# Preliminary report about seals and their sensitivity to oil-exploration in South Greenland

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## The assessment area in relation to seals

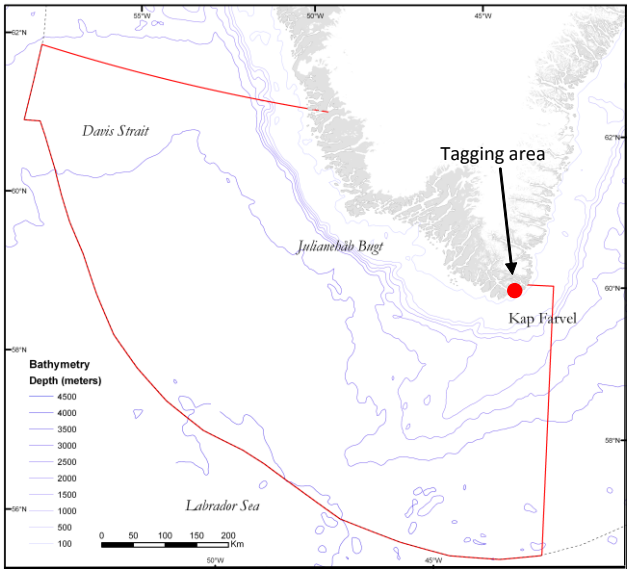



Figure 1.

The assessment area and the tagging area.

The assessment area is home to approximately 8.000 people living in 15 settlements. Seals are an important meat source in all the settlements and subsistence hunting is practiced in all parts of the assessment area. Vast amount of drift ice normally reach Cape Farwell around the start of January and when the pulse of ice is strongest in June-July it often cover the coastal waters in the entire assessment area. This drift ice restricts the range of the hunters significantly and for parts of the year most seals in the area will remain undisturbed by hunting. In recent years some harp seals have started to give birth on the drift ice in the assessment area in early April, whereas hooded seals always have used the drift ice as a platform of foraging in May-June on their migration toward the molting area off Southeast Greenland. The drift ice has also prevented hunting near the southernmost colony of harbor seals during their breeding period (in June). Furthermore the drift ice transports a steady flow of the ice-associated ringed seals and bearded seals into the assessment area.

The main objective of this SEIA seal project has been to describe the distribution and movements of the harbor seals (*Phoca vitulina*) from the southernmost colony in Greenland. Harbor seals have been hunted close to extinction in Greenland. They have now been given total protection against hunting and the colony in the southern part of the assessment area is believed to be one of the last refuges of this species in Greenland. The tagging area was defined for the purpose of catching harbor seals, but other seal species caught in the area were also tagged in order to get an idea of how they use the area.

## Seals and oil spills

The effects of oil on seals were thoroughly reviewed by St. Aubin (St Aubin 1990). Seals are vulnerable to oil spills because oil can damage the fur, produce skin irritation and seriously affect the eyes as well as the mucous membranes that surround the eyes and line the oral cavity, respiratory surfaces, and anal and urogenital orifices. In addition, oil can poison seals through ingestion or inhalation. Furthermore, oil spills can have a disruptive effect by interfering with normal behavior patterns. Pups are most affected by oil (St. Aubin 1990 and references therein) in that, they are very stationary during the weaning period and can therefore not move away from oil spills. The pups of most of the arctic species are protected against the cold by a thick coat of woolly hair (lanugo pelage) and for these pups oil will have a strong negative effect on the insulating properties of this fur. The mother seals recognize their pups by smell and a changed odor caused by oil might therefore affect the mother's ability to recognize its pup. Although the sensory abilities of seals should allow them to detect oil spills through sight and smell, seals have been observed swimming in the midst of oil slicks, suggesting that they may not be aware of the danger posed by oil (St Aubin 1990). Finally, oil spills may also affect seals indirectly by affecting habitat and food sources.

## Seals in the assessment area

### Hooded seal (*Cystophora cristata)*

Hooded seals pass through the assessment area when migrating from their whelping areas off Newfoundland and in Davis Strait to the molting area off Southeast Greenland and back again. They give birth in late-March/early-April. The pups only lactate for about four days and put on about 7 kg/day. It quickly gains a thick layer of insulating blubber, whereas the woolly lanugo pelage, that characterizes other arctic seal pups, is already lost during the fetal stage. The migration towards southeast Greenland starts few weeks after the birth and both adult seals and pups occur in the assessment area in high numbers during May-June. This time a year they are often seen resting on the drift ice and most of the subsistence hunt occurs in this period. After the molt (July-August) the adult seals quickly pass through the assessment area again towards Davis Strait and Baffin Bay whereas most of the juvenile seals stay off the east Greenland coast until they reach maturity.

The hooded seal is a deep diver, feeding regularly below 500 m (down to around 1500 m). Many of the adult hooded seals forage along the continental slope where they mainly take large fish and squids.

*Conservation status:* The hooded seal is listed as 'Least Concern' on the Greenland Red List. The hooded seal population is managed internationally through a working group under ICES and NAFO. The seals in South Greenland are part of the West Atlantic population that counts around 600.000 individuals (ICES 2006).

*The catch*: The Greenland catch is believed to be sustainable and there is no limitation on the hunt. The annual catch in the assessment area is about 1.000-2.000/yr.

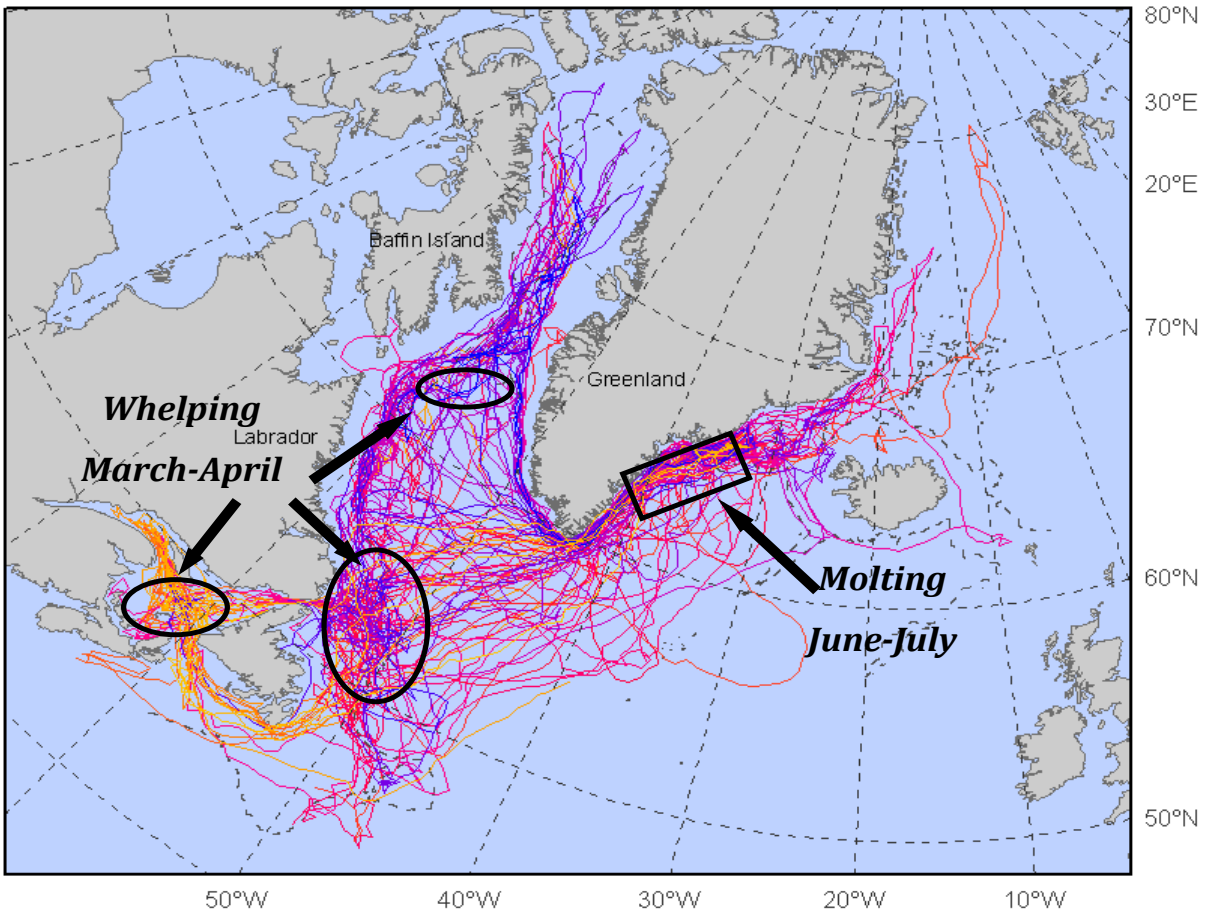



Figure 2. Track lines from adult hooded seals, showing the annual migration pattern from the molting area off Southeast Greenland to foraging areas between Greenland and Canada, to the breeding areas in the Davis Strait and off Newfoundland and back to the molting area. Source: (Andersen et al. 2009).

*Sensitivity*: Hooded seals can be affected by oil spills in the same way as all other seals in terms of i.e. tissue damage and poisoning.

*Important and critical areas/periods in the assessment area*: Hooded seals spend most time in the assessment area during May-June, at which time they are also found in the highest concentrations in the area. In this period they are mainly distributed along the outer edge of the drift ice (the extent of which differ from one year to another).

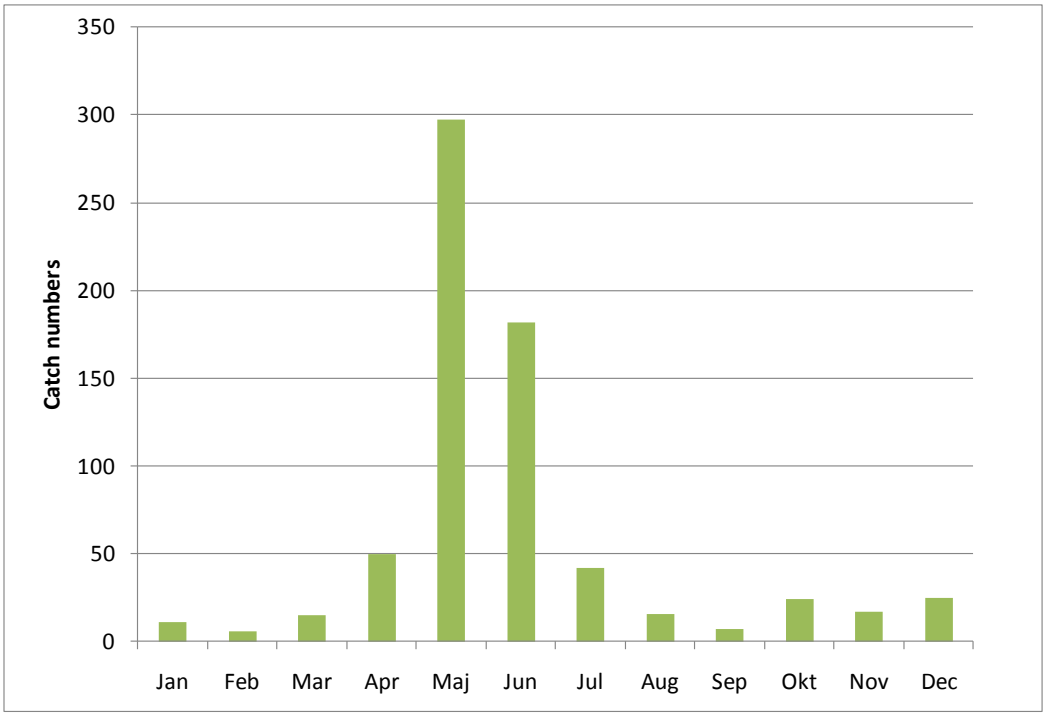



**Figure 3.** Catch of hooded seals in the assessment area in 2007 divided by month.

*Results from the SEIA seal project*: No hooded seals were tagged in this study, but a large scale tagging study has recently been conducted (Andersen et al. 2009). It shows that that close to all hooded seals follows a very uniform migratory pattern as described above and shown in Fig. 2.

Hooded seals. Female with pup and male. (Photo: Aqqalu Rosing-Asvid)

**Harp seal (*Pagophilus groenlandicus*)**
Most of the harp seals in the assessment area are migrant visitors, normally seen in highest numbers in June-July, but some harp seals, mainly juveniles stay in the area throughout the year. The migrant seals mainly come from the West Atlantic population (Kapel 1995). During the last decade some harp seals have started to give birth off south Greenland on the drift ice pulsing up along the west coast during spring and summer. This was first documented in 2007 when some (1000+) harp seal gave birth in the assessment area (Rosing-Asvid 2008). Hunters have reported that this phenomenon has reoccurred every year since then and they have the impression that the number of pups is increasing.

Harp seals are gregarious and adult seals often travel in flocks typically consisting of 5–20 individuals (sometimes up to hundreds). Capelin (*Mallotus villosus*) is their main prey in the coastal parts of the assessment area (Kapel 1991).

*Conservation status*: The harp seal is listed as 'Least Concern' on the Greenland Red List. The population occurring in the assessment area is now up around 8 million (ICES 2011).

*The catch*: The catch in the assessment area is around 10.000-15.000 adult seals/yr. and 7.000-10.000 juvenile seals/yr.

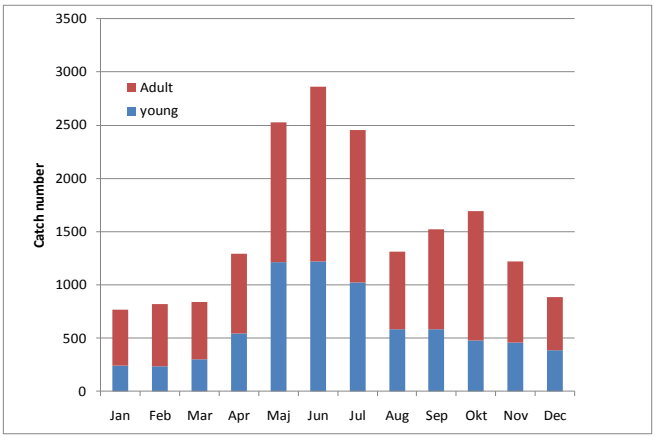



**Figure 4.** Catch of harp seals in the assessment area in 2007 divided by month.

*Sensitivity*: Non-breeding harp seals will be affected by oil spills in the same way as all other seals (i.e. tissue damage and poisoning). Pups, however, are immobile during the first 3-4 weeks of their life. They are recognized by their mother by their odor and they are born with a coat of long woolly lanugo pelage that is very important for their thermoregulation during the first weeks of their life. They have a short 10-12 days lactation period, gaining approximately 2.5 kg/day. The lanugo pelage is not shed till they are around 3-4 weeks of age, but are only vital till around weaning; hereafter the thick blubber layer serves as insulation.

*Critical and important habitats/periods in the assessment area*: The newly established whelping patch in south Greenland will be very sensitive to oil spills during late March-late April. The position of the whelping patch has so far been near the front of the drift ice, but the position of the front differs significantly from year to year. Fig. 4 shows the maximum extend of ice in March, which will be close to the position of the ice front by early April when the harp seal give birth. The front of the ice will some year be on the east coast and some years north of the assessment area, but in most years it will be in the assessment area.

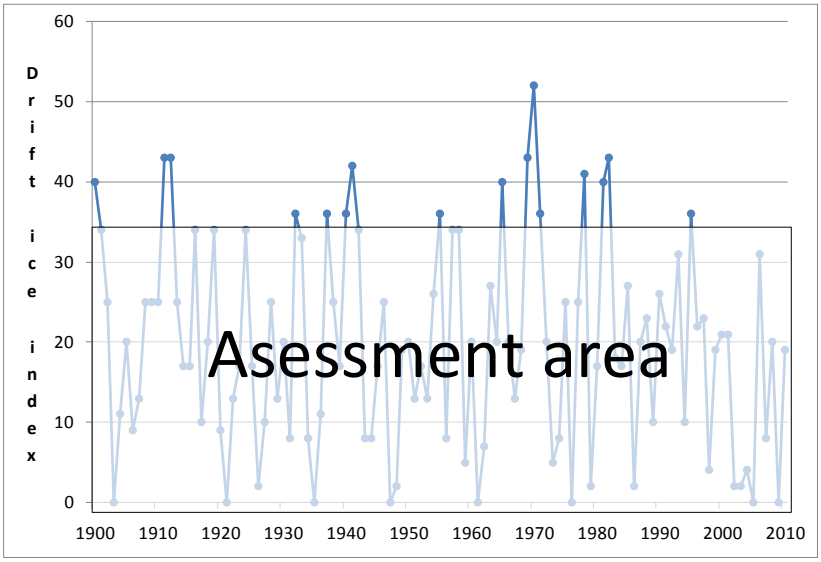



**Figure 5.** Drift ice index (maximum extent in March).The graph show how high on the Greenland west coast a substantial part of the drift ice reached in March I a given year (0 is Cape Farwell and 34 is Paamiut), The shadowed box is the assessment area.

Harp seal mother and pup. Recognition by smell (Photo: Aqqalu Rosing-Asvid)

*Results from the SEIA seal project*: A single adult harp seal was tagged to get some insight in their use of the assessment area and to get a position on the whelping area when it is formed during spring. Unfortunately the tag only lasted 22 days. The track line is shown in Fig. 6. The average and maximal recorded distance of the harp seal from the shore were 5 and 43 km, respectively. Based on positions at sea the harp seal on average frequented regions with depths of 101m.

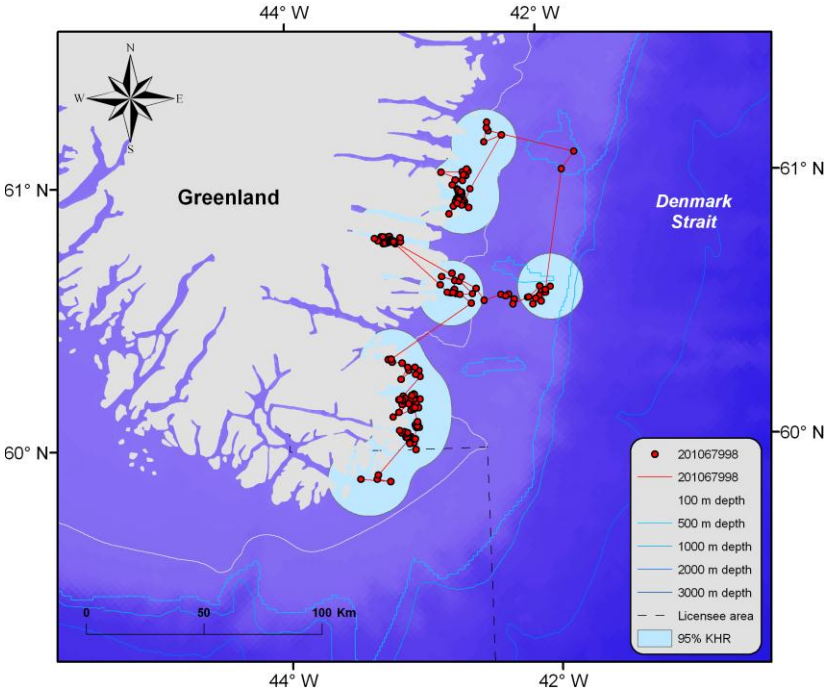
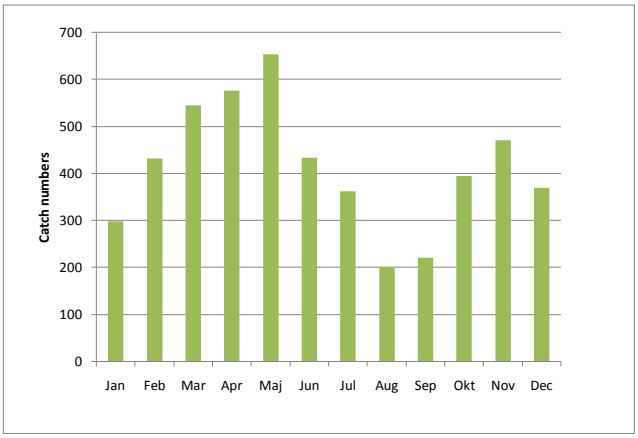



**Figure 6.** Positions and migration routes of a harp seal (#201067998) tracked within September 2010..

## Ringed seal (*Pusa hispida)*

The ringed seal is a small seal that have adapted to life in ice-covered waters, where it maintains breathing holes and gives birth in lairs made in a snowdrift covering a breathing hole. The main breeding habitats are considered to be coastal fast ice and consolidated pack ice. The pups are born in late-March and April and lactation lasts for about 7 weeks (Hammill et al. 1991). The assessment area might hold breeding ringed seals during very cold winters with heavy ice cover. Most of the ringed seals that are found in the assessment area are pups of the year and they are likely to have been born somewhere up along the east coast. The number of these young seals seems to increase in the assessment area during fall and spring (this is reflected in the subsistence hunt, Fig. 7). The increase observed in fall might be related to the sea ice formation in the east Greenland fjords. Adult seals will at this time make breathing holes and establish territories and the young seals therefore move towards areas with more open water. In spring when the pulse of drift ice is strong ringed seals associated with the ice also come to the assessment area.

Polar cod (*Boreogadus saida*), arctic cod (*Arctogadus glacialis*) and amphipods seem to be the main prey of ringed seals in their more northerly core habitat. An ongoing study from the southernmost part of the assessment area has found amphipods and polar cod to be important, but capelin is also an important supplement in this area (Rosing-Asvid unpublished data).




*Catch*: Ringed seals are caught in highest numbers in the southernmost part of the assessment area. The annual catch is about 3.000-5.000/yr.

**Figure 7.** Catch of ringed seals in the assessment area in 2007 divided by month.

*Conservation status*: The ringed seal is listed as 'Least Concern' (LC) on the Greenland Red List. There are no estimates of population size, but the hunt is believed to be sustainable because the ringed seals inhabit a huge area of which the Greenland hunters only explore a tiny fraction.

*Sensitivity*: Breeding ringed seals depend on stable sea ice during their 7 week lactation period. This stationary behavior makes them vulnerable to disturbance and particularly to activities that disrupt the stable ice. The pups have woolly lanugo pelage for insulation during the first two month of their life and oil might significantly harm the insulation properties of their fur. The assessment area is, however, not considered to be a breeding area for ringed seal although some ringed seals will give birth there in very cold winters. Ringed seals are vulnerable to oil spills in the same way as all other seals (i.e. tissue damage and poisoning).

*Critical and important habitats*: The core habitat of this population is considered to be fjords up along the Greenland east coast, but ringed seals core habitat change with the severity of the winter. During cold winters glacier fjords in the assessment area will hold some breeding ringed seals.

Ringed seal mother and pup in lair.

(Display at the zoological museum in Copenhagen. Photo: Aqqalu Rosing-Asvid)

*Results from the SEIA seal project:* Two ringed seals were tagged to get some insight into their use of the assessment area. In 2009 a small pup of the year was tagged. The tag was designed for a seal flipper, but due to the small size of the seal (64 cm and 12 kg). It was put on 1st of September 2009 and only 34 positions were obtained from this animal (#200908379). The seal swam westward of Cape Farwell and stayed in the head of the fjord Sermilik over the winter (from 8 October to 25 March). In mid April the seal had moved to the outer archipelago at $46.3^0$W some 180 km northwest of the tagging site (Fig. 6). It stayed within the 100 m bathymetrical line. The other ringed seal was an adult female tagged just south of Prince Christians Sound. It stayed close to the tagging area except during 3-20 September 2010 and 2-31 December 2010 when it visited an alternative fiord system some 30-40 km north of Prince Christians Sound. . This seal only twice visited depths in excess of 100 m. The ARGOS system gives positions with an accuracy of +/- a few hundred meters meter and the seals are therefore sometimes positioned on land. The average (land positions included) and maximal recorded distance of the ringed seals from the shore were 1 km and 28 km respectively. Based on positions at sea the ringed seal on average frequented regions with depths of 139m.

**Figure 8.** Positions and movements of two ringed seals. One pup male of the year (green) from 1/9/2009 – 15/4/2010 and an adult female (red) from 31/8 /2010– 10/4/2011 (see Table 1 for details).

**Bearded seal (*Erignathus barbatus)***

Bearded seals are widespread in the Arctic and usually occur in low densities. They can make breathing holes, **but prefer to stay** in thin ice and in the northern part of their habitat they either winter in reoccurring leads and polynyas or they follow the pulse of the expanding and shrinking sea ice. Birth takes place in April–May on drifting ice or near ice edges with access to open water and the lactation period is up to 24 days (Gjertz et al. 2000).

Male bearded seals vocalize intensively during the mating season (March-June) and individual seals can be recognized on their songs. Studies that use the song to recognize individual seals have shown that male bearded seals show a high degree of site fidelity (Van Parijs & Clark 2006).

Detailed catch statistics from an ongoing sampling program in the southernmost settlement in Greenland (Aappilattoq), show that only adult males and young juvenile seals are caught in South Greenland during the period without drift ice in the area (typically August-January). Adult females are included in the catch when the drift ice arrives. This indicates a pattern of stationary males and migrating females. The hunt only allows bearded seal to establish territories in the easternmost part of the assessment area where the hunters only rarely come.

According to literature, bearded seal feed on fish and benthic invertebrates in waters, preferably shallower than 100 m depth ((Burns 1981), (Gjertz et al. 2000)).

*Conservation status*: The bearded seal is listed as 'Data Deficient' on the Greenland Red List. The population occurring in the assessment area is believed to be part of a population that spreads up along the Greenland east coast. The number of seals in the population is unknown, but their uniform and widespread distribution is believed to be a good protection against over-exploitation.

*The catch*: The annual catch in the assessment area is about 100-200 /year.

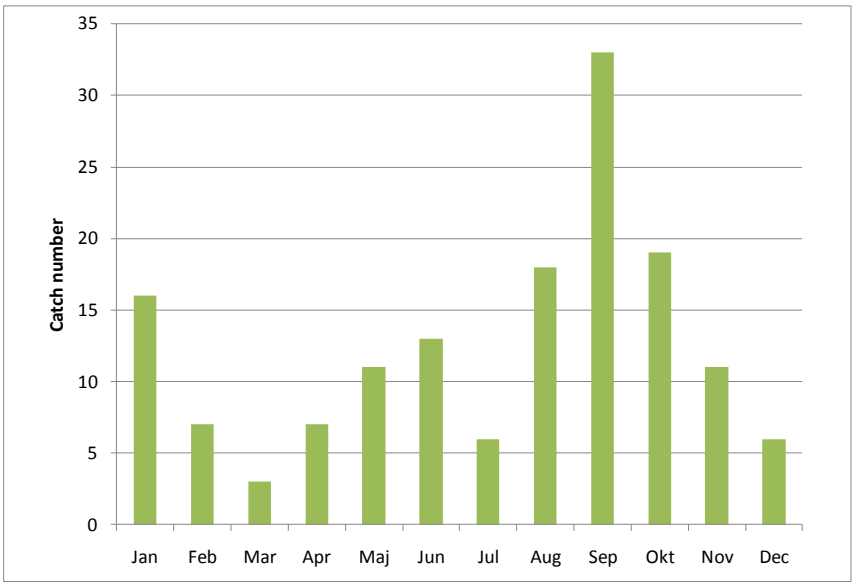



**Figure 9.** Catch of bearded seals in the assessment area in 2007 divided by month.

*Sensitivity*: Bearded seals vocalize very often, especially during the breeding season in spring (Burns 1981); and therefore they may be vulnerable to acoustic disturbances (noise). The benthic feeding habits of bearded seals also make them vulnerable to oil-polluted benthos.

*Critical and important habitat in the assessment area*: The bearded seal is more or less evenly distributed in a large part of the Arctic and no breeding or foraging areas seem to be important to a large number of seals. They are relatively rare in the part of the assessment area where hunting takes place, but they are frequently seen in the easternmost part of the assessment area (east of Cape Farewell), where only few hunters come.

*Results from the SEIA seal project:* Three male bearded seals were caught and each seal were equipped with two tags. One tag was mounted on the head. This tag collects data on dive depths and it has relatively many uplinks, the tag will, however, fall off when the seal molt and it will therefore last less than one year. The other tag is very small and is attached to the flipper. It only provides uplinks when the seal is out of the water. It provided haul-out times and positions and on the bearded seas it operated for close to a year or more (338-399 days). Details about number of uplinks and duration of the tags can be seen in Table 1 in the section about tag performance.

The seals stayed within an average distance of 12.7 km from the tagging site at $59.90^0$N $43.50^0$W and stayed close to the shore or within the fjords in the area (Fig. 8 left). One bearded seal (#200908378, Fig. 8 right) performed a short duration summer (18/6 -2/7) trip up along the east coast as far away as 371 km from the tagging site (ca. $63.00^o$N) and then returned to the tagging area again. The average and maximal recorded distance of the bearded seals from the shore were 2 km and 55 km, respectively. Based on positions at sea the bearded seals on average frequented regions with depths of 82m.

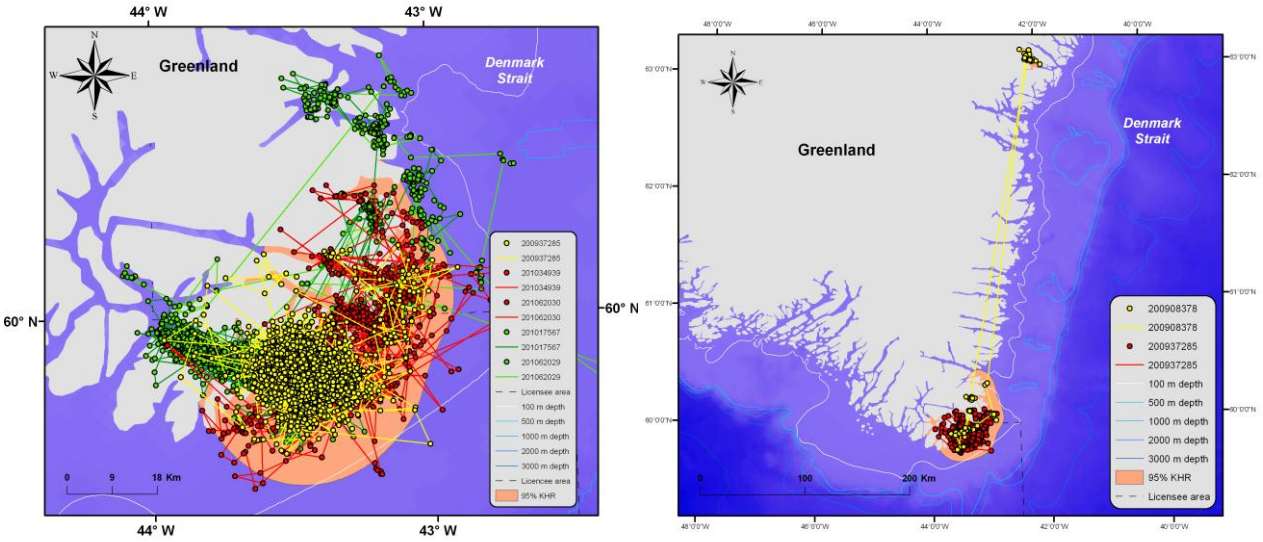



**Figure 10.** Positions and migration routes of three bearded seals, one tagged in September 2009 and two tagged in September 2010 (left) and positions and migration routes of one bearded seals showing a long distance movement (right). All three seals had two tags on (head and flipper) with different resolution and longevity. Contact with the seal transmitters lasted from to 106-399 days. See Table 1 for more details.

Bearded seal with transmitter. (Photo: Aqqalu Rosing-Asvid).

Analyses of the dive pattern of the bearded seal tagged in 2009 shows a seasonal increase in mean dive depth from fall to spring (from around 70 m to 110 m) (Fig. 9). Mean duration of the dives were shortest in fall (about 6 minutes) and longest in winter (about 9 minutes) (Fig. 9). Data on duration and depths are collected in bins and the longest dive lasted 20-25 minutes whereas the deepest dive was in the 500-600 m bin. These dives are the longest and deepest ever recorded for bearded seals.

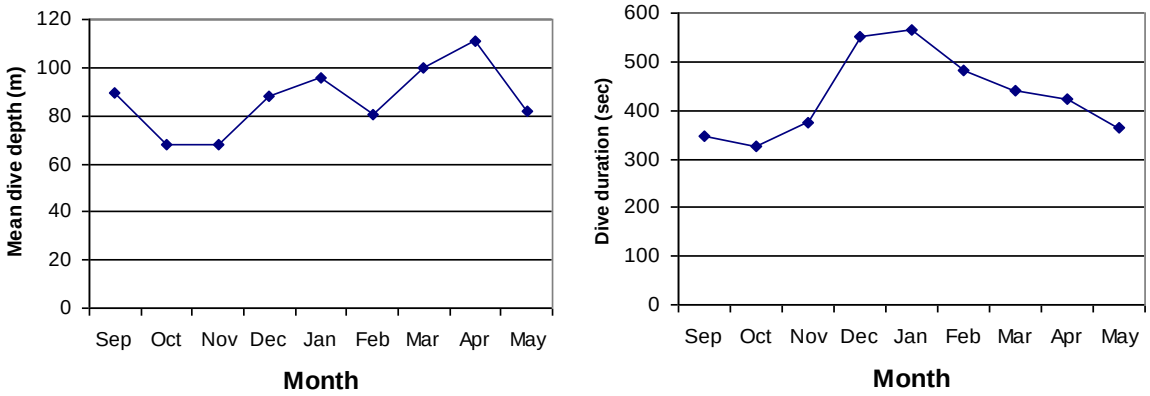



**Figure 11.** Seasonal changes in mean dive depth and dive duration of the bearded seal tagged in September 2009.

## Harbor seal (*Phoca vitulina*)

Harbor seals concentrate near land-based haul-out sites and give birth on land. This species have merely inhabited Greenland in interglacial periods, and it is therefore a relatively new species with only few thousand years of adaptations to the Greenland environment (Andersen et al. 2011). This might be the reason why it has never in historic time been nearly as numerous as any of the ice associated seal species. Its distribution is linked to the subarctic open water area. It gives birth during June to a pup without the woolly lanugo pelage that characterizes the Arctic seal pups (this pelage is lost during fetal stage). As a replacement for this the pup has a nice relatively long-haired fur, which in combination with the rareness of harbor seals have made the fur particularly exclusive and wanted by hunters. This exclusiveness may be the reason why the trousers in the west Greenland traditional woman full-dress have to be made of skin from young harbor seals. The harbor seals in Greenland have therefore been overexploited throughout the last century and most of the catches during the last two decades have been in the eastern part of the assessment area.

*Conservation status*: The harbor seal is listed as 'Critically Endangered' on the Greenland Red List. The number of harbor seals has declined significantly during the past century and most of the traditional haul-out sites have been abandoned (Teilmann & Dietz 1993). Southeast Greenland has been considered one of the last strong holds for this species, but clear signs of overexploitation also exist here (Rosing-Asvid 2010 ). A complete ban on harbor seal hunting in all of Greenland was imposed on December 1st 2010.

*The catch:* The catches in the northern part of the assessment area (north of Qaqortoq) declined from 60-80/yr. in the early 1960s, down to app. zero in the early 1980s. The decline in the population was recognized locally and regulations in 1982 protected some of the haul-out sites against both hunting and disturbance, but this protection came too late. According to the local wildlife officer, harbor seals have left the area and are now only seen on rare occasions.

In the southern part of the assessment area (south of Qaqortoq) a steady catch averaging around 20/yr. was reported from the 1950s up until the 1980s. These seals probably came from a population living in the easternmost part of the assessment area. In the 1990s catches started to increase and they peaked in 2003 with more than 100seals/yr., after which the catch numbers dropped significantly. The drift ice from east Greenland normally prevents hunting near the breeding area during the breeding season in June and for part of the summer as well. During 2003-2005, however, an unprecedented lack of drift ice allowed hunting in this area throughout the year leading to high catches, which probably diminished the population significantly (Rosing-Asvid 2010 ).

*Sensitivity*: Harbor seals will be affected by oil spills in the same way as all other seals (i.e. tissue damage and poisoning). In addition they are likely to be affected by disturbances, which may force them to flee from preferred habitats.

*Critical and important habitat in the assessment area*: At present a small group of Islands (Qeqertat between: $59.88^0$N/$59.90^0$N and $43.45^0$W/$43.48^0$W) seems to be the centre for the remnant population of harbor seals in South Greenland.

All the tagging in the SEIA seal project except one adult ringed seal have been seals caught around these islands.

***Results from the SEIA seal project:***
*Number of seals in the colony*

*Total counts:*

During the 2009 field season a total of 11 days (27/8-7/9) were spent on the islands (Qeqertat). Most days were sunny and warm with a few exceptions with winds and rain. The number of seals basking on the islands was clearly related to the weather conditions as most seals went in the water when weather was cold or rainy. Data from the tagged seals reveal a diurnal pattern with more seals hauling out late in the afternoon.

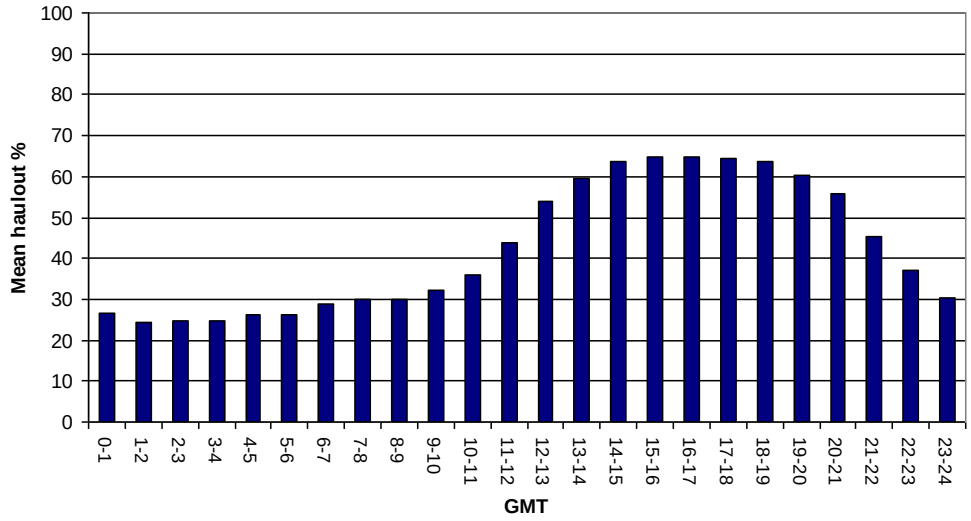



**Figure 12.** Mean daily haulout for the tagged harbor seals during September 2009. N=8 seals.

The seals were tagged in early September, which is late in the molting season. During this period close to all seal will therefore haul-out on warm days as they need strong blood-flow in the outer skin layer to molt properly.

The maximum count of seals on the islands during September 2009 was 32 harbor seals.

During the 2010 field season seven days (1/9-7/9) were spent on Qeqertat. The weather conditions these days were mainly rainy and stormy. There were no "perfect" days and only one count of seals on land was made (23 seals).

*Individual recognition*: During the 2009 field season an attempt was made to make a catalogue with pictures of seals for individual identification. In some instances, however, seals with known identity from tags or from series of pictures were unrecognizable based on the skin pattern, if for instance the pelt was wet /dry or when light conditions differed slightly, see example below.

**Figure 13.** Three pictures of the same seal – with less than one sec. between each picture. Showing the difficulties in matching pictures taken of the same seal.. Mark recapture studies by the use of pictures has been conducted on both harbor seals and grey seals in other areas, but we found that population size easily could be overestimated due to misinterpretation of pictures.

*Mark recapture of tagged seal*: In 2009 eight harbor seals were caught at Qeqertat and equipped with transmitters. Six of them had a transmitter glued on their head, which made them easy to recognize. The area was visited again on 16 November 2009. By then two of the transmitters had stopped. One of the transmitters had stopped 12 October close to some islands 50 km NW of Qeqertat. These islands were visited and only the seal that had been tracked to the islands was seen, but it had lost the transmitter. Some other islands west of Qeqertat were also visited and one other harbor seal was seen there. Fourteen harbor seals were seen at Qeqertat and three of them had a transmitter on the head. Hence, four of the six seals with a transmitter on their head were found among the 16 harbor seals seen when revisiting the area two months after the tagging.

In 2010 six harbor seals were caught and equipped with transmitters. Two of these were pups of the year and four were adult seals of which two were recaptures from 2009.

*Estimated number of seals*: The number of harbor seals equipped with a transmitter on their head in September 2009 and re-sighted two months later can produce a mark-recapture estimate of the number of seals at the islands.

Petersen estimate: $N = M / ({}^{m}/_{n})$ $\quad SE = \sqrt{\frac{M2\,(n+1)(n-m)}{(m+1)2\,(m+2)}} \quad 95\%\,CI = N \pm (1.96\,SE)$

**N** (population size) being unknown, **M** is marked animals, **m** = marked animals recaptured in a sample of **n** animals.

When the area was revisited 16 November 2009 four of six tagged animals were seen among 16 sightings.

M = 6, m = 4, n = 16 means that N = **24**, upper 95% CI: **38**.

It can be argued that the sampling is biased because some islands where only visited because one of the seals had been tracked to the area a month earlier. Skipping this observation would result in an estimate of **30** (upper 95% CI: **48)**. The only seal found near these islands, however, was recognized to be a tagged seal that had lost its tag. Hence, the number of tagged seals that could be recaptured if skipping this seal was only five and maybe only four as one of the other tags also had stopped transmitting. Reducing the number of tagged animals with one or two reduce the point estimate to 25 and 20, respectively.

The seals caught in 2010 can also be used for a mark-recapture estimate. Here the number of marked seals will be eight (the six with tags on the head and two seals with flipper tags) and because two of the six harbor seals caught in 2010 were ‘pups of year’ we have: n = 4 and m = 2, which make an estimate of 16 (upper 95% CI: 40).

The point estimates of these mark-recapture estimates are all lower than the maximum count in 2009. They all have relatively wide CI, which include the maximum count of 32, but the consistent lower value of all the mark-recapture estimates indicates that there is a bias in the sampling. One explanation can be that the marked seals are seals that spend more time around the island than the average harbor seal in the area and that makes them more likely to be captured in the first place and re-sighted and recaptured later on.

The estimates do, however, give more confidence to the assumption that a maximum count at Qeqertat on a warm and sunny day during the end of the molting period (early September) produced a minimum estimate that is close to the total population size. The high fraction of re-sightings two months after the first field work and recapturing of seals one year later, show that the seals in the area are stationary seals and not other seals passing through the area. These conclusions are also confirmed by the tracks of the tagged seals.

The population size in the southernmost part of Greenland is therefore not likely significantly higher than 32 which was the maximum count during 27/8-7/9 2009. Only few harbor seals were observed during searches in all of the southern part of the assessment area both prior to and during this study (during 2008-2010) and harbor seals are only rarely seen in the northern part of the assessment area. Any undiscovered concentration of harbor seals will have to be found on the east coast north of Prince Christians Sound (north of the assessment area.).

Most of the tagged harbor seals stayed within an average distance of 10.2 km from the tagging site (the islands "Qeqertat") and stayed close to the shore or within the fjord system in the area (Fig. 12). Four (27%) of the harbor seals (#200908377, #200908380, #201062028 and #201017776) conducted a trips up along the east coast as far away as 243 km (ca. 62.000N), 144 km (61.100N) 251 km (ca. 62.070N), and likewise 251 km (ca. 62.050N) away from the tagging sites respectively. The three adult harbour seals that travelled to the site ca. 250 km north were there during June and July, which could indicate that this is a breeding site far away from human settlements. The 144 km northward trip took place in December. The average and maximal recorded distance of the harbor seals from the shore were 1 km and 81 km respectively. Based on positions at sea the harbour seals on average frequented regions with depths of 52m.

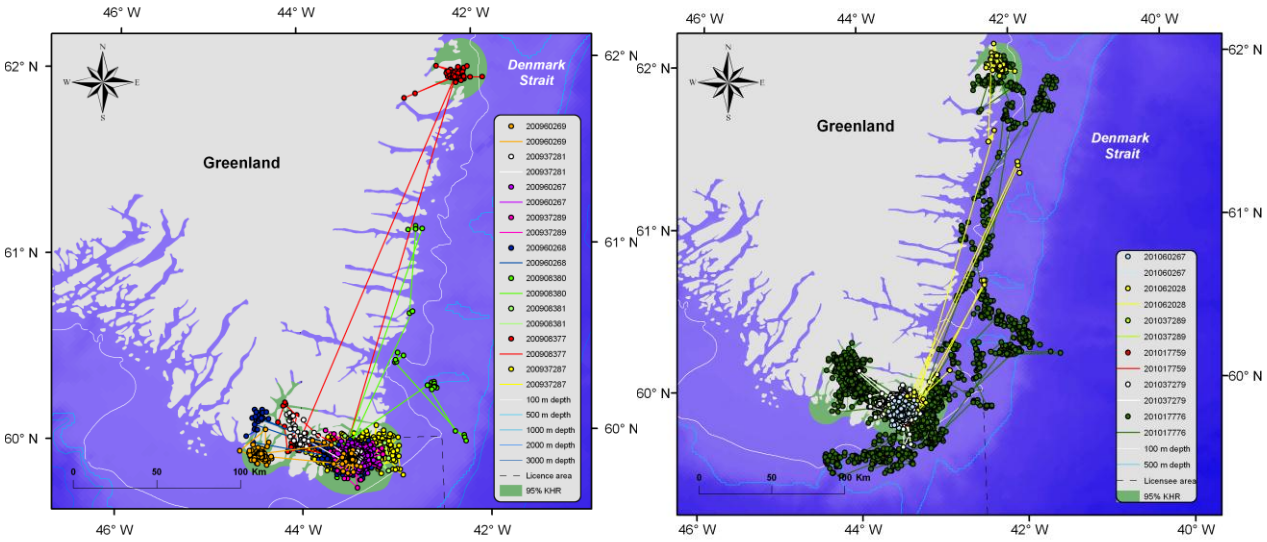



**Figure 14.** Positions and migration routes of nine harbor seals tagged in 2009 (left) and six harbor seals tagged in 2010 (right). Contact with the seal transmitters lasted from to 10-363 days. See Table 1 for more details.

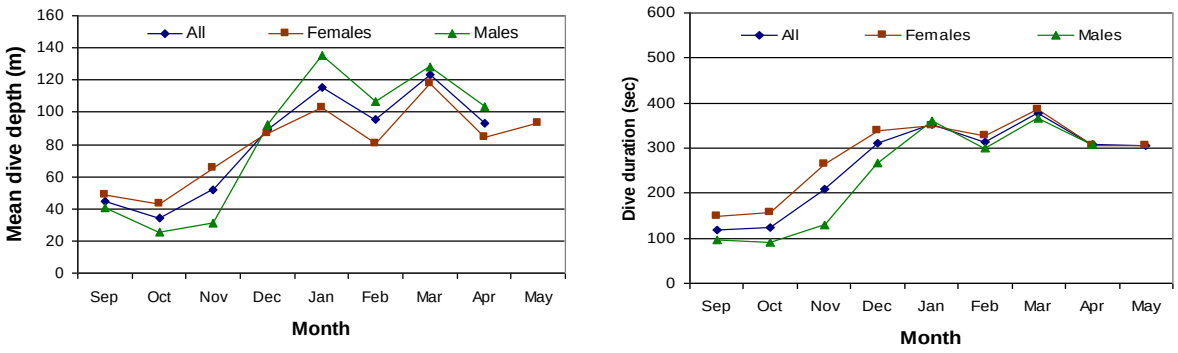



**Figure 15**. Mean dive depth (left) and mean dive duration for harbor seals during September 2009-May 2010.

Young harbor seal with transmitter glued to the head (Photo: Aqqalu Rosing-Asvid).

The harbor seals, like the bearded seals dove deeper and for longer periods of time during winter than during fall (Fig. 11, 15 and 16). This was mainly caused by more dives to the 200-400 m bins. Like for the bearded seal the longest dive lasted 20-25 minutes and the deepest dive was in the 500-600m bin. The deepest dives correspond to the deepest parts of the fjords and sounds near Cape Farwell and these dives are the deepest ever recorded for both bearded and harbor seals.

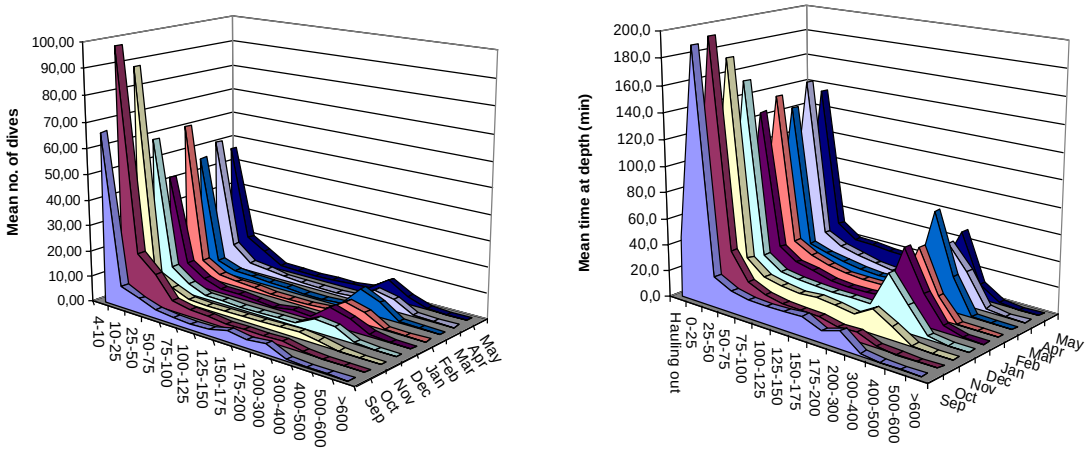



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**Figure 16.** Mean no. of dives (left) and mean time (right) spent in the various depth intervals by harbor seals during September 2009-May 2011.

**Grey seal (*Halichoerus grypus*)**

Grey seals have not previously been documented in Greenland. The first documentation was in 2009 when one or possibly two grey seals were seen and photographed during fieldwork on the small group of islands mention above (Rosing-Asvid et al. 2010). In September 2010 a grey seal (this time a pup of the year) was seen, caught and equipped with a transmitter.

First documented catch of a grey seal in Greenland.

(Photo: Aqqalu Rosing-Asvid)

*Conservation status*: As the grey seal is a new species in Greenland it is not listed in the Red List, and it is included in the category 'Critically Endangered' due to the low number of seals in the population. A complete ban on grey seal hunting in all of Greenland was imposed 1. December 2010.

*Critical and important habitat in the assessment area*: All three observations in Greenland are from the small group of islands, which also host the harbor seal colony. Whether these islands are the center for a very small group of grey seals or whether these grey seals belong to an unknown colony somewhere on the east coast or if they had only strayed from another country is unknown.

*Results from the SEIA seal project*: One male grey seal pup of the year (the first grey seal ever caught in Greenland) was tagged 4$^{th}$ September 2010. Unfortunately this tag only transmitted for 29 days. During this period the seal moved north along the east coast of Greenland and was tracked up to 224 km north of the tagging site (61.80$^{0}$N, Fig. 17). This male pup mainly stayed along the outer coast and made several offshore trips to depths up to 500 m. The average and maximal recorded distance of the grey seal from the shore were 6 and 68 km respectively. Based on positions at sea the grey seal on average frequented regions with depths of 176m.

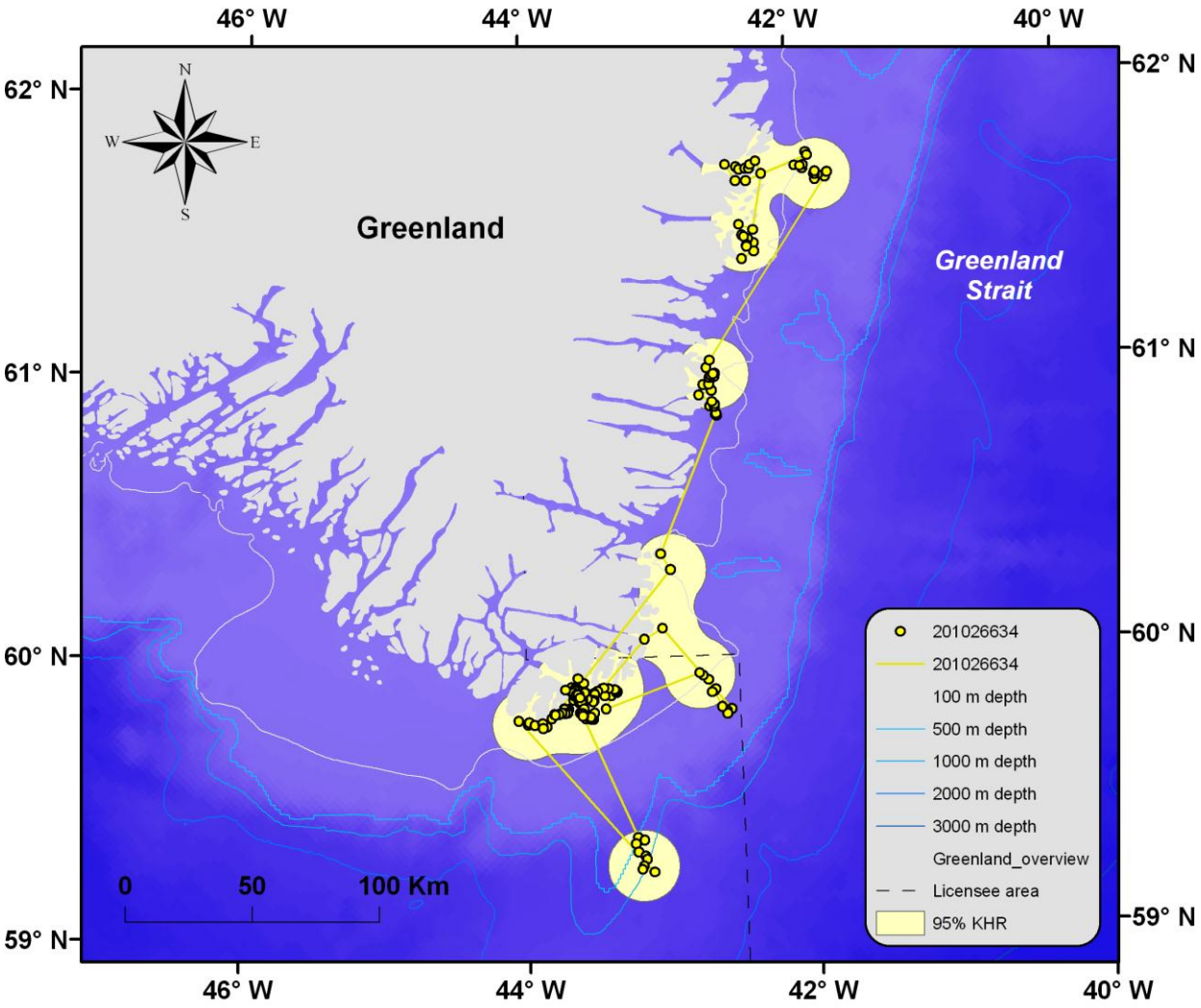


**Figure 17.** Positions and migration routes of a male grey seal (#2001026634, yellow) tracked within September 2010 in South Greenland.

### Tag performance

The tags lasted averagely 243 days with contact duration varying from 10 to 470 days (Table 1). As seven of the tags were still transmitting at the time of this status report, the final performance of the tags will be even better. The shortest lasting tags were probably deployed on seals that had not yet finished molting at the time of tagging. The longest lasting tag was a flipper tag (470 days) mounted on an adult male harbour seal. The flipper tags will not be shed when the animal molts the following year, as they are mounted in two holes in the hind flippers. A total of 21,220 positions were obtained from the 6050 days of contact with the five seal species.

| Species | Argos ID # | Rototag # | Tag type | Mount | Date of tagging | Date of last transmission | Days of contact | Positions obtained | Sex | Std Length (cm) | Weight (kg) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ***Harbour seal*** | | | | | | | | | | | |
| | 2009_37281 | 2 | Splash | Head | 31-Aug-2009 | 21-Jul-2010 | 324 | 112 | F | 140 | 85 |
| | 2009_08377 | 2 | Flipper Spot5 | Hind flipper | 31-Aug-2009 | 12-Aug-2010 | 346 | 276 | F | 140 | 85 |
| | 2009_60267 | 4 | Splash | Head | 1-Sep-2009 | 27-Oct-2009 | 56 | 367 | M | 132 | 63 |
| | 2009_37287 | 5 | Splash | Head | 1-Sep-2009 | 7-Aug-2010 | 340 | 2250 | F | 144 | 84 |
| | 2009_08381 | 7 | Flipper Spot5 | Hind flipper | 2-Sep-2009 | 16-Dec-2010 | 470 | 573 | M | 141 | 68 |
| | 2009_08380 | 8 | Flipper Spot5 | Hind flipper | 3-Sep-2009 | 30-Apr-2010 | 239 | 150 | M | 153 | 93 |
| | 2009_60268 | 9 | Splash | Head | 3-Sep-2009 | 23-Apr-2010 | 232 | 1643 | M | 158 | 99 |
| | 2009_60269 | 10 | Splash | Head | 5-Sep-2009 | 30-Jul-2010 | 328 | 262 | M | 150 | 105 |
| | 2009_37289 | 11 | Splash | Head | 6-Sep-2009 | 30-Jul-2010 | 327 | 885 | F | 148 | 76 |
| | 2010_62028 | 13 | Flipper Spot5 | Hind flipper | 2-Sep-2010 | 26-Jul-2011 | 327 | 266 | M | 144 | 95 |
| | 2010_17759 | 14+15 | Splash | Head | 2-Sep-2010 | 12-Sep-2010 | 10 | 107 | M | 160 | 113 |
| | 2010_37289 | 16 | Head Spot5 | Head | 2-Sep-2010 | 1-Dec-2010 | 90 | 241 | F | 90 | 29 |
| | 2010_17776 | 17 | Splash | Head | 3-Sep-2010 | 1-Sep-2011 | 363 | 3273 | F | 135 | 81 |
| | 2010-60267 | 22 | Head Spot5 | Head | 4-Sep-2010 | 15-Nov-2010 | 72 | 581 | M | 102 | 32 |
| | 2010-37279 | 4 | Splash | Head | 4-Sep-2010 | 25-Aug-2011 | 355 | 3371 | M | 146 | 79 |
| ***Bearded seal*** | | | | | | | | | | | |
| | 2009_37285 | 3 | Splash | Head | 1-Sep-2009 | 5-May-2010 | 246 | 1852 | M | 175 | 175 |
| | 2009_08378 | 3 | Flipper Spot5 | Hind flipper | 1-Sep-2009 | 5-Oct-2010 | 399 | 105 | M | 175 | 175 |
| | 2010_17567 | 18 | Splash | Head | 3-Sep-2010 | 28-May-2011 | 267 | 2729 | M | 195 | 200* |
| | 2010_62029 | 18 | Flipper Spot5 | Hind flipper | 3-Sep-2010 | 14-Aug-2011 | 345 | 266 | M | 195 | 200* |
| | 2010-34939 | 24 | CTD | Back | 6-Sep-2010 | 21-Dec-2010 | 106 | 578 | M | 196 | 204 |
| | 2010-62030 | 24 | Flipper Spot5 | Hind flipper | 6-Sep-2010 | 10-Aug-2011 | 338 | 363 | M | 196 | 204 |
| ***Ringed seal*** | | | | | | | | | | | |
| | 2009_08379 | 6 | Flipper Spot5 | Back | 1-Sep-2009 | 15-Apr-2010 | 226 | 34 | M | 64 | 12 |
| | 2010_34912 | 12 | CTD | Neck | 31-Aug-2010 | 10-Apr-2011 | 222 | 755 | F | 112 | 56 |
| ***Harp seal*** | | | | | | | | | | | |
| | 2010_00020 | 20 | No tag | - | 4-Sep-2010 | - | - | - | F | 94 | 30 |
| | 2010_00021 | 21 | No tag | - | 4-Sep-2010 | - | - | - | F | 105 | 140 |
| | 2010-67998 | 23 | Splash | Head | 6-Sep-2010 | 28-Sep-2010 | 22 | 181 | F | 147 | 84 |
| ***Grey seal*** | | | | | | | | | | | |
| | 2010_26634 | 19 | Splash | Head | 4-Sep-2010 | 30-Sep-2010 | 26 | 184 | M | 106 | 35 |
| Sum | N=23 | | | | | | 6050 | 21220 | | | |
| Average | | | | | | | 243 | 856 | | 142 | 92 |
| Min | | | | | | | 10 | 34 | | 64 | 12 |
| Max | | | | | | | 470 | 3371 | | 196 | 204 |

**Table 1.** Information on longevity and obtained positions of the five seal species tagged in South Greenland for the baseline assessment in 2009 and 2010. Note that the first harbor seal on the list carried two tags, one glued to the fur on the head and one attached to a hind flipper. This is also the case for the three bearded seals. Two harp seals were not satellite tagged but only tagged with numbered plastic tags (roto-tags) in the hind flippers.

## Most critical and important habitats for seals in the assessment area

The overall pattern of the seal dispersal based on the 95% Kernel Home Ranges indicates that the most important areas for the seals was within the 100 m bathymetrical isobath and with important feeding grounds within the fjords and along the east coast of Greenland. The tagged seals showed dispersal primarily in the 50-100 km northeastern corner of the License area and north of this.

All seals are sensitive to oil pollution, but the most critical and important habitats in the assessment area based on results from the SEIA seal project and earlier studies in the area are:

a.) The drift ice (mainly the frontal part) which during the last decade has been the breeding area to a small (around 1000), but growing number of harp seals. The pups will be very sensitive to oil spills from their birth (a two week period around 1. April) and the following 3-4 weeks.

b.) The drift ice (mainly the outer parts) is also important to a large fraction (the majority) of the West Atlantic hooded seal population. Many of these seals spend some time foraging, with this ice as a platform to rest on, during May-early June before they continue their migration to the molting area off the Greenland southeast coast.

c.) The small group of islands "Qeqertat" between: $59.88^0$N/$59.90^0$N and $43.45^0$W/$43.48^0$W, is at present the centre for the remnant population of harbor seals in South Greenland and it is the only place in Greenland from where the existence of grey seals have been documented.

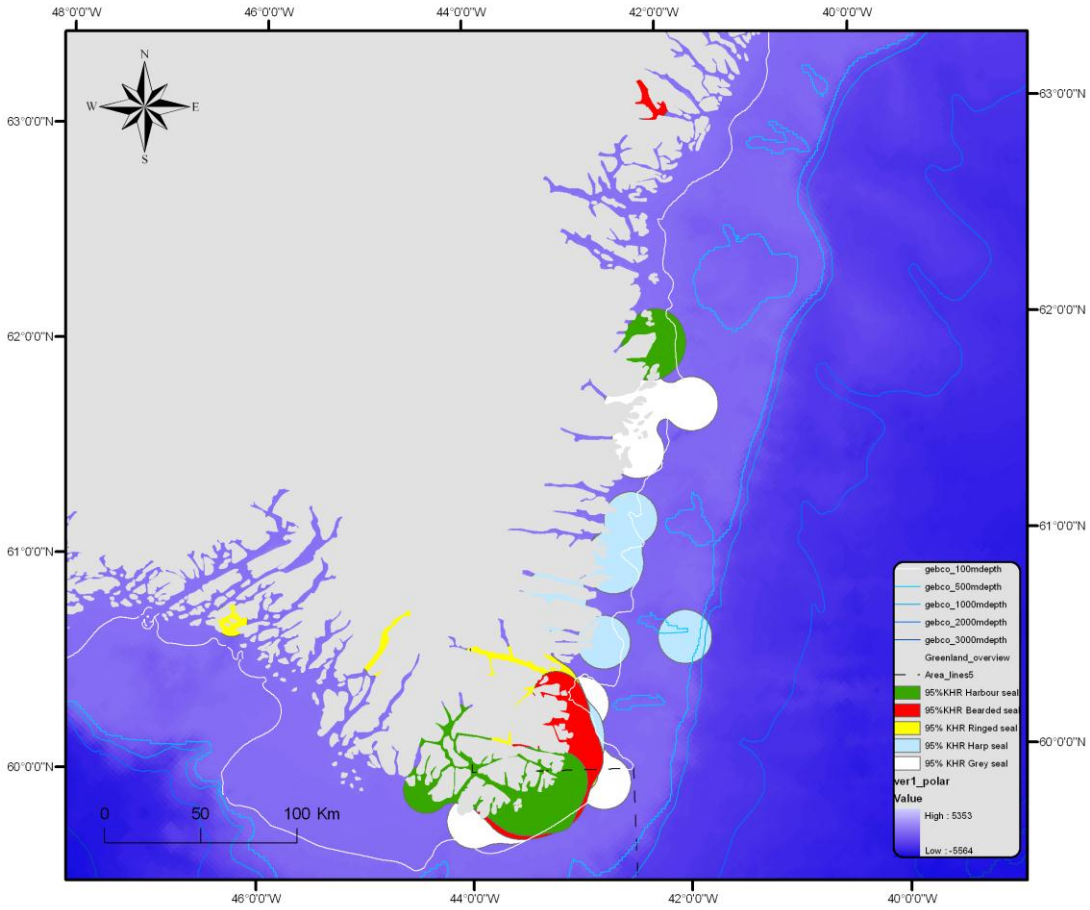


**Figure 18.** Ninety-five % Kernel Home range polygons for the 14 harbor (green), three bearded (red), two ringed (Yellow), one harp (Blue) and one grey seals (white) tagged in 2009 and 2010 in South Greenland.

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