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ESTIMATION OF HOODED SEAL PUP PRODUCTION IN THE GREENLAND SEA PACK-ICE DURING THE 2005 WHELPING SEASON

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SUMMARY

In the period 11 to 29 March 2005 aerial surveys were performed in the Greenland Sea pack-ice (the West Ice), to asssess the pup production of the Greenland Sea population of hooded seals *Cystophora cristata*. Two fixed-wing twin-engined aircrafts (stationed in Constable Pynt, East-Greenland, and Akureyri, Iceland) were used for reconaissance flights and photographic surveys along transects over the whelping patches. A helicopter, operated from the applied expedition vessel (M/V"Polarsyssel"), assisted in the reconnaissance flights, and subsequently flew combined visual/video transect surveys over the whelping patches. The helicopter was also used for other purposes, such as monitoring the drift of ice and patches, age-stageing (also performed along transects over the patches) of the pups, and assessing the fidelity of pups to their natal ice pans. A total of 15 reconnaissance surveys were flown and the total area along the eastern ice edge between 67°25' and 75°00'N were covered during the survey period. The reconnaissance surveys were usually flown at an altude of approximately 300 m. Repeated systematic east-west transects spacing10 nautical miles (sometimes 5 nautical miles apart) were flown from the eastern ice edge and usually 10-20 nautical miles (sometimes longer) over the drift ice to the west. Three hooded seal breeding patches were located and surveyed visually (Patches A and B) and photographically (all patches). The aircrafts were equipped with Leica RC 30 cameras with a motion compensation mechanism shooting AGFA Pan 400 black-and-white film. On 24 March, a total of 39 photo transects were flown at an altitude of about 200 m and 979 photos were shot in the three observed whelping patches (A, B, and C) in the area between 71º 09' – 71º 54'N and 15º 23' – 17º 54'W. Only a few whelping hooded seals and pups were observed outside the three surveyed whelping patches. The results from the aerial surveys will be used to estimate the 2005 hooded seal pup production. Subsequently, the status of the stock will be assessed by fitting population models to the pup production estimate.

INTRODUCTION

Due to uncertainties in the assumptions required when estimating abundance from catch-at-age data, sequential population models and mark-recapture data, independent estimates of pup production have been recommended (e.g., ICES, 1992; 1993; 1994; NAFO, 1995) and used to determine population size of harp *Pagophilus groenlandicus* and hooded *Cystophora cristata* seals both in the northwest Atlantic (Bowen et al., 1987; Hammill et al., 1992; Stenson et al., 1993; 1997; 2002; 2003), in the Greenland Sea (Øritsland and Øien, 1995; ICES, 1998; 1999; Haug et al., 2005), and in the White Sea (ICES 1999; 2001; 2004; Potelov et al., 2003). The status of the stocks are subsequently assessed by fitting population models to the independent estimates of pup production (e..g. Healey and Stenson, 2000; ICES 2001; 2004). It is recommended that the comprehensive aerial surveys needed to provide estimates of current pup production should be conducted periodically, and that efforts should be made to ensure comparability of survey results (ICES, 1994; NAFO, 1995). In the Greenland Sea, harp and hooded seals were surveyed aerially in 2002 (Haug et al., 2005) and 1997 (ICES, 1998; 1999), respectively. Although not formally established, it has been argued that the period between surveys should not exceed 5 years. For this reason, new aerial surveys to assess the status of the Greenland Sea population of hooded seals during their whelping period (usually assumed to peak in the period 15-20 March, see Rasmussen, 1960; Øritsland, 1964; Øritsland and Øien, 1995) were conducted in 2005.

Two (possibly three) stocks of hooded seals are assumed to inhabit the North Atlantic Ocean (Sergeant, 1974; Kovacs and Lavigne, 1986). Whelping occurs east of Newfoundland and in the Gulf of St.Lawrence (the Northwest Atlantic stocks), whereas a possible separate whelping stock of hooded seals occur in the Davis Strait between Greenland and Arctic Canada. Furthermore, hooded seals whelp in the Greenland Sea off the east coast of Greenland (the West Ice stock). It has proved impossible to detect significant genetic differences (allozymes and DNA) between hooded seals from the West Ice and from the Northwest Atlantic (Sundt et al. 1994). Thus, a hypothesis that there is some degree of intermixing between the stocks cannot be rejected. The stocks are, however, managed separately. In general, results from satellite tagging programs indicate that hooded seals tagged in the West Ice during breeding and after moult, remain within the Greenland, Norwegian and Icelandic Sea for the majority of the year (Folkow et al. 1996; Folkow and Blix, 1995; 1999). Recaptures of seals, tagged as pups in the West Ice, are consistent with the satellite tagging results (ICES, 1999).

The Greenland Sea stock of hooded seals have been subject to commercial exploitation for centuries (Iversen, 1927; Sergeant, 1966; Nakken, 1988). The Greenland Sea hunt started as an offshoot of the Spitsbergen hunt for bowhead whales (*Balaena mysticetus*) in the late 17th century. Knowledge of the Greenland Sea catches in the 18th and the first two-thirds of the 19th century, performed by Dutch, British, German and Danish ships, is poor. Norwegian sealers appeared for the first time in the Greenland Sea in 1846, and have subsequently participated with increased effort. Both harp and hooded seals were hunted, but all catch statistics from the years before World War II are both incomplete and unreliable since usually only total catches

(combined numbers for the two species) were recorded. Harp seals are assumed to have been the most important catch object in the early years, whereas hooded seals occurred more frequently in the catches from the 1890s on (Iversen, 1927). After 1920, a substantial increase occurred in the Greenland Sea hooded seal hunt with average annual catches ranging between 40 000 and 50 000 individuals (Rasmussen, 1957; Øritsland, 1959). After a 5 year pause in the sealing operations during World War II, total annual catches quickly rose to a postwar average maximum of about 70 000 for the period 1954-1958. It was evident that these catch levels were higher than the stock could sustain, and some regulatory measures (mainly to reduce effort) were taken in 1958 (Rasmussen, 1957; 1960; Øritsland, 1959; Sergeant, 1966). The total annual catches have subsequently followed a decreasing trend, primarily due to reduction in catch effort, and quotas were imposed in 1971 (Kovacs and Lavigne, 1986; ICES, 2004). Average annual catches in the early 1960s were approximately 47 000 individuals, whereas in the early 1980s the level had sunk to c. 8 000 seals. In the past 25 years, the average annual catch level has remained less than 5 000 animals (almost exclusively pups) which is below the level which is assumed to stabilize the population at its current level (ICES, 2004).

Available knowledge of both previous and present abundance of Greenland Sea hooded seals is rather restricted. As judged both from catch per unit effort analyses and mark-recapture pup production estimates, it has been assumed that the stock has increased ever since the early 1960s, but evidence of the level of increase has been rather imprecise (Ulltang and Øien, 1988; Øien and Øritsland, 1995). Aerial surveys to estimate the hooded seal pup production were attempted, however with rather little succes, in the Greenland Sea both in 1959 (Øritsland, 1959; Rasmussen, 1960) and in 1994 (Øritsland and Øien, 1995). More successful aerial surveys were conducted in 1997 – these suggested a minimum pup production in this year of 24 000 (95% CI 15 000 – 33 000) (ICES, 1998). A new population model, based on historical reproductive parameters, and tuned to the available pup production estimate, gave a projected 2003 pup production estimate of 29 000 (95% CI 17 000 – 44 000) and a total size of the 1+ population of 120 000 with a 95% confidence interval ranging between 65 000 and 175 000 animals (ICES, 2004).

The present study was carried out with the Institute of Marine Research, Tromsø/Bergen, Norway, as responsible institution. The methodology used was to conduct aerial surveys of seal pups in the Greenland Sea pack-ice during the whelping period (late March) in 2005. The techniques used were similar to those developed and used previously for determining population size for harp and hooded seals in the northwest Atlantic (Bowen et al., 1987; Hammill et al., 1992; Stenson et al., 1993; 1997; 2002; 2003) and in the Greenland Sea (Øritsland and Øien, 1995; ICES, 1998; 1999; Haug et al., 2005), and for harp seals in the White Sea (ICES, 1999; 2001; Potelov et al., 2003). In addition to the abundance estimation, behavioural studies of hooded seal pups were conducted. The present report review

I) the activities on the ship bound part of the survey (including all activities using the ship bourne helicopter)
II) details from the activities of two aircrafts used for reconnaissance and photographic surveys.

PART I: REPORT FROM THE SHIP BOUND PART OF THE SURVEY

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LOGISTICS AND METHODS

Ship, aircrafts and personell

The ice-strengthened expedition vessel M/V"Polarsyssel" (length 50 m, 499 gross tonnes, 2500 hp machine engine, classification icebreaker/sealer DnV + 1AJ) owned by Torson Shipping AS, Tromsø, was used for operations in the Greeland Sea drift ice. The ship was equipped with a landing platform for helicopter and equipment in compliance with relevant requirements for helicopter operations. Large flush hatches over the aft shelterdeck were particularly useful because they permitted sheltered stowage of the helicopter during crossings in rough seas to and from the ice.

An Ecureuil AS 350 B1 helicopter (owned by Airlift AS, Bygstad, Norway) was chartered for the expedition. This helicopter type has previously proved useful in similar operations in the Greenland Sea pack ice, both with regard to ease of handling and stowage onboard the ship and because of flight range (Øritsland and Øien, 1995; Haug et al., 2005). The helicopter was fitted with a satellite navigation system (GPS) and radar altimeter. Approximately 50 hours were flown over the ice during the survey.

Two fixed-wing twin engine Piper Navajo aircraft were based in Constable Pynt, East-Greenland, and Akureyri, Iceland, but were also granted permission to use the airport on the Jan Mayen Island (see part II of this report).

In addition to crews on the ship, helicopter and aircraft, the expedition included a scientific personell of 11 persons. Tore Haug (expedition leader), Stine Frie, Lotta Lindblom, Michael Polterman, Arnt-Børre Salberg and Nils Erik Skavberg participated onboard M/S"Polarsyssel". Journalist Trine Hamran participated to produce a documentary about the research operation and about sealing in general.

Reconnaissance surveys

Whelping concentrations were located using fixed-wing and helicopter reconnaissance surveys of areas historically used by hooded seals in the Greenland

Sea, mainly the pack ice areas along the eastern coast of Greenland between 67°42' and 75°00'N (see Fig. 5 in part II of this report). The reconnaissance flights were adapted to the actual ice-confuguration during the survey period. Survey altitudes were usually 300 m. Due to ice drift and a range of pupping dates (mid to late March, see Rasmussen, 1960; Øritsland, 1964; Øritsland and Øien, 1995; ICES, 1998), most areas were surveyed repeatedly to minimize the chance of missing whelping concentrations. Color markers and VHF transmitters were deployed using the helicopter in major whelping concentrations to facilitate relocation and to monitor ice drift.

Reconnaissance flights using the fixed-wing aircrafts were generally flown as repeated systematic east-west transects from the ice edge in the east and into more close drift ice. The length of the trancects were approximately 10-30 nm and they were usually spaced 10 nm apart, modified according to the actual ice configurations during the surveys. More details about the reconnaissance flights, performed by the two planes in the period 11-29 March, is given in part II of this report.

M/S"Polarsyssel" met the ice edge at 71º24'N / 13º23'W on 15 March. The ship moved further north and westwards, and helicopter reconnassance flights were flown on 17 and 24 March in areas between 71º32'N - 72º20'N and 13º50'W - 16º50'W. "Polarsyssel" left the ice on 29 March.

Photographic surveys

Fixed-wing aerial photographic surveys were flown using the Piper Navajos in three observed whelping patches (A, B and C), details are given in part II of this report.

Visual and video surveys

The number of pups present within whelping patches A and B were estimated by conducting systematic visual strip transect surveys, flown using the ship based helicopter at an altitude of 61 m. Observers, seated in the left and rear seats, counted all pups within a 43 and 41 m wide strip on each side of the aircraft, respectively. Each pup observation was recorded directly into a GPS-connected lap-top which ensured that all observations were linked to positions. Each transect began before a navigator, seated in the front, encountered seals and was terminated after the last seal was observed. The survey ended when no seals were seen on transect and were not observed outside the survey area, ensured by the third observer (with forward view) in the helicopter. Simultaneous with the visual observations, a vertically mounted video camera recorded a 50 m strip underneath the helicopter, i.e., between the two strips covered by the observers. The direction of and spacing between transects depended on orientation and size of the concentration. The subsequent data analyses was the same as used for the photographic surveys, assuming complete coverage along a transect (see Stenson et al., 1993).

Temporal distribution of births

To correct the estimates of abundance for pups that had left the ice or were not yet born at the time of the survey, it was necessary to estimate the distribution of births over the pupping season. This was done by using information on the proportion of

pups in each of four distinct age-dependent stages. These arbitrary, but easily recognizable age categories were based on pelage color and condition, overall appearance, and muscular coordination, as described for northwest Atlantic hooded seals by Bowen et al. (1987) and Stenson & Myers (1988):

0. Unborn: Partuirent females.
1. Newborn: Skin in loose folds along flanks, fur saturated to wet, entire pelage with yellowish hue, awkward body movements. Mother present. Often associated with wet placentas and blood stained snow.
2. Thin blueback: Pup dry, ventrum white, neck well defined, trunk conical in shape. Mother present. Mainly 1-2 days old.
3. Fat blueback: Ventrum white, neck not distinguishable, trunk fusiform in shape. Mother present. Mainly 2-4 days old.
4. Solitary blueback: As in fat blueback, but mother not present. Mainly 4 days or older.

Prior to the survey, classifications of pup stages were standardized among observers to ensure consistency. To determine the proportion of pups in each stage on a given day, random samples of pups were obtained by flying a series of transects over the patch. Pups were classified from the helicopter hovering just above the animals. The spacing between transects depended on the size of the actual patch. Repeated classifications were obtained from each patch several days apart.

"Pupping ice fidelity" in bluebacks

Results from satellite tracking of bluebacks in Canada indicate that they may remain associated with the pupping ice (where they may move between pans) as much as two weeks after the mother has left them (Garry Stenson, DFO, Newfoundland, Canada, pers. comm.). Since we are not completely sure of this, some experiments were conducted to check pup behaviour the first days after they had become solitaries. Tags with VHF transmitters were attached to the flippers of 15 recently weaned bluebacks in Patch B. These were monitored continuously (once per hour) during the period 23 – 29 March using a receiver placed on the ice in the area of tagging. Monitoring of tagged pups were also done at more or less regular intervals (twice per day if weather condtions permitted) using a receiver in the helicopter. As long as we received signals from the VHF tags we knew that the pups remain hauled out on the pupping ice – if we lost contact temporarily they might have started diving within the pupping ice area ("moving between pans"); if the connection was permanently broken they might have left the pupping ice. One satellite based Argos calib was deployed in the experimental area, both to monitor ice drift and to facilitate easy localisation of the tagged pups.

PRELIMINARY RESULTS

Identification of whelping areas

A few family groups of breeding hooded seals were observed during fixed-wing reconnaissance flights on 12 March in areas between 71º40'N - 71º47'N and 15º42'W / 15º53'W. On 15 March the fixed-wing aircraft observed an increased number of hooded seal families, thus indicating the beginning of formation of whelping concentrations, in an area bewteen 71º47'N - 72º09'N and 14º40'W / 16º20'W. Based

on ice drift, these possible whelping concentrations were relocated during helicopter reconnaissance flights on 17 March. A small southern patch (Patch A) was found on 17 March at an approximate mean position of 71º49'N / 15º25'W. A larger hooded seal concentration (Patch B) was located on the same date further to the northeast (approximate position of 72º13'N / 14º20'W). VHF transmitters were immediately deployed in both patches to monitor movements which was generally in a southwesterly direction. In patch B, also one satellite based Argos calib was deployed on 24 March.

On 18 March, adult hooded seals (females) were observed (from the plane) to concentrate further north in the area (72º31'N - 73º07'N and between 14ºW - 15ºW), presumably in the initial phase of forming Patch C. On 24 March, this third hooded seal whelping concentration (Patch C) was observed during helicopter reconnaissance flight between 71º40'N - 71º55'N and 15º40'W - 16º10'W. This was subsequently monitored by deploying a VHF transmitter.

No more whelping concentrations were observed, although very scattered hooded seal families were observed over some of the area surveyed during reconnaissance flights, mainly south of 69ºN (see part II of this report).

A substantial number of polar bear *Ursus maritimus* tracks were observed in the area of reconnaissance, and particularly close to the areas of hooded seal whelping concentrations. Direct observations of polar bears were made on 20 March (3 animals close to patch A, position 71º40'N / 15º55'W), 25 March (one animal in patch B, position 71º19'N / 18º03'W, another animal to the northeast of patch B in position 71º56'N / 17º00'W) and on 27 March (again one animal in patch B, now in position 70º57'N / 18º17'W).

Visual / video surveys

Systematic visual strip transect surveys were flown over hooded seal whelping Patch A on 23 March. The patch then occupied an area between approximately 71º16'N - 71º28'N and 16º10'W - 17º30'W. Seven east-west transects were flown spaced 2 nautical mile apart. A total of 7 hooded seal pups were counted on transects within an 84 m wide strip (Table 1). Video recordings were made on all transect lines (strip width: 50 m). By the time the survey was flown, the sealers had removed 711 pups from the patch.

Hooded seal Patch B was surveyed on 23 March when the patch occupied an area between approximately 71º32'N - 71º44'N and 16º55'W - 17º50'W. Seven east-west transects were flown spaced 2 nautical miles apart. In total, 78 pups were counted on the 84 m wide transect strip (Table 2). Video recordings were made on all transect lines (strip width: 50 m). The area covered with visual and videop transects may have been smaller than the actual size of Patch B.

Visual surveys were not flown over whelping Patch C.

Photographic surveys

Photographic surveys covering the entire Patch A, B and C concentrations (now

occupying area between, respectively, 71º10'N - 71º23'N and 16º40'W - 17º30'W, 71º28'N - 71º40'N and 17º00'W - 18º00'W, 71º40'N - 71º55'N and 15º40'W - 16º10'W) were successfully completed by the two aeroplanes on 24 March (see part II of this report).

Temporal distribution of births

Estimations of the proportion of pups in each developmental stage were obtained from all whelping concentrations. Whelping in Patch A and B were very similar in time and were surveyed together. Systematic east-west staging transects (spaced 1-3 nautical miles apart) were flown over Patch A/B on 18, 20, 23, 25, 27 and 29 March, and over Patch C on 24 and 27 March (Table 3). Prior to the pup estimation surveys (visual as well as photographic) newborns were absent while thin bluebacks occurred in very low numbers in the patches. No newborn were observed after the surveys were flown. The majority of pups present during and immediately after the estimation survey periods were fat and solitary (>50%) bluebacks.

"Pupping ice fidelity" in bluebacks

Tags with VHF transmitters were attached to the flippers of 7 recently weaned bluebacks in Patch B on 23 March, and on another 8 pups in the same area on 24 March. These 15 pups were monitored continuously (once per hour) during the period 24 – 28 March using a receiver placed on the ice in the area of tagging. Monitoring of tagged pups was also done at more or less regular intervals (twice per day if weather condtions permitted) using another receiver in the helicopter, last check made on 29 March. Preliminary results from the helicopter monitoring indicated that all pups remained in the area during the entire monitoring period. However, they were not always available for observation during the period, thus indicating that they made occasional trips into the water. This was also the impression from visual observations which also showed that individual pups could move considerable distances on the ice.

CONCLUDING REMARKS

The survey used methods comparable with previous surveys performed for harp and hooded seal assessments in the northwest Atlantic (Bowen et al., 1987; Hammill et al., 1992; Stenson et al., 1993; 1997; 2002; 2003), in the Greenland Sea (Øritsland and Øien, 1995; ICES, 1998; Haug et al., 2005) and in the White Seaa (ICES, 1999; 2001; 2004; Potelov et al., 2003). Extensive reconnaissance of all likely areas were conducted to locate whelping hooded seals, and results from the visual and photographic surveys will be used to estimate the 2005 pup production. Results from the staging analyses will be used to correct the survey results for any pups that may have been missed due to the temporal distribution of births.

The results from the 2005 surveys will be used to estimate the hooded seal pup production and to assess the present status of Greenland Sea hooded seals. Presumably, the obtained results will indicate whether there is evidence of any change in pup production in this population. The latter can be done by comparing the 2005 results with those obtained in 1997 (ICES, 1998), when methods similar to those applied in 2005 were used.

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Table 1. Number of hooded seal pups counted on east-west transects obtained during a helicopter flown visual survey of the Patch A whelping concentration in the Greenland Sea on 23 March 2005. NB: Sealers had removed 711 pups from this patch prior to the survey.

Transect	Latitude	Longitude start	Longitude finish	Pups counted
1	71°28N	16°11W	17°25W	0
2	71°26N	16°10W	17°25W	2
3	71°24N	16°30W	17°30W	1
4	71°22N	16°28W	17°20W	2
5	71°20N	16°30W	17°20W	1
6	71°18N	16°30W	17°20W	1
7	71°16N	16°26W	17°30W	0

Table 2. Number of hooded seal pups counted on east-west transects obtained during a helicopter flown visual survey of the Patch B whelping concentration in the Greenland Sea on 23 March 2005.

Transect	Latitude	Longitude start	Longitude finish	Pups counted
1	71°32N	17°30W	17°50W	1
2	71°34N	17°30W	17°50W	9
3	71°36N	16°56W	17°50W	44
4	71°38N	17°15W	17°48W	2
5	71°40N	17°15W	17°39W	5
6	71°42N	16°55W	17°22W	17
7	71°44N	17°05W	17°30W	0

Table 3. Numbers of hooded seal pups in individual age dependent stages in three whelping patches (A/B and C) in the Greenland Sea during March 2005.

Date	Patch	Stages					Total
		Parturient Females	Newborn	Thin blueback	Fat blueback	Solitary blueback	
March 18	A/B	18	0	227	34	12	291

March 20		18	1	198	80	110	407
March 23		0	0	11	114	75	200
March 25		0	0	14	82	166	491
March 27		0	0	1	28	171	200
March 29		0	0	0	1	225	226
March 24	C	0	0	11	82	50	143
March 27		0	0	2	11	13	26

PART II: REPORT OF THE FIXED-WING RECONNAISSANCE AND PHOTOGRAPHIC AERIAL SURVEYS

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LOGISTICS AND METHODS

Aircrafts and personell

Two fixed-wing twin engine Piper Navajo aircrafts (LN-NPZ and LN-NAB), operated by Blom Geomatics (Sandvika, Norway) were used to conduct reconnaissance and photographic surveys aimed to estimate the hooded seal pup production in the drift ice areas in the Greenland Sea between East Greenland, northern Iceland and the island Jan Mayen (also termed the West Ice). The aircraft LN-NPZ operated over the drift ice during the period 11-29 March and LN-NAB in the period 23-29 March 2005. The aircrafts were mainly based at Constable Pynt airport (50 km north of Scoresbysund, East Greenland), but the airports in Akureyri (Iceland) and on the island Jan Mayen (Norway) were also used. In addition to one pilot and one copilot/operator on each aircraft, Kjell Tormod Nilssen and Kjell-Arne Fagerheim operated on the LN-NPZ and LN-NAB aircrafts, respectively.

Reconnaissance surveys

Reconnaissance fixed-wing surveys were planned and conducted in order to cover the entire area of potential hooded seal whelping in the West Ice, based on knowledge on the whelping period, historically distribution of hooded seals in the Greenland Sea (Rasmussen 1960; Øritsland 1964, Øritsland and Øien 1995; ICES 1998), and the observations of hooded seal whelping during a harp seal survey in the same area in 2002 (Haug *et al*. in press.).

The reconnaissance surveys were usually flown at an altude of approximately 300 m, but due to low cloud base in short periods surveys were also flown at lower altitudes (min. 120 m). Repeated systematic east-west transects spacing10 nautical miles were flown from the eastern ice edge and usually 10-20 nautical miles (sometimes longer) over the drift ice to the west. Transects were usually ended in the west when the ice conditions changed to be very dense, with no water between the ice flowes and increased snow coverage on the ice. Along the eastern ice edge some transects were adjusted in order to cover tongues of drift ice stretching to the east. In areas where hooded seals were concentrated, transects spaced 5 nautical miles.

Photographic surveys

Both fixed-wing aircrafts were equipped with Leica RC 30 cameras with a motion compensation mechanism shooting AGFA Pan 400 black-and-white film. The cameras were fitted with a 15,3 cm lens, and photographic surveys were conducted at altitudes approximately between 160 and 250 m. The cameras were operated in order to cover more than 80 % of the area along each transect line with no frame overlap. LN-NPZ was fitted with radar altimeter, while LN-NAB was fitted with barometric altimeter to obtain correct altitude. Altitudes based on the GPS navigation systems were logged along the transect lines, and later used to correct the altitudes on all photos. The altitudes on each photo were estimated using bilinear interpolation based on the geoid model EGM96 (see http://cdis.gsfc.nasa.gov/ 926/egm96/nasatm.html). Correct transect spacing were maintained using GPS.

PRELIMINARY RESULTS

Ice distribution, aerial transects and seal observations

The drift ice distribution at the start of the reconnaissance surveys on 11 March is shown in Fig. 1. The ice conditions were very stable during the entire survey period 11-29 March in the areas north of approximately 69ºN. In the area just north of Iceland the drift ice distribution increased gradually to the south to reach a maximum southern distribution on 18 March, when the drift ice covered the entire area between Greenland and the northwestern parts of Iceland (Fig.2). Later in March the ice drifted to southwest in the southern areas (Fig. 3 and 4).

Hooded seal observations

The aircraft LN-NPZ covered the area along the eastern ice edge between approximately 68º - 73ºN and 8º-20ºW during five surveys in the period 11-18 March (Fig.5). On 12 March, some whelping hooded seals were observed in the area between 71º 40’ – 71º 47’N and 15º 40’W - 15º 58’W (Fig. 6). On 15 March the number of whelping females had increased to form whelping concentrations in the areas between 71º 46’ – 71º 53’N and 15º 42’– 16º 25’W and further north in the areas between 72º 00’ – 72º 09’N and 14º 33’ – 16º 19’W (Fig. 6). On 18 March concentrations of adult hooded seals were observed in the area between 72º 31’ – 73º 07’N and 14º – 15ºW (Fig. 6), but no whelping or pups were observed from the aircraft in that area.

An attempt to cover the drift ice from 69º N and southwards were done on 21 March but was abrupted due to fog. After a period of poor weather conditions reconnaissance surveys were successfully continued on 23 March when the area along the ice edge between 69º – 71º N were covered with both aircrafts (LN-NPZ and LN-NAB). The southern drift ice areas were covered with fog due to warm weather conditions over the northern parts of Iceland and northwards to the drift ice. However, during the end of March the weather conditions changed so it was possible to also cover the southern areas of the drift ice. In the period 27-29 March the northern areas between 72º 00' – 75º 00'N and 8º45' – 16º 30'W, and the areas in the south between 67º 25'– 69º 09' N and 20º – 24ºW were covered using both aircrafts (Fig. 5).

Outside the observed hooded seal whelping patches, only a few scattered bluebacks and hooded seal families were observed, mainly in the areas between 68º – 69º N (Fig. 6).

A total of 15 reconnaissance surveys (62 hours including the transport flights between the airports and the survey areas) were flown. Three of the surveys (on 21, 26 and 29 March) were abrupted due to fog.

Photographic surveys

On 24 March, the helicopter based on M/V "Polarsyssel", was used to define the geographic range of the three observed whelping patches just before (2-5 hours) the fixed-wing aircrafts started the photographic operations (see part I of this report). Cameras were turned on when seals were observed on a transect line and turned off when no seals were observed for an extended period along the line. Photos were shot with no interruption along all transect lines spacing 1 nautical mile apart in the three whelping patces, which were termed Patch A, B and C, from south to north, respectively (Fig. 7). A total of 342 photos were shot along 15 transects in Patch A using the aircraft LN-NAB (Table 1). A total of 167 photos were shot along 9 transects in Patch B (Table 2), and 470 photos were shot along 15 transects in Patch C, using the aircraft LN-NPZ (Table 3).

The photo altitudes in Patch A were approximately 160 m, but ranged between155 and 233 m (Fig. 8), providing coverage ranging from 233 x 233 m (54465 m^2) to 351 x 351 m (122968 m^2) per photo. The photo altitudes in Patch B ranged between 198 and 247 m (Fig. 9), providing coverage ranging from 297 x 297 m (88191 m^2) to 371 x 371 m (137621 m^2) per photo. In Patch C, the photo altitudes ranged between 208 and 249 m (Fig. 10), providing coverage ranging from 313 x 313 m (97958 m^2) to 367 x 367 m (134645 m^2) per photo.

A total of 39 photo transects were flown in the three whelping patches and 979 photos were taken. The survey time was approximately 9 hours, including the transport flights between Constable Pynt and the survey areas.

Harp seal observations

On 18 March, some whelping harp seals were observed in the area between 74º 10' – 74º 18'N and 11º 13' – 11º 27'W. A large patch of whelping harp seals was observed in the area between 73º 18' – 74º 01'N and 10º 30' – 11º 36'W and a small harp seal

whelping patch around 73º 03'N and 13º11'W (Fig. 6) on 27 and 28 March. Just a few harp seals, mainly groups of males, were observed outside the whelping patches.

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Table 1. East-west transects (spaced 1 nautical mile apart) flown during a fixed-wing photographic survey of the hooded seal whelping concentration Patch A in the Greenland
Sea on 24 March 2005 (positions = deg.,min.). The photo-numbers on each transect and total numbers of photos are given.

Transect	Start		End	Photo num.		
	Latitude N	Longitude W	Longitude W	Start	End	Total
1	71,09	17,54	17,20	5000	5062	62
2	71,10	17,19	17,29	5063	5081	19
3	71,11	17,23	17,38	5082	5103	22
4	71,12	17,15	17,22	5104	5118	15
5	71,13	17,19	17,10	5119	5135	17
6	71,14	17,10	17,18	5136	5149	14
7	71,15	17,22	17,10	5150	5173	24
8	71,16	17,11	17,20	5174	5191	18
9	71,17	17,19	17,09	5192	5210	19
10	71,18	16,59	17,12	5211	5233	23
11	71,19	17,10	16,56	5234	5257	24
12	71,20	16,53	17,10	5258	5287	30
13	71,21	17,03	16,52	5288	5308	21
14	71,22	16,52	17,03	5309	5329	21
15	71,23	17,00	16,53	5330	5342	13
Total						342

Table 2. East-west transects (spaced 1 nautical mile apart) flown during a fixed-wing photographic survey of the hooded seal whelping concentration Patch B in the Greenland
Sea on 24 March 2005 (positions = deg.,min.). The photo-numbers on each transect and total numbers of photos are given.

Transect	Start		End	Photo num.		
	Latitude N	Longitude W	Longitude W	Start	End	Total

51	71,26	17,52	17,39	0	15	15
52	71,27	17,44	17,57	16	33	18
53	71,28	17,53	17,33	34	60	27
54	71,29	17,40	17,54	61	78	18
55	71,30	17,44	17,32	79	94	16
56	71,31	17,34	17,48	95	111	17
57	71,32	17,31	17,10	112	137	26
58	71,33	17,11	17,29	138	157	20
59	71,34	17,09	17,00	158	167	10
Total						167

Table 3. East-west transects (spaced 1 nautical mile apart) flown during a fixed-wing photographic survey of the hooded seal whelping concentration Patch C in the Greenland
Sea on 24 March 2005 (positions = deg.,min.).The photo-numbers on each transect and total numbers of photos are given.

Transect		Start	End	Photo num.		
	Latitude N	Longitude W	Longitude W	Start	End	Total
71	71,40	16,14	15,46	168	201	34
72	71,41	15,57	16,13	202	221	20
73	71,42	15,59	15,45	222	239	18
74	71,43	15,45	16,09	240	268	29
75	71,44	16,06	15,41	269	302	34
76	71,45	15,41	16,44	303	332	30
77	71,46	16,03	15,40	333	362	30
78	71,47	15,43	16,07	363	391	29
79	71,48	16,06	15,40	392	427	36
80	71,49	15,40	16,10	428	463	36
81	71,50	16,12	15,36	464	510	47
82	71,51	15,23	16,47	524	576	53
83	71,52	16,30	15,37	577	608	32
84	71,53	15,38	16,13	609	635	27
85	71,54	15,49	15,36	636	650	15
Total						470

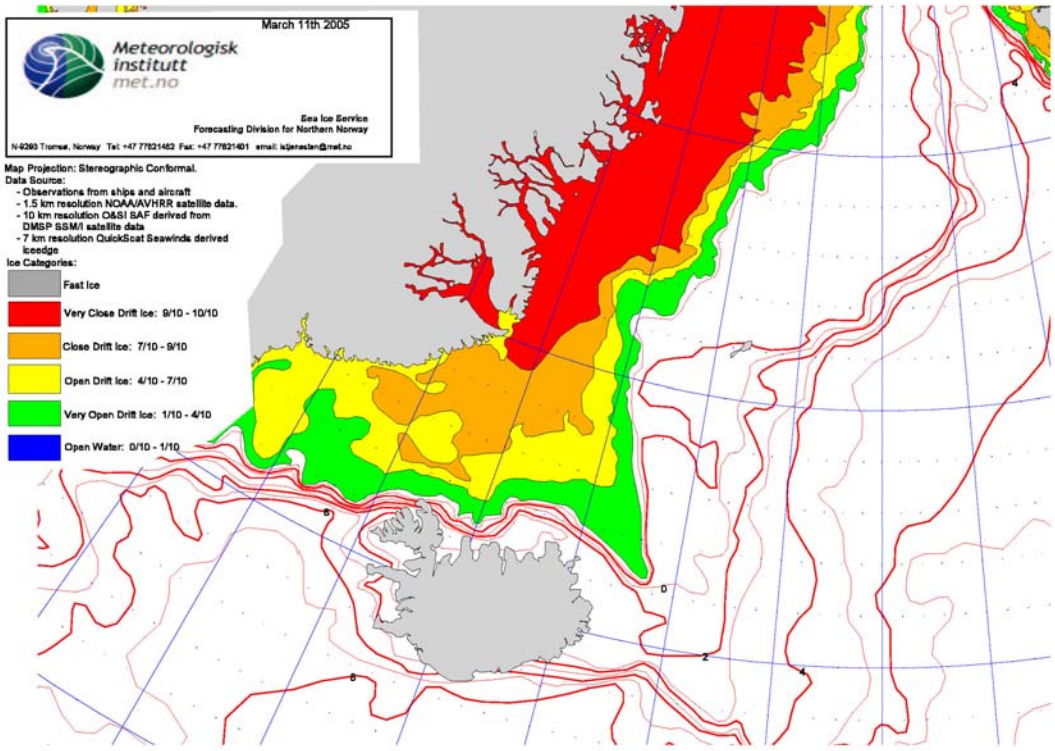

Fig. 1. Drift ice distribution on 11 March 2005 in the Greenland Sea.

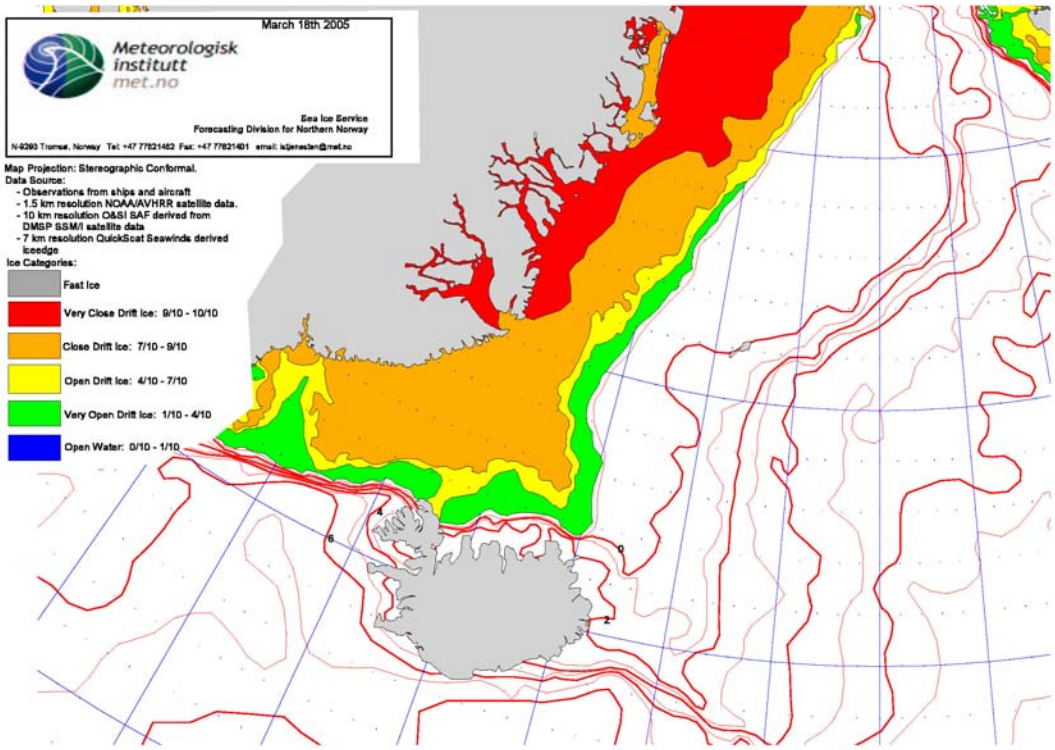

Fig. 2. Drift ice distribution on 18 March 2005 in the Greenland Sea.

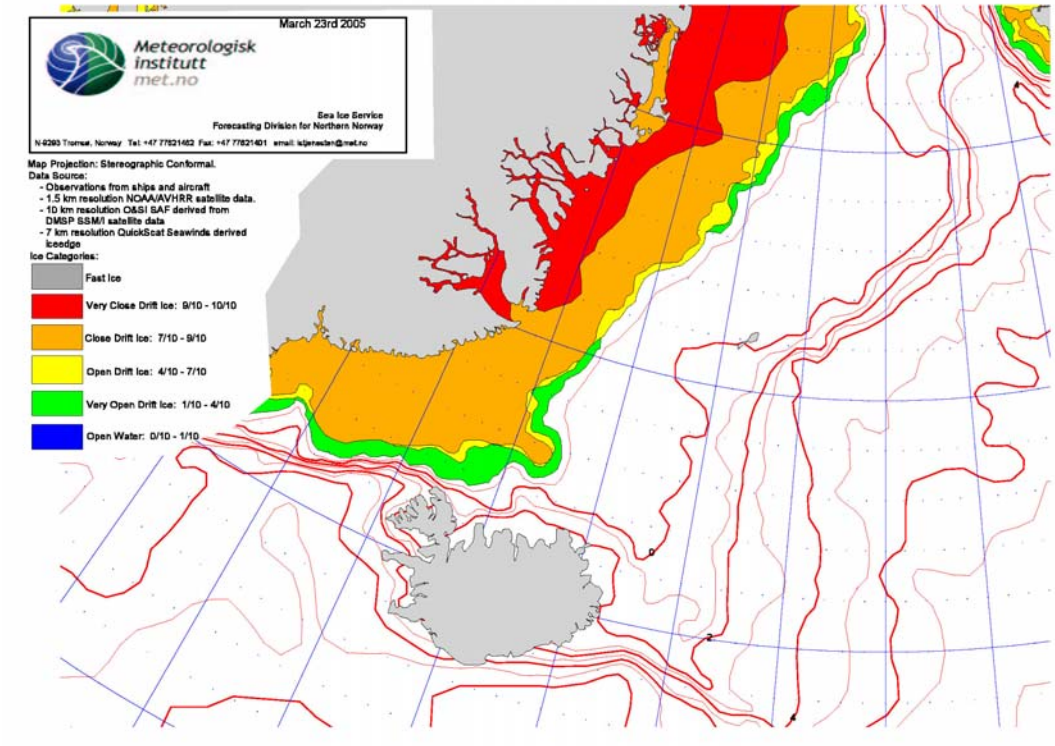

Fig. 3. Drift ice distribution on 23 March 2005 in the Greenland Sea.

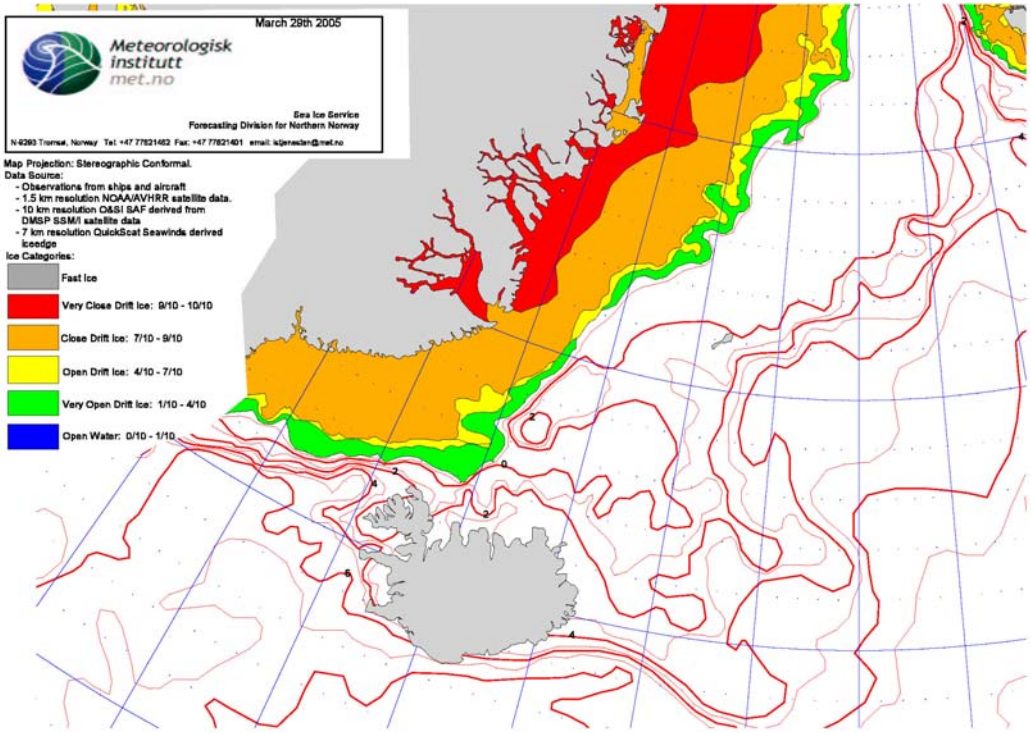

Fig. 4. Drift ice distribution on 29 March 2005 in the Greenland Sea.

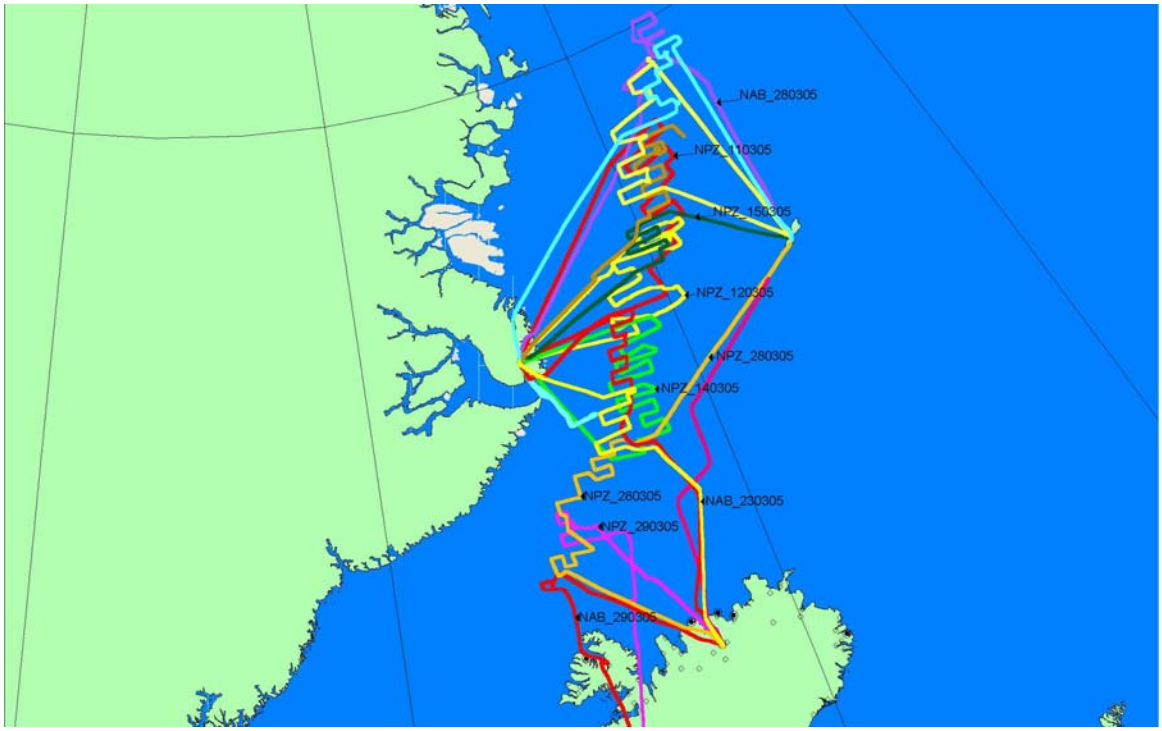

Fig. 5. Reconnaissance surveys conducted by using the fixed-wing aircrafts LN-NPZ and LN-NAB over the drift ice in the Greenland Sea during the period 11-29 March 2005.

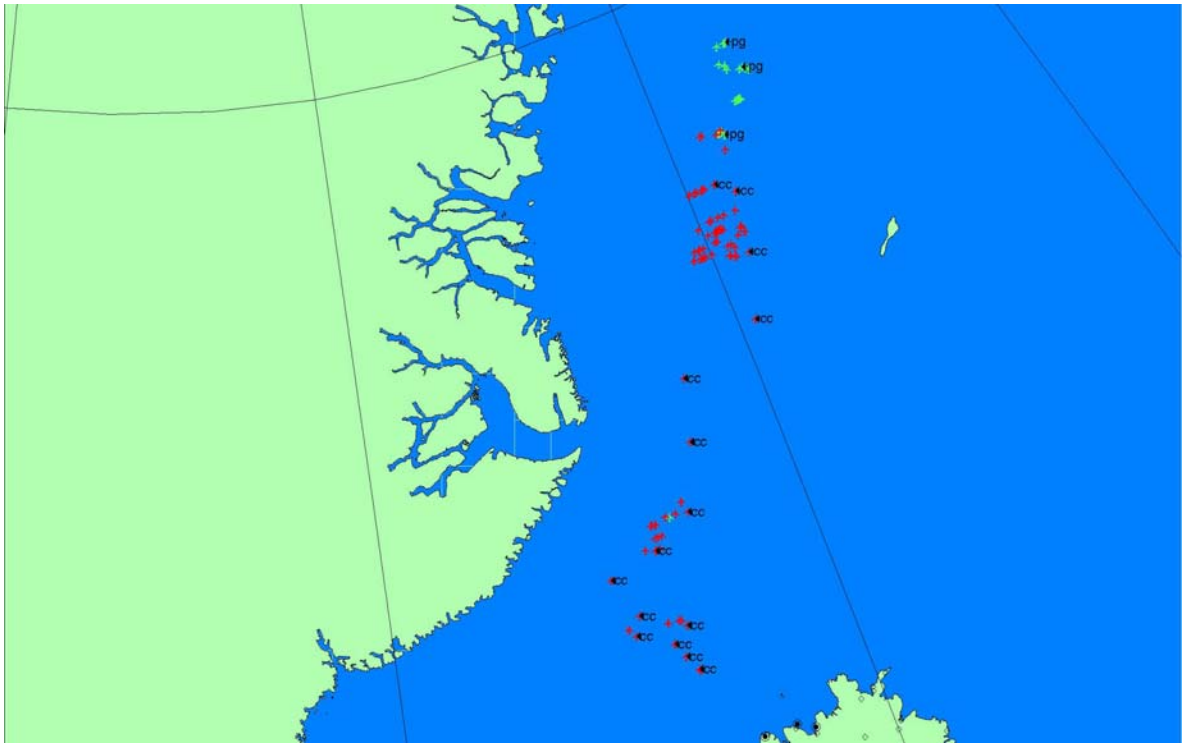

Fig. 6. Observations (1 or >1) of hooded (cc, red) and harp seals (pg, green) obtained during fixed-wing reconnaissance surveys over the drift ice in the Greenland Sea during the period 11-29 March 2005. Observations during the photographic surveyson 24 March are not included.

Fig. 7. Fixed-wing photographic surveys covering the hooded seal whelping patches A, B and C (from south to north) conducted on 24 March 2005.

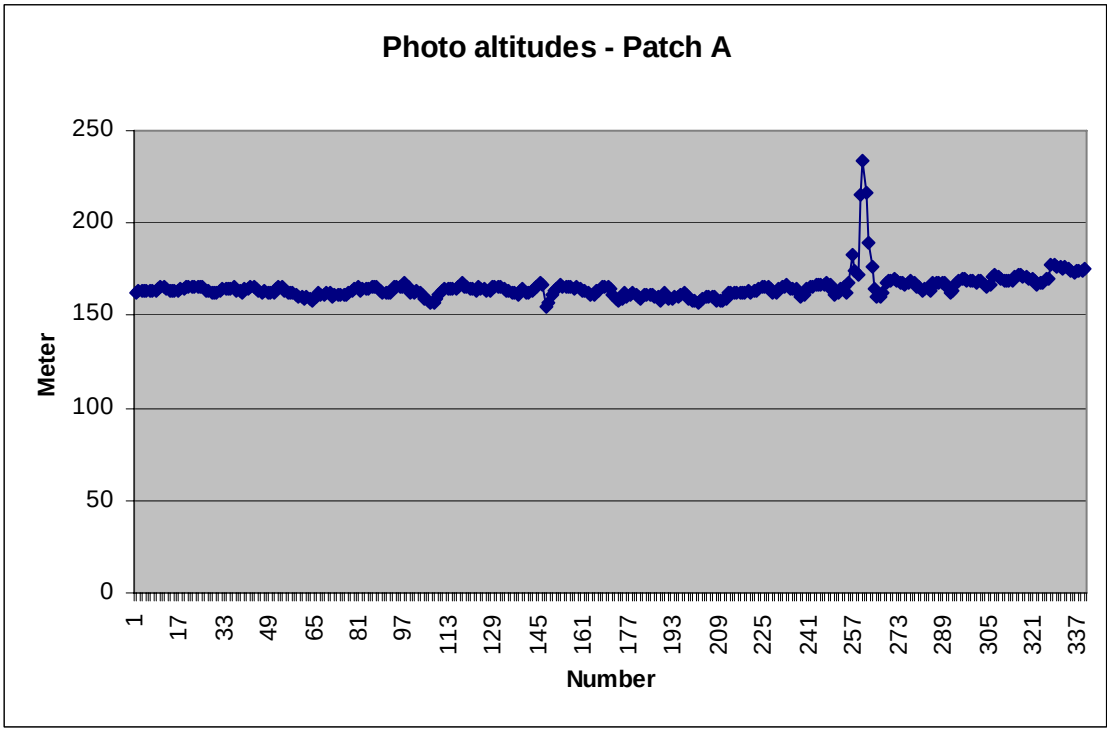

Fig. 8. Recorded and corrected photo altidudes along the transect lines at whelping Patch A.

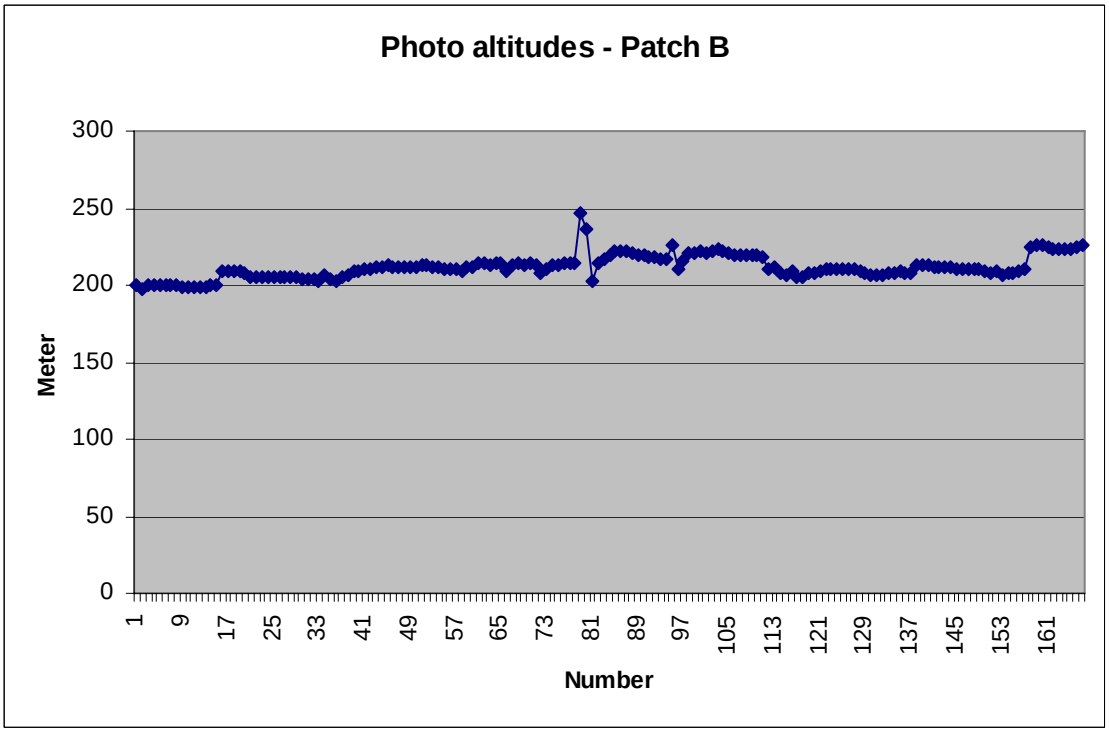

Fig. 9. Recorded and corrected photo altidudes along the transect lines at whelping Patch B.

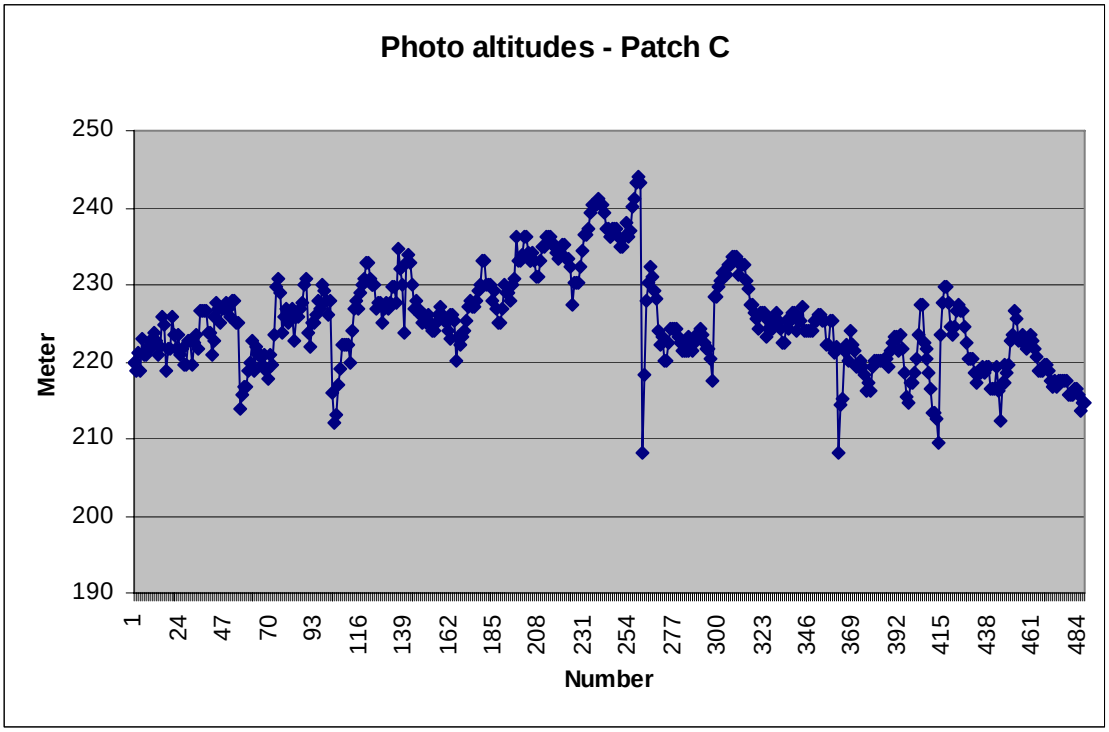

Fig. 10. Recorded and corrected photo altidudes along the transect lines at whelping Patch C.