MEETING
NAMMCO SCIENTIFIC COMMITTEE
WORKING GROUP ON BY-CATCH

REPORT

2 – 4 May 2017

This report contains the views of the Working Group and does not necessarily represent the view of the NAMMCO Scientific Committee and/or the Council.

On the request of the Council, the report was not made public until after the Scientific Committee (SC) had reviewed it. The comments of the SC on this report are found in section 7.1.3 of the 24th SC meeting report. (https://nammco.no/wp-content/uploads/2017/01/24th-scientific-committee-meeting-report.pdf)

On 8 April 2020, the Faroe Islands provided a corrigendum regarding the by-catch data reported in this report. Some of the by-catch events reported under point 8.2 were fictive recordings made during the implementation and the testing of the electronic logbooks. The fictive recordings were removed from the database of the Fisheries Inspection (Vorn) catch database in November 2018. See also footnotes 1 and 2 on page 14 and 15. The corrigendum is attached at the end of the report. The Working Group on By-Catch will re-evaluate its conclusion on the basis of the corrected set of data at one of its next meeting.

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NAMMCO SCIENTIFIC COMMITTEE WORKING GROUP ON BY-CATCH
2 – 4 May 2017, Copenhagen, Denmark
Report

EXECUTIVE SUMMARY

The By-Catch Working Group (BYCWG) met from 2-4 May 2017 in Copenhagen, Denmark, under the chairmanship of Kimberly Murray. The Terms of Reference for the meeting were:

1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
2. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
3. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
4. *Review the information from Greenland on reporting of by-catch for the different species.*

The BYCWG also discussed that the goals of the meeting were not to assess the sustainability of the estimates as the sustainability is reviewed by the species-specific working groups that are doing the population assessments. The BYCWG should provide advice on whether the by-catch estimates are reliable and complete enough to be used in these population assessments.

Norway

The BYCWG reviewed the by-catch situation with humpback and killer whales in herring purse seine fishery, and updated harbour porpoise and harbour and grey seal estimates from the gillnet fisheries.

Humpback and Killer Whales

In recent years, as herring have entered fjords in high densities and both fishermen and whales are following the herring, incidences of humpback and killer whales caught in herring purse seine fisheries have increased. The Fisheries Directorate is working to reduce the risk of these incidents with a recommendation to limit the size of vessels allowed to fish inside the fjords, and recommendations for handling these incidents, including training fishermen, inspectors, and the Coast Guard for disentanglement and release of whales from the seine. The WG encouraged Norway to continue these efforts and also **recommended** investigating technical solutions to avoid the situation, such as night vision equipment to detect whales inside the seine, etc.

Harbour Porpoise

The WG reviewed the various methods of by-catch estimation of harbour porpoises in Norway. The WG **recommended** that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group suggests revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Harbour Porpoise Working Group Assessment in late 2018.

Grey and Harbour Seals

The WG reviewed the various methods of by-catch estimation of grey and harbour seals in Norway. The WG recommended that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group recommended the revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Coastal Seals Working Group Assessment in 2019.

The WG recommends that in the mark-recapture estimation approach, analysts consider the implications of different age structures between the tagged, harvested sample and the by-catch sample.

Other gillnet fisheries
The WG noted that in Norway the small mesh fisheries for mackerel and herring are not monitored, although small mesh is not known to catch harbour porpoises in Norway. This is also a quite small fishery. The gillnet lumpfish fishery has a high by-catch rate, but it is a small seasonal fishery. There is also a recreational fishery that uses gillnets.

Iceland
By-catch of marine mammals, seabirds and elasmobranchs in Icelandic waters has not been systematically investigated until very recently. Based on a study by Pálsson et al. 2015 and literature from other regions, most of the marine mammal by-catch is expected to come from the gill net fisheries for cod and lumpfish close to the coast, while it is possible that a smaller number of marine mammals are caught in the pelagic trawls and purse seines targeting capelin, mackerel, herring and blue whiting.

Most of the monitoring occurs in gillnet gear, where most of the by-catch is assumed. Less information is available from pelagic fishing gears. Fisheries observers cover all gear types (~1% coverage in all fisheries) but the sampling is not focused on documenting marine mammal by-catch. A new electronic logbook system was implemented in 2010, and since then logbook records of by-catch have diminished for unknown reasons. By-catch is not being reported on the e-logbooks, even though it is required for all vessels where possible. It has been shown that in some cases in the lumpfish fishery, the by-catch of marine mammals was an order of magnitude (5x) higher when an observer was present compared to what was reflected in the logbook records, so logbook records are clearly not a reliable source of data.

Data and Analysis
The two main sources of data used in this summary were records of by-catch from observers from the Directorate of Fisheries on-board commercial fishing vessels targeting lumpfish, and records from researchers from the Marine and Freshwater Research Institute (MFRI) during an annual research cod gill net survey. By-catch was estimated in the two gillnet fisheries (cod and lumpfish), by raising observed by-catch with total fleet effort. An alternative raising approach, using a two phase gamma-hurdle model, was also explored for the lumpfish fishery in 2016.

Recommendations
The BYCWG provided recommendations on the analysis of by-catch estimates (see item 7.3 in the main report) and recommended that these be addressed before the estimates are used by the Harbour Porpoise Working Group and Coastal Seals Working Group.

Faroe Islands
A description of fisheries in Faroese waters, fisheries regulations, the logbook system, fleet composition and fishing effort by fleet categories was provided to the WG.

There is little independent observation of fishing activities and no dedicated marine mammal observer scheme in the Faroes. The reliability of the by-catch reporting has not been assessed, but as elsewhere there is very little reported by-catch in logbooks.

The WG noted that reliable by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidence of by-catch in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch. A responsible precautionary approach requires initiating a proper assessment of the by-catch risk in the various fisheries, beginning with those of higher concerns.

The WG provided recommendations for by-catch monitoring and observation (see discussion items 8.1 and 8.2 in main report).

Greenland

The WG reviewed information on the existing knowledge about marine mammal by-catch in Greenland and gave the following recommendations:

1. The WG suggested that for marine mammal species without regulatory measures (e.g. non-quota small cetaceans such as harbour porpoise, dolphins, pilot and killer whales) and some seals, a reporting system similar to that mandated by the species-specific executive orders (i.e., for large whales, beluga, narwhal and some seals) would be helpful.

2. The WG recommends that Greenland include in the online reporting system for the hunters some kind of automatic validation, e.g. a pop-up window requesting information on the by-catch and the fishery in which it occurs.

3. The marine mammal by-catch reports made in fishery logbooks previous to 2016 have become available in the electronic fisheries database maintained by the Greenlandic Fishery License Control Authority in the Ministry of Fisheries and Hunting. The WG recommends that an overview of this information be made available to WG for review.

4. The WG recommends that Greenland perform as soon as feasible the validation of by-catch reporting data from the licensed hunters' online system against those from the buyers to understand levels of by-catch on a routine basis. This will help evaluate the new reporting system and will give an indication of the reliability of the overall reporting system.

5. The WG recommends that data collected by fisheries inspectors be summarized and made available. As the reporting of marine mammal by-catch is included in the protocols of fisheries inspectors, a report of the characteristics of any marine mammal by-catch events, in addition to information on the total fisheries effort, the number of trips observed, and the specific focus of the observation/inspection (fully monitored over the whole trip or just boarded to check gear type) would be helpful.

The WG also provided recommendations for improving the information in the background document SC/24/BYC/14 (see item 9.2 in the main report) and discussed mitigation measures in Greenland (item 10).

General Business

The WG recognizes that while it has recommended that marine mammal by-catch reporting is made mandatory in commercial logbook systems for vessels of all sizes, this information is not reliable without validation, which is difficult. While logbook reporting can be useful for qualitative indicators, the most reliable means to obtain information on by-catch is via dedicated monitoring by fisheries observers or electronic monitoring.

The WG briefly discussed interactions between aquaculture and seals, and encouraged the work of the Norwegian Fisheries Directorate to obtain improved data on the numbers of seals shot at fish farms. The WG also suggested that Norway should look at the numbers of fish mortalities at the fish farms that have been attributed to seals.

The WG also discussed electronic monitoring of by-catch, including a presentation on a system developed in Denmark which could provide a cheaper alternative to observers onboard vessels.

Next Meeting

At the next BYCWG meeting, all countries should:

- Provide information on all fisheries and gear types operating in the country, with levels of effort in each, and whether they are monitored for marine mammal by-catch. NAMMCO will provide a table of requested fields for countries to populate.

- Provide any information on observed trips, following a format provided by NAMMCO as above.
- Providing any new by-catch estimate(s) for review.

Each country should also report on progress with the recommendations made at this meeting.

MAIN REPORT

1. CHAIRMANS WELCOME AND OPENING REMARKS

Kimberly Murray, the chair of the meeting, welcomed the participants (Appendix 3). The participants introduced themselves and gave a brief background on their experience with by-catch issues.

2. TERMS OF REFERENCE

Murray reviewed the terms of reference for this meeting, which were:

1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
2. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
3. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
4. *Review the information from Greenland on reporting of by-catch for the different species.*

The WG also discussed that the goals of the BYCWG were not to assess the sustainability of the estimates as the sustainability is reviewed by the species-specific working groups that are doing the population assessments. The BYCWG should provide advice on whether the by-catch estimates are reliable and complete enough to be used in these population assessments.

3. ADOPTION OF AGENDA

The agenda (Appendix 2) was adopted without changes.

4. APPOINTMENT OF RAPPORTEURS

Prewitt acted as primary rapporteur, with help from Desportes, Murray and other participants where needed.

5. REVIEW OF AVAILABLE DOCUMENTS AND DATA

The documents available to the meeting are listed in Appendix 4.

6. NORWAY

6.1. Fisheries Overview

Rolf Harald Jensen gave a presentation on the work of the Surveillance Unit of the Fisheries Directorate in Norway, which ensures that the fisheries are carried out in accordance with regulations and in responsible methods. The unit consists of 21 inspectors, 2 advisers and 1 manager of service in the administrative staff in Tromsø. In 2016, there were 180 inspected fishing vessels, with 2400 stations/fishing operations (hauls) controlled. The inspector's main duties are to collect length and weight measurements of the fish to consider the need to close or open fishing grounds, however they also report observed incidences of marine mammal by-catch.

Fishermen are required to report marine mammal by-catch, however it is not likely that they are reporting all incidents.

In recent years, as herring have entered Norwegian fjords in high densities and both fishermen and whales are following the herring, incidences of humpback and killer whales caught in herring purse seine fisheries have increased. When the whales are detected inside the seine, and before the fish are dead, it may be possible to release the whales. However, if the herring have died, it is illegal for the fishermen to open the seine (the dead herring are considered discards/slippage which is forbidden).

Additionally, this fishery takes place primarily in the dark (24hrs darkness November to January), and there are cases where entrapped whales are not detected until it is too late.

There has been a recommendation from the Fisheries Directorate that no vessels over 21m be allowed to fish inside the fjords, in an attempt to reduce the risk of by-caught whales. The Fisheries Directorate is also working with the Coast Guard and the fishermen to develop recommendations for handling these incidents, including training fishermen, inspectors, and the Coast Guard for disentanglement and release of whales from the seine.

Discussion

The WG encouraged Norway to continue with their plans on training in disentanglement and release (with David Mattila), and also **recommended** investigating technical solutions to avoid the situation, such as night vision equipment to detect whales inside the seine, etc.

The WG discussed whether this issue may also be occurring in the purse seine fisheries outside the fjords, where they would not be observed as easily by inspectors, Coast Guard, or other people (whalewatchers, etc.). It is possible that this could be happening, but it could also be less of a risk because the fish, fishermen, and whales have more room to move around outside of the fjords.

There have also been incidents of humpback whales in the capelin purse seine fishery in the Barents Sea.

6.2. By-catch Data and Analysis

Harbour porpoise

Bjørge presented a summary of paper SC/24/BYC/08. Data from a monitored segment (18 vessels) of the fleet of about 6,000 small (less than 15m) vessels operating gillnets in the coastal zone were used to estimate the by-catch rate, and landings statistics of the target species for the whole fleet using same gear types were used to extrapolate to the entire fisheries. The previously published estimated annual by-catch of about 6,900 harbour porpoises for the period 2006-2008 (Bjørge et al. 2013) was based on incorrect landings statistics of the target species provided by the Directorate of Fisheries. The by-catch for the entire period 2006-2014 is estimated by two methods: ratio-based approaches and model-based approaches. In the ratio-based approaches, the data were stratified according to five different stratification schemes, by month, by area, by region, and by each possible combination of area × month and region × month. The stratified ratio-based by-catch estimates ranged from 2,211 (CV 0.16) to 3,218 (CV 0.17) porpoises. In the model-based approaches, generalized additive models (GAMs) were used to estimate the by-catch rate and to extrapolate to entire fisheries. Poisson and negative binominal distributions and their zero-inflated counterparts were compared. The Poisson distribution performed best, and the best model based on Akaike's Information Criterion adjusted for small samples, AICc, yielded an annual by-catch of 2,317 (CV 0.10) porpoises.

Discussion

The document used for the main WG discussion on harbour porpoise (and seal) by-catch rates was SC/24/BYC/Info07, rather than SC/24/BYC/08, because SC/24/BYC/Info07 was completed after SC/24/BYC/08, and provided the most recent set of results from the different estimation techniques used.

Data

The WG discussed the possibility of using fishery effort instead of landings data as a measure of effort. The landings fluctuate from year to year and fishermen may increase their net length if fish are scarce. Although SC/24/BYC/Info07 showed that the relationship between landings and effort was good, the WG **recommended** that other measures of effort should be explored. This exploration should include cooperation between IMR and the Fisheries Directorate on identifying what data are available (e.g. number of trips, soak length, net size, etc.). It would be helpful for the Directorate to clarify to data requestors what data fields are available for by-catch analyses.

Jensen also informed the WG that fishermen must report to the Coast Guard when a net is deployed and when it is pulled, and the location (including start and end) of the net, which could be used to calculate the length of the net. These data would enable much more detailed by-catch estimation.

If landed weight is used, ideally the by-catch rates should be extrapolated using total landings for all species, not only the target species (e.g., monkfish or cod), as it is the gear that is in the water that poses risk of porpoise by-catch. Using a portion of the catch as a measure of fishing effort underestimates the possible marine mammal by-catch. A suggestion was made to estimate by-catch for gillnet "gear", ideally separated into large and small mesh groups, rather than for "cod" and "monkfish" fisheries (see Technical Comments, Appendix 1).

Coastal Reference Fleet

All vessels in the Coastal Reference Fleet (CRF) are less than 15m, but catch statistics used in the by-catch extrapolation may include all vessel sizes. The WG **recommended** that this should be clarified.

The WG discussed that it would be good to look into whether the same vessels are used in the CRF year after year. There is almost certainly bias in the CRF data if the vessels are not switched out on a regular basis. Moan also acknowledges in SC/24/BYC/Info07 that these kinds of repeated samples cause correlations in the data samples, which could lead to errors in the analysis. One solution to this problem might be to change the design of the reference fleet selection process, such that any one vessel cannot participate 2 consecutive years.

The CRF fishes mainly in the coastal zone. It could be interesting to stratify by inshore/offshore if the data are available.

Estimation Approaches

SC/24/BYC/Info07 reported by-catch rates estimated using a model-based approach and a ratio-estimator approach. The WG agreed that between the 2 approaches, the ratio-estimator approach was preferred, though revisions were required before the ratio-estimator results could be endorsed by the group (see Technical Comments, Appendix 1). The ratio-estimator approach was preferred because some of the GAM models used to estimate by-catch provided a poor fit to the data, and this may have been due to a variety of factors that could not be clearly identified. For instance, poor fits may be due to the model selection process, the high-degree of zeros in the data, the clustered nature of the sampling events, correlated data, etc. The group felt that the ratio-estimator approach was more robust to these kinds of issues compared to the model-based approach.

Other gillnet fisheries

The small mesh fisheries for mackerel and herring are not monitored, although small mesh is not known to catch harbour porpoises in Norway. This is also a quite small fishery.

The gillnet lumpfish fishery has a high by-catch rate, but it is a small seasonal fishery.

There is also a recreational fishery that uses gillnets. The landings are reported if the catch is sold, but if they are not selling it the recreational fishermen do not need to report. No license is required, however there is a maximum length and number of nets that can be deployed (210m of net can be set at a time). The soak time limit is the same as for the commercial fisheries: gillnets for cod, haddock and saithe have a limit of one day; Greenland halibut, blue ling, ling and redfish must be pulled every second day; and monkfish every third day. There is also likely some level of illegal fishing, which is of course difficult to monitor.

By-catch of seals in Norway

Bjørge presented document SC/24/BYC/Info07 which reported by-catch rates of seals using a model-based approach and a ratio-estimator approach. A third approach was presented in SC/24/BYC/08, whereby seal by-catch was estimated via mark-recapture techniques. For the period 1997-2014 Norway has statistics on the number of grey and harbour seals harvested from the populations, as well as information on number of seals tagged, number of tags recovered from the hunt and number of tags

recovered from fishery by-catches. These data provided an opportunity to estimate the total number of seals taken as by-catch, assuming equal ratios of animals in the total harvest to the tagged harvest, and total by-catch to the tagged by-catch.

Discussion

The working group noted that while hunters may take a wide range of age groups, most by-caught seals are juveniles, so assumptions regarding tag loss and annual mortality rate, emigration and immigration being similar between the two sets of animals are unlikely to be upheld.

For hunted animals, the data may not reflect the full age structure of the hunt. Hunters are only required to report number of seals hunted and the sex (i.e., not length or some other data that could be used for aging). For some years, the lower jaw was collected which would be able to provide information on age.

In addition, the authors acknowledge that some of the by-caught seals that were identified as grey seals may have been incorrect. Issues with these assumptions were discussed at the Coastal Seals Working Group meeting (NAMMCO 2016).

Given these issues, and the existence of more detailed estimates of by-catch from sampling the CRF, the WG agreed that the mark-recapture method was not the preferred approach. However, if these data were to be used for other purposes it would be important to consider the implications of the different age structures between the harvested and by-caught animals, and how this might affect the probability of recovering a tag.

For instance, in the calculations of by-catch estimates for seals, the total harvest should be replaced by total juvenile harvest. Only juveniles were tagged and almost all the recoveries were within the first year, so all ages should not be lumped. The WG **recommended** separating out the seals less than 1 yr, or investigating other ways to separate out the differing probabilities of tag recovery based on age.

6.3 Recommendations

Harbour Porpoise

1. The WG **recommended** that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches for reasons mentioned above; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group suggests revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Harbour Porpoise Working Group Assessment in late 2018.

Grey and Harbour Seals

1. The WG recommended that the ratio estimates as presented in SC/24/BYC/Info07 be preferred over the model-based approaches for reasons mentioned above; however, the group advises that the ratio estimates need to be revised before they can be endorsed by the By-catch Working group. The group recommended the revisions per the Technical Comments listed in Appendix 1, and that these be addressed and endorsed prior to the Coastal Seals Working Group Assessment in 2019.

2. The WG recommended that in the mark-recapture estimation approach, analysts consider the implications of different age structures between the tagged, harvested sample and the by-catch sample.

7. ICELAND

7.1. Fisheries Overview

Guðjón Sigurdsson presented information on by-catch in Iceland, which summarized SC/24/BYC/10.

The major fisheries in Icelandic waters can be divided into pelagic and demersal fisheries. The pelagic fishery targets capelin, herring and mackerel with pelagic trawl and purse seines. The demersal fishery targets various species of ground fish (gadoids and redfish), flatfish and crustaceans with long line, demersal seine, bottom trawl and gill nets.

7.2 Monitoring

By-catch of marine mammals, seabirds and elasmobranchs in Icelandic waters has not been systematically investigated until very recently. Based on a study by Pálsson et al. 2015 and literature from other regions, most of the marine mammal by-catch is expected to come from the gill net fisheries for cod and lumpfish close to the coast, while it is possible that a smaller number of marine mammals are caught in the pelagic trawls and purse seines targeting capelin, mackerel, herring and blue whiting.

Most of the monitoring occurs in gillnet gear, where most of the by-catch is assumed. Less information is available from pelagic fishing gears. Observers cover all gear types (~1% coverage in all fisheries) but the sampling is not focused on documenting marine mammal by-catch. Observers are not always in a position to document marine mammal by-catch in all fisheries. For instance, in the pelagic pair trawl fishery, observers are below deck to monitor the catch, and not in a position to see if a marine mammal is caught. Since 2014 this has improved with stricter guidelines regarding marine mammal by-catch and supervision of the observers, but prior to that data were not reliable for reporting of marine mammal by-catch.

A new electronic logbook system was implemented in 2010, and since then logbook records of by-catch have diminished for unknown reasons. By-catch is not being reported on the e-logbooks, even though it is required for all vessels where possible. Smaller vessels that cannot use the e-log system have to report catch and by-catch in paper-based logbooks. It has been shown that in some cases in the lumpfish fishery, the by-catch of marine mammals was an order of magnitude (5x) higher when an observer was present compared to what was reflected in the logbook records, so logbook records are clearly not a reliable source of data.

7.3 Data and Analysis

The two main sources of data used in this summary were records of by-catch from observers from the Directorate of Fisheries on-board commercial fishing vessels targeting lumpfish, and records from researchers from the Marine and Freshwater Research Institute (MFRI) during an annual research cod gill net survey. By-catch was estimated in the two gillnet fisheries (cod and lumpfish), by raising observed by-catch with total fleet effort. In the case of the cod gillnets, observed by-catch in the survey was first raised by effort (nets pulled x soak days) in April, to get an estimate of by-catch by the fleet in April. This estimate for April was then raised for other months by effort but then adjusted for seasonal variation in marine mammal abundance. For lumpfish nets, observed by-catch was raised by overall effort of the fishing fleet in terms of nets pulled and the number of soak days. An alternative raising approach, using a two-phase gamma-hurdle model, was also explored for the lumpfish fishery in 2016. In this approach, the likelihood of a by-catch event occurring was estimated using a binomial generalized linear model, and then the magnitude of the event using a gamma GLM.

By-catch estimates from 2014-2016 using the standard raising method are given in Table 1, and from the lumpfish fishery in 2016 using the gamma hurdle model are given in Table 2.

The extremely high estimates of grey seal by-catch in the lumpfish fishery are due to three observed events, where 17, 16 and 12 grey seals were caught. Outside of those three events only one grey seal was observed among 57 observed hauls. Based on the latest population estimate of grey seals in Iceland, the estimated by-catch amount represents close to 60% of the total population. This estimate is therefore inaccurate and requires further analysis. Possible solutions would be to add spatial stratification to the estimate, as those three events took place in the same general area and might not be representative for the entire fleet. In addition, data could be pooled over the 3 years to report an average annual estimate, which will reduce the overall effect of those extreme by-catch events.

Even with the grey seal estimate removed, authors saw an increase in marine mammal by-catch from the estimates done in 2014 and 2015, mostly due to a 4-fold increase in harbour porpoise by-catch. As fishing effort has been stable, it could be an indicator of an increase in the local density of harbour porpoises between years, or a sporadic event which might become evident with further sampling.

Discussion

The WG noted that the most important factor in by-catch estimation is confidence in the data inputs. Iceland informed the WG that they have very high confidence in the cod gillnet data, and high confidence in the lumpfish fishery data. There is a potential bias in the lumpfish data, as some of the observer trips are targeted to observe boats that have reported little or no cod catch in relation to other boats in the area. This has been addressed with the Directorate of Fisheries, and they will mark those trips as "non-random" starting in 2017 which will allow for an analysis of this potential bias.

The WG noted that in general all the standard deviations of the estimates seemed surprisingly low, and it was **recommended** that uncertainty be re-evaluated with other means, perhaps a bootstrapping approach (see R2 below).

Cod Fishery

This fishery is further offshore and in deeper waters than the lumpfish fishery, and consequently harbour porpoises are by-caught more often than seals (harbour and grey) in cod gillnets in Iceland. In 2016, 35 harbour porpoises were recorded in 3948 net days (at 100 nets fished/day, this is ~40 days). When comparing coverage with the same metric, the capture rate in cod gillnets was about 10 times the capture rate in lumpfish nets.

There was an increase in harbour porpoise by-catch in cod gillnets in 2016. The rate is four times higher compared to 2015 (with the same amount of observer effort), suggesting that harbour porpoise density on the fishing grounds might be changing.

It was suggested that Iceland examine trends in commercial effort in the cod fishery over time, because the change in the by-catch estimate (the 2015 estimate went from 553 to 2,618 in 2016) might be influenced by increases in commercial fishing effort, in addition to higher by-catch rates.

The estimated harbour porpoise by-catch in 2016 was ~2-9% of the abundance estimate of 43,179, however this abundance estimate was considered to be a minimum estimate because it was based on an incomplete aerial survey. The WG noted that large ecosystem changes have been observed in the Icelandic ecosystem between 2015 and 2016, which could have affected the abundance and distribution of porpoises. A new estimate based on next of kin genetic analysis is ongoing.

The WG noted that as a way to check if the high by-catch rates would be expected, rates could be evaluated relative to a density per area. Density values are available in Gilles et al (2011). The density estimate in area 1 (where high observed by-catch rates occurred) is low (0.15 in July), despite the high by-catch rates in that area. However, the density values are based on a harbour porpoise survey conducted in July, while the high by-catch rates are based on a study conducted in April, and the densities of harbour porpoises may change seasonally.

Banana pingers were tested in 2017 to try to reduce porpoise bycatch in the cod gillnet survey. There was no difference in the observed by-catch in a paired trial, with three porpoises caught in 70 observed hauls of 840 nets with banana pingers and four in 70 observed hauls of 840 nets without any pingers.

Table 1. Estimated numbers of marine mammal bycatch by species and fishing gear type in Icelandic waters in 2014-2016 from the standard raising methods. Standard deviation of the estimate is shown in the brackets.

Species	**Cod gill nets**			**Lumpfish nets**			**Other gear**			**Total**		
	2014	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**	**2014**	**2015**	**2016**
Harbour porpoise	551 (30)	553 (48)	2618 (77)	139 (61)	215 (75)	374 (153)	0 (0)	0 (0)	0 (0)	690	768	2992
Harbour seal	0 (0)	46 (0.7)	0 (0)	232 (116)	1,288 (1335)	624 (356)	0 (0)	86 (3.3)	0 (0)	232	1,420	624
Gray seal	0 (0)	0 (0)	0 (0)	162 (118)	1,216 (1824)	2870 (9820)	0 (0)	0	0 (0)	162	1,216	2,870
Harp seal	92 (1.5)	212 (7.7)	144 (7.0)	23 (7.5)	72 (61)	187 (42)	0 (0)	0 (0)	0 (0)	115	284	331
Ringed seal	38 (1.0)	0 (0)	0 (0)	46 (7.5)	143 (31)	0 (0)	0 (0)	0 (0)	0 (0)	84	143	0
Hooded seal	0 (0)	46 (0.7)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	0	46	0
Bearded seal	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)	124 (23)	0 (0)	0 (0)	0 (0)	0	0	124
Total	681	857	2,762	602	2,934	4179	0	86	0	1,283	3,877	6,941

Table 2. Estimated numbers of marine mammal bycatch by species in the lumpfish fishery in 2016 using the gamma-hurdle model. Mean estimate is shown, as well as the 95% CI in brackets.

Species	Lumpfish nets
Harbour porpoise	259 (84 – 473)
Harbour seal	2171 (511 – 4156)
Gray seal	1881 (622-3798)
Harp seal	134 (35-229)
Ringed seal	0
Hooded seal	0
Bearded seal	146 (13-310)
Total	4591 (2076-7445)

Lumpfish Fishery
Seals (grey and harbour) are the main marine mammal by-catch in the lumpfish fishery, as this fishery occurs in shallow water close to haul out sites. Estimates of by-catch in the lumpfish fishery rely on observers who sample a portion of the gillnet fleet. Observer coverage in the lumpfish fishery was 1.7%. However, data from the lumpfish fishery were not always drawn from a random sample of vessels, because some observations have been directed at vessels with lower reported cod catches than other boats fishing in the same area. Starting in 2017, this potential bias can be better quantified, because the observations are coded depending on why the vessel has been selected for monitoring.

Grey seals
Out of 57 trips, 46 grey seals were by-caught, which led to a by-catch ratio estimate of 2,870 (SD=9,820). The grey seal population in Iceland in 2012 was 4200 (95% CI: 3400 – 5000) seals, which is an annual decrease of 5% (90% CI: 4%-6%) between 2005 and 2012 (Hauksson et al. 2014). A new abundance estimate is expected from a survey planned for summer 2017. The WG noted that this by-catch estimate is 57-84% of the 2012 abundance estimate, and it is likely biased high. As the group recommended revisions to the by-catch estimate analysis, these comparisons to abundance are subject to change.

As seen in other areas (Norway, UK, US), most of the by-caught seals are young of the year.

Three trips took the majority of seals (i.e 17 seals in 1 trip) and are likely skewing the estimates, because very high by-catch rates are being applied to the entire fishery. The estimate could be improved by spatially stratifying the data to focus on the region which contained most of the observed by-catch. Additionally, it is possible that young harp seals are being misidentified as grey seals, so improved species identification is recommended.

Estimates from the gamma hurdle model estimate were considerably lower (1,881, CI=622-3798) than the ratio estimate, but a preferred approach was not selected. The WG did not have the gamma hurdle model details to evaluate the differences or recommend a preferred approach.

Harbour Seals
The current abundance estimate for harbour seals in Iceland is 7652 animals, which indicates a decrease of 32% since the last estimate in 2011 (Þorbjörnsson et al 2017). The harbour seal by-catch estimate is 6-12% of this abundance estimate. As above, the group recommended revisions to the by-catch estimate analysis so these comparisons to abundance are subject to change.

Recommendations
Lumpfish Fishery
R1. The WG **recommended** that Iceland explore different stratification schemes for the ratio estimate, and pool data over the 3-year time frame to report an average annual estimate of by-catch.

R2. The group also **recommended** that the uncertainty around the estimates be re-evaluated, such as with a bootstrap approach. These revisions should be completed and endorsed by the group prior to the Harbour Porpoise Working Group Assessment meeting in 2018, and the Coastal Seals Working Group Assessment meeting in 2019.

R3. The WG **recommended** that fishing trips sampled for estimating by-catch rates be selected as randomly as possible, to ensure observer coverage is representative of various fishing behaviours.

R4. The WG **recommends** that for seals, observers collect jaws or photos to improve species identification, and to collect skin samples to inform genetic research.

Cod Fishery

R5. The WG **recommended** that the uncertainty around the estimates be re-evaluated, such as with a bootstrap approach. These revisions should be completed and endorsed by the group prior to the Harbour Porpoise Working Group Assessment meeting in 2018, and the Coastal Seals Working Group Assessment meeting in 2019.

Other

R6. The WG **recommended** that Iceland conduct monitoring of the monkfish and Greenland halibut gillnet fishery, as by-catch has been observed in this type of gear in other areas.

8. FAROE ISLANDS

8.1 Fleet description and Fisheries Regulations

Mikkelsen presented SC/24/BYC/13 which provided a description of fisheries in Faroese waters, fisheries regulations, the logbook system, fleet composition and fishing effort by fleet categories.

The main fisheries in Faroese waters are mixed-species, demersal fisheries and single-species, pelagic fisheries. The demersal fisheries are mainly conducted by Faroese vessels, fishing primarily for cod, haddock and saithe. The pelagic/midwater fisheries, which targets blue whiting, herring and mackerel, are conducted by Faroese and foreign fishing vessels, licensed through bilateral and multilateral fisheries agreements. All vessels over 15 tonnes are equipped with satellite tracking devices

The fishery within the Faroese exclusive economic zone is regulated by individual transferable effort quotas in days within fleet groups. The individual transferable effort quotas (number of fishing days) applies primarily to four main fleet categories: trawlers <400 HP, longliners >110 HK, longliners and trawlers <110 GRT and boats <15 GRT. The single trawlers >400 HP do not have effort limitations, but they are not allowed to fish within the 12 nm limit, and are also, together with trawlers <400 HK, regulated by area closures. Also, their catch of cod and haddock is limited by maximum by-catch allocations. The single trawlers <400 HP are given special licenses to fish inside 12 nm with a by-catch allocation of 25% cod and 12% haddock. In addition, they are obliged to use sorting grids in their trawls. One fishing day by longliners <110 GRT is considered equivalent to two fishing days for jiggers in the same gear category. Longliners <110 GRT could therefore double their numbers of days by converting to jigging. Technical measures such as area closures during the spawning periods, to protect juveniles and young fish and mesh size regulations, are also in effect.

The fishery for greater silver smelt (*Argentina silus*) in Faroese waters is a bottom/semi-pelagic fishery, performed with very high vertical opening (VHVO) trawls of about 100 m x100 m. This fishery is regulated by quota and number of operating vessels (6 vessels working in pairs). The fishery occurs in the summer months (April - September) at depths between 300 - 700 meters.

The gillnetters target Greenland halibut and monkfish with set gillnets. They operate in deep waters off the Faroe Plateau, Faroe Bank, Bill Bailey's Bank, Lousy Bank and the Faroe-Iceland Ridge. This fishery is regulated by the number of licensed vessels (8 vessels) and technical measures like depth and gear specifications. The minimum depth for set gillnets targeting Greenland halibut is 500 meters, while in the monkfish fishery gillnets must be set deeper than 380 meters.

The Faroese pelagic fisheries are conducted by purse seiners and larger purse seiners also equipped for pelagic trawling. The pelagic fishery by Russian vessels is conducted by large factory trawlers, while other countries use purse seiners and factory trawlers, operating as pair trawlers. The fishery for blue whiting has exhibited a more than ten-fold increase since 2011 and is by far the most important fishery in terms of landings (over 230000 tons in 2015), followed by mackerel and herring.

The dominant fishing equipment for recreational fishing is hand line with baited hooks. A limited effort using longlines (halibut) and gillnets (herring) does occur in nearshore waters. There are no restrictions in gears or landings imposed on the recreational fishery.

8.2 By-catch information[1]

By-catch reporting

Also based on SC/24/BYC/13, Mikkelsen reported that electronic logbooks, with on-line access and delivery (e-logbooks) to the Faroese Fisheries Inspection (www.vorn.fo), were introduced for the Faroese fleet larger than 15 GRT in the fishing year 2012/13, when also by-catch registration of marine mammals became mandatory.

By-catch registration is a dedicated column in the logbook, where fishermen register or are prompted to set "null" for no by-catch before being able to close the registration form Information on the species of bycaught whales and seals is not given, because the option is not available in the e-logbook, however the information can be added under comments.

The by-catch numbers registered in the e-logbooks are 2 whales in 2012/13, 2013/14 and 2014/15, respectively, and 5 whales in 2015/16. For some by-caught whales, the species has been given, and in these cases this has been either pilot whales or killer whales. Almost all by-catches originate in the pelagic/midwater fisheries for mackerel.

Table 3. From NAMMCO/SC/24/BYC/13, Landings (tonnes) of the main fisheries in Faroese waters – colours indicate fisheries with potential for bycatch of marine mammals (blue=gillnets, purple=high vertical opening trawl, green=pelagic trawl).

Fisheries in Faroese waters										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Cod	12851,2	12359,2	10819	9724,1	12506,5	11731,9	7287,7	5209,7	6529,3	7103,3
Haddock	15457,8	11291,9	6763,2	4474,1	4514,4	3195,5	2353,1	2624,6	2499,1	2660,7
Tusk	2386,9	2031,6	2556,6	2243,9	3323,7	2872,2	3232,2	1274,8	1522	1124,5
Ling	3430,7	3006,4	3341,4	3237	4518,4	4060,9	5010,7	3513,5	5065,6	3795,1
Blue ling	1690,2	1600,9	926,1	853,5	1413,4	1294,9	1062,7	540,7	799,8	578,6
Saithe	59884,2	54961,4	50966,0	52579,5	39713,5	26842,6	31968,8	23660,2	21391,0	22666,4
Greenland halibut	900,8	1586,8	2103,9	2311,9	1165,1	1738,1	2241,1	2739,9	2904,4	3007,1
Redfish	3464,5	3031,4	1455,1	1468,7	1650,5	913,7	677,8	786,1	591,2	785
Monkfish	4334,1	3401,7	1869	1779,5	2015,3	1901,2	1079,2	454,8	590,8	543,6
Greater silver smelt	12270	13437	19248,8	19740,3	19189,5	18711,7	12265,6	14195,7	12018,8	14093,9
Salmon	0	0	0	0	0	0	0	0	0	0
Blue whiting	161939	145889,4	105167,8	24261,8	26964,1	14435	40594,4	83761	173810	231502
Norway pout	0	0	0	0	2,5	49,6	1751,2	586,1	1098,4	0
Herring	24559	10925	4256,7	4181,4	11891,3	56487,6	43005	110791,8	37448,5	37829
Horse mackerel	0	12,4	9,5	0	199,5	8,7	0,1	0	15,1	4,5
Mackerel	0	201,3	120,7	4990,7	66072,2	122047,4	107115,7	142735,1	95301	71148
Total	303168,4	263736,4	209603,8	131846,4	195139,9	266291	259645,3	392874	361585	396841,7

[1] When reading item 8.2 and sub-items ***By-catch reporting*** and ***Discussion for 8.1 and 8.2***, one should be aware of the corrigendum on erroneous by-catch reporting provided by the Faroe Islands on 8. April 2020, which has been added at the end of the report. See also the third note on the front page of the report.

Discussion for 8.1 and 8.2

There is little independent observation of fishing activities and no dedicated marine mammal observer scheme in the Faroes. The reporting of by-catch in logbooks has become mandatory but only for vessels larger than 15 GRT. The reliability of the by-catch reporting has not been assessed, but as elsewhere there is very little reported by-catch in logbooks (11 whales in the period 2012-2016).

The information provided in SC/24/BYC/13 was supplemented by the information provided at the previous meeting of the WG (SC/23/13) and compared with information from other fisheries in an attempt to identify possible risk.

Pelagic and semi-pelagic fleet

Pilot, minke, and killer whales have been reported as by-catch in the Faroe Islands. Within one incident, a pod of 5 killer whales was by-caught in one trawl[2]. VHVO trawlers have caught marine mammals in other regions in the North Atlantic. For example, in Spain VHVO is a gear with high by-catch. It has therefore the potential for by-catch in the Faroes due to the nature of the fishing operation and temporal and spatial overlap with marine mammals.

There are 6 pelagic trawlers reporting on average 1 whale per vessel per year. The WG noted that in comparison, UK observers have monitored over 150 fishing trips by pelagic trawlers targeting mackerel and herring in adjacent waters (ICES Divisions 6a and 4a) without any records of cetacean bycatch, although killer whales are often observed swimming around pelagic trawlers targeting mackerel during haulback, there has been no report of killer whale by-catch.

Demersal trawl

No by-catch has been reported in the Faroe Islands. In the US, however, a variety of small cetaceans and pinnipeds are by-caught in bottom trawls targeting groundfish. The WG also noted that in the UK during the 1980s around 20 porpoises had been recovered from demersal trawlers fishing around Shetland.

Purse seine

Pilot whales, killer whales and minke whales have all been reported as by-catch in the Faroe Islands.

Gillnet targeting herring in coastal waters

There has been no reported by-catch in the gillnet herring fishery in the Faroe Islands.

Gillnet targeting Greenland halibut and monkfish

There has been no reported by-catch, and by-catch risk is assumed to be low by the Faroe Islands because of the depth at which the gillnets are set.

In the UK, the by-catch rate is low in the monkfish fishery in deep water (over 150m) but high in shallower waters. In the US, however, the monkfish fishery typically has a high by-catch rate regardless of depth, due to the large mesh size used in the gear.

In conclusion, the WG noted that reliable by-catch rates are missing for all fisheries. However, there is a spatial and temporal overlap of several marine mammal species (mainly cetaceans) and fishing operations with gears which have a high by-catch risk in other countries, as well as anecdotal evidence of by-catch in the Faroe Islands. This strongly suggests that the low reporting of by-catch in electronic logbooks may not reflect actual levels of by-catch. A responsible precautionary approach requires initiating a proper assessment of the by-catch risk in the various fisheries, beginning with those of higher concerns.

Animals taken as by-catch are not always identified to species, (for instance, 5 “whales” were reported in 2015/16 logbook data), and this should be improved.

[2] As footnote one. The reporting of the five killer whales being by-caught in a single trawl event was a fictive reporting during testing of the electronic logbooks.

In general, the pelagic pair trawl fishery appears to be a fishery with a high by-catch rate, simply from the number of vessels operating in the fishery and the recorded number of bycaught whales. For instance, out of 5 vessels in the fleet, there were 5 whales bycaught in 2016, which is 1 whale per boat on average. This is relatively high compared to similar vessels with more observer coverage in the UK.

Recommendations
In order to get a better understanding of the by-catch risk in the Faroese fisheries, and taking advantage of the Faroese political decision of increasing and improving the monitoring of the Faroese fisheries (upon recommendation from ICES), the group agreed to recommend as first steps and priorities:

1. The WG recommends that in regards to by-catch reporting:

    1.1. Add selection of local marine mammal species to e-logbook design, so species identification can be easily reported.

    1.2 Implement a reporting system for vessels below 15 GMT, as also recommended by the previous BYCWG.

2. WG recommends that in regards to by-catch observation:

    2.1 Improve reporting of by-catch on pelagic pair trawl fisheries by monitoring vessels in the fleet with an electronic monitoring video system (EM) or onboard observers. Electronic Monitoring might be more cost-effective than an observer scheme, particularly because only 5 vessels operate in the pelagic pair trawl fishery, and likely only a few hours per fishing trip need to be observed and videoed. The use of the EM could also be rotational. These fisheries are difficult to observe due to the high volume of catch and the multi-vessel nature of the fishery, so attention must be given to where the observer or cameras are placed and to the stage of the haul.

    2.2 Implement observer coverage in other fleets with potential for by-catch, such as the high vertical opening trawl fleet (6 vessels).

    2.3 Review the data already collected by fishery observers on the monkfish fishery during an experimental monitoring of the fishery prior to 2015.

    2.4 Include documentation of marine mammal by-catch in the protocol of fisheries observers, as well as other standard characteristics of the fleet (effort, location, month, etc.) to measure by-catch rates.

In addition, the WG mentioned that passive acoustic monitoring on the pelagic trawlers could indicate whether there is a routine association between killer whales and these gears or whether the by-catch of a pod of five killer whales was the consequence of a random event. This would help inform the by-catch risk in these gears.

9. GREENLAND

Nette Levermann (Ministry of Fisheries and Hunting) joined the meeting via videoconference on 3 May 2017 and presented paper SC/24/BYC/14, which gives information on the existing knowledge about marine mammal by-catch in Greenland. Its focus is on landings, use of different fishing gear, distribution of adjacent marine mammal species, and the fishery's potential for spatial and temporal overlap with marine mammals. This information and reported marine mammal by-catches were then used to discuss the risk of by-catch of marine mammals in general in Greenlandic waters.

The use of set gill nets and pound nets in coastal fisheries for Greenland halibut, cod, salmon and lumpfish which mainly occur during May-October. This period directly overlaps the period when the harp seals and hooded seals, along with the large baleen whales are most abundant in the near shore Greenlandic waters.
The reporting of by-catch data comes from different sources:

1) Hunting grounds and living resources are open to harvest and use by Greenlandic citizens, subject to hunting licenses (full time or part time license). All catches have to be reported to the Ministry of Fisheries and Hunting where they are entered into the database. Until a new online reporting system was implemented in 2013, by-catches of seals and small cetaceans were required to be reported as catches.

Given that the vast majority of the fishermen who deploy fishing gear have a hunting licence, there is reason to believe that most by-catches of seals and small cetaceans are consumed or sold in the same way as the animals that are shot with rifle during regular hunting, and may have been reported as such.

2) There is a general ban on discard as well as an obligation to record and report all catches including birds and mammals, this applies for all Greenlandic and foreign vessels operating in Greenland waters. From 2016 this includes even small vessels i.e. below 6m length. It is obligatory for fishing vessels to deliver standardised logbooks to the Ministry of Fisheries and Hunting. The latest version of these logbooks includes an item for by-catch of marine mammals, which is entered into an electronic fisheries database at the Ministry of Fisheries and Hunting. The reporting of all marine mammal by-catch in logbooks is mandatory, as it is for the by-catches of commercially important fish species

3) A fishery observer scheme is enforced for all large Greenland vessels and for foreign vessels operating inside the Greenlandic EEZ. The observer scheme aims for a minimum coverage of 50 % of fishing trips in key fisheries and fisheries where there is a risk that one or more rules are not respected.

4) From April 2016 a new executive order on catch reporting has made it compulsory for the fishermen and buyers to report all catches, including by-catches which are not passed to the buyers. This includes all marine mammals, birds, fish or any other family of species. The systematically collection of data about by-catches in fisheries from the fishery it-self is stored and available for analysis in the fisheries database.

5) Other species registered as by-catch in Greenland include the entanglement of large whales as humpback-, minke-, bowhead and fin whales in fishing gear, with the highest number reported are the humpback whale. An average registration of three large whales annually is registered as entanglements in Greenland in the period 1998-2016, data reported to the IWC. The Greenland Government has in collaboration with the International Whaling Commission in June 2016 had a training course for local fishermen and wildlife officers on a “Fishermen assisted release program”, when large whales are by-caught in fishing gear.

Discussion
In the salmon gillnet fishery in the 1970s there were high numbers of by-catch of killer whales, and harbour porpoises, but there have been no reports recently. No information was available to the WG as explanation for this.

In the Greenland shrimp fishery, exclusion grids have been used and since then no marine mammal by-catch has been recorded on the logbooks and the by-catch is therefore assumed to have been mitigated. However, the WG commented that the use of a grid does not necessarily imply that by-catch is prevented, because it depends on the design of the grid and how it functions as the trawl is fishing.

9.1. By-catch reporting and reliability

Greenland is an atypical case because any marine mammals that are caught, either directly or indirectly, are likely to be consumed so as long as the primary concern is to ensure that any by-catch is included in the total number of removals to be used in population assessments there is no real need to distinguish

hunted from bycaught animals. However, it is interesting to be able to distinguish between catch and by-catch, both regarding the certification of fisheries and in terms of mitigation (should the total removals not be considered sustainable). In an effort to improve the by-catch and hunting data collection and monitoring, Greenland implemented online reporting in 2013, and is continuing to improve the system.

Prior to 2013, it is assumed that by-catch of small cetaceans and seals would have been reported as catches – and therefore not distinguished from the hunt. Now, data from 2013-2016 include records of marine mammals taken as by-catch and during the hunts. The 2015/2016 data were validated by calling hunters and fishermen to check how they recorded the data. Of the 272 recorded "by-catches" (28 hunters reporting 72 monthly events of by-catches from April to December 2015 and January to September 2016. Data is summed per month for the reporting scheme. Species: harp seal young and adult, hooded seal, bearded seal, white-sided dolphin, harbour porpoise, narwhal, killer whale. Range 1-15 animals per hunter per month.), approximately two thirds were validated and of these, only 6 (4 events) were confirmed by-catches (others were shot by rifle, struck and loss, or not able to confirm). This indicates uncertainty in previous data as to the reporting category. The 6 recorded by-catch events were bearded seal and adult harp seal in the lumpfish fishery.

9.1.1. Large whales

The WG agreed with the Scientific Committee (NAMMCO 2016) that the reporting of by-catch of the larger species was reliable, as the Ministry of Fisheries and Hunting covers the financial expenses associated with by-catch of large whales. Also, the by-catch of large whales is usually also reported by the fisheries and hunting inspectors or by the municipality where the incident occurs. This is assuming the animal has not swum away with the gear.

9.1.2. Smaller whales

Smaller cetacean species are not subject to the species-specific executive order for quota species. The by-catch may have been reported as catch by the hunters, but this is not possible to validate. The executive order from 2016 (see point 4 above) on catch reporting should make the reporting more systematic and also provide a tool for validation.

9.1.3. Seals

There are no quotas for seal hunting, and it is unknown whether seals that were by-caught were previously reported as catch. However, the by-catch is required to be reported based on the executive order from 2016 (see point 4 above). This should make the reporting more systematic and also provide a tool for validation.

9.2. Recommendations

1. The WG suggested that for marine mammal species without regulatory measures (e.g. non-quota small cetaceans such as harbour porpoise, dolphins, pilot and killer whales) and some seals, a reporting system similar to that mandated by the species-specific executive orders (i.e., for large whales, beluga, narwhal and some seals) would be helpful.

2. The WG recommends that Greenland include in the online reporting system for the hunters some kind of automatic validation, e.g. a pop-up window requesting information on the by-catch and the fishery in which it occurs.

3. The marine mammal by-catch reports made in fishery logbooks previous to 2016 have become available in the electronic fisheries database maintained by the Greenlandic Fishery License Control Authority in the Ministry of Fisheries and Hunting. The WG recommends that an overview of this information be made available to WG for review.

4. The WG recommends that Greenland perform as soon as feasible the validation of by-catch reporting data from the licensed hunters' online system against those from the buyers to understand levels of by-catch on a routine basis. This will help evaluate the new reporting system and will give an indication of the reliability of the overall reporting system.

5. The WG recommends that data collected by fisheries inspectors be summarized and made available. As the reporting of marine mammal by-catch is included in the protocols of fisheries inspectors, a report of the characteristics of any marine mammal by-catch events, in addition to information on the total fisheries effort, the number of trips observed, and the specific focus of the observation/inspection (fully monitored over the whole trip or just boarded to check gear type) would be helpful.

Suggestions for improving SC/24/BYC/14

The WG gave suggestions to Greenland that would help improve the tables in SC/24/BYC/14.

Table 2 and 3 in SC/24/BYC/14

- Investigate if data is available for other measures of effort instead of/in addition to landings (such as days at sea, trips, etc.)
- Also provide the characteristics of the gears (i.e. mesh size, depth of nets set, etc.)
- For the number of active boats with "N/A" recorded (no data available), look into whether there could be an estimate of effort from the number of licenses or gives the number of licenses as a proxy for effort.
- In the lumpfish fishery, data on the number of licenses are available but this does not indicate the scale of the fishery, hence the WG suggested that Greenland look into whether the number of nets is available for lumpfish. There's now a quota so that may be helpful
- Grid use in the trawls – include the information on what type of grid, whether it is mandatory or voluntary, etc.
- Indicate for all fisheries whether the by-catch data reporting is voluntary or mandatory

Table 5 in SC/24/BYC/14

- For the pelagic trawls, cetacean by-catch is seen in other areas, so Greenland should specify whether this fishery has had inspectors and still no observed catches, or just no reportings (which is considered unreliable).
- In general, look at all the gear types to identify if they are used in other areas and whether by-catch is seen in those fisheries. This can be used as a general indicator of whether there is risk of by-catch in Greenland.
- Indicate which fisheries have been monitored by fisheries observers and provide the monitoring effort, relative to trips taken.
- Add the mesh size and depth range for the gillnets.
- Include information on temporal overlap of fisheries with marine mammal presence in a column.
- Quantify the number of trips that fisheries inspectors have been on, including trips where the inspector was on board the whole time or if there was only a spot inspection.

Table 2 of SC/24/BYC/14. Overview of main regulated fisheries in West Greenland

Species	Areas (West Greenland)	Season	Gear type	Regulation	*Active boats 2016	*Landings in tons 2016	Potential mammalian by-catch
Shrimp	Offshore; Inshore Disko Bay	Year round	Shrimp trawl	Licences	15	68,931	Low risk. None registered after sorting grid was mandatory.
Greenland halibut	1.000-1.500 m depth off Nuuk & Qeqertarsuaq; Inshore Disko, Uummannaq and Upernavik. Qaanaaq	Peak in late summer, ends in November	Trawl Gill net/ long-line	Licences Open boats/dog sledge	274 1000	15,609	Data from 2016 under review
Scallop	Inshore from Nuuk to Upernavik.	Year round	Dredgers	Licences	4	735	Low risk. None registered.
Snow crab	Inshore from Upernavik and southwards	April - December	Crab pots	Licences	43	2,160	Entanglement of humpback and bowhead whales
Redfish	Offshore Southwest Greenland	June-October	Trawlers	Licences		9	Unknown, none registred.
Cod	Mainly inshore Offshore SW Greenland	Year round, peak June and July	Pound nets, hand lines, long-lines and set gillnets	Licences	NA	37,685	Entanglement of humpback whales (pound nets)
Capelin	Inshore, mostly Disko Bay and further north	May-July	Handnets	Licences	0	0	Very low risk
Atlantic salmon	Inshore	August 15 – October 31	Gill net Open boats	Licences	14	27	Unknown, none registred
Lumpfish	Inshore, 59º-72ºN	March 01 – July 15	Gill net	Licences	NA	NA	Data from 2016 under review
Arctic char	Fresh water and close to a few rivers in central West Greenland	June 15 – September 25	Gill net		NA	NA	Low risk. None registered

*figures in estimated live weight from Greenland Fishery License Control Authority. Shrimp figures are from 2015. Division between East and West are in some cases based on estimation as quota types on which catches are recorded sometimes include both East and West.

Table 3 of SC/24/BYC/14. Overview of main regulated fisheries in East Greenland

Species	Areas (East Greenland)	Season	Gear type	Regulation	*Active boats 2005	*Landings in tons 2016	Potential mammalian by-catch
Shrimp		Year round; peak Dec-Apr.	Shrimp trawl	Licences	14	575	Low risk. None registered after sorting grid was mandatory
Greenland halibut		Year round	Trawl	Licences	14	8.325	Data from 2016 under review
Redfish	Offshore Irminger Sea	June-October	Trawlers	Licences	12	60	Unknown, none registred
Cod	Mainly offshore	Year round, peak June - July	Pound nets, hand lines, long lines and set gillnets	Licences	1	14.214	Entanglement of humpback whales (pound nets)
Capelin	Offshore 66°-69°N	Offshore: June 20 - April 30	Purse seines	Licences	2	0	Unknown, none registred
Lumpfish		March 01– July 15	Gill net	Licences	NA	NA	Data from 2016 under review
Mackerel		June – August	Trawl	Licenses	NA	36,211	Unknown, none registred
Herring		July-August	Trawl	Licenses	NA	NA	Unknown, none registred

*figures in estimated live weight from Greenland Fishery License Control Authority. Shrimp figures are from 2015. Division between East and West are in some cased based on estimation as quota types on which catches are recorded sometimes include both East and West.

Table 5 of SC/24/BYC/14 Estimated grouping of mammalian by-catch risk

Gear type	Estimated risk	Comments
Bottom dredges	Green	Low risk. No by-catch registered.
Bottom trawl	Yellow	Cetaceans follow the vessels and catches what falls out of the trawls. Grid is not mandatory for halibut bottom trawling, but is used in some cases to avoid Greenland shark. No by-catch registered.
Shrimp trawl	Green	Low risk. None registered after sorting grid was mandatory.
Crab pots	Yellow	Entanglement of humpback and bowhead whales reported.
Pelagic trawl	Green	Large pelagic trawls are dragged at high speed in the surface, potential for by-catches. No by-catch registered.
Gill nets	Red	Footnote[3]
Long-line	Green	No by-catch registered.
Pound nets	Red	By-catch of large whales reported.
Hand lines	Green	No by-catch registered.
Seine	Green	Large fishing gear, potential for by-catches. No by-catch registered.

10. OTHER BUSINESS

Mitigation measures in Greenland

The WG discussed a few possible mitigation measures that could be implemented in Greenland.

Greenland has had incidents of whales caught in lines for snow crab pots. Whales are also seen dragging the gear, which could also be from other areas and not Greenlandic gear. In the US large whales are often documented entangled in lobster pot lines. Several mitigation measures have been tested or implemented in the US fishery, including the use of weak links, but none has so proved unequivocally successful.

Whales are also seen caught in pound nets in Greenland. The WG noted that this has been an issue in Newfoundland, Canada, where acoustic deterrent devices were first trialled to prevent whales from becoming entangled in coastal trap nets. The WG suggested that Greenland contact Whale Release and Strandings in Newfoundland, or the Fisheries and Marine Institute of Memorial University of Newfoundland (Paul Winger) for more information.

The WG noted that for sea turtles caught in the leaders in pound nets, they have had success with fishing only the bottom of the net, i.e., keeping the net in the lower 1/3 of the water column. This results in less gear in the water to entangle the turtles, but it is unknown whether this would work for other fisheries, or for whales.

General Business

The WG recognizes that while it has recommended that marine mammal by-catch reporting is made mandatory in commercial logbook systems for vessels of all sizes, this information is not reliable without validation, which is difficult. While logbook reporting can be useful for qualitative indicators, the most reliable means to obtain information on by-catch is via dedicated monitoring by fisheries observers or electronic monitoring.

Aquaculture

There are ca 900 fish farms in Norway, however there are no reports of seals shot (Coastal Seals WG,

[3] North Atlantic Marine Mammal Commission; Management Committee Working Group on Bycatch. National Progress Reports: Bycatch Reporting for 2005. NAMMCO/16/MC/BC/4.

NAMMCO 2016). The WG noted that this seems very unlikely given the levels of interactions seen between seals and fish farms in other countries. The Directorate is working on improving reporting, however Norway informed the WG that previous studies did not show issues with seals, but instead identified interactions with otters. Additionally, devices used to deter seals around the fish farms are being used to limit seal-fish farm interactions. Nevertheless, the WG encouraged the work of the Directorate to obtain improved data on the numbers of seals shot at fish farms. The WG also suggested that Norway should look at the numbers of fish mortalities at the fish farms that have been attributed to seals. If these are low, that would suggest that measures to minimise depredation are working; however if there are lots of mortalities due to seals, there are likely interactions (e.g., seals being shot).

Electronic Monitoring

Lotte Kindt-Larsen, DTU AQUA (Institut for Akvatiske Ressourcer, Lyngby Copenhagen), who was visiting, kindly agreed to make an *ad hoc* presentation about Remote Electronic Monitoring (REM) of by-catch (fish, birds and marine mammals), with which she has worked since 2008 in different regimes. Her presentation focussed on the monitoring of marine mammal by-catch. She described the system that has been developed for, and in co-operation with DTU Aqua with Anchor Lab (http://www.anchorlab.dk/), its characteristics, possibilities and constraints. The REM system recorded time, GPS position and closed-circuit television (CCTV) footage of all hauls. REM data could be used to identify fishing grounds, quantify fishing effort and document marine mammal by-catch. The time for videoing the tapes was reduced for marine mammals, as for such large animals the tape can be reviewed at high speed. DTU AQUA tried but abandoned the idea of developing automatic recognition software. Kindt-Larsen was overall very positive about REM for monitoring by-catch, particularly of marine mammals, and with the system that was finally adopted, which was cheap compared to others and to using observers, easy to set up even on small boat, and adaptable. The REM systems in use were connected on-line, which, among others, allowed Kindt-Larsen to check for and adjust their functioning and settings from her office.

11. NEXT MEETING

1. For all countries:
   - Provide information on all fisheries and gear types operating in the country, with levels of effort in each, and whether they are monitored for marine mammal by-catch. NAMMCO will provide a table of requested fields for countries to populate.
   - Provide any information on observed trips, following a format provided by NAMMCO as above.
   - Providing any new by-catch estimate(s) for review.

2. For Norway and Iceland, recommended revisions to the by-catch estimates presented at this meeting should be provided to the WG before the next Harbour Porpoise and Coastal Seals assessment meetings.

3. For Greenland, provide a progress report on recommendations 1 and 2 and data on Recommendations #3, 4 and 5.

4. For Faroes, provide data on Recommendation #2.3, and a progress report and/or data on Recommendation #1 and #2.1, 2.2 and 2.4.

References

Bjørge A, Skern-Mauritzen M and Rossman MC (2013) Estimated bycatch of harbour porpoise (*Phocoena phocoena*) in two coastal gillnet fisheries in Norway, 2006-2008. Mitigation and implications for conservation. *Biological Conservation* 161: 164-173.

Gilles A, Gunnlaugsson Th, Mikkelsen B, Pike DG, Vikingsson GA (2011). Harbour porpoise *Phocoena phocoena* summer abundance in Icelandic and Faroese waters, based on aerial surveys in 2007 and 2010. NAMMCO SC/18/AESP/11.

Hauksson E, Ólafsson HG and Granquist S (2014) *Talning útselskópa úr lofti haustið 2012* (Counting grey seal pups from the air in Fall 2012) (In Icelandic with English abstract). Veiðimálastofnun VMST/14050

NAMMCO (2016) Report of the 23rd meeting of the Scientific Committee. Tromsø, Norway.

Pálsson ÓK, Gunnlaugsson Th and Ólafsdóttir D (2015) By-catch of sea birds and marine mammals in Icelandic fisheries (In Icelandic with English abstract). Marine Research in Iceland no. 178.

Þorbjörnsson JG, Hauksson E, Sigurdsson GM and Granquist SM (2017) Aerial census of the Icelandic harbour seal (*Phoca vitulina*) population in 2016: Population estimate, trends and current status. Report of the Marine and Freshwater Institute (Iceland), HV 2017-009, ISSN 2298-9137.

Appendix 1: Technical comments on Norwegian by-catch estimates

Comments on Data Inputs to Models:

1. Questions remain about what exactly is in the CRF data and what were used to extrapolate the estimates. First, the group is concerned that the landings data used do not reflect all the landings from gillnet fishing activity in the area.

From SC/24/BYC/Info07 (Moan thesis):
"The CRF did not target cod and monkfish exclusively; other commercially important species (such as saithe (*Pollachius virens*, L. 1758), mackerel (*Scomber scombrus*, L. 1758), herring (*Clupea harengus*, L. 1758), haddock (*Melanogrammus aeglefinus*, L. 1758), and many more) were frequently fished as well. In the period 2006 – 2015, cod catches constituted 44.9% of total landings, and monkfish a mere 2.7%."

The WG suggested that estimates of by-catch rates be made for fixed gillnet gear, and include all landings from Directorate, not just cod and monkfish, and be stratified by time and area. Partitioning into mesh size groups would reduce variance around the by-catch rates even further. If mesh size is not available in the Directorate of Fisheries data, mesh size can be inferred from catch composition, which is correlated to mesh size and can serve as a proxy.

2. It would be helpful to see summary tables of the CRF data and the MRF data. Specifically, a summary of total landings by species for gillnet vessels fishing in the 8 statistical areas, grouped by vessel length. From the CRF data, similar information, plus observed by-catch.

3. The sampling unit is unclear in the analysis.

On pg 20: "Assuming each fishing trip is associated with the hauling of one set of nets (that have soaked for approximately 24 hours) in one location, then we may consider each fishing trip as one "event"".

Is the sampling unit a full trip (which consists of several net hauls), or a single haul?

4. Correlated data/vessel bias:
Pg 59: "One assumption underlying the entire analysis is that the data collected by this segment of about 20 of the approximately 6000 fishing vessels was representative for the whole fleet. This, however, is an unrealistic assumption. We may expect that different fishing vessels exhibit unique fishing patterns. Different vessels may tend to frequent the same particular fishing sites, use one specific kind of gear, fish at particular depths, specialize in one particular catch species, etc. A consequence of these vessel-specific fishing patterns is that observations associated with the same vessel most likely are correlated, and not independent, as is assumed."

The sample fleet is a relatively small number of boats compared to whole fleet (40 of 6,000). It would be helpful to evaluate bias in the sampling frame from individual vessel effects.

For future data collection, the WG suggested that Norway should build in mechanisms for random selection in contracting process, perhaps renewing contracts for the same vessel over a longer time period, ie. if vessel A fishes in year 1 that vessel wouldn't be allowed to compete again until year 4, etc.

5. Examine a time series of coastal gillnet trips by year and area to see how constant the effort has been, because patterns in the total effort can help interpret results, and to check effect of pooling over several years of data.

Comments on By-catch Estimation:

6. The WG had concerns about the bootstrap methodology (see pg 60):

It appears as if the bootstrap unit might have been a stratum, rather than the sample observation, which is the trip (or haul? See comment #3). Bootstrapping grouped records (as in a stratum) will underestimate the variance. Also, confidence intervals can be derived directly from bootstrap replicates, not from standard error around the replicates.

7. The WG also recommends the authors revisit the equation on pg 17, which adds a 1 to the denominator to avoid dividing by 0. However, the text reads as if the issue is 0 by-catch in numerator, which would be a zero by-catch rate, and not a problem. Adding a 1 to the denominator may inflate the by-catch estimate if the catch is < 1 ton.

8. The WG had concerns about the post-hoc stratification in the ratio estimates. Normally data should be stratified based on *a priori* biological assumptions, rather than patterns in the data. Perhaps the authors could define 'areas' based on patterns in porpoise or seal abundance and behaviour, rather than administrative fishing boundaries. Otherwise the authors should provide rationale for the stratification scheme, other than what has been provided, on pg 13.

AGENDA

1. CHAIRMAN WELCOME AND OPENING REMARKS
2. TERMS OF REFERENCE

    1. *Review the Norwegian harbour and grey seals and harbour porpoise by-catch data and estimates;*
    2. *Review the Icelandic lumpfish and cod gillnet fishery by-catch data and estimates;*
    3. *Review the situation in the Faroese mid-water trawling - precise fleet description, by-catch risk and reporting; methods for improving the situation;*
    4. *Review the information from Greenland on reporting of by-catch for the different species.*

3. ADOPTION OF AGENDA
4. APPOINTMENT OF RAPPORTEURS
5. REVIEW OF AVAILABLE DOCUMENTS AND DATA
6. NORWAY
    - 6.1. By-catch data
    - 6.2. Fisheries and effort data
    - 6.3. Extrapolation method
    - 6.4. Evaluation of by-catch estimates
    - 6.5. Recommendations
7. ICELAND
    - 7.1. By-catch data
    - 7.2. Fisheries and effort data
    - 7.3. Extrapolation method
    - 7.4. Evaluation of by-catch estimates
    - 7.5. Recommendations
8. FAROESE
    - 8.1. Fleet description, including effort data
        - 8.1.1. Mid-water trawling
        - 8.1.2. Other
    - 8.2. Bycatch information
    - 8.3. Data gaps
    - 8.4. Recommendations
9. GREENLAND
    - 9.1. By-catch reporting and reliability
        - 9.1.1. Large whales
        - 9.1.2. Smaller whales
        - 9.1.3. Seals
10. OTHER BUSINESS
11. NEXT MEETING

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LIST OF DOCUMENTS

Working Documents

Number: SC/24/BYCWG/XX	Title
01	Draft Agenda
02	Participants List
03	Lumpfish Effort Iceland 2016
04	Mammal Data Iceland Gillnets
05	Mammal Data Iceland Lumpfish
06	Some background information for the Icelandic datasets (papers 03,04,05)
07	Bycatch of grey and harbour seals in Norway
08	Bjørge Moan Revised estimates of bycatch of harbour porpoise
09	Document List
10	Incidental by-catch of marine mammals in Icelandic waters
11	Gill net fisheries in Norway for the period 20160101-20170428
12	Overview from cases of bycatch with Humpback- and Killer whales in purse seine fisheries for Herring
13	Fisheries in Faroese waters and potential bycatch risk of marine mammals
14	Review of existing knowledge on marine mammal bycatch in Greenland

For Information Documents

Number: SC/24/BYCWG/XX	Title
Info01	Bycatch WG Report 2016
Info02	Bjørge et al. 2013. Bycatch of harbour porpoises
Info03	ICES_WGBYC Report 2016
Info04	ICES_WGBYC Report 2015
Info05	ASCOBANS 2015-Consolidated Bycatch Recommendation to EU
Info06	ICES_Protected species bycatch_Final Advice_April15-2016
Info07	Andre Moan 2016 Bycatch of harbour porpoise harbour seal and grey seal in Norwegian gillnet fisheries
Info08	Review on existing knowledge about marine mammal by-catch in Greenland
Info09	By-catch of sea birds and marine mammals in Icelandic fisheries
Info10	US MMPA Fish and Fish Product Import Provisions of the Marine Mammal Protection Act; Final Rule
Info11	Report of the NAMMCO Coastal Seals WG March 2016

UTTANRÍKIS- OG MENTAMÁLARÁÐIÐ

MINISTRY OF FOREIGN AFFAIRS AND CULTURE

NAMMCO
Att. Dr Geneviève Desportes, General Secretary
Sykehusveien 21-23
N-9294 Tromsø
Norway

Tórshavn 8 April 2020

Dear Genevieve,

I refer to the Report of the NAMMCO Scientific Committee Working Group on By-Catch of 4 May 2017 and the subsequent Report of the Scientific Committee of November 2017.

It has recently been drawn to my attention that due to technical reasons relating to the introduction and testing of electronic logbooks onboard fishing vessels flying the flag of the Faroe Islands, a fictive registration of a pod of 5 killer whales by-caught in a single trawl was mistakenly recorded as official data in 2016. As a result, the above-mentioned Scientific Committee Working Group meeting report (in particular sections 8.1.and 8.2) assesses the extent and risk of by-catch in Faroese fisheries on an incorrect basis.

This error was rectified in the records of the Faroe Islands Fisheries Inspection on 21 November 2018. Please find attached the relevant corrigendum note of the Faroe Islands Fisheries Inspection.

We greatly regret having provided, albeit unwittingly, inaccurate information as a basis for the work carried out by the Working Group in 2017.

In the interests of full transparency and accuracy, I hereby kindly request the Secretariat to add this letter and the attached corrigendum note to the above-mentioned reports, as well as to circulate this information to other NAMMCO Members and the Scientific Committee.

Yours sincerely,

Páll Nolsøe

Head of Delegation to the Council

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Ministry of Foreign Affairs & Culture
Mr. Páll Nolsøe
Head of Delegation of the Faroe Islands to NAMMCO

Date 01-04-2020

Registration of marine mammal by-catch in the Faroe Islands Fisheries Inspection catch database

The Faroe Islands Fisheries Inspection has evaluated all the by-catch data available from vessel logbooks - electronic logbooks and the traditional fishing logbook – during the period 2013 - 2018.
After this evaluation it has been clear, that there has been made some mistakes, where vessels applying the electronic logbook in a test period have reported by-catch of marine mammals. This information has by an oversight been registered as marine mammal by-catch data in the Faroe Islands Fisheries Inspection catch database.
The introduction of electronic logbooks on board Faroese fishing vessels began graduallly in 2013. In the testing period from 2013 to 2018, all masters were instructed how to apply the electronic logbook and how to record marine mammal by-catch, if it occurred in the relevant fisheries. The testing was made when the electronic logbooks were installed on board the vessels, and the vessels were consequently not fishing, but at the quayside. The testing continued when a new master came on board. Every master had to use the test button “marine mammals”, and some masters used it several times, to see how it functioned.
On 26 January 2016 a vessel reported a by-catch of 5 killer whales. However, the vessel was not fishing but at the quayside testing the electronic logbook. This misreporting was by an oversight registered in the Faroe Islands Fisheries Inspection catch database.
It is hereby confirmed that on 21 November 2018 this misreporting of marine mammal by-catch in the test period was deleted from our inspection files, and the catch database revised accordingly.
For ease of reference please find enclosed hereto the rectified registration, as of the above-mentioned date, of marine mammal by-catch in the files of the Faroe Islands Fisheries Inspection catch database.

Yours sincerely

Meinhard Gaardlykke
Adviser
The Faroe Islands Fisheries Inspection

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Ministry of Foreign Affairs & Culture
Mr. Páll Nolsøe
Head of Delegation of the Faroe Islands to NAMMCO

Date 01-04-2020

Enclosure

Faroe Islands Fisheries Inspection catch database
Marine mammal by-catch
Revised: 21 November 2018

Year	Total by-catch	*Pilot whale*	*Minke whale*
2013	0		
2014	0		
2015	2	1	1
2016	0		
2017	1	1	
2018	2	1	1

Yours sincerely

Meinhard Gaardlykke
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