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BY-CATCH OF HARBOUR PORPOISE (*PHOCOENA PHOCOENA*) IN THE LOWER BAY OF FUNDY GILLNET FISHERY, 1998–2001

by

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ABSTRACT

Trippel, E.A., and T.D. Shepherd. 2004. By-catch of harbour porpoise (*Phocoena phocoena*) in the lower Bay of Fundy gillnet fishery, 1998-2001. Can. Tech. Rep. Fish. Aquat. Sci. 2521: iv +33 p.

The most serious threat to the status of harbour porpoise (*Phocoena phocoena*) is incidental mortalities caused by entanglement in fishing gear. As part of an ongoing study to evaluate the utility of mitigation techniques to reduce such harbour porpoise mortalities, observers were placed on-board vessels participating in the lower Bay of Fundy demersal gillnet fishery from 1998-2001. The number of vessels participating in the fishery declined from 22 in 1998 to 13 in 2001. Despite this decline, total annual effort remained relatively stable. Over the 4-yr period, a total of 52 porpoise mortalities were observed, all but four of which were in the Swallowtail region off Grand Manan, New Brunswick. For the Bay of Fundy, total estimated by-catch was 38, 32, 28, and 73 porpoises from 1998-2001, respectively. A lack of spatial and temporal observer coverage did not allow us to generate estimates of variance in by-catch estimates. In all years, the majority of the estimated porpoise by-catch occurred in the Swallowtail region. In general, by-catch was highest in July except in 1999 when it was highest in August. The increase in by-catch seen in 2001 was due to increased catch rates rather than increased effort. While the Canadian by-catch in 2001 appears low (73 porpoises), it was nearly as high as the U.S. by-catch (80 porpoises) which has a much larger fishery. Given that the Canadian by-catch appears to represent a significant source of mortality, observer coverage should be better allocated both spatially and temporally in the future so that more reliable by-catch estimates and their associated variance can be estimated.

RÉSUMÉ

Trippel, E.A., and T.D. Shepherd. 2004. By-catch of harbour porpoise (*Phocoena phocoena*) in the lower Bay of Fundy gillnet fishery, 1998-2001. Can. Tech. Rep. Fish. Aquat. Sci. 2521: iv +33 p.

La plus sérieuse menace au statut des marsouins communs (*Phocoena phocoena*) concerne les mortalités accidentelles causées par l'empêtrement dans les engins de pêche. Dans le cadre d'une étude visant l'évaluation de l'utilité de techniques mitigatives pour réduire ce type de mortalités chez le marsouin commun, des observateurs ont été embarqués à bord de bateaux participant à la pêche au poisson de fond à l'aide de filets maillants dans la Baie de Fundy entre 1998–2001. Le nombre de bateaux participant à cette pêche a diminué de 22 en 1998 à 13 en 2001. Malgré ce déclin, l'effort annuel total est demeuré relativement stable. Au cours de ces 4 années, un total de 52 mortalités de marsouins ont été observées, toutes sauf 4 étant survenues dans la région Swallowtail au large de Grand Manan, Nouveau-Brunswick. Pour la Baie de Fundy, les prises accidentelles totales de 1998 à 2001 ont été estimées à 38, 32, 28, et 73 marsouins, respectivement. Un manque de couverture spatiale et temporelle des observateurs en mer n'a pas permis d'estimer la variance autour

de ces estimations de prises accidentelles. Pour chacune des années, la majorité des prises accidentelles de marsouins sont survenues dans la région Swallowtail. En général, les prises accidentelles ont été les plus élevées en juillet, sauf en 1999 où elles ont été les plus élevées en août. L'augmentation des prises accidentelles observée en 2001 était liée à l'augmentation du taux de capture plutôt qu'à une augmentation de l'effort. Bien que les prises accidentelles canadiennes puissent sembler faibles en 2001 (73 marsouins), elles étaient presque aussi élevées que les prises accidentelles des États-Unis (80 marsouins) qui mène une beaucoup plus importante pêcherie. Considérant que les prises accidentelles canadiennes semblent constituer une source significative de mortalité, la couverture par les observateurs en mer devrait être mieux distribuée dans le temps et l'espace dans le futur de manière à obtenir des estimations fiables des prises accidentelles et de la variance de ces estimations.

INTRODUCTION AND OVERVIEW OF THE PROJECT RATIONALE AND OBJECTIVES

This report summarizes the results of the Aquaculture Collaborative Research and Development Program (ACRDP) Fish Health and Oceanography Project. These results were presented and discussed at the final meeting of the project team, held on 17 February 2004. This report includes an overview of the project's rationale and objectives, summaries of results for each of the project components, conclusions, and recommendations. The agenda, list of participants, and slides from the presentations at the final project meeting are included as appendices.

A brief overview of the project rationale and objectives is given below. Additional background can be found in Page and Chang (2002).

The design of the Fish Health and Oceanography Project began in the fall of 2000 and spring of 2001 and it initially received funding from the Fisheries and Oceans Canada (DFO) Aquaculture Collaborative Research and Development Program (ACRDP) in late 2001.

The consideration and approval of four new salmon farms in the southern Grand Manan area in 2001 triggered the desire for the project. One of the new sites raised the particular concern that an existing even year-class salmon farm (MF-303) in the Long Pond Bay area of southern Grand Manan would not be sufficiently isolated from the newly and conditionally approved odd year-class farm (MF-403) in terms of water exchange between the sites (Appendix 3, slide 3). There was also the more general concern within the fish health and salmon aquaculture communities that the Bay Management Area (BMA) boundaries in southern Grand Manan may not be consistent with water exchange patterns in the area and that the fish health management strategies for the area might be compromised (Appendix 3, slide 3). These concerns were combined with a research desire to improve our ability to link oceanography to fish health management issues.

The project team (Appendix 2) consisted of oceanographers and fish health specialists from DFO, biologists and fish health specialists from the New Brunswick Department of Agriculture, Fisheries and Aquaculture (NBDAFA), representatives of the salmon industry (Northeast Salmon Inc., Heritage Salmon Ltd., Fundy Aquaculture Ltd., and the New Brunswick Salmon Growers' Association) and members of the regional Fish Health Technical Committee. The latter included provincial (NBDAFA), federal (DFO), university (Atlantic Veterinary College) and private (Aquaculture Veterinary Services International, Maritime Veterinary Services Ltd., Skretting) veterinarians and fish health specialists.

The conceptual approach adopted by the project was that of the passive advective transport and dispersal of viral particles that may be released from fish farms (Appendix 3, slide 4). Given the many uncertainties associated with the water-borne transmission of the infectious salmon anemia (ISA) virus, it was decided that it was reasonable for the project to assume the virus was passively transported in the upper few meters of the water column in association with buoyant organic matter shed by the caged salmon. Furthermore, it was decided that it was reasonable to focus on the mean tidally driven component of the circulation and its associated transport and dispersal properties. It was felt that although the tides are not constant and that other factors such

as wind influence the circulation, the most persistent component of the circulation was the tides and the mean tide was a good starting point. This enabled the project to develop a conceptual approach and useful information for immediate fish health management purposes, while generating a solid foundation that, in the future, could incorporate additional components such as wind-driven circulation and viral behaviour if deemed useful.

Although some hydrographic and current meter data had been previously collected in southern Grand Manan and a preliminary three-dimensional tidal circulation model had been developed, the work was not sufficiently advanced to adequately address the issues of concern. The preliminary model results (Appendix 3, slide 5) indicated the tidal circulation in the southern Grand Manan area was spatially complex, that the horizontal resolution of the model needed to be improved in some areas and that additional observations were needed to help calibrate and validate the model in the areas of interest. Hence, additional field work and model development was required and time was needed to develop, test and apply software tools to the questions and concerns that triggered the project.

The specific objectives of the project were therefore:

1. To develop a better understanding of the water circulation within the Long Pond Bay area of Grand Manan by:
   - obtaining empirical observations of drifter trajectories and current velocities in key areas,
   - analyzing existing and new observations, and
   - refining and calibrating a three-dimensional tidal circulation and particle tracking model.

2. To characterize the fish health issues of importance to the salmon aquaculture industry that may have a significant oceanographic component to their spread and management considerations, especially in the Long Pond Bay area.

3. To define approaches and guidelines for estimating fish health risks based on oceanographic information.

4. To examine the implications of water circulation in southern Grand Manan, and Long Pond Bay in particular, to the exchange of ISA between farms MF-303 and MF-403 and between BMAs 19, 20 and 21.

5. To facilitate the exchange of information between fish health specialists and oceanographers and hence help develop a mutually improved understanding of fish health and oceanographic issues in the Grand Manan area and help identify how oceanographic knowledge can contribute to the management of these issues.

6. Contribute to a general examination of the suitability of BMA boundaries in the southern Grand Manan area from the perspective of water circulation and exchange pathways, with particular attention given to the water exchanges between Seal Cove and Long Pond Bay and between Long Pond Bay and Duck Island Sound.

summarized at the string level to avoid the potentially confounding effect of mesh type. Data were first partitioned by year, fishing area (Fig. 2) and season (2-wk periods). A small number of observations did not include location data (4%). These observations were assigned to a fishing location based on known locations fished by vessels from the same port of origin during that year and season. Catch rates of harbour porpoise (mean catch per string) were calculated for each year, fishing location, and season combination. A typical fishing trip by a lower Bay of Fundy gillnet vessel involves fishing five strings. A string is defined as three approximately 100-m long webs that are fished as a unit for approximately 24 h before retrieval. To facilitate the application of observed catch rates to unobserved data, catch rates per string were multiplied by five in order to derive an estimate of porpoise by-catch per trip.

ESTIMATING CATCH RATES

Spatial and temporal observer coverage in the dataset was generally low except at Swallowtail (Table 3). Since 1994, observed coverage has been in place at Swallowtail for each year except 1999. Because of this, Swallowtail catch rates were used as a "standard" against which unknown catch rates for other locations could be estimated. While the fishery begins in June, effort is typically very low and there has never been any porpoise by-catch reported in June in the lower Bay of Fundy. Because of this, it was assumed that porpoise catch rates in June of each year were zero. Observer coverage extended past September 15 only in 1999 at the Wolves during which no porpoises were captured. Because of this, it was assumed that porpoise catch rates after September 15 of each year were zero. In a number of fishing grounds (i.e., Grand Manan Banks, Head & Horns, and Digby Neck; Fig. 1) there have not been any instances of observed by-catch in the gillnet fishery. The by-catches in these areas were assumed to be zero in all years.

In order to estimate catch rates when no observer coverage was present, ratios were calculated between the catch rates of each fishing location and Swallowtail using data from the years 1994–2001, i.e., where paired observations during a season existed between Swallowtail and a particular fishing area, the ratio of its catch rate to Swallowtail was calculated. The mean of these ratios from all pairs for a particular fishing area represented the mean ratio of its catch rate relative to Swallowtail. When observer coverage was absent for a particular fishing location/season/year combination, it was estimated by pro-rating the associated Swallowtail catch rate by the mean ratio relative to Swallowtail.

In 1999, observer coverage was absent from Swallowtail but was extensive at the Wolves. In order to estimate Swallowtail catch rates, seasonal catch rates from the Wolves were multiplied by the reciprocal of the Wolves mean ratio to Swallowtail from other years. In some years, seasonal catch rates were missing from Swallowtail. They were estimated by using the seasonal mean ratio of catch rates, using August 1-15 as a standard in a manner analogous to fishing location mean ratios. August -15 was selected as a standard since observer coverage was most complete for this period.

ESTIMATING PORPOISE BY-CATCH

Observed effort (trip level) was first subtracted from reported effort (trip level) in order to derive unobserved effort. Reported effort was extracted from the DFO commercial fishery database which includes information on location fished and landings for each trip. Catch rates for each year/location/season were multiplied by the unobserved effort of the associated year/location/season combination in order to estimate unobserved porpoise by-catch. Total estimated by-catch was obtained by adding the observed by-catch to the estimated unobserved by-catch.

RESULTS

THE FISHERY

From 1998–2001, the number of vessels participating in the fishery decreased from 22 in 1998 to 13 in 2001 (Table 2). Of the vessels participating, most fished only through July and August. Fishing effort by at least some participating vessels increased over the study period since the total number of trips reported by participating vessels fell only modestly from 276 trips in 1998 to 257 trips in 2001 (Table 3). The spatial distribution of fishing effort appeared to shift between 1998 and 2001. In all 4 yr the majority of the effort was concentrated on Swallowtail (Table 3). In 1998, Gravelly Bulkhead was secondary to Swallowtail in effort reported. In subsequent years, effort at Gravelly Bulkhead decreased while it increased at the Wolves (Table 3). By 2001, the Wolves was secondary to Swallowtail in fishing effort.

OBSERVED PORPOISE MORTALITIES

Over the entire 4-yr period, 52 porpoise captures were observed (Table 4). Observed porpoise by-catch was low from 1998-2000 and relatively high in 2001 (Table 5). From 1998-2001 porpoise by-catch was observed in three areas: Swallowtail, the Wolves and Gravelly Bulkhead (though minimal observer coverage occurred elsewhere). All but four porpoise captured were observed at Swallowtail (Table 5; Fig. 2). Two of the porpoise catches at the Wolves were in mixed strings (i.e., strings with both 100% nylon-mesh webs and barium-sulphate mesh webs). In both cases, porpoises were captured in 100% nylon-mesh webs. General trends in observed catch rates per string (Table 6) were similar to observed catch rates per trip (Table 5). Not unexpectedly, when catch rates per string were adjusted to the trip level using five strings per trip (Table 7) they became much higher than the observed catch rates per trip (Table 5).

DEVELOPMENT OF PRO-RATED CATCH RATES TO ESTIMATE BY-CATCH

The observer database encompasses the years 1993-2001. Data from 1993 were not used in this analysis since information on the geographic location of fishing effort was absent. Rather, 1993 included data on port of origin (Trippel et al. 1996a). During the period from

1994-2001, porpoise catches were observed at Swallowtail, Wolves, Gravelly Bulkhead, Head Harbour and the Channel (Table 8; Fig. 2). At no time during this period was there total spatial and temporal observer coverage. Relative to Swallowtail, historical catch rates in Head Harbour and Gravelly Bulkhead were high while those at the Wolves and the Channel were low (Table 9). A considerable amount of uncertainty existed for some estimates of mean ratio catch rates (e.g., Gravelly Bulkhead) due to the low number of seasonal pairs available. Seasonal catch rates at Swallowtail were highest from July 1-31 (Table 9). Using Swallowtail as a standard allowed us to fill in unknown catch rates for all year/location/season combinations (Table 10).

PORPOISE BY-CATCH

Total estimated porpoise by-catch (observed by-catch plus estimated unobserved by-catch) for the lower Bay of Fundy was 38, 32, 28, and 73 porpoises for 1998-2001, respectively (Fig. 3). The 2001 by-catch (73 porpoises) was lower than by-catch reported prior to 1996, but higher than those reported between 1996 and 2000 (Fig. 3). Total estimated by-catch was highest at Swallowtail during all years and accounted for between 43.8% and 75.3% of total estimated by-catch annually (Table 11; Fig. 4). Effort in the Channel was not sufficient to generate estimated unobserved by-catch. Total estimated by-catch in the other areas was generally low relative to Swallowtail. By-catch was generally highest in either early or late July except 1999 when almost all of the total estimated by-catch occurred in late August (Table 11) and observer effort was dedicated exclusively to the Wolves (Table 5). The increased by-catch in 2001 appeared to be due to increased catch rates (Fig. 5). Total catch rates calculated from observed by-catch and total estimated by-catch showed a similar trend where it was relatively low from 1998-2000 and subsequently increased considerably in 2001 (Fig. 5).

DISCUSSION

The annual by-catch estimates for the period 1998-2001 have remained below the 110 animals set as a cap by the DFO Maritimes Region's Harbour Porpoise Conservation Strategy (DFO 1995). The most recent BOF/GOM population estimate was reported to be 89,700 animals (survey conducted in 1999; Waring et al. 2001), and consequently, this level of mortality is not considered to be high relative to population size (0.12%). Reduced quotas and shortened fishing seasons under restrictive groundfish management plans are primarily responsible for the maintenance of annual by-catches in the Bay of Fundy of less than 110 porpoises since the mid-1990s. The cumulative mortality in both Canada and the U.S. for this population is shown in Table 1. The by-catch for the Bay of Fundy in 2001 was surprisingly nearly equivalent to the entire U.S. by-catch for this population. This is partly due to the high by-catch rate observed in the Swallowtail area, Bay of Fundy, from July 16-31 of 2001: 0.625 porpoises/trip in 100% nylon nets and 0.360 porpoises/trip in barium-sulphate nets. Only in 1994 was a similar by-catch rate observed in control gear with a mean of 0.61 porpoises/trip occurring from August 15-31 in the Swallowtail area (Trippel et al. 1996a). By-catch rate was also high in 1993 by vessels fishing out of Grand

Manan (3.20 porpoises/trip; Trippel et al. 1996a). The high abundance of porpoises in the BOF/GOM population, the annual variability in the portion of the population that enters the Bay of Fundy, and the resulting potentially high by-catch rates indicates the importance of annual monitoring of by-catch in the Bay of Fundy.

This report highlights the need for improved observer coverage. Fishing in areas prone to high porpoise by-catch rates (Wolves and Head Harbour fishing grounds) by vessels departing from Campobello Island did not receive annual observer coverage. This necessitated pro-rating of known by-catch rates to areas of unknown by-catch rates (e.g., rate in one area such as Swallowtail to another area), presumably leading to inaccuracies and uncertainty in the number of estimated mortalities. Moreover, only rarely over the previous 10 yr (e.g., 1994) did widespread observer coverage exist for the more distant areas of the Bay of Fundy accessed by both New Brunswick and Nova Scotia gillnetters (e.g., Grand Manan Basin, Northeast Bank). Nova Scotia gillnetters in the Bay of Fundy were rarely covered and were assumed not to catch porpoises (based on zero by-catch during sporadic observer coverage). However, porpoise sightings are frequent in these areas during population surveys (Palka 1995a) suggesting entanglements in Nova Scotia fishing gear may be occurring. It is recommended that another year of widespread observer coverage be conducted in the Bay of Fundy and south-west Nova Scotia in order to establish whether zero by-catch is a reasonable assumption for these areas and to re-evaluate the level of pro-rating currently applied among areas.

The by-catch patterns in September 2001 alert us to a number of important issues. Not since 1994 have estimates been made of bi-weekly by-catch through the entire fishing season (i.e., early July–mid September). In 2001, by-catch rates were lower in August than in either July or September. In contrast, 1994 by-catch rates were highest in August. Annual changes in seasonal variation of by-catch of porpoise in the Bay of Fundy seem to occur and consequently closing the fishery every year during a fixed 2-wk period may not necessarily reduce by-catch significantly. Earlier analyses led to a possible recommendation to reduce by-catch by simply closing the fishery in sensitive areas from August 16-30 (in 1994 total by-catch would have been reduced by 38% by this 2-wk closure; Trippel et al. 1996a). However, this 2-wk closure of the Swallowtail and Wolves areas would not have had a significant impact in 2001 (5.5% of total estimated by-catch). It should also be noted that the relatively high by-catch rate in September 2001 should reduce confidence in our assumption that no by-catch occurred after September 15 of each year.

Alternatively, enforced use of mitigative gear could be a more suitable management option to explore. To date, it is not clear from experimental tests which is the most suitable form of mitigation (acoustic pingers vs. reflective nets). Results on the efficacy of reflective gillnets in 2001 (nylon: 0.16 porpoises/trip, barium-sulphate: 0.11 porpoises/trip) were not as promising as earlier research in 1998 (nylon: 0.08 porpoises/trip, barium-sulphate: 0 porpoises/trip) and 2000 (nylon: 0.05 porpoises/trip, barium-sulphate: 0 porpoises/trip). In 1999 mixed webs were used flawing the experimental design. The change in effectiveness may be associated with an unusually high abundance of harbour porpoises in the Bay of Fundy in the summer of 2001 (entrapment of porpoises in weirs was among the highest

recorded – 1998 = 34, 1999 = 93, 2000 = 20, 2001 = 312, 2002 = 53, and 2003 = 31; source: Grand Manan Whale & Seabird Station). By-catch rates in gillnets (100% nylon) in 2001 were the second highest in the period from 1994-2001 (Table 8; July 16-31, 2001 at Swallowtail: 0.625 porpoises/trip, Aug 16-31 1994 at Head Harbour and July 1-15, 1998 at Gravelly Bulkhead: 1.0 porpoises/trip).

Abundance of porpoises in the Bay of Fundy is positively correlated with abundance of Atlantic herring (*Clupea harengus*) (Palka 1995b; Trippel et al. 1999), their principal prey (Recchia and Read 1989). We speculate the aversive behaviour of porpoises around gillnets in 2001 may have been altered and possibly diminished from earlier test years (Trippel et al. 2003) as porpoise could have been exhibiting aggressive swimming and diving behaviour while foraging resulting in reduced alertness to barriers such as gillnets. Because of this, integration of herring abundance data, from fishery sources, may assist in the prediction of regionally high porpoise by-catch levels. On the other hand, the effectiveness of reflective netting may be inherently lower than previously reported (Trippel et al. 2000; Larsen et al. 2002; Trippel et al. 2003). Consequently, it is recommended that further field-testing of barium-sulphate gillnets be undertaken in the Bay of Fundy under various levels of regional porpoise abundance. The present period of reduced groundfish quotas provides a good opportunity to conduct these field trials without incurring large losses of animals.

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Table 1. Estimates of harbour porpoise by-catch in demersal gillnet fisheries in the Bay of Fundy, New England, and off the U.S. mid-Atlantic states from 1990-2001. Numbers in parentheses for U.S. data represent 95% confidence intervals of by-catch estimates. Numbers in parentheses for Bay of Fundy data represent ± 1 standard error and 95% confidence limits for 1993 and 1994, respectively.

Year	New England[1]	Bay of Fundy[2]	U.S. Mid-Atlantic[3]	Other[4]	Total
1990	2900 (1500 – 5000)	-	-	-	2900
1991	2000 (1000 – 3800)	-	-	-	2000
1992	1200 (800 – 1700)	-	-	-	1200
1993	1400 (1000 – 2000)	424 (200 – 648)	-	-	1824
1994	2100 (1400 – 2900)	101 (80 – 122)	-	-	2201
1995	1400 (900 – 2500)	87	103 (11 – 254)	-	1590
1996	1200 (800 – 1800)	20	311 (162 – 567)	-	1531
1997	782 (501 – 1208)	43	572 (296 – 1071)	-	1397
1998	332 (170 – 728)	38	446 (294 – 894)	-	816
1999	270 (78 – 364)	32	53 (3 – 98)	19	374
2000	570 (169 – 924)	28	21 (1 – 53)	1	620
2001	51 (2 – 166)	73	26 (1 – 83)	3	153

[1] 1990-1996 from Palka 1997, 1997-1999 from Waring et al. 2001, 2000 from Marine Mammal Commission 2002, 2001 from D.Laist, Marine Mammal Commission.

[2] 1993-1994 from Trippel et al. 1996a, 1995 from Trippel et al. 1996b, 1996-1997 from DFO 1998, 1998-2001 from this study.

[3] 1995-1996 from Palka 1997, 1997-2000 from Marine Mammal Commission 2002, 2001 from D. Laist, Marine Mammal Commission.

[4] Harbour porpoise strandings with signs of gillnet fishery related interactions in areas of the U.S. mid-Atlantic region not monitored by observers (A. Read, Duke University, Beaufort, N.C., pers. comm.).

Table 2. Number of fishing vessels participating in the lower Bay of Fundy gillnet fishery by season (2-wk period) and for all seasons combined from 1998-2001.

Season	1998	1999	2000	2001
June 1-15	3	1	0	1
June 16-30	4	3	1	1
July 1-15	11	8	9	12
July 16-31	15	8	10	12
Aug 1-15	16	7	10	5
Aug 16-31	14	9	8	3
Sep 1-15	12	8	8	4
Sep 16-30	9	8	4	0
All seasons	22	11	13	13

Table 3. Summary of fishing effort (trips reported) by the lower Bay of Fundy demersal gillnet fishery from 1998-2001. Numbers in parentheses represent proportion of reported trips that were observed.

1998

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
June 1-15	0	0	4 (0.00)	0	0	7 (0.00)	11 (0.00)
June 16-30	0	0	2 (0.00)	0	0	3 (0.00)	5 (0.00)
July 1-15	45 (0.22)	0	6 (0.33)	5 (0.00)	0	6 (0.17)	62 (0.21)
July 16-31	27 (0.70)	6 (0.67)	18 (0.11)	1 (0.00)	0	3 (0.33)	55 (0.47)
Aug 1-15	16 (0.38)	6 (1.00)	17 (0.18)	1 (0.00)	0	6 (0.33)	46 (0.37)
Aug 16-31	14 (0.14)	4 (0.75)	22 (0.14)	1 (0.00)	0	2 (0.00)	43 (0.19)
Sep 1-15	11 (0.00)	0	18 (0.06)	0	0	1 (0.00)	30 (0.03)
Sep 16-31	5 (0.00)	1 (0.00)	15 (0.00)	0	0	3 (0.67)	24 (0.08)
Total	118 (0.31)	17 (0.76)	102 (0.11)	8 (0.00)	0	31 (0.19)	276 (0.24)

1999

June 1-15	0	0	0	0	0	1 (0.00)	1 (0.00)
June 16-30	0	2 (0.00)	6 (0.00)	0	0	0	8 (0.00)
July 1-15	28 (0.00)	6 (1.00)	12 (0.00)	0	0	1 (0.00)	47 (0.13)
July 16-31	43 (0.00)	17 (0.59)	10 (0.00)	0	0	3 (0.00)	73 (0.14)
Aug 1-15	18 (0.00)	8 (0.25)	8 (0.00)	0	1 (0.00)	1 (1.00)	36 (0.08)
Aug 16-31	16 (0.00)	9 (0.33)	2 (0.00)	7 (0.00)	0	7 (0.26)	41 (0.12)
Sep 1-15	2 (0.00)	4 (1.00)	10 (0.00)	5 (0.00)	0	4 (0.00)	25 (0.16)
Sep 16-31	1 (0.00)	7 (0.14)	2 (0.00)	6 (0.00)	0	11 (0.00)	27 (0.04)
Total	108 (0.00)	53 (0.49)	50 (0.00)	18 (0.00)	1 (0.00)	28 (0.11)	258 (0.11)

Table 3 (cont.)

2000

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
June 1-15	0	0	0	0	0	0	0
June 16-30	0	1 (0.00)	0	0	0	0	1 (0.00)
July 1-15	12 (0.00)	2 (0.00)	7 (0.00)	0	0	4 (0.00)	25 (0.00)
July 16-31	31 (1.00)	8 (0.00)	30 (0.00)	2 (0.00)	0	3 (0.00)	74 (0.42)
Aug 1-15	44 (1.00)	2 (0.00)	3 (0.00)	0	0	5 (0.00)	54 (0.81)
Aug 16-31	37 (0.70)	16 (0.00)	14 (0.00)	0	0	2 (0.00)	69 (0.38)
Sep 1-15	10 (0.10)	4 (0.00)	11 (0.00)	0	0	3 (0.00)	28 (0.04)
Sep 16-31	0	0	0	0	0	0	0
Total	134 (0.76)	33 (0.00)	65 (0.00)	2 (0.00)	0	17 (0.00)	251 (0.41)

2001

June 1-15	0	0	2 (0.00)	0	0	0	2 (0.00)
June 16-30	0	0	4 (0.00)	0	0	0	4 (0.00)
July 1-15	44 (0.41)	5 (0.00)	14 (0.00)	4 (0.00)	0	0	67 (0.27)
July 16-31	53 (0.74)	18 (0.00)	4 (0.00)	1 (0.00)	0	3 (0.00)	79 (0.49)
Aug 1-15	36 (0.81)	6 (0.00)	0	0	0	0	42 (0.69)
Aug 16-31	35 (1.00)	0	0	0	0	0	35 (1.00)
Sep 1-15	24 (1.00)	0	0	0	0	4 (0.00)	28 (0.86)
Sep 16-31	0	0	0	0	0	0	0
Total	192 (0.76)	53 (0.00)	24 (0.00)	5 (0.00)	0	7 (0.00)	257 (0.56)

Table 4. Summary of observed porpoise catches in the lower Bay of Fundy demersal gillnet fishery from 1998-2001.

Year	Date	Area	Mesh	Porpoise	Latitude (°N)	Longitude (°W)
1998	07-Jul-98	Swallowtail	Nylon	3	44.8067	66.6596
1998	11-Jul-98	Gravelly Bulkhead	Nylon	1	-	-
1998	04-Aug-98	Swallowtail	Nylon	1	44.7904	66.6703
1999	23-Jul-99	Wolves	Mixed	1	44.9117	66.7550
1999	23-Aug-99	Wolves	Nylon	1	44.9067	66.7767
1999	14-Sep-99	Wolves	Mixed	1	44.9117	66.7450
2000	28-Jul-00	Swallowtail	Nylon	1	44.8125	66.6960
2000	01-Aug-00	Swallowtail	Nylon	1	44.8323	66.6877
2000	09-Aug-00	Swallowtail	Nylon	1	44.8208	66.7127
2000	11-Aug-00	Swallowtail	Nylon	1	44.1467	66.7198
2000	11-Aug-00	Swallowtail	Nylon	1	44.8032	66.7079
2001	10-Jul-01	Swallowtail	Barium-sulphate	1	44.8168	66.7047
2001	14-Jul-01	Swallowtail	Nylon	1	44.7983	66.6837
2001	14-Jul-01	Swallowtail	Nylon	1	44.8001	66.7032
2001	16-Jul-01	Swallowtail	Nylon	1	44.7964	66.6826
2001	16-Jul-01	Swallowtail	Nylon	1	44.7996	66.7004
2001	16-Jul-01	Swallowtail	Nylon	2	44.7992	66.6945
2001	16-Jul-01	Swallowtail	Barium-sulphate	1	44.8134	66.7121
2001	16-Jul-01	Swallowtail	Nylon	1	44.7993	66.7002
2001	16-Jul-01	Swallowtail	Barium-sulphate	1	44.8082	66.6945
2001	17-Jul-01	Swallowtail	Nylon	2	44.7978	66.6949
2001	17-Jul-01	Swallowtail	Barium-sulphate	1	44.8010	66.7164
2001	17-Jul-01	Swallowtail	Barium-sulphate	1	44.8067	66.6835
2001	18-Jul-01	Swallowtail	Nylon	1	44.7985	66.6837
2001	18-Jul-01	Swallowtail	Nylon	1	-	-
2001	20-Jul-01	Swallowtail	Barium-sulphate	1	44.8090	66.6762
			Subtotal	30		

Table 4 (cont.).

Year	Date	Area	Mesh	Porpoise	Latitude (°N)	Longitude (°W)
2001	20-Jul-01	Swallowtail	Nylon	3	44.8017	66.6937
2001	20-Jul-01	Swallowtail	Barium-sulphate	1	44.8188	66.7042
2001	21-Jul-01	Swallowtail	Nylon	1	44.7967	66.6872
2001	21-Jul-01	Swallowtail	Barium-sulphate	1	44.7971	66.6821
2001	21-Jul-01	Swallowtail	Barium-sulphate	1	44.8018	66.6903
2001	30-Jul-01	Swallowtail	Nylon	1	44.7991	66.6954
2001	11-Aug-01	Swallowtail	Nylon	1	44.8368	66.6985
2001	15-Aug-01	Swallowtail	Barium-sulphate	1	44.8074	66.6986
2001	16-Aug-01	Swallowtail	Barium-sulphate	1	44.8088	66.6926
2001	18-Aug-01	Swallowtail	Nylon	2	44.7995	66.7013
2001	29-Aug-01	Swallowtail	Nylon	1	44.8362	66.7065
2001	01-Sep-01	Swallowtail	Barium-sulphate	1	44.8333	66.6983
2001	04-Sep-01	Swallowtail	Barium-sulphate	1	44.8096	66.7152
2001	05-Sep-01	Swallowtail	Nylon	1	44.8096	66.7152
2001	05-Sep-01	Swallowtail	Nylon	1	44.8029	66.6983
2001	06-Sep-01	Swallowtail	Nylon	1	44.8020	66.6977
2001	07-Sep-01	Swallowtail	Barium-sulphate	1	44.7540	66.7224
2001	08-Sep-01	Swallowtail	Barium-sulphate	1	44.7936	66.7149
2001	10-Sep-01	Swallowtail	Barium-sulphate	1	44.7908	66.6894
			Total	52		

Table 5. Observed effort (trips observed) and porpoise catches of both nylon and barium-sulphate gillnet mesh nets from 1998-2001.

1998

		Trips (#)		Catch (#)		Catch Rate (Porpoises/Trip)	
Season	Location	Nylon	Barium-sulphate	Nylon	Barium-sulphate	Nylon	Barium-sulphate
July 1-15	Swallowtail	10	10	3	0	0.3000	0.0000
July 16-31	Swallowtail	14	19	0	0	0.0000	0.0000
Aug 1-15	Swallowtail	6	4	1	0	0.1667	0.0000
Aug 16-31	Swallowtail	2	2	0	0	0.1667	0.0000
July 16-31	Wolves	4	1	0	0	0.0000	0.0000
Aug 1-15	Wolves	6	5	0	0	0.0000	0.0000
Aug 16-31	Wolves	3	2	0	0	0.0000	0.0000
July 1-15	Gravelly Bulkhead	2	0	1	0	0.5000	0.0000
July 16-31	Gravelly Bulkhead	2	0	0	0	0.0000	0.0000
Aug 1-15	Gravelly Bulkhead	3	0	0	0	0.0000	0.0000
Aug 16-31	Gravelly Bulkhead	3	2	0	0	0.0000	0.0000
Sep 1-15	Gravelly Bulkhead	1	1	0	0	0.0000	0.0000
July 1-15	Head & Horns	1	1	0	0	0.0000	0.0000
July 16-31	Head & Horns	1	1	0	0	0.0000	0.0000
Aug 1-15	Head & Horns	2	0	0	0	0.0000	0.0000
July 16-31	Grand Manan Banks	2	1	0	0	0.0000	0.0000
	Total	62	49	5	0		

Table 5 (cont.)

1999

		Trips (#)			Catch (#)			Catch Rate (Porpoises/Trip)		
Season	Location	Nylon	Barium-sulphate	Mixed	Nylon	Barium-sulphate	Mixed	Nylon	Barium-sulphate	Mixed
July 1-15	Wolves	6	6	4	0	0	0	0.0000	0.0000	0.0000
July 16-31	Wolves	9	0	10	0	0	1	0.0000	0.0000	0.1000
Aug 1-15	Wolves	2	0	0	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Wolves	3	0	0	1	0	0	0.3333	0.0000	0.0000
Sep 1-15	Wolves	5	0	5	0	0	1	0.0000	0.0000	0.2000
Aug 1-15	Basin	1	1	1	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Basin	2	2	1	0	0	0	0.0000	0.0000	0.0000
Aug 1-15	Digby Neck	3	3	1	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Digby Neck	11	10	7	0	0	0	0.0000	0.0000	0.0000
	Totals	42	22	29	1	0	2			

Table 5 (cont.)

2000

		Trips (#)		Catch (#)		Catch Rate (Porpoises/Trip)	
Season	Location	Nylon	Barium-sulphate	Nylon	Barium-sulphate	Nylon	Barium-sulphate
July 16-31	Swallowtail	31	21	1	0	0.0323	0.0000
Aug 1-15	Swallowtail	44	44	4	0	0.0909	0.0000
Aug 16-31	Swallowtail	26	26	0	0	0.0000	0.0000
Sep 1-15	Swallowtail	1	1	0	0	0.0000	0.0000
	Total	102	92	5	0		

2001

July 1-15	Swallowtail	18	18	2	1	0.1111	0.0556
July 16-31	Swallowtail	39	38	14	8	0.3590	0.2105
Aug 1-15	Swallowtail	27	29	1	1	0.0370	0.0345
Aug 16-31	Swallowtail	35	35	3	1	0.0857	0.0286
Sep 1-15	Swallowtail	22	24	3	5	0.1364	0.2083
	Total	141	144	23	16		

Table 6. Observed effort (strings observed) and porpoise catches of both nylon and barium-sulphate gillnet mesh nets from 1998-2001.

1998

		Trips (#)		Catch (#)		Catch Rate (Porpoises/String)	
Season	Location	Nylon	Barium-sulphate	Nylon	Barium-sulphate	Nylon	Barium-sulphate
July 1-15	Swallowtail	31	12	3	0	0.0968	0.0000
July 16-31	Swallowtail	45	27	0	0	0.0000	0.0000
Aug 1-15	Swallowtail	19	5	1	0	0.0526	0.0000
Aug 16-31	Swallowtail	7	2	0	0	0.0000	0.0000
July 16-31	Wolves	19	1	0	0	0.0000	0.0000
Aug 1-15	Wolves	24	5	0	0	0.0000	0.0000
Aug 16-31	Wolves	9	2	0	0	0.0000	0.0000
July 1-15	Gravelly Bulkhead	5	0	1	0	0.2000	0.0000
July 16-31	Gravelly Bulkhead	2	0	0	0	0.0000	0.0000
Aug 1-15	Gravelly Bulkhead	3	0	0	0	0.0000	0.0000
Aug 16-31	Gravelly Bulkhead	6	2	0	0	0.0000	0.0000
Sep 1-15	Gravelly Bulkhead	3	2	0	0	0.0000	0.0000
July 1-15	Head & Horns	3	1	0	0	0.0000	0.0000
July 16-31	Head & Horns	2	1	0	0	0.0000	0.0000
Aug 1-15	Head & Horns	6	0	0	0	0.0000	0.0000
July 16-31	Grand Manan Banks	4	1	0	0	0.0000	0.0000
	Total	188	61	5	0		

Table 6 (cont).

1999

		Trips (#)			Catch (#)			Catch Rate (Porpoises/String)		
Season	Location	Nylon	Barium-sulphate	Mixed	Nylon	Barium-sulphate	Mixed	Nylon	Barium-sulphate	Mixed
July 1-15	Wolves	16	8	6	0	0	0	0.0000	0.0000	0.0000
July 16-31	Wolves	22	0	26	0	0	1	0.0000	0.0000	0.0385
Aug 1-15	Wolves	8	0	0	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Wolves	12	0	0	1	0	0	0.0833	0.0000	0.0000
Sep 1-15	Wolves	20	0	9	0	0	1	0.0000	0.0000	0.1111
Aug 1-15	Basin	2	3	2	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Basin	23	13	3	0	0	0	0.0000	0.0000	0.0000
Aug 1-15	Digby Neck	3	3	1	0	0	0	0.0000	0.0000	0.0000
Aug 16-31	Digby Neck	26	10	7	0	0	0	0.0000	0.0000	0.0000
	Totals	132	37	54	1	0	2			

2000

		Trips (#)		Catch (#)		Catch Rate (Porpoises/String)	
Season	Location	Nylon	Barium-sulphate	Nylon	Barium-sulphate	Nylon	Barium-sulphate
July 16-31	Swallowtail	46	25	1	0	0.0217	0.0000
Aug 1-15	Swallowtail	84	51	4	0	0.0476	0.0000
Aug 16-31	Swallowtail	80	49	0	0	0.0000	0.0000
Sep 1-15	Swallowtail	2	2	0	0	0.0000	0.0000
	Total	212	127	5	0		

2001

		Trips (#)		Catch (#)		Catch Rate (Porpoises/String)	
Season	Location	Nylon	Barium-sulphate	Nylon	Barium-sulphate	Nylon	Barium-sulphate
July 1-15	Swallowtail	49	50	2	1	0.0408	0.0200
July 16-31	Swallowtail	112	111	14	8	0.1250	0.0721
Aug 1-15	Swallowtail	75	87	1	1	0.0133	0.0115
Aug 16-31	Swallowtail	92	99	3	1	0.0326	0.0101
Sep 1-15	Swallowtail	60	68	3	5	0.0500	0.0735
	Total	388	415	23	16		

Table 7. Porpoise catch rates adjusted from catch per string to catch per trip (five strings per trip) from 1998-2001.

1998

Season	Location	Nylon Catch Rate (Porpoises/Trip)	Barium-sulphate Catch Rate (Porpoises/Trip)
July 1-15	Swallowtail	0.4839	0.0000
July 16-31	Swallowtail	0.0000	0.0000
Aug 1-15	Swallowtail	0.2632	0.0000
Aug 16-31	Swallowtail	0.0000	0.0000
July 16-31	Wolves	0.0000	0.0000
Aug 1-15	Wolves	0.0000	0.0000
Aug 16-31	Wolves	0.0000	0.0000
July 1-15	Head & Horns	0.0000	0.0000
July 16-31	Head & Horns	0.0000	0.0000
Aug 1-15	Head & Horns	0.0000	0.0000
July 1-15	Gravelly	1.0000	0.0000
July 16-31	Gravelly	0.0000	0.0000
Aug 1-15	Gravelly	0.0000	0.0000
Aug 16-31	Gravelly	0.0000	0.0000
Sep 1-15	Gravelly	0.0000	0.0000
July 16-31	Banks	0.0000	0.0000

1999

Season	Location	Nylon Catch Rate (Porpoises/Trip)	Barium-sulphate Catch Rate (Porpoises/Trip)	Mixed Catch Rate (Porpoises/Trip)
Aug 1-15	Basin	0.0000	0.0000	0.0000
Aug 16-31	Basin	0.0000	0.0000	0.0000
Aug 1-15	Digby Neck	0.0000	0.0000	0.0000
Aug 16-31	Digby Neck	0.0000	0.0000	0.0000
July 1-15	Wolves	0.0000	0.0000	0.0000
July 16-31	Wolves	0.0000	0.0000	0.1923
Aug 1-15	Wolves	0.0000	0.0000	0.0000
Aug 16-31	Wolves	0.4167	0.0000	0.0000
Sep 1-22	Wolves	0.0000	0.0000	0.5556

Table 7 (cont.)

2000

Season	Location	Nylon Catch Rate (Porpoises/Trip)	Barium-sulphate Catch Rate (Porpoises/Trip)
July 16-31	Swallowtail	0.1087	0.0000
Aug 1-15	Swallowtail	0.2381	0.0000
Aug 16-31	Swallowtail	0.0000	0.0000
Sep 1-15	Swallowtail	0.0000	0.0000

2001

Season	Location	Nylon Catch Rate (Porpoises/Trip)	Barium-sulphate Catch Rate (Porpoises/Trip)
July 1-15	Swallowtail	0.2041	0.1000
July 16-31	Swallowtail	0.6250	0.3604
Aug 1-15	Swallowtail	0.0667	0.0575
Aug 16-31	Swallowtail	0.1630	0.0505
Sep 1-15	Swallowtail	0.2500	0.3676

Table 8. Observed catch rates (porpoises/trip) used to calculate proportional catch rates between fishing grounds.

1994

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15						
July 16-31	0.5000	0.0833		0.0000	0.0000	0.0000
Aug 1-15	0.5500	0.5000		0.5000	0.0909	0.0000
Aug 16-31	0.6111	0.6111		1.0000	0.0000	0.0000
Sep 1-15	0.2000	0.2000		0.0000	0.0000	0.0000
Sep 16-30						

1995

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	0.3864					
July 16-31						
Aug 1-15						
Aug 16-31						
Sep 1-15	0.3636					
Sep 16-30						

1997

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15						
July 16-31						
Aug 1-15	0.2391	0.0000		0.4706		
Aug 16-31						
Sep 1-15						
Sep 16-30						

1998

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	0.4839		1.0000			0.0000
July 16-31	0.0000	0.0000	0.0000			0.0000
Aug 1-15	0.2632	0.0000	0.0000			0.0000
Aug 16-31	0.0000	0.0000	0.0000			
Sep 1-15			0.0000			
Sep 16-30						

Table 8 (cont.)

1999

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15		0.0000				
July 16-31		0.0000				
Aug 1-15		0.0000				0.0000
Aug 16-31		0.4167				0.0000
Sep 1-15		0.0000				
Sep 16-30		0.0000				

2000

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15						
July 16-31	0.1087					
Aug 1-15	0.2381					
Aug 16-31	0.0000					
Sep 1-15	0.0000					
Sep 16-30						

2001

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	0.2041					
July 16-31	0.6250					
Aug 1-15	0.0667					
Aug 16-31	0.1630					
Sep 1-15	0.2500					
Sep 16-30						

Table 9. Mean ratio of observed catch rates in each fishing area (or season) relative to Swallowtail catch rates (or Aug 1-15). N = number of seasonal pairs between a particular fishing area and Swallowtail for which the mean ratio of catch rates could be calculated.

Mean ratio relative to Swallowtail

Location	Mean Proportion of Swallowtail	N	Standard Error
Wolves	0.4849	6	0.2092
Gravelly Bulkhead	1.1810	2	1.0229
Head Harbour	1.3591	5	0.3984
Channel	0.0615	4	0.0468

Mean ratio relative to Aug 1-15 within Swallowtail

Season	Mean Proportion of Aug 1-15	N	Standard Error
July 1-15	2.7406	2	0.5378
July 16-31	2.8997	4	2.2922
Aug 15-31	0.7127	4	0.5854
Sep 1-15	1.2053	3	1.1730

Table 10. Mean catch rates (porpoises/trip) calculated from observed catch rates between Swallowtail and other fishing grounds. Numbers in bold italics indicate catch rates were calculated from observed data. Numbers not in bold italics were calculated by pro-rating standard catch rates.

1998

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	***0.4839***	0.2346	***1.0000***	0.6576	0.0298	***0.0000***
July 16-31	***0.0000***	***0.0000***	***0.0000***	0.0000	0.0000	***0.0000***
Aug 1-15	***0.2632***	***0.0000***	***0.0000***	0.3577	0.0162	***0.0000***
Aug 16-31	***0.0000***	***0.0000***	***0.0000***	0.0000	0.0000	0.0000
Sep 1-15	0.3172	0.1538	***0.0000***	0.4311	0.4311	0.0000

1999

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	0.0000	***0.0000***	0.0000	0.0000	0.0000	0.0000
July 16-31	0.0000	***0.0000***	0.0000	0.0000	0.0000	0.0000
Aug 1-15	0.0000	***0.0000***	0.0000	0.0000	0.0000	***0.0000***
Aug 16-31	0.8593	***0.4167***	1.0148	1.1679	0.0528	***0.0000***
Sep 1-15	0.0000	***0.0000***	0.0000	0.0000	0.0000	0.0000

2000

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	0.6525	0.3164	0.7706	0.8868	0.0401	0.0000
July 16-31	***0.1087***	0.0527	0.1284	0.1477	0.0067	0.0000
Aug 1-15	***0.2381***	0.1155	0.2812	0.3236	0.0146	0.0000
Aug 16-31	***0.0000***	0.0000	0.0000	0.0000	0.0000	0.0000
Sep 1-15	***0.0000***	0.0000	0.0000	0.0000	0.0000	0.0000

2001

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other
July 1-15	***0.2041***	0.0990	0.2410	0.2774	0.0033	0.0000
July 16-31	***0.6250***	0.3031	0.7381	0.8494	0.0101	0.0000
Aug 1-15	***0.0667***	0.0323	0.0787	0.0906	0.0011	0.0000
Aug 16-31	***0.1630***	0.0791	0.1926	0.2216	0.0026	0.0000
Sep 1-15	***0.2500***	0.1212	0.2953	0.3398	0.0040	0.0000

Table 11. Total estimated porpoise by-catch in the lower Bay of Fundy demersal gillnet fishery from 1998-2001. Numbers in parentheses is proportion of annual estimated by-catch (small rounding errors may be present).

1998

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
July 1-15	20 (0.526)	0	5 (0.132)	4 (0.105)	0	0	29 (0.763)
July 16-31	0	0	0	0	0	0	0
Aug 1-15	4 (0.105)	0	0	1 (0.026)	0	0	5 (0.132)
Aug 16-31	0	0	0	0	0	0	0
Sep 1-15	4 (0.105)	0	0	0	0	0	4 (0.105)
Total	28 (0.737)	0	5 (0.132)	5 (0.132)	0	0	**38**

1999

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
July 1-15	0	0	0	0	0	0	0
July 16-31	0	1 (0.031)	0	0	0	0	1 (0.031)
Aug 1-15	0	0	0	0	0	0	0
Aug 16-31	14 (0.438)	4 (0.125)	3 (0.094)	9 (0.281)	0	0	30 (0.938)
Sep 1-15	0	1 (0.031)	0	0	0	0	1 (0.031)
Total	14 (0.438)	6 (0.188)	3 (0.094)	9 (0.281)	0	0	**32**

2000

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
July 1-15	8 (0.286)	1 (0.036)	6 (0.214)	0	0	0	15 (0.536)
July 16-31	1 (0.036)	1 (0.036)	4 (0.143)	1 (0.036)	0	0	7 (0.250)
Aug 1-15	4 (0.143)	1 (0.036)	1 (0.036)	0	0	0	6 (0.214)
Aug 16-31	0	0	0	0	0	0	0
Sep 1-15	0	0	0	0	0	0	0
Total	13 (0.464)	3 (0.107)	11 (0.393)	1 (0.036)	0	0	**28**

2001

Season	Swallowtail	Wolves	Gravelly Bulkhead	Head Harbour	Channel	Other	Total
July 1-15	9 (0.123)	1 (0.014)	4 (0.055)	2 (0.027)	0	0	16 (0.219)
July 16-31	31 (0.425)	6 (0.082)	3 (0.041)	1 (0.014)	0	0	41 (0.562)
Aug 1-15	3 (0.041)	1 (0.014)	0	0	0	0	4 (0.055)
Aug 16-31	4 (0.055)	0	0	0	0	0	4 (0.055)
Sep 1-15	8 (0.110)	0	0	0	0	0	8 (0.110)
Total	55 (0.753)	8 (0.110)	7 (0.096)	3 (0.041)	0	0	**73**

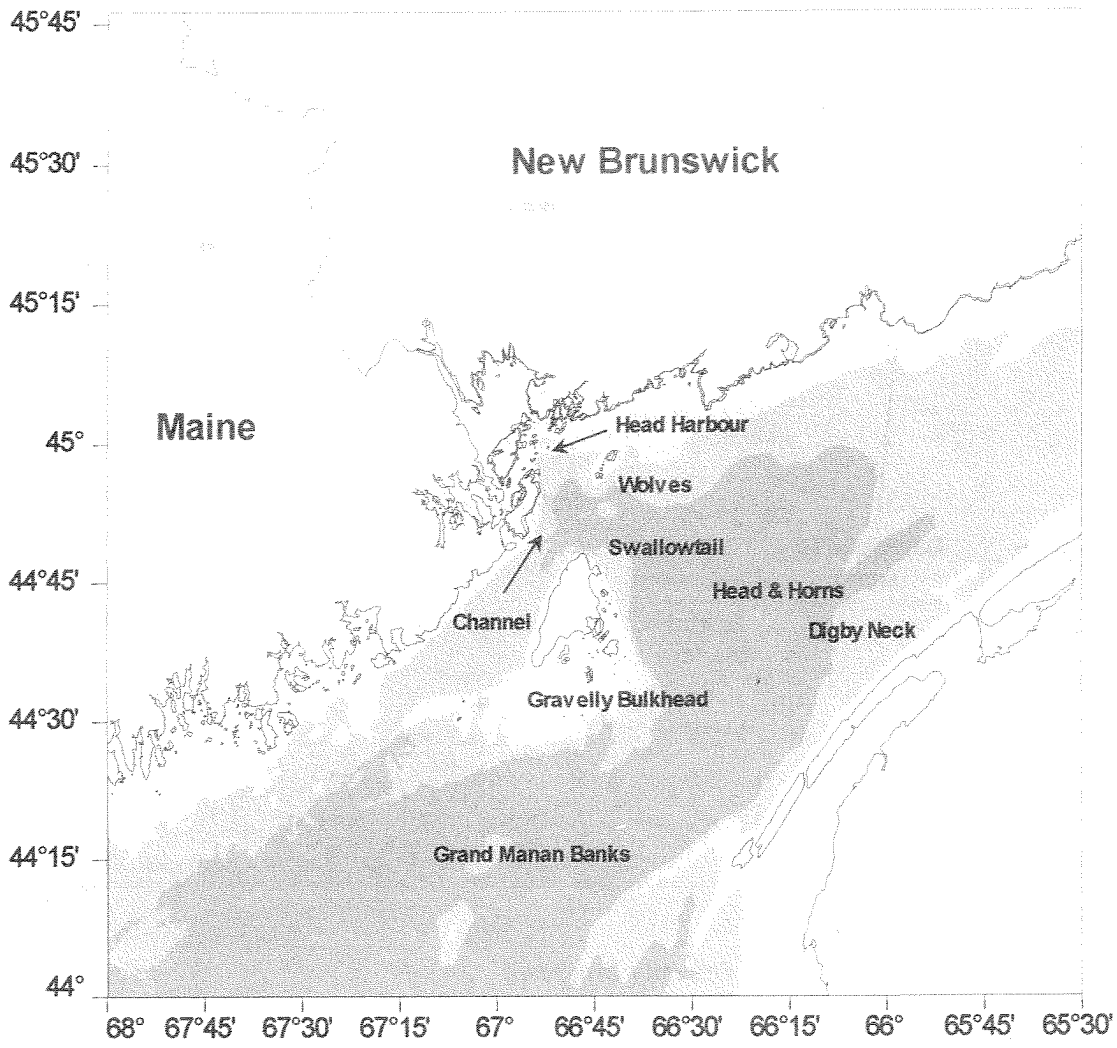

Fig. 1. Map of lower Bay of Fundy listing areas of traditional fishing grounds.

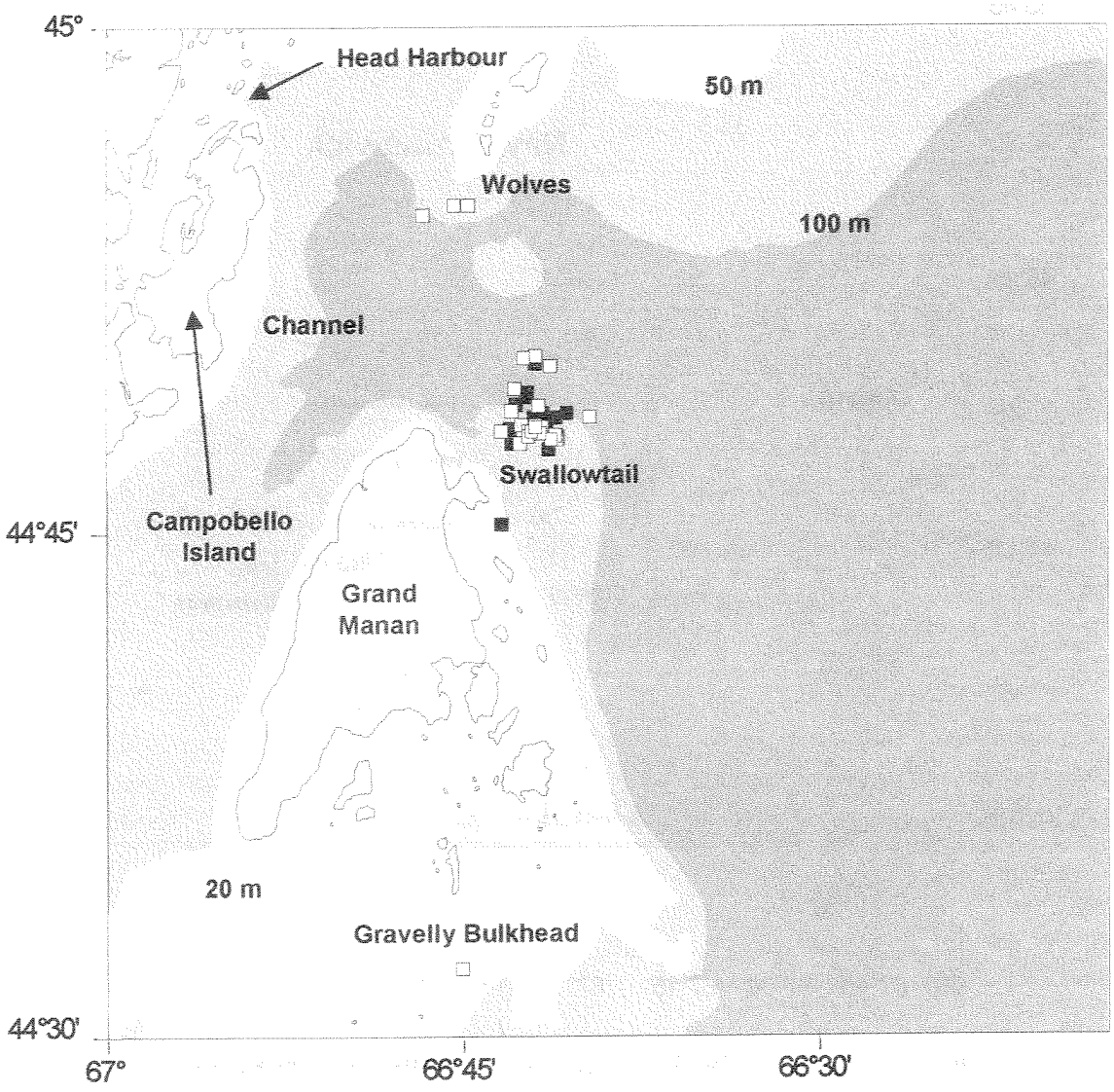

Fig. 2. Map of all observed porpoise mortalities in the lower Bay of Fundy demersal gillnet fishery from 1998-2001 (n=52, some overlap exists). White squares represent mortalities in 100% nylon-mesh nets while solid squares represent mortalities in barium-sulphate nets. Fishing areas used to partition effort for the estimation of by-catch are indicated.

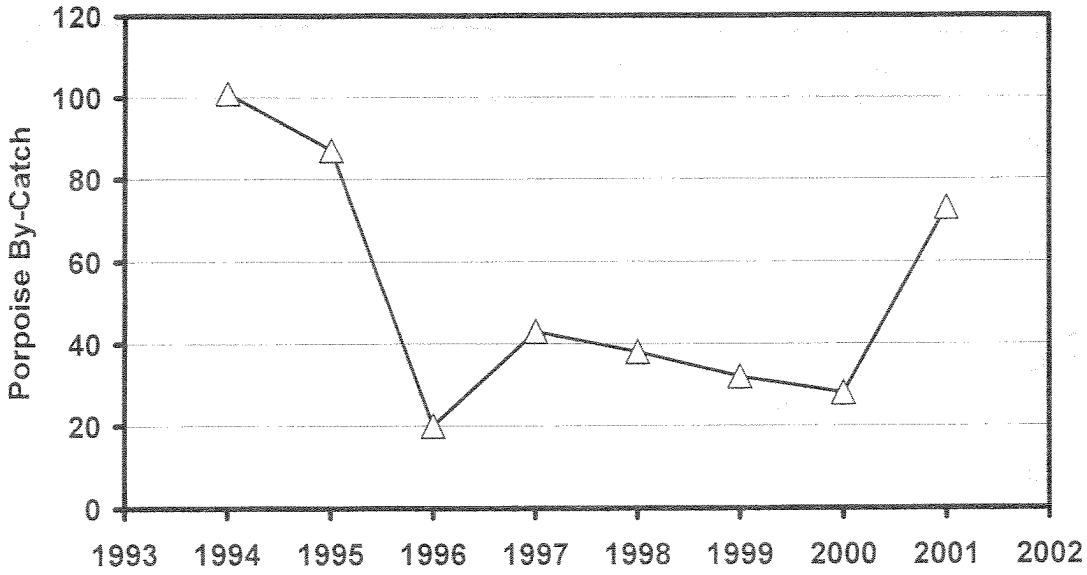

Fig. 3. Total estimated porpoise by-catch in the lower Bay of Fundy demersal gillnet fishery from 1994-2001.

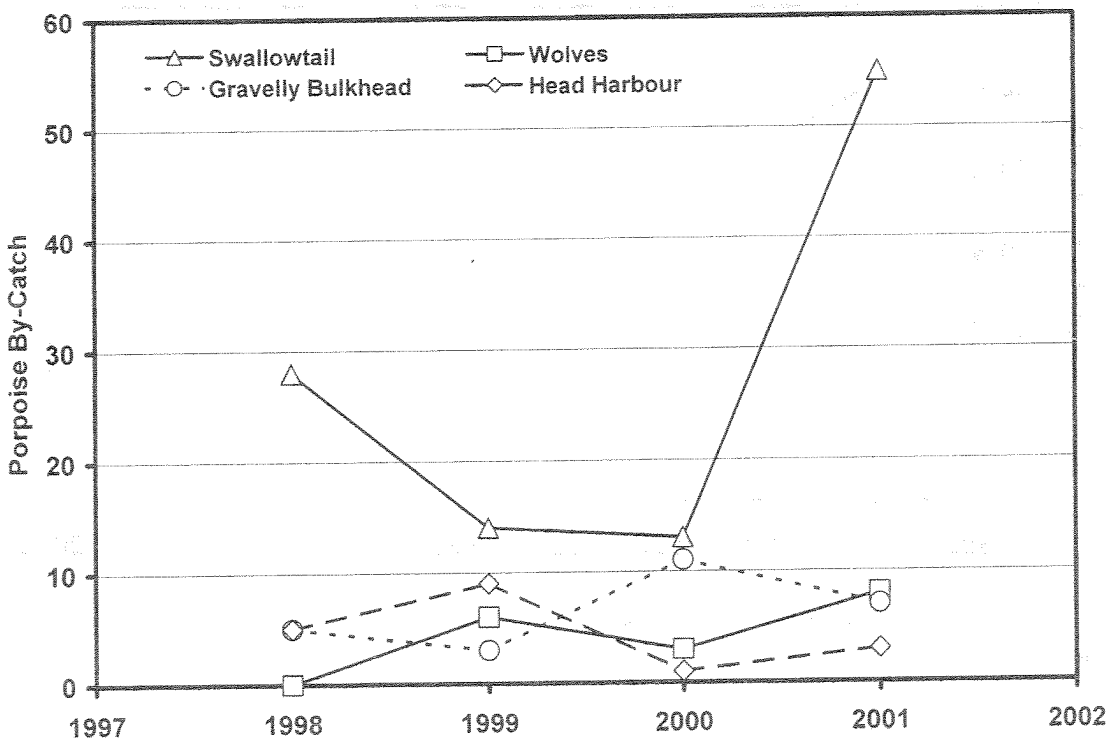

Fig. 4. Temporal trends in estimated porpoise by-catch in the lower Bay of Fundy demersal gillnet fishery from 1998-2001 within four fishing grounds.

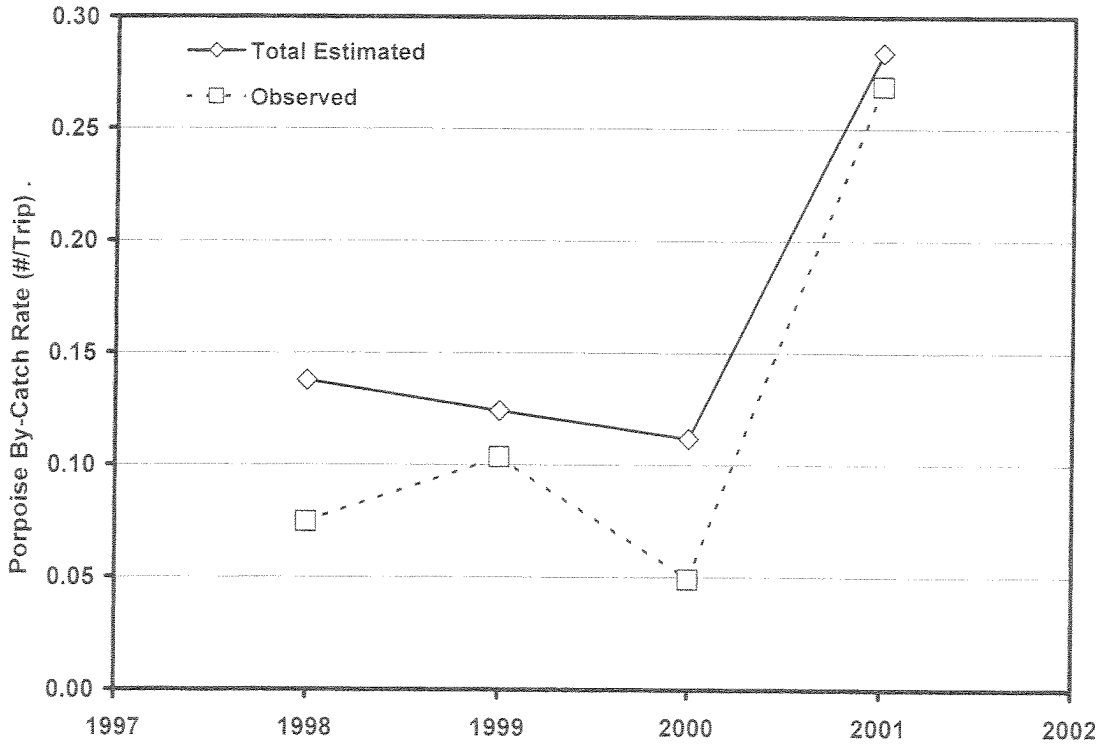

Fig. 5. Temoral trends in observed and total estimated porpoise by-catch rate in the lower Bay of Fundy demersal gillnet fishery from 1998-2001.