance to record hatching date, brood size and possible predation. Do not flush incubating waterfowl to check the nest. If incubating ducks are accidentally flushed from the nest, the eggs are counted, whereupon they are covered with the nest down. Observations of young of these species are similarly recorded.

In years with many foxes, skua nests should not be approaced closer than 5 m, but close to hatching, eggs may be floated in the same way as wader eggs to estimate hatching time.

Breeding phenology of snow bunting and wheatear is monitored by records of calling young and observations of fledged juveniles.

Leave several nest markers scattered in the terrain and move them now and then to prevent foxes from discovering their connection to nests.

3.2.6. Laboratory work

The incubation stage of wader and skua eggs is estimated by using the criteria stated in table 3.2.6.1 (see also van Paassen et al. 1984: A simple device for determination of incubation stages in eggs. - Wildfowl 35: 173-178).

Table 3.2.6.2. Egg laying, incubation and fledging periods (days) of waders and skuas. Add 1-2 days for fully fledged, but still downy-necked wader young.

Species	Egg-laying (4 eggs)	Egg-laying + incubation	Fledging
Common ringed plover	5	29	24
Red knot	4	26	19
Sanderling	4	26	17-20
Dunlin	4	26	17-20
Ruddy turnstone	4	26	17-20
Long-tailed skua	2 (2 eggs)	24 (1 egg)	25

The age of wader and long-tailed skua young are similarly determined by means of species specific growth curves (Figs 3.2.6.1-6). The estimated hatching date of the largest young in a brood is recorded as the hatching date of the brood.

First egg dates are consequently calculated using the egg laying, incubation and fledging periods given in table 3.2.6.2.

After the season, ringing reports are mailed to the Zoological Museum, Ringing department, Universitetsparken 15, DK-2100 Copenhagen Ø, Denmark.

3.2.7. Input of data into database

All observations and controls of nests and young are entered into the Excel data files 'Bird nests' and 'Bird broods', respectively. The file with bird nests gives the following columns: Species, Year, Serial no., UTM East, UTM North, Month, Day, Observer, Nest building (Yes, or no. of individuals), Bird incubating (0 or 1), Bird(s) attending (incl. neighbours attracted by alarm calling parents), No. of eggs, Bottom angle (for the most developed egg), Float height (for the most developed egg), Float angle (for the most developed egg), No. starred, No. pipped, No. wet pulli, No. dry pulli, Band no. I, Band no. II, Band no. III, Band no. IV, Weight I (of pullus), Weight II (of pullus), Weight III (of pullus), Weight IV (of pullus), Shell fragments (from hatching eggs: Yes or No), Predated shells, Smell of fox, Fox tracks/faeces, No. of cold eggs, 1st egg date, Accuracy, Eggs laid, Pulli hatched (give known or estimated number in Conclusion - see below), and Comments.

The serial number simply follows the cronology in wich the nests and broods were found. Nests and broods are numbered consecutively, so that they can be entered into the Bird territories database with the same numbering. Broods that are too old to be associated with a specific territory, together with nests and broods that are encountered outside the census area, have 100 added to their number to indicate that they do not appear in the Bird territories database. The same apply to observations of newly fledged juveniles.

The 'Bird broods' data base gives the following columns: Species, Year, Serial no., UTM East, UTM North, Month, Day, Observer, Bird(s) attending (incl. neighbours attracted by alarm calling parents), No. of pulli, No. of juveniles, Band no. I, Band no. II, Band no. III, Band no. IV, Weight I, Weight II, Weight III, Weight IV, 1st egg date, Accuracy, and Comments. Under Comments you may e.g. note that this brood possibly could be the same as x brood (when not cought or only part of the possible number of young have been found.

In the 'Bird nest' database, 1st egg date, Accuracy and number of Eggs laid and Pulli hatched are filled in as a conclusion record after the dated records of each nest. This is indicated by stating 'Conclusion' in the 'Observer' column. The 1st egg date must be given as yyyymmdd (e.g. 20000615 for 15 June 2000). In the Accu-

racy column, codes 1-6 denote the kind of data that the 1st egg date estimate was based upon (Table 3.2.7). The known/estimated number of pulli hatched from a nest e.g. includes all starred and pipped eggs from nests that later were found empty with no sign of predation. Under comments you may e.g. note that this nest may have been a relay of x (failed) nest.

Table 3.2.7. Codes denoting accuracy categories of estimated first egg dates in waders etc. The codes represent the different kind of data that the estimates and calculation are based on.

Code 1: record of incomplete clutch

Code 2: record of starred and pipped eggs or young still in nest

Code 3: record of pulli weights

Code 4: record of egg floating

Code 5: age estimates of chicks that were not caught and measured

Code 6: observations of newly fledged juveniles (e.g. with downy head and neck) that were still in company with alarm calling adults.

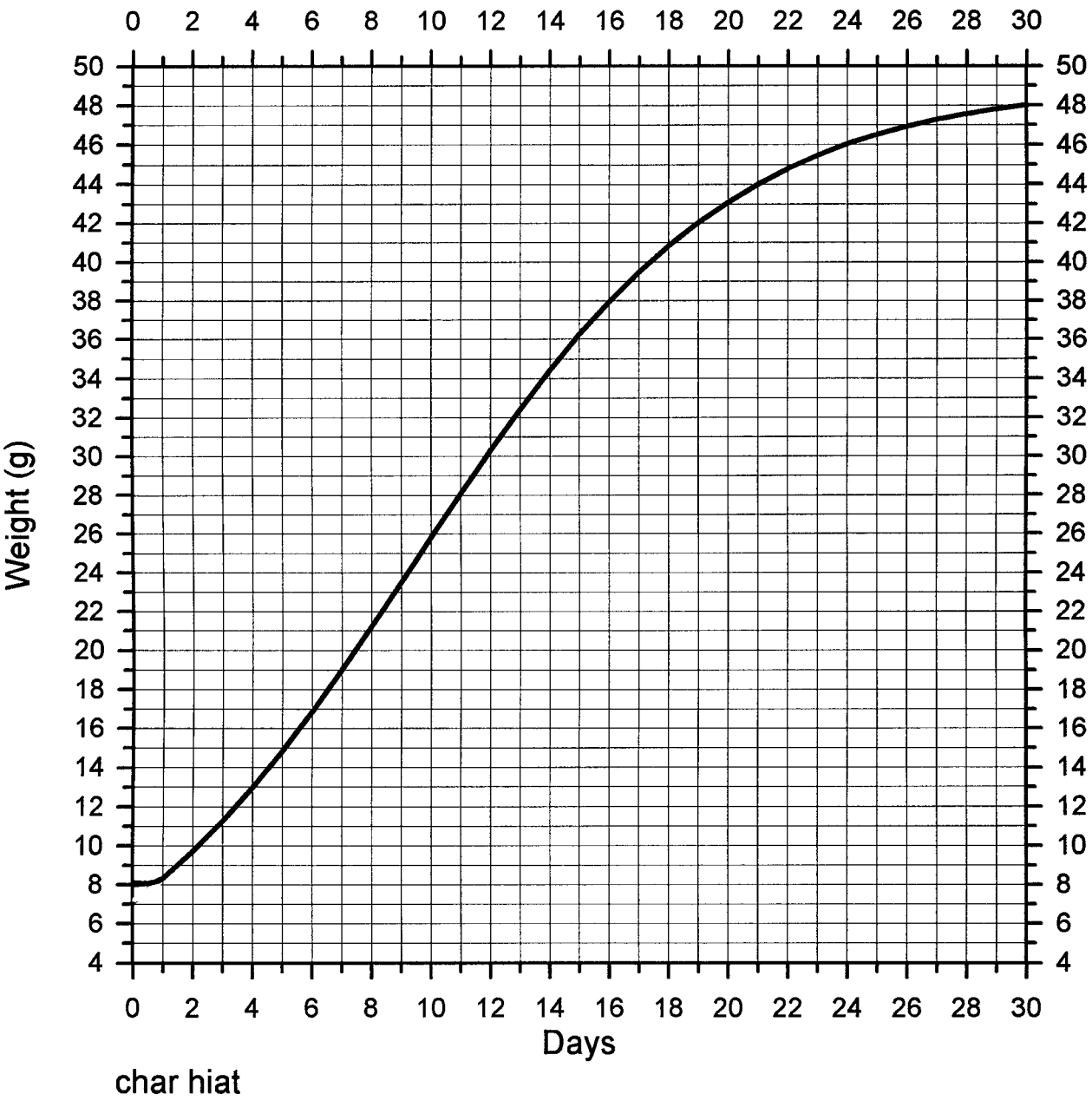


Fig. 3.2.6.1. Growth curve for common ringed plover chicks (modified from Hans Schekkerman in litt.).

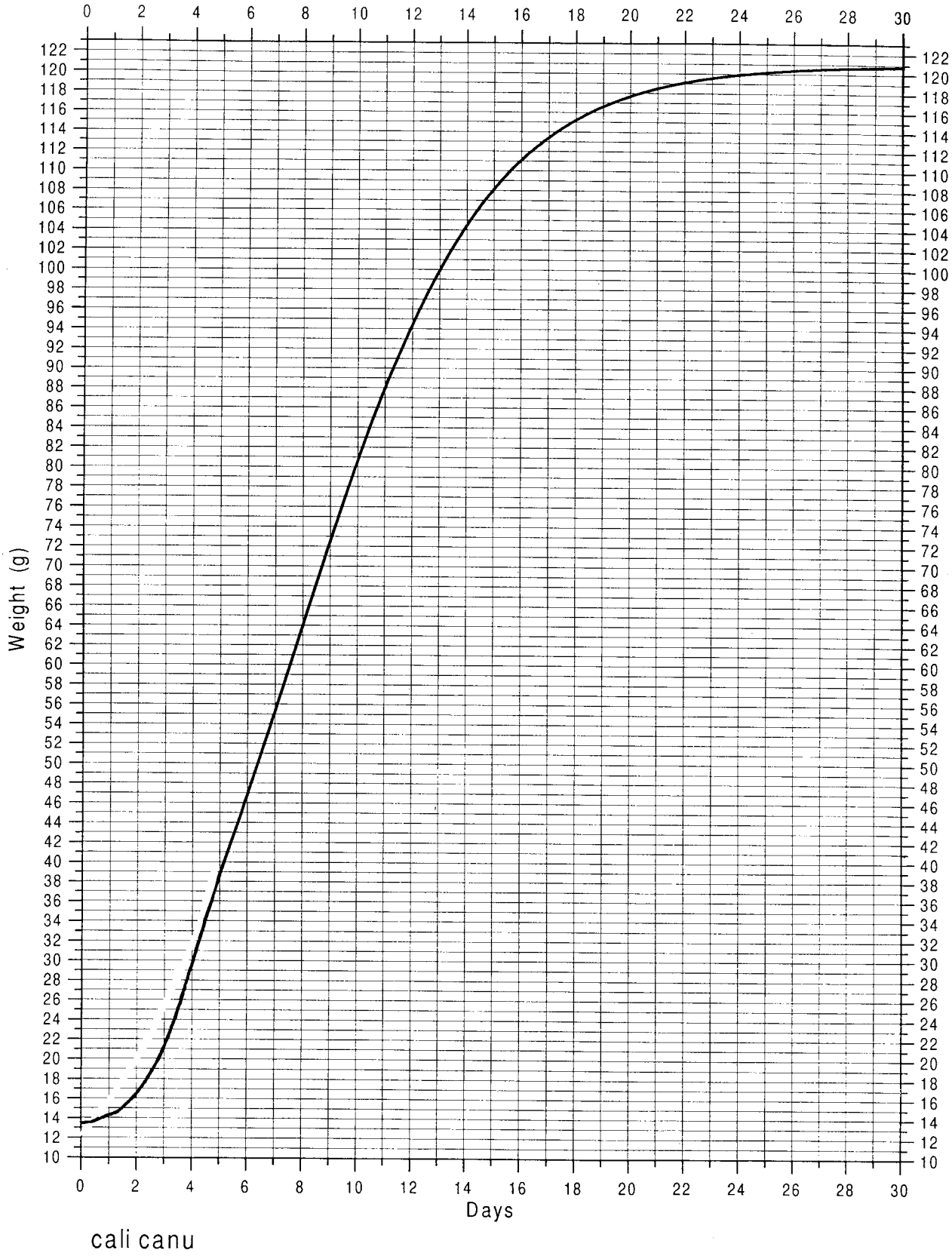


Fig. 3.2.6.2. Growth curve for red knot chicks (modified from Hans Schekkerman in litt.).

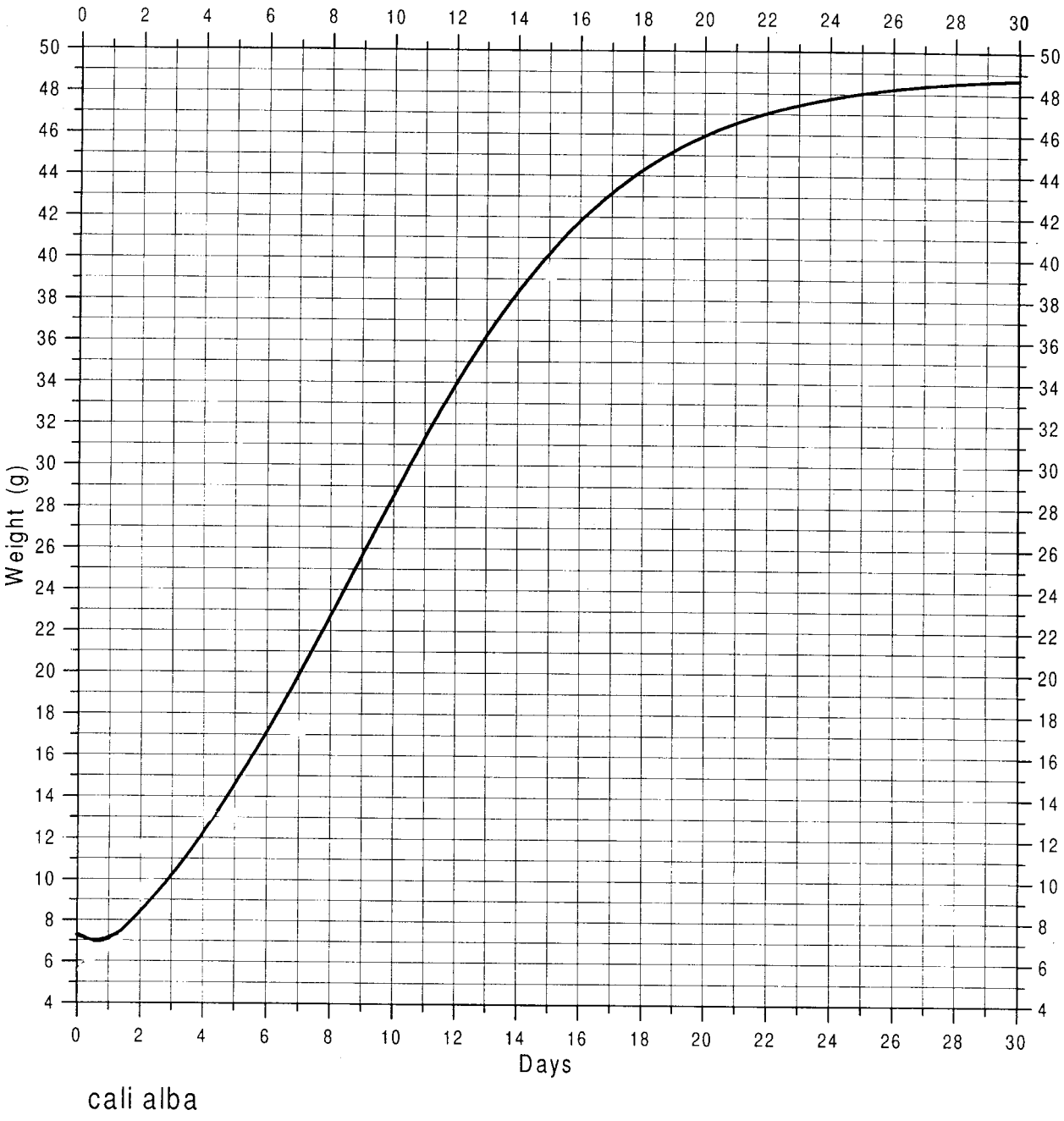


Fig. 3.2.6.3. Growth curve for sanderling chicks (modified from Hans Schekkerman in litt.).

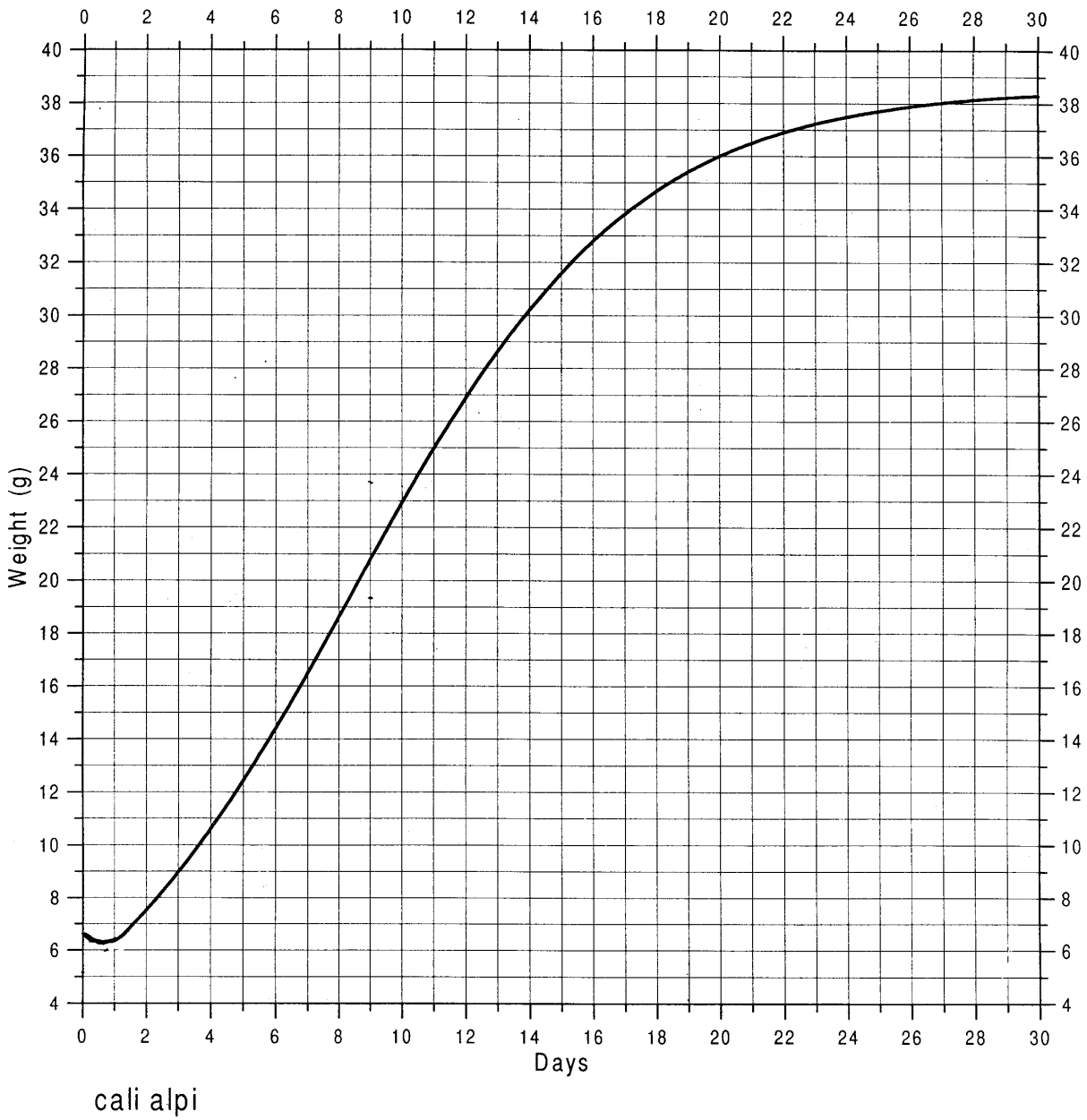


Fig. 3.2.6.4. Curve for dunlin chicks (modified from Hans Schekkerman in litt.)

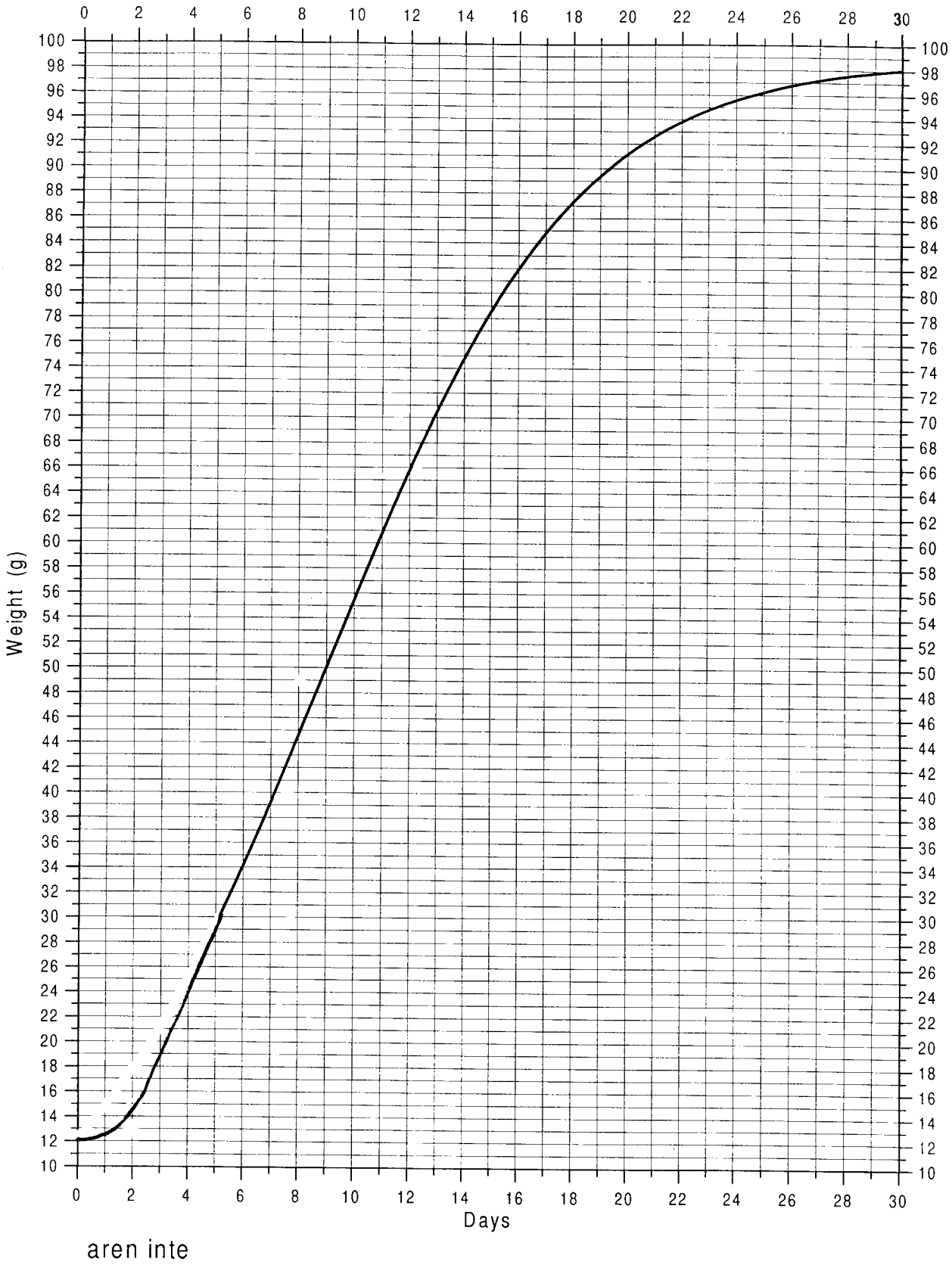


Fig. 3.2.6.5. Growth curve for ruddy turnstone chicks (modified from Hans Schekkerman in litt.)

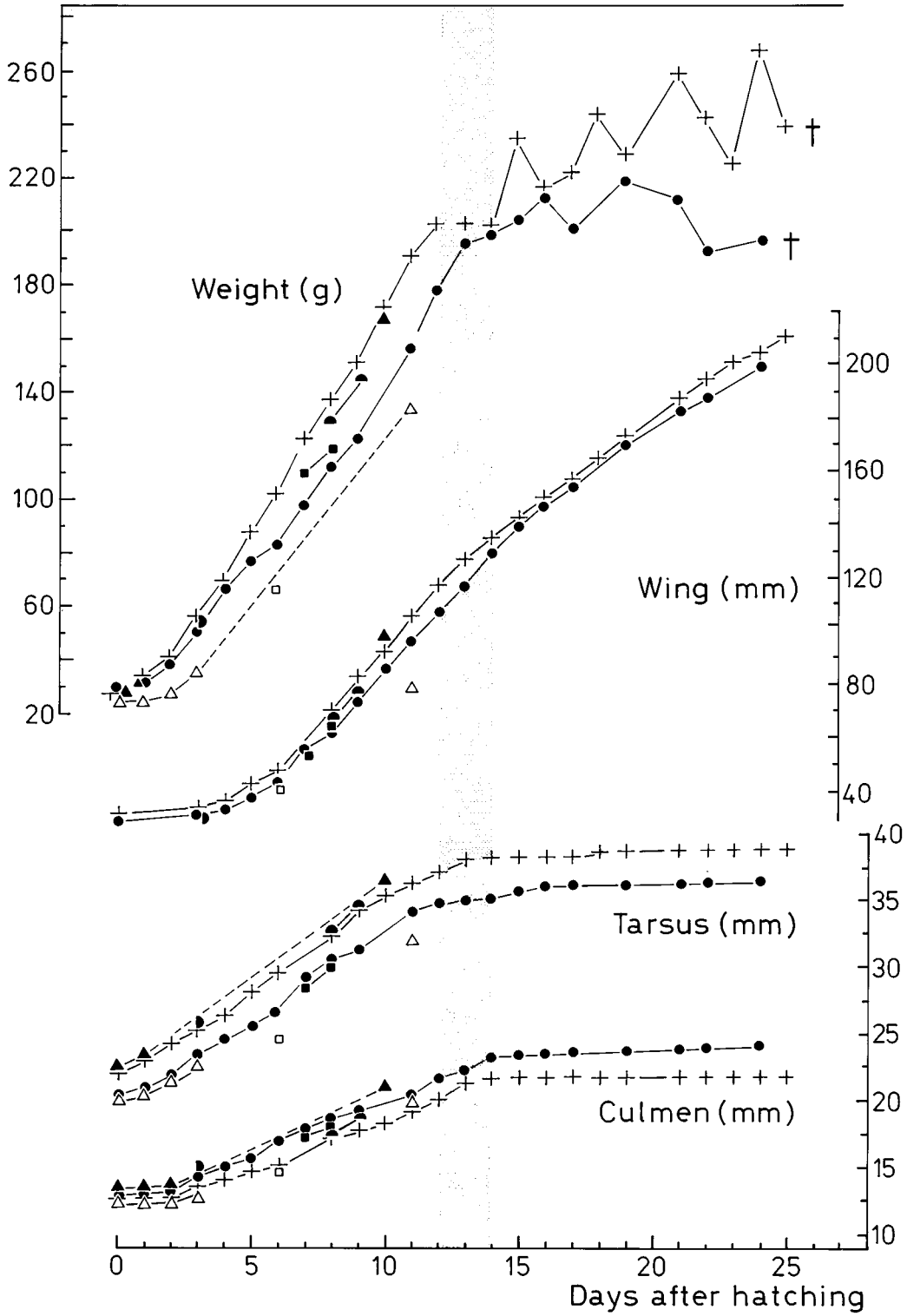


Fig. 4. Weights and measurements of eight chicks at Kærelv 1975, including those depicted in fig. 3, in relation to age; + indicates penned single chick; ● ◗ ◓ indicate free single chicks; ▲ ■ indicate senior sibling chicks; △ □ indicate junior sibling chicks; † indicates day of death.

Fig. 3.2.6.6. Growth curves for long-tailed skua chicks (from de Korte 1986)

3.3. Fledging success in waders

3.3.1. Species to be monitored

Great ringed plover *Charadrius hiaticula* (stor præstekrave)

Red knot *Calidris canutus* (islandsk ryle)

Sanderling *Calidris alba* (sandløber)

Dunlin *Calidris alpina* (almindelig ryle)

Ruddy turnstone *Arenaria interpres* (stenvender)

3.3.2. Frequency of sampling

Every third day between 20 July and the termination of the field season. In case of rough weather or coincidence with sampling dates for flowering phenology and invertebrates (see table 1.1.2), the count may be performed one day earlier or later.

3.3.3. Equipment to be used

A tide table

Binoculars

Spotting scope

A tally counter (kliktæller)

Dictaphone

Hip boots

3.3.4. Location of the sampling plot

The former and the present deltas of Zackenbergelven. The separation between the two deltas is defined as the western end of the raised plateau, Trekanten, between the two areas.

3.3.5. Sampling method

The waders in the two deltas are counted during low tide. Begin the count at the time of minimum tide. On sunny days, counts should not be performed at low tides after 15 hrs, due to unfavourable light. Instead, use the morning low tide.

For each species, the individuals present are separated into adults and juveniles.

In the present delta of Zackenbergelven, most waders are often found on the muddy spit on the western side of the main course of the river. This area may be a bit difficult to cover, but it can be done from the westernmost sandbank in the delta. Waders behind the gravel 'cliff' can only be recorded at very low tides, when it is possible to count from a vantage point in the south-western part of the delta. Beware that the substrate in certain places in the present delta is extremely muddy and sticky.

Other species of waterbirds are counted as well, including separation into age (and sex) classes.

3.3.6. Laboratory work

Writing out the dictaphone recordings.

3.3.7. Input of data into database

Count results are entered into the Excel database 'Waterbird counts' giving the following columns: Year, Month, Day, Time (starting time of the count in the old delta), Low tide (time of low tide according to tide table), Water level (at low tide according to tide table minus 0.9 m), Species, DGD ad. (adults counted in the old delta), DGD juv. (juveniles counted in the old delta), DGD usp. (non-aged individuals counted in the old delta), DND ad. (adults counted in the new delta), DND juv. (juveniles counted in the new delta), DND usp. (non-aged individuals counted in the new delta), and Remarks. Under Remarks you may e.g. note the sex of eiders and other waterfowl).

If a count is missed, interpolated bird numbers from the previous and the following cunts are entered into the database, clearly stating under Remarks that data are interpolated.

3.4. Census of barnacle goose broods in Zackenbergdalen

3.4.1. Species to be monitored

Barnacle goose *Branta leucopsis* (bramgås)

3.4.2. Frequency of sampling

The presence of broods in Zackenbergdalen is monitored during late June, July and August.

3.4.3. Equipment to be used

Binoculars

Spotting scope

Dictaphone

3.4.4. Location and marking of sampling plots

None.

3.4.5. Sampling method

Broods are recorded whenever they are encountered in Zackenbergdalen. The traditional brood rearing site at Lomsø must be checked regularly by spotting scope from a roof of a station building or from the gravel plateau SE of the runway.

3.4.6. Laboratory work

Writing out the dictaphone recordings.

3.4.7. Input of data into database

Data are entered into the general bird observation database 'Fugleobservationer etc.' (see section 3.7) giving as many details as possible on brood sizes, location, reactions to disturbance etc.

3.5. Line transect between Daneborg and upper Store Sødal

See section 4.6.

3.6 Census of breeding Sabine's gulls, Arctic terns and eiders on Sandøen

3.6.1. Species to be monitored

Common eider *Somateria mollissima* (ederfugl)

Sabine's gull *Larus sabini* (Sabinemåge)

Arctic tern *Sterna paradisaea* (havterne)

Other waterbird species breeding in the colonies

3.6.2. Frequency of sampling

Annually in mid or late July, when the ice in Young Sund has broken up (provided that relevant personnel is available).

3.6.3. Equipment to be used

Binoculars

Bird rings from the Zoological Museum, University of Copenhagen

Tongs for bird rings

Notebook

Dictaphone

3.6.4. Marking of sampling plots

Use sticks to mark appropriate sections or transects of the island. Each section/ transect should not be wider, than it can be overlooked by one (or two) person(s) passing along and counting the nests. Sticks are moved consecutively in parallel rows, as the island is covered.

3.6.5. Sampling method

In mid or late July the number of nests of eiders, Sabine's gulls and Arctic terns on Sandøen are counted per sector. All nest cups that are or have been in use during the season are accepted as occupied nest cups. The number of eggs or young in each gull and tern nest is recorded. If

incubating eiders are accidentally flushed from the nest, the eggs are counted, whereupon they are covered with the nest down.

Identification:
Sabine's gull: Eggs subelliptical, smooth and slightly glossy; olive to buff-olive, variably marked darker olive-brown, sometimes concentrated in zone around broad end. 44 x 32 mm (41-47 x 30-33). Clutch: 2 (1-3). Incubation: 23-25 days by both parents. Young have much longer tarsi than Arctic terns. Fledging period: Unknown.

Arctic tern: Eggs subelliptical, smooth and not glossy; pale buff to olive, rarely brown, also variably blotched, spotted, and scrawled black and dark brown. 41 x 30 mm (36-46 x 26-33). Clutch 1-3. Incubation: 20-24 days. Young have so short tarsi that there is hardly room for a ring. Fledging period: 21-24 days.

All young of Sabine's gull and up to 100 young of Arctic tern are ringed.

3.6.6. Laboratory work

Writing out dictaphone recordings.

3.6.7. Input of data into data bases

Count results are stored in the 'Bird observations' database.

3.7. 'Random' observations

3.7.1. Species to be monitored

All bird species (plus lemmings, woolly-bear catarpillars, butterflies, and bumble bees).

3.7.2. Frequency of sampling

Continuously during entire field season

3.7.3. Equipment to be used

Binoculars

Spotting scope

Dictaphone

3.7.4. Marking of sampling plots

Entire activity area

3.7.5. Sampling method

Keep watch for everything with feathers. Record flock size, sex and age, special behaviour, geographical position etc.

Especially, Gadekæret, Sydkærene Kystkærene, Lomsø and the deltas should be checked every day e.g. in connection with the muskox census.

Around 20 July, the moulting pink-footed and barnacle geese around Halvøen and along the remaining part of the coast off Zackenbergdalen should be recorded. Bring a spotting scope and make the count around Halvøen in the afternoon, if it is a sunny day. Cover the lakes in Morænebakkerne and west of Lindemanselven in the same period.

Additionally, record all observations of foxes, lemmings, woolly-bear catarpillars and bumble bees together with other unusual occurrences during the bird census work.

3.7.6. Laboratory work

Writing out dictaphone recordings. All records are kept in a journal (Excel files named 'Fugleobservationer etc.') together with general information on snow and ice conditions, weather etc.

3.7.7. Input of data into data bases

See section 3.7.6. The file should hold the following columns: Date, Species etc., Observations.

4. Mammals

4.1. Monitoring of collared lemming winter nests and summer burrows

4.1.1. Species to be monitored

Collared lemming *Dicrostonyx groenlandicus*

4.1.2. Frequency of sampling

Each year after snow melt. It takes about two weeks to cover the study area.

4.1.3. Equipment to be used

Observation sheet S1

Pencil

Around 30 red and white poles to keep a straight transect

GPS setup: WGS 84, using UTM zone 27.

4.1.4. Location and marking of study plot

The study plot covers 208 ha between Zackenbergelven and Kærelv. The northern and southern borders are marked by permanent blue poles (see Fig. 4.1.4; map M1).

4.1.5. Sampling methods

East-west running transect lines are walked with 15 m intervals throughout the study area starting along the north border. The southern transects within 400 m from the south boarder may not be walked before 10 August. Poles are placed with regular intervals to ensure a straight transects. At least two poles should be visible in a row backwards from a given pole. When reaching a pole on the way back, the pole is moved 15 meters southwards to the next parallel transect leaving a straight row backwards.

Winter nests are examined following S1 and are given UTM co-ordinates using the GPS. Fresh and old winter nests must be separated. A typical fresh winter nest is characterised by a light yellow to light grey colour, a fresh smell of hey and a fluffy appearance (Fig. 4.1.5.1). Old nests are flat and dark. The study plot has been examined since 1995 and is considered almost emty for old nests.

For each winter nest the following data are recorded: i) record no., ii) UTM co-ordinates, iii) size category (1: $\leq$10 cm 2: 10<x$\leq$15, 3: 15<x$\leq$20, 4: 20<x$\leq$25 and 5: x>25 cm), iv) amount of faeces (category: 1: $\leq$500 pellets, 2: 501-2000, 3: 2001-4000 and 4: >4001), v) posission of nest (dug into the vegetation or soil or losely placed on top of the vegetation), vi) breeding expressed as the presence of small slender fecal pellets (length< 2mm) close to the nest, vii) signs of predation by stoat is recognised as a nest with an immence amount of lemming fur inside the nest used for insulation before taking over the nest as ermine residence (Fig. 4.1.5.2), additionally there may be a pile of stoat faeces nearby. Faeces from foxes are recorded as well but does not necessarily indicate predation by fox. viii) presence of lemming faecal pellets in the nest as "present" or "filled with", ix) occurrence of moulted fur (note white or grey colour, NB white hairs have a grey basis!).

4.1.6. Laboratory work

None

4.1.7. Input of data into database

Data from S1 is entered into Excel data fil named "Lemming nest" holding the following columns: Year, Observer, Year Lbno., Easting [UTM x-coordinate], Nording [UTM y-coordinate], Nest type [1: fresh, 2: old], NestSize [1-5], PelCat [1-4], Nestplace [1: in the surface; 2: on the surface], Breed [0:no breeding, 1: breeding], Pred [1: stoat, 2: fox], LemPelCat [1: present, 2: filled with pellets], Colour [1: grey hairs, 2: white hairs, 3: musk ox wool].

Fig. 4.1.5.1. Fresh winter nest.
Photo: Aurora Photo/ Thomas Bjørneboe Berg

Fig. 4.1.5.2. Fresh winter nest (opened) taken over by an ermine Photo: Aurora Photo/ Thomas Bjørneboe Berg

4.2. Daily counts of muskoxen

4.2.1. Species to be monitored

Musk ox *Ovibos moschatus*

4.2.2. Frequency of sampling

Daily between 19 and 22 hrs, when the sun haze has disappeared.

4.2.3. Equipment to be used

Spotting scope (30 x)

Observation sheet S2

Field map M2

Pencil

4.2.4. Location and marking of study plot

The census area appears from Fig. 4.2.4, but even animals outside this area must be recorded.

4.2.5. Sampling method

Herds and lonely musk oxen are recorded from the roof of the ZERO building. All animals visible from the roof are recorded, but no separation into age or sex groups are made. Each record of a herd or a single animal is given a number on the map (M2) and on the field sheet (S2), whereupon the herd size and area is noted in the appropriate columns. Animals that appear within the M2 should be given UTM co-ordinates, otherwise they are just assigned OSCAR-East or OSCAR-West depending on which side of the census area they occur. No counts should be made when clouds or fog covers the slopes of Aucella-bjerg below 600 m a.s.l.

4.2.6. Laboratory work

None.

4.2.7. Input of data into database

Data on herd size and their respective UTM co-ordinates (read from M2) is entered into an Excel datfil a named "Musk ox Daily count" holding the following columns: Year, Month, Day, Hour, Observer, Cloud cover [given as x/8], Min. visibility, Max. visibility, Obs. no., UTM East, UTM Nord, Altitude, OCSAR West, ISCAR, OSCAR East, and Remarks.

4.3. Total counts of muskoxen

4.3.1. Species to be monitored

Muskox *Ovibos moschatus*

4.3.2. Frequency of sampling

Total counts are made throughout July and August one or two days after the weekly flowering and invertebrate sampling dates (see Table 1.1.2) or the first day thereafter with acceptable weather

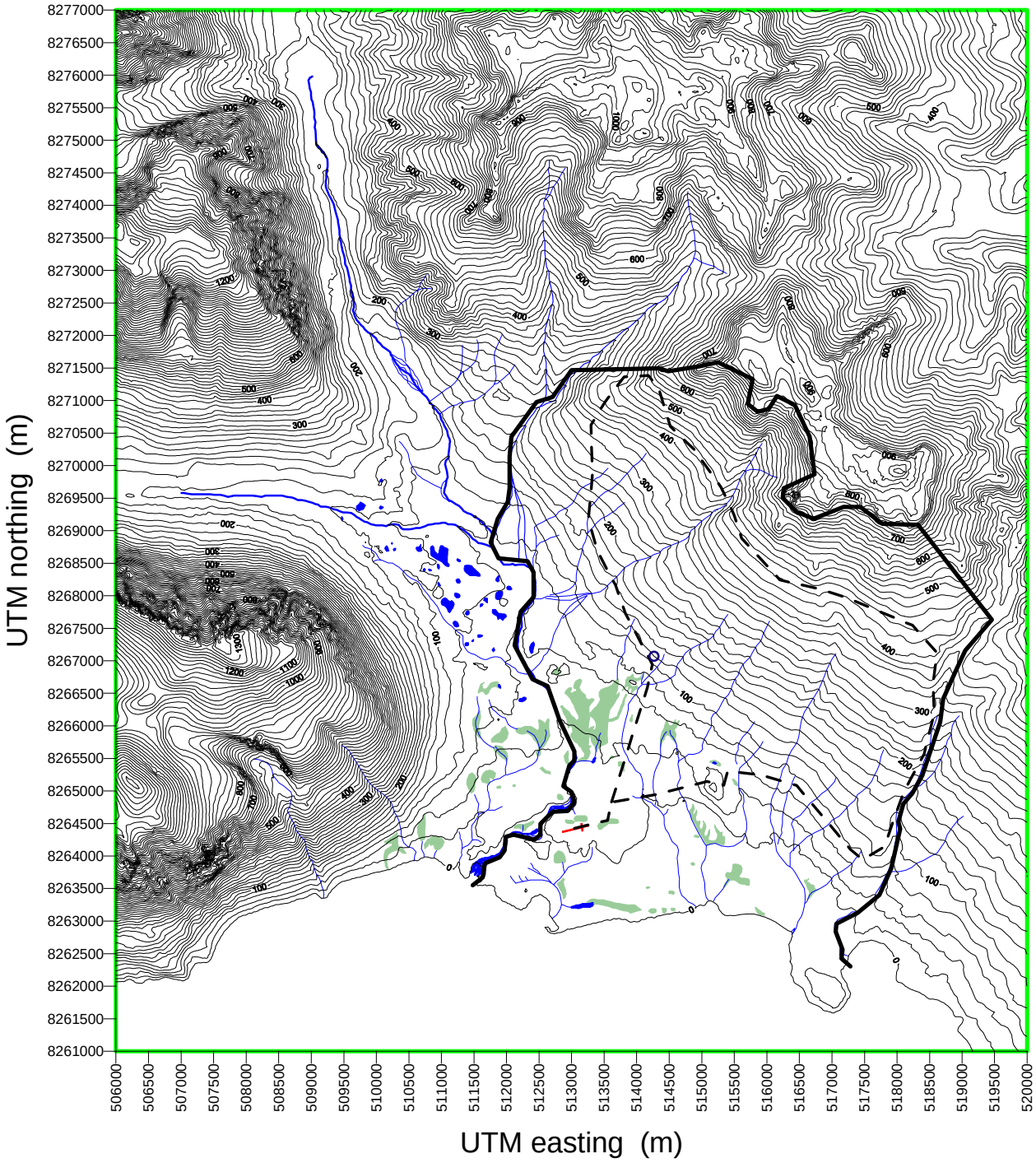


Fig. 4.3.4. Map M2. Musk ox census area (solid line) with the basic route (stippled line) for the total count. Also the position of four botanical plots is marked by a circle along the route (se section 1.1 and 1.2).

conditions (good visibility below 600 m curve).

4.3.3. Equipment to be used

Binoculars (10 x)

Spotting scope (30 x)

Tripod

Observation sheet S3

Field map M2

Pencil

Muskox field guide

Skis and/or snow shoes if necessary

GPS

4.3.4. Location and marking of study plot

See Fig. 4.2.4

4.3.5. Sampling methods

Fig. 4.2.4 shows the basic route through the census area. The only fixed point on the route is the summit of Ulvehøj.

From the top of Ulvehøj, the muskox herds are roughly marked on M2. The route is followed eastward, looking up the individual herds. Whenever a herd is found within the monitoring area it should be approached until an exact sex and age determination can be made according to the categories given on Observation sheet S3 [see Appendix 1 (Muskox field guide)]. The herd is marked on M2 by the same observation number as on S3. If the encounter will disturb the herd too much, the sex determination of yearlings can be dropped and the animals filed under yearling unsp. instead. Musk oxen in area "OSCAR East" are recorded by spotting scope from the Eastern turn point at 400 m a.s.l. Musk oxen in area "OSCAR West" are recorded continously through out the transect.

Note that the eastern border of the census area follows the ridge in front of Kuhnelv and that the route toward west does not turn until the two small lakes between Palnatokeelv and Lindemanselv can be seen. During snow melt, Aucellaelv may be too dangerous to cross, and in that case the route turns down along the east side of the river instead. Remember to specify when this detour is made. Before crossing the Aucellaelv the ice cover of Langemandssø, Sommer-fuglesø, and Store Sø in Store Sødal is estimated to nearest 10 %. The total route takes seven to eight hours to complete.

4.3.6. Laboratory work

None.

4.3.7. Input of data into database

Data from S3 are entered into Excel data fil named "Musk ox Weekly Count" holding the following columns: Year, Month, Day, Start [full hour], End [full hour], Observer, Cloud cover, Min. visibility, Max. visibility, Obs.no., UTM East, UTM Nord, Altitude, Herd size is noted within one of the three relevant columns: OCSAR West, ISCAR, OSCAR East, (see 4.2.5), Herd composition each age category with separate columns: M4+, M3, M2, M1, F4+, F3, F2, F1, Usp. 1, Calf, and Remarks. "4+" represents animals of four years or older.

4.4. Monitoring of muskox carcasses

4.4.1. Species to be monitored

Muskox *Ovibos moschatus*

4.4.2. Frequency of sampling

All fresh carcasses found during the summer should be analysed before the end of the field season.

4.4.3. Equipment to be used

Field map M2

Pencil l (waterproof)

A small saw

GPS

Eppendorf tubes for tissue samples

Plastic bags for bone and tooth samples

Scalpel

A pair of tweezers

Alcohol

Labels

4.4.4. Location and marking of study plot

Primarily the muskox census area (M2), but fresh carcasses found in Zackenbergdalen outside this area and along the two transects (see 4.6.4) are recorded as well.

4.4.5. Sampling methods

Carcasses from the previous winter are given UTM co-ordinates and are recorded following S4. The ID (yyyy-xx) of the carcass is painted on a free spot on the cranium. One molar (no. 1 or no. 2) inner back tooth). A tissue sample of flesh or skin is taken. The scalpel and the tweezers are cleaned i alcohol before taking the tissue sample. Prevent touching the sample by hand. A small piece of tissue is cut loose and is placed in the Eppendorf tube. Use the tweezers if necessary. All samples should be labelled with the carcass ID-number.

One of the humerus or femur bones (front leg/hind leg) are sawed through to check for bone marrow (Fig. 4.4.5.1 and 4.4.5.2). If marrow is present, the consistency (solid, jelly, or liquid) and colour (white or light yellow) should be described. If however the bone is filled with flie pupae, bone marow has been present, and eaten by the larvae. Remarks on horn and mandible are made along with estimation of the age of the animal given within categories: Calf, 1 yr, 2 yrs, 3 yrs, 4-6 yrs, 7-10 yrs, and 11+ yrs.

4.4.6. Description of laboratory work

Eppendorph tubes containing samples are stored in the freezer at the station until departure. Collected material, teeth and tissue are shipped to Mads C. Forchhammer, University of Copenhagen, Inst. of Zoology, Dept. of Population Ecology.

4.4.7. Input of data into database

Data from S4 are entered into Excel data fil named "Musk ox Carcass" holding the following columns: Year, Month, Day, Observer, ID no., UTM East, UTM North, Sex, Estimated age, Samples each with separate columns (1: sample taken): Femur, Incisor, Molar, DNA, Bone marrow description, Horn remarks, Mandibel remarks, General remarks.

Fig. 4.4.5.1. Cross cut of a leg bone filled with bone marrow. Photo: Thomas Bjørneboe Berg

Fig. 4.4.5.2. Upper left front leg without marrow. Photo: Aurora Photo/Thomas Bjørneboe Berg

4.5. Arctic fox dens

4.5.1. Species to be monitored

Arctic fox *Alopex lagopus*

4.5.2. Frequency of sampling

All fox dens are checked every year within the first and third week of every month June to September for occupation and litter.

4.5.3. Equipment to be used

Observation sheet S5
Binocular (10 x)
Spotting scope (30 x)
Tripod
GPS
Map

4.5.4. Location and marking of study plot

Ten dens are known within Zackenbergdalen (Table 4.5.4). Dens no. 7 and 9 consists of only one entrance. Den no. 9 is under the boulder Kjovestenen. In addition two dens are known outside (den no. 11 and 12) (Fig 4.5.4.1)

Table 4.5.4. UTM co-ordinates of fox dens.

Den no.	Easting	Nording
1	511350	8264150
2	514530	8264252
3	513325	8267150
4	513336	8267086
5	515792	8267275
6	514500	8265700
7	512649	8264039
8	511477	8267065
9	513110	8265267
10	517007	8263613
11	520901	8260807
12	518657	8265213

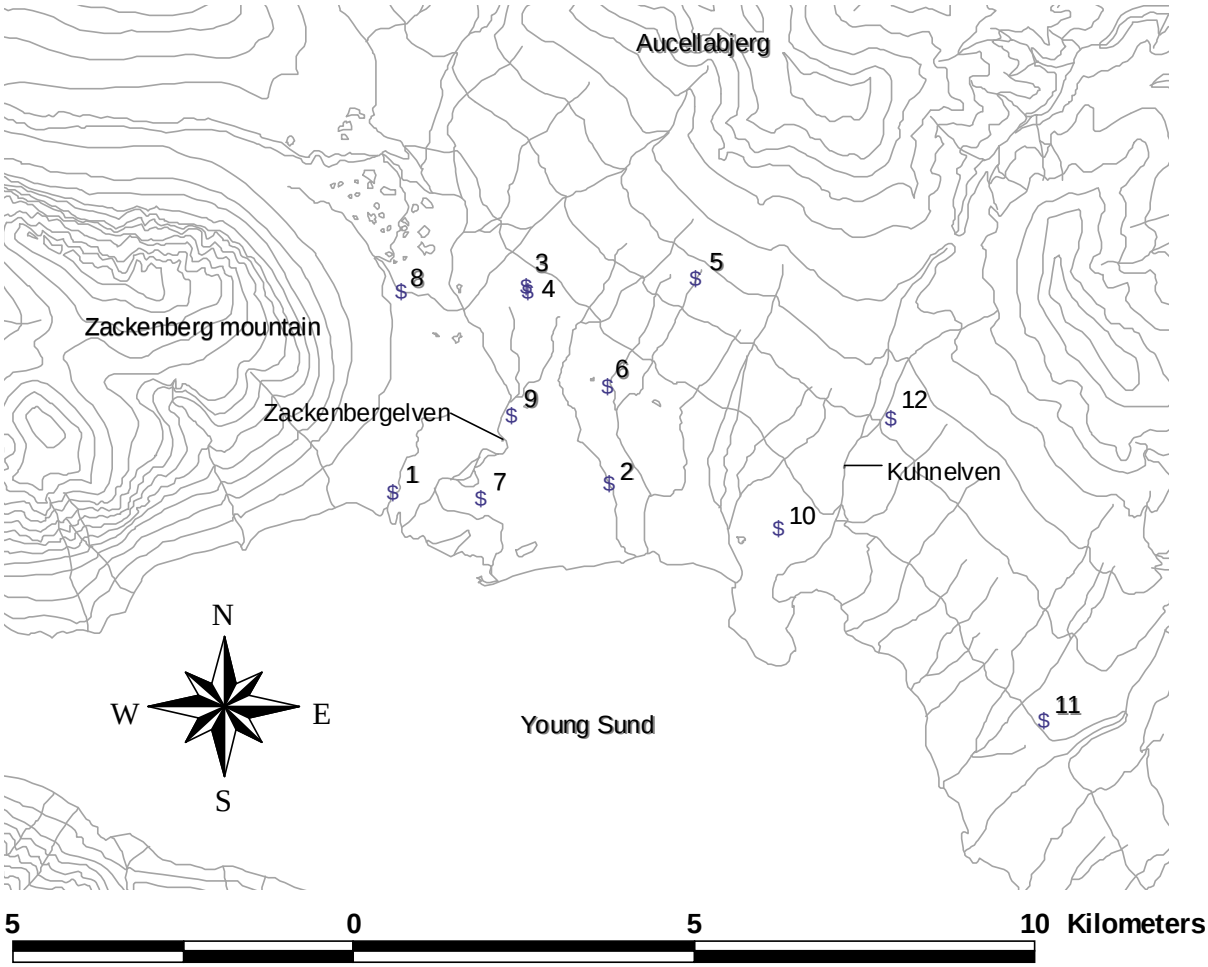


Fig. 4.5.4.1. Positions of the twelve known fox dens

4.5.5. Description of sampling methods

The Arctic fox population in Zackenbergdalen is monitored by means of den occupation. In early June all dens (except den no. 11) are checked for tracks in the snow surrounding the dens and white or dark moulted fur remains in the den entrances (holes). If present, fur remains are removed from the entrances. Determination of presence of pups is made later in June. If the den contains pups (actual sight or determined by footprints of pups), the litter size should be determined by a full day's observation in late June or early July, followed by regular visits (once a week as a minimum) to monitor the survival of the pups. Colour morph of all the individuals (adults and pups) must be recorded. The white colour morph is recognised during summer by a yellow-white belly, whereas the blue is brown all over. All new dens should be given exact UTM co-ordinates.

4.5.6. Laboratory work

None.

4.5.7. Input of data into database

Data from S5 are entered into Excel data fil named "Arctic fox den" holding the following columns: Year, Month, Day, Observer, Den no., UTM east, UTM North, White ad. White juv., Blue ad., Blue juv., and Remarks.

4.6. Monitoring of Arctic hares

4.6.1. Species to be monitored

Arctic hare (*Lepus arcticus*)

4.6.2. Frequency of sampling

Along with the the daily counts of musk oxen (see 4.2.).

4.6.3. Equipment to be used

Spotting scope (30 x)

Tripod

Observation sheet S2

Pencil

4.6.4. Location and marking of study plot

East facing slope of Zackenberg mountain

4.6.5. Sampling method

Records are made from the roof of the ZERO building of the Zackenberg Station. Survey carefully the slopes of the Zackenberg mountain from the foothills to the top by means of the 30 x spotting scope. Each record of a group or a single animal is given a number (starting from 100) on the map (M2) and on the field sheet (S2). Animals that appear outside the study plot and within the M2 are recorded as well as random observations. All records should be given UTM co-ordinate. No counts should be made when clouds or fog covers the slopes of Zackenberg below 1000 m a.s.l.

4.6.6. Laboratory work

None

4.6.7. Input into data bases

Data from S2 (hares only) are entered into Excel data fil named "Arctic hare roof counts" holding the following columns: Year, Month, Day, Full hour, Observer, Cloud cover x/8, Min. visibility, Max. visibility, Obs No. UTM East, UTM North, Altitude, Group size, and Remarks.

4.7. Seal counts

4.7.1. Species to be monitored

All seals on the sea ice in Young Sund

4.7.2. Frequency of sampling

Along with the the daily counts of musk oxen (see 4.2.).

4.7.3.

Spotting scope (30 x)

Tripod

Observation sheet S2

4.7.4. Location and marking of study plot

The entier Young Sund visible from the roof of the ZERO building of the Zackenberg Station.

4.7.5. Sampling method

The sea ice is searched carefully by means of the spotting scope. The monitoring may be canseled if there is too much sun haze. Records of total number of seals are stated on S2.

4..6. Laboratory work

None

4.7.7. Input into data bases

Data from S2 (seals only) are entered into Excel data fil named "Seals" holding the following columns: Year, Month, Day, Full hour, Observer, Cloud cover x/8, Min. visibility, Max. visibility, No. of Seals, and Remarks.

4.8. Transect census of mammals and birds between Daneborg and upper Store Sødal

4.8.1. Species to be monitored

All species of mammals and birds together with bumble bees and butterflies.

4.8.2. Frequency of sampling

Mid July (week 28).

4.8.3. Equipment to be used

Binoculars (10 x)

Spotting scope (30 x)

Monopod or tripod for the spotting scope

Topographic map with transect route and census sections delineated (M3)

Dictaphone

GPS

Rifel

Neoprene boots

Walking stick for crossing rivers

Observation sheets S4 and S6

A small note book and pencil

Musk ox Field Guide

Two trip controls for counting musk ox pellets

Eppendorf tubes for tissue samples

Plastic bags for tooth samples

Scalpel

A pair of tweezers

Alcohol

Labels

Camping equipment and provisions for four days (only on transect “S”, see 4.8.4)

4.8.4. Location and marking of study plot

The transect census of mammals and birds consist of two separate transect lines, one from Daneborg to Zackenberg (DZ) and from Zackenberg to the bottom of Store Sødal (S), i.e. point “Valhal”. Each transect line is divided into a number of fixed way-points: five along the DZ- transect and 17 along the S- transect (Fig. 4.8.4, Table 4.8.4).

4.8.5. Sampling methods

The DZ transect is walked in one day. Observers are transported to Daneborg by Zodiac or plane. The transect from DZ-1 to DZ-5 is initiated after arrival at Daneborg and is terminated when Kuhn-elv is reached in the late afternoon, 8-10 hours later.

In contrast, the S transect requires three days to complete. Provisions, tent and other

Table 4.8.4. Topographic description of the fixed way-points. Confer also with M3.

Way-point #	Topographic description
S-1	Where Palnatokeelv meets Zackenbergelven.
S-2	Below the first long crevice on the south-facing slope of Dombjerg.
S-3	At the eastern end of Store Sø.
S-4	At the large river delta in the western end of Store Sø. Base camp is established on the southwest side of the delta.
S-5	At the first round lake, i.e. "Mimers Brønd" in upper Store Sødal. The lake is on a straight line between the glacier towards northwest and Moltke Bjerg towards southeast on Clavering Ø.
S-6	Below the large hanging crevice/ avalanche on the slope towards northwest.
S-7	At the western end of "Oksesøen".
S-8	At the foot of "Valhall". The glacier in "Fenrisdalen" towards northwest has to be in sight.
Valhal	On top of the sadle of Valhal
S-9	At the western end of the lake "Mjølner".
S-10	At the western end of "Lange Issø", on line with the large hanging crevice/avalanche on the opposite side (see S-7).
S-11	At the eastern end of "Lange Issø", where it turns into a river.
S-12	On the line between the narrowing of Store Sø and the first top of the Zackenberg massif towards the south.
S-13	At the eastern end of Store Sø.
S-14	Off the long crevice on the south-facing slope of Dombjerg.
S-15	The hut Blæsenborg.
S-16	The hill Vesterport.
DZ-1	Daneborg Weather Station.
DZ-2	The mouth of the river from Lille Sødal.
DZ-3	The river from Isdal.
DZ-4	The river from Skiferdal.
DZ-5	Kuhnelv.

field equipment are thus needed. The route from S-1 to S-4 is walked the first day and takes 7-8 hours to cover. Base camp is established at S-4. It is essential to cross the river delta in the upper third part. By crossing the delta close to the lake you increase the risk of getting stock in the wet, fine-grained sand. You are safe if you stay within the upper third. The second day embrace the route from S-4 over S-6 to S-11 ending at S-4 11 hours later. The third and final day includes the route from S-4 to S-16 and takes 6-7 hours. Observations made between the station and DZ-5, S-1 or S-16, respectively, are not included in the census.

At each way-point (e.g. S-1), time, cloud cover (x/8), wind (direction and Beaufort) and visibility (km) are recorded.

Within each census section, all mammals and birds in the entire valley are recorded. Mammals and birds should not be searched for by use of the binoculars. They should be detected by the naked eye or ear, and then identified, aged etc. by use of the binoculars. The only exception from this is waterbirds on ponds and lakes, that should be actively

Fig. 4.8.5.1. Fresh summer pellet. Due to the high water content of the summer food the pellets are wet and look more like a cow dung.
Photo: Aurora Photo/Thomas Bjørneboe Berg

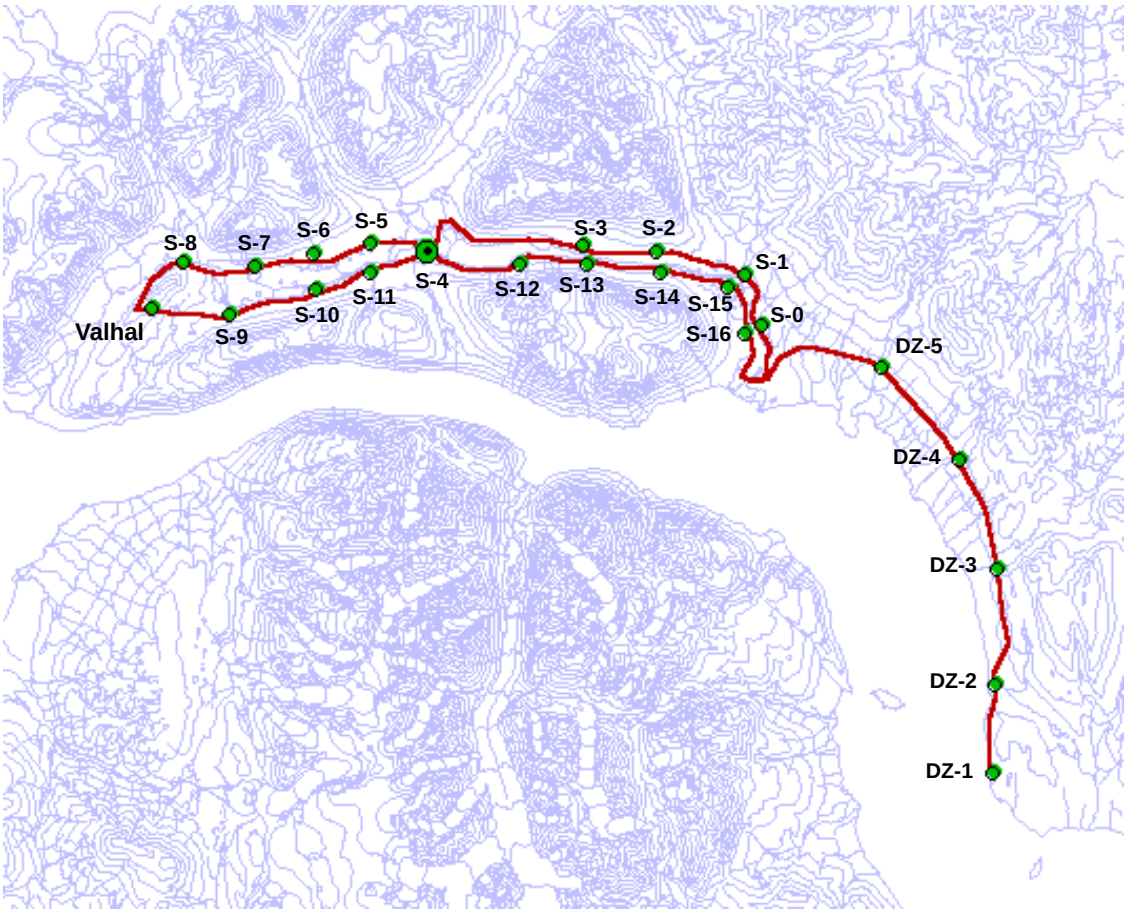


Fig. 4.8.4. Map (M3) of the transect census route between Daneborg and upper Store Sødal. The fixed way-points are given by the red green and the line between these indicate the approximate transect route. Way-points related to the Store Sødal transect are proceeded by "S", whereas those related to the Daneborg-Zackenberg transect is proceeded by "DZ".

searched for by the binoculars. Scan all lakes along the route with your binoculars for divers, moulting geese, etc. as soon as the lake is seen. Spotting scope is used to sex and age distant musk ox herds according to the Muskox Field Guide (see Appendix).

Herd or flock size and composition (e.g. sex and age groups, brood sizes in birds and colour phase in Arctic foxes) are recorded as detailed as possible. The same apply to information on breeding behaviour (singing, distraction behaviour etc. in birds; see table 3.1.5).

If mammals or birds move between census sections during the census, only the initial observation should be recorded.

Additionally, record all wolly-bear caterpillars, bumble bees and butterflies seen by the naked eye are recorded.

Location of observed fox dens are marked by UTM co-ordinates using GPS and noted under remarks.

The number of musk ox faecal pellet heaps from last winter and this summer are recorded per transect section by both

Fig. 4.8.5.2. Winter pellets from past winter. The winter pellets are round and can be found in piles like this or a few pellets together, droped while the animal was walking. Photo: Aurora Photo/Thomas Bjørneboe Berg

observers separately. Count only the pellet groups encountered within 1 m on both sides of you. Fresh winter and summer pelltes are characterised by a brown-black colour. Older pellets turns grey (Figs. 4.8.5.1. and 4.8.5.2.). Arctic hare pellets are slightly eliptic, light-brown and have more visible fibres.

Lemming nests from the previous winter and the present summer are noted when encountered within 3 m to each side of the transect. Characteristics of nests are recorded according to standards given in section 4.1.5 (Figs 4.1.5.1 - 4.1.5.4).

New muskox carcasses (i.e. from the previous autumn/winter period) should be recorded with UTM co-ordinates and described with respect to sex and age as described in the Muskox field guide (Appendix pp: 62-65). However, concerning samples, only teeth and tissue should be taken (for methods see 4.4.5).

In addition to the observations related to the transects, all *ad hoc* observations before or after the census, e.g. during camping, should be noted.

4.8.6. Laboratory work

Writing out dictaphone recordings.

4.8.7. Input of data into database

Data from S5 are entered into Excel data fil named "Line Transects" holding the following columns shown in fig 4.8.7 Start and End are given in full hours. The Store Sødal transect is split into two sections: Outer Store Sødal: waypoints 1-4 plus 4-16 and Inner Store Sødal: waypoints 4-11. These two sections must be indicated in the "Section" coulumn. Permanent couluns are: "Month, "Species", and "Species no.". Brood size, pairs ect. in birds is given under remarks.

4.9. Monitoring of walrus on Sandøen

4.9.1. Species to be monitored

Walrus *Odobenus rosmarus*

4.9.2. Frequency of sampling

Annualy in July/August if appropriate.

4.9.3. Equipment to be used

Binoculars (10x)

Observation sheet S6

Camera with tele-objective

4.9.4. Marking of sampling plots

Sandøen

4.9.5. Description of the sampling method

The island is censused for walrus. As many individual walrus photo portraits as posible are taken. At the first visit in mid July the automatic digital camera box is plased at the marked spot on a tripod and turned on. At the last visit in late August the camera box and Tripod is taken back to Zackenberg where pictures from data card are downloaded to the computer. If possible age and sex is determined. The two timers are set to activate the camera at hours: 00, 06, 12, 18. Each timer has the cabability to activate the camera 14 times during a week. The first timer should cover the hours 00 and 12, while the other should cover the hours 06 and 18.

Age estimation:

Calves are less that 170 cm and have no visible tusks. At the age 1 year the animal is close to 200 cm and has around 3 cm long tusks. 2 year old animals exceeds 200 cm and have around 6 cm tusks.

Sex characteristics:

Year	Month	Day	Obs 1	Obs 2	WPT	Start	End	Cloud	Wind	Species	Adults	Pulli	Remarks	Section	Species no.
	7				1-2					Red-throated diver				Outer Store Sødal	Bird 01
	7				1-2					Pink-footed goose				Outer Store Sødal	Bird 02
	7				1-2					Barnacle goose				Outer Store Sødal	Bird 03
	7				1-2					King eider				Outer Store Sødal	Bird 04
	7				1-2					Long-tailed duck				Outer Store Sødal	Bird 05
	7				1-2					Rock ptarmigan				Outer Store Sødal	Bird 06
	7				1-2					Gyr falcon				Outer Store Sødal	Bird 07
	7				1-2					Great ringed plover				Outer Store Sødal	Bird 08
	7				1-2					Red knot				Outer Store Sødal	Bird 09
	7				1-2					Sanderling				Outer Store Sødal	Bird 10
	7				1-2					Dunlin				Outer Store Sødal	Bird 11
	7				1-2					Ruddy turnstone				Outer Store Sødal	Bird 12
	7				1-2					Long-tailed skua				Outer Store Sødal	Bird 13
	7				1-2					Glaucous gull				Outer Store Sødal	Bird 14
	7				1-2					Arctic tern				Outer Store Sødal	Bird 15
	7				1-2					Snowy owl				Outer Store Sødal	Bird 16
	7				1-2					Northern wheatear				Outer Store Sødal	Bird 17
	7				1-2					Common raven				Outer Store Sødal	Bird 18
	7				1-2					Arctic redpoll				Outer Store Sødal	Bird 19
	7				1-2					Snow bunting				Outer Store Sødal	Bird 20
	7				1-2					Gynaephora larvae				Outer Store Sødal	insect 1
	7				1-2					Clossiana sp.				Outer Store Sødal	Insect 2
	7				1-2					Bumblebee				Outer Store Sødal	Insect 3
	7				1-2					Arctic hare				Outer Store Sødal	Animal 01
	7				1-2					Collared lemming				Outer Store Sødal	Animal 02
	7				1-2					Summer burrow				Outer Store Sødal	Animal 02b
	7				1-2					Winter nest				Outer Store Sødal	Animal 02n
	7				1-2					Blue arctic fox				Outer Store Sødal	Animal 03b
	7				1-2					White arctic fox				Outer Store Sødal	Animal 03w
	7				1-2					Ermine				Outer Store Sødal	Animal 04
	7				1-2					Muskox M4+				Outer Store Sødal	Animal 051.1
	7				1-2					Muskox M3+				Outer Store Sødal	Animal 051.2
	7				1-2					Muskox M2				Outer Store Sødal	Animal 051.3
	7				1-2					Muskox M1				Outer Store Sødal	Animal 051.4
	7				1-2					Muskox F4+				Outer Store Sødal	Animal 052.1
	7				1-2					Muskox F3+				Outer Store Sødal	Animal 052.2
	7				1-2					Muskox F2				Outer Store Sødal	Animal 052.3
	7				1-2					Muskox F1				Outer Store Sødal	Animal 052.4
	7				1-2					Muskox calf				Outer Store Sødal	Animal 053
					1-2					Muskox usp.				Outer Store Sødal	Animal 054
	7				1-2					Summer faeces				Outer Store Sødal	Animal 05s
	7				1-2					Winterfaeces				Outer Store Sødal	Animal 05w

Fig. 4.8.7. Example of Excel data base for the Line ransect Store Sødal. The waypoint column (column no. 6) indicate the distance on which the observations are made (in this case between waypoint 1 and 2.

Adult males have a broader nose, bigger and slightly convex shaped tusks. Cross section of a male tusk is generally ellipse shaped in contrast to the more rounded shape of the female tusk. Old males have a knotty back. If the male is lying on its side, the penis opening is visible close to the navel.

Adult females have most often a more slight head and neck, more slender and parallel to concave shaped tusks.

The behaviour of the animals are described. Check for faeces.

4.9.6. Description of laboratory work

No laboratory work needed.

4.9.7. Input of data into data bases

Data from S6 are entered into Excel data fil named "Random Observations".

4.10. Collection of faeces and casts

4.10.1. Species to be monitored

Faeces from: ermine *Mustela erminea*, Arctic fox *Alopex lagopus* and Arctic wolf *Canis lupus*. Casts from: Long-tailed skua *Stercorarius longicaudus* and snowy owl *Nyctea scandiaca*.

4.10.2. Frequency of sampling

Once a year, in the last week of August.

4.10.3. Equipment to be used

Binoculars

Observation sheet S7

40 paper bags

Labels

Pencil

Pink spray painting

Black permanent speedmarker.

GPS

4.10.4. Location and marking of study plot

29 stones between the airstrip and Kærelv, i.e. within the lemming study area are marked by pink fluorescence painting on the west facing side of the stone and numbered with black numerals (Table 4.10.4.).

4.10.5. Sampling method

The area within 1 m from each of the 28 stones are examined carefully and all faeces and casts are collected in paper bags (one bag per sample, with reference to species) with reference to the stone number. The samples are recorded following observation sheet S8. The painting and number are repainted if necessary. If non-marked stones with plenty of faeces or casts are found, these should be marked by pink paint and given the next serial number as well as UTM co-ordinates. Faeces and casts are collected as described above and marked as new site on S8.

4.10.6. Laboratory work

The paper bags are stored open until the samples are completely dry. Material are shipped to the NERI Dept. of Arctic Environment.

4.10.7. Input of data into data bases

Data from S5 are entered into Excel data fil named "Faeces and Casts" holding the following columns: Year, Month, Day, Observer, Stone no., UTM East, UTM North, No. of Fox faeces, Ermine faeces, Skua casts, Owl casts, respectively, and Remarks.

Table 4.10.4. UTM co-ordinates for the 29 stones

Stone	UTM East	UTM North
1	513685	8264794
2	513750	8264760
3	513795	8264908
4	513960	8264832
5	513875	8264815
6	513857	8264664
7	513835	8264695
8	513835	8264676
9	514030	8264670
10	514192	8264688
11	514338	8264622
12	514293	8264514
13	514369	8264427
14	514444	8264238
15	514441	8264144
16	514483	8264068
17	514445	8264046
18	514328	8264106
19	514261	8263957
20	514180	8264136
21	514104	8264141
22	514048	8264134
23	513991	8264108
24	513888	8264100
25	513744	8264414
26	513822	8264360
27	513615	8264119
28	513557	8264073
29	514260	8263970

4.11. 'Random' observations

4.11.1. Species to be monitored

All mammal species.

4.11.2. Frequency of sampling

Continuously during entire field season.

4.11.3. Equipment to be used

Binoculars (10x)

Spotting scope (30 x)

Tripod

Dictaphone

Observation sheet S8

4.11.4. Location and marking of study plot

Entire activity area.

4.11.5. Sampling method

Keep watch for everything with fur. Record geographical position, flock size, sex and age, special behaviour etc. All personnel must be encouraged to supply observations. For this purpose, S7 is displayed in the messroom. For musk oxen, only herds or individuals outside the census area should be recorded.

4.11.6. Description of laboratory work

Writing out dictaphone recordings.

4.11.7. Input of data into data bases

Data from S5 are entered into Excel data fil named "Random Observations" and holding the following columns: Year, Month, Day, Observer, Location, UTM East, UTM North, Species, Adult, Juvenile, Remarks. For musk oxen the nomeclature from section 4.3.7. is used. Only musk oxen of four year or older are filed under "Adults". Colour morphs of foxes are stated under species as ex. "Arctic fox white"under remarks.

5. Lakes

5.1. Physical-chemical parameters, phytoplankton and zooplankton

5.1.1. Parameters and species to be monitored

Ice cover

Water temperature

Water transparency

pH

Conductivity

Chlorophyll

Total Nitrogen

Total Phosphorus

All taxonomic groups of phytoplankton

All taxonomic groups of zooplankton

5.1.2. Frequency of sampling

Three times per year, during late July, early and mid August, respectively. Preferably, sampling should take place with c. 10 days intervals, in the middle of each period.

Ice cover on the two lakes is estimated and recorded whenever possible during June and July, both at visits at the lakes and from the slopes of Aucellabjerg.

5.1.3. Equipment to be used

5.1.3.1. Equipment for field work

A rubber dinghy with oars, rope and anchor*

A pump for the rubber dinghy*

A water sampler with two weights*

A 30 l tub*

A Secchi disc with a tape measurer*

Two plastic containers with rope for buoys*

A thermometer with a 0.2º scale

Waders

Life-jacket

Four 250 ml new clean plastic bottles per sampling

Two 1 l plastic bottles per sampling

A bottle with acid lugol solution and a 5 ml plastic pipette

A 20 µm plankton net mounted on the end of a tube (only in mid August)

Funnel that fits into a 100 ml bottle

One 100 ml brown glass or plastic bottle (only in mid August)

A squeeze bottle (only in mid August)

Rubber gloves

*) permanently based in a metal box on a hilltop between the two lakes

5.1.3.2. Equipment for laboratory work

Glas fiber filters Whatmann GF/C, 1.2 um, ø47 mm from Frisenette Aps., phone 8634 2244, e-mail agf@frisenette.dk.

Otherwise equipment already used by GeoBasis, which you may also ask for advice on the analysis.

5.1.4. Location and marking of sampling plots

The two sampling lakes, Sommerfuglesø og Langemandssø, are situated in the northeastern part of Morænebakkerne (see map p. *iv*). The sampling stations are in the deepest parts of the lakes. Sommerfuglesø is 1.8 m deep and Langemandssø 6.1 m. Cairns with red stones are situated on land to mark directions to the deepest points. At the first sampling each year, the deepest place is marked with a small plastic container tied to a rope and a stone for anchor.

5.1.5. Sampling method

At each sampling, full hour, cloud cover (x/8), wind force (m/s) and per cent ice cover are recorded for each lake.

When still on land, tie the anchor rope and the water sampling cord to the boat! Wash the tub and all bottles to be used with lake water. Bring the Secchi disc, the water sampler and the 30 l tub in the dinghy and row to the deepest place in the lake. When anchored on the sampling station, the transparency is measured with the Secchi disc on the sunny side of the dinghy. Lower it in the water until it disappears, and then pull it gently up again until it is just visible. The depth of the disc is then taken from the tape measurer (to 0.1 m). Often the disc will be visible right to the bottom.

Take a total of 5 l (20 l in mid August) of water equally distributed from different depths of the lake. Start with samples from right under the surface, then from 1 m, 2 m etc. The bottom samples should be taken 0.5 m over the bottom, as it is very important not the have sediments in the samples. If the lake sediment accidentally is disturbed, you have to wait 5-10 minutes or move a little away before taking a new sample.

On the shore, stir the water and measure the temperature (to 0.1º) with the thermometer held in the water. Take one sample of 200 ml (fill only the bottle 4/5) for total N and P. Take one more sample of 200 ml, which is preserved with 5 ml lugol for phytoplankton analysis. Finally, take a sample of 1 l for pH, conductivity and chlorophyll measurements. Stir the water between each sampling. Wrap all samples in black plastic to protect them against sunlight, and write lake name (LS or SS) and date on all bottles with an alcohol resistant pen.

At the sampling in mid August, 15 l of stirred water (record the exact volume) are funnelled through the plankton net, whereupon the plankton net is turned around and the content carefully is sprayed down into a brown bottle (max. 80 ml of water). Finally the sample is preserved with 5 ml lugol.

After each sampling of the lakes, the rubber dinghy must be de-inflated and stored together with the rest of the gear in the metal box to prevent foxes etc. from harming it. At the last sampling, the dinghy must be dried as much as possible with some cloth or kitchen paper, and the edge of the lid should be taped to the box to prevent snow from blowing into the box during winter. Cover the box safely with rocks to protect it against wild beasts!

5.1.6. Laboratory work

pH is measured (to nearest 0.1) after calibration of the meter with two buffers that have a pH around the value of the lakes i.e. pH 4 and 7 (see the specific manual for pH measurements). In the same sample, conductivity is measured (to nearest 1 µS).

For chlorophyll measurements, 1 l of water (record exact volume) is filtered through a 47mm GF/C filter, whereupon the filter is folded once, wrapped in alufoil (6x6 cm), put in a zip plastic bag and frozen (-20ºC). Write lake name (LS or SS), date and filtered volume (very important) on each bag.

Besides the marking of lake name and date on the bottles, each bottle must be labelled with Manilla labels giving the same information.

The zooplankton and phytoplankton samples are stored dark in the refrigirator (not in the freezer!). The 200 ml samples for total N and P are frozen. All samples are brought to the National Environmental Research Institute at the end of the season. Frozen samples must be kept frozen (or at least below +5ºC and in darkness) during the transport. The samples are sorted and analysed on relevant laboratories.

Store the thermometers in an upright position for the winter to avoid bubbles in the tubes.

5.1.7. Input of data into database

All recorded data are entered into separate Excel data sheets for each lake and year. After sorting of the samples, the results are added. Each sheet holds the following columns: Year, Month, Day, Hour, Cloud (cover), Wind m/s, Lake, Ice, Temp, Secchi (put the depth in brackets, if it is the bottom), pH, Conduc (Conductivity; µS/cm), volume of filtered chlorophyl sample (ml), Chloro (Chlorophyll; to 0.01 µg/l), TN (µg/l), TP (µg/l), Taxon, No./l (to 0.1 individual per l), Biovol/l (mm3/l) and Remarks. All phytoplankton and zooplankton taxa should be stated for each sampling (including early data on ice cover), but "No sampling" should be added under Remarks, when the actual taxon was not sampled at that date. Data stated under phyllum/family are unidentified taxa.

6. Abiotic parameters

6.1. Microclimate temperatures in ITEX and arthropod study plots

6.1.1. Parameters to be monitored

Micro climate temperatures in ITEX and arthropod monitoring plots

6.1.2. Frequency of sampling

Automatically 5-12 times per day year round. Data are tapped once a year, at the end of the season.

6.1.3. Equipment to be used

30 active Tinytag Plus data-loggers and a few spare ones

Silicon

Plastic pegs

6.1.4. Marking of sampling plots

Dataloggers are situated under a small pile of stopes at each of the monitoring plots. In some occasions, one datalogger 'covers' two or three plots close together. Arthropod plot 1 (window traps) has no datalogger, as the water temperature in the surrounding pond is monitored by GeoBasis.

6.1.5. Sampling method

As soon as the datalogger appears from the snow, it must be checked that the thermistor is in place in the vegetation and fixed with a peg, that the cable is OK (covered by earth and not destroyed e.g. by foxes) and that the datalogger looks OK.

Each year in the second half of August, the dataloggers are brought home to the station for tapping, whereupon they are put in position again. Leave the thermistor and cable in position during the process. Record the exact time of removal as well as re-establishment. Seal all cable entrances inside the datalogger with silicon before reestablsihment.

6.1.6. Laboratory work

See the GeoBasis manual.

6.1.7. Input of data into databases

Date and time of removal and re-establishment is stored in an Excel file named 'Datalogger dates', giving Plot, Logger no., Removal (date and time), Restart (date and time), Re-establishment (date and time), and Remarks. Under Remarks it is e.g. stated if the datalogger has been replaced by another (give type and no.) and why.

The data file names give Plot no. and year (e.g. Sal1-98.ttd). Add defect to the year, if data are invalid, or 1 and 2 to the year if data have been tapped more than once during the season.

6.2. Snow melt in vegetation and arthropod study plots

See 1.1.5, 1.4.5 and 2.1.5.2.

6.3. General observations

6.3.1. Parameters to be monitored

Weather

Snow cover and snow melt

Snow and ice on ponds and lakes

Start of flow in rivers and streams

Melt and break up of fjord and sea ice

Drying up of ponds

6.3.2. Frequency of sampling

Continiously during entire season

6.3.3. Equipment to be used

Binoculars

Dictaphone

6.3.4. Sampling sites

Keep record of snow cover and snow melt in the main study area, snow and ice on ponds around the research station (Gadekæret, Teltdammen, Sydkærene, Lomsø and Kystkærene) together with the lakes in Morænebakkerne (see 5.1.2) and Store Sø, start of flow in Zackenbergelven and the streams on the slopes of Aucellabjerg, and the formation of open water off the delta of Zackenbergelven, land water along the coast, open water in the mouth of Young Sund (e.g. as seen from Zackenbergfjeldet during snow monitoring photo trips - see 6.2), the break up of the fjord ice, and finally drying up of the ponds in Sydkærene, Gadekæret and Teltdammen.

6.3.5. Sampling method

Keep record of general weather conditions (cloud cover, hard wind, precipitation etc.). Record major patterns of snow cover and snow melt in the lowland and on the slopes of Aucellabjerg. Record occurrence of new snow e.g. in the upper part of the study area (give lower limit and duration of snow cover). Record progress in snow and ice melt on the ponds and lakes (give estimates of percent open water at appropriate intervals). Record the start of water flow in rivers and streams (separate between water soaked snow in stream beds, running water on the snow and fully develloped channels). Record the formation of open water off the delta of Zackenbergelven (give area or estimated extent of open water) and along the coast. Record the date when the fjord ice in Young Sund breaks up (ice floes moving away from their original position) and the disappearence of the ice from the fiord. Record major inputs of drift ice into the fiord. Record drying up of ponds and tarns (Teltdammen, Sydkærene, Gadekæret) during August.

6.3.6. Laboratory work

Writing out dictaphone recordings.

6.3.6. Input of data into data base

All records are kept in a journal (Exel files with date, theme, and observations) together with records of birds, mammals etc. (see section 3.7).

7. Disturbance

7.1. Parameters to be monitored

'Person-days' spent in the different research zones

ATV trips in the different research zones

Aircraft activities to and from and over Zackenbergdalen

Discharges

Manipulative research projects

Take of organisms

7.2. Frequency of sampling

Concomitantly during entire field season

7.3. Equipment to be used

None

7.4. Marking of sampling plots

None

7.5. Sampling method

Record arrival and departure of field active personnel together with visits in research zones other than 1A (see the ZERO Site Manual). Record all trips with the ATV separated on driving on snow and bare ground, on or off the 'road' etc. Record all visits by fixed wing aircrafts and helicopters together with aircrafts passing over Zackenbergdalen at low altitude. Record discharges other than ordinary waste water from kitchen and bathrooms. Record research project manipulations of any kind, together with other interferences with the local environment. Record any collection of individuals of plants and animals.

7.6. Laboratory work

None

7.7. Input of data into database

None. The records are summarised for each season in the annual ZERO reports.

Field work schedule

See the calendar below for recordings that must take place on fixed dates.

Daily or almost daily during all or part of the summer field season:

Map breeding birds in the census area in Zackenbergdalen during June - July (no. 3.1).

Keep record of bird nests and broods (i.e. breeding phenology and hatching success) in the census area in Zackenbergdalen during early June - mid August (no. 3.2).

Monitor barnacle goose broods that appear in Zackenbergdalen during late June - August (no. 3.4).

Count and map all musk oxen in Zackenbergdalen daily during the entire field season (no. 4.2).

Count all seals hauled out on the fjord ice and all Arctic hares on the east facing slopes of Zackenberg mountain daily during June - mid July and July-August, respectively (nos. 4.6 and 4.11).

Record all 'random' observations of birds and mammals during the entire season (nos 3.7 and 4.9).

Keep record of snow and ice melt in the study area and on the fjord during June and July (no. 6.3).

Keep record of human activities in the different sectors of the study area including all aircraft operations in and around Zackenbergdalen (no. 7.1).

Every third day during 20 July - 31 August:

Count all waterbirds in the old and the present delta of Zackenbergelven (no. 3.3).

Weekly during the summer field season:

Record snow cover, RVI, flowering phenology and herbivore insect occurrence in each of the 22 botanical plots together with snow cover in the four cotton grass plots and the three plant community plots (nos 1.1, 2.3, 2.4, 2.5 and 6.2).

Empty the 48 pitfall traps for land arthropods (no. 2.1).

Empty the two 'window traps for freshwater insects at the pond in Gadekæret (no. 2.2).

Perform a complete census of muskoxen within the 40 km^2 census area in Zackenbergdalen, including sex and age classification (no. 4.3).

Check fox dens for occupation and cups every first and third week from June to September (no. 4.5).

Every tenth day during June:

Take photogaphs from 500 m a.s.l. on the eastern slope of Zackenbergfjeldet of the snow cover in Zackenbergdalen (no. 6.3).

Every tenth day during July and early August:

Count barnacle goose families and brood sizes together with moulting immatures at Lomsø and elsewhere inside the valley as often as possible.

Once (or a few times) during the summer field season:

Measure the snow depth at four stakes in Zackenbergdalen as soon as possible after arrival

Count flowers etc. in the 25 botanical plots once between early/mid June and early August (depending on species and plot) (no. 1.2).

Record and map winter nests of lemmings in the census area in Zackenbergdalen after snow melt (no. 4.1).

Walk the transect line between Daneborg and Zackenberg and through Store Sødal in mid July for recording of mammals and birds (nos 3.5 and 4.7).

If appropriate, record numbers of breeding eiders, Sabine's gulls and Arctic terns together with walruses on Sandøen and at Daneborg in mid July (nos 3.6 and 4.8).

Sample Langemandssø and Sommerfuglesø in Morænebakkerne for physico-chemical characteristics and phytoplankton in late July, early and mid August, besides zooplankton in mid August (no. 5.1).

Record and sample all fresh muskox carcasses found during the summer (no. 4.4).

Count flowers and berries etc. in the six berry production plots (no. 1.7).

Collect ermine, Arctic fox and Arctic wolf faeces together with snowy owl and skua casts at 30 selected perches at the end of each season (no. 4.10).

Tap dataloggers in ITEX and arthropod study plots and renew batteries at the end of each season (no. 6.1).

Collect information on waste water and other discharge into Zackenbergelven, together with manipulative research projects and collection of organisms (no. 7).

With intervals of five years:

Record changes in vegetation composition and coverage along the ZERO transect line (no. 1.3) (by specialist).

Check the 41 study plot for changes in the cryptogamic vegetation (no. 1.6) (by specialist).

Check the nine ITEX point frame plots for changes in species compostion and cover (no. 1.8).

List of scientific and technical consultants

Botany:

Christian Bay, Ph.D., Botanical Museum, University of Copenhagen

Eric Steen Hansen, Cand. scient., Botanical Museum, University of Copenhagen

Per Mølgaard, Lic. agro., Danish School of Pharmacy

Zoology:

Jens Böcher, D.Sc., Zoological Museum, University of Copenhagen

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Mads Cedergreen Forchammer, Ph.D, Institute of Population Biology, University of Copenhagen

Erik Jeppesen, D.Sc., National Environmental Research Institute, Denmark

Date	June	July	August
1	Snow photos from Zackenbergfjeldet	Flowering phenology and invertebrate traps	Delta water bird census
2			
3	Flowering phenology and open invertebrate traps	Musk ox total count	
4			Delta water bird census
5			Flowering phenology and invertebrate traps
6			
7			Musk ox total count / Delta water bird census
8		Flowering phenology and invertebrate traps	
9	Snow photos from Zackenbergfjeldet		
10	Flowering phenology and invertebrate traps	Musk ox total count	Delta water bird census
11			
12			Flowering phenology and invertebrate traps
13			Delta water bird census
14			Musk ox total count
15		Flowering phenology and invertebrate traps	
16			Delta water bird census
17	Flowering phenology and invertebrate traps	Musk ox total count	
18			
19			Flowering phenology and invertebrate traps / Delta water bird census
20	Snow photos from Zackenbergfjeldet	Delta water bird census	
21			Musk ox total count
22		Flowering phenology and invertebrate traps	Delta water bird census
23		Delta water bird census	
24	Flowering phenology and invertebrate traps	Musk ox total count	
25			Delta water bird census
26		Delta water bird census	Flowering phenology and invertebrate traps
27			
28			Musk ox total count / Delta water bird census
29		Flowering phenology and invertebrate traps / Delta water bird census	
30			
31	Snow photos from Zackenbergfjeldet	Musk ox total count	Delta water bird census

Fixed dates of BioBasis elements

Appendix

Cassiope plot no.							
Date	Sample	Snow	Buds	Flowers	Senescent	Total	Remarks
	A						
	B						
	C						
	D						
	A						
	B						
	C						
	D						
	A						
	B						
	C						
	D						
	A						
	B						
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	D						
	A						
	B						
	C						
	D						

Dryas plot no.									
Date	Sample	Snow	Buds	Flowers	Senescent	Larvae	Eaten	Total	Remarks
	A								
	B								
	C								
	D								
	A								
	B								
	C								
	D								
	A								
	B								
	C								
	D								
	A								
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	A								
	B								
	C								
	D								

Papaver plot no.									
Date	Sample	Snow	Buds	Flowers	Senescent	Open	Eaten	Total	Remarks
	A								
	B								
	C								
	D								
	A								
	B								
	C								
	D								
	A								
	B								
	C								
	D								
	A								
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Salix plot no.												
Date	Sample	Snow	Buds	M flow	F flow	Hairs	Grazed	Fungus	Larvae	Total M	Total F	Remarks
	A											
	B											
	C											
	D											
	A											
	B											
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	D											

Silene plot no.							
Date	Sample	Snow	Buds	Flowers	Senescent	Total	Remarks
	A						
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Saxifraga plot no.								
Date	Sample	Snow	Buds	Flowers	Senescent	Open	Total	Remarks
	A							
	B							
	C							
	D							
	A							
	B							
	C							
	D							
	A							
	B							
	C							
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	B							
	C							
	D							

Eriophorum								
Date	Plot	Sample	Snow	E.s. normal	E.s. infertile	E.t. normal	E.t. infertile	Remarks
	1							
	1							
	1							
	1							
	1							
	1							
	1							
	1							
	1							
	1	A						
	1	B						
	1	C						
	1	D						
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	2	C						
	2	D						
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	4							
	4							
	4							
	4	A						
	4	B						
	4	C						
	4	D						

Snow in 400 m^2 plots				
Date	Veg. 1	Veg. 2	Veg. 3	Remarks
*				

Year	Month	Day	Observer	Plot	Sample	Buds	Flowers	Scenescent	Berries	Total	Remarks	
				Arc1	A							
				Arc1	B							
				Arc1	C							
				Arc1	D							
Year	Month	Day	Observer	Plot	Sample	Buds	Flowers	Scenescent	Berries	Total	Remarks	
				Emp1	A							
				Emp1	B							
				Emp1	C							
				Emp1	D							
Year	Month	Day	Observer	Plot	Sample	Buds	Flowers	Scenescent	Berries	Total	Remarks	
				Vac1	A						Infected branch	
				Vac1	B							
				Vac1	C							
				Vac1	D							

Pitfall plot no.									
Date & hour									
	A	B	C	D	E	F	G	G	Remarks
Snow cover									
Trap days									
COLLEMBOLA									
HETEROPTERA									
Nysius groenlandicus									
Aphidoidea									
Coccoidea									
THYSANOPTERA									
LEPIDOPTERA									
Lepidoptera larvae									
Colias hecla									
Clossiana sp.									
Lycaenidae									
Plebeius glandon									
Noctuidae									
DIPTERA									
Nematocera larvae									
Tipulidae larvae									
Tipulidae									
Trichoceridae									
Culicidae									
Chironomidae									
Ceratopogonidae									
Cecidomyiidae									
Mycetophiliidae									
Sciaridae									
Brachycera larvae									
Empididae									
Phoridae									
Syrphidae									
Cyclorrhapha larvae									
Agromyzidae									
Anthomyiidae									
Calliphoridae									
Fannidae									
Heleomyzidae									
Muscidae									
Scatophagidae									
Tachinidae									
HYMENOPTERA									
Hymenoptera larvae									
Ichneumonidae									
Braconidae									
Ceraphronoidea									
Chalcidoidea									
Cynipoidea									
Scelionidae									
Bombus sp.									
ACARINA									
ARANEA									
Dictynidae									
Linyphiidae									
Lycosidae									
Lycosidae egg sac									
Thomisidae									
Unident.									
OSTRACODA									
SIPHONAPTERA									
*									

Window traps		
Date & hour	Number	Remarks
Ice		
Trap days		
COLLEMBOLA		
COLEOPTERA		
Latridius minutus		
HEMIPTERA		
Nysius groenlandicus		
Coccoidea		
THYSANOPTERA		
LEPIDOPTERA		
Colias hecla		
Clossiana sp.		
Noctuidae		
Geometridae		
DIPTERA		
Nematocera larvae		
Tipulidae		
Trichoceridae		
Culicidae		
Ceratopogonidae		
Chironomidae		
Cecidomyiidae		
Mycetophiliidae		
Sciaridae		
Empididae		
Phoridae		
Syrphidae		
Agromyzidae		
Anthomyiidae		
Calliphoridae		
Heleomyzidae		
Muscidae		
Scatophagidae		
Tachinidae		
HYMENOPTERA		
Braconidae		
Ichneumonidae		
Chalcidoidea		
Bombus sp.		
ACARINA		
ARANEAE		
Linyphiidae		
Lycosidae		
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Appendix

Muskox Field Guide to sex and age classification on East Greenland populations

Calf.

Calf *Photo: Palle Uhd Jepsen*

No horns are visible. Through the winter the white hairs on the forehead become more woolly and appear to cover the horns. The neonate coat colour is dark brown with light brown underwool (qiviut). There is no light coloured area (saddle) on the back as in yearlings and older animals., Guard hairs are not developed and the lower part of the legs is covered with short caramel-coloured hairs. Through the first summer the dark coat colour achieves a lighter shade.

Yearling

The short horns project straight out with a very slight for- ward curve. The length of the visible part of the horns depends on the development of the white curly hairs on the forehead. At the end of the second winter the yearling horns have reached a length of 10—15 cm. The body size is larger than of the calf. Blackish guard hairs reach the ventral part of the abdomen but do not cover the legs. The horns

Yearling *Photo: Henning Thing*

of a male yearling are a little thicker, longer, and less curved than the horns of a female of the same age.

Two-year-old female

Horns are slender and appear in frontal view to project laterally straight out. In profile they are bent straight forward with with white woolly hair and no horn bases are visible Coat colour varies some- what with the season, as in other age-classes, being lightest in fall and darkest in late winter. Guard hairs reach down just distal of the joint to the lower legs. This cohort loses the under- wool (qiviut) earlier than older animals and appears to have a smooth-looking coat throughout most of the summer, when older individuals are still shedding the qiviut Body size is significantly larger compared with yearlings and distinctively smaller than in 3-year-old females.

Two-year-old female *Photo: Henning Thing*

Two-year-old male

The horns of a 2-year-old male are thicker and more conical than in a female of similar age. The proximal two-thirds projects laterally from the head at a 45° angle and the distal part is curved sharply forward Horn ends appear very pointed. These characteristics are best seen in the profile view. Between the horns, white woolly hair covers the forehead and no horn bases are present. Guard hairs of the coat reach down proximal to the joint to the lower legs. Body size is usually slightly less than that of an average-sized adult female.

Two-year-old male *Photo: Henning Thing*

Three-year-old female

In this age-class, horns reach their full length, but are still slender and have black pointed ends. Both in frontal view and in profile the curved appearance of the horns is apparent. The forehead still has cream-coloured woolly hair covering the developing horn bases. Body size is near its maximum and guard hairs of the coat may be long enough to cover half of the lower legs Females often reach sexual maturity at this stage.

Three-year-old female *Photo: Carsten Riis Olesn*

Three-year-old male

Horn development in this age-class is characterised by a pronounced downward orientation of the proximal two-thirds of the horn and a distinct upcurving of the distal part. Except for the black ends the horns have a characteristic yellowish colour easily recognisable in the field.

Three-year-old male *Photo: Carsten Riis Olesen*

Four-year-old+ female *Photo: Carsten Riis Olesen*

The horn bases extending dorsolaterally from the forehead with a decreasing amount of white woolly hair appear as two fluffy structures at the proximal end of the horns. Horn diameter at the orbital level is greater than that of adult females, but horn spread is similar. Guard hairs of the coat may cover half of the lower legs. Body size is a little bigger than for an average adult cow.

Four-year-old and older female

At the age of 7—10 years the whitish woolly hair on the forehead has partially disappeared exposing the horn bases, thus allowing the observer to the best characteristic of a mature older female. Horn bases may increase to 6—7 cm in width, and therefore are much smaller than those of mature bulls. The coats of older females are often characterised by a fleece of shed qiviut loosely attachcd to the guard hairs throughout the summer. In very old females guard hairs may be worn so short that the cream-coloured legs again are mostly exposed.

Four-year-old and older male

During the fifth summer and fall the forehead patch of white woolly hair is reduced considerably and the massive developing horn boss becomes evident. When the animal turns 5 years old (Fig. 8) the horn boss has increased to a near-maximal size,

Four-year-old+ male *Photo: Carsten Riis Olesen*

leaving only a narrow (the width of a finger) hair-filled space in the midline. At this age the horns are longest with the greatest forward curve and with black-coloured

pointed ends. The horn boss is a massive structure with a somewhat cracked surface. It may increase to a width of 20 cm (measured as a straight line parallel to the midline between horns). Especially during winter, the massive boss may appear very light coloured when observed at a distance This could lead the observer to misinterpret the boss as the whitish forehead hair of a cow or a subadult bull and consequently to misclassify the adult male, particularly when no cow or subadult bull is nearby for comparison.

As the muskox bull grows older than 8-9 years the horns are worn down or broken so that the curved ends and black tips disappear.

As seen from Fig. 9, muskox skulls can be sexed and aged with the same accuracy as with living individuals.

The guide is edited from

Olesen & Thing (1989: Can.J.Zool. 67: 1116-1119)

and

Henrichsen & Grue (1980: Danish Rev. Garne Biol. 11: 1-18)

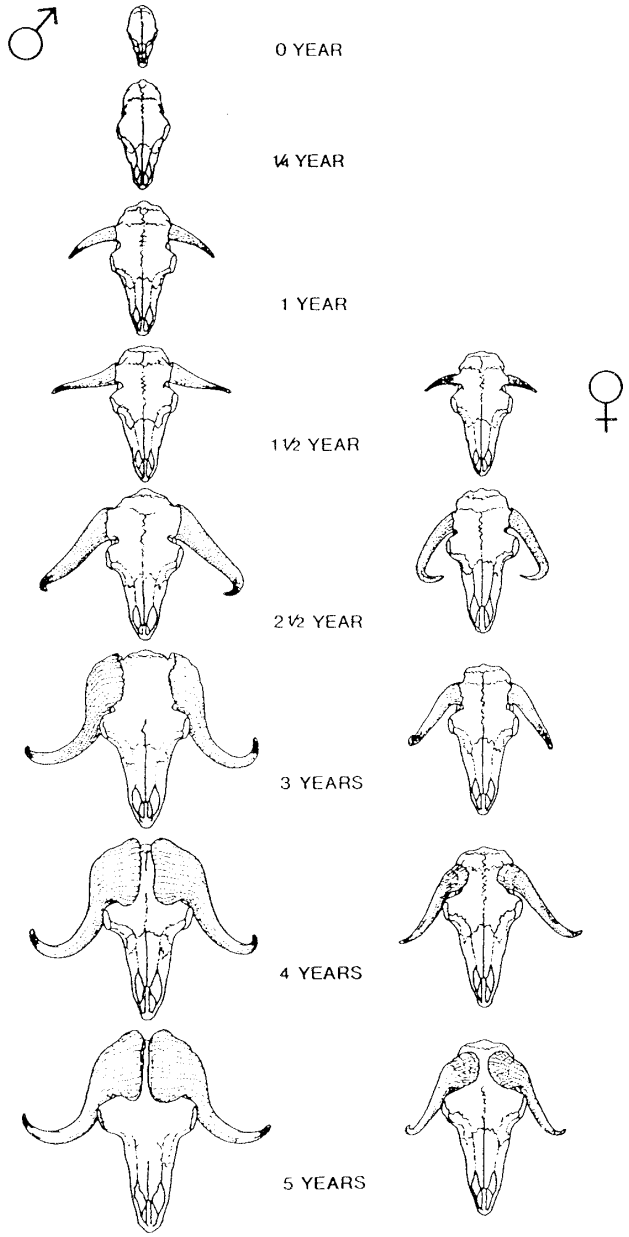

Fig. 9 Muskox skulls

Lemming nest survey S1	Year:		Obs:			Page no.				
	ZIP -code		Nest data							
Rec. no.	Easting (x-axsis, 1-26)	Nording (y-axis, 1-14)	Cat.: Fresh:1; Old:2	Size: 1-5	Pellet cat. 1-4	Placement: in:1; on:2	Breeding nest: 1	Predation: Stoat: 1, Fox: 2	Pellet: with: 1; filled: 2	Fur: grey: 1; white: 2, ox: 3

Field Sheet S1, Lemming winter nest survey

Roof counts S2			**Year:**		**Date:**		**Full hour**
Observer			**Cloud cover /8**		**Visibility -**		
Obs. No.	UTM East	UTM North	m a.s.l.	ISCAR	OSCAR East	OSCAR West	Remarks

Further observations recorded from the roof:

Seals ssp. on the sea ice in Young Sund:

Pink-footed geese

Barnacle geese

Divers

Others

Field Sheet S2, Muskox daily census

Total counts S3		**Year:**	**Date:**		**Start:**		**End:**		**Cloud: /8**		**Visibility: -**			**Observer:**	
Obs. no.	UTM East	UTM North	Altitude	Herd size	M 4+	M 3	M 2	M 1	F 4+	F 3	F 2	F 1	Usp. 1	Calf	Remarks

Field Sheet S3, Muskox weekly census

Carcass sheet S4			**Year:**								
Month	**Day**	**Observer**	**ID no. yy-xx**	**UTM East**	**UTM North**	**Sex**	**Estimated age**	**Molar sample**	**Bone marrow index**	**DNA sample**	**General remarks**

Field Sheet S4, Muskox carcass survey

Fox den survey, S5						**Year:**				
Month	Day	Observer	Den no.	UTM East	UTM north	White juvenile	White adult	Blue juvenile	Blue adult	Remarks

Field Sheet S5, Fox den survey

Year	Month	Day	Obs 1	Obs 2	WPT	Start time	End time	Cloud (x/8)	Wind	Species	Adults	Pulli/juv.	Remarks	Species no.
										Red-throated diver				Bird 01
										Pink-footed goose				Bird 02
										Barnacle goose				Bird 03
										King eider				Bird 04.1
										Common eider				Bird 04.2
										Long-tailed duck				Bird 05
										Rock ptarmigan				Bird 06
										Gyr falcon				Bird 07
										Great ringed plover				Bird 08
										Red knot				Bird 09
										Sanderling				Bird 10
										Dunlin				Bird 11
										Ruddy turnstone				Bird 12
										Long-tailed skua				Bird 13
										Glaucous gull				Bird 14
										Arctic tern				Bird 15
										Snowy owl				Bird 16
										Northern weathear				Bird 17
										Common raven				Bird 18
										Arctic redpoll				Bird 19
										Snow bunting				Bird 20
										Gynaephora larvae				insect 1
										Clossiana sp.				Insect 2.1
										Colias crocea				Insect 2.2
										Bumblebee				Insect 3
										Arctic hare				Animal 01
										Collared lemming				Animal 02
										Summer burrow				Animal 02b
										Winter nest				Animal 02n
										Blue arctic fox				Animal 03b
										White arctic fox				Animal 03w
										Ermine				Animal 04
										Muskox M4+				Animal 051.1
										Muskox M3+				Animal 051.2
										Muskox M2				Animal 051.3
										Muskox M1				Animal 051.4
										Muskox F4+				Animal 052.1
										Muskox F3+				Animal 052.2
										Muskox F2				Animal 052.3
										Muskox F1				Animal 052.4
										Muskox calf				Animal 053
										Muskox usp.				Animal 054
										Summer faeces				Animal 05s
										Winterfaeces				Animal 05w

Field Sheet S6, Transect census

Faeces and Casts, S 7			Year:		August		Day: Observer:
Stone	UTM East	UTM North	No. of fox faeces	No. of ermine faeces	No. of skua casts	No. of owl casts	Remarks
1	513685	8264794					
2	513750	8264760					
3	513795	8264908					
4	513960	8264832					
5	513875	8264815					
6	513857	8264664					
7	513835	8264695					
8	513835	8264676					
9	514030	8264670					
10	514192	8264688					
11	514338	8264622					
12	514293	8264514					
13	514369	8264427					
14	514444	8264238					
15	514441	8264144					
16	514483	8264068					
17	514445	8264046					
18	514328	8264169					
19	514261	8263957					
20	514180	8264136					
21	514104	8264141					
22	514048	8264134					
23	513991	8264108					
24	513888	8264100					
25	513744	8264414					
26	513822	8264360					
27	513615	8264119					
28	513557	8264073					
29	514260	8263970					
		Totals					

Field Sheet S7, Feases and cast survey

Random observations of mammals in 1997					adulte=voksen, juv. (juvenile)=unge)														Sheet no. S7
Obs.	Observer	Locality or		Lemming	Arctic hare		Arctic fox (blue)		Arctic fox (white)		Ermine		Arctic wolf		Muskoxen (out side Zackenberg valley !)				Seals/Whalros/Polar bear
date		UTM co-ordinates					(dark)		(white belly, dark back)		Hermelin								
					adulte	juv.	adulte	juv.	adulte	juv.	adulte	juv.	adulte	juv.	adulte	1 year	calf	total	
dd/mm	Name(s)	easting	nording		white	grey	fluffy tale	slender tale	fluffy tale	slender tale	c. 25 cm					small horn	no horn		

Field Sheet S8, Random observations