Report of the NAMMCO Working Group on Coastal Seals 2016

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The Chair of the Coastal Seals Working Group, Kjell Tormod Nilssen, welcomed the participants to the meeting and commented that the WG had good representation from around the North Atlantic.

The original agenda was modified to discuss agenda Item "Seal Interaction with Fisheries and Aquaculture" first so that the by-catch information could be included in the population assessments. The modified agenda is available in Appendix 1.

1. TERMS OF REFERENCE

Nilssen reviewed the Terms of Reference for the meeting:

- assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway.
- address by-catch issues in Norway, Iceland, and the Faroe Islands
- re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
- develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).

2. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS

The participants' attention was drawn to the documents that were available to the WG (Appendix 2).

3. SEAL INTERACTION WITH FISHERIES AND AQUACULTURE

The WG discussed the nature and scope of interactions between seals and fisheries and aquaculture in Norway, Iceland, and the Faroe Islands.

a. Geographical review
b. Problem size
c. Mitigation methods in use

Norway

Bjørge presented paper SC/23/CSWG/08. Three different sources (mark recapture data, data from the Coastal Reference Fleet (a monitored segment of the coastal fishing fleet), and from modelling population trajectories) were used to estimate levels of by-catch of grey and harbour seals in Norway. The total harvest of grey and harbour seals is known for the period 1997-2014. Information is also available on the total number of flipper-tagged seals, the total number of tagged animals in the hunt, and the total number of returned tags from fishery by-catch during the same period (Table 1.).

Table 1. The total numbers of harvested and flipper-tagged grey and harbour seals, and tags recovered from the harvest and by-catch.

Species	Total harvest 1997-2014	Total tagged	Total tagged harvest	Total tagged by-catch
Grey seals	4311	2642	73	142
Harbour seals	7991	174	7	9

Assuming equal proportions of tagged animals among harvested seals and bycaught seals, the by-catch is:

Total by-catch = Tagged by-catch x Total harvest / Tagged harvest.

For grey seals this resulted in an estimate of total by-catch of 8,379 animals for the period 1997-2014, with an annual by-catch of 466 grey seals. The estimated total by-catch of harbour seals for the period 1997-2014 was 9,989 animals resulting in an annual by-catch of 555 harbour seals. The by-catch of grey seals is about twice the annual hunt (240 seals) and the by-catch of harbour seals is about 125% of the hunt.

Data from a monitored segment of the coastal fishing fleet were used to calculate by-catch rates, (number of bycaught seals per kg of the target species) in gill net fisheries for cod (*Gadus morhua*) and monkfish (*Lophius piscatorius*). General Additive Models (GAMs) were used to model by-catch rates and landing statistics from the Directorate of Fisheries which was then used to extrapolate to the entire fisheries with the same gear type. This gave an estimate of annual by-catch of 479 harbour and 84 grey seals in two gill net fisheries in the period 2006-2014. However, young grey seals could have been wrongly identified as harbour seal resulting in an under estimate of grey seals and overestimate of harbour seals.

A modelling approach to population trajectories of grey seals in Sør-Trøndelag and Nord-Trøndelag counties required an annual by-catch of 150 and 80 seals, respectively, in the two counties to explain a recent decline in observed pup production. However, the model fit was not good.

It is likely that the level of by-catches has been increasing in recent years north of 62°N due to an increase in fishing effort with large mesh gill nets, particularly in the monkfish fishery.

Discussion

The monkfish fishery started in Sør-Trøndelag and has moved north to Troms county in recent years. This is a relatively new fishery that increased in effort in the 1990s, and prior to 2010, each boat was allowed to use 1,000 gillnets (about 27 km in length). After 2010, a regulation was introduced to limit each boat to 500 gillnets. This is a new source of mortality that has been introduced into the area and this mortality is possibly the main reason for the rapid and significant decline in observed grey seal pup production in the Trøndelag counties. The conclusion was that the current grey seal population model (Øigård et al. 2012) is too 'stiff' to account for the rapid changes in pup production, and IMR is working on improving the model's ability to handle the data.

The WG suggested investigating whether the model can predict the 2012 pup production, which could give an idea of whether estimates of by-catch are reasonable.

The group discussed whether Norway has an estimate of non-reported recapture of tagged seals. Norway reported that these figures are not available, and the rate of under-reporting is unknown, therefore these by-catch estimates based on mark recapture data are considered minimum estimates. Underreporting of recovered tags and tag loss could contribute to underestimating the by-catch.

The WG also discussed how movements of animals in and out of tagging areas may influence tag recovery (and reporting of tag recovery) and therefore the estimates. For example, these by-catch estimates do not include animals that are tagged in Russia. In a previous joint Russian/Norwegian tagging program in the early 1990s many tags were recovered in Norwegian waters. There might also be migration of grey seals from Norway to Russia, UK, and other locations, and are not accounted for in these estimates. In addition, Bjørge and McConnell (1986) reported that many tags were recovered in Norway from grey seals tagged in the UK indicating that as many as 650 UK grey seals entered the Norwegian coast annually during the period 1960-1981.

The by-catches in the cod fishery peak in February-April while the higher levels seen in the monkfish fishery occur from July-December. The autumn removals probably have a more important impact on the population due to pups being most vulnerable to by-catch during the first 4 months after birth (Bjørge et al. 2002b). In a tagging study in Nordland county in 2012, four of five tagged grey seal pups were documented caught in gill nets a few months after tagging, and the track of the fifth pup indicated that it was caught. This should be considered in the population modelling.

The WG noted that knowing the age structure of the harvest and the by-catch is important if the ratio of the tagged seals to untagged seals from hunt is used to estimate by-catch. If the age structure is different between the harvest and the by-catch, this could result in a bias in the estimate of the by-catch. The model assumes age structure is the same, but this may not be correct. For example, in Canada, the age structure of the commercial harvest and “personal use” harvest is much different than the by-caught age structure.

The group also discussed whether the estimated by-catch levels can explain the observed drop in the grey seal pup production. If the by-catch rate is increasing over time, there is a lag in the effect on the pup production. The WG also suggested that the annual landings of the target fish species could be used to evaluate annual differences in by-catch estimated from the coastal reference fleet.

There may be other sources of mortality than by-catch and harvest, and these other sources might be showing up in the model. It is known that there is some predation by killer whales (*Orcinus orca*). It is unknown whether the number of killer whales is increasing in these areas, but it is known that the killer whale distribution is changing. During the winter, killer whales follow the over wintering herring and may move closer to seal colonies. In addition, killer whales along the Norwegian coast have been known to eat harbour and grey seals. In Scotland, killer whale predation on harbour seals seems to be on the increase.

The WG discussed whether killer whales in the North Atlantic are specialist predators on fish or mammals, but noted that while killer whales may eat both fish and mammals, individual pods of killer whales may be specialists to fish or mammals.

Grey seals may also be a source of mortality for harbour seals, either as predators or as competitors. In various areas where harbour seals and grey seals overlap, the population growth rate of harbour seals is usually lower. This has been seen in the Baltic Sea, Sable Island (Canada), Scotland, and New England (USA).

For the current grey seal assessment, even though the population model may not be completely accurate, it is known that the mark-recapture estimates are likely more realistic, and should be used in this population assessment. For near future grey seal assessments, the mark-recapture would not work because there has not been recent tagging. Therefore, future assessments should use data from the reference fleet, and explore the possibility of estimating annual variation in by-catches.

Fish farming
The aquaculture industry in Norway is extensive and in 2015 it comprised 990 locations for salmon (*Salmo salar*) and trout (*Oncorhynchus mykiss*) farming, 79 locations for other fish species, and 151 locations for shellfish farming. The industry is distributed along the entire coastline, but the highest numbers of farms is on the west coast from Hordaland to Nordland county.

In order to investigate the level of interaction between seals and fisheries, Norway tagged 29 harbour seals with radio tags in an area in Møre with 3 fish farms and a high density of harbour seals (Bjørge et al. 2002a). The tagged seals were not attracted to the farms, and the fish farmers did not report conflicts with seals in the area when interviewed. However, in other areas, farmers report on conflicts with seals that are thought to be grey seals. Farmers are allowed to shoot seals near farms and reporting is mandatory, but little to no reports are provided to the Directorate.

Faroes

By-catch
It is not thought that by-catch of grey seals in Faroese fisheries is a problem because there is no gillnet fishery in shallow waters. The longline fishery for halibut may be the only somewhat problematic fishery, but it is believed to by-catch less than 10 animals annually. This is not supported by data, but communication with fishermen has not revealed reports of more by-catch.

Removals at fish farms
For the Faroes, the most significant interaction of grey seals is in connection with salmon farming, and occurs in the vicinity of the sea farms spread around in the archipelago. Salmon farmers have been licensed with rifle permits for shooting seals, when interacting with their sea farms, as a protective act. The salmon farming industry grew significantly in the early 1980s, with farms started at suitable sheltered locations around in the islands. With the development of this industry, culling of grey seals also evolved. Hunting logbooks have not been mandatory, and therefore no statistics are available on the number of grey seals harvested at salmon farms from the early days of the industry. No management regime has been implemented; fish farmers are free to shoot all seals approaching the farm.

In 2009, a logbook recording system for fish farmers was implemented to register seals shot at sea farms. The aim was to gain reliable harvest statistics on a mandatory basis, following a recommendation by the NAMMCO Scientific Committee. All sea farms were asked to

register seal harvests on a monthly basis, and deliver statistics annually. It has taken time to have the reporting system introduced and improved. The system is not optimal, and there is still a demand to remind the industry, consisting of four companies operating at 35 localities today, to deliver their annual harvest statistics.

The grey seal harvest statistics from the Faroes are not complete (the largest company, with 21 of the 35 fish farm licenses, is missing in the statistics). In 2010, when harvest numbers were available from all farms, around half the seals were shot at farms of this company. Total harvest numbers for three companies (40% of fish farms) were ca. 153 seals in 2011, 132 seals in 2012, 63 in 2013, 113 in 2014 and 94 in 2015. Anticipating that these numbers represent about half the removed seals, the total numbers of grey seals removed at aquaculture farms in the Faroe Islands are estimated to be around 150-250 grey seals annually.

Other possible removals
There is no recreational hunt for grey seals in the Faroes. The tradition of seals as food has waned; therefore, although there could be removals that are not documented, these are likely low.

Other induced mortality, i.e. reporting on suspicious sighting of dead seals, perhaps indicating a virus outbreak or other illnesses have never been documented or described in the literature. Perhaps a more notable source of mortality, especially for the small grey seal population in the Faroes, could be predation by killer whales.

Discussion
The WG noted that there is no reliable population estimate. A best rough estimate is around 1,000-2,000 animals. The removals via aquaculture may be high enough to have kept the population at low levels. These removal levels (150-250 seals) are around 10-20% of the rough estimate of population size. The group expressed concerns that removals seem high compared to the population levels.

The Faroes do not have an age structure of the removals from either by-catch or grey seal removals at fish farms. Information from other areas indicates that it is likely that it is the adults feeding at farms as specialists. For example, in the UK, seals that are shot in association with aquaculture are usually adult males who are holding territory. There have been previous recommendations to the Faroes to collect the carcasses to obtain biological parameters of the culled seals.

The WG discussed the inter-annual variability in levels of removals that are reported. There does appear to be wide variability based on the logbooks that have had multiple years reporting (up to four fold in successive years).

As discussed in further detail under Item 4.3, the WG noted that the abundance of this population is unknown, and it is important to get at least a minimum population estimate in order to assess whether the level of removals is sustainable.

Iceland

By-catches of seals in Iceland should, according to legislation, be reported. The Marine Research Institute (MRI) is systematically collecting by-catch information on all marine mammal species in an annual gill net survey. Comparison of that data with logbooks has,

however, shown that a large proportion of by-caught marine mammals are not reported. The most reliable by-catch numbers could be obtained by extrapolating numbers from a cod gill net research programme and fishery inspection trips on lumpsucker (*Cyclopterus lumpus*) boats.

Gunnlaugsson et al. 2014 described recent efforts to obtain by-catch estimates. In 2013, a study was initiated to obtain by-catch estimates. Reports from inspectors on board vessels and the fishermen reports were compared in the lumpsucker fishery. There were some discrepancies in reported numbers (both ways, with inspectors reporting numbers both higher and lower than the fishermen), and it appears that some of these can be explained by incorrect dates on the fisherman's reports. MRI has developed a correction factor for fishermen's logbook reports.

Discussion

The WG noted that Iceland does not have information on the age structure of the by-caught animals.

Fish farming

In Iceland there are approximately 10 fish farms, and the industry is increasing. The farms are generally not subject to predation from seals due to the use of double netting that is mainly used to keep cormorants and other birds out, but also keeps the seals out.

Fish farmers are allowed to shoot seals near the farms, but it is unknown how many are shot per year. A survey (described in Osmond 2013) was put out to fish farmers to investigate this, but resulted in only a few responses. However, the removals are thought to be low, about 2-3 per year.

Interaction with salmon fishery

The main harbour seal hunting occurs around the river mouths. Since it is likely that not all hunters are included in the present catch statistics, there is a clear need for an improved catch reporting system. There is insufficient regulation for hunting seals and it is not required to report numbers of shot seals.

Iceland is currently conducting research into diets to look at whether seals are eating salmonids, but thus far have found little evidence of predation on salmon (via hard parts, stable isotopes, prey-DNA and low reports of injuries on the salmon in rivers from seals). The WG discussed the likelihood of detecting salmon hard parts in scat and cautioned that otoliths may not always pass through the GI tract intact, and some species, such as salmonids, erode easily and may therefore be hard to detect. However, vertebrae should be recoverable and can provide evidence of species consumed. Iceland noted that they are aware of this problem and that vertebrae are also collected, and that the combination of different methods is used due to this potential problem with salmonid otoliths.

Smout cautioned on using broad scale sampling because there may be specialist seals that are concentrating on the salmon, and if they are not sampled then it appears that the seals do not eat salmon. Iceland noted that they were attempting to avoid this problem by collecting as many samples as possible to try and detect possible salmon specialists. They currently have a large number of samples. One idea that was discussed to attempt to identify salmon specialists was a photo ID study. This could be a "citizen science" type of project where people are asked to take photos of "problem seals", and attempt to individually identify these specialists.

The group discussed using pingers at the river mouths to deter seals from the area. This is potentially problematic for a few reasons. One problem is that pingers can also lose their effectiveness over time and end up being an attractant, almost like a "dinner bell" which indicates the presence of fish to the seals. However, there are now some new types of pingers with particularly aversive sounds that appear to last longer as a deterrent. Another problem is that the area is actually an important pupping site, and it could be a problem for the seal population to be deterred from this area.

Nematode infestation
Previous studies showed high parasite (sealworm) loads. There was a bounty on grey seals prior to 2009 and harbour seals until 1995 to try and reduce parasite loads in fish. No follow up studies on parasite loads were conducted after 1999 to see if decreasing the seal population had an effect on parasites. Although the relationship between seal population size and infestation rate is not 1:1, it would be interesting to measure the current infestation levels as seal populations are decreasing. Samples should be obtained from the area where the previous studies were carried out.

Sealworms are also an issue in Norway, and seals have been culled in the past in order to try to reduce the sealworm population, however no studies were conducted to follow up the sealworm abundance in fish after culling seals. After the PDV-epidemic in 1988 which resulted in a decline of more than 50% of the harbour seal population in Østfold county, a sharp decrease in sealworm infestation rate in cod was observed. However, the decrease in infection levels appeared to be short-lived, with higher worm burdens in cod a year after the observed decrease (Clers and Andersen 1995).

4. STATUS OF HARBOUR SEAL STOCKS
    a. Information on catches and regulatory measures
    b. Current Research (Biological parameters, stock identity, distribution/migration)
    c. Population assessments

The WG discussed the status of harbour seals stocks in the North Atlantic. A summary of the current abundance and trend is provided in Table 2.

4.1 Norway

Catches
Document SC/23/CSWG/10 provides information on the catches of harbour seals from 1997-2015 (Table 3). The hunt has been regulated by quotas since 1997, and in 2003 the quotas and bounties were increased. In 2010, a management plan for harbour seals was implemented, and since then there have been decreases in the yearly reported catches. The Directorate of Fisheries has not received any reports of removals around fish farms, but it is likely that there are removals.

Hunters must sign into the hunt and report their catch to the county daily. The hunt is stopped when the quota is taken.

<u>Discussion</u>
Traditionally seals were mainly hunted for the meat, but the skin was also used. After 1945, the hunt greatly reduced the harbour seal population, and in some areas the seals were protected.

Stock identify

The current management units for Norwegian harbour seals are defined by county limits (see Fig. 1) and hunting quotas are given by county (SC/23/CSWG/05). However, information on movements patterns of harbour seals in Norway (Bjørge et al. 2002b; Ramasco 2015) as well as recent genetic evidence of fine scale population structure in Danish and Swedish waters (Olsen et al. 2014), raise concerns that there may be population subdivision within counties.

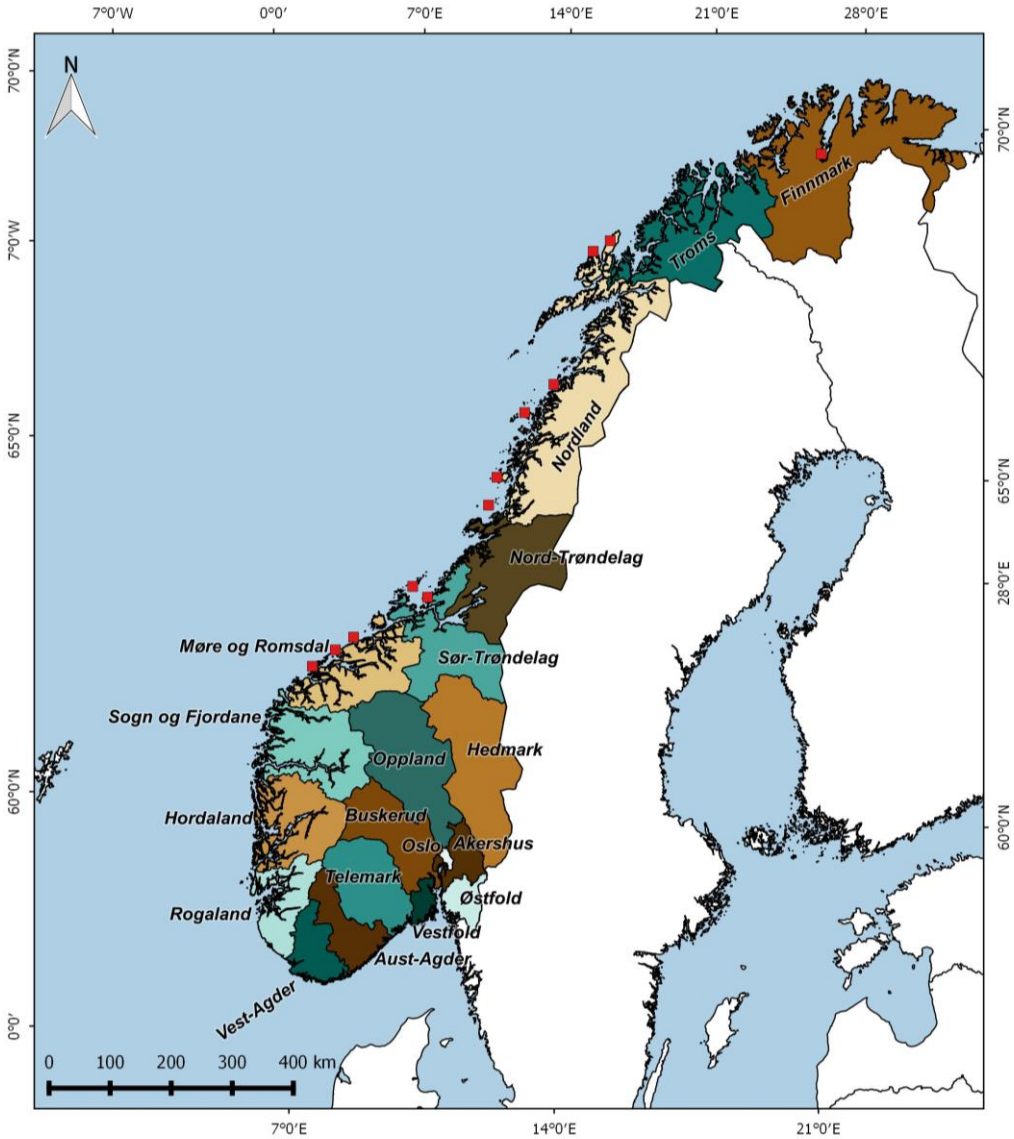

Fig. 1. Counties in Norway. Red squares indicate locations where DNA samples were collected.

In particular, in some of the counties that are quite large (with a long coastline), the management units are likely much bigger than the biologically significant populations. In order to investigate this, a genetics study was initiated to look at the population structure, particularly within the largest counties. For the past few years, genetic samples have been collected in breeding colonies along the Norwegian coast (Fig. 1) to evaluate the delineation of management units. So far, 173 samples are available from 6 major breeding areas. Analyses of 14 microsatellite markers for these samples show clear evidence of population subdivision between 3 breeding areas within Nordland county. All of these areas also show significant differences with samples collected in Sør-Trøndelag county and with samples from

the more southern county of Møre and Romsdal. No significant difference was found between the two neighbouring counties Sør-Trøndelag and Møre and Romsdal, but this could be due to low sample size for Møre and Romsdal. Only 4 samples were available for the northernmost county of Finnmark and therefore no conclusions can be drawn from this material. Earlier analyses of mitochondrial sequences from hunted samples in Finnmark and Troms counties have, however, shown significant differences between the Porsangerfjord area and neighbouring areas on the coast of northern Troms and western Finnmark (Frie, unpubl. data). In addition, mitochondrial control region sequences will also be analysed for the breeding samples and more breeding samples will be included in the analyses as they become available.

Table 2. A summary of the current abundance and trends of harbour seals in the North Atlantic. More detail is provided under each country's agenda Item.

Country	**Survey Year(s)**	**Abundance**	**Current trend**
Norway			
Entire mainland coast	2011-2015	7,642	stable
western Finnmark	2013	395	stable
Iceland			
	2011 (full survey)	11,000-12,000	
	2014 (partial survey)	ca 8,000*	declining?
Greenland	None	<100	unknown
Russia			
Murman coast	1998	500	unknown
Sweden and Denmark			
Skagerrak	2015	6,000	increasing (6.6%/yr)
Kattegat/ Danish Straits	2015	10,000	increasing (6.2%/yr)
southern Baltic	2015	1,000	increasing (8.4%/yr)
Limfjord	2015	1,000	increasing (5.6%/yr)
Kalmarsund	2015	1,000	increasing (9%/yr)
Wadden Sea	-	25,000	uncertain (see 3.5)
France	2008	150	unknown
United Kingdom			
Scotland	2007-2014	23,355	local declines (Moray Firth)
England and Wales	2007-2014	4,806	stable or increasing
Northern Ireland	2007-2011	948	stable or increasing
Eastern Canada			
south of Labrador	1970s	12,700	unknown
Estuary and Gulf of St Lawrence	1994-2000	4,000-5,000	Unknown
Eastern United States	2012	75,834	decline?

* This abundance is calculated assuming that the populations are stable in the other parts of the country that were not surveyed in 2014 and therefore should be used with caution. See Item 3.2.

Table 3. Harbour seal catches in Norway.

Year	Østfold	Vestfold and Telemark	Rogaland	Sogn og Fjordane	Møre og Romsdal	Sør-Trøndelag	Nord-Trøndelag	Nordland	Troms	Finnmark	SUM
1997	9	0	4	12	10	3	4	12	4	2	**60**
1998											**83**
1999	5	0	19	24	72	36	12	102	22	16	**308**
2000	10	0	33	78	30	51	2	115	31	9	**359**
2001	18	0	31	83	64	60	12	160	29	9	**466**
2002	28	0	34	67	63	76	5	101	33	5	**412**
2003	19	0	28	95	0	123	10	154	23	15	**467**
2004	19	0	35	93	68	82	6	111	87	48	**549**
2005	22	0	36	93	42	101	13	109	87	111	**614**
2006	7	0	44	40	37	86	18	197	69	40	**538**
2007	28	0	47	41	67	178	18	386	95	45	**905**
2008	18	0	46	42	62	185	19	383	95	50	**900**
2009	30	0	35	40	64	140	22	111	100	43	**585**
2010	9	0	17	13	25	33	6	37	9	10	**159**
2011	14	0	15	0	0	21	5	106	64	5	**230**
2012	15	0	12	0	0	89	5	164	60	10	**355**
2013	13	0	28	22	19	118	6	222	57	26	**511**
2014	10	0	26	20	20	15	0	211	78	29	**409**
2015	10	25	14	26	19	15	0	141	27	20	**297**

Status

Harbour seals were counted along the entire mainland Norwegian coast at known haulout sites during the moulting period from mid-August to early September 2011-2015. In 2011 and 2012, moulting areas from Rogaland to Finnmark counties and in Østfold county were covered by aerial photo surveys flown at altitudes of approximately 245-275 m during low tide (± 2 hours). Surveys in Østfold county were flown at approximately 90 m. The small tidal amplitudes in Østfold permitted counts to be carried out during day time irrespective of the tidal cycle. Usually three independent surveys were conducted. Visual counts using binoculars from small boats and land were also carried out in areas not covered by aerial surveys, or where results from the aerial surveys seemed to be incomplete. The surveys revealed a minimum total population of 7,642 harbour seals along the mainland Norwegian coast in 2011-2015. In western Finnmark, 395 harbour seals were counted in 2013. West Finnmark was not covered in the two previous surveys. The 2011-2015 count of 7,247 harbour seals (not including West Finnmark) is close to the counts of 6,938 animals in 2003-2006 and 7,465 in 1996-1999.

Discussion

Seals in the water are counted during the boat-based counts, but only counted close to haulout sites in the aerial surveys, likely underestimating seals in the water in the aerial surveys. The WG asked what proportion of the counts are based on the boat-based counts versus the aerial counts, and whether there could be an issue with sometimes counting the animals in the water and sometimes not. Norway informed the WG that the numbers of animals counted in the water are generally very small and therefore have little effect on the counts. The group

concluded that as long as the methods are kept consistent, it works fine as index numbers and trend analysis.

It could be important to investigate whether haulout behaviour has changed over time. For example, seal haulout behaviour may have changed due to behavioural changes in response to predation and/or disturbance. Some harbour seal areas in Norway may be affected by tourism (e.g. kayaks) and some fishing activity. In the UK, modelling of the haulout behaviour of harbour seals revealed that the most important covariate ended up being day of the week which was found to be related to the weekend days when people were out walking their dogs close to seal haulouts.

Request from the Norwegian Directorate of Fisheries
The Directorate has asked for advice on setting a quota for seals in Aust-Agder county, citing an influx of seals from the Swedish coast.

The Secretariat noted that this request did not follow the proper procedures for requests for advice from the NAMMCO Scientific Committee, and that the WG therefore was not in a position to give formal advice on this issue. Nevertheless, the WG did comment that there is no data supporting seals coming from other areas into Norwegian Skagerrak. Additionally, there are too few seals in this area to set a quota. Norway is planning to start telemetry studies on seals in Norwegian Skagerrak to get information on possible movements between areas and may be able to comment further after the result from these studies are available.

Recommendations for Norway

- Increase the number of vessels in the reference fleet in the areas of high by-catch (especially Nordland that has a long coastline)
- Increase survey effort. Important areas could be identified to be surveyed in between other full-coast surveys.
- Management by county should be re-examined, as these management units do not always follow the population structure of harbour seals, especially Nordland county. This is discussed further under Item 6 (Review of the Norwegian management plan)
- Reporting of all removals. Currently there is little to no reporting of removals around fish farms, or of by-catches in commercial gill net fisheries and recreational fisheries.
- Collect data from by-catches (age, sex, etc.). It would be ideal to collect jaws from bycaught seals which will provide information on age, sex and species. It would be particularly helpful to have samples from the reference fleet.

4.2 Iceland

Management
In 2006, the Icelandic government published a management plan where a minimum population size of 12,000 harbour seals was recommended (NAMMCO annual report, 2006). The management plan states that management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor a definition the term “appreciably”. A partial harbour seal count in 2014 indicates that the population was already under the recommended population size (see population assessment below).

Catches and regulatory measures
Traditional hunting of harbour seals has decreased from around 3,000-4,000 in the 1980s to around 300 per year during the last decade. In Iceland, seal hunting does not require a specific

hunting license (only the license to own a weapon), and no specific quota system has been established for the seal populations. Seal hunting from land and shallow waters is managed by land owners and there are no special protected areas or protected periods (e.g., breeding season) of the year for seals except those imposed by land owners and general regulations on hunting. It is not mandatory to report direct seal catches to the government. Members of the Seal Farmers Union (SFU) can voluntarily report their catch statistics to the organization and other known hunters are contacted directly by the Icelandic Seal Center.

The catch numbers from the early years are likely reliable because there was a bounty (to reduce sealworms), so hunters had a good incentive to report their numbers. Recent catch numbers are less reliable.

Population Assessment

Harbour seal surveys are conducted during the moulting period in August, and in the first nine surveys the entire coastline was surveyed at least once. During the latest full census in 2011 (Granquist et al. 2011), the survey method was updated following Teilmann et al. (2010) and the whole coast was counted 3-4 times instead of once like in earlier surveys. The population size in 2011 was estimated to be between 11,000 and 12,000 animals.

Due to financial reasons a full census has not been conducted since 2011. However, a partial count was carried out in 2014, where areas with known high harbour seal density were counted (northwest, west and south west parts of Iceland). In the same areas that were surveyed in 2014, 62.0% (SD = 5.07%) of the seals were found in the survey from 2011, and hence given that the distribution of the seals has not changed severely, these areas should give a fairly good indication of the status of the population. The results showed that on average, the annual decrease was 28.55% in the surveyed areas. It should, however, be underlined that there are too many unknown variables to know if the decrease is applicable to the rest of the country (Granquist et al. 2014). Nevertheless, assuming that the decrease found in 2014 only applies to the counted areas and that the population is stable in other areas, the whole population is estimated to have decreased from ~11,500 to ~8,000 animals between 2011 and 2014.

There is a large uncertainty regarding reasons behind the possible decline and further research regarding this is necessary. One theory has been that a decrease in sandeel (*Ammodytes marinus*) could have affected the seal population. Hunting could have played an important role in the harbour seal population decrease, but it is uncertain how much. Due to low reliability of direct catches and by-catch numbers, the reported numbers of removals can be seen as a minimum and hence, human removals probably have an effect on the seals. The knowledge about the stock identity of the Icelandic harbour seal population is also scarce and more research regarding pup production, general age distribution in the population, etc. is needed.

Current research on biological parameters and stock identity

A study on haulout patterns of harbour seals in Iceland has confirmed that the timing of surveys is appropriate. The distribution of seals showed a bimodal pattern, with the first peak occurring in late May/early June and the second peak occurring in late July/early August, corresponding to pupping and moulting period respectively (Granquist and Hauksson 2016). Further, factors affecting the haulout probability were air-temperature, tide height and wind-direction which of only tide height has been possible to taken in to consideration in previous censuses. According to the results of Granquist and Hauksson (2016), the population should

preferably be surveyed during a period of approx. 3 weeks, starting in the end of July. A challenge with the Icelandic census is, however, that a fairly large coastline has to be covered in a short amount of time, which has been proven to be hard due to often bad weather conditions and poor visibility and hence few possible flying days. This has resulted in prolonged survey time, which could reduce the significance of the results.

A more detailed study of the timing of pupping and factors affecting pupping under Icelandic conditions is planned and a pilot study on Vatnsnes, NW Iceland shows that the peak of the pup/adult ratio was reached the 15th of June and that the main pupping period was late May/early June (Hauksson and Granquist 2016).

The condition of the harbour seal population was investigated by Hauksson and Ólafsson (2016) by comparing blubber thickness on the lower end of sternum from seals caught in 1981, 1995 and 2009. The results showed that blubber thickness was lower in 2009 compared to the two other years, both for female and male seals which indicate that the condition of the seals has decreased. The reason for this needs further investigation.

In collaboration with an engineering company in Iceland (Svarmi ehf), possibilities for using infrared cameras on drones for monitoring seal haulout sites is being developed.

The importance of harbour seals as prey species for killer whales is being investigated using stable isotope analysis.

Stock identity

Andersen et al. (2011) found that Icelandic harbour seals were significantly differentiated from harbour seals in Greenland, Northern Norway and Svalbard. Two subsamples from Iceland analysed by Andersen et al. (2011) did not show significant differentiation, but their haplotype composition differed strongly from earlier data presented by Stanley et al. (1996). The reason for this discrepancy is not clear but could possibly derive from sequencing problems in the earlier analyses when technical aspects of sequence analysis were less developed.

Muscle samples from Icelandic harbour seals will be included in a study of harbour seal DNA from several populations including Norway and the UK, the study will hopefully help resolving uncertainties.

Discussion

The WG noted that it is somewhat illogical that it is mandatory to report by-catches, but not hunted animals.

The WG discussed at length the target population level for harbour seals that has been set by the Icelandic government, which is not based on any biological assessment. Over the past decade, a number of approaches have been developed to manage marine mammal populations. These management approaches incorporate the precautionary approach (PA) which strives to be more cautious when information is less certain, does not accept the absence of information as a reason for not implementing conservation measures, and defines, in advance, decision rules for stock management when the resource reaches clearly stated reference points (Punt and Smith 2001). The basis for this approach is to identify points or levels, referred to as conservation (limit), precautionary and target reference points, that provide an indication of the status of a population (ICES 2001). The NAMMCO/ICES/NAFO Working Group on Harp and Hooded Seals has developed an approach that has been adopted

by Norway, Russia and Canada to manage harp and hooded seals. It is also consistent with the approach developed by HELCOM. Using the highest population level observed or inferred as the reference level, WGHARP identifies a precautionary level at 70% of the reference and a critical level at 30% of the reference level. Below the critical level, the population is considered to be in danger of serious harm while a population that falls between the critical and precautionary levels is considered to be a conservation concern.

If a similar management approach was adopted for Icelandic harbour seals, the reference level would be 33,000 which was the highest population observed. The Precautionary level would be 23,100 and the Critical level would be approximately 10,000. The current minimum number identified in the Icelandic Management Plan would fall within the cautionary zone, only slightly above the Critical Level. The most recent full population survey (2011) was 11,000 and would place the population just above the Critical Level. However, if the population estimate of 8,000 (from the partial survey in 2014) was used it could place the population below the Critical Level.

The IUCN has developed criteria to identify when populations are a conservation concern. One of the key indicators is a decline in abundance from historical levels. For example, IUCN considers a 50% decline in abundance over a period of up to 3 generations to be sufficient to classify a population as Threatened while a decline of 70% would indicate that a population should be considered Endangered. Harbour seals are considered to have a generation time of 15 years which would result in considerations of declines over a period of up to 45 years. The Icelandic harbour seal population would meet the criteria for Endangered according to the IUCN framework

Recommendations for Iceland

- An assessment survey of the entire population should be conducted as soon as possible
    - Surveys should then be conducted every 2 years while the population is lower than the target level
- All removals should be reported (e.g., hunting, by-catch, etc.)
- A Management Plan should be developed including outlining the frequency of surveys and legislation of seal hunting
- The target population level objective should be re-evaluated and be based on biological criteria.
- Reproductive rates should be collected
- The effects of disturbance from tourism should continue to be investigated
    - Develop mitigation measures
- The method of catching pups in nets should be investigated. In NAMMCO, killing methods should be immediate. This issue should be referred to the NAMMCO Hunting Committee.

4.3 Greenland

At SC/22, Greenland reported that "…a new small group of harbour seals (three mothers with pups) was documented. Only four regularly used haulout places (with a total of less than 100 seals) is presently known in Greenland. All hunting on this species was banned in 2010 and it is believed that several small remnant populations still exist, but live undetected."

4.4 Sweden and Denmark

Annual harbour seal population growth rates after 2002 varied between 5.5 and 9% among areas, which is considerably lower as compared with earlier decades, when annual growth rates varied between 11 and 12%.

Total projected numbers in 2015 amounted to about 6,000 harbour seals in the Skagerrak, with a rate of increase of 6.6% per year (since 2002), and there are signs of that the population is approaching the carrying capacity.

The Kattegat/Danish Straits harbour seal population size is estimated at 10,000, with a rate of increase of 6.2% from 2002-2015. This rate is lower than the +12% increases seen in previous years, suggesting that the growth is levelling off, possibly caused by density dependent effects.

The Southern Baltic harbour seal population is 1,100, with an average annual rate of increase of 8.4% up to 2015.

The size of the Limfjord harbour seal population appears to have been fluctuating around 1,000 individuals since the early 1990s and appears to have reached its carrying capacity, although an annual increase at 5.6% is suggested by the surveys from 2003-2015. However, genetic analysis indicates that there may be movement of seals between this area and the Wadden Sea.

The harbour seal population in Kalmarsund is genetically divergent from adjacent harbour seal populations (Goodman et al. 1998) and experienced a severe bottle-neck in the 1970s, when only some 30 seals were counted. Long-term isolation and low numbers have resulted in low genetic variation in this population (Härkönen et al. 2006). The population has increased annually by 9% since 1975 and counted numbers amounted to about 1000 seals in 2014. See also Härkönen and Isakson (2011).

Discussion

The WG inquired whether grey seals could be having an impact on the Kattegat/Skagerrak harbour seals, however the grey seal population is small in this area so it is unlikely.

4.5 Mainland Europe

The Wadden Sea Secretariat writes on their home page: “Since the last massive epizootic in 2002, which killed almost half of the population, harbour seal numbers increased constantly until 2013. The experts considered recent growth rates as a sign that the overall increase of the population has slowed down. Traditionally the seal counts are conducted during the moulting period in August, when many animals rest on haul out sites on sand banks and beaches. Consequently, last year’s influenza effects were documented for the first time in this year’s seal numbers. In Denmark and Schleswig-Holstein, which were mostly affected by the disease, 3,400 harbour seals were found dead or severely sick. In Lower Saxony and the Netherlands only a small number of dead animals were found later in the year. Last year’s assumptions by the TSEG that the disease might not have a major impact on the overall population were finally confirmed by seal numbers in 2015. During the surveys a total of 26,435 harbour seals were counted in the Danish, Dutch and German Wadden Sea”

Harbour seals in France occur in three areas: Baie du Mont Saint Michel, Baie des Veys and Baie de Somme. The largest colony is situated at the Baie de Somme, with a maximum of 186 individuals recorded on one occasion in the summer of 2008. No later data are available.

4.6 United Kingdom

Smout gave an update on the status of harbour seals in the UK.

Latest UK survey results
From August surveys carried out between 2007 and 2014, the minimum number of harbour seals counted in Scotland was 23,355 and in England & Wales 4,806 making a total count for Great Britain of 28,161. Including 948 harbour seals counted in Northern Ireland in 2011, the UK harbour seal total count for this period was 29,109.

In the annually surveyed part of the Moray Firth (Helmsdale to Findhorn), the moult count was the lowest ever recorded for this area. The severe decline continued in the Firth of Tay & Eden Estuary harbour seal Special Areas of Conservation (SACs see http://jncc.defra.gov.uk/page-23 and http://jncc.defra.gov.uk/ProtectedSites/SACselection/SAC_list.asp?Country=S), with the 2014 moult count (29) being the lowest recorded to date, 42% lower than the 2013 count (50). This new count suggests that only 6% of the average population counted between 1990 and 2002 currently remain within this harbour seal SAC. No additional declines have been identified in other parts of the UK, for which new data are available (i.e. east coast of England, W Scotland), and populations seem to be stable or possibly even increasing. Surveys planned for August 2016 will hopefully complete the current round-Scotland survey.

Intensive study in the Northern Moray Firth Area
Behavioural, demographic and population data from a population in part of the Moray Firth (north- east Scotland) were used to fit an age-structured population model in order to estimate vital rates and changes in these rates over time. A Bayesian hidden process approach facilitated detailed modelling of observation errors e.g. allowing for the behaviour of animals to influence the probability of observing them. The effects of removals due to shooting were included. Forecasts from the model suggest a slow population recovery in the near future. Of the demographic rates, the fecundity rate seems to vary most rapidly, suggesting this parameter is particularly sensitive to short-term environmental changes. The possible impact of covariates on vital rates was also investigated including prey, environmental indices, and biological variables such as grey seal population density and concentration of biotoxins. Evidence of an effect was found for two of these: (a) grey seal abundance (affecting pup survival) and (b) sandeel abundance (affecting fecundity).

4.7 Russia

No new information was available to the WG. Table 2 gives an abundance estimate from 1998 as reported in Zyryanov and Egorov (2010).

4.8 Canada

Little is known about the current status of harbour seals in eastern Canada given the last, and only comprehensive, study was conducted in the early 1970s when the total population south of Labrador was estimated to be 12,700 (Boulva and McClaren 1979). Since then research has

been limited to specific areas. After increasing during the 1980s, harbour seal abundance on Sable Island underwent a rapid decline through the 1990s when it was estimated to be less than 100 animals (Bowen et al. 2003). In contrast, harbour seals are reported to have increased in the Bay of Fundy although the numbers are not known. Sjare et al. (2005) found that the distribution of harbour seals in Newfoundland and Labrador was generally consistent with observations made in the 1970s. There was also limited evidence suggesting that local abundance of seals at some known haulout sites in the more southern portions of the province may have increased while abundance at sites in more northern areas of the west, northeast and Labrador coast are generally consistent with reports from the 1970s (Sjare et al. 2005). Based on surveys carried out between 1994-2000, abundance of harbour seals in the Estuary and Gulf of St. Lawrence was estimated to be approximately 4,000–5,000 animals (Robillard et al. 2005). However, trends in abundance could not be determined due to the small number of surveys.

Discussion

The WG noted that the last survey in eastern Canada was conducted 45 years ago, and whether this stock could be considered data deficient in the IUCN system.

The WG suggested that Canada collect data on harbour seals in eastern Canada, especially an abundance estimate.

4.9 Eastern US

Abundance and Removals

The most recent abundance survey for harbour seals in the U.S. was conducted in May 2012. Aerial photographic surveys and radio tracking of harbour seals on ledges along the Maine coast were conducted during the pupping period, to count seals and to develop a correction factor for the fraction of seals not observed. The corrected estimate of harbour seal abundance in 2012 was 75,834 (CV=0.15) (Waring et al. 2015a). The 2012 population estimate was 24% lower than the 2001 estimate of 99,340 (CV=0.09) (Gilbert et al. 2005). Currently there is some uncertainty in the patterns of harbour seal abundance and distribution in the Northeastern U.S. Johnston et al. (2015) document a decline in stranding and by-catch rates of harbour seals, providing support for an apparent decline in abundance. However, there has been very little systematic research conducted on fine-scale changes in habitat use, particularly in relation to the sympatric population of grey seals. Therefore, a decline in the apparent abundance of harbour seals could be explained by changing distributions and survey designs. There are plans to conduct a new survey in the next few years.

For the period 2008-2012, the total human caused mortality and serious injury to harbour seals was estimated to be 441 per year (Waring et al. 2015b). This includes 431 (CV=0.12) mortalities in U.S. commercial fisheries, and 10 from non-fishery related causes.

5. STATUS OF GREY SEAL STOCKS

a. Information on catches and regulatory measures
b. Current Research (Biological parameters, stock identity, distribution/migration)
c. Population assessments

The WG discussed the status of grey seals stocks in the North Atlantic. A summary of the current abundance and trend is provided in Table 4.

5.1 Norway

Catches
Prior to 2003 catches were reported in block periods, so they are reported as an average per year. After 2003, quotas were introduced. IMR recommended quotas of 5% of the population but the quotas were set at 25% of the population. The highest catches were in the northernmost counties of Troms and Finnmark (Fig. 1, Table 5). Tags from animals tagged in Russia have been recovered in northern Norway and two animals satellite tagged in Russia moved to Norway (Henriksen et al. 2007)

Genetics
The microsatellite data fits well with the current management areas, while the mitochondrial data shows sign of further subdivision (Frie unpubl. data).

Table 4. Recent abundance and trends of grey seals in the North Atlantic.

Country	**Recent Survey Year(s)**	**Abundance**	**Current trend**
Norway			
Total	2011	Pup production (2006-2008): 1275 Total: 8,740 (95% CI 7,320-10,170)*	increasing
Trøndelag and Nordland	2014-2015	Pup production: 332?	ca 60% decline in pup production
Finnmark		206	stable
Iceland			
	2012	4,200 (95% CI: 3,400-5,000	declining?
Faroe Islands			
	None	~1,000-2,000**	unknown
Baltic			
	2014	~33,000	increasing
Wadden Sea	2015	4521	increasing
France	2007	150	
United Kingdom			
Inner Hebrides	2014	4,054 (pups)	slight decline
North Sea	2014	6,627 (pups)	increasing
Republic of Ireland	2012	2,100 (pups)	increasing
Eastern Canada	2014	505,000 (95% CI: 329,000-682,000)	increasing

* Modelled estimate; ** This estimate is not based on survey data.

Pup production surveys and modelling
Øigård et al. (2012) used a population model to describe the dynamics of the Norwegian grey seal population based on data from the three pup counts covering the entire grey seal distribution area in the period 1996-2008, as well as empirical data on hunting and by-catch mortalities. The model also required estimates of natural mortality and female reproductive rates, but since empirical data on these parameters were outdated or absent, they were estimated by the model using a Bayesian approach. Model runs indicated an increase in abundance of the total Norwegian grey seal population during the last 30-years, suggesting a

total of 7,120 (5,710 – 8,540) animals (1+) in 2011. Including an estimated pup production of 1,620 (95% CI 1,410-3,050), resulting in a total of 8,740 (95% CI 7,320-10,170) animals estimated in 2011.

Table 5. Grey seal catches in Norway. See Fig. 1 for county locations.

Year	Rogaland	Sør-Trøndelag	Nord-Trøndelag	Nordland	Troms	Finnmark	SUM
1980	0	0	14	8	3	55	**80**
1981	0	0	31	20	3	55	**109**
1982	0	80	10	65	3	55	**213**
1983	0	55	0	78	3	55	**191**
1984	15	200	8	146	3	55	**427**
1985	5	32	0	0	3	55	**95**
1986	5	10	0	16	3	68	**102**
1987	5	10	22	38	3	68	**146**
1988	5	10	5	20	3	68	**111**
1989	5	10	5	20	3	68	**111**
1990	5	10	5	20	3	68	**111**
1991	5	10	5	3	3	5	**31**
1992	5	10	5	3	3	5	**31**
1993	5	10	5	3	3	5	**31**
1994	5	10	5	3	3	5	**31**
1995	5	10	5	3	3	5	**31**
1996	5	10	5	3	3	5	**31**
1997	5	10	5	3	3	5	**31**
1998	5	10	5	3	3	5	**31**
1999	9	44	14	7	3	53	**130**
2000	70	45	5	31	3	22	**176**
2001	27	20	12	34	12	0	**105**
2002	23	24	19	20	5	19	**110**
2003	44	96	46	120	9	50	**365**
2004	30	67	51	94	42	54	**338**
2005	51	48	34	105	14	127	**379**
2006	60	51	27	69	39	129	**375**
2007	60	40	23	134	35	174	**466**
2008	60	40	72	103	37	203	**515**
2009	67	31	62	119	4	235	**518**
2010	38	19	38	41	20	208	**364**
2011	23	7	5	25	25	26	**111**
2012	17	8	14	16	8	12	**75**
2013	31	14	20	58	1	59	**183**
2014	65	11	19	41	12	68	**216**
2015	59	0	0	17	1	4	**81**

New boat based surveys carried out in the entire area from Froan in Sør-Trøndelag to Lofoten in Nordland in 2014-2015 showed a significant decrease in the grey seal pup production compared with the counts in the period 2007-2008. The 2014-2015 pup counts in each area ranged between 34.8% and 47.5% of the counts in 2007-2008. In Finnmark the pup production in 2015 was approximately equal to the results in 2006.

These new pup counts were included in the Øigård et al. (2012) model resulting in estimated populations in 2016 of 453 (95% CI: 300-606), 263 (95% CI: 108-418), 1,128 (95% CI: 685-1,571) and 1,328 (95% CI: 914-1,742), respectively for the counties Sør-Trøndelag, Nord-Trøndelag, Nordland and Finnmark. When assuming the same population sizes in 2016 as in 2006-2008 for the counties Troms and Rogaland, the total number of grey seals in Norway was suggested to be 3,850 animals (95% CI: 3,504-4,196) in 2016.

The population dynamics model of grey seals (Øigård et al. 2012) is too constrained to reproduce the inter-annual variability pattern observed in the pup production data, most likely as a result of lack of model complexity i.e. the model includes too few biological processes. Also, the lack of updated pup counts in Troms and Rogaland suggest that the 2016 estimate should be re-examined and the 2011 estimate considered to be the most recent acceptable.

Discussion

A significant decline in pup production has been observed in the counties Sør-Trøndelag, Nord-Trøndelag and Nordland, suggesting a possible decline in the total population. However, the current population model is unable to account for the decline, therefore the total abundance estimate is not reliable. The decline in pup production is likely due to high levels of by-catch in the monkfish fishery. The WG suggested that it could be interesting to plot the monkfish catches against the pup production. Although they do not have annual surveys, it could be a good visual comparison.

Detailed suggestions were given for improvements for the modeling, such as incorporating improved input estimates of by-catch for the model, age structure of the by-catch, and temporal (and spatial, if possible) variation in by-catch. Another suggestion was to use the modelling to estimate ‘catchability’ parameters for grey seals in fishing gear. These would directly scale actual fishing effort (or catch, although that is less useful as an index) into seal deaths. It might be possible to use observed by-catch rates from the reference fleet as priors for these catchabilities. Catchabilities could be estimated as a function of seal age.

Recommendations for Norway

- Development of the model. The model must be re-examined to try and determine if it can be modified to account for the observed changes in pup production. Can the model estimate changes in mortality that could explain the drop in pup production?
    - First update the by-catch, using the coastal reference fleet, create an annual estimate of by-catch based on annual landings statistics. May start to capture the fluctuations.
    - Need to look at age structure of the by-catch, especially if some older animals are taken. Samples for age data should be collected (e.g., jaws).
- More frequent surveys, particularly in the areas of decline. A survey every 5 years is not sufficient to detect these rapid drops in pup production. These data will also help refine the population model.
- Tagging of grey seal pups

- Age-structure of the hunt: If the mark-recapture flipper tags are used for by-catch estimation, the age structure of the hunt needed because flipper tag recoveries from the hunt are used in the equation for by-catch estimates. The age structure of the hunt is assumed to be the same age structure as the by-catch, and this assumption needs to be tested
- Complete the genetics study within this year
- Increase the number of vessels in the reference fleet in the areas of high by-catch (especially Nordland)
- Increased survey effort on grey seal assessments in areas of significant decline. Important areas could be identified to be surveyed in between other full-coast surveys.
- Reporting of all removals. Currently there is little to no reporting of removals around fish farms and from both commercial gill net fisheries and recreational fisheries

Additional recommendations related to the evaluation of the Norwegian management plan for grey seals are listed in Item 6.

5.2 Iceland

Current management
In 2006, the Icelandic government published a management plan where a target grey seal population size of 4,100 was recommended (NAMMCO annual report, 2006). Management actions should be initiated if the population dropped appreciably below that number, but no specific population regulating method was mentioned, nor was "appreciably" defined. Calculations based on the latest population count in 2012 reveal a 44% likelihood that the population was smaller than the recommended number of 4,100 animals, which should be consideration in regards of management and exploitation of the population.

The regulations for hunting are the same as for harbour seals. The number of direct catches of grey seals are few, with only 1-2 recorded per year in recent years.

Status
Pup counts were conducted during the pupping period since 1980 (11 full surveys and 4 partial counts) of all breeding sites. The assessments are mainly performed via aerial surveys, with some ground and boat based surveys. The pupping period is 29 September-31 October, with the peak at 5 October. Until 2005, only one count was performed at each site, but since then three counts were performed at each site. The pup counts are minimum estimates because they are not corrected for possible missed pups.

The most recent abundance estimate (from the 2012 survey) is 4,200 (95% CI: 3,400-5,000).

The reference point for the highest population level was 10,000 from a survey in 1991 but this should be considered a minimum estimate because the survey was only flown once and therefore seals may have been missed on that particular day.

In 2007-2010, 58 hunted seals were aged and found to be mainly pups and juveniles.

A tagging study has begun, where 200 pups have been tagged so far. Tagging will continue during the next population count. So far, only 3 tags have been recovered from by-catch.

Discussion

As similarly discussed for the harbour seal (Item 3.2), the target population size set by the Icelandic government is not based on biological assessments.

If a similar management approach (see Item 3.2, harbour seals) was adopted for Icelandic grey seals, the reference level would be 10,000 which was the highest population observed. The Precautionary level would be 7,000 and the Critical level would be 3,000. The current minimum number identified in the Icelandic Management Plan would fall within the cautionary zone, above the Critical Level. The most recent population estimate (~4,200) would place the population below the Precautionary Level.

The WG also discussed that this population might not be above the minimum viable population size (Traill et al. 2010) necessary to maintain genetic diversity, which has been estimated to be around 5000 individuals (95% CI = 3577–5129).

Additionally, the rate of decline may be greater than it appears (i.e., the previous population size was larger) because the previous estimates are not as reliable as the estimates since 2005.

Stock structure
Frie also noted that genetics studies (Frie 2009) indicate that the Icelandic grey seals are an isolated population.

Recommendations for Iceland

Primary
- A Management Plan should be developed including:
    - the frequency of surveys
    - legislation of seal hunting
    - Re-evaluation of the target population level objective with the new level being based on biological criteria.
- A complete survey should be conducted to obtain a full, reliable abundance estimate
- Reporting of all removals (e.g., by-catches, hunted seals, any other removals)

Next steps
- Pup production surveys at least 3 times to make sure that the peak pupping period is covered.
    - Iceland should also consider tagging pups for staging.
    - Iceland should also investigate whether the peaks in pupping differ in different areas around the country.
- Genetics samples should be collected and analysed to explore stock structure

5.3 Faroes

Mikkelsen presented paper SC/23/CSWG/16. For grey seals in Faroese waters, the most updated knowledge was on stock identity. Grey seal samples from Faroe Islands were integrated in a study on population structure and demographic history, using samples from 22 colonies from Western and Eastern Atlantic and the Baltic Sea (Klimova *et al*., 2014). The markers used were represented by a 350 base-pairs region of the mitochondrial hypervariable and up to nine microsatellites. The overall finding of the study was a strong population structure among the colonies. Interestingly, a highly asymmetrical pattern of gene flow was inferred, with the Orkney Islands being a sort of emigrants to other areas in the Eastern

Atlantic. Furthermore, the expansion across the species range had mainly occurred in the postglacial period. Additionally, Cammen *et al*. (2011), when studying the genetic diversity in the major histocompatibility complex of grey seals from 8 colonies in UK, Sable Island and the Faroe Islands, found significant genetic differences between all colonies. With respect to the grey seal colony in the Faroe Islands, the results show that they have evolved from UK colonies sometimes after the postglacial period, and that the colony has been isolated, evolving to a distinct population.

Movements of Faroese grey seals have been investigated using satellite tags. The seals were found to be stationary on the Faroe Plateau, where only a few of the seals were tracked outside the 100m depth contour. Also, for most of the tracking period the seals were distributed close to their preferred haul-out sites, which typically numbered one to three sites. Movements between locations occurred mainly in shallow waters. When making multiple trips to off-shore feeding areas, the seals typically repeated their tracks to the same area. No seal was found to move longer distances from land than 35 nautical miles and for no longer period than three days. The overall movement pattern demonstrated that Mykines, Dímun and Fugloy are hot spot areas for grey seals in the Faroes.

Movements of UK grey seals to the Faroe Islands have been documented based upon both flipper and satellite tags (Hammond *et al*. 1993, Boyd and Campbell 1971, McConnell *et al*. 1999). Although a connection between Faroese and British grey seals has been demonstrated, showing that Faroese waters could be part of the space used by grey seals from the British Isles (Matthiopoulos *et al.* 2004), the intensity or influence of such a migration is not known. Of 199 grey seals tagged with satellite transmitters in UK, two seals travelled to the Faroes (1% of the tagged animals).

Population assessment

There has not been a population assessment for Faroese grey seals. Grey seals seldom haul out in high numbers in the Faroes. At most, up to 30 can be seen at favourable haulout sites, with the exception of the island of Mykines which is probably the most densely populated and frequently used area, where up to 300 seals can be seen at times. The present population size is probably on the level of 1,000-2,000 animals. Irregular observations around the islands indicate that the Faroese population has not shown a rapid increase, as has been evident for colonies around Britain (NAMMCO 2003) and in West Atlantic (Bowen *et al*. 2003). The main reason is thought to be because seals are subject to removals around salmon sea farms. This removal, which seemingly is keeping the population at a low level, started with the establishment of aquaculture in the islands in late 1970s. Also, high pup mortality, especially during the intense fall storms which could wash pups off breeding grounds, may affect population growth of grey seals in the Faroes. Many former breeding grounds, described by Landt (1800), are not in use today. The reason may be increased human activities and landscape deformation, forced by wave action, eroding the steep foreland of the Faroes (Reinert 1982, pers. obs.). A reduction in the number of protected breeding grounds, acting as a factor of density-dependence, may have affected breeding success. For the relatively small population of grey seals in the Faroes, removal of a significant number of animals around fish farms, together with high pup mortality, will have the potential for a significant impact on the size and development of the population.

Discussion

As discussed under Item 3, the impact of removals at fish farms may be high considering the uncertain, and small, estimated population level. The WG recommended that the Faroes 1)

obtain reliable and complete removal numbers and 2) calculate the necessary population size to sustain the removals.

The Faroes appears to have a localized population based on telemetry and molecular markers (Klimova et al 2014), that is significantly different from Norwegian grey seals. Frie (unpubl. data).

Recommendations for the Faroe Islands

Recommendations for research and monitoring are discussed under agenda Item 7.

5.4 Baltic

The Baltic grey seal (*Halichoerus grypus macrorynchus*) is a recognised subspecies of the Atlantic grey seal (*H.g.grypus*). The subspecies is motivated by distinct geographical distribution range in the Baltic Sea and a difference in birth timing (Oct. –Jan. in East Atlantic, Jan. - March in the Baltic).

In the Baltic, the grey seal has been heavily hunted during the 20th century and also the fertility rates were reduced by environmental toxins in the second half of the century. The population went through a depression in the 1970s with numbers as low as only 3,000 individuals (Harding and Härkönen 1999). In the last decades of the 20th century the population started to recover and currently the species is classified as “least concern” in the HELCOM Red List of Species (HELCOM 2013).

Given the continuous distribution of the species and free movement of individuals in the Baltic Sea the species is treated as a single management unit, and the grey seal management principles are defined by the HELCOM Seal Recommendation (HELCOM 2006). The long term objectives are: to allow population growth towards the carrying capacity, to allow the breeding seals to expand to suitable distribution in all areas of the sea, and attaining health status that secures continued existence of the populations. The population target limit is defined by the ecological carrying capacity.

The grey seal population is monitored by counting the hauled out proportion of the animals during the annual moult. The counts are based on aerial photography and monitoring effort is synchronised between countries to reduce double counting. Population increase is calculated from the counts and has reached 10-12% per annum during the early 2000s, but has slowed to about 6% in recent years. Counted numbers fluctuate annually because of weather and other factors, but clear increasing trends in populations can be observed in all parts of the Baltic Sea. In sub–areas, the increase in seal counts is most notable in Southern Sweden - Danish Belts. Pup numbers cannot be used for population estimate in the Baltic as the species prefers ice as a breeding platform where pups are more difficult to count.

<u>Discussion</u>
When ice-conditions are poor, the seals will move to breed on land in roughly the same area. If there is ice present at all, they will breed on the ice. Therefore, accounting for pups on the ice could be very important, however the abundance estimates are based solely on the moult counts, not a population dynamics model.

Breeding time is earlier in the southern Baltic (January-early February). Younger females tend to breed earlier than older females in the Baltic, however in the UK younger females breed later.

Jüssi noted that weaning weights of pups born on the ice are higher than pups born on land, and weaning weights of ice-born pups in recent years are lower than in the 1990s. The WG noted that the weaning weights were not significantly different in different areas. Despite the differences, the lower weaning weights may not be below the critical weaning mass limit. Information on survival of the pups after weaning would be interesting.

5.5 Russia (Murman Coast)

There is no updated population estimate since the early 1990s on grey seals (Haug et al. 1994) from Russia, when the total grey seal population were calculated to be about 3400.

5.6 United Kingdom and Republic of Ireland

Smout presented information on status of grey seals in the UK and the Republic of Ireland.

In the 2014 grey seal breeding season, pup production at the Inner Hebrides colonies was estimated to be 4,054, slightly lower than the 2012 estimate of 4,088.

At the four English North Sea colonies, pup production in 2014 was 6,627 compared with 4,963 in 2012 and 5,539 in 2013. There was a massive increase in the number of pups born at Blakeney Point (2,425 pups born in 2014 compared with 1,560 in 2013) which is now the biggest grey seal breeding colony in England, overtaking Donna Nook (1,799 pups) for the first time.

Some investigations were carried out, based on the existing Bayesian state-space modelling methodology for British grey seal populations. The model allowed for density dependence in pup survival, using a flexible form for the density dependence function, and assumed no movement of recruiting females between regions. This model is identical to that used to provide last year's advice, and the same "revised" priors were used, including a prior on adult sex ratio. One small change in data was that the total population size estimate was adjusted to account for the fact that the population model is based only on regularly monitored breeding colonies (approx. 94% of the total population). We used the model to predict past the last data point (2012) to give estimates of population size in 2014. Estimated adult population size in 2014 was 95,200 (95% CI 76,400-127,500).

The model assumes constant adult (i.e., aged 6+) female survival. The prior distribution has support in the range (0.8, 1.0) with a prior mean of 0.91 (SD 0.05); the posterior mean is an implausibly high 0.99 (SD 0.01). We investigated the effect of constraining the prior to the range (0.8, 0.97). Posterior mean adult survival with this revised prior was 0.95 (SD 0.03); estimated population size with this revised prior was 105,200 (95% CI 87,000-128,800).

Female survival is currently assumed to be the same for all ages. We investigated the possible effect of including survival senescence, and concluded that adding it would make no practical difference to the modelled population dynamics.

Sex ratio is an important parameter in the model, scaling estimates of adult female population size from the population dynamics model to total population size (total population refers to the population of moulting 1+ animals). The current prior 1.7 (SD 0.02) that is applied to the female numbers from the population model is highly informative (assuming that there are 0.7 male to 1 female). We investigated the consequences of using a less informative prior suggested in a previous briefing paper (prior mean 1.2, SD 0.63). With this prior (and the revised prior on adult female survival), total population size was estimated to be much lower (88,600 with 95% CI 70,200-111,700), but the ratio of total population:adult females was an implausibly low 1.14 (SD 0.09).

In the Republic of Ireland, an increasing trend in pup production was observed in 2012. A pup production count in 2005 showed 1,600 pups while a new estimate in 2012 indicated an increase to 2,100 pups.

Discussion

The WG identified a couple of issues with the model. Firstly, the model shows that fecundity is high, but pup survival is very low. There may be inconsistency between the "independent estimate" and the pup counts, forcing fecundity to be too high. The August survey is probably not reliable because there is likely a lot less grey seals in the UK versus in the breeding season.

The problem may also lie with the sex ratio which is assumed to be 1.7 but is based on very old data. Further modelling did not give any information on the sex ratio, suggesting that more information is needed.

The main problem with the model is putting all density dependence on pup survival, which forces the fecundity rate up to unrealistic levels. If the density dependence was split between pup survival and fecundity, then the rate should be more realistic. The WG suggested testing the model's ability to predict the density dependent relationship for both fecundity and pup survival at a single point.

In addition, vital population parameters estimated by the model-fitting process deviate dramatically from empirical data on grey seals and all other phocid seals. Numbers of pups in the UK have increased by 5-6% per year over a longer period and amount to about 58,000. Therefore, there must have been a steady recruitment of females to the adult population section by 6-7% per year (assuming that pregnancy rates do not change and constant juvenile survival). Consequently, each sub adult cohort must have been more numerous than subsequent adult cohorts. This means that the very high pup mortality used in the model is unrealistic. If empirical values on vital population parameters for grey seals based on estimates from other areas are used in a Leslie matrix, the female population size needed to produce 58,000 pups would be about 130,000 females of all age classes, and the total population size including males could be about 250,000 (however, this depends on the sex ratio in the UK population which is not currently well known). The model fit currently has very low juvenile survival compensated by very high adult female survival and high fecundity. Further work is needed on the model to make the outputs (estimates of vital rates) more realistic.

5.7 Mainland Europe

Härkönen reported on annual pup production and moult counts in the Wadden Sea (Danish, German and Dutch coasts). Following a remarkable increase in 2014, the total number of grey

seals in the Wadden Sea was 4,521 during the moulting period in spring. This is an increase of 5% compared to last year. The number of 829 pups indicates a further growth of the breeding population. For the first time specific grey seal counts in Denmark were conducted and the first newborn pup in the Danish Wadden Sea was documented. It seems that the grey seal population is establishing itself further in the Wadden Sea area and that the population is expanding northwards

In France, the most recent data available was a count of 150 grey seals 2007.

5.8 Eastern Canada

Canadian grey seals form a single genetic population that is divided into three groups for management purposes based on the location of breeding sites. Most pups (81%) are born on Sable Island (Sable), while 15% are born in the Gulf of St Lawrence (Gulf) and 4% are born along the coast of Nova Scotia (CNS). These proportions have changed over time, with a decline in the fraction of the population born in the Gulf.

The most recent assessment of Canadian grey seals was completed in 2014. A population model incorporating estimates of reproductive rates up to 2012 was fitted to pup production estimates up to 2010 to describe the dynamics of the grey seal population in Atlantic Canada. Combining all three herds, the model estimated a total 2014 grey seal pup production in Atlantic Canada of 93,000 (95% CI=48,000-137,000) animals, with an associated total population of 505,000 (95% CI=329,000-682,000). The model predicts that population size in all three management areas continues to grow.

Surveys to estimate current pup production were completed in February 2016. The results of these surveys, and a new estimate of total abundance, are expected in the fall of 2016.

In Canada, removals from the population from 2008-2013 include animals taken in the commercial harvest (1+) (an average of 389 per year), for scientific collections (an average of 205 per year), and as nuisance animals (an average of 3461 per year) (DFO 2014). Estimates of the number of seals killed as nuisance seals are poorly known. There are no data available on incidental catches, but the numbers are thought to be small.

5.9 Eastern US

Abundance and Removals

Efforts are underway to derive a minimum population estimate and population trend for the portion of the grey seal stock in U.S. waters, based on aerial surveys conducted in Massachusetts from 2005-2015 during grey seal moulting periods. In addition, the use of fixed-wing and rotary drones, as well as manned aircraft, was used to conduct surveys in 2016 over the grey seal breeding grounds in the U.S. These data will be used in coordination with those collected by Department of Fisheries & Oceans Canada (DFO) in 2016 to estimate pup production over the entire range of the stock.

For the period 2008-2012, the total estimated human caused mortality and serious injury to grey seals in U.S. waters was 1,095 per year (Waring et al. 2015b). This includes 1,086 (CV=0.11) mortalities in U.S. commercial fisheries and 9 from non-fishery related causes. Analysis of by-catch rates from fisheries observer programs likely underestimates lethal (Lyle and Wilcox 2008), and greatly under-represents sub-lethal, fishery interactions. Photographic

analysis of grey seals at haulout sites on Cape Cod, Massachusetts revealed 5-8% of seals exhibited signs of entanglement (Sette et al. 2009).

6. REVIEW OF HARBOUR AND GREY SEAL STUDIES ON ECOLOGY

General

The WG noted that harbour seals appear to be declining in many areas where grey seals are increasing. There are some hypotheses that involve grey seals causing the decline, either through competition for prey or breeding/haulout areas. Although there have been observations of grey seals predating on harbour seal pups, there are little data to indicate if this could have any impact on the harbour seal populations.

Norway

Grey seal diet

In order to achieve the knowledge of feeding habits and prey consumption of grey seals, data were sampled in selected areas along the Norwegian coast. Prey were recovered from 298 grey seals, including 128 gastrointestinal tracts and 177 faecal samples, collected between spring 1999 and winter 2007 in the Nordland, Finnmark and Rogaland counties. The grey seals fed on a wide variety of mainly benthic fish, where the most important prey were the gadoids cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and saithe (*Pollachius virens*), and the wolffish (*Anarchichus* spp).

Total annual grey seal prey consumption of various species was estimated using a bio-energetic model. The input variables in the model are seal numbers, energy demands, diet composition in terms of biomass and the energy density of prey species throughout the year. Assumed that the observed grey seals diet composition in the sampling areas are representative for the diets in the three management regions Lista - Stad, Stad - Lofoten, Vesterålen - Finnmark, the mean total annual consumption of 3850 grey seals (95% CI: 3504-4196) of various fish species was estimated to be 8 240 tonnes (95% CI: 4664-12846) in Norwegian waters. The total estimated grey seal consumption of wolffish was 2088 tonnes (95% CI:1227-3164), while the total consumption of cod was 2102 tonnes (95% CI: 1311-3164). Mean consumption estimates of saithe, haddock and unidentified codfish were respectively 720, 311 and 2570 tonnes.

The estimated grey seal prey consumption of gadoids is low compared with fishery catches (commercial and recreational/tourist fishery) and with stock sizes of cod, haddock and saithe.
Future studies of grey seal feeding habits should include diet samplings throughout the year, and telemetric studies to detect important feeding areas.

Harbour seal diet

Nilssen presented on a local study on harbour seal diets (Ramasco 2016): “The local coastal cod stock of the Porsangerfjord has drastically declined in the 80’s and never fully recovered since. A population of harbour seals, known to be resident in the fjord all year round, has been hypothesised to act as predator-pit for cod in the area, affecting its lack of recovery. In order to understand the role of these seals in this local marine ecosystem, their foraging behaviour was investigated by assessing the presence of preference for certain prey and the behavioural response to the seasonal dynamics of prey distribution in the fjord. The movement patterns of individual harbour seals (n = 15) were followed between 2009 and 2013. The data obtained (i.e. GPS location, time-depth dive profiles, etc.) were first thoroughly analysed to provide a

robust interpretation of the behavioural patterns of activities of the single individuals and identify the methodological caveats in the detection of foraging behaviour. Among the major results, two types of resting behaviour at sea were described, in the form of prolonged periods at surface but also as resting dives, a behaviour never documented before for this species. The patterns of activity suggested that harbour seals mainly forage during daylight in autumn and spring in this area. The foraging locations identified were then compared to the availability of potential prey in the fjord (i.e. herring, capelin, small and large codfish and sculpins). The availability of prey was assumed to be dependent on their biomass densities, their distance from the seals' haulout sites and the accessibility of the areas where prey was located. The latter could be restricted, for example, by the presence of sea ice in winter and spring. Results on the analyses of prey selection suggested that harbour seals in Porsangerfjord had a preference for small size fish (< 25cm). Small codfish was preferred during autumn, but a response to the presence of pelagic fish was seen when the latter aggregated to overwinter in cold deep waters in the inner parts of the fjord. The formation of ice in these areas during the winter season, however, provoked a shift to small codfish, due to the sudden inaccessibility of the pelagic fish. A strong reversed trend was observed in late spring when the ice melted and pelagic fish was preferred again. The results suggest the preference for small aggregated fish close to the haulout areas. The impact of harbour seals on the cod population of Porsangerfjord can be therefore hypothesized to change across seasons and to be lowered by the availability of highly aggregated pelagic fish during winter and spring."

Discussion

Bjørge reported that there are geographical differences in diet and also some interannual variability (Olsen and Bjørge, 1995, Berg et al. 2002).

In general, a small proportion of cod is found in the diet of harbour seals throughout Norway. Diet samples have indicated that grey seals are eating some cod, although the grey seal populations are probably too low to have any significant effect on the cod stocks in Norway.

Iceland

Diet

In the period 1992-94 (Hauksson & Bogason, 1997) collected stomach data for investigating diet of seal in Icelandic waters. In 2007-2010 seal stomachs were collected in the north-western coastal waters of Iceland, which made a comparison between diets of seals in the areas possible. This comparison revealed some switching in prey-species of seals in-between these periods, such as harbour seals feeding less on herring (*Clupea harengus*) and saithe (*Pollachius virens*), but more on capelin (*Mallotus villosus*), grey seals feeding less on sandeel (*Ammodites* spp.), saithe and bull-rout (*Myoxocephalus scorpius scorpius*), and more on lumpsucker (*Cyclopterus lumpus*), and harp seals (*Phoca groenlandica*) feeding less on sandeel, herring and saithe, but more on capelin, in the latter period, than the former. These shifts in diet are markedly similar to the environmental and biotic changes which had occurred in Icelandic waters in these periods; according to the annual ground fish abundance survey carried out by the Marine Research Institute, Reykjavik, Iceland, since 1985 there has been an increasing cod (*Gadus morhua*) population, haddock (*Melanogramus aeglefinus*) have been getting more abundant in the colder northern waters, capelin distribution has shifted toward more northerly feeding grounds, and last but not least ,nearly a total collapse of the lesser sand-eel (*Ammodites marinus*) population, at least in the southern waters of Iceland.

Discussion
The WG commented that in the absence of direct observations of historical sandeel abundance, an index of relative abundance can be deduced from historical variations of sandeel proportions in the diet of haddock, as done in recent ecological studies on common minke whales (Víkingsson et al. 2014, 2015).

Body condition
In this study seasonal change in blubber distribution and body morphology of 229 harbour seals, mostly pups and juveniles caught in northwestern Icelandic waters in the season May – July during 2007 – 2010 were examined. The young harbour seals were fattest, in best condition in beginning of July and leaner in April and in the end of July, which could be related to the beginning of the moulting in July. There were statistically nonsignificant indications that juvenile females and males were in worse shape (leaner) in the period 2007-2010, than the two earlier periods, 1979-1983 and 1990-2000, in May and June respectively, although data were limited. The authors speculate that evidence for worse condition could be related to poorer feeding opportunities in the latest period, compared to the two former periods, due to collapse of the lesser sandeel (*Ammadytes marinus*) population in Icelandic waters.

Discussion
The WG discussed that the body location on the seal where the blubber depth measurement is taken is important. Hauksson informed the WG that measurement was taken from 4 cuts along the dorsal and 4 cuts along the ventral side of the animals.

The WG also discussed that the energy content of the sandeels may vary seasonally, as for other species such as herring and capelin, and therefore it is important to consider this when classifying sandeels as an energy rich prey item.

Iceland noted that there also are some regional differences in consumption of sandeels by seals. The collapse of sandeel seems to be correlated to poor breeding success in seabirds. The reason for the sandeel collapse is unknown.

Tourism
A study on Vatnsnes, NW Iceland, showed that the harbour seals distribution changed during the main tourist period and that seals increased their vigilance during periods with many tourists in the area. However, this effect was also shown to depend on the behaviour of tourists since calm tourists had less impact on the seals (Granquist and Sigurjónsdóttir 2015). A review of seal watching codes of conduct was made (Öqvist 2014) and the potential to reduce negative impact on the seals during seal watching by interpretations on signs has been investigated (Marschall 2015). The effect of a seal watching boat on the behaviour of harbour seals has also been investigated and the results show that the boat affect the vigilance level of the seals, and that there is a correlation between flush response of the seals and the distance between the boat and the seal colony (Clack 2016).

Discussion
The frequency of the tourism (i.e., source of disturbance) was discussed. The boat trips can occur 3 times per day if tickets are sold. On the land site near the seal center, there is a constant flow of people (i.e., there are not set visiting times), and over the course of the year there are seasonal peaks.

Canada

The WG discussed Harvey et al. (2012), Hammill et al. (2014), and Swain et al. (2015). The potential impact of grey seals on depleted demersal fish populations (e.g. Atlantic cod, white hake and thorny skate) in the southern Gulf of St. Lawrence (sGSL), Canada was discussed. Twenty years ago, the Atlantic cod population collapsed due to overexploitation. Despite negligible levels of fishing mortality and strong rates of production of small juvenile fish, these populations have shown no sign of recovery and some continue to decline. Lack of recovery is due to dramatic increases in the natural mortality of larger individuals in these populations. Predation by grey seals has been proposed as an important cause of this high mortality. Stenson presented results from studies including population dynamics of the named fish species and others based on stratified-random bottom-trawl surveys conducted by the Canadian Department of Fisheries and Oceans (DFO) in the sGSL each September since 1971; on habitat use by demersal fishes in relation to predation risk (grey seals) at large spatial and temporal scales in the southern Gulf of St. Lawrence ecosystem; telemetry studies of grey seals in relation to distribution of these fish species (and others) during late autumn and winter; diet studies of grey seals taken in overwintering areas in deeper waters of these fishes.

Distributions of cod, hake and skate have been correlated to the risk of predation by seals, with distribution shifting into lower risk areas as predation risk increased. Non-prey species did not show similar changes in habitat use. Spatial variation in fish condition suggests that these low-risk areas are also less profitable for cod and skate in terms of food availability. The effects of density dependence and water temperature were also important in models, but did not account for the changes in habitat use as the risk of predation increased.

Data from satellite transmitters deployed on grey seals (between 1993 and 2005) and winter bottom-trawl survey data (1994 to 1997) showed that the distribution of searching effort by male grey seals varied throughout the winter. In early winter, males concentrated their movements around St. Paul's Island. In late winter, they were found to the southeast of this area, where females also occurred. The fish community differed between apparent foraging and non-foraging areas. Densities of small plaice, hake and redfish, large herring and cod of all sizes were relatively high in the male grey seal foraging zones; female foraging zones were characterized by higher densities of small plaice and redfish and large cod. Areas where grey seal foraging was not concentrated were characterized by high densities of medium and large redfish as well as large turbot and witch flounder.

In the Cabot Strait, where overwintering aggregations of cod were present, cod accounted for 68% (range 57–80%) of the male grey seal diet from stomachs, and 46% (range: 31–64%) of the diet determined from intestines. The mean length of cod consumed by seals was in the range from 28 cm to 39 cm in different areas but larger cod was also taken. Cod and hake were more important to the diet of males than that of females. The contribution of cod to the diet of grey seals foraging in the cod overwintering area was much greater than has been reported elsewhere.

Discussion

In general, there is good evidence that male grey seals feed on overwintering cod, and larger fish than had been previously thought, however it is unclear whether the level is sufficient to be limiting the recovery of the cod.

The WG noted that there could also be competition between grey seals and cod for prey. Frank et al. (2005) describes a cascading effect of changes in cod populations with increasing

populations or influx of pelagic species, providing more food for grey seals. Although it was noted that some researchers believe that this paper may have mis-interpreted the data on abundance of pelagic fish.

UK
Smout presented Jones et al. (2015) which uses seal telemetry used to create habitat usage maps.

ABSTRACT: "Species distribution maps can provide important information to focus conservation efforts and enable spatial management of human activities. Two sympatric marine predators, grey seals *Halichoerus grypus* and harbour seals *Phoca vitulina*, have overlapping ranges on land and at sea but contrasting population dynamics around Britain: whilst grey seals have generally increased, harbour seals have shown significant regional declines. We analysed 2 decades of at-sea movement data and terrestrial count data from these species to produce high resolution, broad-scale maps of distribution and associated uncertainty to inform conservation and management. Our results showed that grey seals use offshore areas connected to their haul-out sites by prominent corridors, and harbour seals primarily stay within 50 km of the coastline. Both species show fine-scale offshore spatial segregation off the east coast of Britain and broad-scale partitioning off western Scotland. These results illustrate that, for broad-scale marine spatial planning, the conservation needs of harbour seals (primarily inshore, the exception being selected offshore usage areas) are different from those of grey seals (up to 100 km offshore and corridors connecting these areas to haul-out sites). More generally, our results illustrate the importance of detailed knowledge of marine predator distributions to inform marine spatial planning; for instance, spatial prioritisation is not necessarily the most effective spatial planning strategy even when conserving species with similar taxonomy."

Discussion
It was noted that the telemetry has been pooled from many different years, but one question is whether space use has changed over time.

7. EVALUATE THE NORWEGIAN MANAGEMENT PLANS FOR HARBOUR AND GREY SEALS

Bjørge presented Paper SC/23/CSWG/04. Management plans for coastal seals (harbour and grey seals) in Norway were adopted and implemented by the Ministry of Fisheries and Coastal Affairs on the 5th November 2010. There is now a five-year period of experience on how these plans have performed as the basis for management of seal populations in Norway. The overarching goal in the management plans is to ensure viable populations of harbour and grey seals within their natural distribution areas. In practical management, however, the government must balance the desire for the preservation of large seal populations against damage on fisheries and aquaculture in the coastal zone.

Harbour seals are monitored by counting hauled out seals during the moulting period and the government decided that the harbour seal population should be stabilized at a level where 7,000 moulting seals can be recorded. Grey seals are monitored by counting pups and the government decided that the population should be stabilized so that 1,200 pups can be recorded annually. These population levels are defined as the Target Level and quotas should be used to stabilize populations at these levels.

After a decade with high quotas and a declining population of harbour seals, since 2011 quotas were based on scientific advice in accordance with the management plan. This resulted in an initial increase before the population stabilized at the Target Level (TL).

It can therefore be concluded that the introduction of the management plan in combination with a new mechanism for providing scientific management advice (e.g. on quotas) resulted in a sound management of harbour seals that has fulfilled the politically decided objectives for management of the species in Norway.

The harbour seal is managed with the county borders as management unit. Using counties as administrative management areas for harbour seals is functioning well for the practical management (setting quotas, allocating hunting licenses, collating hunting statistics, etc). However, this should not prevent the completion of a genetic study to explore the population structure of harbour seals along the Norwegian coast in order to develop a better understanding of the biological units to conserve.

Until recently, the population of grey seals has been increasing slightly, and a survey in 2006-2008 revealed an annual pup production of 1,275. The quotas based in the years 2012-2014 were based on scientific advice in accordance with the management plan. In 2014 the Trøndelag counties and the southern part of Nordland county were surveyed and a significant and unexpected reduction in pup production was revealed. The recorded pup production was less than 50% of the pup production recorded in 2006-2008. According to the management plan the quotas should then be set to zero for these areas. The quota was immediately set to zero for these areas. In 2015 the northern part of Nordland county (the areas between Vega and Lofoten) were surveyed. This completed the survey of the Central Management Unit (Stad-Lofoten), and the total number of pups recorded in the area was less than 50% of the Target Level for the area and a zero quota was set for the Central Management Unit.

The management plan, in combination with the Scientific Advisory Board, provided the basis for quick management response to the reduction in pup production recorded by the abundance surveys. It can therefore be concluded that the management plan has performed well. The reason for the recent dramatic decline in recorded pup production is not clear. However, the decline is most likely caused by factors not regulated by the management plan, e.g. fisheries by-catch, reproductive failure due to illness, increased mortality due to illness, possible predation by killer whales, etc.

The NAMMCO WGCS in 2011 recommended that 0.7 TL should be the limit for setting quotas to zero. In the current case with the grey seals in the Central Management Area the decline had exceeded 0.5 TL before it was detected by the abundance surveys. However, this was mainly due to the timing of the surveys. The conclusion we draw from this is that large changes in pup production may occur within the five-year interval between surveys. The survey intervals should therefore not be extended, but rather shortened. We also advise that 0.7 TL should be the limit for setting quotas to zero in accordance with the recommendation from NAMMCO (2011).

Norway will maintain the three Management Units for grey seals based on biological evidence (the Southern MU from Lista to Stad; the Central MU from Stad to Lofoten; and the Northern MU from Vesterålen to Varanger). However, the first hand administration of hunting licenses and collation of hunting statistics are undertaken by the county authorities. For practical reasons we therefore suggest that administrative Management Areas should follow the county borders and that quotas are set for each county within the wider Management Units.

The management plans contain advice on research and monitoring. The abundance monitoring programme is carried out following the principles outlined in the management plans. However, the management plans advised on other research topics relevant for the management of the coastal seals. In particular, there were recommendations for research on the interactions between seals and fisheries. One aspect of such interactions is by-catch of seals in fisheries. Monitoring of by-catches of marine mammals is currently undertaken by the IMR. These by-catches are considerable and should be accounted for when generating hunting quotas.

According to the current legal regulation for management of seals at the Norwegian coast, it is legal to shoot seals that damage fish farms. It is important that seals shot at fish farms are reported to the Directorate of Fisheries and included in the statistics of animals removed from the populations. To mitigate the conflict between seals and fish farms there should be a mechanism for consulting seal experts at IMR when the location of new fish farms is planned. Such consultations could possibly be mentioned in the management plans.

Discussion

The WG agreed that the Norwegian management plans for harbour and grey seals managed the hunt, for which it was designed, well. However, recent information about the extent of the by-catches in a new fishery were not expected when the plan was implemented.

The WG noted that, similar to Iceland, the target population levels set by the Norwegian government for seals are not based on biological assessment. Although the Norwegian populations of seals are less at risk of loss of genetic diversity because they are connected to the UK and Russian populations, and the historical population levels (Øynes 1964, 1966) were lower than the current population levels for both species, this target level should be re-examined (see below).

Recommendations for the Norwegian Harbour and Grey Seal Management Plans

- The target population levels for both species should be evaluated (as discussed for Iceland) as the levels are not based on any biological assessment. The current target levels are set equal to the highest numbers recorded in recent years.
- The WG agreed with the Norwegian evaluation of the management plan to recommend that the quota is set to 0 when the population is at 70% of the target level instead of 50%. This change was also previously recommended at the 2011 CSWG.
- Management plans should include all sources of mortality, not just the hunt.
    - The CSWG recommends that Norway continue working with the NAMMCO WG on By-catch to ensure that the by-catch estimates are as good as possible.
    - The WG also recommends that all anthropogenic removals are considered when setting hunting quotas. This implies that seals shot at fish farms and salmon rivers should be reported to the Directorate of Fisheries and that data on marine mammal by-catches in recreational fisheries should be generated.
- The WG noted that there is a conflict between seals and fish farms, but there is no mechanism in the application process for establishing new fish farms for consideration of seal distribution. A mechanism for consulting IMR when fish farms are being built should be required when management plans are revised.

8. MONITORING PLAN FOR FAROE ISLANDS AND RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT

8.1 Recommendations for future research

The WG **recommended** analyses that can be undertaken with the existing data and should be completed as soon as possible.

- Population Viability Analysis
  - Numbers of removals can be used to estimate minimum population size of grey seals in the Faroes that is necessary to sustain the levels of removals. This requires that data is available from basically all parts of the Faroes. Longer time series of data on removals would give more robust estimates than shorter.

- Analysis of existing telemetry data
  - The Faroes should coordinate with the UK on the existing telemetry data to look at possible migration between the UK and the Faroes. This would be particularly informative from animals tagged in the Hebrides and Orkney.

The WG also **recommended** new research that should be conducted in the Faroes, and prioritized these studies.

First Priorities

- Obtain minimum population estimates via haulout counts. These counts should be conducted at least 3 times on different days and cover the whole area. Comparable haulout counts should be repeated regularly to obtain trend information.
- Obtain reliable and complete reporting of all removals (e.g., all companies operating fish farms need to report).

Secondary Priorities

- Telemetry tagging studies to develop correction factors for the haulout counts (animals in the water and, if possible, in caves) and also obtain information on movements and distribution
- Samples should be collected from animals shot at farms (e.g., jaws to obtain information on age, sex, genetics etc.).
- A study using cameras to observe animals going in and out of caves
- Photo-ID study for a mark-recapture based population size

The WG further **recommended** that the Faroes develop a written monitoring plan that includes regular assessments.

9. OTHER BUSINESS

The WG noted that the management objectives for seals are approached differently when compared to other species managed within NAMMCO.

10. MEETING CLOSURE

The report was accepted preliminarily on 4 March 2016, and the final version on 22 April 2016 via correspondence. The WG thanked the Chair for his able chairmanship. The Chair thanked the rapporteur and participants for their hard work and input. The WG thanked MRI for the good meeting facilities and wonderful hospitality.

The meeting was closed at 16:30 on 4 March 2016.

REFERENCES

Andersen, L.W., Lydersen C., Frie A.K. et al. 2011. A population on the edge: genetic diversity and population structure of the world's northernmost harbour seals (*Phoca vitulina*). *Biological Journal of the Linnean Society*. 102:420–439.

Berg, I., Haug, T. & Nilssen, K.T. 2002. Harbour seal (*Phoca vitulina*) diet in Vesterålen, north Norway. *Sarsia* 87: 451-461.

Bjørge, A. and McConnell, B. 1986. Recoveries in Norway of grey seals, *Halichoerus grypus*, tagged in Great Britain. *Fisken og havet.* 1986 (2): 1-8.

Bjørge, A., Bekkby, T., Bakkestuen, V. & Framstad, E. 2002a. Interactions between harbour seals, *Phoca vitulina*, and fisheries in complex coastal waters explored by combined GIS and energetics modelling. *ICES Journal of Marine Science*, **59**: 29-42.

Bjørge, A., Øien, N., Hartvedt, S., Bøthun, G. & Bekkby, T. 2002B. Dispersal and bycatch mortality in gray, *Halichoerus grypus*, and harbor, *Phoca vitulina*, seals tagged at the Norwegian coast. *Marine Mammal Science*, **18**(4): 177-190.

Boulva, J., AND I. A. McClaren. 1979. Biology of the harbor seal, *Phoca vitulina*, in eastern *Canada. Bull. Fish. Res. Board Can*. 200: 24 p.

Boyd, J.M. and Campbell, R.N. 1971. The Grey seal (*Halichoerus grypus*) at North Rona, 1959 to 1968. *J. Zool.* 164:469-512.

Bowen, W.D., S.L. Ellis, S. J. Iverson and D. J. Boness 2003 Maternal and newborn life-history traits during periods of contrasting population trends: implications for explaining the decline of harbour seals (*Phoca vitulina*), on Sable Island. *J. Zool., Lond.* (2003) 261, 155–163.

Bowen, W.D., McMillan, J. and Mohn. R. 2003. Sustained exponential population growth of grey seals at Sable Island, Nova Scotia. *ICES J. Mar. Sci.* 60:1265-1274.

Cammen, K., Hoffman, J. I., Knapp, L. A., Harwood, J., Amos, W. 2011. Geographic variation of the major histocompatibility complex in Eastern Atlantic grey seals (*Halichoerus grypus*). *Mol. Ecol.* 20: 740-752. Doi:10.1111/j.1365-294X.2010.04975.x

Clack, G. The Impact of Tourism on Harbour Seals and Their Distribution Around Iceland. Master of Resource Management: Coastal and Marine Management. Ísafjörður, 2016. Háskólasetur Vestfjarða, Háskólinn á Akureyri.

Clers, S.D. and Andersen, K. 1995. Sealworm *(Pseudoterranova decipiens)* transmission to fish trawled from Hvaler, Oslofjord, Norway. *Journal of Fish Biology*. 46: 8-17

Department of Fisheries & Oceans Canada, 2014. Stock assessment of Canadian grey seals (*Halichoerus grypus*). *DFO Can. Sci. Advis. Sec. Sci. Advis. Rep*. 2014/010

Frie, A.K. 2009. Distribution and diversity of grey seals haplotypes in the North Atlantic and the Baltic Sea. Presented to the 15th meeting of NAMMCO Scientific Committee, Qeqertarsuaq, Greenland, 11-14 April 2008. Unpublished. 10pp.

Frank, K.T. Petrie,B., Choi J.S. and Leggett W.C. 2005. Trophic cascades in a formerly cod-dominated ecosystem. Science 308: 1621-1623.

Gilbert J. R., G.T. Waring, K.M. Wynne, and N. Guldager. 2005. Changes in abundance of harbor seals in Maine, 1981–2001. *Marine Mammal Science*, 21: 519–535.

Granquist, S., Hauksson, E., Árnadóttir, A., B. and Kasper, J. 2011. Landselstalning úr lofti árið 2011. Framvinda og niðurstöður [Aerial survey of the Icelandic harbour seal population]. Institute of Freshwater Fisheries, November 2011. VMST/11051

Granquist, S. 2014. Ummerki eftir sel á veiddum laxfiskum í völdum laxveiðiám í Húnaþingi vestra og AusturHúnavatnssýslu. [Seal induced injuries on caught salmonids in rivers in Húnaþingi vestra and AusturHúnavatnssýslu, English summary]. Report to the Institute of Freshwater Fisheries, VMST/14019

Granquist, S. and Hauksson, E. 2016. Seasonal, meteorological, tidal and diurnal effects on haul-out patterns of harbour seals (*Phoca vitulina*) in Iceland. Polar Biology, in press.

Granquist, S.M. and Sigurjónsdóttir, H. 2014. The effect of land based seal watching tourism on the haul-out behaviour of harbour seals (*Phoca vitulina*) in Iceland. *Applied Animal Behaviour Science.* 156:85-93.

Goodman, S.J. (1998). Patterns of extensive genetic differentiation and variation among European harbor seals (*Phoca vitulina vitulina*) revealed using microsatellite DNA polymorphisms. *Molecular Biology and Evolution*, 15(2), 104-118.

Gunnlaugsson T, Pálsson ÓP, Ólafsdóttir D. 2014. By-catch of seabirds and marine mammals in fishing in Icelandic waters. Paper SC/21/11. 21st meeting of the NAMMCO Scientific Committee, 3-7 November 2014, Bergen, Norway

Hammond, P.S., McConnell, B.J. and Fedak, M.A. 1993. Grey seals off the east coast of Britain: distribution and movements at sea. *Symp. Zool. Soc. Lond.* No. 66:211-224.

Harding, Karin C., and Tero J. Härkönen. 1999. Development in the Baltic grey seal (*Halichoerus grypus*) and ringed seal (*Phoca hispida*) populations during the 20th century. *Ambio*. 619-627.

Härkönen, T., R. Dietz, P. Reijnders, J. Teilmann, K. Harding, A. Hall, S. Brasseur, U. Siebert, S. Goodman, P. Jepson, T. Dau Rasmussen, P. Thompson (2006). A review of the 1988 and 2002 phocine distemper virus epidemics in European harbour seals. *Diseases of Aquatic Organisms*, 68: 115-130.

Härkönen, T. and Isakson, E. 2011. Historical and current status of harbour seals in the Baltic proper. *NAMMCO Sci. Publ*. 8: 71-76.

Haug, Tore, Gunnar Henriksen, Andrej Kondakov, Vasily Mishin, Kjell Tormod Nilssen, and Nils Røv. 1994. The status of grey seals *Halichoerus grypus* in North Norway and on the Murman coast, Russia. *Biological Conservation*. 70(1): 59-67.

Hauksson E. and Bogason V. 1997. Comparative Feeding of Grey (*Halichoerus grypus*) and Common Seals (*Phoca vitulina*) in Coastal Waters of Iceland, with a Note on the Diet of Hooded (*Cystophora cristata*) and Harp Seals (*Phoca groenlandica*). *Journal of Northwest Atlantic Fishery Science*. 22:125-135.

Hauksson, E. and Ólafsson, H. 2016. Condition of harbour seals (*Phoca vitulina*) in the period 2007-2010, in Icelandic northwestern coastal waters. Comparison with data from the periods, 1979-1983 and 1990-2000. NAMMCO Working Group on Coastal seals, Reyjavík, 1-4 March 2016.

HELCOM. 2013. HELCOM Red List of Baltic Sea species in danger of becoming extinct. Balt. Sea Environ. Proc. No. 140.

HELCOM. 2006. Seal Expert Group First Meeting, Sigtuna, Sweden, 18-20 October 2006

Henriksen, G., Haug, T., Kondakov, A., Nilssen, K.T., and Øritsland T. 2007. Recoveries of grey seals (*Halichoerus grypus*) tagged on the Murman coast in Russia. *NAMMCO Scientific Publications*, 6: 197-201.

International Council for the Exploration of the Sea (ICES). 2001. Report of the study group on further developments of the precautionary approach to fishery management. ICES CM 2001/ACFM:11

Johnston D.W., J. Frungillo, A. Smith, K. Moore, B. Sharp, J. Schuh, and A.J. Read. 2015. Trends in stranding and by-catch rates of gray and harbor seals along the Northeastern coast of the United States: Evidence of divergence in the abundance of two sympatric phocid species? *PLoS ONE* 10(7): e0131660. doi:10.1371/journal.pone.0131660

Jones E.L., McConnell BJ, Smout S., Hammond P.S., Duck CD, Morris C.D., Thompson D., Russell D.J.F., Vincent C., Cronin M., Sharples R.J., Matthiopoulos J. 2015. Patterns of space use in sympatric marine colonial predators reveal scales of spatial partitioning. *Mar. Ecol. Prog. Ser.* 534: 235–249. doi: 10.3354/meps11370

Klimova, A., Phillips, C.D., Fietz, K., Olsen, M.T., Harwood, J., Amos, W., Hoffman, J.I. 2014. Global population structure and demographic history of the grey seal. *Mol. Ecol.* 23: 3999-4017.

Landt, J. 1800. Om Sælhunde-Fangst (About seal hunting). In: Forsøg til en beskrivelse over Færøerne. Tidsjob Forlag, København, 214-216. [In Danish].

Lyle J.M. and S.T. Wilcox. 2008. Dolphin and seal interactions with mid-water trawling in the commonwealth small pelagic fishery, including an assessment of bycatch mitigation. Australian Fisheries Management Authority, Final Report Project R05/0996, 49p.

Matthiopoulos, J., McConnell, B., Duck, C. and Fedak, M. 2004. Using satellite telemetry and aerial counts to estimate space use by grey seals around British Isles. *J. Appl. Ecol.* 41:476-491.

McConnell, B.J., Fedak, M.A., Lovell, P. and Hammond, P.S. 1999. Movements and foraging areas of grey seals in the North Sea. *J. Appl. Ecol.* 36:573-590.

North Atlantic Marine Mammal Commission. 2003. Report of the NAMMCO Scientific Committee Working Group on Grey Seals, Annex 2. In: *NAMMCO Annual Report 2003*, NAMMCO, Tromsø, pp. 231-250.

North Atlantic Marine Mammal Commission. 2006. *NAMMCO Annual Report 2006*, NAMMCO, Tromsø.

Olesiuk, P.F. 2010. An assessment of population trends and abundance of harbour seals (*Phoca vitulina*) in British Columbia. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2009/105.vi + 157 p.

Olsen, M. and Bjørge, A. 1995. Seasonal and regional variations in the diet of harbour seal in Norwegian waters. Pp. 271-285 in: Blix, A.S., Walløe, L. & Ulltang, Ø. (eds). Whales, seals, fish and man. Elsevier Science B.V.

Olsen, Morten T., Liselotte W. Andersen, Rune Dietz, Jonas Teilmann, Tero Härkönen, and Hans R. Siegismund. 2014. Integrating genetic data and population viability analyses for the identification of harbour seal (*Phoca vitulina*) populations and management units. *Molecular Ecology*. 23(4): 815-831.

Osmond, AW. 2013. Seals and Aquaculture in Iceland Potential for Conflict and Practical Mitigation Measures. Master's Thesis, University of Akureyri.

Punt, A. E., and Smith, D. M. 2001. The gospel of maximum sustainable yield in fisheries management: birth, crucifixion and reincarnation. *In* Conservation of exploited species, pp. 41-66. Ed. by J. D. Reynolds, G. M. Mace, K. H. Redford and J. G. Robinson. Cambridge University Press, Cambridge, UK.

Ramasco, V. 2015. Spatial and temporal patterns of foraging of harbour seals (*Phoca vitulina*) in Porsangerfjord: from behavioural interpretation to resource selection. PhD Dissertation. University of Tromsø.

Reinert, A. 1982. Havet omkring Færøerne. Sæler (Seals). In: Nørrevang, A. and Lundø, J. (eds.); Danmark Natur. Færøerne, 12:55-58. [In Danish].

Robillard, A., V. Lesage, and M.O. Hammill. 2005. Distribution and abundance of harbour seals (*Phoca vitulina concolor*) and grey seals (*Halichoerus grypus*) in the Estuary and Gulf of St. Lawrence, 1994–2001. *Can. Tech. Rep. Fish. Aquat. Sci.* 2613: 152 pp.

Sette L.A., G.T. Waring, K. Touhey, S. Sharp, B. Sharp, and S. Landry 2009. Photographic surveys of entanglement occurrence at gray seal (*Halichoerus grypus*) and harbor seal (*Phoca vitulina*) haul-outs on Cape Cod, Massachusetts. Poster presentation, 18th Biennial Conference on the Biology of Marine Mammals.

Sjare, B., M. Lebeuf and G. Veinott. 2005 Harbour seals in Newfoundland and Labrador: a preliminary summary of new data on aspects of biology, ecology and contaminant profiles. *DFO Can. Sci. Advis. Sec. Res. Doc.* 2005/030.

Stanley HF, Casey S, Carnahan JM, Goodman S, Harwood J, Wayne RK. 1996. Worldwide patterns of mitochondrial DNA differentiation in the harbour seal (*Phoca vitulina*). *Molecular Biology and Evolution* 13**:** 368–382.

Teilmann, J., F. Riget, T. Härkönen. 2010. Optimising survey design in Scandinavian harbour seals: Population trend as an ecological quality element. *ICES Journal of Marine Science*, 67: 952–958

Teilmann, J., F. Riget, T. Härkönen. 2010. Optimising survey design in Scandinavian harbour seals: Population trend as an ecological quality element. *ICES Journal of Marine Science*, 67: 952–958

Traill, Lochran W., Barry W. Brook, Frankham, Richard R. and Bradshaw, Corey JA. 2010. "Pragmatic population viability targets in a rapidly changing world" *Biological Conservation* 143, no. 1 (2010): 28-34.

Víkingsson G.A, Elvarsson B.Þ., Ólafsdóttir D., Sigurjónsson J., Chosson V., and Galan A. 2014. Recent changes in the diet composition of common minke whales (*Balaenoptera acutorostrata*) in Icelandic waters. A consequence of climate change? *Marine Biology Research.* 10(2):138-152. DOI: 10.1080/17451000.2013.793812

Víkingsson G.A., Pike D.G., Schleimer A., Valdimarsson H., Gunnlaugsson Þ., Silva T., Elvarsson B.Þ., Mikkelsen B., Øien N., Desportes G., Bogason V., Hammond P.S. 2015. Distribution, Abundance and Feeding Ecology of Baleen Whales in Icelandic Waters: Have Recent Environmental Changes Had an Effect? *Frontiers in Ecology and Evolution.* 3(6):1-18. DOI:10.3389/fevo.2015.00006

Waring, G.T., R.A. DiGiovanni Jr, E. Josephson, S. Wood, and J.R. Gilbert. 2015a. 2012 Population estimate for the harbor seal (*Phoca vitulina concolor*) in New England waters. U.S. Dep. Of Commer., NOAA Technical Memorandum NMFS-NE-235, 15p.

Waring G.T., E. Josephson, K. Maze-Foley, P.E. Rosel, editors. 2015b. US Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2014. NOAA Tech Memo NMFS NE 231; 361 p. doi: 10.7289/V5TQ5ZH0

Øigård, T.A., Frie, A.K., Nilssen, K.T., and Hammill, M.O. 2012. Modelling the abundance of grey seals (*Halichoerus grypus*) along the Norwegian coast. *ICES Journal of Marine Science*, **69**: 1436–1447.

Öqvist, E.L. 2014. An evaluation of codes of conduct for seal watching worldwide. B.S. thesis. Department of Zoology, Stockholms Háskóli, Stokkholm, Sweden. 22pp.

Øynes, P. 1964. Sel på norskekysten fra Finnmark til Møre. Fiskets gang 50 (48): 694–707.

Øynes, P. 1966. Sel i Sør-Norge. Fiskets gang 52 (45): 834–839.

Appendix 1 – AGENDA

1. TERMS OF REFERENCE
   - assess the status of all populations, particularly using new abundance estimate data that are available from Iceland and Norway.
   - address by-catch issues in Norway, Iceland, and the Faroe Islands
   - re-evaluate the Norwegian management plans (which have been already implemented) for grey and harbour seals.
   - develop specific plans for monitoring grey seals in the Faroes, e.g., obtaining a relative series of abundance (if a full abundance estimate is not possible at this time).
2. REVIEW OF AVAILABLE DOCUMENTS AND REPORTS
3. SEAL INTERACTION WITH FISHERIES AND AQUACULTURE
   a. Geographical review
   b. Problem size
   c. Mitigation methods in use
4. STATUS OF HARBOUR SEAL STOCKS
   a. Information on catches and regulatory measures
   b. Current Research (Biological parameters, stock identity, distribution/migration)
   c. Population assessments

   4.1 Norway
   4.2 Iceland
   4.3 Denmark
   4.4 Greenland
   4.5 Sweden
   4.6 Mainland Europe
   4.7 United Kingdom
   4.8 Russia
   4.9 Eastern Canada
   4.10 Eastern US
5. STATUS OF GREY SEAL STOCKS
   a. Information on catches and regulatory measures
   b. Current Research (Biological parameters, stock identity, distribution/migration)
   c. Population assessments

   5.1 Norway
   5.2 Iceland
   5.3 Faroes
   5.4 Baltic
   5.5 Russia (Murman Coast)
   5.6 United Kingdom
   5.7 Mainland Europe
   5.8 Eastern Canada
   5.9 Eastern US
6. REVIEW OF HARBOUR AND GREY SEAL STUDIES ON ECOLOGY
7. EVALUATE THE NORWEGIAN MANAGEMENT PLANS FOR HARBOUR AND GREY SEALS
8. MONITORING PLAN FOR FAROE ISLANDS *(if approved by Council)*
9. RECOMMENDATIONS FOR RESEARCH AND MANAGEMENT

   7.1 Recommendations for future research
   7.2 Recommendations for management, by area and stock
10. OTHER BUSINESS

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Appendix 3 – LIST of DOCUMENTS

Meeting Documents

Document Number	Title	Agenda Item
SC/23/CSWG/01	Agenda	
SC/23/CSWG/02	Participant List	
SC/23/CSWG/03	Document List	
SC/23/CSWG/04	Bjørge & Nilssen. Five years experience with management plans for harbour and grey seals in Norway. Is there a need for revision?	7
SC/23/CSWG/05	Nilssen et al. Status of harbour seals along the Norwegian coast in 2011-2015	3.1
SC/23/CSWG/06	Hauksson, E. et al. Seasonal and inter-periodical feeding of Grey (*Halichoerus grypus*) and Harbour seals (*Phoca vitulina*) in north-western coastal waters of Iceland, in 1990-1994 and 2007 - 2010, with a note on the diet of Harp (*Phoca groenlandica*) seals.	
SC/23/CSWG/07	Jüssi. Review of current status of the Baltic grey seals	
SC/23/CSWG/08	Bjørge. Levels of bycatch of harbour and grey seals in Norwegian fisheries.	5
SC/23/CSWG/09	Grey seal 2016 status in Norway	
SC/23/CSWG/10	Coastal seal catches Norway	
SC/23/CSWG/11	Status of Baltic harbour seals	
SC/23/CSWG/12	Status of the grey seal population in Iceland	
SC/23/CSWG/13	Management and status of harbour seal population in Iceland 2016: Catches, population assessments and current research	
SC/23/CSWG/14	Condition of harbour seals (*Phoca vitulina*) in the period 2007-2010, in Icelandic northwestern waters. Comparison with data from earlier periods, 1979-1983 and 1990-2000	
SC/23/CSWG/15	Current status grey seals Faroes 2016	
SC/23/CSWG/16	Hauksson, E and Granquist, S. 2016. Timing of birth and pup production of Harbour Seal (*Phoca vitulina*) on Vatnsnes, NW-Iceland.	
SC/23/CSWG/17	Preliminary analysis of population structure in Norwegian harbour seals	
SC/23/CSWG/18	Diet and prey consumption of grey seals (*Halichoerus grypus*) in Norwegian waters	

For Information Papers

Document Number	Title	Agenda Item
SC/23/CSWG/O01	Management plan for Norwegian grey seals	
SC/23/CSWG/O02	Management plan for Norwegian harbour seals	
SC/23/CSWG/O03	Report of the NAMMCO CSWG (2011)	
SC/23/CSWG/O04	Report 2003 WG_Grey_Seals	
SC/23/CSWG/O05	2006 Harbour_seals_Rep_final	
SC/23/CSWG/O06	Kvoter på kystsel i 2016 with cover (to be translated at the meeting)	
SC/23/CSWG/O07	Osmond. Seals and Aquaculture in Iceland	
SC/23/CSWG/O08	Nebel. The consumption of commerically valuable fish by pinnipeds in Northwest Icelandic waters.	
SC/23/CSWG/O09	Ramasco Dissertation. Spatial and temporal patterns of foraging of harbour seals (*Phoca vitulina*) in Porsangerfjord from behavioural interpretation to resource selection	
SC/23/CSWG/O10	Klimova et al 2014 Global population structure and demographic history of the grey seal	
SC/23/CSWG/O11	Harbour seal population modelling: the Moray Firth	
SC/23/CSWG/O12	The status of UK harbour seal populations in 2014, including summer counts of grey seals	
SC/23/CSWG/O13	Grey seal pup production in Britain in 2014 A progress report	
SC/23/CSWG/O14	2012 Population Estimate for the Harbor Seal (*Phoca vitulina concolor*) in New England Waters	
SC/23/CSWG/O15	Harbor seal (*Phoca vitulina concolor*): Western North Atlantic Stock (US Stock Assessment)	
SC/23/CSWG/O16	Stock Assessment of Canadian Grey Seals (*Halichoerus grypus*)	