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By-Catch of Harbour Porpoise (*Phocoena phocoena*) in the Lower Bay of Fundy Gillnet Fishery in 1995

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Abstract

Observer coverage to estimate the incidental mortality of harbour porpoise (Phocoena phocoena) by gillnet vessels in the lower Bay of Fundy, Canada was conducted in 1995. Observer coverage in the Swallowtail area was high (89% in July and 48% in September), though no coverage was made of vessels fishing the Wolves area (by-catch for Wolves was estimated by pro-rating 1994 data). The estimated porpoise by-catch among the Fundy Isles was 87 (Swallowtail area=55, Wolves area=32). Tests of acoustic pingers spaced one every 50 m indicated that rate of porpoise entanglement can be significantly reduced by their implementation. The Bay of Fundy by-catch of 87 porpoises contributes 0.19% of the total by-catch for this population (U.S. and Canada combined). Reduction in groundfish quotas in 1995 restricted gillnetting effort significantly. The fishery was open from July 1-20, closed July 21-August 31, and re-opened in September. As a result the historical peak porpoise by-catch period of August was closed to fishing in 1995.

Résumé

Un relevé par observateurs a été effectué en 1995 pour estimer la mortalité par captures accidentelles du marsouin commun (Phocoena phocoena) causée par les bateaux pêchant au filet maillant dans la partie d'aval de la baie de Fundy (Canada). La couverture par observateurs a été élevée (89% en juillet et 48% en septembre) dans la zone de Swallowtail, mais nulle pour les bateaux pêchant dans la zone de Wolves (les prises accidentelles de cette zone ont été estimées au prorata à l'aide des données de 1994). Les captures accidentelles estimées de marsouins dans les îles de Fundy se sont élevées à 87 (Swallowtail: 55 et Wolves: 32). L'essai de bouées acoustiques disposées à tous les 50 m a montré que le taux de capture accidentelle des marsouins pouvait ainsi être réduit de façon appréciable. Les prises accidentelles dans la baie de Fundy, de 87 marsouins, représentent 0,19% du total des prises accidentelles de cette population (Canada et États-Unis). La réduction des quotas de poisson de fond imposée en 1995 a eu pour effet de réduire de façon appréciable l'effort de pêche au filet maillant. La pêche a été ouverte du 1er au 20 juillet, fermée du 21 juillet au 31 août et réouverte en septembre. Il n'y a donc pas eu de pêche au mois d'août en 1995, période pendant laquelle les prises accidentelles de marsouins étaient généralement les plus élevées.

Introduction

Harbour porpoise (*Phocoena phocoena*) are captured as by-catch in the Canadian and U.S. demersal gillnet fisheries in the Bay of Fundy and Gulf of Maine. Annual by-catch estimates have been made by the U.S. since 1990 and by Canada since 1993. There are concerns that the combined mortality levels by gillnetters in the two countries are high enough to be considered unsafe for the long-term sustainability of the Bay of Fundy/Gulf of Maine transboundary population (National Marine Fisheries Service 1993). Although population structure is not well understood, this population is assumed to have only limited contact with individuals from other parts of the species range (Wang 1993).

DFO Maritimes Region has developed a Harbour Porpoise Conservation Strategy for the Bay of Fundy which limits the annual Canadian by-catch to 110 porpoises, commencing in 1996 (Fisheries and Oceans 1995). In 1996, the U.S. Take Reduction Task Force was formed. Its primary role was to determine the necessary mitigative measures and recommended targets required to approach zero mortality levels by April 30, 2001, as stipulated under amendment to the U.S. Marine Mammal Protection Act (Section 118). To reduce porpoise mortalities, time-area closures of U.S. gillnet activity commenced in 1994 in accordance with Amendment 5 of the New England Groundfish Fisheries Management Plan. U.S. experimental gillnet fisheries using acoustic pingers to reduce by-catch have also commenced in 1995.

Harbour Porpoise Abundance

The U.S. National Marine Fisheries Service estimated the abundance of harbour porpoise in the Bay of Fundy/Gulf of Maine in 1991, 1992, and 1995 (Palka 1996). Abundance estimates were made during cetacean sighting surveys conducted during August that are stratified based on water depth and previous knowledge of porpoise densities. Study area, field procedures and analysis methods were similar among all three surveys (Palka 1996). Increased in abundance in 1995 was related to increased sighting rates (the number of groups observed per nautical mile searched).

Year	Abundance	95% CI
1991	37,500	26,700-86,000
1992	67,500	32,900-104,600
1995	74,000	40,900-109,100

Harbour Porpoise By-Catch

United States- Harbour porpoise by-catch in the U.S. groundfish gillnet fishery in the Gulf of Maine was (Bravington and Bisack 1996, Bisack 1996):

Year	Estimated By-Catch	95% CI
1990	2,900	1,500-5,500
1991	2,000	1,000-3,800
1992	1,200	800-1,700
1993	1,400	1,000-2,000
1994	2,000	1,400-2,900 (time/area gillnet closures)
1995	presently unavailable	

Canada- Harbour porpoise by-catch in the Canadian groundfish gillnet fishery in the Bay of Fundy was (Trippel et al. 1996):

Year	Estimated By-Catch	Standard Error
1993	424	224
1994	101	3

In 1993 and 1994, the two key geographical areas of by-catch spanned 24 km^2 at Swallowtail, Grand Manan Island and 7 km^2 at the Wolves Islands, representing 95-100% of the observed Bay of Fundy by-catch in these two years. Uncertainty exists in the 1993 estimate due to low observer coverage and the absence of temporal stratification. Forty percent of the 1994 Bay of Fundy by-catch occurred from August 16-31 during the 8-weeks of observer coverage (July 15-September 15) (Trippel and Conway 1995, Trippel et al. 1996). The geographically widespread evaluations in 1993 and 1994 did not reveal porpoise by-catch in other areas outside the Fundy Isles (offshore gillnetting in Bay of Fundy; ports: Ingalls Head (accesses Grand Manan Basin) and Seal Cove (accesses Northeast Bank south of Grand Manan Island) and in Meteghan in southwestern Nova Scotia (accesses McDormand Patch).

Objectives of the 1995 Bay of Fundy Observer Program-- By-Catch Estimate and Testing of Acoustic Pingers

In 1995, porpoise by-catch in the gillnet fishery was estimated in collaboration with Dr. Jon Lien of the Whale Research Group at Memorial University (Whale Research Group 1996). The use of acoustic pingers, which are attached to gillnet floatlines, were tested as a possible mitigative measure to reduce by-catch in the Bay of Fundy (Whale Research Group 1996).

Methods

Reduction in groundfish quotas in 1995 restricted gillnetting effort significantly. The fishery was open from July 1-20, closed July 21-August 31, and re-opened in September (based on bi-monthly groundfish quotas). As a result, the peak porpoise by-catch period of August was closed to fishing in 1995. Observer coverage spanned July 1-20 and September 1-25.

Swallowtail By-Catch

Acoustic pingers designed by Dr. Lien (Anon. 1994; Lien et al. 1995) and constructed by observers were tested in the Swallowtail area off of North Head, Grand Manan Island. Fishing was conducted by nine vessels. In July, 39% of gillnet strings fished were esonified and in September 35% were esonified. Pingers emitted a broadband signal ranging from 1-25 kHz, with a source level of 115 dB re 1 micropascal @ 1m pulsed for approximately 300ms once every 4 seconds. These sounds are within the auditory range of harbour porpoise (Andersen 1970, Kastelein et al. 1995). Very high observer coverage of vessels was attained (89% in July and 48% in September). Fishers typically made 4-5 trips per week, and commonly set 4-5 strings of gillnet per trip, each string being comprised of three webs, and each web being approximately 100 m in length and 3 m in height. In esonified strings, pingers were placed at the end of each string, at each bridle (connection between webs), and at mid-web locations. One string of three webs would therefore have seven pingers attached (one every 50 m). Gillnets were set in water ranging in depth from 70-110 m. In 1994, Dr. Lien reported this version of pinger spaced one every 100 m reduced porpoise by-catch by about 50% in the Swallowtail area, with the recommendation made for additional experimentation with versions of pingers that produce a louder sound (Lien and Hood 1994; Lien et al. 1995). In 1995, to produce more sound throughout the length of a gillnet it was decided to add three additional pingers of the 1994 version to each string of three webs (seven pingers per string).

The intent of esonifying gillnets was not to frighten porpoises out of the region, but rather to enhance gillnets as barriers, which porpoises would avoid. Studies were conducted in 1996 to assess the distance at which porpoises could detect pingers (J. Terhune, University of New Brunswick, Saint John, New Brunswick). Previous experimentation in the laboratory has shown that porpoises will react to and avoid pingers (Kastelein et al. 1995).

In 1995, from July 1-20, observers recorded data on 129 esonified strings (treatment) and 200 non-esonified strings (control) and from September 1-25 recorded data on 54 esonified strings and 101 non-esonified strings. Mean porpoise by-catch rate per string for each month was determined for esonified and non-esonified gear, respectively.

The number of vessel trips were determined from the DFO Catch and Effort Statistical System Data Base (information on strings is not recorded). The number of trips in July was 82 and in September the number of trips was 139. Fishers regularly used both esonified and non-esonified strings during the same trip and therefore the following method was used to estimate the equivalent amount of effort per trip (i.e., number of esonified and non-esonified trips). By-catch rate was estimated per trip to be consistent with previous analyses (Trippel et al. 1996). Number of esonified trips=(observed esonified strings/ observed total strings)X number of trips. Number of non-esonified trips=(observed non-esonified strings/observed total strings)X number of trips.

Porpoise by-catch was estimated separately for esonified and non-esonified gear during each time period and then summed to produce a total by-catch estimate. This was done by multiplying the observed mean porpoise by-catch rates per trip in esonified and non-esonified gear by the number of trips for each month and then summing.

Wolves By-Catch

There was no observer coverage of the four vessels fishing the Wolves in 1995 (none of which deployed pingers). Consequently, derivation of the 1995 Wolves by-catch rate was based on proportional by-catch rates between the Wolves and Swallowtail areas using 1994 data.

Results and Discussion

Swallowtail By-Catch

From July 1-20, 1995, 2 porpoises were observed in esonified strings (n=129) and 17 in non-esonified strings (n=200) (all observed porpoise entanglements were fatal). By-catch rate was significantly lower in esonified vs. non-esonified strings (0.016 vs. 0.085 porpoises per string; 0.069 vs. 0.386 porpoises per trip) (Table 1). From September 1-25, no porpoises were observed in esonified strings (n=54) and 8 porpoises in non-esonified strings (n=101), with by-catch rates remaining significantly lower in esonified compared to non-esonified strings (0 vs. 0.079 porpoises per string, 0 vs. 0.364 porpoises per trip, respectively) (Table 1). The first observed mortality occurred on July 6 and the last on September 19. In July, by-catch per trip ranged from 0-3 porpoises (multiple porpoises per trip included 2 trips with 2 porpoises and 1 trip with 3 porpoises) and in September ranged from 0-2 porpoises (1 trip of which had 2 porpoises). Similar by-catch rates in non-esonified gear in July and September are believed to represent the two tails of the peak porpoise by-catch rate that normally exists in August when the fishery is open (Trippel et al. 1996). The porpoise by-catch rate per trip of 0.386 from July 1-20, 1995 was lower than 0.50 per trip reported for July 15-31, 1994. The porpoise by-catch rate per trip from September 1-25, 1995 was 0.364 and was higher than the 0.20 observed from September 1-15 in 1994.

Prorating by-catch rates by effort yielded an estimated 55 (standard error=1) harbour porpoise mortalities in the Swallowtail area in 1995 (21 during July and 34 during September) of which two were estimated to be captured in esonified gear (Table 1). The number of trips to the Swallowtail area were 82 in July and 139 in September. In July, 39% of gillnet strings fished were esonified and in September 35% were esonified.

The pingers were very effective in reducing by-catch. Combining the July and September data, the porpoise by-catch rate was 0.0109 in esonified vs. 0.0831 in non-esonified strings (i.e., a 7.6-fold difference or 87% effectiveness based on 301 control and 183 treatment strings) (Table 1).

Wolves By-Catch

There was no observer coverage of four vessels fishing the Wolves (none of which deployed pingers). Consequently, derivation of the 1995 Wolves by-catch rate was based on proportional by-catch rates between the Wolves and Swallowtail using 1994 data. In 1994, the Wolves by-catch rates during July and September were 16% and 126% of those which occurred in the Swallowtail area, respectively (Table 2). Thus, non-esonified by-catch rates per trip for Swallowtail in 1995 (July=0.383, September=0.372) were multiplied by 0.155 and 1.26 respectively, to derive the 1995 Wolves by-catch rates of 0.058 (July) and 0.466 (September). These values were multiplied by the corresponding number of vessel trips to the Wolves in 1995 (from DFO data sources: July 1-20=35, September 1-25=65) and summed to produce an estimate of the Wolves 1995 by-catch of 32 porpoises (2 for July and 30 for September) (Table 2). Standard error was not estimated for the Wolves area by-catch. No fishery occurred from July 21-August 31, 1995.

Total By-Catch

The combined 1995 by-catch for North Head and the Wolves was 55+32 = 87 porpoises. This value has declined substantially from the 1993 estimate of 424 and is slightly less than the 1994 estimate of 101. Closure of the gillnet fishery from July 21-August 31, 1995 had the secondary effect of reducing porpoise by-catch significantly. The use of pingers in 1995 by North Head fishers reduced the by-catch by an estimated 28 porpoises (10 in July and 18 in September). If no pingers had been tested the total by-catch could have reached 115 porpoises. If there had been a fishery open throughout the summer and no pingers were tested the by-catch would likely have exceeded 200-300 porpoises (note 72% of the 1994 by-catch occurred in August; Trippel et al. 1996).

Implications of Bay of Fundy By-Catch on Population Growth

Available data indicate the 1995 Canadian by-catch of harbour porpoise represents 0.12% of the 1995 population estimate of 74,000 and 0.23% of the 1991 population estimate of 37,500. The combined U.S. and Canadian by-catch for 1994 of 2,100 porpoises represents 2.8% of the 1995 population size estimate, of which Canada contributes 0.14%. The maximum potential population growth rate estimate for this species is approximately 4% (Woodley and Read 1991, Caswell et al. 1994, Blaylock et al. 1995). The 1995 Canadian by-catch was not a limiting factor to the population's growth potential, though this was dependent in part on experimentation with pingers and area closure.

Use of Pingers to Reduce Harbour Porpoise By-Catch

Pingers appear to be a suitable method to reduce the rate of porpoise entanglement without restricting fishing effort (properly deployed pingers reduced by-catch by 87%). However, several factors may influence the annual effectiveness of this potential mitigative measure and include: (i) durability of pingers, (ii) effects on non-target species and (iii) impact on porpoise habitat.

(i) Pinger durability might limit their life expectency and thus reduce their utility as a dependable mitigative measure. Upon hauling of the gear, some pingers were not operating and had to be replaced with functional spare pingers kept on board the vessel. Fishers have not been trained on how to manufacture these pingers. Pinger design is still in its infancy and it is anticipated that improved versions will evolve as the area commercializes. Fishers support the use of pingers to reduce by-catch, though they are concerned about the cost of pingers even if self-made at $15-20 each (Whale Research Group 1996). Fishers recommend pinger deployment as a method to reduce porpoise by-catch and are opposed to time-area closures.

(ii) From an economic viewpoint, the main concern is the 30% reduction in pollock (*Pollachius virens*) catches associated with pinger deployment (Richter and Lien 1996), which next to cod (*Gadus morhua*) comprises the greatest contribution of this fishery's marketable catch. The additional weight of negatively buoyant pingers every 50 m on gillnet float lines may have reduced the effective fishing height of nets, thus reducing pollock catches (the majority of pollock are caught in the upper half of gillnets). Additional floats should be secured to the floatline in the area of pinger attachment to achieve positive buoyancy if the same version of pinger is to be used in the future. The 1996 Bay of Fundy observer program that was recently completed was designed to test the effectiveness of commercially available pingers which have previously been shown to be successful (2 porpoises in 423 active strings vs. 25 porpoises in 421 control strings) in the 1994 U.S. fall gillnet fishery on Jeffreys Ledge, Gulf of Maine (Kraus et al. 1995). In the U.S., these were tested in gillnet strings with one pinger every 300 ft (92 m) which emitted a broadband signal centered at 10kHz, with a source level of 132 dB re 1 micropascal @ 1m pulsed for 300ms once every 4 seconds.

Herring (*Clupea harengus*) have sensitive hearing (Enger 1967) and significantly fewer were captured in esonified vs. non-esonified gillnets (Richter and Lien 1996). Herring weir fishermen have expressed some concern about the potential negative impact an esonified fleet would have on the schooling behaviour of herring and on weir catches off Swallowtail.

(iii) There is also the possibility of a reduction in porpoise habitat due to their avoidance of esonified gillnets. A completely esonified fleet in the Swallowtail area amounts to 284 pingers or 10.5 pingers/km^2 and in the Wolves area of 162 pingers or 27 pingers/km^2. The introduction of sound to the aquatic environment has previously been identified as a potential problem for cetaceans in the Fundy Isles region (Strong et al. 1995).

Management Recommendations

Possible management measures exist to maintain by-catch below the level of mortality set by the Harbour Porpoise Conservation Strategy. These include (a) enforcement of pinger utilization on all gillnets in the Swallowtail and Wolves areas and (b) closure to gillnetting of these areas during part or all of August.

Whether these will be effective in each year is unknown, as a number of factors are likely to influence the annual level of harbour porpoise by-catch. These include the seasonal distribution and amount of fishing effort and the local distribution and abundance which, in turn, may be affected by interannual changes in the abundance and arrival of prey such as herring (Recchia and Read 1990; Palka 1995). However, the ecological factors which affect local abundance of harbour porpoise are poorly understood. Thus, current estimated by-catch levels in the gillnet fishery could change and thus management measures that are effective today may not be adequate in the future.

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Table 1. 1995 Swallowtail Fishing Effort and Estimated Harbour Porpoise By-catch

Dates 1995 dd/mm	Gear treatment	Number of vessel trips [1]	Number of vessel trips observed [2]	Percent of vessel trips observed	Observed number of strings fished	Number of strings fished	Observed by-catch	Observed by-catch per trip[3] (mean ± SE)	Observed by-catch per string (mean± SE)	Estimated porpoise by-catch [4]
01/07-20/07	Esonified	32	29		129	145	2	0.069± 0.048	0.016± 0.010	2.2
	Control	50	44		200	225	17	0.386± 0.074	0.085± 0.020	19.3
	Combined	82	73	89.2	329	370	19			21.5
01/09-25/09	Esonified	46	11		54	227	0	0	0	0
	Control	93	22		101	426	8	0.364 ± 0.105	0.079± 0.027	33.8
	Combined	139	33	23.7	155	653	8			33.8
Total	Combined	221	106	48.0	484	1023	27			55.3

1 Total vessel trips were estimated for esonified and control by multiplying total trips by the ratios of observed esonified and control strings to the observed strings fished respectively.
2 Observed effort by trip for esonified and control were estimated by multiplying total observed trips by the ratios of observed esonified and control strings to the total observed strings fished respectively. Most trips employed a combination of esonified and control strings.
3 The observed by-catch per trip was estimated for esonified and control by dividing the observed by-catch by the observed number of trips.
4 The estimated by-catch was calculated by multiplying the obseved by-catch per trip by the number of vessel trips.

Table 2. 1995 Wolves Fishing Effort and Estimated Harbour Porpoise By-catch

Month	1994 by-catch rate Wolves (strings) (A)	1994 by-catch rate Swallowtail (strings) (B)	Ratio (C)=A/B	1995 by-catch rate Swallowtail (trips) (D)	Estimated 1995 Wolves by-catch rate (trips) (E)=C*D	1995 Wolves fishing effort (trips) (F)	1995 Wolves by-catch (estimation) (G)=E*F
July	0.023	0.15	0.155	0.386	0.060	35	2.1
September	0.058	0.046	1.26	0.364	0.459	65	29.8
Total						100	31.9
				Combined	Swallowtail	and Wolves	87

Figure 1.Observed Harbour Porpoise Mortalities in the Swallowtail Area in 1995