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2002

Rune Dietz
Jonas Teilmann
National Environmental Research Institute

Mads-Peter Heide Jørgensen
Mikkel Villum Jensen
Greenland Institute of Natural Resources

Data sheet

Title:	Satellite tracking of Humpback whales in West Greenland
Authors:	Rune Dietz[1], Jonas Teilmann[1], Mads-Peter Heide Jørgensen[2], Mikkel Villum Jensen[2]
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Abstract:	In June 2000, 6 humpback whales (*Megaptere novaeangliae*) were tagged with satellite transmitters off West Greenland. Contact remained for up to 42 days. The tagging revealed that within the month of June, humpback whales off West Greenland moved between Fiskenæs Banke, Fyllas Banke, Tovqussaq Banke, Sukkertop Banke and Lille Hellefiske Banke. The whales showed a preference for the continental slopes with depths less than 200 m, however, few dives were recorded down to 500 m. The whales had a preference for dives lasting 7-8 min. (15%) and no dives lasted longer than 15 min.
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Summary

Tagging and longevity information

The tagging of six humpback whales (*Megaptere novaeangliae*) off West Greenland was conducted in June 2000. Data were obtained from the tagged whales over a period from 0 to 42 days (Mean = 12.5 days; n = 6), whereas locations were only obtained during 0 to 17 days (Mean = 6.2 days; n = 6). The four whales from which positions were obtained were tracked for a total of 1,042 kilometres. The tagging revealed that humpback whales off West Greenland within the month of June, as a minimum, can move between Fiskenæs Banke, Fyllas Banke, Tovqussaq Banke, Sukkertop Banke and up to Lille Hellefiske Banke. The whales showed a preference for the continental slopes with depths less than 200 m. The whales may travel up to 120 nautical miles (220 km) from the shores to water deeper than 1,000 m, and they may also visit the Central West Greenland fiord systems.

Depth of dives

The humpback whales primarily are at the surface during the middle of the day, where they spend as much as 83.3 % of the time in the upper 8 m of the water column. This means that noon is the optimal time to count humpback whales off West Greenland during the summer season (June - July). It was documented that the humpback whales use the majority of their time in the upper 4 m (36.7 %) and 4-20 m (24.5 %). The dive categories 20-35, 35-50, 50-100, 100-150, 150-200 and 200-300 m were frequented from 3.0 to 7.5 % of the time, whereas the humpback seldom dived to 300-400 m (0.27 %) and 400-500 m's (0.035 %) depth. No recordings were registered deeper than 500 m.

Dive duration

The length of the dives confirmed the preference for shallow feeding of the humpback whales. Most of the dives (22 %) were recorded in the category of dives lasting less than a minute, representing animals staying close to the surface. The one-minute dive duration intervals between 1 and 7 min represented from 6 to 14 % of the dives and most dives were recorded at a length of 7-8 min. (15 %). Dives of 8-9 min. were less common (5 %) and dives longer than 9 min. were rare (<1 %). No dives lasted longer than 15 min. The average dive duration of the 667 recorded dives was 3.8 min.

Use of the drilling and license area

Two of the tracked whales provided positions within the Fylla licence area but less than 10 % of the positions were obtained within this area. The closest position to Qulleq-1 was 24.3 NM, which means that chances for direct encounter with the drill ship was remote. The exploration drilling was carried out on 1,152 m water depth, an area of little or no importance for the feeding of the humpback whales, as no dives below 500 m were recorded. None of the transmitters provided positions beyond the starting day of "West Navions" drilling. From the literature only few sightings have been recorded outside the banks within the license area. This condition is supported by the fact that the West Greenland humpback whales showed a preference for shallow water for their feeding, as 93 % of their time was used at depths shallower than 200 m. In addition the whales observed in this study and in previous studies have mainly shown a

preference for the landward slopes of the banks. This means that the banks will reduce noise generated from activities further offshore.

Conclusion

The fact that the humpback whales have been tracked to and re-sighted at other banks along the Greenland west coast, means that the whales have alternatives to the Tovqussaq and Fyllas Banke if they are disturbed. The summering areas in Greenland must be regarded as a critical habitat as the whales are building up their blubber deposits which they are dependant on during the rest of the year, where they are not feeding.

Imaqarnersiornera

Nalunaaqutsersuineq malittarineqarnerisalu sivisussusiannik paasissutissat

Qipoqqaat arfinillit (Megaptere novaeangliae) Kitaata imartaani 2000-mi junip qaammataata ingerlanerani nalunaaqutserneqarput. Qippoqqarnit nalunaaqutserneqarsimasunit paasissutissat ullut 0-42-t tikillugit pissarsiarineqarsinnaasimapput. (Agguaqatigiissillugu = ullut 12,5; n = 6), sumiissusialli taamaallat ullut 0-17-nit ingerlaneranni (Agguaqatigiissillugu ullut = 6,2; n = 6). Qipoqqaat sisamat sumiissusersiorlugit katillugit 1042 kilometerini malittarineqarsinnaasimapput. Nalunaaqutsersuinerup ersersippaa Kitaani qipoqqaat junip qaammataani minnerpaamik Fiskenæs Bankip, Fyllas Bankip, Tovqussaq Bankip, Sukkertop Bankip Lille Hellefiske Bankillu akornanni ingerlaartartut. Qipoqqaat immap naqqata sivingarngi 200 meterinik itinerunngitsut najorumanerugaat takuneqarsinnaavoq. Qipoqqaat 120 sømilit (220 km) angullugu sinerissamit avasissuseqarlutik imaq 1000 meterit sinnerlugit itissuseqartoq tikillugu ingerlaarsinnaasarput, Kitaatalu qiterpiaani kangerlunniissinnaasarlutik.

Aqqartarnerisa itissusiat

Qipoqqaat ullup qeqqata nalaani immap qaatungaaniinnerusarput piffissap annersaa (83,3 %) immap qaavani 8 meterinik ititigisumiikkajuttarlutik. Taamaattumik Kitaani aasaanerani (juni-juli) ullup qeqqata nalaa qipoqqarnik kisitsiffigissallugu pitsaanerpaajuvoq. Uppernarsineqarsimavoq piffissap annersaani qipoqqaat immap qaatungaa 4 meterinik (36,7 %) aammalu 4-20 meterinik (24,5 %) itissuseqartoq najortaraat. Itissutsit assigiinngitsut, tassa 20-35, 35-50, 50-100, 100-150, 150-200 aamma 200-300 meteri piffissap 3,0-7,5 % akornanni aqqartarput, qaqutigullu qipoqqaat 300-400 m (0,27 %) aamma 400-500 m (0,035 %) aqqartarlutik. Itissuseq 500 meteri sinnerlugu nalunaarsuinerup nalaani aqqartarsimanngillat.

Aqqartarnerisa sivisussusiat

Aqqartarnerisa sivisussusiisa uppernarsarpaat qipoqqat immap qaatungaani annertunerusumik nerisassarsiortarnerat. Piffissap sivisunersaani (22 %) aqqaamasarneri minutti ataaseq inorlugu sivisussuseqartarput, taamaattumik nalunarani uumasut immap qaatungaaniinnerusartut. Aqqaamanerit minutsimik ataatsimik sivisussuseqartut minutsip ataatsip minutsillu arfineq marluk akornanni sivisussuseqartut ataatsimut katillugit 6-14 %-it akornanniipput aqqaamanerisalu amerlanersaat minutsinik 7-8-nik (15 %) sivisussuseqarput. Aqqaamanerit minutsinik 8-9-nik sivisussuseqartut ikinnerupput (5 %) aqqaamanerillu minutsit 9-at sinnerlugit sivisussuseqartut qaqutigoorlutik (<1 %). Minutsit 15-it sinnerlugit aqqaamasoqarsimanngilaq. Aqqaamanerit nalunaarsorneqarsimasut 667-sut agguaqatigiissillugu 3,8 minutsinik sivisussuseqarsimapput.

Qilleriffiup uuliasiorfigineqartullu iluaniinnerat

Qipoqqaat marluk Fyllami uuliasiornermut akuersissuteqarfiusup iluaniissimasut takuneqarsinnaavoq, sumiiffiisali 10 %-ii inorlugit akuersissuteqarfiusup iluani pissarsiarineqarsimallutik. Putumut qilleriffiusumut, Qulleq-1-mut sumiissusiisa qaninnersaat tassaasimavoq 24,3 sømilit, taamaattumillu umiarsuarmut

qillerivimmut anngunnissaat ungasiarluni. Uuliasiorluni qillerineq imaani 1152 meterinik itissuseqartumi ingerlanneqarsimavoq, najukkami qipoqqarnut neriniartunut pingaaruteqarpianngitsumi, kiisalu 500 meterit sinnerlugit itisigisumi aqqaamasoqartarsimanngilaq. „West Navion" qillerilluni aallartimmat qipoqqarnik eqqaaniittoqarsimanngilaq. Nalunaarusiat allat tunngavigalugit akuersissuteqarfiusup iluani qipoqqarnik ikittuinnarnik takunnittoqartarsimavoq. Tamannalu tupinnanngilaq, tassami Kitaani qipoqqaat neriniarlutik immami ikkattumiikkusunnerusarmata, soorlu piffissap 93 %-ata iluani imaani 200 meterit inorlugit itissusilimiittarsimanerat ilisimaneqarpoq. Kiisalu misissuinermi uani misissuinernilu siuliini paasineqarsimavoq ikkannerit sivingarngi nunavimmut sammisut najorusunnerusaraat. Taamaattumik sivingarngit avataani qillerinermi pisorpaluk ikkannerit annikillisassavaat.

Naliliineq

Qipoqqaat Kitaata sineriani malittarineqarsinnaanerisa ikkannersuarnilu allani nassareeqqinneqarsinnaanerisa ersersippaat akornusersorneqaraangamik Toqqusaq Fyllas Bankillu saniatigut allanut qimaaffissaqartut. Kalaallit Nunaanni aasaanerani najortagaat pingaartorujussuusutut isigisariaqarput, tassami ukiup sinnerani nerisassaqannginnerminni atugassaminnik orsuqalersaramik. Neriniarnerisalu nalaani akornusersorneqartillutik neriniarnerminnut atatillugu Kalaallit Nunaata imartaaniinnertik qanoq sivitsorsinnaatigineraat erseqqissumik oqaatigineqarsinnaanngilaq.

Resumé

I juni 2000 blev seks pukkelhvaler (Megaptere novaeangliae) mærket med satelllitsendere i Vestgrønland udfor Nuuk. Dykkedata blev modtaget fra de mærkede hvaler i henholdsvis 0, 2, 7, 7, 17 og 42 dage (middel = 12,5 dage), mens positioner kun blev modtaget i henholdsvis 0, 0, 1, 5, 14 og 17 dage (middel = 6,2 dage). De fire hvaler hvor positioner blev modtaget blev fulgt over ialt 1042 km. Mærkningerne viste at pukkelhvaler fra Vestgrønland i juni måned som minimum svømmer mellem Fiskenæs Banke, Fyllas Banke, Tovqussaq Banke, Sukkertop Banke og op til Lille Hellefiske Banke. Hvalerne viste en præference for kontinental skrænterne på dybder under 200 m. Hvalerne viste sig at svømme op til 220 km fra kysterne til områder med dybder på mere end 1000 m, og opholdt sig også i de vestgrønlandske fjordsystemer.

Dykkedybder

Pukkelhvalerne var primært ved overfladen midt på dagen hvor de brugte helt op til 83 % af deres tid i de øverste 8 m af vandsøjlen. Det betyder at midt på dagen er det optimale tidspunkt at tælle og observere pukkelhvaler om sommeren (juni-juli) i Vestgrønland. Studiet viste også at pukkelhvaler generelt bruger mest tid i de øverste 4 m (37 %) og på dybder mellem 4-20 m (25 %). Hvalerne befandt sig i dybdekategorierne 20-35, 35-50, 50-100, 100-150, 150-200 and 200-300 m fra 3,0 til 7,5 % af tiden, mens hvalerne sjældent dykkede til dybder på 300-400 m (0,27 %) og 400-500 m (0,035 %). Der blev ikke registreret nogen dyk dybere end 500 m.

Dykketider

Der er en god sammenhæng mellem varigheden af pukkelhvalernes dyk og dykkenes dybde. De fleste dyk (22 %) varede mellem 0-1 minut. Disse dyk optræder typisk når hvalen befinder sig nær overfladen for at trække vejret. I et minuts intervallerne fra 1 til 7 minutter faldt andelen støt fra 14 til 6 %, mens der skete en kraftig forøgelse af antallet af dyk på 7-8 min (15 %). Dyk på 8-9 min var mindre almindelige (5 %) og dyk på mere end 9 min var yderst sjældne (<1 %). Det længste dyk blev registreret i intervallet 12-15 min. Den gennemsnitlige dykketid udfra 667 dyk var 3,8 min.

Hvalernes brug af bore- og licensområdet

To af de fulgte hvaler svømmede ind i Fylla licensområdet hvorfra ca. 10 % af positionerne blev modtaget. Ingen af hvalerne gav positioner efter prøveboringen fra "West Navion" fandt sted. Den tætteste position fra hvalerne var 45 km fra borestedet, Qulleq-1, hvilket, udefra de tilgængelige data, betyder at risikoen for direkte kontakt med boreskibet var lille. Prøveboringen fandt sted på 1152 m dybde, et område med lille interesse for hvalerne til fødesøgning, eftersom ingen dyk blev registreret over 500 m. Fra tidligere studier er der kun blevet set få pukkelhvaler undenfor bankerne i licensområdet. Dette understøttes af de hvaler der er fulgt i dette studie brugte 93 % af deres tid på dybder lavere end 200 m. Ydermere har pukkelhvalerne i dette og tidligere studier vist at de foretrækker den side af bankerne der vender ind mod land. Det betyder at bankerne til en vis grad vil reducere støj fra offshore aktiviteter på dybere vand længere vestpå.

Konklusion

Det er vist at pukkelhvalerne vandrer mellem bankerne langs Vestgrønland. Det betyder at hvalerne har alternative levesteder til Tovqussaq og Fyllas Banke hvis de skulle blive forstyrret af råstofaktiviteter. Hvalerne udnytter den specielle fødeadgang der findes langs Vestgrønlands banker, som derfor må betragtes som en kritisk habitat for pukkelhvalerne om sommeren. Dette skyldes ikke mindst at hvalerne opbygger deres energireserver som de tærer på hele vinteren hvor de ikke spiser.

1 Introduction

Environmental impacts

A description of the marine resources in the Fyllas Banke area as well as an assessment of the environmental impacts linked to oil exploration activities have been conducted by Mosbech *et al.* (1996; 1998). The humpback whale (*Megaptera novaenglia*) was identified as one of the species, where more research was needed in order to assess their vulnerability. It was also concluded that knowledge on the behaviour and response to seismic operations and offshore drilling in a disturbance context was needed dependent on the area and extent of the operations. The oil exploration drilling off Fyllas Banke in summer 2000 provided an opportunity to study the potential impact from the operation on the humpback whales summering off Fyllas Banke, West Greenland.

Hunting protection

The humpback whale was the second species to be classified as a protected stock by the International Whaling Commission in 1955 with prohibition of commercial (non-subsistence) hunting in the North Atlantic Ocean. The species have subsequently not been hunted except for a small subsistence harvest in Greenland of up to 10 per year until 1980 (Kapel 1979) and the last whale was taken in 1986.

Population size

The summer population of humpback whales off West Greenland is considered to be discrete (Katona & Beard 1990) and was estimated to approx. 387 individuals (SE = 24) based on observations from in 1988 to 1993 (Larsen & Hammond 2000). The total northern Atlantic stock of humpback whales was estimated to be within the range of 5,000 to 6,500 animals according to Klinowska & Cooke (1991). The most recent estimates of the total humpback whale population in North Atlantic based on data from 1992-1993 from both the breeding and feeding areas was 10,600 (95 % confidence interval 9,300-12,100) based on photographic identification and a very similar estimate 10,400 (95 % confidence interval 8,000-13,600) was obtained from the genetic identification (Smith *et al.* 1999). The species is still regarded as vulnerable despite signs of recovery under protection (Klinowska & Cooke 1991). According to the IUCN Red Data Book, the identification and protection of critical feeding and breeding habitats are needed to allow recovery to proceed unhindered.

Distribution

The available observations on marine mammals show that the humpback whale frequents the banks in West Greenland to feed every summer and autumn (Larsen & Hammond 2000). Humpback whales undertake substantial annual migrations. Photo-identification of fluke patterns have revealed a connection between the West Greenland and Newfoundland summering stocks as well as the wintering grounds in the Caribbean (Larsen 1991; Seton *et al*. 2001). In order to protect the humpback whales on their winter breeding grounds, Silver Banks, 150 km off the north coast of the Dominican Republic, was designated as a sanctuary in 1986 established by Presidential Decree (NOAA, NMFS 1989). There is also an unknown portion of the humpback whales, that remain in West Greenland year round, and it is unknown, why these animals decide to stay.

Satellite telemetry

Satellite telemetry has proven to be a powerful tool to study local habitat use, large scale migrations, stock abundance as well as behavioral and physiological parameters in Odontocetes (*e.g.* Dietz *et al.* 1995, 2001; Heide-Jørgensen *et al.* 1995, 2001a). In baleen whales this method is also becoming attractive as the tag longevity is increased (*e.g.* Mate *et al.* 1998, 1999; Heide- Jørgensen *et al.* 2001b).

Study objectives

The objectives of the present study were to 1) assess site fidelity in the Fyllas Banke area off West Greenland, where humpback whales congregate during the summer season, 2) collect information on foraging behaviour extrapolated from the dive patterns of the humpback whales, 3) examine the possible exchange among whales from different aggregations, and if possible 4) observe reactions and possible habituation to the noise from the drilling activity off the Fyllas Banke.

2 Materials and methods

2.1 The drilling operation

A 121,000 tons and 253 m long drill ship, the West Navion (Fig 2.1) drilled an offshore well "Qulleq-1" at 63º48'48'' N, 54º27'06'' W from 10 July to 4 September 2000 within the Fylla licence area lying between 63º - 64º30' N and 53º – 56º W (Christiansen *et al.* 2001).

The well was spudded in 1,152 m depth and reached a total depth at 2,973 m below the rotary table. The north-eastern part of the license area contains the southern part of Tovqussaq Banke and a minor part of the western side of Fyllas Banke. Part of this area is known to be part of the feeding ground for humback whales (Fig. 2.2). The majority (> 90 %) of the license area is deeper than 200 m and more than 60 % of the area has depths in excess of 1,000 m.

Figure 2.1. The 121,000 tons and 253 m long drill ship West Navion that operated at Qulleq-1 during summer 2000.

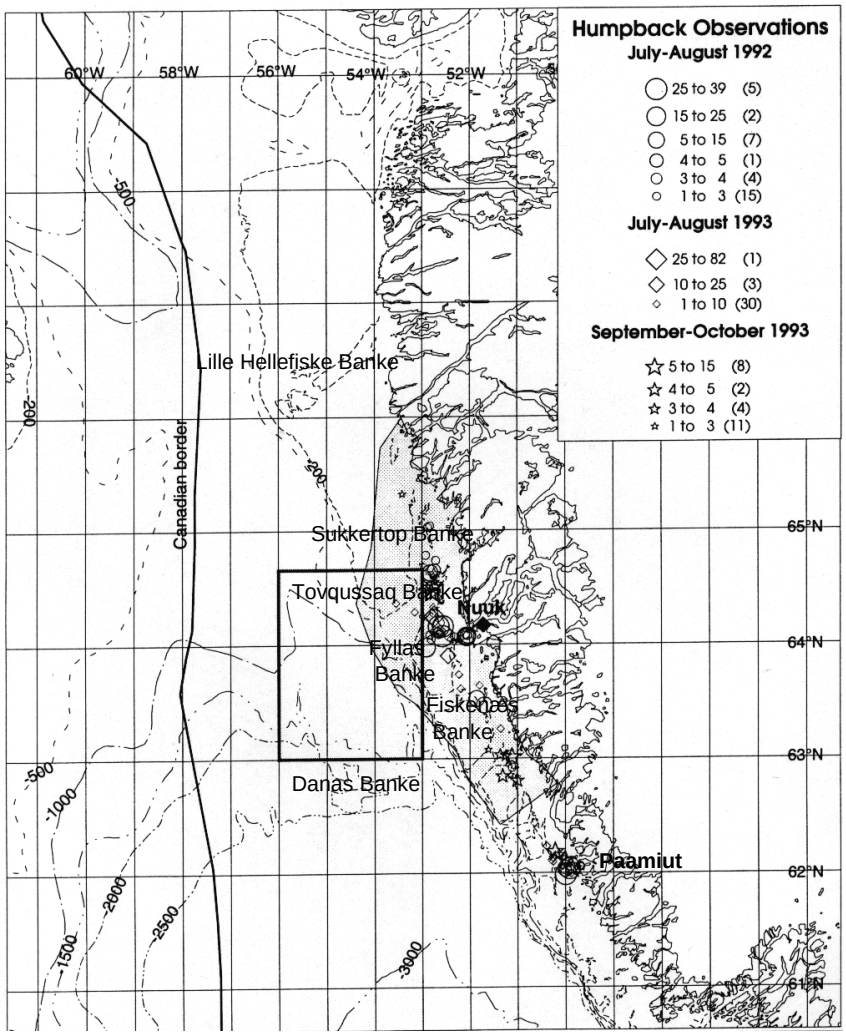

Figure 2.2. Observations of humpback whales based on data from Larsen *et al.* 2000. The square indicated the Fylla license area. The hatched area indicates possible zone of influence from seismic sound sources (Modified from Mosbech *et al.* 1996).

2.2 The field operation

2.2.1 Tagging of the whales

The field team operated from a 43 feet 39 Brt. vessel (m/s "Laurent") at the northeast slope of the Fyllas Banke, where large congregations of humpback whales are found during summer (Larsen & Hammond 2000). The operation took place from 2 to 14 June 2000. The tags were deployed from the stern of a MK II Zodiac powered by a 30 Hp engine. The whales were approached slowly to identify the whales by series of photos taken of the dorsal fin and if possible the ventral side of the fluke. A person secured with a harness at the stern of the inflatable deployed the transmitter with a 6.8 m aluminium pole (Ø 33 mm).

Figure 2.3. The transmitters were deployed on the humpbacks with an aluminium pole from the stern of an inflatable.

Eight transmitters were brought to the field but only six were deployed. One tag was lost during the tagging operation and another was malfunctioning and hence returned to the manufacturer.

Figure 2.4. The transmitters used for deployment on the humpback whales in West Greenland in June 2000.

The satellite transmitters (SDR-T16) were produced by Wildlife Computers (Redmond, Washington) and fitted with a harpoon spear for attachment. The transmitter had a length of 10 cm and a diameter of 2.5 cm. The attachment spear could be fitted to different lengths varying from 14.5 to 27.5 cm. A floating canister kept the tag buoyant if the tag were not deployed successfully in the skin of the whale.

2.2.2 Photo identification

In addition to the results from the satellite telemetry a number of other investigations were conducted. Photos of flukes and dorsal fins were taken of the ventral surface of the tail to identify the individual whales as described by e.g. Katona & Whitehead (1981) and Larsen (1991). The photos were taken from a distance of 10 to 100 m as the whales dived for food and raised their flukes in the air. The camera used was a motor driven Nikon D1 digital camera with a 28-200 mm zoom. In some cases photos were grabbed from a Sony DCR-TRV900E digital video camera. The individual whales have been identified from the pictures and will be compared with previous

records under the YONAH (Years of the North Atlantic Humpback Whales) program as well as the extensive North Atlantic Humpback Whale Catalogue (NAHWC) held at College of the Atlantic, USA (Seton *et al.* 2001).

Figure 2.5. Fluke patterns can be used to identify individual humpback whales.

2.2.3 Biopsy sampling

Biopsies were obtained from six whales during the tagging operation to be compared with previous studies on genetic identification and fingerprinting of the North Atlantic humpback whales. The samples were either obtained from a cork borer attached to the tagging pole or from a “Larsen Gun” specially designed for this purpose.

The six samples were sent to Conservation Genetics Laboratory, University of California, Berkeley, USA, where the genetic profile (i.e., the composite genotype across all six micro satellite loci) was analysed. The results were matched to the database which among other contains genetic profiles from 2,368 individual North Atlantic humpback whales typed at the same six loci.

Figure 2.6. A Larsen Gun for genetic identification obtained biopsy samples from individual humpback whales.

2.3 Satellite telemetry

The tags can be programmed by the users for type and resolution of data to be sampled, stored and transmitted. Data will be transmitted over the NOAA satellites using the Service ARGOS system. Positions will be determined by use of the Global Positioning Detection System (GPDS) where accuracy of up to 150 m can be obtained, if adequate uplinks are obtained during a satellite passage. By limiting the number of daily transmissions to 150 and 75 the tags were programmed to last for 67 and 134 days, respectively. Positions as well as dive behaviour were collected from all whales.

2.3.1 Service Argos System

The Service Argos System is on board five NOAA satellites. These satellites are sun synchronous polar orbiting satellites, which will make 14 orbits per day (24 hrs). The satellites travel in an altitude of 850 km and are in "view" for 9-12 minutes per passage. Hence the satellite coverage is latitude dependent, with the best coverage around the Poles. Each satellite contains facilities for receiving data like dive information as well as calculating positions based on the "Doppler Shift Principle". The accuracy of the calculated position is dependent on the number and time between the consecutive transmissions received during a satellite passage.

The data are downloaded to ground stations as the satellite passes over.

2.3.2 Data collection

Data on movements, diving behaviour and transmitter status were collected via the Argos Location Service Plus system (Toulouse, France; Fancy *et al.* 1988) and received on-line over the Internet and on CD-roms. The software program Satpak 3.0 (Wildlife Computers) was used for validating dive data received from Argos. Excel 97 was used for statistical analysis and graph presentations. MapInfo was used for mapping the movements of the tagged whales.

Argos divides the derived location quality (LC) in six classes B, A, 0, 1, 2 and 3, for which the average of the latitude and longitude 68th percentile errors predicted by Argos are as follows. LC 3: 150 m; LC 2: 350 m; LC 1: 1,000 m; LC 0, A, and B have no assigned precision. Results from four grey seals tagged in captivity with 500 mW transmitters (PTT 100; Microwave Telemetry Inc., Columbia, MD) have recently been published (Vincent *et al*. 2002). The following accuracy on latitude/longitude were obtained: LC 3: 15 m/295 m; LC 2: 259 m/485 m; LC 1: 494 m/1,021 m; LC 0: 2,271 m/3,308 m, LC A: 762 m/1,244 m and LC B: 4,596 m/7,214 m.

Data were stored in histograms including data aggregated in 6-hour periods and then relayed to the satellite during the following 24 hours. Three types of 6-hour histograms were sampled: (1) maximum depth for each dive, (2) duration of each dive, and (3) time spent in each depth interval (TAD). Data from these three categories were sampled and stored in 14 user-defined intervals. Intervals for type 1

were (m): 8-20, 20-35, 35-50, 50-100, 100-150, 150-200, 200-300, 300-400, 400-500, 500-600, 600-700, 700-800, 800-900 and >900. Intervals for type 2 were (min): 0-1, 1-2, 2-3, 3-4, 4-5, 5-6, 6-7, 7-8, 8-9, 9-12, 12-15, 15-18, 18-21, 21-24. Intervals for type 3 were (m): above water, 0-4, 4-20, 20-35, 35-50, 50-100, 100-150, 150-200, 200-300, 300-400, 400-500, 500-700, 700-900 and >900. The pressure transducer had a resolution of +/- 5 meter and an accuracy of +/- 0.5 % of the depth reading.

Two other types of information were transmitted in separate messages: status messages and timelines. The status messages included the maximum dive depth during the previous 24 hours and status of the sensors and battery performance. The timelines consisted of 72 twenty minutes periods (24 hrs). Each of these periods were assigned a “0”, if more than 50 % of the 20-minute period was spend above 8 m depth, and a “1” if more than 50 % was spend below 8 m. We define surface time (breathing, resting) as the time spent above 8 m depth. This may also represent the time where humpback whales are visible from aerial surveys. The timelines were sampled over 24 hours before transmitted to the satellite.

3 Results

3.1 Tagging and longevity information

Six humpback whales were tagged off West Greenland between 4 and 8 June 2000 on the eastern side of Fyllas Banke (Table 3.1). We obtained data from 0-42 days (mean = 12.5; n = 6) from the six tagged whales (Table 3.1). However, we only obtained locations from 0-17 days (mean = 6.2; n = 6). Positions were obtained from four whales, which were tracked for a total of 1,042 kilometres.

The poor performance of #21783 was probably due to a lack of loosening of the floating canister, as the whale swam off with the canister still attached to the transmitter. This may have prevented the saltwater switch from functioning and increased the drag resulting in premature loss of the tag. Another important factor is the position of the tag. A tag lying along the back of the whale or attached to low on the side of the body would not have the antennae pointing out of the water resulting in none or poor transmission.

The number of positions from the four whales that provided positions were quite limited. Of the obtained positions LC B, A and 0 with an 68 % in-accuracy between 762 to 7,214 m were dominant (86 %). Only four LC 1 positions were received (494 - 1,021 m) and no position of LC 2 and 3. The lack of a fair number of positions with high accuracy prohibited the calculation of reliable swimming speed.

Table 3.1. Summary on tagging numbers, date, positions, programming, tag longevity, number of transmissions and tracked distance.

Whale ID-N0	Tagging date	Tagging Position	Programmed Transm./day	Days with contact	Days with locations	Tracked distance (km)
20158	4.6.2000	64º05'N; 52º28'W	150	7	5	154
21783	4.6.2000	64º06'N; 52º29'W	150	0	0	-
20160	4.6.2000	64º06'N; 52º28'W	150	7	1	66
21809	8.6.2000	64º04'N; 52º19'W	75	2	0	-
21801	8.6.2000	64º04'N; 52º20'W	75	42	14	555
21802	8.6.2000	64º05'N; 52º21'W	75	17	17	267
			Total	75	37	1,042
			Average	12.5	6.2	174

Table 3.2. Summary on the number and quality of the obtained positions from the four whales from which positions were obtained.

Whale ID-N0	LC B positions	LC A positions	LC O positions	LC 1 positions	Sum
20158	3	2	0	2	7
20160	2	0	0	1	3
21801	8	2	0	0	10
21802	4	1	2	1	8
Total	17	5	2	4	28
Average	4.3	1.3	0.5	1.0	7.0

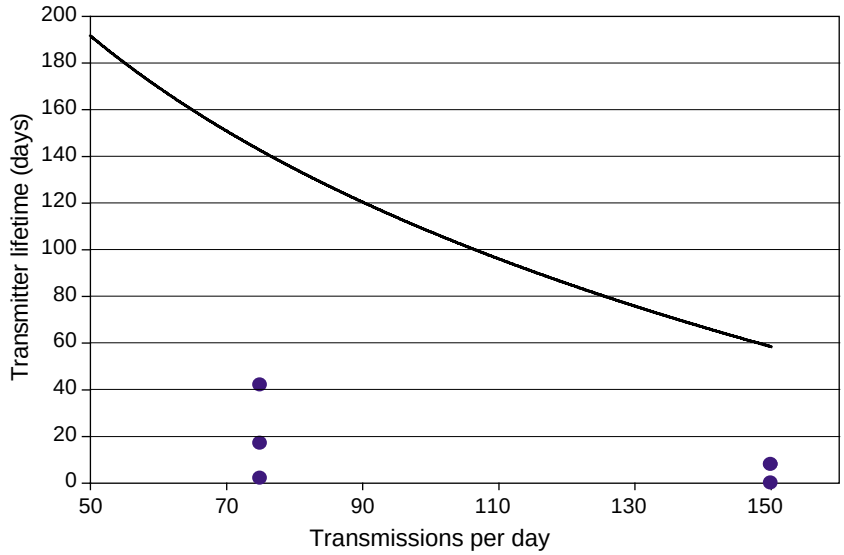

Figure 3.1. The programmed number of transmissions per day relative to the transmitter lifetime. The dots indicate actual lifetime of the six transmitters. The line indicates the theoretical lifetime of the transmitters based on laboratory tests of battery performance.

From Fig. 3.1. it is obvious that the duration of contact with the whales was significantly shorter than expected. The three transmitters transmitting 150 times per days were expected to provide 67 days of information but gave only 4.7 day on average (range 0 – 7 days). The other three transmitters programmed to 75 uplinks per day were expected to provide 134 days of information but gave only 20.3 days on average (range 2 – 42 days). This indicates that the transmitters either fell of, were mounted inappropriate for transmitting or had premature electronic failure.

3.2 Distribution and movements

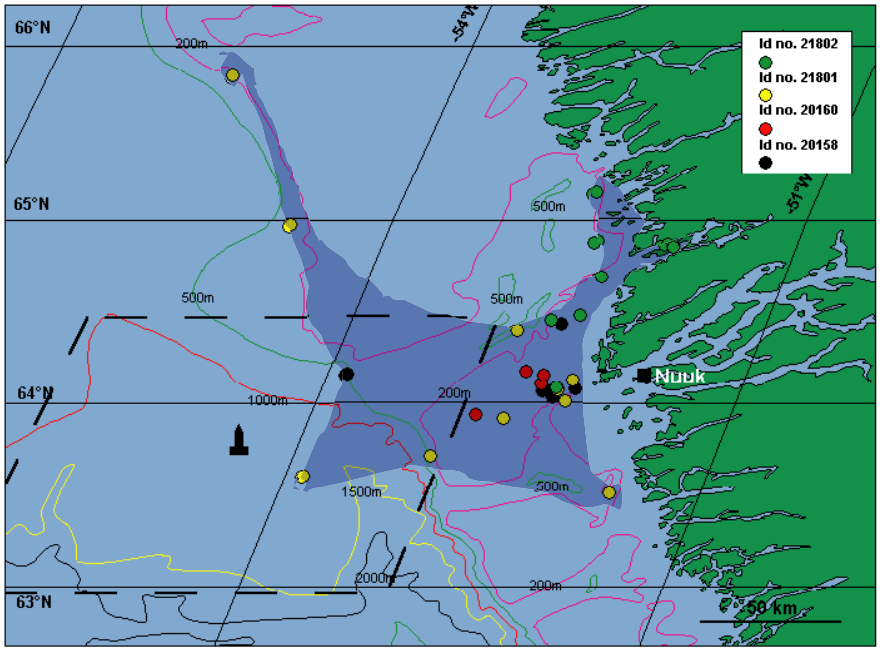

Figure 3.2. Positions of four of the tagged humpback whales tracked for at total of 1,042 km. The shaded area is showing the minimum convex polygon of the tagged humpback whales within the monitored period from 4 June to 20 July. The "tower" indicates the position of the spudded well "Qulleq-1", and the hatched square is the Fylla licence area.

As a minimum, the tagged humpback whales may have moved within the shaded area in Fig. 3.2. from 63°30′ to 65°49′ N; and from 51°40′ to 55°39′ W. This means that humpback whales during this season move between Fiskenæs Banke, Fyllas Banke, Tovqussaq Banke, Sukkertop Banke and up to Lille Hellefiske Banke (for place names see Fig 2.2.). The whales showed a preference for the continental shelf with depths less than 200 m. In addition some whales (including whales with re-sighted flukes) moved into the Central West Greenland fiord systems, and one whale moved as much as 220 km offshore to waters deeper than 1,000 m.

Whale #20158 was tagged on 4 June on the northeastern side of the Fyllas Banke at the inner part of Godthåb Dyb (Fig. 3.3.). From there it moved 37 km east along the 200 m isobath. The next position was obtained 44 km north 4 days later again close to the 200 m isobath now facing the Sukkertop Dyb. From there it moved out through the Sukkertop Dyb where the last position was obtained on 8 June over 500 m of water. The transmitter provided dive data for additional 3 days.

Whale #20160 was also tagged on 4 June on the north-eastern side of the Fyllas Banke (Fig. 3.4.). From there it migrated 66 km southwest over the bank where the last position was obtained on the very same day. Even though uplinks and dive data were obtained for another 7 days no more positions were obtained.

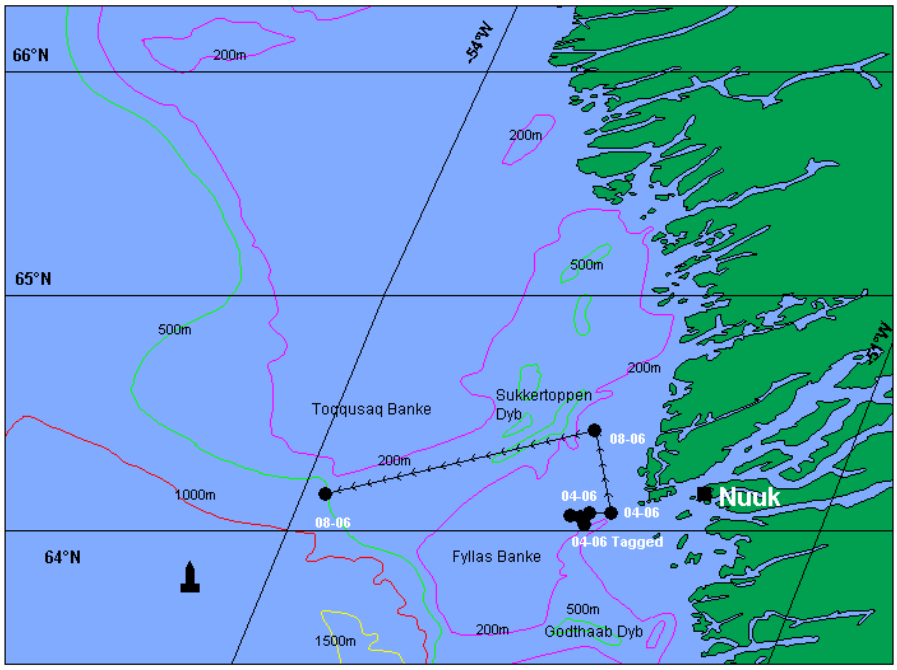

Figure 3.3. Movements of a tagged humpback whale (#20158), tracked for 154 km from 4 to 8 June 2000. The "tower" indicates the position of the spudded well "Qulleq-1".

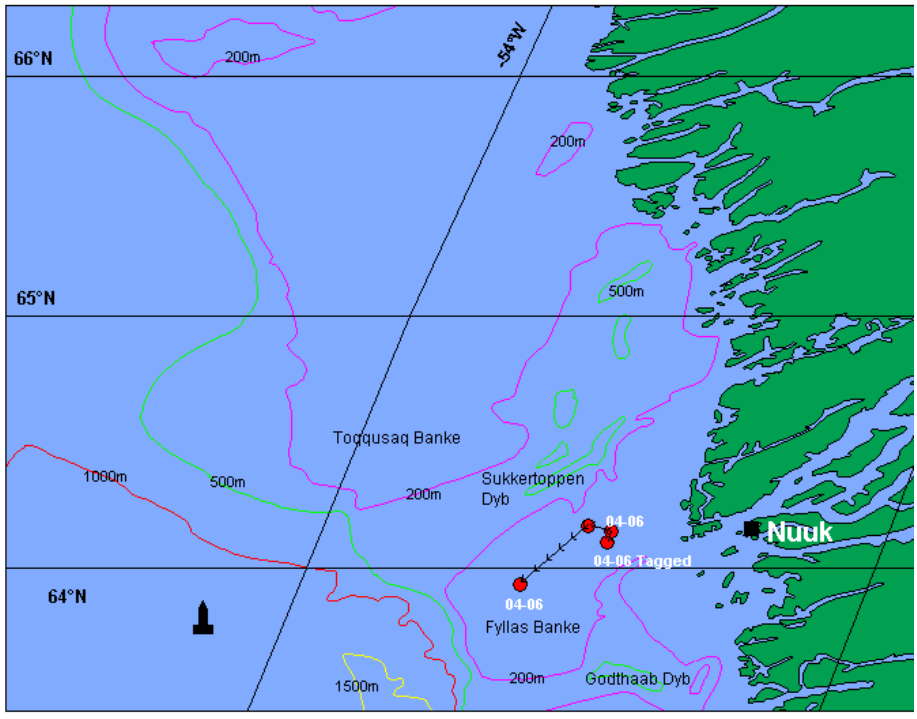

Figure 3.4. Movements of a tagged humpback whale (#20160), tracked for 66 km from 4 June 2000. The tower indicates the position of the spudded well "Qulleq-1".

Whale #21801 was tagged on 8 June on the northeastern side of the Fyllas Banke (Fig. 3.5.). From there it moved 117 kilometres west-southwest over Fyllas Banke to water deeper than 1,000 m. On 11 June it turned around and went 110 km back in an eastern direction through the Godthåb Dyb until it reached the 200 m depth curve on 13 June. From here it travelled 109 km northwest to Sukkertop Dyb

and passed the tagging site on 14 June. From Sukkertop Dyb it moved 115 km over Tovqussaq Banke until it reached the western side of the bank. From here it followed the bank 104 km north-northwest from 16 to 21 June to the western side of Lille Hellefiske Banke. Dive data were obtained for almost another month (29 days), but too few uplinks were received to obtain additional positions.

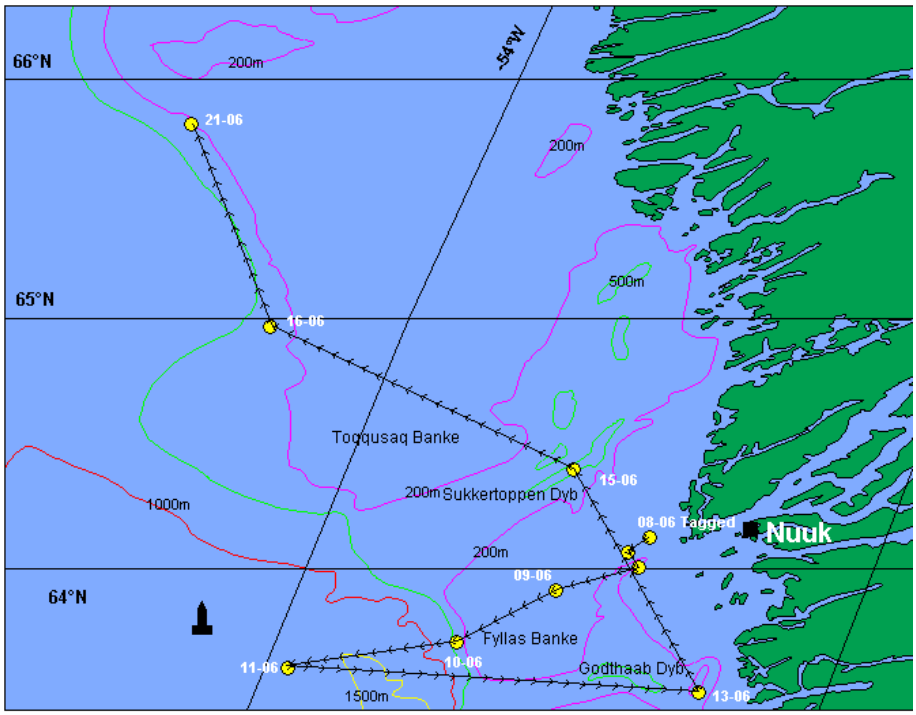

Figure 3.5. Movements of a tagged humpback whale (#21801), tracked for 555 km from 8 to 21 June 2000. The tower indicates the position of the spudded well "Qulleq-1".

Whale #21802 was tagged on 8 June on the north-eastern side of the Fyllas Banke (Fig. 3.6.). The next position was obtained 44 km north 6 days later close to the 200 m isobath now facing the the Sukkertop Dyb. From here it migrated north-west into the head of the relatively shallow Angmagssivik fjord, where it stayed from 17 to 19 June. On 21 June it returned offshore along the 200 m isobath of the inner Sukkertop Dyb. The coast was followed north 55 km for one day where-after the whale turned south again where the whale was tracked 79 km over the next two days. The last position was obtained from 64,475 N, 52,384 W west of Nordlandet on 24 June. The transmitter provided dive data one more day after which the transmitter either fell off or stopped transmitting.

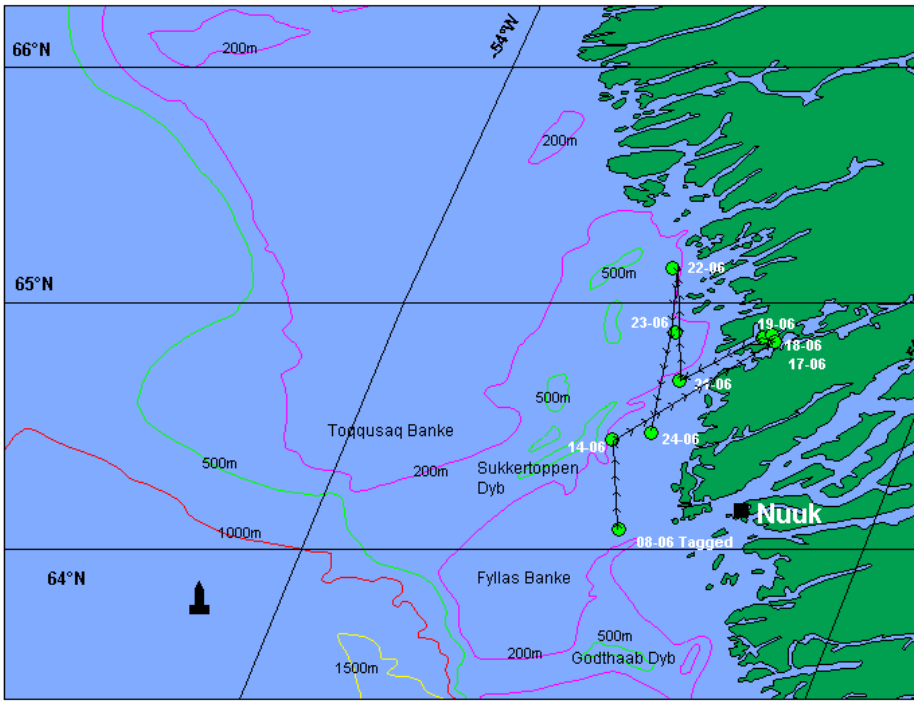

Figure 3.6. Movements of a tagged humpback whale (#21802), tracked for 267 km from 8 to 24 June 2000. The tower indicates the position of the spudded well "Qulleq-1".

3.3 Diving behaviour

The transmitters were equipped with a timeline facility programmed to monitor the surface time i.e. the time spend in the upper 8 m of the water column. Based on investigations from smaller toothed whales (Richard *et al.* 1994) it is likely that humpback whales are visible down to around 8 m from a survey aircraft.

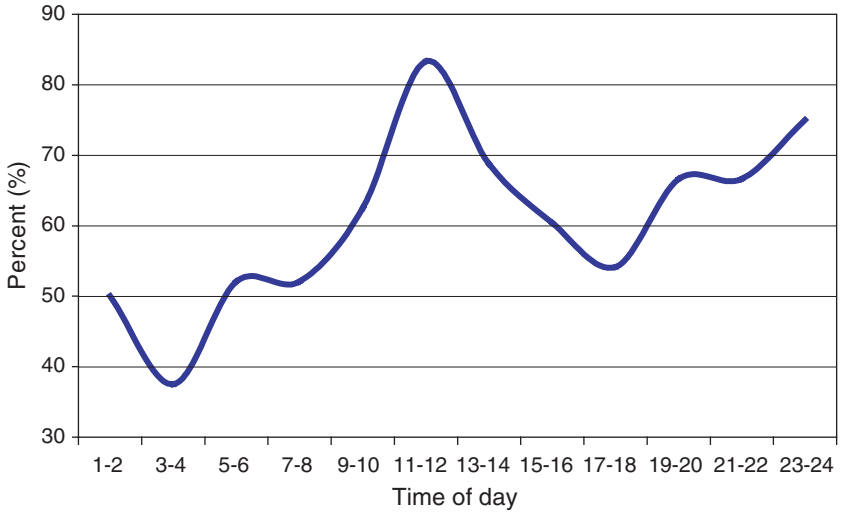

Figure 3.7. Percent of the time (average over 2-hrs intervals) spend at the surface (upper 8 m) of two of the tagged humpback whales (#21801 and #21802) representing diurnal patterns from 9, 10, 16, 18 and 19 June and 16 to 18 July 2000.

From Fig. 3.7. it becomes evident that the humpback whales primarily are at the surface during the middle of the day and in the middle of the night, where they spend as much as 83.3 % and 75 %, respectively, of their time in the upper 8 m of the water column. The data may be used as correction factors for submerged whales during the day for estimating the actual population size from aerial counting of the whales. However, a larger sample size should be obtained, to verify whether these figures are comparable for other individuals, areas and seasons.

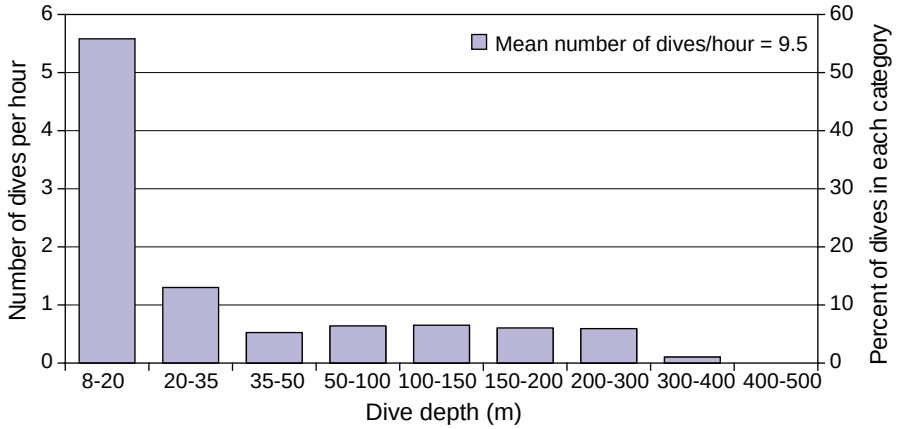

Figure 3.8. Number of dives per hour from humpback whales (#20158, #21801 and #21802) monitored for 876 dives during a total of 90 hours from 4 June to 4 July around Fyllas Banke, West Greenland.

The maximum dive depth from each dive was stored into the user-defined depth categories to get an idea of what depths the whales prefer and where they searched for food. Even though the defined depth intervals increased in length the percentage of dives in the different depth categories decreased. The whales most often dove to depths between 8 and 20 m (56 %) followed by the depth category 20-35 m (13 %). The frequencies of dives within depth categories between 35 and 300 m were quite similar (5.3-6.5 %) even though the depth intervals increased from 15 to 100 m. Depths from 300 to 400 m were reached in 1.0 % of the dives, whereas no dives below 400 m were recorded. This means that even though the whales were observed in areas with depths over 1,000 m, they never dove to the bottom in these areas.

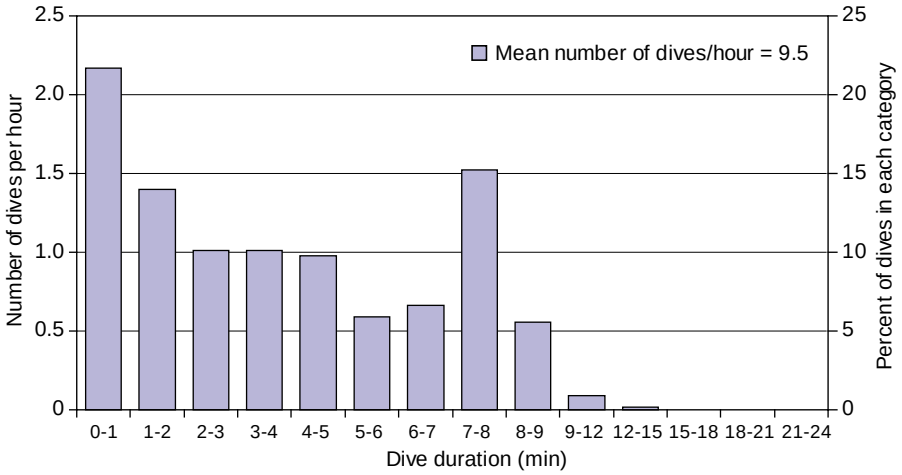

Figure 3.9. Dive duration frequencies from three humpback whales (#20158, #21801 and #21802) monitored for 664 dives during a total of 72 hours from 7 to 23 June around Fyllas Banke, West Greenland.

Most of the dives (22 %) were short dives lasting less than a minute, and were probably short dives between breathings or dives during travelling. The dive duration had a bimodal distribution with another top at the 7-8 min. interval (15 %). The dive duration intervals from 1-7 min. represented from 6 to 14 % of the dives. Dives from 8-9 min. represented 5 % of the dives whereas dives longer than 9 min. were few < 1 %. The longest dive was recorded in the 12-15 min. category and hence no dives lasted longer than 15 min.

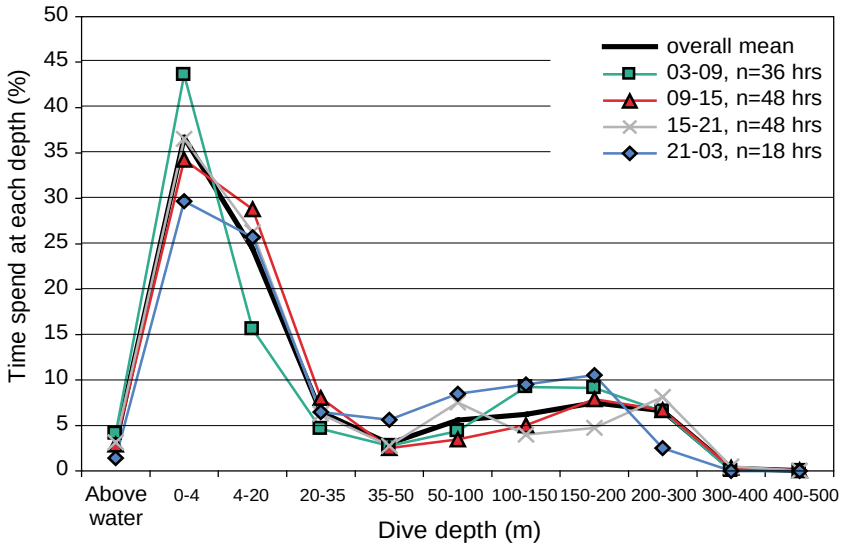

Figure 3.10. Percent of the time spend at each of the programmed depth categories. Data are based on a total of 150 hrs of diving from five humpback whales (#20158, # 20160, #21801, # 21802 and #21809) monitored from 6 June to 19 July around Fyllas Banke, West Greenland. The graphs are presented as four diurnal intervals as well as the average.

From Fig. 3.10. it is seen that the humpback whales used the majority of their time in the upper 4 m (29.7-43.6 %). The largest percentage (43.6 %) recorded during early morning (03-09 hrs) and the least time (29.7 %) was spend at night (21-03 hrs) in this depth category. Four to 20 m was the second most frequented depth category with maximum (28.8 %) around noon (09-15 hrs) and minimum (15.6 %) in the early

morning (03-09 hrs). There is no clear match between the diurnal pattern in Fig. 3.7. and 3.10. This may be explained by the difference in depth resolution and time intervals as well as the number of animals included in the two figures. The dive categories 20-35, 35-50, 50-100, 100-150, 150-200 and 200-300 m were frequented from 2.5 to 10.5 % of the time, whereas the humpback seldom dove to 300-400 m (<0.49 %) and 400-500 m's (0.09 %) depth. No recordings were registered in the depth categories of 500-700, 700-900 and >900 m. Information from the status messages revealed daily maximum dives from five days ranging from 320 to 392 m. The deepest exact dive recorded was hence 392 m, but the few readings in the depth interval between 400 and 500 m means that humpback occasionally dive below 400 m depths.

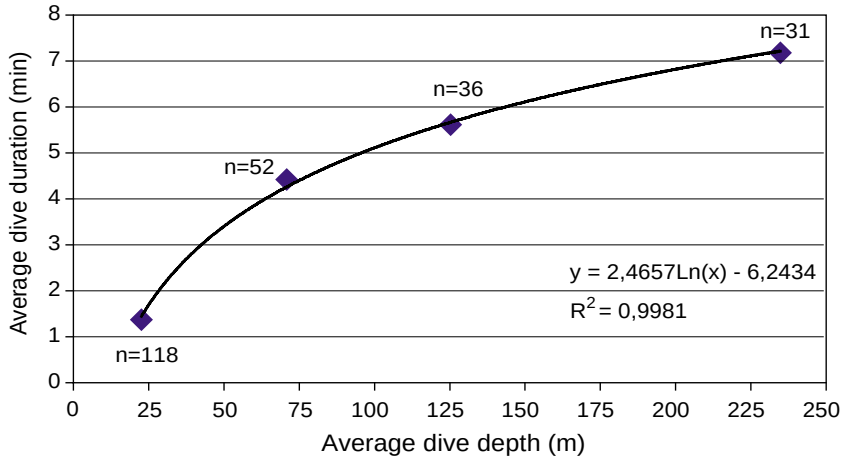

Figure 3.11. Relation between dive duration and dive depth of two whales in mid June. In only four 6 hour periods data on both dive depth and dive duration were available. n represents number of dives within these 6 hour periods.

As seen from Fig. 3.11. a highly significant logarithmic relationship was identified between the dive duration and the dive depth. This relationship probably underestimate the duration of the deeper dives as a dive to 392 m would take 8.5 min. and a dive down to 500 m would take 9.0 min. which is far below the longest dives recorded in the 12-15 min. category.

3.4 Use of the drilling and license area

Two of the tracked whales provided positions within Fylla licence area, but only three out of the 32 obtained positions (9.4 %) were obtained within this area. However, the closest position (#21801 on 11 June) to Qulleq-1 was 24.3 NM, which means that chances for direct encounter with the drill ship was remote. The exploration drilling was carried out on 1,152 m water depth, an area of little or no importance for the feeding of the humpback whales, since none of the humpback dives were recorded below 400 m. Only one of the transmitters (#21801) operated beyond the starting day of West Navion's drilling operation (10 July) at Qulleq-1. However, beyond that date only dive data were obtained and no migration reactions could be related to the operation.

3.5 Genetic analysis

Biopsies were obtained from six whales during the tagging operation.

Previously 148 individual West Greenland humpback whales have been genetically identified. None of the six samples collected in the present study matched to any of the samples in the database and thus constitutes new additions. Hence no new data on migration could be added from the biopsies.

Table 3.3. Summary on the microsatellite genotypes of the six whales from which biopsies were obtained.

ID No.	GATA028		TAA031		GATA053		GATA098		GATA417		GGAA520	
	1st Allele	2nd Allele	1st Allele	2nd Allele	1st Allele	2nd Allele	1st Allele	2nd Allele	1st Allele	2nd Allele	1st Allele	2nd Allele
WG00001	115	115	133	148	176	188	90	106	206	211	193	347
WG00002	115	115	142	154	176	180	90	90	199	213	201	218
WG00003	115	122	136	144	176	196	90	106	210	215	233	339
WG00004	115	123	148	154	192	196	106	118	210	222	193	205
WG00005	115	115	151	151	176	200	106	126	195	203	209	233
WG00006	115	123	151	157	192	196	90	118	213	222	193	209

4 Discussion

4.1 Tagging and tag duration information

We obtained data from the tagged whales from 0-42 days with an average of 12.5 days from the six tagged whales (Table 3.1.). However, we only obtained locations from 0-16 days with an average of 6.2 days. The four whales from which positions were obtained were tracked for a total of 1,042 kilometres. In comparison Mate *et al.* (1998) reported a study on six humpback whales tagged off Hawaii in April and May 1995 where the tags transmitted from 0.5-17 days (X = 8.5 ± 2.7 days).

Heide-Jørgensen *et al.* (2001b; in litt) conducted a tagging program in 1998 and 1999 where the longest tagging from a blue, a fin and minke whale lasted 21, 28 and 38 days, respectively. The longest tagging of baleen have been achieved on a blue whale operating as long as 251 days for "position only" tags (Lagerquist & Mate 2001). Such results have been obtained as one out of many tagged animals and for the smaller "location only" tags. However, most tags will operate considerably shorter and failing tags are not always reported.

The miniaturisation process within the electronic technology is steadily improving the longevity, as the tags will last longer the smaller the transmitter gets. Krutzikowsky & Mate (2001) recently studied the tag retention and loss on Alaskan humpback whales. They documented, that after two months five out of nine whales had lost the tags, while four were still in place. Partial or complete healing was documented in all five whales and the tissue appeared to heal quickly within a matter of weeks. They therefore concluded that tag loss limits the useful lifetime of some tags.

In general, tag longevity on large whales is shorter than on smaller toothed whales, where tags have lasted from 10 to 14 month dependant of the tagged species and tag generations (present authors unpubl.).

4.2 Distribution and movements

The available observations from the literature show that the humpback whales of West Greenland may occur from the southern tip of Greenland to Avanersuaq in the north (Kapel 1979, Born 1987), but are abundant only between c. 62º N and c. 66º N (Larsen 1984, 1986; Larsen & Nielsen 1989; Larsen *et al.* 1989; Larsen & Hammond 2000). They occur in the Davis Strait from June to November and most frequently in July and August (Kapel 1979). However, some animals are observed year round in the fiord systems around Nuuk (L. Witting, pers. comm.). Their distribution, based on annual surveys made during the 1990'ies, seems to be closer to the coast compared to the fin whale, while the distribution overlaps with that of the minke whales (Boertmann *et al.* 1992). Humpback whales are sighted most frequently in the region between Paamiut and the mouth of Søndre

Strømfjord. A number of areas with higher densities have been observed at the eastern edge of Fyllas Banke off Nuuk, the eastern edge of Fiskenæs and Danas Banke as well as the continental slope off Paamiut (Fig. 5.4.). The humpback whales that come to Greenland every summer takes advantage of the high productivity, where the whales can feed on e.g. capelin, sandeels and euphausids (e.g. Perkins *et al.* 1982; Larsen & Hammond 2000). The high productivity is generated by the ocean currents moving north along southern and central West Greenland that branches off into the deeper channels between the banks and creates areas of upwelling and mixing, which brings cold and nutrient rich water to the surface (Larsen & Hammond 2000). The areas off Nuuk and Paamiut were traditional catching sites in Greenland; however, humpback whales have been protected since 1986.

The present study showed that humpback whales during June 2000 moved between Fiskenæs Banke, Fyllas Banke, Tovqussaq Banke, Sukkertop Banke and up to Lille Hellefiske Banke. Resightings within and between years obtained over a six year programme from 1988 to 1993 provided information on the site fidelity of humpback whales (Larsen & Hammon 2000). Information from four humpback whales seen in five or six years were re-sighted from Frederikshåb Banke on 62º N to Tovqussaq Banke including presence on eastern sides of Danas, Fiskenæs and Fyllas Banke. However, there was evidence of preference for the same region, as significantly more individuals were observed in the same region than in different regions (Larsen & Hammond 2000). An overall conclusion of the humpback whales in West Greenland is therefore that individual animals clearly feed in different zones within the same year and in different years, but that there is a tendency for area preference.

Our study suggests that the whales showed a preference for the continental slopes with depths around 200 m. In addition the whales move as much as 120 nautical miles (220 km) from the shores to water deeper than 1,000 m and also moved into the Central West Greenland fjord systems.

4.3 Diving behaviour

It was documented that the humpback whales used the majority of their time in the upper 20 m (61.1 %) of the water column. The six dive categories between 20 m and 300 m were frequented from 3.0 to 7.5 % of the time. The humpback whales seldom dove from 300 to 500 m (0.31 %), and no dives were recorded deeper than 500 m. Dolphin (1987b) found, based on 284 dives with sonar, that the humpback whales in Frederick Sound, Alaska restrict their foraging to the top 120 m, as only 3 % of the dives exceeded this depth. In comparison the monitored humpback whales used 87 % of their time at depths from 8 to 150 m, confirming a preference for relatively shallow feeding. The whales were often positioned at the banks with depths less than 200 m and 93 % of their time within depths less than 200 m.

In Icelandic waters humpback, minke and blue whales prefer areas close to the coast with depths from 250 to 1,000 m, whereas fin and

sei whales prefer deeper waters ranging from 400 to 2,000 m (Sigurjónsson 1995).

Most of the dives (22 %) were short dives lasting less than a minute and were probably during resting and breathing at the surface or when the whale were moving between feeding areas. Another large proportion (15 %) of the dives lasted 7-8 min. and could be the preferred length of humpback whale feeding dives. The average dive duration of 3.8 min. was 26.7 % longer than found for humpback whales at the Alaskan feeding grounds in Frederick Sound, who had average dive duration of 3.0 ± 2.7 min. (Dolphin 1987b). These humpback whales used 80 % of their time feeding between July and September (Dolphin 1987a). Dive duration for bowheads have been reported to be higher being 6.3 ± 7.7 min. (Würsig *et al.* 1984). Most dives (43 %) of bowhead whales from the Baffin Bay lasted less than one minute, and more than 5 % lasted 24 minutes or more (Heide-Jørgensen *et al.* in press). This shows that bowheads have longer dive capabilities compared to the humpback whales from our study, where dives longer than 15 minutes were not observed.

The observed dive rate of 9.5 dives per hour in West Greenland was smaller than reported from Alaskan humpback whales, where an overall average dive rate of 17 dives per hour was found (Dolphin 1987a). However, the finding that the West Greenland humpback whales dive deeper and make longer dives, means that less time is available for consecutive dives. This inverse relationship between dive rates and dive depths have been documented for narwhals (*Monodon monoceros*) and belugas (*Delphinapterus leucas*) showing seasonal differences in depth habitats (Heide-Jørgensen *et al.* 2001a)

Dolphin (1987b) calculated a significant ($p < 0.001$) positive relation between dive depth and dive time (*Time (sec) = 0.52 Depth (m)+ 3.95*). If the same relation is true for the West Greenland humpback whales as well, a dive to e.g. 200 m should last 108 sec. However, we found a logarithmic relationship between dive depth and dive duration resulting in much longer lasting dives. Using our relation (*Dive duration (min.) = 2.4657 ln (Dive depth) – 6.2434*) a 200 m dive would last 6.8 min., which is 3.8 times longer than the Dolphin (1987b) estimate.

No detailed studies of the feeding habits of humpback whales have been made from the Greenland area. However capelin, sandeels and euphausids are believed to be of importance (e.g. Perkins *et al.* 1982; Larsen & Hammond 2000).

4.4 Use of the license area

Two of the tracked whales provided positions within the Fylla licence area but less than 10 % of the positions were obtained within this area. The closest position to Qulleq-1 was 45 km which means that chances for direct encounter with the drill ship was remote. The exploration drilling was carried out on 1;152 m water depth, an area of no importance for the feeding of the humpback whales, as the whales preferred the shallower and more productive upwelling areas. None of the transmitters provided positions beyond the

starting day of West Navions drilling. From the literature only few sightings have been recorded outside the banks within the license area (Larsen & Hammond 2000). This is supported by our findings that the tagged humpback whales showed a preference for the eastern sides of the banks and that 93 % of their dives went to depths shallower than 200 m. This means that the banks will somehow act as an acoustic barrier for the low frequency noise coming from noise sources in the deeper waters west of the banks. This finding is consistent with Larsen and Hammond (2000), who state that: "Humpback whales are found in the deeper water between the banks and along the landward slopes of the banks, but very rarely on the shallow banks and never along the slopes towards the Davis Strait".

The fact that the humpback whales have been observed at other banks along the Greenland west coast, means that the whales have alternatives to the Tovqussaq and Fyllas Banke if they are disturbed. There are indications that the range of the humpback whales along the West Greenland coast have contracted over the last century, as the distribution of the catches in the 1920's and 1930's also were abundant from 66ºN up to the Disko Bay (Hjort & Ruud 1929; Kapel 1979). Whether these changes are due to over-harvesting or changes in currents, temperature and productivity is uncertain. Dolphin (1987a) pointed out that high densities of e.g. euphausiids were necessary to meet the daily energy requirement of the humpback whales. However, Perkins *et al.* (1982) did not find any relation between zooplankton densities and the distribution of humpback whales. On the other hand their presence was correlated with flocks of greater shearwaters, which together with observation of lunge feeding made the authors conclude that the humpback whales were dependant of high densities of small fish such as *Ammodytes sp.* The summer presence in Greenland must be regarded as a critical habitat, as the whales are building up their blubber deposits, which they are dependant on during the rest of the year, where they are not feeding. To what extend the whales can extent their stay in Greenland waters to compensate for interruption in their summer feeding is uncertain. The whales however, need a certain amount of time (more than 40 days each way if migrating 5 km/h) to migrate the 5,000 km south to the Caribbean and back as well. Even if the whale could make the trip, a shortening in the time in the Caribbean would reduce the breeding and mating period, which could interfere with the breeding success of the animals.

4.5 Connection with other areas of the North Atlantic

The transmitters did not last long enough to provide information on the connection with humpback whales observed in other areas of the North Atlantic. The results from the large number of photos taken during this survey are presently being worked on, in order to match potential resightings from West Greenland with the 17,753 photographs of humpback whales, representing 5,345 individuals sampled during the past 25 years in the North Atlantic (Seton *et al.* 2001).

Humpback whales are known to occur at the summer feeding grounds in West Greenland as well as in Newfoundland-Labrador, the Gulf of St. Lawrence, the Gulf of Maine-Scotian Shelf and further east in the Denmark Strait and along Iceland or even as far as the European coast. Another important region for the humpback whales is their breeding grounds off the Dominican Republic, Puerto Rico and the Virgin Islands. In addition to the feeding and breeding grounds humpback whales have been observed on their migrations along the mid-Atlantic U.S. coast, Ireland, Azores, Spain, and the Cap Verde Islands may also be a breeding area for humpback whales.

Photo-identification of fluke patterns have revealed a connection between the West Greenland and Newfoundland summering stocks as well as the wintering grounds in the Caribbean (Larsen 1991; Seton *et al*. 2001). Of the 1,181 North Atlantic humpback fluke photos held at the NAHWC and taken in Greenland, 411 different whales have been identified from this region. Of these whales 211 have been re-sighted more than one year and 95 have been re-sighted in more than one area. Of these re-sightings 12 have been made off Newfoundland, 3 off the Gulf of St. Lawrence, 1 off the Gulf of Maine, 3 of Bermuda, 62 of the Dominican Republic, 7 off Puerto Rico and 7 off the Virgin Islands (Seton *et al.* 2001).

In order to protect the humpback whales breeding ground around Silver Banks (a shallow, limestone plateau 80 miles off the north coast of the Dominican Republic) this area was designated a sanctuary in 1986 established by Presidential Decree (NOAA, NMFS 1989).

4.6 Known and potential impacts

In 1987 the Administrator of NMFS assigned the office of Protected Resources to construct a Recovery Plan for the humpback whale (NOAA, NMFS 1989). Among the items dealt with was an overview of the known and potential impacts to the humpback whale. The report concluded that hunting caused the major decline in all humpback whale populations, but that they were no longer endangered by that activity. However, humpback whales occur adjacent to human population centers and are affected by human activities throughout their range. Both habitat and prey are affected by human-induced factors that could impede their recovery. These factors include subsistence hunting, incidental entrapment or entanglement in fishing gear; and collision with ships or disturbance or displacement caused by noise and other factors associated with shipping, recreational boating, high-speed thrill craft, whale watching or air traffic. Introduction and / or persistence of pollutants and pathogens from waste disposal; disturbance and / or pollution from oil, gas or other mineral exploration and production; habitat degradation or loss associated with coastal development; and competition with fisheries for prey species may also impact the whales. These factors could affect individual reproductive success, alter survivorship, and / or limit availability of needed habitat.

Action tasks were recommended in four general categories: 1) maintain and enhance habitats used by humpback whales currently or historically; 2) identify and reduce direct, human related mortality,

injury and disturbance; 3) measure and monitor key population parameters; and 4) improve administration and co-ordination of recovery efforts.

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Denmark
Tel: +45 46 30 12 00
Fax: +45 46 30 11 14

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National Environmental Research Institute
Vejlsøvej 25
PO Box 314
DK-8600 Silkeborg
Denmark
Tel: +45 89 20 14 00
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DK-8410 Rønde
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