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Modified Tuna Purse Seine Net Achieves Record Low Porpoise Kill Rate

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Earlier this year the Southwest Fisheries Center (SWFC) of the National Marine Fisheries Service (NMFS), La Jolla, Calif., released a gear research cruise report which described results of one of the latest efforts in the NMFS program to develop gear and techniques designed to reduce porpoise mortality in commercial tuna purse seining operations. The following information, taken from this cruise report, was prepared by James M. Coe, Fishery Biologist, SWFC, and Philippe Vergne of the Porpoise Rescue Foundation.

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The cruise described in this report extended from 7 October 1976 to 9 December 1976. The area involved was the yellowfin tuna fishing grounds off Mexico and Central America within the Inter-American Tropical Tuna Commission's yellowfin regulatory area.

VESSEL AND EQUIPMENT

The tuna purse seiner MV *Elizabeth C. J.* was chartered for this cruise, with Nicholas L. Lavalouis as master, Manuel Jorge, fish captain, and Joe Jorge, alternate fish captain. The vessel, 252 feet long with a 42-foot beam and a draft of 21 feet, can carry up to 1,700 tons of frozen tuna in 10 pairs of brine wells. Propulsion is provided by a twin-screw system with two 2,800-horsepower main engines giving a top cruising speed of 18 knots; a 400-horsepower bow thruster aids in maneuverability. The net used during the cruise was 700 fathoms long by 13 standard 4¼-inch mesh strips deep. The experimental "super apron" and double-depth safety panel of 1¼-inch mesh webbing (Fig. 1) were installed in the backdown area of the net.

PURPOSE AND OBJECTIVES

Purpose of the cruise was to test a modification of the "Bold Contender" system, termed the "super apron," and to develop techniques for its efficient use in reducing incidental porpoise mortality during commercial tuna purse seining operations. This work was done in partial conjunction with tuna-porpoise behavioral studies made during a portion of the same cruise period.

In addition to evaluating the effectiveness of the "super apron" modification of the "Bold Contender" system in reducing incidental porpoise mortality, other objectives of the cruise were: 1) to adjust flotation and deployment techniques during backdown to reduce the incidence of a prematurely submerged corkline and the resultant accidental loss of fish; 2) to adjust flotation and apron structure to permit controlled sinking of the backdown apex; and 3) to conduct further tests of the use of a small, one-man inflatable raft to assist in porpoise removal during and after backdown.

RESULTS

During the cruise, 30,233 porpoise were captured and 915.5 tons of yellowfin tuna were taken in 45 net sets on

Figure 1.—"Super apron" modification of the "Bold Contender" system, 16 December 1976, assembly diagram (vertical distances not to scale).

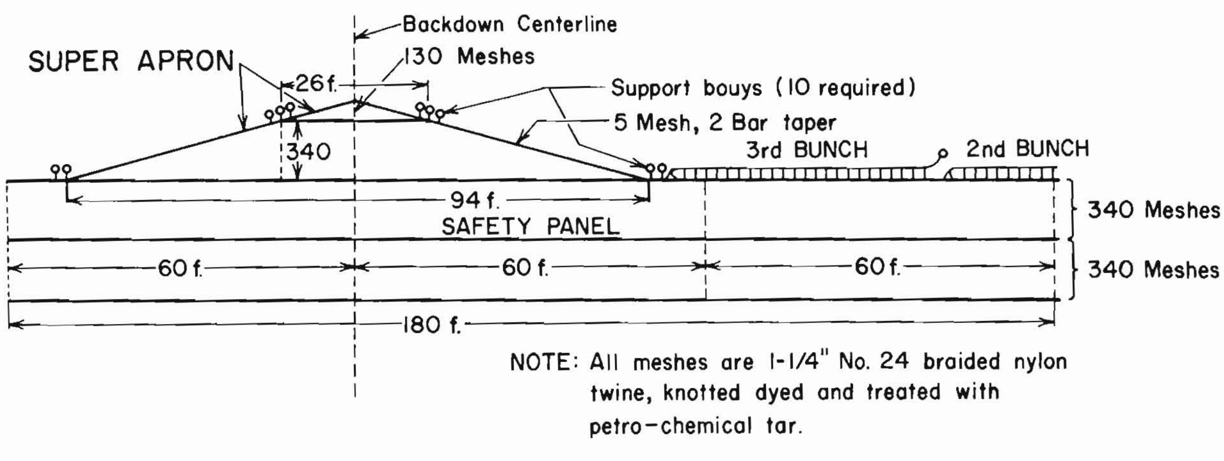

Table 1.—Data summary.

No. sets	Reason segregated	Tons tuna	Porpoise caught	Porpoise mortality	Kill per ton	Kill per set	Captured porpoise (percent) killed
15	Behavioral experiment	361.0	8,592	12	0.03	0.80	0.13
26	Gear-experimental sets without gear malfunction	492.5	19,512	4	0.008	0.15	0.02
5	Gear-experimental sets with gear malfunction	62.0	2,129	0	0	0	0
2	Schoolfish sets	95.0	—	—	—	—	—
48		1,010.5	30,233				

[1]Includes 5 tons skipjack tuna.

Table 2.—Set data.

Set no.	Exp. set no.	Date	Lat. (N)	Long. (W)	Average crew est. of porp. caught	% spin. in porp. caught	Tons[1] YF	Speed-boats used to tow	Elapsed back-down time (min)	# Raft rescued during back-down	# Porp. live in net after back-down	# Raft res-cued after back-down	Spotter killed	East. spin-ner kil-led	White-belly spin-ner kil-led	Other killed	Total killed
1		10-14	18°32′	113°55′	533	—	45	0	20	3	0	0	0	0	0	0	0
2		10-14	18°27′	113°52′	325	—	35	1	8	2	0	0	0	0	0	0	0
3	1	10-16	11°19′	113°02′	water set	—	0										
4	2	10-17	10°33′	109°25′	1,350	13	65	0	16	5	1	1	6	1	0	0	7
5	3	10-18	11°15′	109°25′	950	3	25	0	20	0	0	0	1	0	0	0	1
6		10-19	10°45′	109°00′	275	—	12	0	20	0	0	0	0	0	0	0	0
7	9	10-20	10°25′	108°38′	350	1	15	0	9	1	0	0	0	0	0	0	0
8		10-20	10°22′	108°49′	975	30	25	0	13	0	0	0	0	0	0	0	0
9		10-23	10°52′	107°42′	175	—	5	0	14	0	0	0	0	0	0	0	0
10	6	10-25	9°33′	104°46′	213	—	10	0	25	0	0	0	0	0	0	0	0
11	7	10-26	9°14′	105°16′	1,066	10	70	0	19	8	0	0	0	0	0	0	0
12	8	10-27	9°21′	105°38′	183	—	18	2	9	3	0	0	4	0	0	0	4
13	4	10-27	9°46′	105°47′	1,033	17	65	2	10	5	0	0	0	0	0	0	0
14	5	10-28	9°45′	105°03′	300	—	8	0	11	3	0	0	0	0	0	0	0
15	10	10-29	9°44′	104°37′	1,000	12	55	0	11	2	0	0	0	0	0	0	0
16		10-30	9°41′	104°40′	125	—	15	0	11	3	0	0	0	0	0	0	0
17	11	10-31	9°37′	107°22′	90	—	4	2	10	4	1	1	0	0	0	0	0
18	12	10-31	9°46′	107°54′	625	45	6	2	8	3	0	0	0	0	0	0	0
19	13	11-1	10°36′	107′52′	816	1	8	1	8	0	0	0	0	0	0	0	0
20		11-1	10°43′	109°06′	1,066	6	30	1	17	0	0	0	0	0	0	0	0
21	14	11-2	10°40′	109°27′	283	—	8	1	9	4	0	0	0	0	0	0	0
22		11-2	11°27′	109°50′	766	—	8	0	26	2	4	3	0	0	0	1	1
23		11-4	18°21′	113°23′	866	78	10	1	16	5	0	0	0	0	0	0	0
24		11-4	18°34′	113°54′	933	5	50	0	7	5	0	0	0	0	0	0	0
25		11-5	18°40′	113°30′	1,033	13	20	1	15	7	0	0	0	0	0	0	0
26		11-5	18°23′	113°30′	683	15	5	1	20	0	0	0	0	0	0	0	0
27		11-9	13°53′	104°21′	683	—	10	0	11	6	0	0	0	0	0	0	0
28		11-11	13°58′	101°35′	833	—	12	0	15	10	0	0	0	0	0	0	0
29		11-11	14°14′	101°34′	683	0	9	1	13	5	0	0	0	0	0	0	0
30	15	11-12	13°43′	101°39′	333	0	4	0	15	3	0	0	0	0	0	0	0
31		11-12	13°34′	101°28′	55	0	0	0	6	1	0	0	0	0	0	0	0
32		11-13	12°20′	102°51′	700	0	4	0	12	5	0	0	0	0	0	0	
33		11-15	9°15′	100°18′	Sch. F	—	0										
34		11-16	9°20′	98°20′	266	—	45	1	10	4	0	0	0	0	0	0	0
35		11-16	9°08′	98°03′	433	—	12	1	8	2	0	0	0	0	0	0	0
36		11-18	10°15′	98°09′	Sch. F	—	90										
37		11-19	10°01′	97°31′	86	—	25	1	8	1	0	0	0	0	0	0	0
38		11-19	9°36′	97°15′	316	—	14	0	10	3	0	0	0	0	0	0	0
39		11-20	9°18′	97°50′	106	—	10	0	6	2	0	0	0	0	0	0	0
40		11-21	9°27′	97°46′	1,400	—	35	1	12	3	0	0	0	0	0	0	0
41		11-21	9°42′	97°44′	266	—	16	1	13	0	0	0	0	0	0	0	0
42		11-21	9°45′	97°54′	300	—	7	1	12	2	0	0	0	0	0	0	0
43		11-23	15°30′	101°27′	1,233	65	12	0	16	15	0	0	1	2	0	0	3
44		11-26	19°38′	111°21′	800	—	15	0	17	5	0	0	0	0	0	0	0
45		11-27	18°21′	114°18′	233	5	10	0	24	7	0	0	0	0	0	0	0
46		12-2	10°52′	109°53′	2,500	5	32	0	12	3	0	0	0	0	0	0	0
47		12-5	19°13′	111°49′	550	—	25	0	15	4	0	0	0	0	0	0	0
48		12-6	18°55′	112°50′	1,666	95	1.5	0	15	0	0	0	0	0	0	0	0
Total (behavior sets)					8,592		361	10	180 (Avg. 12.86)	41	2	2	11	1	0	0	12
Total (gear sets)					20,864		644.5	12	422 (Avg. 13.61)	105	4	3	1	2	0	1	4
Total (all sets)					29,456		1,005.5	22	602 (Avg. 13.38)	146	6	5	12	3	0	1	16

[1]Tonnages are estimates made at time of set, not actual unloading weights.

yellowfin tuna associated with porpoise. One set was a water set and two sets were made on tuna associated with floating objects (logs) in which 90 tons of yellowfin and 5 tons of skipjack tuna were landed. Table 1 presents a summary of the catch and kill data for the behavioral research and gear research sets. Table 2 presents the date, location, catch, kill, and raft-use statistics by set with subtotals for the gear and behavioral sets.

Porpoise mortality occurred on only 5 of 45 sets made on tuna-porpoise-associated schools. Sixteen porpoises were killed on these 5 sets—4 during the course of regular fishing operations and 12 during the activities of the scientific party. Excluding mortality during scientific activity, the mortality rates were 0.09 per set, 0.004 per ton of yellowfin caught in association with porpoise, and 0.013 percent of the porpoise captured.

Fourteen net sets were made for the purpose of studying porpoise behavior in detail. As many as three skiffs and six divers were inside the net prior to and during backdown. In three of these sets (numbers 4, 5, and 12) the presence of the divers and tagging efforts during backdown hampered porpoise release and resulted in 12 of the 16 deaths. The remaining four deaths occurred during backdown in two gear experimental sets that had no operational malfunctions. The animals became folded into the side of the backdown channel at a depth that precluded hand rescue.

The extremely low porpoise mortality rate experienced during this cruise was the result of the care and efficiency of the fishing captain and crew members in setting and hauling their net, using speedboats to adjust the corkline (18 sets), and in backing down until all live porpoise were released (42 of 45 sets). These efforts, in conjunction with the "super apron" and double-depth safety panel of 1¼-inch stretch-mesh webbing, allowed this vessel to achieve a record low kill rate.

The "Super Apron"

The apron-type appendage to the backdown area of purse seine nets was first tried on an NMFS-chartered vessel in the fall of 1974 and subsequently led to the development and successful testing of the apron-chute complex known as the "Bold Contender" system, 1 year later. It includes a porpoise safety panel of 1¼-inch mesh webbing 12 fathoms deep and 180 fathoms long. A 10-vessel mass test of the "Bold Contender" system in 1976 resulted in mortality rates substantially below the 1976 fleet averages for vessels using conventional nets, i.e., 2-inch stretch mesh in the safety panel. However, the mass testing revealed two generally recognized problems with its use. First, the smaller mesh size of the safety panel and apron-chute complex caused considerably greater drag when being pulled through the water during backdown than did the normal 2-inch safety panel. This caused the corkline perimeter of the backdown channel to submerge in the early stages of backdown, thus increasing the danger of loss of fish and necessitating a slower-than-normal backdown. Secondly, several vessels reported that the inability to sink the corkline at the apex of the backdown channel in the later stages of the procedure caused greatly increased need for hand rescue and longer backdown times.

To alleviate these problems, the two-stage taper employed in the "Bold Contender" system (five mesh, two bar on the apron and one mesh, two bar on the chute) was changed to all five mesh, two bar. This straight taper allowed more even distribution of the downward pull on the corkline as backdown proceeded. Although the corklines did tend to sink slightly in the early stages of backdown, and backdown still had to begin slowly, no fish were lost at this stage during the charter and it was generally agreed that there was no problem.

With the "super apron" modification, the topmost strip of 1¼-inch webbing (designated as the chute in the "Bold Contender" system) is approximately 200 meshes shallower at the backdown apex than its predecessor. The fish captain was able to sink the backdown apex to release the porpoise at will during all stages of the procedure. The resurfacing of the corkline after sinking was probably slightly slower than for nets with the 2-inch porpoise safety panel. Two or three speedboats were deployed at the backdown channel apex on every set to help prevent accidental fish loss and to hand-release porpoise as needed. The chief scientist estimated that approximately 18 tons of tuna were accidentally backed out of the net during porpoise release in the 45 porpoise sets during the cruise. In general, the fish captain and the alternate fish captain were pleased with the porpoise-saving characteristics of the "super apron."

Observations from the inflatable raft during backdown on the charter of the MV *Bold Contender* (fall 1975) showed that spotted porpoise sometimes became passive and piled up on the bottom of the backdown channel where they could be mistaken for dead. The removal of the extra webbing in the chute (discussed above) eliminated the two-step shelf formed with the "Bold Contender" system. Thus, as backdown proceeded with the "super apron," the channel became progressively shallower and ramp-like, raising the "passive" spotters up and flushing them out of the net. This reduced the necessity for hand rescue considerably. Of the 146 animals hand-released from the raft during backdown, the rescuer was quite certain that most of them would have been backed out anyway. No porpoise were killed in the six porpoise sets for which the raft was not used.

The use of the "super apron" atop the small-mesh, double-depth safety panel is not without operational faults, primarily because of the increased drag of the small mesh as it is moved through the water or as it is held against a current. In each of the porpoise sets which caught 50 tons of tuna or more the corkline tended to sink after backdown in the area just outboard of the third bow bunch. Though only a few tons of tuna were lost in porpoise sets, approximately 35 tons were lost in set 36 (schoolfish on a log) in this area. Underwater observation of the net in that area showed that as the net is hauled in after backdown the small mesh squeezes the entrapped water against the bunches which act as a dam. The blocked water forces the small mesh outboard of the third bow bunch to canopy out and when stretched to its limit the corkline begins to sink. The faster the net was rolled the more rapidly water had to be squeezed out and the deeper the corkline sank. It was found that this kind of sinking could be alleviated easily by release of the third and second bunches slightly earlier than normal. With large catches (>50 tons) it may be necessary to roll the net aboard a little more slowly.

On set 33 (schoolfish with a log) a very strong surface current and an oblique subsurface current caused the entire area of small mesh from the second bow bunch to mid-net to sink and stay down until the purse rings were brought up out of the deep current. The surface current moved the log and almost all of the fish over the sunken corkline. It was not possible to judge the degree to which the small mesh was responsible for the sinking but it surely contributed to it. To avoid this problem in areas of strong currents, the captain must note the current direction and position all sets to avoid pursing the small mesh area of his net against the current.

As with the "Bold Contender" system, there is a tendency for the center of the "super apron" to fold into or out of the net in some sets. On 15 sets a speedboat was used without incident to open or adjust the backdown apex prior to backdown. No maintenance was required on the small mesh during the cruise and only a few broken meshes and shark holes were seen by the underwater observer.

Inflatable Raft

During 39 of 45 porpoise sets, a small inflatable raft was used as an observation-and-rescue platform by one of the scientists employing a mask and snorkel. The raftman signaled the captain when the backdown release area was clear of fish. In addition, he assisted in the removal of the last few porpoise in the late stages of backdown. Generally, backdown was continued until the raftman signaled that all porpoise including the "passive" spotters had been released.

In checking to see if all live porpoise were out of the net, it was discovered that the raftman could hear vocalizations of porpoise that were still in the net but could not be seen. This final listening check became common practice and several animals were saved as a result.

The raft was also used during backdown to herd the porpoise toward the release area. This seemed to work well but only if the raft stayed more than about 10 meters from the nearest animals. When some groups of porpoise (10 to 100) would refuse to go over the corkline during backdown the raftman would wait until they were congregated near the sunken corkline and then paddle straight at them making as much commotion as possible. The initial avoidance response of the nearest animals often started them over the corkline and backdown would proceed to completion.

In four sets with expected large catches of fish the raft was used to attach up to four flotation balloons to the corkline along the sides of the backdown apex to lessen the chance of fish loss if all of the fish happened to move into the apex at one time. This was probably a good safeguard but it was never really tested with a large catch. After backdown the balloons were collected in the raft to facilitate net retrieval.

SUMMARY

The record low mortality rate experienced on the charter cruise is the result of the concurrent evolution of improved fishing techniques and gear modifications developed by NMFS and the tuna industry and increased awareness of the captain and crew of the necessity to reduce incidental porpoise mortality. The following general list summarizes the activities which allowed the low mortality rate.

1) Set positioning to minimize negative effects of wind and current.

2) Early recognition of potential net collapse areas and use of speedboat(s) to prevent collapse.

3) Use of speedboats to herd porpoise out of potential danger areas.

4) Use of speedboats to adjust backdown area corkline prior to backdown.

5) Consistent use of two or three speedboats at backdown apex to prevent fish loss and to rescue porpoise.

6) Consistent backing down until all live porpoise are out of the net (very important).

7) Use of person in inflatable raft to:

a) Signal when backdown apex is clear of fish;

b) herd and hold the porpoise in the backdown apex;

c) determine by using a mask and snorkel and by listening, when all live porpoise are out of the net; and

d) hand-releasing animals.

8) Incorporation of small-mesh, double-depth safety panel.

9) Incorporation of "super-apron."

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