Entrapments in Fishing Gear and Strandings in Newfoundland and Labrador Reported to the Entrapment Assistance Program During 1994.

A Report to the Department of Fisheries and Oceans and the Atlantic Fisheries Adjustment Program

15 March 1995

by

Jon Lien, Dwayne Pittman, Catherine Hood,
Christoph Richter, Diane Borggaard, Fernanda Marques, Sean Todd

Whale Research Group
Ocean Sciences Centre and Department of Psychology
Memorial University of Newfoundland
St. John's, Newfoundland A1C 5S7

Summary

Because of fishery closures reduction of fishing effort resulted in fewer entrapments of whales and sharks in inshore fishing gear during 1994 compared to previous years. Only 21 humpback whales and 3 minke whales were reported entrapped in gear. There were 5 species of large sharks reported entrapped. In addition a total of 20 strandings were reported.

During 1994 the third year a census of humpback whales (YoNAH) was completed. Over 150 humpbacks were individually identified by photograph, and biopsies were obtained from over 50.

Tests investigated the use of acoustical devices to minimize the take of cetaceans in fishing gear in Newfoundland, Australia, and the Bay of Fundy. Tests completed on groundfish gillnets indicate that adding noise to nets holds promise as a method of reducing incidental catches. New acoustic alarms were developed to meet requirements of new fisheries and species. There were intensive efforts to apply acoustic alarm technology to fisheries in many countries.

Finally, educational activities of the Whale Research Group included distribution of educational materials, school visits and the distribution of previously produced videos.

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Acknowledgements

Funds for the Entrapment Assistance Program were provided by the Atlantic Fisheries Adjustment Program (AFAP). We would especially like to thank Jim Ploughman and Eric Way for their help. Dawn Mitchell, Sean Todd, Wayne Barney, O.J. Lien, Fernanda Marques, Helene Van Doninck, Frank Hinlopen and many D.F.O. officers helped in the field. Special thanks go to the C.B.C. Fisheries Broadcast for informing fishermen about the program. Finally, cooperation of fishermen with the program deserves mention. The Entrapment Assistance Program works because they want it and put so much of themselves into the program. They are thanked and congratulated for their contributions. Provincial vets, especially Hugh Whitney, Richard Taylor, Andrew Peacock and Robert Hudson all assisted us during strandings; their contribution is welcomed and acknowledged.

Funds for the acoustic alarm work, in addition to those of the AFAP, came from Fisheries and Oceans - Ottawa and the Department of Fisheries and Aquaculture, Government of New Brunswick.

Volunteer observers for the alarm experiment at Grand Manan, N.B. were Kazumi Arai, Arlene Benham, Rachel Bryant, Silvia Caicedo, Ben Laurel, Elling Lien, Daniel Palahniuk, Amy Salmela and Mireille Sampson. Dawn Mitchell helped with lab logistics and data management. They all deserve thanks.

Skippers of fishing crews participating in the tests and discussions were George Brown, Mendell Frost, Ted Frost, Fred Green, Walter Green, Philip O'Neil, Jackie Rayner, and Barry Urghart. We acknowledge that this is their experiment and thank them for their fine work. It was exciting for us to watch the strengthening bonds between fishermen and researchers; these were signalled when fishermen offered crew positions to observers for the lobster fishery, and by the unreserved admiration that observers expressed for the fishermen they worked with. We believe that developing such relationships are a key to solving many of the numerous problems which plague fisheries. We would also like to thank Ron Cronk of the Department of Fisheries and Aquaculture for all his humour and help. Sean Sanson of the Department of Fisheries and Oceans also provided much valued assistance during the Grand Manan experiment for which we are very grateful.

For our alarm experiments at the Hibernia construction site in Trinity Bay the help of Jack Temple, Dave Taylor and David Day contributed immeasurably and were greatly appreciated.

Work to be Performed

There were five aspects to the work performed during 1993-1994 including: (1) the Entrapment Assistance Program; (2) a census of humpback whales; (3) experimental work evaluating net modifications to minimize cetacean entrapments in fishing gear; (4) continued development of acoustic alarm technology and its use in other fisheries and (5) educational programs.

(l) <u>The Entrapment Assistance Program:</u>

The Entrapment Assistance Program has operated continuously since 1979 to assist inshore fishermen of Newfoundland and Labrador with whale and shark problems. Large whales and sharks collide with fishing gear and become entrapped; removing them quickly and safely is difficult for fishermen. The program is designed to assist fishermen in minimizing gear and down-time losses which occur when these large animals collide with and become entrapped by fishing gear, and to minimize unnecessary mortality to whales that become entrapped.

Results of the Entrapment Assistance Program from previous years have been summarized in annual reports to the Department of Fisheries and Oceans and the Newfoundland and Labrador Department of Fisheries (Lien 1980; Lien and Aldrich 1982; Lien et al. 1982; 1983; 1984; 1985; 1986; 1987; 1988; 1989; Lien 1990; 1991; 1992; 1993; 1994).

During 1994 the Entrapment Assistance Program operated using methods similar to those of previous years (Lien 1994). The program was widely advertized by a variety of publications and advertisements, through Fisheries and Oceans field offices, by Nfld./Lab. Dept. of Fisheries field workers, mailings to fishermen and local media.

Fishermen could call a 24-hour, toll-free phone service for advice and assistance with problem whales and sharks. If assistance was needed, a crew was dispatched to help remove the entrapped animal as quickly as possible. Calls were received which reported a variety of problems in addition to the entrapment of whales and sharks. These calls included marine mammal strandings and ice entrapments of cetaceans.

Results of the Entrapment Assistance Program: There were a total of 59 calls received during 1994 that required assistance. Twenty-one of the entrapment calls involved humpbacks, 3 were concerned with minke whales, 1 with other cetacean species in fishing gear. There were also a total of 20 calls which reported strandings of cetaceans or seals, and 14 reporting shark captures.

Of the 21 humpbacks reported entrapped, 6 died (28%) as a result of the entrapment (Table 1). Most entrapments occurred in gillnets (48%). Other humpback entrapments involved a variety of gear types.

Only 5 minke whales were caught, most in gillnets (40%) and capelin traps (40%). Three died (60%) as a result of entrapment (Table 2). One other entrapment report, on 28 April, involved a beluga whale caught in a herring net near Lewisport, N.D.B. It was released alive.

There were a total of 20 strandings reported during the year. Most commonly these involved sick or injured harp seals. Cetacean species reported include white-beaked dolphin (n = 5), white-sided dolphin (n = 2), and a lone harbour porpoise and sperm whale. Two of the strandings with dolphins occurred because of ice entrapment (Table 3).

Five species of sharks were reported incidentally caught in fishing gear during 1994. Species included blue (n = 7), basking sharks (n = 2), and single Greenland, porbeagle and thresher sharks.

Table 1. Entrapments of humpback whales reported during 1994.

Date	Location	Gear	Comments
June 14	Holyrood, C.B.	gillnets	towed gear off
21	Baie Verte, W.B.	lumpfish	released alive
23	Lords' Cove, B.P.	gillnets	dead
July 13	Deer Is. Cv., T.B.	gillnets	dead
17	Trepassey	gillnets	dead
18	Baie de Verde	gillnets	towing nets
18	Cape Spear	rope	towed off
31	St. Brides	flounder	released alive
22	St. Marys	unknown	dead
29	St. Marys	flounder	released alive
29	St. Brides	flounder	released alive
31	Little Bay, NDB	gillnets	towed gear off
Aug. 4	Perry's Cv., C.B.	gillnets	towed gear off
4	Elliston	flounder	partial release,
9	Normans Cv., T.B.	unknown	dead
9	Chapel Arm, T.B.	moorings	dead
9	Sops Arm, W.B.	moorings	released alive
9	Middle Cove	moorings	released alive
11	Kelligrews, C.B.	gillnets	self release
14	Pinware, Lab.	flounder	towed gear off
Dec. 4	Twillingate	squid trap	released alive

Table 2: Minke whales reported entrapped during 1994.

Date	Location	Gear	Comments
June 20	Farewell, Fogo	lumpfish	dead
July 14	Random Is., T.B.	capelin trap	dead
29	Rocky Hbr.	capelin trap	dead
Aug. 11	Catalina, T.B.	flounder nets	released alive
19	St. Phillips, CB	exp. gear	self-release

Table 3: Strandings reported during 1994.

Date	Location	Species	Comment
Jan. 3	Branch	wt.-sided dolphin	dead
3	Partridge Cv.	harbour porpoise	dead
23	Margaree	wt.-beaked dolphins	25 in ice;no mortality
10	Arnolds Cv.	wt.-sided dolphin	dead - sampled
May 4	Harbour Beach	wt.-beaked dolphin	3 caught in ice
June 21	Hamilton Sd.	large whale (spp.?)	dead, floating .
Nov. 7	Harbour Main	harp seal	went off alive
16-26	Many seal strandings reported: Killigrews, C.B., Spaniards Bay, C.B. Bonavista, Bay Bulls, Killigrews, C.B. Mobil, Bauline S., Outter Cove		
Dec. 2	Bell Is., C.B.	harp seal	alive; killed
20	Northern Bay,CB	wt.-beaked dolphin	dead
21	Renews	wt.-beaked dolphin	dead
Jan. 5	Bellvue Beach	wt.-beaked dolphin	alive; killed

March 6	Fortune	sperm whale	dead 15 m male

Table 4: Shark captures incidental to fishing operations reported to the Entrapment Assistance Program during 1994.

Date	Location	Spp. and Comments
June 20	Bauline	Greenland shark - 3 seals in stomach
Aug. 1	Bonavista	6 m basking shark in flounder nets
4	Boat Hbr., PB	3.2 m porbeagle in flounder nets
16	Hermitage	3.4 m blue in mackerel net
24	St. Brides	blue shark in flounder nets
25	Upper Is. Cv.	3.5 m basking shark in flounder nets
Sept. 1	Leading Tickles	4 m blue shark in mackerel net
20	Portugal Cv. S	blue shark in flounder net
23	Salvage, BB.	2 m blue shark
Oct. 4	Seal Cv., CB.	4.4. m thresher shark in herring net
Nov. 1	Leading Tickles	2 m blue shark in squid trap
14	Glovertown, BB.	3.5 m blue shark

Table 5: Misc. sightings of interest reported during 1994.

Date	Location	Species	Comment
April 15	Middle Cove	beluga	75-100 m offshore
28	Lewisport	beluga	caught in gear briefly
June 16	near Hermitage	bottlenose (?)	reported but could not verify
July 12	St. Vincent's	right whale	sighted again on 16th

18	Cape Spear	6-7 orca	stayed in area several days
20	Bell Is., CB.	2 orca	also seen on 13 July; 1 male, 1 female
Jan. 6	Lords Cove	6 orca	in area several days

Unusual sightings were reported to the Entrapment Assistance Program from time to time. These are summarized in Table 5.

(2) A Census of Humpback Whales:

YoNAH (Years of the North Atlantic Humpback) is a coordinated census effort by the US, Canada, Greenland, Iceland, Denmark, and Norway to study the humpback population of the North Atlantic. This population congregates in Caribbean waters for breeding in winter and then migrates to distinct feeding areas throughout the North Atlantic in summer. The goal of the project is to determine abundance, and to understand stock structure.

A total of 717 photo-identifications and 220 biopsies were obtained for Eastern Canada during 1993; 550 photo-identifications and 182 biopsies were obtained during 1993.

During the field season in 1994 a total of 154 identifications were obtained, along with 51 biopsies. Effort was concentrated in northeastern Newfoundland. Results from all three years are presently being analyzed.

(3) Tests of "Alarms" to Prevent Accidental Entrapments:

3(A) Tests to reduce harbour porpoise by-catch in groundfish gillnets in the Bay of Fundy, N.B.

Accidental catches of whales, dolphins and porpoise in fishing gear are an emotional issue for many people. As a group of animals, cetaceans have been badly depleted and abused by humans through hunting and incidental catches in several fisheries. Thus, there is great popular sympathy and concern for the continued survival of the animals generally, and certain populations in particular. This results in pressures on those responsible for management of fisheries to mitigate by-catch quickly and effectively.

Such a climate, in turn, can directly impact fishermen with imposed regulations, sometimes with serious economic consequences. Indirectly, fishermen can be effected by changes in market access or prices for their catches due to public pressure. While in the past by-catch could often be ignored, dismissed or disguised, such an approach to criticism is more difficult, and less effective at present. Fishermen are, therefore, typically faced with the choice of new regulations imposed by managers, or actively developing solutions for the problems themselves. Confronted with such a choice, fishermen generally select self-control and develop solutions if such an option is practical and made available to them (Lien et al. 1994). Innovation by primary producers and self-control as an effective management approach has been recommended in many resource sectors (Chambers et al. 1989; Hiemstra et al. 1992).

However, solutions to small cetacean by-catch are complicated by a lack of understanding of what produces accidental catches. There is no single, known cause which accounts for marine mammal by-catch in fishing nets. It may be that animals fail to detect nets because of the cryptic nature of most fishing gear; the animal may be inattentive or inexperienced with the minimal cues which nets provide; animals may be attracted to the nets by food or curiosity; nets may be occluded by bait, oceanographic conditions or conspecific activities near it; or the animal simply may not be able to solve the problem of detouring around such barriers (Nelson and Lien 1993; Perrin et al. 1994; Lien et al. 1994).

Lack of information regarding causes of fishing gear by-catch has impeded efforts to modify nets to minimize it (Todd and Nelson 1993; Perrin and Donavan 1994). Failing effective modification of fishing technology, other measures which limit fishing, such as time/area closures, effort controls, limited entry, quotas, deployment regulations, and so on are commonly advocated as mitigation techniques. However, there is a lack of information on the actual effectiveness of such techniques and the costs they impose on the fishing industry.

Some recent tests have offered promise in reducing whale collisions with fishing gear by simple gear modifications. Noise-making devices added to codtraps are effective in preventing collisions and entrapments of humpback whales in the gear (Lien et al. 1993). Use of acoustic alarms in preventing entrapment of harbour porpoise in groundfish sink gillnets off New England, U.S.A., while inconclusive, have been positive (Lien et al. 1994).

The Bay of Fundy has been an area reported to be high in harbour porpoise by-catch; this has resulted in the animals classification as "threatened" by COSEWIC (Gaskin 1991). An area of primary concern is near Campobello and Grand Manan Islands. High catch rates make it a good location for testing the effectiveness of acoustic devices. The area has also been the focus of international attention demanding reduction of harbour porpoise by-catch.

The purpose of the present study was to work with gillnet fishermen in the Bay of Fundy, New Brunswick in an experiment to evaluate acoustic alarms and variables associated with by-catch, to formulate a strategy to reduce the incidental take of harbour porpoise to an acceptable level, and to present these results to the responsible fishery managers.

This report will only describe data associated with alarm evaluation and provide recommendations of fishermen for further mitigation efforts. Studies of the biological and oceanographic variables associated with by-catch, which were also conducted in the same investigation, will be presented in future papers by C. Hood.

Methods: Tests of acoustic devices on groundfish gillnets were conducted in the Swallowtail area off Grand Manan Island, Bay of Fundy, Canada during the summer of 1994, from 15 June through 15 September. The gillnet fishery for cod and pollock peaks during this period, as does the abundance of harbour porpoise in the area. The level of incidental take in this particular area is high and accounts for a very high percentage of Bay of Fundy harbour porpoise by-catch (Gaskin 1991; Tripple 1994; Conway 1995).

Initially, a series of meetings were held with groundfish fishermen on Grand Manan to discuss the problem of harbour porpoise by-catch, possible solutions, to present results from previous alarm experiments, and to insure basic understanding of the problem from all sides, by both fishermen and scientists.

Only fishermen that traditionally had high incidental catch, and planned to fish within the Swallowtail area of peak harbour porpoise by-catch, were encouraged to sign-up for the experiment. Initially, a total of 15 fishermen from Grand Manan agreed to participate. At a similar, later meeting on Campobello Island, an additional 3 fishermen that fished the Wolves area agreed to participate in the experiment. Follow-up interviews with individual fishermen indicated that not all of those willing to participate in the experiment, in fact, fished in high take areas; they were not considered further for alarm use. In addition, if fishermen moved nets from high catch areas during the experiment, their inclusion in the tests terminated.

At the initial planning meetings, all fishermen expressed concern that accurate by-catch data could be used to hurt them, rather than help develop solutions they considered realistic. Others were concerned that alarms could effect fish catch. Some were concerned about carrying observers on their boats because of past experiences in which daily by-catch reports became incorporated into local gossip even before fish catches were unloaded.

An agreement was therefore made with fishermen that: (1) no intact harbour porpoise would be landed; sampling was permitted at sea; (2) summaries of catch information would be made available to participating skippers each week during the fishing season; there would be no release of such summaries to anyone else, other than the observers; (3) at the conclusion of the experiment, findings would be summarized in a report given first to the fishermen; after receipt of the report they would be given time to respond to the findings with suggestions for further mitigation actions which would be incorporated into the report. At that time the report would be made available to sponsoring agencies.

Fishermen, generally, accepted responsibility for the by-catch problem and favoured developing solutions themselves in dealing with it. Continuing contacts, over time, developed trust between scientists, observers and fishermen.

Observers in the experiment were volunteers with the Whale Research Group of Memorial University of Newfoundland. Generally, they were enrolled in biology programmes at various universities, had interests in the marine environment, and whales in particular. They worked without monetary compensation in return for educational benefits. Few had little direct knowledge of fishing at the beginning of the project. Much of the serious teaching which occurred during the summer was the result of efforts by fishermen to keep observers safe, happy and to explain details of their fishery.

Observers arrived at Grand Manan approximately one month prior to the start of the fishing season to learn about the by-catch problem, the fishery, the marine environment, experimental methodology and data recording. Short courses were given in basic oceanography and marine biology. Observers were also given a modified Sea Sampling Observer course developed by NMFS. Modifications to data collected by Sea Sampling Observers were developed in consultation with fishermen and DFO.

Fishermen participating in the alarm evaluation carried an observer each trip. Data sheets completed by observers for each trip. Fishing gear was completely described, oceanographic and environmental conditions were recorded. As strings of gillnets were hauled, catch of target species, non-target fish species and by-catch species were recorded. Location in the net (in n of floats from nearest net end) of any by-catch taken was recorded. Stomach contents of fish and by-catch species were sampled. Measures were made on captured harbour porpoise in a study to determine lapsed time since death, and samples were taken for later analysis.

Fleets consisting of 3 nets which were used by each fishermen were randomly assigned to one of 3 conditions once a location for setting the fleet had been determined. Experimental strings were fitted with acoustic alarms designed for groundfish gillnets. Devices were placed on the head rope at net ends and at each bridle; thus each fleet of nets was fitted with 4 devices and was completely ensonified. The device, along with its frequency spectrum, is shown in Figure 1. Harmonic patterns vary somewhat between devices. The devices produced sound with source levels at 1 m of about 115 db re 1 micropascal.

Figure 1: A gillnet acoustic alarm and a spectrograph of its sound.

Control nets were of two types. Some fleets of nets were equipped with alarms which served as silent sound controls for effects of the alarm itself on net performance and to control for possible effects of the alarm in hauling or placing nets. These were placed on fleets exactly like the acoustic alarms. The silent alarms produced no audible sound and thus could be recognized as different from the alarms on experimental nets. Control nets were not fitted with any alarms or devices.

Initially it was planned to also test passive acoustical devices (Goodson and Mayo 1994) along with the active devices. However, there were problems. Many methods of attaching them to the webs were tested with the help of fishermen; all methods caused frequent tangling as the floats slipped between webs. Therefore, this aspect of the experiment was abandoned.

During the experiment it was planned to measure ambient underwater noise in the fishing area and to study the sound along ensonified alarm nets. Because of several problems, this was not accomplished during the fishing season. Sound recording and measurement were not possible until November. These are, therefore, described in a section later in this report.

Results: At the outset it was hoped that a large scale experiment could be conducted to definitively test acoustic alarm effectiveness in minimizing harbour porpoise by-catch. This was not possible because of two conditions.

First, the Department of Fisheries and Oceans (DFO) operated a monitoring program which began late in the summer, and operated only during peak harbour porpoise by-catch (Conway 1995). Initially, it was anticipated that DFO observers could assist in monitoring the alarm experiment. However, the DFO program was operated parallel to the experimental alarm program. DFO observers were placed on vessels where there were already observers for this experiment; this duplication reduced possible observer coverage, and the amount of fishing effort which could be monitored.

Second, fishing for targeted species was generally poor during 1994; some of the crews and boats from Grand Manan Island that planned on fishing in the high take area did not fish regularly. There were two additional, non-participating boats from Grand Manan that fished in the high take area occasionally but did not carry observers. A total of 7 Grand Manan boats participated in the experiment. Because of poor fishing, effort was reduced in terms of number of trips and fishing days. If fishermen did fish, they typically used the maximum number of fleets of nets that conditions would allow. Typically this was a minimum of 3 fleets.

Two of the 3 boats that signed-up for the experiment from Campobello Island fished in the high take Wolves area. These fishermen were given alarms and their catches were monitored by DFO observers. However, because of differences in procedures, data from Campobello Island fishermen are not included in this report. A summary is provided in Conway (1995).

Fishing effort for participating fishermen from Grand Manan is presented in Table 6. A total of 2,078 webs in 677 hauls were monitored for 2,764 net days. Average soak time for a fleet was 32.9 hrs. There was no differences in fleet length between experimental conditions.

Table 6: Effort for fleets of gillnets in experimental control conditions. Mean soak time for a fleet was 32.9 hrs.

Experimental condition	N fleets hauled	N webs hauled	Net Days
Acoustic alarms	266	813	1,054
Silent control alarms	169	519	723
No alarms	242	746	987
Total	677	2,078	2,764

Locations of sets observed during the summer are presented in Figure 2. All occurred within the high take zone where most previous by-catch was reported (Tripple 1994; Conway 1995).

Figure 2: Locations of sets observed during the experiment.

Catch of target fish species is presented in Table 7. Cod was the primary fish captured (65%); pollock was less common (35%); few haddock were taken. There were no significant differences in number of fish taken between experimental conditions.

Table 7: Frequency of individual fish captures by experimental condition.

Experimental condition	Cod N	/net day	Pollock N	/net day	Haddock N	/net day
Acoustic alarms	2,523	3.1	1,644	2.0	45	0.1
Silent alarm controls	1,949	3.8	818	1.6	7	0.0
Controls	2.276	3.2	1,191	1.6	8	0.0
Totals	6,748	3.3	3,653	1.3	60	0.0

By-catch of cetaceans is shown in Table 8. A total of 43 harbour porpoise were caught during the summer. This is an average catch per fleet day of 0.064; 0.041 in acoustic alarm fleets, 0.077 in silent alarm fleets, and 0.078 in control nets. Mean catch per net day was 0.016; 0.010 in acoustic alarm nets, 0.018 in silent alarm nets, and 0.019 in control nets. A total of 11 animals were caught in experimental nets; 16.4 would be expected. A total of 32 porpoise were caught in silent alarm and control nets without alarms, 26.6 would be expected. Difference between acoustic alarmed nets and control nets is significant (Chi-square = 3.28, d.f. = 1, $p > .05$).

There was also by-catch of other species of animals including 12 mako sharks, 3 thresher sharks, 5 porbeagle sharks, 9 shearwaters, 1 herring gull, and 2 unknown birds. This by-catch did not vary significantly between net conditions.

Fishing did not begin until 9 July. Throughout the remainder of July only 6 porpoise were caught, which is 14% of by-catch. During this period, 24% of total fishing effort occurred and 30% of the fish were landed. Many porpoise were caught in August (72% of total catch), as well as 63% of total fish catch during 58% of total fishing effort. In September, 14% of porpoise by-catch occurred during 17% of fishing effort; only 6% of fish were caught during this period. These data are shown in Table 9.

Table 8: Cetacean by-catch in all experimental conditions

Experimental Condition	N harbour porpoise	Catch/ fleet haul	Catch/net day effort
Acoustic alarm	11	0.041	0.010
Silent alarm control	13	0.077	0.018
Control	19	0.078	0.019
Total	43	0.064	0.016

Table 9: Catch during the fishing season.

Catch Category	9-14 July	15-30 July	1-14 August	15-31 August	1-10 Sept.	Total
Cod	735	1,613	2,030	1,975	410	6,763
Pollock	125	663	1,343	1,277	258	3,667
Haddock	1	6	34	13	6	60
Total	862	2,282	3,407	3,265	674	10,488

% total	8.2	21.7	32.5	31.1	6.4	---
CPUE	4.67	4.59	4.05	4.16	1.34	3.75
Porpoise	2	4	22	9	6	43
% by-catch	4.6	9.3	51.2	20.9	13.9	---
Net days effort	185	497	808	784	490	2,764
% effort	6.6	17.8	28.9	28.0	17.5	---

There were few differences in net characteristics which were related to fish or porpoise catch. Catch by net color (Table 10), for example, with the exception of dark green web color, generally reflected effort. There appeared to be no portion of the net that captured more porpoise than any other.

Complete analysis of the biological and oceanographic data collected during this experiment will be presented in future reports by C. Hood.

Table 10: Effort by net color and porpoise by-catch.

	Net Color Clear	Lt. Green	Green	Other
% total effort	61	21	17	1
% total by-catch	70	21	9	0

Examination of the alarms at the end of the experiment indicated that 11% had some water damage; in over half of these cases, leakage was caused by over-tightening the alarm porthole cap which displaced the rubber '0' ring. In about one-quarter of the cases, leakage occurred through screw ports. Batteries were able to power alarms to produce adequate amplitude noise even after two operating months. In removing batteries to check the alarm electronics in was found that, because of the force required to remove batteries from the casing, sound generator adhesion to the alarm case loosened in about one-third of the alarms.

Acoustic tests: Acoustic tests were conducted on 11 November 1994 at periods of slack and changing tides. There was a stiff 35-

40 km/hr breeze; sea conditions were force 6, with 1.5-2 m waves. Measurements were made approximately 100 m off Swallowtail Lighthouse, Grand Manan Island using a Sony DAT recording system (Model TDC D10) with a flat response to 25 kHz and Bruel and Kjaer hydrophones directed through Bruel and Kjaer 2635 charge amplifiers. Recordings were analyzed using Canary software at a sampling rate of 22.3 kHz, and an FFT of 1024 points (frame length = 46 ms, filter bandwidth = 88.24 Hz).

Ambient sound levels reached an amplitude of 107 dB re 1 uPa in the frequency range 0 Hz-10 kHz, primarily in the range from 100-300 Hz during periods when tide was running. Frequency of ambient noise did not differ appreciably during slack water, however, sound levels were approximately 10 dB less.

Acoustic alarms were recorded at distances up to 50 m from source. Although the alarm signal was difficult to detect at that distance, human ears could hear the recorded signal in spite of high ambient noise. At times, however, it was difficult to hear alarm noise at distances greater than 25 m., although under most circumstances they could be detected.

The effects of surface conditions on ambient noise could not be assessed during the single day in which acoustic testing was possible.

Discussion of experimental results: Ambient sound conditions in the Bay of Fundy are higher amplitude, especially during periods of tidal change, than in other areas where acoustic alarms have been tested (Lien et al. 1994). Lien et al. (1994) found that alarms which produced sounds at 115 dB re 1 uPa were easily heard along the entire length of a fleet of 5 gillnets which were fished in quiet water. They suggest that such acoustical definition of a target barrier may be an important factor in preventing cetacean collisions with fishing gear. In the ambient sound conditions which prevailed during this experiment, alarm sounds were difficult to detect even one net from source. A critical ratio for signal to noise detection for harbour porpoise would be about 28 db (Johnson 1968).

Alarms used in this experiment exhibited some construction problems. Some water damage occurred. Most of this is preventable by proper procedures in tightening the port cap. An additional source of leakage were screw ports. In addition, because of difficulty in removing batteries, some alarm components were displaced during servicing.

Differences in catch of fish species, and non-cetacean by-catch, were not significant in this experiment. Fishermen confirm this. By-catch of harbour porpoise did differ between experimental conditions. The difference in catch rates between alarmed and non-alarmed nets was not as dramatic as in previous experiments. One reason for this could be the higher noise/signal ratio. Further work is required to evaluate optimal signal strengths to achieve target definition given varying environmental conditions.

A large portion of total effort on the fishing grounds off Swallowtail, Grand Manan Island was monitored during this experiment. The total catch of porpoise by all fishermen in the area would likely be under 55 animals; this appears to represent a substantial percentage of harbour porpoise taken in the entire Bay of Fundy. Areas where porpoise by-catch are a problem are relatively discrete and concentrated. The fishing grounds off Swallowtail, for instance, are only approximately 3 square nm. In addition, catch was concentrated by time; over half the total by-catch of porpoise was taken in the first two weeks of August. Well defined, small fishing areas are typical of areas in the Bay of Fundy where harbour porpoise by catch problems are known to occur (Conway 1995). This suggests that use of acoustic deterrent devices, developed for reducing numbers of seals near aquaculture sites, which drastically reduce numbers of harbour porpoise in an area (Olesiuk et al. 1995), may be effective in reducing harbour porpoise by-catch. The effect of such devices, if used, must be investigated for impact on other cetacean species as well as ascertaining the implication of resulting habitat loss for the porpoise.

Cooperation by fishermen with observers and scientists during this experiment was excellent. A fine working partnership is developing which can provide an accurate estimate of the nature and impact of harbour porpoise by-catch and, eventually, reduce the problem to an acceptable minimum.

Discussion, conclusions and recommendations by fishermen:

A meeting was held on 11 November 1994 with skippers who participated in this experiment. They had previously been given the summary of the experiment presented above.

The point of the meeting was to discuss findings from the summers work, and make recommendations for further study and/or mitigation of porpoise by-catch. Following drafting of a summary of discussion and recommendations, this section was again given to fishermen for review. A second meeting was not possible. Thus, to speed completion of the report, each fishermen was called by the first author, and this section was discussed paragraph by paragraph The following presentation was approved by them by consensus.

"We worked with the scientists and students of the Whale Research Group of Memorial University of Newfoundland to study porpoise catches and reduce them. The summer went well. Good working relations developed between fishermen, observers and scientists.

It is amazing how much hardship and worry scientists can impose on fishermen when they mistakenly adopt inadequate models and rely on poor data. We have been victimized by hysterical conclusions regarding porpoise by-catch at Grand Manan and the Bay of Fundy. Stories are repeated, and grow, far from our shores, but effect us all the same.

We want to say, at the outset, that we are good, hard-working fishermen who intend to always live in the Bay of Fundy. We care about the basis for our livelihoods - the resources of a healthy ocean. This requires a balance of exploitation and conservation. Our commitment to sustainable fisheries was recently recognized when our Association received a Gulf of Maine Visionary Award for our efforts in promoting sustainable management of fish and shellfish stocks in the Bay of Fundy.

Results of our work this summer show several things for sure:

(l) We are willing to cooperate and work toward a solution to the problem of porpoise catches. We worked with observers, used alarms, followed rules imposed by the experiment. We want the porpoise problem solved.

(2) Catches of harbour porpoise are, in fact, far lower than previous estimates given by scientists. We were screened and selected for the experiment, over all other fishermen, because we caught the most porpoise. This occurs in a small area between the Wolves and Grand Manan Island. Our experiment monitored approximately 80% of the fishing effort on the grounds off Swallowtail, Grand Manan Island; we caught only 43 porpoise. Thus, there were a maximum of perhaps 55 porpoise caught in this area - total.

We know of no fishermen in the Bay of Fundy that caught nearly as many porpoise as we did. In fact, we know of no fishermen, outside our group that fished off Swallowtail that even caught a porpoise. There could be some but, in fact, catches are far lower than believed. Scientists need to understand the restricted area where porpoise are caught when they make their estimates of total catches in the Bay of Fundy.

(3) The alarms that we used reduced catches of porpoise. Results of our experiment show that alarms cut catches of porpoise in half. We didn't like listening to them - but they worked.

There are several other thing that managers should know about our fishery that are important in considering porpoise catches:

Compared to U.S fishermen, there are already many controls in place on our fishery which minimize porpoise catches. These include limited entry, gear restrictions, effort limitations and quotas. Even-handedness across borders requires that the U.S. develop conservation management measures themselves, before they begin telling us what to do. Their extreme affection and concentration on porpoise blurs a proper view of balanced conservation of all the oceans' creatures, and the need for fishermen to earn a livelihood. The U.S. should not be allowed to impose their approach and problems on us.

While we do not believe that the porpoise catches in our fishery are having nearly the impact on the population suggested by some, we are eager to minimize them. Porpoise catches are of absolutely no benefit to us and, because of outside perceptions, they threaten our fishery. Thus, we want to minimize catches as far as possible, while still maintaining a viable gillnet fishery. Survival of this fishery is very important to us.

We fish at a time, and in an area, where porpoise are present simply because we have to. During summer months, no alternative fishery is presently available to us, and no other gear would produce adequate returns. The peak numbers of fish occur together with peak numbers of porpoise on the fishing grounds. Moving even slightly off these fishing grounds results in very large catches of dogfish, for which there are no market. If other fisheries were available, for instance if the lobster season could be extended, then we would not be so dependent on the gillnet fishery which catches porpoise. At present the gillnet fishery, although not our most important fishery, is an essential seasonal fishery for us which provides wages, and maintains our fishing capacity during a period where we have no alternatives. In future, as groundfish stocks improve, this gillnet fishery may well become much more important to our total fishing year.

We recommend the following plan to continue to mitigate porpoise catches:

(l) Discussions with managers regarding alternative fisheries which could be made available to at least some of the effected fishermen. This could reduce some gillnet effort in high porpoise catch areas without adversely effecting fishermen;

(2) There should be more alarm experiments conducted. Alarms help and with work and wider adoption by fishermen will reduce porpoise catches. In conjunction with alarm experiments, monitoring of fishery activities will accurately show the numbers of porpoise caught;

(3) Canadian fishery managers should forcefully defend our fishery against American threats. They should stress accurate porpoise catch information, which shows catches are much lower than popularly believed, existing controls on our fishery, and our cooperation in monitoring and reducing porpoise catch. They should also communicate our concern with the overall conservation and sustainable exploitation of ocean resources and urge a balanced approach to conservation, not one narrowly focused on a single species."

Conclusions: (1) Based on monitoring of over 80% of fishing effort in an area of peak porpoise catch off Swallowtail, Grand Manan Island, total catch of porpoise is about 55 animals. This is lower than previous expectations.

(2) Monitoring shows a discrete time/area of porpoise catch. Most catches occurred in early August.

(3) Nets with alarms exhibited catch rates about half of unprotected nets. Fishermen believe the alarms are helpful and recommend continued monitoring by observers, in conjunction with additional alarm experiments. These should be conducted in a coordinated manner with DFO observers.

(4) Sound measures suggest that the noise/signal ratio of alarms used in this experiment is higher than in previous tests. Any additional alarm experiments should use new version alarms which produce a somewhat louder noise.

(5) Fishermen indicate willingness to work with scientists to monitor and minimize porpoise catches. They request discussions with managers to insure continuation of their fishery, and they expect managers to defend their fishery against American pressure to disrupt it.

(B) Tests of whale alarms on debris nets at the Hibernia construction site, Trinity Bay, Newfoundland.

During the construction phase of the gravity based structure (GBS) for the Hibernia Project in Bull Arm, Trinity Bay debris nets were placed to prevent any material from floating seaward. These nets provided an opportunity to further evaluate the effectiveness of whale alarms as whale abundance is typically high in Trinity Bay, and ensonification of nets and its effectiveness with large baleen whales has not been sufficiently tested.

A pattern of debris nets were ensonified and others used as controls. A daily pattern of monitoring whale abundance in the immediate area and in lower Trinity Bay was established to relate net collisions to activity patterns of individual whales and to whale abundance generally.

During the summer of 1994, daily transects were conducted on 50 days over 371 hours. Sightings and positions of all cetaceans sighted were recorded and, as possible, individual animals were identified by photograph. Unfortunately, only a total of 374 whales were sighted, few were in Bull Arm itself. Totals of 66 humpback, 25 finback, 66 minke, 86 harbour porpoise, 76 white-beaked dolphins, 28 white-sided dolphins and 9 unknown cetaceans were sighted. Only 18 seals of all species were seen.

There were no collisions of any kind with debris nets which were deployed. This is a likely outcome of the low abundance of cetaceans in the area of Bull Arm, and specifically Mosquito Cove. Data from the study are still being analyzed and will be the subject of additional reports by D. Borggaard.

(C) Development of new versions of acoustic alarms.

Recently tests have been completed in British Columbia using high intensity seal scaring devices to protect salmon cages. Data clearly indicates that seals habituate to the devices and they may, in fact, operate as "dinner bells" once local seals learn of their association with salmon. However, in test tests the abundance of harbour porpoise near alarm installations was also monitored. Results indicate that the devices dramatically reduce the number of harbour porpoise from a wide area (Olesiuk et al. 1995). Further tests are being planned to evaluate this phenomena. Potential applications for such devices include those situations where the by-catch occurs as nets are dropping or being raised in the water column. Seal scarers could be carried on vessels that experience such catches and operated only these periods of maximum risk. Installation of such devices on a permanent basis could produce significant habitat loss for harbour porpoise and the impact of such an effect would necessarily have to be investigated, as would the impact of the high intensity sound on other cetacean species in the area.

Based on modifications indicated in the alarm tests on Grand Manan, a new alarm has been developed which eliminates screw ports, uses a more efficient circuit which requires fewer batteries, and provides greater amplification of the basic alarm signal. Because of concerns by groups in the U.S. regarding habitat degradation due to noise produced by alarms, the alarm version tested in this experiment was designed to produce low amplitude sounds. However, gains in amplitude have been made by modifying the resonating capacity of the alarm housing. The new alarm version produces a similar frequency spectrum, but it much louder which make in more effective in some applications where there are high ambient sound levels.

Many inquiries have been received regarding applications of acoustic alarms to new fisheries and new species. These are summarized in Table 11.

Table 11: Summary of potential new applications for acoustic alarms.

Country	Target spp.	Gear	By-catch spp.
U.S.A.	monkfish	gillnet	harbour porpoise

Denmark	groundfish	gillnet	harbour porpoise
Germany	groundfish	gillnet	harbour porpoise
Indonesia	reef fish spp.	gillnet	dugong
Uruguay	various	gillnet	dolphin spp.
Brazil	various	gillnet	Sotalia dolphin
Australia	sharks	gillnet	humpbacks, dolphins dugongs
Holland	groundfish	gillnet	harbour porpoise
Canada			
Hudson Bay	char	gillnet	beluga
Bay of Fundy	groundfish	gillnet	harbour porpoise
B.C.	various	gillnet	harbour porpoise

(5) Educational Programmes

Educational activities continued throughout 1994 and included distribution of posters and 'fact sheets' to schools, school programmes, and distribution of videos. An additional 250 copies of the Whale Release Video and the Identification Guide to the Whales of Newfoundland and Labrador were distributed to individuals and institutions.

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