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An estimate of the fraction of belugas (*Delphinapterus leucas*) in the Canadian high Arctic that winter in West Greenland

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Abstract Five belugas, or white whales (*Delphinapterus leucas*), were tracked by satellite from Creswell Bay, Somerset Island, in the Canadian high Arctic towards West Greenland in autumn 2001. After 1 October, three of the whales stayed in the North Water polynya and the other two whales moved to West Greenland. One of the whales that moved to Greenland migrated south along the west coast, following a route and timing similar to another beluga tracked in 1996. The belugas that moved towards West Greenland from Canada did so before or near 1 October. The movements of both these whales followed a similar timing and assumed migratory route of belugas hunted in autumn in West Greenland. In Greenland, the hunt begins in September, where the first whales are taken in the northernmost community of Qaanaaq. Hunting takes place farther south in Upernavik in October, and finally in November and December, belugas are taken even farther south in Uummannaq and Disko Bay. The whales that remain in the North Water after 1 October most likely do not contribute to the harvest in West Greenland. Based on the total number of belugas satellite-tracked in Canada between 1995 and 2001 with tags that lasted beyond 1 October, approximately 0.15 (95% CI 0.06–0.35; $n=26$) of the summering stock of belugas in the Canadian high Arctic move to West Greenland for the winter. Genetic studies have indicated that belugas moving east through Lancaster Sound are significantly differentiated from belugas taken in the autumn hunt in West Greenland. These conflicting results suggest molecular genetics cannot be solely relied on to reveal the stock identity of these belugas.

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Introduction

Historically, it has been assumed that the majority of belugas, or white whales (*Delphinapterus leucas*), summering in the Canadian high Arctic move to West Greenland for the winter. It has been proposed that only a small proportion remain in the North Water polynya (referred to here as the "North Water"), situated at the entrance to Smith Sound between Northwest Greenland and the northeastern Canadian high Arctic (Vibe 1967; Finley and Renaud 1980; Reeves and Mitchell 1987; Richard et al. 1998a). However, results from recent satellite-tracking studies of belugas have revealed that a large number of tagged belugas actually remain in the North Water, long after the major migratory pulse arrives in West Greenland (Richard et al. 2001a).

The seasonal timing of beluga catches and observations of beluga arrival in hunting areas in West Greenland suggest that a large pulse of whales arrive in the northernmost municipalities of Qaanaaq in late September and Upernavik in early October. Whales appear to be passing through these areas throughout October, and arrive farther south in the Disko Bay area in November (Heide-Jørgensen 1994). Furthermore, belugas are frequently seen and caught from

January to March south of Disko Bay, and are only occasionally seen south of 65°N. Visual observations and catches indicate that belugas remain between Maniitsoq and Disko Island until mid-May, after which they move north. Belugas are occasionally taken along the ice edge in Upernavik in spring, supporting the idea of this northward movement.

Satellite telemetry, genetic studies and organochlorine analyses show belugas have strong site fidelity to certain fjords, estuaries and wintering grounds (O'Corry-Growe et al. 1997, 2002; Richard et al. 2001a; de March et al. 2002; Innes et al. 2002a, 2002b; Palsbøll et al. 2002). To date, two different beluga wintering grounds have been identified in the Baffin Bay region: one in Central West Greenland between Maniitsoq and Disko Island, and the other in the North Water. A large decline in beluga abundance was detected in the area between Maniitsoq and Disko Island between 1981 and 1999 (Heide-Jørgensen and Acquarone 2002). The cause of the decline has been attributed to unsustainable beluga hunting in West Greenland (Butterworth et al. 2002; Innes and Stewart 2002). No data are available to detect changes in population abundance in the North Water, where only limited hunting takes place (Richard et al. 1998a).

There is a need to develop catch levels, which can be applied to abundance estimates, to adjust catches to sustainable levels or levels that would allow a recovery of the depleted beluga stock in West Greenland (cf. Butterworth et al. 2002; Innes and Stewart 2002; Sejersen 2002). It is important to know from which locality a harvested stock of a migratory animal originates, and also what fraction of the source population is subjected to a hunt (or multiple hunts in different areas). Belugas follow strict spatial and temporal patterns of movements and display a high degree of site fidelity to seasonal habitats. Because of these tendencies, beluga stock or sub-population discreteness must be evaluated on a small geographical scale. This study presents results of satellite-tracking studies of belugas in the Canadian high Arctic from August 2001 to February 2002, and links relevant evidence on movement patterns to population discreteness within Canada and Greenland. Additionally, an estimate of the fraction of belugas from the Canadian high Arctic that move to West Greenland for the winter is calculated, based on satellite-tracking studies conducted between 1995 and 2001 (Richard et al. 1998b, 2001a; present study).

Materials and methods

Satellite tracking

Six belugas were live captured at Creswell Bay, Somerset Island, Canada (Fig. 1) in August 2001 using hoop nets (cf. Orr et al. 2001). The whales were instrumented with satellite-linked radio-transmitters attached to the dorsal ridge with stainless-steel wires and either 6-mm nylon pins or 5-mm titanium rods (see Table 1 for specifications). The satellite transmitters (SPOT1 and SPOT2, Wildlife Computers, Redmond, Wash.) provided geographic positions of the whales and were either programmed to transmit on the 5th, 15th and 25th day of each month, or to transmit every 4 days. Data from the transmitters were collected via the ARGOS system (Service Argos 1989; Harris et al. 1990). Only good-quality positions were used in the analysis. Positions from ARGOS were examined visually and dates of passage between different landmarks or geographic coordinates were compiled. The data were compared to departure and passage dates for specific localities from other satellite-tracking data collected from belugas tagged in the Canadian high Arctic in 1995 and 1996 (Richard et al. 1998b, 2001a).

Harvest statistics

Statistics on monthly distribution of catches of belugas in West Greenland were obtained from the Directorate of Hunting and Fisheries under the Greenland Home Rule (Piniarneq 1993–2000). Direct observations of catches and reports collected from hunters were extracted from unpublished reports (Greenland Institute of Natural Resources, Nuuk). Catches were examined on a monthly scale, and peaks for each of the regions where belugas were taken in Greenland were identified. These data were compared to the temporal scale of the migratory path taken by the belugas that travelled to Greenland.

Data analysis

The probability that a beluga moved to West Greenland for the winter (or stayed in the North Water) was assumed to be binomially distributed where $\hat{p}$ was the proportion of whales moving to West Greenland with standard deviation

$$\mathrm{sd}(\hat{p}) = \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$

Confidence limits (95%) were calculated by log-odds transformation where:

$$\hat{P}_{lower} = \frac{\hat{p}}{\hat{p} + (1-\hat{p}) * C}$$

and

$$\hat{P}_{upper} = \frac{\hat{p}}{(\hat{p} + (1-\hat{p}))/C}$$

where

$$C = \exp\left[\frac{1.96 * sd(\hat{p})}{(\hat{p}(1-\hat{p}))}\right]$$

(Burnham et al. 1987)

Table 1 List of instrumented belugas in Creswell Bay, 2001. Transmitter 7931 was programmed to transmit every 4 days and all other tags were programmed to transmit on the 5th, 15th and 25th day of each month

Animal ID	Date in August 2001	Sex	Length (cm)	Fluke width (cm)	Colour	Last day with positions
7931	8	Male	320	–	Grey	1 February
20160	8	Male	370	–	White	15 October
20688	10	Female	373	79	White	5 November
20689	10	Male	325	68	Grey	5 October
20693	10	Female	375	90	White	15 August
26712	14	Female	390	89	White	15 October

Results

Belugas in 2001–2002

Between 8 and 14 August, six belugas were tagged at Creswell Bay (Somerset Island) on the west side of Prince Regent Inlet. All whales immediately left the area and travelled to Peel Sound or Barrow Strait, where they headed east towards Lancaster Sound as late as 25 August (Figs. 1, 2). They continued in this direction to the end of September. At this time, four of the remaining five whales were either in the eastern part of Lancaster Sound moving north along the east coast of Devon Island, or had reached Jones Sound (Figs. 2, 3). The whales with the latest departure date from Lancaster Sound were the last to arrive in Jones Sound (arrival on 5 October), and one whale remained in Barrow Strait longer than the others (20688).

Of the five whales that provided positions beyond 1 October, three (7931, 20160, 26712, Fig. 2) reached the coast of Northwest Greenland (north of 76°N) at approximately 76°N, 72°W between 2 and 5 October 2001. One of these whales (26712) remained in Northwest Greenland until 15 October, while a second whale (20160) was further southeast in Melville Bay, West Greenland at approximately 75°N, 61°W on 5 October. The third whale (7931) provided more detailed movements along the West Greenland coast because the tag was programmed to give positions every 4 days and batteries had greater longevity. Between 2 and 12 October 2001, this whale travelled close to the coast of the Qaanaaq and Upernavik municipalities (Fig. 3) and stayed in the northern part of Upernavik (> 74°N) until 1 November. Between early November to mid-December, it frequented coastal areas of southern Upernavik (between 72° and 74°N). It passed offshore of Uummannaq municipality by mid-December, and reached the entrance to Vaigat Strait on 28 December. It continued south offshore of Disko Island and approached the coast of West Greenland south of Disko Bay in mid-January. Finally, the beluga reached its southernmost position on 24 January, just north of the town of Sisimiut. From there, it moved northwest until contact was lost in early February 2002.

Timing of catches in West Greenland

According to catch statistics based on catches of 4,807 belugas collected between 1993 and 2000, catches show a pronounced peak in October in Upernavik, after a broader catch period farther north in Qaanaaq between September and October (Fig. 4). Catches in Uummannaq are concentrated in November and in Disko Bay, and farther south, peaks appear in November and April.

The range of dates of the first and last autumn catches of belugas in Upernavik (based on data from jaw collections, hunters, or other observations) show a clear temporal pattern. No catches occur before 28 September, and most catches take place during the 1st week of October (Fig. 5). This suggests whales are taken as they move south from Qaanaaq.

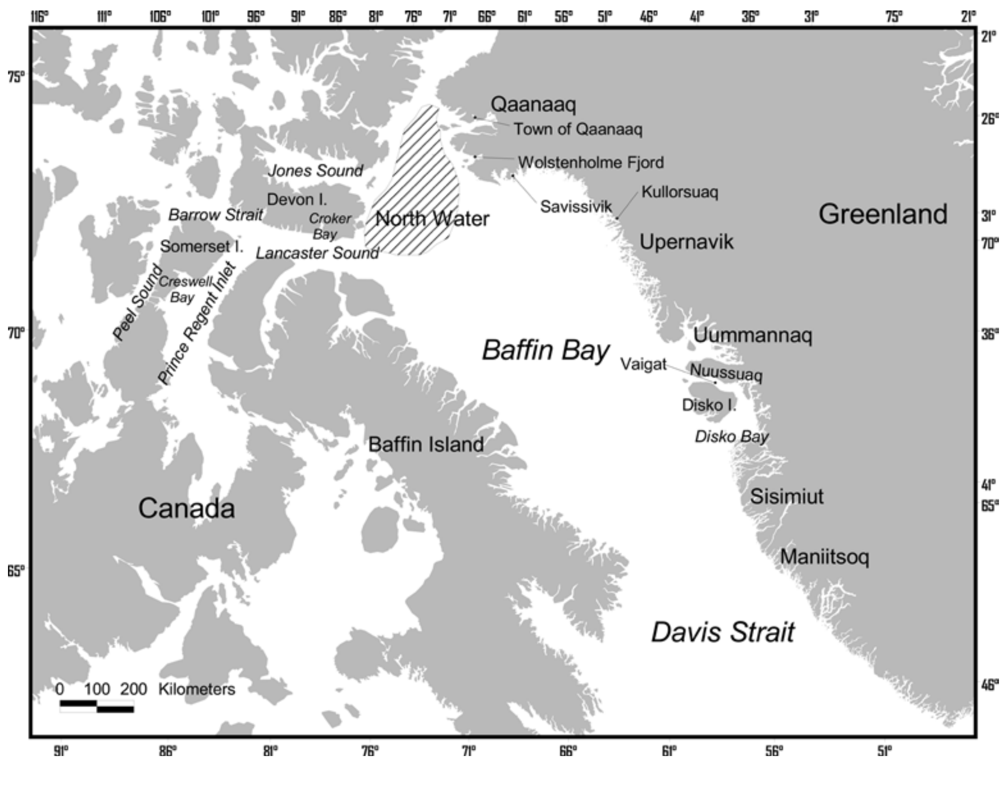

Fig. 1 Map of localities mentioned in the text and the location of the North Water polynya

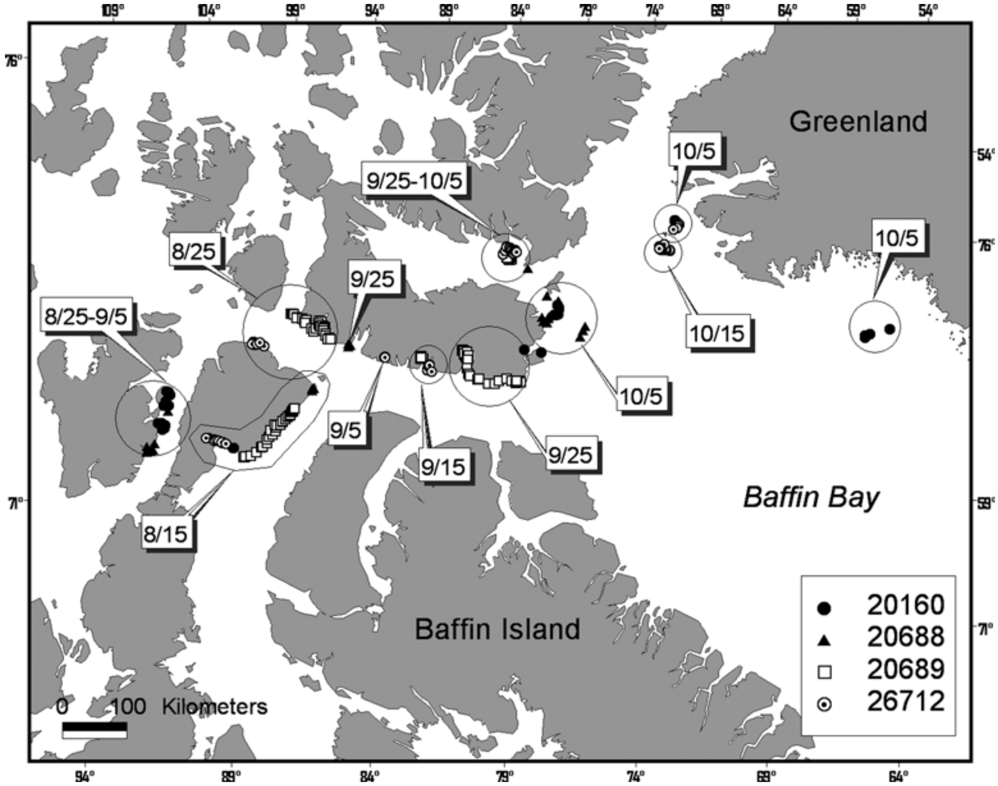

Fig. 2 Geographic positions of four belugas satellite tracked from Creswell Bay, Somerset Island, 2001. All whales were tagged in August. Whale 26712 is included in the fraction of whales that were considered to remain in the North Water in the winter because the whale did not reach West Greenland (south of 76°N) by early October. Whale 20160 was included in the fraction that move to West Greenland because it left the North Water and travelled east before early October

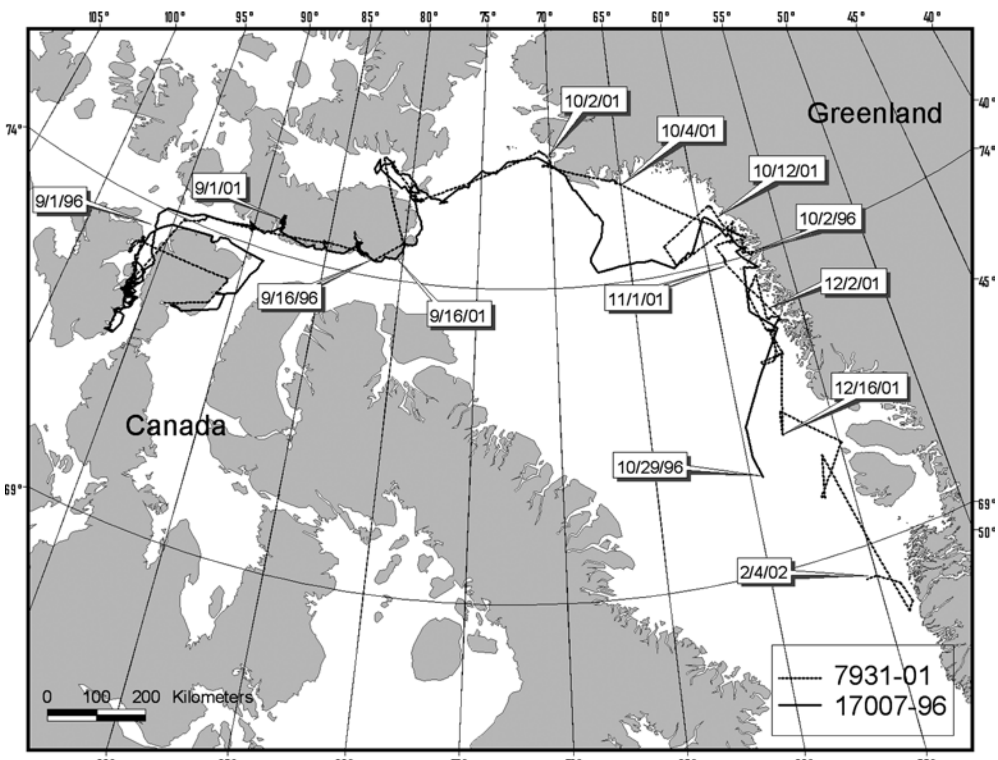

Fig. 3 Tracklines of beluga 7931 tagged in 2001 (present study) and whale 17007 tagged in 1996 (results reported in Richard et al. 2001a). The total distance travelled for whale 7931 was 8,679 km when distances between all positions between 8 August 2001 and 4 February 2002 were used, 4,814 km when only good-quality positions ($LC > 0$) were used for the same time period, and 4,037 km when average daily positions were used. Whale 17007 travelled 17,748 km between 22 July and 30 October (100 days) when all position qualities were considered and 5,160 km when only good-quality positions ($LC > 0$) were used for the same time period

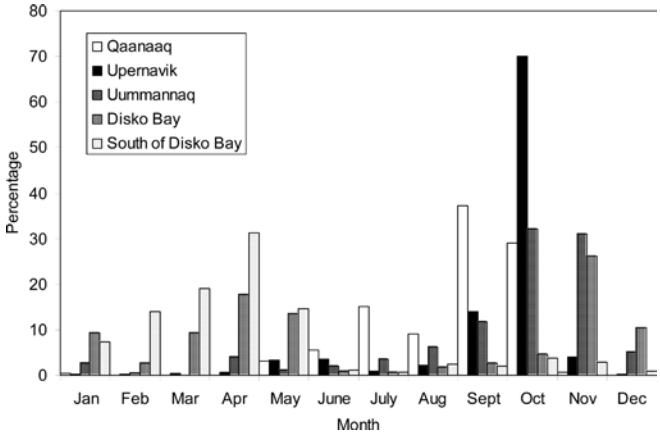

Fig. 4 Distribution of reported beluga catches by month in West Greenland between 1993 and 2000 ($n = 4{,}807$). Catches were reported for the municipalities of Qaanaaq, Upernavik, Uummannaq, Disko Bay, and south of Disko Bay (Piniarneq 1993–2000)

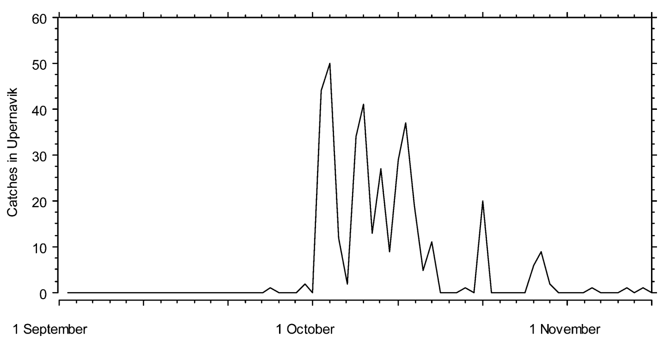

Fig. 5 Peak period of catches of belugas from direct observations of date and number of whales killed in Upernavik 1989–1999

Review of previous autumn tracking of belugas from Canada to Greenland

Approximately 33 belugas have been satellite-tracked in the Canadian high Arctic during 4 studies at 4 different localities between 1995 and 2001. Six of the 33 whales failed to provide positions beyond 1 October (the date after which belugas are expected to reach the West Greenland coast, based on the occurrence of belugas in the coastal hunt), and were excluded from the analysis. The remaining 26 tags, used in this analysis, provided positions well into October (beyond 10 October), with 5 tags lasting at least into November.

In mid-September 1995, six belugas were instrumented on the south coast of Devon Island (Croker Bay) and tracked for several months. They remained in the North Water from mid-October to mid-November, when contact was lost (Richard et al. 1998b). In early September 1996, nine belugas were tagged in Croker Bay and tracked to the North Water. None of the whales moved towards Northwest Greenland (i.e. passed 73°W) even though they were tracked for several weeks after 1 October (tags stopped between 16 October and 18 November; Richard et al. 2001a).

In mid-July 1996, 12 belugas were tagged in 3 different estuaries around Somerset Island (Cunningham Inlet, Elwin Bay, and Creswell Bay). Seven tags provided positions after 1 October (Richard et al. 2001a). Six of the seven whales stayed in the North Water area until contact was lost between 12 October and 28 November. The last remaining whale (17007) moved east on 23 September and reached the Greenland coast south of Wolstenholme Fjord on 25 September (Fig. 3). Around 2 October, it approached the northernmost settlement (Kullorsuaq) in Upernavik and followed a route and timing that were both similar to the movements of the belugas tracked in the present study, and similar to the sequence of hunting events in West Greenland. The last locations from this whale were obtained on 29 October when it was offshore of Disko Island, Greenland (Fig. 3).

The belugas tracked in our study closely followed the migratory schedule observed during previous tracking studies; the whales moved to Peel Sound in mid-August, left Lancaster Sound in mid-September, and moved north into Jones Sound in late September (Tables 2, 3). The tracks indicate that whales can apparently be segregated into two groups in the second half of September: some whales head towards the banks off Jones Sound, and others continue towards Northwest Greenland, where they appear in early October.

Fraction of Canadian high-Arctic belugas that move to West Greenland

Of the 26 beluga tags that lasted beyond 1 October, 4 individuals reached the West Greenland coast (south of 76°N) around 5 October, and 22 individuals stayed in the North Water. All four whales that went to Greenland were tagged in Creswell Bay, on Somerset Island. Of the 22 that stayed in the North Water, 8 (1995: 2, 1996: 5, 2001: 1) gave positions in this area well into November, indicating there was not a delayed migration from the North Water to West Greenland. Therefore, it can be assumed that the belugas that stayed in the North Water in November also stayed there during the winter. When results from all 3 years were combined, the fraction of whales that moved to West Greenland was 0.15 (95% CI 0.06–0.35).

Discussion

The departure of belugas from the central Canadian high Arctic follows a regular schedule that has apparently not changed much over the past century. Based on aerial surveys, Koski et al. (2002) found that most belugas left Lancaster Sound in mid-September in the 1970s. A similar timing was also observed at Croker Bay in 1934, where the beluga hunting peaked between 20 and 22 September (Reeves and Mitchell 1987).

Table 2 Details on the travel distances, duration of tracking and the arrival at certain positions for 5 whales tracked in 2001. Data were compared to averages of the 6 whales tracked in 1995 (Richard et al. 1998b) and the 20 whales tracked in 1996 (Richard et al. 2001a). *NA* indicates "not applicable" and *dashes* indicate that the whales did not move to those localities or the tags stopped transmitting. Dates are in Julian days after 1 January

	1995		1996		2001				
Whale ID	Females	Males	Females	Males	7931M	20160M	20688F	20689M	26712F
Travel distance (km)	1554–2661	2258–2761	1245–4599	191–5160	4814	1477	1434	985	1146
Duration of tracking (days)	32–49	32–54	40–99	2–106	184	68	87	56	62
Speed (km/day)	54	61	46	52	26	22	16	18	18
Enter Lancaster Sound (89°W)	NA	NA	253	245	244–247	258–268	268–278	237–247	237–247
Exit Lancaster Sound (80°W)	266	262	259	258	258–268	258–269	268–278	258	258–268
Arrival Jones Sound (> 75°N, 81°W)	262	266	262	267	267–271	268	268–278	268–278	268–278
Arrival West Greenland (73°W)	–	–	–	268	275	278–288	–	–	278–288
Arrival Upernavik (74°30′N-57°30’W)	–	–	–	276	285	–	–	–	–
Passing Nuussuaq (70°45′N)	–	–	–	271	362	–	–	–	–

Table 3 An overview of results from satellite-tracking studies of belugas in the Canadian high Arctic, 1995–2001. Tagging at Somerset Island includes three estuaries: Creswell Bay, Cunningham Inlet and Elwin Bay

Localities and years	*n*	*n* with contact after 1 October	Last dates with contact after 1 October	Number in West Greenland/North Water	Reference
Croker Bay 1995	6	6	16 October–10 November	0/6	Richard et al. (1998b)
Somerset Island 1996	12	7	12 October–28 November	1/6	Richard et al. (2001a)
Croker Bay 1996	9	8	19 October–18 November	0/8	Richard et al. (2001a)
Creswell Bay 2001	6	5	5 October–February 2002	3/2	This study
Total	33	26		4/22	

The timing of the autumn movements of belugas in Northwest and West Greenland also follows a regular pattern. Beluga whales arrive and are hunted in the municipality of Qaanaaq (either at the settlements of Qaanaaq or Savissivik) in late September (usually around 20 September in Qaanaaq and 25 September in Savissivik) (Heide-Jørgensen 1994). The settlements of northern Upernavik take their first belugas around 28 September, and catches peaked in this area in the first 2 weeks of October during the 1990s. Catches farther south in Uummannaq and Disko Bay occur in November and December, and belugas are taken in winter and spring south of Disko Bay.

The whale that was tracked in this study through February 2002, was located near the West Greenland communities during times that are consistent with knowledge on beluga phenology obtained from catch statistics, aerial surveys and observations. The whale arrived in northern Upernavik exactly when autumn catches peak, and also in the very same area where the majority of the catches took place during the 1980s and 1990s. In January, the whale was found outside Disko Island at the same time when belugas are hunted in this area. In February, the beluga appeared in the same concentration area where multi-annual surveys have been conducted for trends in beluga abundance (Heide-Jørgensen et al. 1993; Heide-Jørgensen and Reeves 1996; Heide-Jørgensen and Acquarone 2002). The track of the whale in this study was consistent with that from the beluga tracked from Creswell Bay between July and November 1996 (Richard et al. 2001a).

Satellite-tracking studies of belugas were conducted in three estuaries in the Canadian high Arctic (Creswell Bay, Elwin Bay, Cunningham Inlet); however, only whales tagged at Creswell Bay moved to West Greenland. Based on these results, there appears to be some segregation within the beluga population in Canada and, possibly, within a single summering locality. Tagging at Devon Island (Croker Bay) in September most likely included whales from all summering grounds around Somerset Island (including the three estuaries above), and possibly even localities where tagging studies have not yet been conducted. This is because the general pattern is such that most whales (from all areas around Somerset Island) move out through Lancaster Sound and pass this area in September, visiting Croker Bay (Richard et al. 2001a). It should also be noted that the two belugas that went to West Greenland passed Croker Bay on 15 September, the peak time of the capture operations at this locality. Thus the autumn tagging at Croker Bay is likely a random sample, which constituted more than half of the whales in this study.

Current knowledge on molecular genetics of high-Arctic belugas shows that belugas from Lancaster Sound are significantly different from those caught in West Greenland (Upernavik and Disko Bay) based on mitochondrial DNA haplotype distribution (de March et al. 2002). This contradicts the evidence presented here collected by satellite tracking of known individuals moving between the two areas. An overall genetic difference was also reported for belugas between Creswell Bay and West Greenland in 1996 (where the beluga that moved from Creswell Bay to West Greenland was included in the genetic analysis reported by de March et al. 2002); however, a difference was not found for samples taken in Creswell Bay in 1993. No whales were tagged in that year. In both 1996 and 2001, the satellite-tagged whales visited several West Greenland beluga hunting grounds. These results question how clearly genetic studies can discriminate between wintering stocks of belugas that summer in the same area. One explanation, suggested by Palsbøll et al. (2002), is that due to the nature of the genetic sampling programs, genetic studies are more likely to discriminate pods of related whales, rather than stocks in different areas. The samples for genetic studies are often collected from harvest events, where whales from the same pod are killed. Consequently, there is a high risk of obtaining samples from related individuals. This same sampling bias may be true for whales from satellite-tagging studies at a specific site; however, in many harvest situations, entire pods of a single family unit are sampled for genetic studies, which results in a higher degree of interrelatedness than individual whales that are live captured over a period of days in estuaries.

Regardless of sample size, the satellite tracks presented here provide direct evidence that there is a link between the belugas summering in the Canadian high Artic and those in the West Greenland wintering area. Therefore, to assess the contribution of the summering population to the hunted West Greenland winter stock, it seems more effective to examine the probability that whales from a single summering ground move to one of two wintering grounds. This is especially important in situations (like the present) where most hunting occurs in the wintering area. Satellite tracking provides an opportunity for direct estimation of movement probability, and pooling tracks from several years (and localities if justified) can augment sample size. Our estimate of 0.15 (4/26) of the belugas from the Canadian high Arctic moving to West Greenland for the winter updates the estimate of 0.04 (1/21) based on earlier tracking studies with smaller sample sizes (Richard et al. 1998b, 2001a). It is important to note the percentage of whales moving to West Greenland can be variable. None of the whales from the two Devon Island studies moved to Greenland, yet as many as two-thirds of the whales from Creswell Bay in 2001 did. This variability stresses the need for additional studies to elucidate the inter-annual and inter-region differences in movement probability. If the 2001–2002 data alone had been used to calculate a fraction, as many as 60% would have been estimated to move to Greenland.

Only 4 of the 26 whales that were tracked after 1 October could have been subjected to hunting in West Greenland in October or later. If the remaining 22 belugas were available for the Greenland hunt, they would have had to move east later in the season (i.e. in December) after contact was lost. Although such a late movement of belugas from the Canadian high Arctic cannot be entirely excluded, it is highly unlikely. The geographic positions where contact was lost were in an area where belugas are known to occur and most likely remain in winter. Heavy pack ice surrounds the North Water polynya from December to May (Canadian Ice Service 2002), and belugas have not been found outside this area from March to May, except for the coastal open-water areas in West Greenland and some coastal leads in Lancaster Sound (Heide-Jørgensen and Reeves 1996; Heide-Jørgensen and Acquarone 2002). Furthermore, the belugas that were tracked through November did not suggest a secondary pulse of whales moving to Greenland. Thus, there is presently little support for the idea of additional whales moving to Greenland beyond those that leave in October.

Another possibility that could explain the results presented here is that the belugas may alternate between wintering grounds. This possibility is considered unlikely because monodontids are creatures of habit, with extreme site fidelity to their selected summering and wintering grounds in the Arctic (O'Corry-Growe et al. 2002). Additionally, comparisons of organochlorine profiles in the blubber of belugas caught in Jones Sound (probably North Water animals) and in Upernavik-Disko Bay (West Greenland animals), corrected for age and sex differences, have revealed significant differences in the relative composition of organochlorine contaminants between the two areas, which indicates whales are segregated during the winter season (Innes et al. 2002a).

The most recent estimate of beluga abundance in the Canadian high Arctic is 21,213 whales (SE 5,359) in 1996, corrected for the proportion of whales submerged (availability bias) and those missed by the observers (perception bias) (Innes et al. 2002b). Using the fraction of whales that move to West Greenland (0.15, $n=26$), the actual number wintering in West Greenland can be derived by resampling the lognormal distribution of the population size and the binomial fraction $(\hat{p})$ that move to Greenland and taking their product. Repeating this procedure 1,000 times provides mean abundance estimates of 3,156 (95% C.L.: 643–7,334) belugas wintering in West Greenland, and 18,057 (95% C.L.: 13,879–20,570) belugas wintering in the North Water and adjacent areas.

The wintering stock of belugas in West Greenland was estimated to be 7,941 (95% CI 3,650–17,278) in 1998–1999 (Heide-Jørgensen and Acquarone 2002). This wintering stock is approximately 37% of the estimate of the summer population in the Canadian high Arctic (Innes et al. 2002b), and implies that 13,000 whales winter in the North Water and adjacent areas. Both methods of estimating the number of whales in the North Water indicate that substantially more belugas winter in the North Water than what was estimated from reconnaissance surveys in the area. Finley and Renaud (1980) and Richard et al. (1998a) gave counts of approximately 500 whales at the surface in leads and cracks in the North Water in winters 1978 and 1994, respectively. These figures were not corrected for whales that were submerged and overlooked by the observers, which could be a factor of 5–6 times the numbers reported (cf. Heide-Jørgensen and Acquarone 2002). Furthermore, the estimates do not include numbers of whales from unsurveyed areas. Recent evidence of ice entrapments in northern Baffin Bay (Heide-Jørgensen et al. 2002) indicate that belugas also occur in shore leads in Lancaster Sound and Jones Sound, and perhaps in other areas adjacent to the North Water. The figures for the population sizes presented above are both associated with considerable uncertainty and if the range of the uncertainty is considered, the expected number of whales wintering in the two areas, derived from the fraction that move to West Greenland, does not deviate from the abundance estimates.

Regardless of the uncertainty about population size or the specific fraction of belugas that move to West Greenland, it appears that less than 50% of the total beluga population in the Canadian high Arctic winter in West Greenland, based on a combination of satellite telemetry, genetic and organochlorine data. Most of these whales may winter in the North Water or use leads in Lancaster Sound, which have not been adequately covered by past surveys. Belugas are creatures of habit, following strict migratory patterns with strong fidelity to certain areas despite being intensively hunted at these localities. The estimated fraction that moved to West Greenland based on the studies reported here may be an artefact of the decrease in winter abundance in West Greenland, and may not reflect the natural equilibrium between the fraction wintering in West Greenland and the fraction in the North Water. A natural equilibrium could possibly be close to 50% wintering in Greenland, or even higher, since the beluga abundance in West Greenland historically was substantially higher than that observed today (Butterworth et al. 2002).

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