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WORKING GROUP ON BY-CATCH

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Video Conference

REPORT

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NAMMCO

Postbox 6453, Sykehusveien 21-23, N-9294 Tromsø, Norway, +47 77687371, nammco-sec@nammco.org,

www.nammco.no, www.facebook.com/nammco.no/, www.twitter.com/NAMMCO_sec/

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1. WELCOME FROM CHAIR & OPENING REMARKS

Kimberly Murray, Chair of the NAMMCO By-catch Working Group (BYCWG), welcomed all the participants and expressed how good it was to see everybody again, albeit still not in person. She also gave the observer from ASCOBANS, Peter Evans and the Assistant Scientific Secretary of NAMMCO, Heleen Middel the opportunity to introduce themselves as they had not participated in previous BYCWG meetings.

2. ADOPTION OF AGENDA

Murray reviewed the draft agenda (available as Appendix 1 to this report) and reminded the group of the main purpose of this meeting, which was to endorse seal by-catch estimates from Iceland and Norway for use in the assessments to be performed by the NAMMCO Coastal Seals Working Group in 2022, as well as the recently published harbour porpoise by-catch estimates from Norway.

The agenda was adopted without change.

3. APPOINTMENT OF RAPPORTEURS

NAMMCO Assistant Scientific Secretary, Heleen Middel, was appointed as rapporteur, with assistance from the NAMMCO Scientific Secretary, Fern Wickson, BYCWG Convenor and NAMMCO General Secretary, Genevieve Desportes, and other participants as necessary.

4. REVIEW OF AVAILABLE DOCUMENTS

Murray pointed out the two working documents for this meeting: SC/28/BYCWG/04 on the by-catch of coastal seals in Norwegian gillnet fisheries and SC/28/BYCWG/05 providing an update on by-catch in Icelandic waters.

In addition to these two working documents, Murray noted that there were 15 for information documents, some of which may be specifically referred to during the meeting. This included document SC/28/BYCWG/FI02 containing the published harbour porpoise by-catch estimates from Norway and document SC/28/BYCWG/FI04 with an update of Norway's pinger trials. SC/28/BYCWG/FI11 included some by-catch estimates from the cod gillnet fishery in Iceland.

5. COASTAL SEALS

5.1. ICELAND

5.1.1. Lumpsucker gillnet fishery

Sigurðsson presented document SC/28/BYCWG/05 - *Update on bycatch in Icelandic waters*, and reviewed SC/28/BYCWG/FI15 - *Bycatch of seabirds and marine mammals in lumpsucker gillnets 2014-2018.*

Author's Summary

The main results of the document were presented, as very little new monitoring data was available to update the estimates due to the COVID-19 pandemic. As before, the estimates stratified by

management area likely represent the best available estimates (see Table 1). In addition, new closed areas that were put in place in 2020, aiming at reducing the by-catch of seals, were shown to the WG.

For gear other than lumpsucker (*Cyclopterus lumpus*) gillnets, summary information both from onboard inspectors and fishing logbooks were presented. Due to few observations, it is difficult to estimate the overall by-catch for most of the species observed.

Table 1: Summary of the four different annual by-catch estimates of marine mammals in Iceland as presented in SC/28/BYCWG/FI15.

Species	Non-stratified 2014-2018 (±CV*estimate)	Stratified by management area 2014-2018 (± CV*estimate)	Stratified by depth 2014-2018 (± CV*estimate)	Stratified by month 2014-2018 (± CV*estimate)	Logbooks 2018
Harbour porpoise	530 (429-631)	528 (296-760)	615 (289-941)	468 (314-669)	96
Harbour seal	1625 (1381-1869)	1389 (903-1875)	1976 (1205-2747)	1422 (853-1991)	324 (all seal species)
Grey seal	1167 (817-1517)	989 (504-1572)	977 (371-1583)	1634 (833-2435)	
Harp seal	283 (201-365)	240 (82-398)	344 (103-585)	296 (166-456)	
Ringed seal	59 (28-90)	49 (1-98)	61 (7-115)	56 (6-106)	
Bearded seal	24 (7-41)	28 (10-46)	NA	28 (8-48)	
White beaked dolphin	0	0	0	0	1
Total marine mammals	**3688 (3209-4167)**	**3223 (1225-5221)**	**3973 (1509-6436)**	**3904 (2303-5505)**	**421**

Discussion

The WG noted that there were no new estimates of coastal seal (grey seal (*Halichoerus grypus)* and harbour seal (*Phoca vitulina*)) by-catch in the lumpsucker fishery in Iceland and that estimates for use by the CSWG had been endorsed at the previous meeting. The discussion therefore focused on the challenges associated with these estimates and the follow-up on recommendations for improving them from the 2020 BYCWG meeting.

In 2020, the BYCWG agreed that the available data set presents some challenges for providing statistically robust estimates. The small sample size means that the unstratified estimates are more precise than the stratified estimates. However, to capture temporal and spatial variation in fishing patterns, as well as vessel characteristics and fishing behaviours, stratification by management area was preferred over no stratification. The 2020 report endorsed the stratification by management area for use in the CSWG assessments, but also recommended additional analyses be explored, including a combined stratification scheme, e.g. combining management areas and season. During this meeting, Sigurðsson stated that unfortunately the statistical power was not sufficient to allow such an analysis. However, he also informed the group that the Directorate of Fisheries plans to have a high level of observation coverage in 2022. This larger than usual observation effort was initially planned for 2020 and 2021 but could not be achieved due to COVID-19 limitations. The collection of additional data during 2022 will hopefully enable further stratification analyses.

For depth stratification analysis, 15% of the trips were excluded as depth information was missing. Regarding the 2020 recommendation that Iceland investigate ways to interpolate the missing depth data in the lumpsucker gillnet analysis, Sigurðsson explained that although this was considered following the last meeting, since depth data was only missing from some of the trips in 2014, and there

were not many records in that year, this was deemed unlikely to have a significant effect on the final estimates.

In 2020, the WG also noted that there was a significant difference in the ratio of seal species registered as by-caught in the logbooks of fishermen and inspector reports and acknowledged that species misidentification could be an issue. However, during this meeting, Sigurðsson clarified that only the data from fishery inspectors were used in the by-catch estimates. He further noted that inspectors were well trained on how to identify the different seal species. He, therefore, did not believe that misidentification between seal species was a major issue for the inspectors 'data.

The WG, however, acknowledged that species identification in the fishermen's logbooks may be an issue. Although accurate identifications could be validated and improved by requesting photos of by-caught seals, the problem would remain that many of the by-caught animals are not brought on deck, but drop out of the net or are removed from the net in the water, which makes species identification challenging even for experts or trained inspectors.

In 2020, the WG recommended that DNA samples be analysed to verify species identification and assess the rate of misidentification. Granquist informed the group that some analysis of DNA samples provided by fishermen had been performed and was currently under review for publication. Although many samples remain available, further progress on determining a misidentification rate requires additional funding. Interestingly, the preliminary analysis indicated that some DNA samples coming from by-caught seals labelled as harbour seals or grey seals were actually ringed seals.

The WG **recommended** that efforts towards improving species identification by both inspectors and fishermen continue, and that collecting DNA samples and taking photos of by-caught seals be encouraged in 2022 to validate inspector reports and calculate the rate of misidentification by fishermen, so this could be corrected for.

In 2020, the WG also recommended to further investigate the clumping effect of seal by-catch and to what extent these events were linked to a particular time period and/or aspects of the fleet. Sigurðsson indicated that no such link was apparent, and that the three events that stand out for their high number of by-caught seals were unlikely to be correlated.

The WG asked for information on how the COVID-19 pandemic had affected effort by the industry and impacted the observer schemes. Sigurðsson informed that the observers managed to cover 20 trips in June 2020 in Breidafjordur (West Iceland) when a break in the pandemic provided an opportunity. The complete results cannot be shared due to sensitivities from collecting data on only 20 trips in one of the seven management areas, but the general result of this observation effort suggested by-catch rates for harbour seals similar to previous years, but lower rates for grey seals. Due to healthy lumpsucker stocks, the number of landings in 2020 was only somewhat lower than in previous years (~2200 fishing trips vs 3400 in 2014-2018) despite considerable changes in demand due to the pandemic, and the same is expected for 2021. Despite this lower number of trips, lumpfish catch was considerably higher than before. Data gaps in by-catch rates for these COVID years could potentially be filled with historical information. This is, however, not a priority for Iceland at the moment as the planned large observation effort in 2022 is expected to provide better data.

Some fishing areas had been closed ahead of the 2020 season as a protective measure against by-catch. The WG asked for clarification on how the closure areas had been defined and what effect the closures had had on by-catch. Sigurðsson informed the group that the choice of areas was primarily based on what the fishermen considered to be important seal areas. Some of these areas were then extended slightly based on information provided by the Marine and Freshwater Institute. The WG noted that the MFRI haul-out data suggests that the most important sites for seals are outside the closed areas and are areas that overlap with a high level of fishing. Additionally, in general there was previously little fishing effort within the now closed areas. The high observation efforts that were planned for 2020 (and now postponed to 2022 due to COVID-19) aimed to assess the effect of the closures. The WG therefore **looks forward** to seeing the assessment of the impact of the closures following the 2022 observation season.

Since the CSWG assessment will take place in early 2022, the data resulting from the 2022 observation will not be available for that assessment. At its 2020 meeting though, the WG **endorsed** the estimates of marine mammal by-catch in the lumpsucker fishery in Iceland and these can therefore be used in the upcoming assessments of coastal seals. BYCWG agreed that all the stratification approaches could be presented as relevant but **recommended** that assessments use the estimates from the stratification by management area as this approach captured some of the spatial and temporal variations and characteristics of the fishery. These endorsed by-catch estimates are reported in Table 1.

5.1.2. Cod and Greenland halibut gillnet fisheries

The Greenland halibut (*Reinhardtius hippoglossoides*) fishery is an emerging and growing fishery with considerable effort in recent years. Logbook records report by-catch of several species, including "usual species" (harbour porpoise (*Phocoena phocoena*), harp seal (*Pagophilus groenlandicus*), grey seal (*Halichoerus grypus*), harbour seal (*Phoca vitulina*), ringed seal (*Pusa hispida*)) but also unusual species such as humpback whales (*Megaptera novaeangliae*), Northern bottlenose whales (*Hyperoodon ampullatus*) and Risso's dolphin (*Grampus griseus*). The WG therefore **recommended** that by-catch in this fishery be closely monitored and followed.

Iceland noted that it is challenging to differentiate between the cod (*Gadus morhua*) and Greenland halibut fisheries in their effort database, as both use the same mesh-size nets, and there is no field for target species in the fishermen's logbooks. Yet, the cod fishery is more coastal and the Greenland halibut fishery more offshore, with about 5% of the effort overlapping. In theory it could therefore be possible to try to separate the two. The WG noted, however, that if there are no operational differences between the cod and Greenland halibut fisheries, it may not be particularly important to distinguish the two for estimating by-catch. The WG **recommended** that a field for target species be included in the logbook as well as other ways to distinguish these coastal and offshore fisheries for monitoring bycatch.

There are currently no endorsed by-catch estimates for the cod gillnet and/or other fisheries in Iceland. Punt *et al.* (2020) (available as SC/28/BYCWG/FI11) presents figures of approximately 18 (95% CI 2-44) seals by-caught annually in cod and Greenland halibut gillnets. The WG considers this an underestimate though as it is roughly half the number that the fishermen themselves have reported in logbooks (38 harbour seals and 7 grey seals). The WG **recommended** that the estimates of seal by-catch in the cod fishery published in Punt et al. 2020 could be forwarded to the CSWG to be used as a preliminary information in the assessments, with associated caveats and uncertainties.

5.2. NORWAY

5.2.1. Updated seal by-catch analyses – cod/monkfish gillnet

Moan presented SC/28/BYCWG/04 - *Bycatch of coastal seals in Norwegian gillnet fisheries conducted by coastal fishing vessels*.

Author's Summary

In SC/28/BYCWG/04, by-catch rates and total by-catch for harbour and grey seals caught in Norwegian commercial gillnet fisheries were estimated using a stratified ratio estimator, with number of hauls as a proxy for fishing effort. Estimates were derived from data collected with a contracted reference fleet of small coastal vessels (less than 15 meters length overall) and scaled up to the whole fleet using data from national landing statistics. To address unreliable species identifications, by-catch data on both species were pooled before by-catch estimates were calculated. The relative abundances of each seal species in different coastal regions were then used to apportion total estimates into species-specific estimates. Relative abundance estimates were based on harbour seal abundance estimates from the survey cycle that was completed in 2015 and on grey seal abundance estimates from either 2011 or 2017. The reason for using grey seal abundance estimates from two different survey periods was that

the later survey showed a substantial reduction in grey seal abundance in one specific region. Average yearly by-catch over a 15-year period, from 2006 to 2020, was estimated to be 757 seals (CV 0.12), of which harbour seals comprised 394 (95% confidence interval CI 303 - 479) and grey seals comprised 363 (95% CI 298 – 474) (Table 2).

Table 2 Estimated average yearly by-catch of harbour seals and grey seals in Norway (SC/28/BYCWG/04).

Species	Fishery	Region	Estimated by-catch	CV	95% CI
Harbour seal	Large mesh	1	90.0	0.16	65.6 – 123.6
		2	85.2	0.05	77.1 – 94.1
		3	55.3	0.16	40.4 – 75.8
	Medium mesh	1	114.8	0.13	89.1 – 148.0
		2	15.8	0.15	11.8 – 21.3
		3	7.3	0.16	5.3 – 9.9
	Small mesh	1	8.0	0.25	5.0 – 12.9
		2	2.6	0.20	1.8 – 3.8
		3	14.9	0.16	10.9 – 20.3
	Total	Total	394	0.12	303 – 479
Grey seal	Large mesh	1	90.3	0.16	65.8 – 124.0
		2	116.2	0.05	105.2 – 128.3
		2	7.3	0.16	5.3 – 10.0
	Medium mesh	1	110.5	0.13	85.8 – 142.4
		2	23.9	0.15	17.8 – 32.3
		3	0.9	0.16	0.7 – 1.3
	Small mesh	1	8.1	0.25	5.0 – 13.2
		2	3.7	0.20	2.5 – 5.5
		3	1.9	0.16	1.4 – 2.6
	Total	Total	363	0.12	298 – 474

Discussion

The WG noted that its 2020 recommended had been followed, i.e., that the by-catch data of grey and harbour seals be pooled and apportioned according to: 1) the relative population estimate and 2) the relative harbour seal and grey seal pup/yearling abundance in the management areas.

The WG agreed that apportioning the total seal by-catch in proportion to the relative population estimates of grey and harbour seals by areas provided better by-catch estimates than previous analyses but remained a relatively crude approach to addressing the challenges posed by species misidentification. Moan informed the WG that a habitat-preference model developed by researchers from the University of St. Andrews has now been shared with Norway and is being investigated as another way forward for apportioning seal by-catch to species, i.e, using habitat preference rather than abundance. It was emphasised that this type of modelling was still in its early stages but that it could provide a valuable approach to handling species misidentification in by-catch estimates.

Bjørge informed the group that although there is no trend in overall by-catch over the years, there seems to be a decreasing trend within some regions, likely linked to a dramatic reduction in effort in the monkfish (*Lophius piscatorius*) fishery.

Norway is currently exploring the use of Remote Electronic Monitoring (REM) in a pilot form, and if successful, this would be applied on up to 30 vessels (<15m). The intention is to deploy REM on vessels not already operating in the coastal reference fleet (CRF), and thereby effectively double the number of vessels 'reporting' by-catch. It is also anticipated that REM could significantly improve species identification. Although photo identification of seals on deck was considered preferable over the use of REM for accurate species identification, it was noted that this would require a specific effort that may be difficult to implement in practice. Norway is starting the REM project with one prototype, to test the system and the level of species identification possible from the video. To address the problem of assessing drop-out rate, the vessels will be equipped with two cameras; one that monitors the deck and a second that monitors the net as it comes out of the water.

The CRF data indicates a very high level of seal by-catch, and equivalent to direct takes in some cases. Moan pointed out that in some regions, the total removal (by-catch and direct takes) is higher than the calculated Potential Biological Removal limit (PBR). Despite this the harbour seal population in Norway has been stable over the past 10-15 years. In contrast, grey seal pup production has been declining. In considering the stability of the harbour seal population despite total removal levels exceeding PBR, the WG strongly underlined that PBR is a conservative approach to calculating what constitutes an appropriate level of take and is not on its own directly a measure of sustainability.

Due to limited time, the WG could not discuss many technical questions regarding the analysis presented in document SC/28/BYCWG/04. These questions, which did not hinder the group's endorsement of the estimates, were circulated to the WG and the authors after the meeting (Appendix 4). Author responses will be circulated to the group at the earliest convenience.

The WG agreed that the use of fishery classifications presented in this paper, based on mesh size, was an interesting and useful approach. The inclusion of fisheries other than the cod fisheries was also viewed as valuable. The WG concluded that this updated analysis addressed the concerns and recommendations of the 2020 BYCWG and commended the authors for their work.

The WG **endorsed** the updated seal by-catch estimates presented in SC/28/BYCWG/04 and provided here in Table 2. The WG also strongly **recommended** the continuous improvement of species identification through REM, habitat preference models, and photographs.

6. HARBOUR PORPOISE

6.1. NORWAY

6.1.1. Review recently published harbour porpoise estimates

Moan presented SC/28/BYCWG/FI02 – *Assessing the impact of fisheries-related mortality of harbour porpoise caused by incidental bycatch in the dynamic Norwegian gillnet fisheries.*

Author's summary

In SC/28/BYCWG/FI02, harbour porpoise by-catch for Norwegian commercial gillnet fisheries from 2006 to 2018 was estimated using a traditional ratio estimator and generalised additive linear mixed models, with weight of fish landed and number of gillnet hauls as proxies for fishing effort. Estimates were derived from data collected with a contracted reference fleet of small coastal vessels and scaled up to the whole fleet using data from landing statistics. By-catch estimates exhibited large yearly variations, ranging from 1,151 to 6,144 porpoises per year (see Table 3 and Table 4). By-catch estimates in 4 of the last 5 years were significantly less than in the preceding 2 years. The best ratio-based and

model-based yearly by-catch estimates were 1,580 porpoises (CV: 0.10, 95% CI = 1,302–1,902) and 1,642 porpoises (CV: 0.15, 95% CI = 1,165–2,142), respectively. About 75% of by-caught porpoises were taken in the cod and monkfish fisheries, while the rest were taken in a variety of different gillnet fisheries. Our results suggest that by-catch of harbour porpoise in Norwegian gillnet fisheries has been unsustainable for several of the last 13 years but are currently within international by-catch limits due to a recent reduction in monkfish fishing effort.

Table 3: Estimated average yearly harbour porpoise by-catch in the years 2006 to 2018, using four estimation approaches (SC/28/BYCWG/FI02)

	Stratified ratio estimates (w/catch as fishing effort)			Stratified ratio estimates (w/hauls as fishing effort)			GLM estimates			GAMM estimates		
Grouping variable	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***
By region												
Region 1	592	0.16	355–717	957	0.11	744–1 151	550	0.15	408–748	893	0.23	552–1 260
Region 2	909	0.15	587–1 109	773	0.09	621–916	836	0.18	634–1 276	1 161	0.35	539–1 772
Region 3	610	0.09	492–715	722	0.09	595–848	538	0.19	369–795	421	0.34	219–732
Region 4	460	0.10	366–544	434	0.09	351–507	445	0.17	324–613	396	0.25	242–605
By season												
January–June	1 176	0.11	817–1 356	1 523	0.08	1 279–1 742	1 075	0.13	859–1 432	1 394	0.15	890–1 690
July–December	1 395	0.08	1 141–1 568	1 363	0.06	1 184–1 527	1 294	0.12	1 030–1 665	1 477	0.26	792–1 983
By fishery												
Cod	1 300	0.08	1 050–1 489	1 126	0.06	975–1 258	708	0.16	525–987	1 127	0.24	650–1 456
Monkfish	647	0.10	497–767	1 134	0.10	904–1 334	1 131	0.11	920–1 442	1 234	0.23	770–1 739
Others	624	0.21	331–806	626	0.10	493–738	530	0.24	375–965	510	0.23	259–626
Total	2 571	0.07	2 131–2 831	2 886	0.05	2 576–3 142	2 369	0.09	1 969–2 843	2 871	0.17	1 910–3 324

Table 4: Estimated average yearly harbour porpoise by-catch in the years 2014-2018, by different grouping variables, using four estimation approaches (SC/28/BYCWG/FI02)

	Stratified ratio estimates (w/catch as fishing effort)			Stratified ratio estimates (w/hauls as fishing effort)			GLM estimates			GAMM estimates		
Grouping variable	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***	**Bycatch**	***C.V.***	***95% CI***
By region												
Region 1	297	0.29	151–487	428	0.30	216–757	540	0.16	374–716	578	0.22	385–889
Region 2	292	0.16	206–404	219	0.20	141–307	628	0.24	431–1 028	554	0.28	299–903
Region 3	228	0.18	153–317	347	0.17	236–460	368	0.19	244–505	219	0.30	106–366
Region 4	644	0.14	486–837	586	0.13	448–752	407	0.17	286–569	291	0.25	185–504
By season												
January–June	829	0.13	635–1 050	1 026	0.14	780–1 330	1 080	0.14	850–1 453	960	0.16	709–1 321
July–December	632	0.15	475–844	554	0.13	429–727	863	0.13	669–1 137	682	0.23	412–1 003
By fishery												
Cod	370	0.23	215–559	625	0.25	318–857	770	0.16	560–1 053	443	0.22	254–607
Monkfish	746	0.13	579–965	532	0.12	494–799	664	0.13	517–858	843	0.19	604–1 268
Others	345	0.16	240–468	423	0.15	303–554	509	0.27	339–881	356	0.20	245–509
Total	1 460	0.10	1 216–1 788	1 580	0.10	1 302–1 902	1 943	0.11	1 630–2 495	1 642	0.15	1 165–2 142

Discussion

Clarification was requested on the choice of using the GAMM model due to the inclusion of random effects, specifically the vessel term, which counteracts the non-random clustering of harbour porpoise by-catch from the reference fleet vessel. The authors explained that the data are provided on the haul level, and observations are correlated and clustered by vessel. This vessel effect is deemed to be quite large and important to include in the modelling. It was pointed out that in the U.S. there are predominantly observations with only one individual per haul in gillnet fisheries, so clustering is not an issue, whereas in Norway it is more common to see multiple by-caught individuals per haul.

In the past, the monkfish fishery had a high level of by-catch but this has decreased with a decrease in effort in the fishery. A possible recovery of this fishery in the future could therefore increase the by-catch again. Bjørge suggested that depletion of the stock was not the only cause of the decline of the fishery, but a drop in the price of monkfish was also a contributing factor. The decline in the monkfish fishery has not resulted in a significant increase of effort in other fisheries, as the monkfish fishery has always been small compared to the cod fishery.

The possibility of equipping monkfish gillnets with pingers was briefly discussed. Pingers are currently only used in the cod fisheries and their use remains a challenge due to negative perceptions amongst the fishermen and in the media. Additionally, monkfish nets have strings that can include up to 500 nets, with 14km per string, and a large number of pingers would be required to cover all the nets. Northridge pointed out that in the UK this was overcome by using louder, rather than more, pingers and placing them 2km apart - although it was noted that this still increases the ensonification of the environment.

The WG **endorsed** the estimates, provided here in Table 3 and Table 4, and due to the uncertainty in the trend in effort of the monkfish fishery agreed that these estimates should be presented for both time periods.

6.1.2. Update on pinger experiments

Moan presented SC/28/BYCWG/FI04 – *Pinger trials in Norwegian commercial fisheries confirm that pingers reduce harbour porpoise bycatch rates and demonstrate low level of pinger-associated negative impacts on day-to-day fishing operations*.

Author's summary:

A field trial was conducted to determine the effect of acoustic deterrent devices (ADDs, or pingers) on harbour porpoise and harbour seal by-catch in three Norwegian commercial gillnet fisheries targeting cod, saithe (*Pollachius virens*) and monkfish. Catch data on 2,658 net-km-days were collected by 8 fishing vessels operating gillnets in high by-catch regions over two years. A total of 19 harbour porpoises and 9 harbour seals were by-caught, with all harbour porpoises and 67% of harbour seals taken in control (non-pingered) nets. By-catch was modelled using a generalised linear mixed modelling approach and fitted with penalized maximum likelihood. Modelling results indicated that using pingers on gillnets reduced the risk of by-catching a harbour porpoise by an estimated 96.9% (95% CI = 95% - 98%) compared to ordinary pinger-free nets. The effect of pingers was not significantly different between different fisheries. The pingers also had no significant effect on catch rates of fish (Wilcoxon rank sum test, p = 0.61) or harbour seals (Wilcoxon rank sum test, p = 0.25). Self-reported pinger-associated extra time costs on day-to-day fishing operations were low, averaging about 2.8 minutes per operation. These results add to a growing body of scientific evidence that pingers can lead to substantial reductions in harbour porpoise by-catch rates in gillnet fisheries, and that extra time costs associated with operating nets with pingers are low.

Discussion

It was pointed out that the IWC, and other bodies, consider that the decrease of harbour porpoise by-catch using pingers is a proven concept not requiring any further trials for demonstration. Bjørge indicated that the purpose of the Norwegian trial presented here was to test the practicalities and demonstrate the efficiency of using pingers in Norwegian fisheries and under the unique environmental conditions of Norway, and to thereby help convince the authorities – and the fishermen – that pingers were efficient.

Moan informed that both the Banana pinger by Fishtek Marine Industries and the Dolphin pinger by Future Oceans were used for this trial, but no differentiation was made between these in the analysis (nor is it known if there is any difference in efficiency between the two types). The only differentiation used in the analysis is the use of pingers vs. no pingers, with the same nets used for both the trial and the control. During the trial, 9 seals (registered as harbour seals by the fishers, and not verified by the researchers) were by-caught, of which 6 were taken in non-pingered nets. There was no significant difference in catch rates of the target species. It was mentioned that in other fisheries, the banana pingers had been shown to attract seals, but that the frequency of the banana pingers used in the Norwegian study was increased to prevent this.

Sigurðsson briefly presented results of a study using banana pingers in Iceland. This study observed no effect of the pingers on harbour porpoise by-catch, but a negative effect on the catch of target species

(cod). Although the trial and the control group took place at the same time, they were at least 1nm, and usually 2nm, apart. The WG noted that this is the first trial they are aware of where the pingers did not reduce by-catch. The difference in results between Norway and Iceland could possibly be due to a difference in the acoustic environment, or due to differences in the sounds being emitted by the Banana pinger devices. It was noted that the provider of the pingers, Fishtek, regularly updates their models and changes their source levels and therefore having more information on the specific levels associated with the actual devices being used would be valuable. The WG **recommended** comparing the pingers used in the Norway and Iceland trials to investigate any possible differences in the noise they produce.

7. RISK ASSESSMENT

Due to the limited time available, the risk assessment for all fisheries, including an overview of the Lenfest Project and a discussion on other ways to proceed were not able to be discussed. Desportes suggested scheduling a meeting in the near future to focus on this topic, and a possible time for this meeting will be investigated.

8. RECOMMENDATIONS

8.1. RECOMMENDATIONS FOR RESEARCH

Norway/Iceland

- *To compare the pingers used in the trials conducted in Norway and Iceland to investigate similarities and differences in their deterrent signals*
- *To use the estimates of seal by-catch in the cod fishery published in Punt et al. 2020 as a preliminary information in the CSWG assessments, with associated caveats and uncertainties.*

Norway

- *To investigate the value of using habitat preference models for apportioning seal species in the generation of by-catch estimates*

8.2. RECOMMENDATIONS FOR CONSERVATION & MANAGEMENT

Iceland

- *To continue efforts towards improving species identification by both inspectors and fishermen, and encourage collecting DNA samples and taking photos of by-caught seals in 2022 to validate inspector reports and calculate the rate of misidentification by fishermen, so this could be corrected for.*
- *To support the analysis of DNA samples to assess rates of species misidentification through the provision of necessary funding.*
- *To include a field for target species in the logbook as well as other ways to distinguish these coastal and offshore fisheries for monitoring by-catch.*
- *To closely monitor the Greenland halibut gillnet fishery and its related by-catch.*

Norway

- *To continue improving the monitoring of by-catch rates and accurate species identification through the implementation of REM systems.*

8.3. ENDORSED ESTIMATES

- *The estimates of marine mammal by-catch in the lumpsucker fishery in Iceland, presented in* Table 1*. The stratification by management area approach is recommended for use in assessments.*
- *The updated estimates of harbour seal and grey seal by-catch in commercial gillnet fisheries in Norway, presented in* Table 2*.*
- *The estimates of harbour porpoise by-catch in commercial gillnet fisheries in Norway, presented in* Table 3 *and* Table 4*.*

9. OTHER BUSINESS

Evans mentioned a new ASCOBANS review of by-catch mitigation measures will soon be published and could be distributed to the group for information.

An observer from Russia, Zabavnikov, also attended the meeting and provided the group with information on by-catch in Russian fisheries in the Barents Sea via e-mail. The information is summarized in Table 5 below.

Table 5: By-catch information from PINRO observers in the Barents Sea (2002-2009)

Fishing Gear – Target species	Position	Years	Observed by-catch
Bottom trawl - cod	Between 76°-78°N and 25°-30°E	2002-2019	9 Harp seals
Bottom trawl - cod	80°N/10°E	2002-2019	1 Bearded seal
Bottom trawl – cod longline	71°N/31°E	2002-2019	1 White-beaked dolphin
Pots – Snow Crab fishery	77°N/44°E	2002-2019	1 Humpback whale
Pots – King Crab fishery	69.5°N/41°E	2002-2019	2 Humpback whales
Pots – King Crab fishery	70°N/45°	2002-2019	1 Minke whale
Pelagic Trawl – Herring and Mackerel	63.5°N/04.5°W	2002-2019	1 Minke whale

10. MEETING CLOSE AND ADOPTION OF REPORT

Murray thanked all the participants for their active participation in the online meeting. The WG thanked the Chair for her able chairing.

A draft meeting report was circulated 26th October 2021 and finalised following the integration of amendments on 11th November 2021.

REFERENCES

Punt, A. E., Siple, M., Sigurðsson, G. M., Víkingsson, G., Francis, T. B., Granquist, S. M., ... & Zerbini, A. N. (2020). Evaluating management strategies for marine mammal populations: an example for multiple species and multiple fishing sectors in Iceland. *Canadian Journal of Fisheries and Aquatic Sciences*, *77*(8), 1316-1331.

APPENDIX 1: AGENDA

1. **Welcome from the Chair**
2. **Adoption of agenda**
3. **Appointment of rapporteurs**
4. **Review of available documents**
5. **Coastal Seals: Endorse estimates for 2022 CSWG assessment**
   - 5.1.Iceland
     - 5.1.1.Lumpsucker gillnet fishery
     - 5.1.2.Cod and Greenland halibut gillnet fisheries
   - 5.2.Norway
     - 5.2.1.Updated seal by-catch analyses - cod/monkfish gillnet
     - 5.2.2. Other fisheries or vessels (i.e. >15m)
6. **Harbour porpoise**
   - 6.1.Norway
     - 6.1.1.Review recently published harbour porpoise estimates
     - 6.1.2.Update on pinger experiments
7. **Risk assessment for all fisheries**
   - 7.1.Overview of Lenfest project: Developing Recommendations to Estimate By-catch for the MMPA
     - https://www.lenfestocean.org/en/research-projects/developing-recommendations-to-estimate-bycatch-for-the-marine-mammal-protection-act
   - Other ways forward
8. **Recommendations**
   1. Recommendations for research from this WG
   2. Recommendations for conservation and management from this WG
9. **Other business**
10. **Adoption of report**
11. **Next meeting**

APPENDIX 2: LIST OF PARTICIPANTS

Arne Bjørge (NO)
Norwegian Institute for Marine Research
Blindernveien 31
Oslo
Norway
arne.bjoerge@hi.no

Geneviève Desportes (NAMMCO Secretariat, Convenor)
General Secretary
PO Box 6453
N-9294 Tromsø
Norway
genevieve@nammco.org

Peter Evans (ASCOBANS, Observer)
Co-Chair ASCOBANS-ACCOBAMS Bycatch Working Group
UN Campus
Platz der Vereinten Nationen
153113 Bonn
Germany
peter.evans@bangor.ac.uk

Sandra M. Granquist (IS, SC)
Marine and Freshwater Institute
The Icelandic Seal Center
Höfðabraut 6
530 Hvammstangi
Iceland
sandra.magdalena.granquist@hafogvatn.is

Jesper Ødegaard Jakobsen (GL)
Ministry of Fisheries and Hunting
GL-3900 Nuuk
Greenland
jeod@nanoq.gl

Marjorie Lyssikatos (Invited Expert)
NOAA/Northeast Fisheries Science Centre
166 Water Street
Woods Hole, MA, 02543-1026
USA
marjorie.lyssikatos@noaa.gov

Heleen Middel (NAMMCO Secretariat)
Assistant Scientific Secretary
PO Box 6453
N-9294 Tromsø
Norway
heleen@nammco.org

Bjarni Mikkelsen (FO, SC Chair)
Faroe Marine Research Institute
Nóatún 1
100 Tórshavn
Faroe Islands
bjarnim@hav.fo

André Moan (NO)
Norwegian Institute for Marine Research
Blindernveien 31
Oslo
Norway
andre.moan@hi.no

Kimberly Murray (Chair, Invited Expert)
NOAA/Northeast Fisheries Science Centre
166 Water Street
Woods Hole, MA, 02543-1026
USA
kimberly.murray@noaa.gov

Simon Northridge (Invited Expert)
Scottish Oceans Institute
University of St Andrews
Institiud Chuantan na h-Alba
Gatty Marine Laboratory
East Sands St Andrews
KY16 8LB
Scotland
United Kingdom
spn1@st-andrews.ac.uk

Guðjón Sigurdsson (IS, SC)
Marine and Freshwater Research Institute
PO Box 1390
IS-121 Reykjavik
Iceland
gudjon.mar.sigurdsson@hafogvatn.is

Fern Wickson (NAMMCO Secretariat)
Scientific Secretary
PO Box 6453
N-9294 Tromsø
Norway
fern@nammco.org

Vladimir Zabavnikov (RU, Observer)
Polar Branch of VNIRO (PINRO)
6 Knipovicha St.,
183038 Murmansk
Russia
ltei@pinro.ru

APPENDIX 3: LIST OF DOCUMENTS

Working Documents

Doc. No.	Title	Agenda item
SC/28/BYCWG/01	Draft Agenda	2
SC/28/BYCWG/02	Draft List of Participants	1
SC/28/BYCWG/03	Draft List of Documents	4
SC/28/BYCWG/04	A. Moan & A. Bjørge Bycatch of coastal seals in Norwegian gillnet fisheries conducted by coastal fishing vessels	5.2
SC/28/BYCWG/05	G. M. Sigurdsson Update on bycatch in Icelandic waters	5.1

For Information Documents

Doc. No.	Title	Agenda item
SC/28/BYCWG/FI01	Report of NAMMCO Scientific Committee Working Group on By-Catch – May 2020	4
SC/28/BYCWG/FI02	A. Moan et al. (2020). Assessing the impact of fisheries-related mortality of harbour porpoise (Phocoena phocoena) caused by incidental bycatch in the dynamic Norwegian gillnet fisheries. *ICES Journal of Marine Science* 77(7-8), 3039-3049.	6.1
SC/28/BYCWG/FI03	A. Bjørge et al. (under review). Estimates of humpback, minke and killer whale fishing gear interactions in Norwegian fisheries suggest low anthropogenic mortality. (Consult with authors prior to citation)	7.2
SC/28/BYCWG/FI04	A. Moan & A. Bjørge (2021). Pinger trials in Norwegian commercial fisheries confirm that pingers reduce harbour porpoise bycatch rates and demonstrate low level of pinger-associated negative impacts on day-to-day fishing operations. *IWC SC/68C/HIM/02*	6.1.2
SC/28/BYCWG/FI05	G.P. Course (2021). Monitoring Cetacean Bycatch: An Analysis of Different Methods Aboard Commercial Fishing Vessels.	7.2

	ASCOBANS Secretariat, Bonn, Germany. 74 pages. ASCOBANS Technical Series No.1.	
SC/28/BYCWG/FI06	FAO (2021). Fishing operations. Guidelines to prevent and reduce bycatch of marine mammals in capture fisheries. *FAO Technical Guidelines for Responsible Fisheries No.1, Suppl. 4. Rome.*	7.2
/28/BYCWG/FI07	UN (2012). Resolution adopted by the General Assembly on 27 July 2012 - The future we want. *General Assembly 11 sept 2011: A/RES/66/288**	7.2
SC/28/BYCWG/FI08	G.M. Verutes et al. (2020). Using GIS and stakeholder involvement to innovate marine mammal bycatch risk assessment in data-limited fisheries. *PloS one*, 15(8), e0237835.	7.2
SC/28/BYCWG/FI09	E. Hines et al. (2020). Getting to the bottom of bycatch: a GIS-based toolbox to assess the risk of marine mammal bycatch. *Endangered Species Research*, 42, 37-57.	7.2
SC/28/BYCWG/FI10	A.E. Punt et al. (2021). Can we manage marine mammal bycatch effectively in low-data environments? *Journal of Applied Ecology*, 58(3), 596-607.	7.2
SC/28/BYCWG/FI11	A.E. Punt et al. (2020). Evaluating management strategies for marine mammal populations: an example for multiple species and multiple fishing sectors in Iceland. *Canadian Journal of Fisheries and Aquatic Sciences,* 77(8), 1316-1331.	5.1.3
SC/28/BYCWG/FI12	A.E. Punt et al. (2021). Assessing pinniped bycatch mortality with uncertainty in abundance and post-release mortality: A case study from Chile*. Fisheries Research*, 235, 105816.	7.1
SC/28/BYCWG/FI13	A.E. Punt et al. (2020). Robustness of potential biological removal to monitoring, environmental, and management uncertainties*. ICES Journal of Marine Science* 77(7-8), 2491-2507.	7.1
SC/28/BYCWG/FI14	P.S. Hammond et al. (2021). Estimating the Abundance of Marine Mammal Populations*. Frontiers in Marine Science*, 1316.	7.1
SC/28/BYCWG/FI15	Marine and Freshwater Research Institute (2019). Bycatch of Seabirds and Marine Mammals in Lumpsucker Gillnets, Iceland 2014-2018. *NAMMCO SC/27/BYCWG/04*	5.1.1

APPENDIX 4: TECHNICAL QUESTIONS REGARDING SC/28/BYCWG/04

A. Bycatch of coastal seals in Norwegian gillnet fisheries conducted by coastal fishing vessels. Report to the NAMMCO By-Catch Working Group. September 2021. Andre Moan and Arne Bjorge Institute of Marine Research. NAMMCO SC/28/BYCWG/04

ML Comments:

1. The terms 'stratum' and reference/prediction metier's appear to be used interchangeably. Metiers are defined but perhaps stick with one term for the remainder of the paper to avoid confusion.
    a. What are the reference métiers (h)? Region x mesh size.
2. What is a stratum? Region & fishery = métier = 9 different ones (3 regions x 3 mesh sizes)
    a. Do stratum and reference métier have the same meaning?
3. Why is the mean bycaught # of seals and CRF fishing effort being used to calculate bycatch rates (eq. 1) instead of total # of seals and hauls? Is it averaged over all 15 years in the time series? This will affect variance estimate too. It seems there are some intermediary summing over years and terms that aren't defined in eq. 1? Perhaps describing in more detail in the methods how you calculated the bycatch rates would be helpful.
4. Prediction métiers = fleet wide (DOF) métiers. Calling the parameter a "prediction" métier because mesh size was predicted using the bagged classification tree. The DOF prediction métier corresponds with the reference métier (h), correct? .
5. Is there an error in notation after equation (5) on page 5? The cv is for the bycatch estimate $\bar{Y}_p$ not on the mean # of seals bycaught $\hat{y}_h$.
6. Page 5 last paragraph - Do you mean to say CVs and variances around the bycatch estimates were calculated with the survey R package?
7. How was the CV calculated for the bycatch estimates? Taylor expansion from 'Survey' R package was used to calculate standard errors which must have been used to calculate the CV's – look up R package. A little more detail on how CV was calculated would be helpful.
8. Time period choice for scaling bycatch estimates to species appears to only be consequential for region 2. Observer coverage over the 15 year time period, overall averaging 2.5% is on the low end.
    a. Consider including a table that shows # of CRF vessels relative to total vessels by region.
9. I don't find Figure 2 particularly informative. There is going to be inter-annual variablility in annual observer bycatch events from the CRF, particularly during time periods where the CRF contract changes. Perhaps pointing out where in the time series on the x-axis the CRF participating vessels changed might be informative.
    a. Consider adding a table that shows CRF bycatch by all the métiers and years (like Figure 3) along with CRF effort.
10. Figure 3. Bycatch rates - on what basis were years combined? Years were pooled based on low or missing effort in respective métiers? Was there a tool used to inform pooling of years in the different strata?
    a. Overall, across all 3 regions, bycatch rates have declined. Exceptions are region 1 medium mesh, region 3 large mesh.
        i. See CRF % coverage within these métiers would be helpful here. See comment 12.a.
11. Page 8. Figure 3. So how do these annual bycatch rates within each metier correspond with equation 1 - bycatch rates based on averages? What bycatch rates were used to estimate total bycatch? See comment #3.

12. Page 9. Figure 4. What's the difference between panels A and panels B? Not described in the Figure legend.
13. Page 12. Figure 6. Pv and Hg bycatch estimates based on what apportionment scheme? The one that reflects Gray seal abundance in 2017?
14. 4.1 Discussion – Methodology – last sentence. Registering MM bycatches is mandatory for CRF regardless of the emphasis on monitoring fish catches, correct?
15. Page 14. Last paragraph. Suggest using only the last 5 years to average mean bycatch against PBR. Fifteen years is to long a history to average for both species.
16. The Harbor and gray seal in Norway are part of a larger population that includes immigration from greater N. Sea population, correct? Consequently, should the Nmin for both species be from the larger N. Sea gray seal and harbor seal populations? In other words, is PBR underestimated – could be higher?
17.

Region	**Harbour seals (2015)**	**Grey seals (2011)**	**Grey seals (2017)**	**Total1**	**Total2**
Region 1 (North)	1,967	2,001	1,789	3,968 (Pv=50%) (Hg=50%)	3,756 (Pv=52%) (Hg=48%)
Region 2 (Mid)	3,989	6,496	1,910	10,485 (Pv=38%) (Hg=62%)	5,899 (Pv=68%) (Hg=32%)
Region 3 (South)	1,934	246	270	2,180 (Pv=89%) (Hg=11%)	2,204 (Pv=88%) (Hg=12%)
Total	7,890	8,743	3,969	16,633	11,859