Southeast Fisheries Science Center
Mississippi Laboratories
Pascagoula Facility
P.O. Drawer 1207
Pascagoula, MS 39568-1207

May 13, 1996

MEMORANDUM FOR: Dr. Andrew Kemmerer

FROM: John Mitchell

SUBJECT: TED Testing Committee Recommendations
re: Moore Ramp and new control TED.

Attached are the final recommendations from the TED testing review committee regarding certification of the Moore Ramp and the use of a new control TED for future TED certification tests. Panel members included the following individuals:

Industry representatives: Jim Murray, Jim Bahen, Gary Graham and Dave Harrington (note: Dave's recommendations were submitted "for" Dave by Lindsey Parker.)

Turtle conservation representatives: Larry Ogren, Erich Stabenau, André Landry and Sandy MacPherson.

In summary, the committee voted as follows:

Certification of the Moore Ramp: 6 yes / 2 no
Change of Control TED: 5 top opening / 2 bottom opening / 1 top or bottom

Also included are comments and recommendations on each of these issues from the Harvesting Branch.

cc: Brad Brown
Scott Nichols
Wil Seidel
John Watson
Wendy Taylor
Chuck Oravetz
David Bernhart
Colleen Coogan

1996 TED Testing Committee Review
Testing Summaries and Question Statements

1996 TED Testing Committee Review

Testing Summaries and Statements of Questions

INTRODUCTION

The following testing summaries are presented to the TED testing review committee to assist in providing comments and recommendations to the National Marine Fisheries Service regarding candidate TED certification and modification to the TED testing protocol. Committee members who wish to review the test procedure, including the statistical protocol and the size of the turtles used in the 1995 test, are referred to the enclosed document labeled "*Summary of 1995 TED Test Procedures*".

This year the committee is asked to review and comment on the results from two tests conducted using the juvenile sea turtle TED testing procedure in May of 1995. The first test was conducted at the recommendation of the 1995 TED testing review committee and compared the turtle exclusion efficiency of the existing control TED (NMFS design) against a top opening and a bottom opening Super Shooter TED. The purpose of the test was to determine if, and what type of new control TED should be selected for future TED testing.

The second test was conducted on a proposed optional modification to existing hard TEDs called the "Moore Ramp". The function of the ramp is to direct shrimp away from the TED exit hole as they transit the TED.

As a companion to each test summary, we have provided a video excerpt from the actual test so that the committee may better understand the candidate TED design and effect on turtle escapement. Once you have reviewed the written material and video, please make your recommendations on the attached sheets which correspond to each test and return them in the envelope provided. This year, we are asking for your recommendations on just two tests. We estimate that it should require approximately 1 hour to review the material and provide recommendations for each test question.

Along with the test results, your recommendations will be reviewed by the NMFS Southeast Regional Director in making a decision to amend existing TED regulations to include the new TED type/modification and or modification to the testing protocol.

TEST #1 TESTING OF ALTERNATE CONTROL TED

BACKGROUND

The current test protocol utilizes the NMFS TED with a hinged door and accelerator funnel as the control (Figure 1). During the 1994 TED test, a sub-sample of 3 Kemp's ridley and 3 Loggerhead turtles with straight line carapace lengths (SLCL) ranging from 23.3 cm to 27.7 cm were observed to be unable to open the NMFS TED door during the 5 minute exposure period. Table 1 provides the mean escape time for turtles with SLCL≤ 28 cm and >28.1cm which were exposed to the NMFS TED from 1991 to 1995.

Table 1 Sample size, captures, escapes, % escape and mean time of escape for SLCL ≤ 28 cm and > 28.1 cm for the NMFS TED from 1991-1995.

Turtle SLCL	N	# Captures	# Escapes	% Escape	Mean Escape Time (sec)
≤ 28 cm	24	8	16	67%	102
> 28.1 cm	100	9	91	91%	98

Several members of the 1994 test review committee motioned to investigate the use of a new control TED, specifically, one which would allow smaller sized sea turtles to escape. At the conclusion of the meeting, the committee unanimously recommended that a top and bottom opening mid-sized Super Shooter TED (Figure 1) should be tested as a possible new control during the 1995 TED tests. These tests were to be conducted in conjunction with testing of the standard NMFS TED.

NOTE: The technical description of the NMFS TED has been amended in the federal TED regulations. A hinged door is no longer an allowable component of the NMFS TED and may be replaced with a webbing flap possessing legal opening dimensions. This situation further emphasizes the need for a change in the control TED used for TED testing.

TEST SUMMARY

A 25 turtle sample test was conducted for each of the following TED designs, NMFS TED, bottom opening mid-sized Super Shooter with accelerator funnel, and top opening mid-sized Super Shooter with accelerator funnel. Table 2 summarizes the results from these tests. Testing of the NMFS TED resulted in 1 capture in 25 releases. The captured turtle had a SLCL of 29.7 cm. Testing of a top opening and bottom opening Super Shooter resulted in 0 in 25 releases for each TED type.

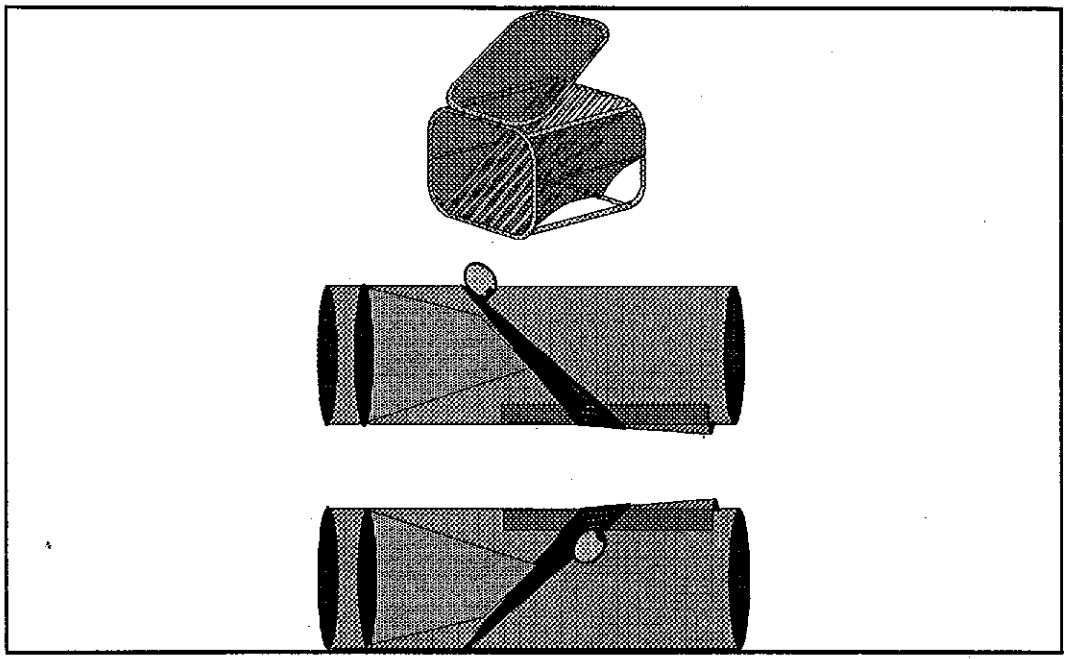

Figure 1 NMFS TED, top opening Super Shooter and bottom opening Super Shooter TEDs.

Table 2 Results from testing of alternate control TED. 1995 NMFS TED Tests

TED TYPE	n	CAPTURE / ESCAPE
NMFS TED	25	1 / 24
Top Opening S. Shooter w / accel. funnel & ext. flap	25	0 / 25
Bottom Opening S. Shooter w/ accel. funnel & ext. flap	25	0 / 25

Mean , range and standard deviation for escape times of turtles were calculated for each TED type (Table 3). Mean time of escape was 85 seconds, 126 seconds and 69 seconds for the NMFS TED, bottom opening Super Shooter and top opening Super Shooter respectively. Analysis of variance showed a significant difference in the mean time of escape between the NMFS TED and a bottom opening Super Shooter and between the top opening and bottom opening Super Shooters. No significant difference in mean time of escape was found between the NMFS TED and the top opening Super Shooter. The top opening Super Shooter showed the lowest mean escape time and had the smallest variation in escape time.

Table 3 Analysis of turtle escape times (seconds) for NMFS TED (N = 24), top opening Super Shooter (N=25) and bottom opening Super Shooter (N = 25)

TED TYPE	RANGE	MEAN	STANDARD DEV.
NMFS TED	15 - 200	85	52
S. SHOOTER BOT	37 - 230	126	57
S. SHOOTER TOP	20 - 158	69	37

DISCUSSION

In making a recommendation regarding a change in the control TED, it may be helpful to review the current "pass/fail" criteria or statistical protocol used in the test.

A majority vote by the 1994 committee resulted in a recommendation to increase the risk of rejecting a candidate TED which is as good or better as the control TED (Type 1 error or α) from ~10% to ~22%. This change in the statistical protocol will decrease the possibility of passing a candidate TED which is inferior to the control (Type 2 error or β). NOTE: Although the committee recommended maintaining Type 2 error at ~ 22%, the value will vary depending on the capture rate of the control TED.

If the score of either the top or bottom opening Super Shooter in this test is applied as the control data set (0 captures), Table 4 provides an example of the changes in β at various candidate TED rejection levels. Focusing on the row in the table marked with an astrix, the following can be derived; a candidate TED which is only 80% as effective as the control TED (Column 1), will stand a 0% chance of passing the test if α is controlled at 16% (Column 2), the chance of passing will increase to 3% at an α of 8% (Column 3). Table 5 provides α and β values for a control capture rate of 1 capture in 25 releases.

Table 4 Type 2 error (β) risk of accepting inferior TED, for Type 1 error (α) risk of rejecting a good TED at 16% and 8% given a control capture rate of 0 captures in 25 exposures.

True but unknown efficiency of candidate TED	Reject candidate TED at 1 capture $\alpha = 0.16$ β	Reject candidate TED at 2 captures $\alpha = 0.08$ β
95%	0.28	0.64
90%	0.07	0.27
* 80%	0.00	0.03
70%	0.00	0.00

Table 5 Type 2 error (β) risk of accepting inferior TED, for Type 1 error (α) risk of rejecting a good TED at 28%,15% and 8% given a control capture rate of 1 captures in 25 exposures.

True but unknown efficiency of candidate TED	Reject candidate TED at 2 captures $\alpha = 0.28$ β	Reject candidate TED at 3 captures $\alpha = 0.15$ β	Reject candidate TED at 4 captures $\alpha = 0.08$ β
95%	0.64	0.87	0.97
90%	0.27	0.54	0.76
80%	0.03	0.10	0.23
70%	0.00	0.01	0.03
60%	0.00	0.00	0.00

The results from 1995 testing of top and bottom Super Shooters indicate that these TEDs may be more efficient at excluding sea turtles in the test than the NMFS TED. Thus, electing either of these TED types as the new control could make "passing"the test more difficult for a candidate TED. Equally, selection a more efficient control may further assure that candidate TEDs which pass the test are truly efficient TEDs.

TEST #2 TESTING OF MOORE RAMP

BACKGROUND

Ramp modifications to hard TEDs have been used in the shrimp fishery for some time, albeit illegally. The purpose of the ramp is much the same as an accelerator funnel, specifically, to direct shrimp away from the TED exit hole (Figure 1). The preference of a ramp over an accelerator funnel as expressed by some fishermen, is that it is less likely to clog with debris in trashy fishing conditions. Fishermen have also indicated that ramps are most effective for shrimp retention in bottom exiting TEDS, and are not of much benefit in top opening devices.

Because of the apparent desire for a ramp modification within the industry, testing of it's effect on sea turtle escapement and a subsequent technical description was needed. The ramp design evaluated during the 1995 TED test was sponsored by Mr. Richard Moore of Galveston, TX and is thus called the "Moore ramp".

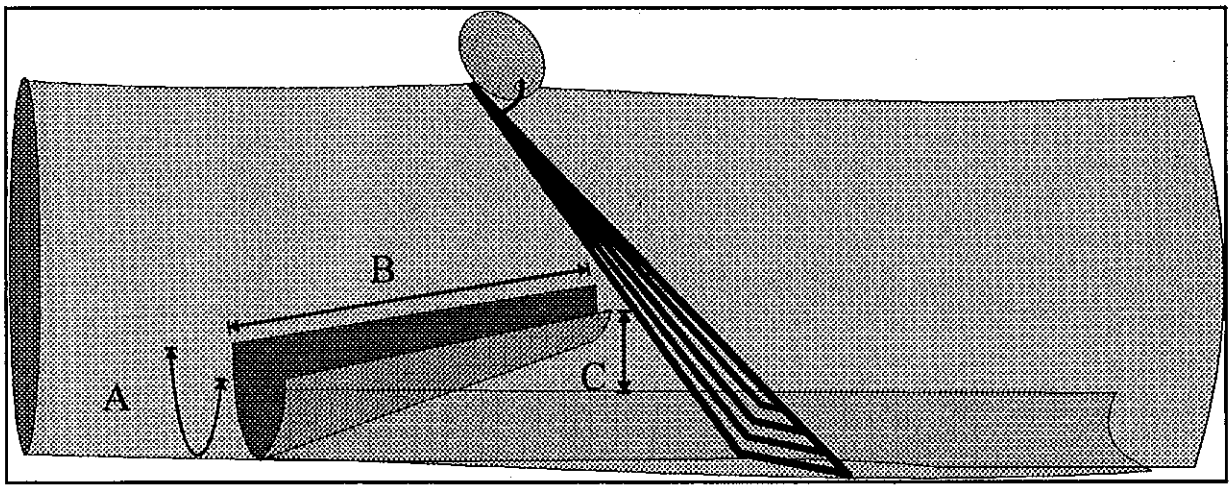

Figure 2 Moore Ramp installed in a mid-size Super Shooter TED 1995 TED Test. A = Leading edge of ramp panel: 30M of ramp panel attached to 48M of flap. B = 25M edge of ramp panel attached to 20 bars of TED extension, 5 meshes left unattached. C = Trailing edge of ramp stepped up 4 meshes from flap seam.

Certification testing of the Moore ramp was conducted with the modification installed in a bottom opening mid-sized Super Shooter. The ramp was constructed of 1-1/2-inch stretched mesh, #24 nylon webbing. The leading edge of the ramp (30M) was sewn to 48M of the leading edge of the TED flap. The 25M sides of the ramp were sewn along bars of the TED extension. The trailing edge of the ramp was measured at a 4 mesh step-up from the flap seam.

While under tow, the space between the trailing edge of the ramp and the TED deflector bars was measured at 8-inches of clearance at center and a 5-inches of clearance at the sides. The angle of the TED frame was measured a 45° under tow.

TESTING SUMMARY

The results from testing of the Moore ramp are summarized in Table 6. Escape times for turtles exposed to the Moore ramp ranged from 36 seconds to 297 seconds with a mean of 136 seconds.

Table 6 Results from testing of bottom opening mid-sized Super Shooter with Moore ramp modification. 1995 TED tests.

N	Capture / Escape	Average Escape Time (seconds)	Range (seconds)
25	0 / 25	136	36 - 297

DISCUSSION

Observations of turtles encountering the Moore ramp indicated that the ramp had little effect on escapement. Turtles were observed to have little difficulty in maneuvering over the ramp to make their escape out of the trawl. The mean turtle escape time of 136 seconds seems to be consistent with that of a bottom opening Super Shooter TED with accelerator funnel (126 seconds).

Committee members are reminded that this test was performed with no recommendation as to establishment of a control. However, the Moore ramp modified TED performed better than the NMFS TED and as well as both the top and bottom opening Super Shooters in this series of tests. Thus the candidate TED could be viewed as having "passed" the test, regardless of the control TED recommendation.

Should the Moore ramp be approved as an allowable modification to hard TEDs?

Dr. Jim Murray *Director, Marine Advisory Service, North Carolina Sea Grant*

Recommendation - Yes

Justification: The ramp is apparently needed by industry and does not work much differently than an accelerator funnel, which is allowed. Also, the ramp performed similarly to the bottom opening super shooter without a ramp and better than the NMFS control TED.

My only concern is that the clearance between the ramp and the TED deflector is 8" in the middle. Although this distance does not affect the juvenile test animals, what is the girth measurement (belly to high point of carapace) of a large loggerhead. My guess is, without having access to the data, is that it is close to eight inches. If so, the ramp may need to be shortened a mesh or two. I would defer to the turtle biologists on the measurement aspect.

Jim Bahen *Marine Advisory Agent, North Carolina Sea Grant*

Recommendation Yes, the Moore Ramp should be certified

Justification: The Moore Ramp passed the small turtle test with 25 escapes. It appears to be nothing more than a modified accelerator funnel and therefore should be allowed as an alternative to an accelerator funnel. I do have concern regarding the distance between the trailing edge of the ramp and the deflector bars. The space may need to be larger to accomodate larger turtles. I feel that the ramp could be certified as an allowable modification to any existing hard TED design.

Dave Harrington *University of Georgia, Marine Extension Service*

Recommendation: Yes.

Justification : The Moore Ramp passed the test, it should be certified as an allowable modification to hard TEDs. Suggest however that the ramp be tested at the Cape to insure that it will not prevent the escape of large turtles.

Gary Graham *Associate Professor, Texas A&M University, Sea Grant*

Recommendation: Yes, the Moore ramp should be approved for use in hard TEDs

Justification : The ramp seemed to have no effect on the escapement of the juvenile test turtles, and in fact all 25 escaped. Some shrimp fishermen here in Texas are supporting the certification of a ramp because it does not clog with trash the way an accelerator funnel will, and it seems to prevent shrimp loss.

Larry Ogren *(Retired NMFS), Sea Turtle Biologist , Panama City, Florida*

Recommendation: I recommend that the NMFS not allow the Moore Ramp as a modification to hard TEDs for all areas in SE U.S.

Justification: The Moore Ramp was designed for use in bottom opening TEDs. The NMFS prefers TEDs to release turtles, especially small individuals, from the top of the trawl (refer to escape times of turtles from top opening TEDs as compared with bottom opening types).

In addition, the continuing re-designing of TEDs by shrimp fishermen must be limited and not encouraged (see "soft TED" issue). In order to evaluate all the designs promulgated by the industry, many man-hours and travel expenses (plus vessel costs) are required. Also, a continuous supply of test animals must be raised to appropriate sizes for

these tests, further burdening the NMFS limited resources. The industry has been given many years to refine their TEDs -- most did not satisfy the NMFS requirement to protect sea turtles.

Dr. André Landry *Texas A&M University*

Recommendation: Yes- The Moore Ramp should be approved

Justification: The device passed the NMFS protocol and should therefore be considered for approval. The space between the trailing edge of the ramp and the deflector bars should be regulated to the same dimensions as the TED escape opening.

Dr. Erich Stabenau *Physiology Department, East Carolina State Univ.,Greenville, North Carolina*

Recommendation: The Moore Ramp should be approved as an allowable modification to Super Shooting TEDs with the caveat that the installation of the Ramp would be identical to the installation used during the TED certification trials (i.e., comparable mesh sizes and clearances).

Justification: The recommendation of Moore Ramp modification to the Super Shooter TED is based on the fact that the Moore Ramp did not substantially alter the average escape time from the control Bottom Opening Super Shooter TED and the modified TED excluded all 25 turtles during testing. However, the recommendation of the Moore Ramp is limited to comparable installation of the Ramp in comparable TED designs. Recommendation of the Moore Ramp for all hard TED designs can not be made without additional testing.

Sandy MacPherson *Coordinator, Sea Turtle Recovery, U.S. Fish and Wildlife Service*

Recommendation: The Moore Ramp was only tested in a bottom opening Super Shooter and therefore should only be considered for certification for use in a bottom opening Super Shooter. Use of the Moore Ramp in other bottom opening TEDs should undergo individual certification testing. Regardless, based on the design of the Moore Ramp used in the test with the bottom opening Super Shooter, I recommend that it not be certified.

Justification : Although the bottom opening Super Shooter with a Moore Ramp excluded all test turtles within the 5-minute exposure period, the space between the trailing edge of the ramp and the TED deflector bars was very small (i.e., 8-inch clearance at center and 5-inch clearance at the sides). The turtles used in the tests ranged from 27.4 cm to 37.7 cm and were all able to squeeze through the opening. However, an adult turtle might not be so fortunate. To deal with this, I recommend that the space between the trailing edge of the ramp and the TED deflector bars be redesigned to meet the TED opening size requirement. Following redesign, the Moore Ramp should be retested.

If the decision is made to certify the Moore Ramp, I urge that it only be allowed in the bottom opening Super Shooter. Although the function of the ramp is to direct shrimp away from the TED exit hole, it also serves to direct turtles away from the exit hole. Use of the Moore Ramp in the bottom opening Super Shooter resulted in successful escapes, but somewhat increased escape times. In one case, a turtle was only 3 seconds short of the 5-minute exposure time. As a result, increased escape times resulting from use of the Moore Ramp may be a potential problem for using the devise sic in other bottom opening TEDs. Therefore, individual testing of the Moore Ramp in other bottom opening TEDs should be conducted prior to consideration for certification for use in those TEDs.

NMFS Harvesting Systems Recommendations

Should the Current Control TED (NMFS) be replaced with a top or bottom opening Super Shooter TED?

Dr. Jim Murray

Recommendation: Yes, replace the NMFS control TED with the top opening super shooter TED.

Justification: For small < 28 cm turtles the NMFS TED has a relatively high capture rate (33%). Additionally, since a hinged door is no longer allowable then it seems to me we are sending the wrong message by using a hinged door TED as the certification standard.

Since the super shooter is widely utilized by industry and since its turtle escape rates performed better than the NMFS TED in this test, then we ought to adopt it as the new standard. I recommend the top opening since the time it took a turtle to exit was decreased from a mean 126 second to 69 seconds. The adoption of the top opening super shooter would assure that we are using the most efficient TED as the standard.

Jim Bahen

Recommendation: The control TED should be changed to a top opening Super Shooter

Justification: The Super Shooter seems to be the hard TED of choice. The top opening configuration had shorter escape times. We should establish a control which, based on testing, performs the best.

Dave Harrington

Recommendation: Vote to select bottom opening Super Shooter as new control

Justification: We should attempt to simulate what is most preffered and used by industry, i.e.bottom opening hard TEDs.

Gary Graham

Recommendation: Vote to select bottom opening Super Shooter as new control

Justification: The bottom opening Super Shooter released all 25 turtles within the required time period, and therefore performed as well as the top opening device. In addition to being an efficient TED, the control should attempt to duplicate what the majority of industry is actually using, i.e. bottom opening TEDs.

Larry Ogren

Recommendation: I recommend that the NMFS replace the current control TED with a top opening Super Shooter TED.

Justification: The Super Shooter TED design is widely used by shrimp fishermen. It would be a logical move for the NMFS to replace the older control TED with a design that more closely resembles the industry (shrimp) designed models. Also, it would appear that smaller turtles escape faster from TEDs without rigid (framed) netting over the exit "hole".

A more equitable test for certification purposes is desirable in order to enhance acceptance and compliance of the NMFS regulations concerning TED design by shrimp fishermen. The more similar the control TED is to a TED currently accepted by the industry, the better the test for obvious reasons.

Dr. André Landry

Recommendation: Either top or bottom

Justification: As both top and bottom opeing designs performed equally well under the test criteria, they both seem to be acceptable choices for the new control.

Dr. Erich Stabenau

Recommendation: I recommend that the current control NMFS TED be replaced with a Super Shooter TED. I further recommend that the Top Opening Super Shooter should be adapted as the new control TED for TED certification trials.

Justification: The reasons to recommend that the Top Opening Super Shooter be adapted as the new control for the NMFS TED certification trials include: (1) the TED which excludes the maximum number of turtles should serve as the control TED. The Super Shooter TEDs excluded 50 of 50 turtles, whereas the NMFS TED had one capture in 25 turtles (not to mention the poor performance of the NMFS TED during past tests with small turtles); and (2) based on exclusion of turtles with half the escape time and less variation in escape time, the Top Opening Super Shooter should be adapted as the control.

Sandy MacPherson

Recommendation:

I recommend that the current control TED (NMFS) be replaced with a top opening Super Shooter.

Justification: Although both the top opening and bottom opening Super Shooters excluded all test turtles within the 5-minute exposure period, the top opening design did so in a significantly shorter period of time. With the bottom opening Super Shooter, turtles shown in the video consistently tried to swim upward away from the exit hole. This seems to be a problem with bottom opening TEDs in general, because greater capture times, which may result in increased stress to the animals, have been observed with them. Also, turtles in the bottom opening Super Shooter test seemed to spend more time pressed up against the TED deflector bars where there appeared to be the opportunity for abrasion to the carapaces and plastrons of the animals. I have no information on which to assess this, but would be interested in knowing if any carapace or plastron damage has been noted in TED certification tests.

NMFS Harvesting Recommendation

SUMMARY OF 1995 TED TESTING PROCEDURES AND GEAR DESCRIPTION

1995 TED Certification Test
R/V Caretta
Panama City, Florida
May 27 - June 6, 1995

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
Mississippi Laboratories
Pascagoula Facility
P.O. Drawer 1027
Pascagoula, MS 39568-1207

INTRODUCTION

The Harvesting Systems Branch of the National Marine Fisheries Service conducted certification testing of candidate TED designs using the juvenile sea turtle protocol during the period of May 27 through June 6, 1995 in Panama City, Florida. Two year-class loggerhead turtles (*Caretta caretta*) were released into candidate TED equipped trawls in order to determine TED exclusion efficiency. Candidate TED designers were invited to participate in testing their respective TEDs.

As recommended by the 1994 TED Testing Review Committee, testing was also conducted on top and bottom opening Super Shooter TEDs. The committee will review the results of these tests and make recommendations as to a replacement of the NMFS TED as a control.

The juvenile turtle TED test was developed in 1989 due to the inability to adequately test candidate TED designs using the Cape Canaveral protocol. The juvenile turtle test protocol has been used to evaluate new TED designs in 1989, 1991,1993 and 1994.

Results from the juvenile turtle TED tests are presented to the TED Testing Review Committee comprised of shrimping industry representatives and sea turtle conservationists. Based on their review, the committee formulates recommendations to the NMFS Southeast Regional Director on candidate TED certification, and modifications to the test procedure.

METHODS

Area of Operation

Testing was conducted in the Gulf of Mexico, 1/4 mile off Shell Island, Panama City, Florida. A 4 mile east/west towing lane was established in 5 to 7 meters of water.

Preliminary Inspection of Candidate TEDs

Preliminary diver inspection and underwater video recordings were made of each candidate TED before initiating the test for that TED. TED designers were given the opportunity to review the inspection video of their respective TED, consult with NMFS gear specialists, and make modifications to their device prior to testing. Continued inspection dives and modifications were allowed as time permitted.

Test Turtles

A total of 166, 2-yr. class loggerhead turtles were used in the tests/evaluations. The turtles had a mean straight line carapace length of 34.9 cm with a range of 27.4 cm - 37.7 cm. (Appendix 1, Table 1). Care and handling of the test turtles was conducted by NMFS Galveston personnel. A detailed description of their procedures may be found in *"Conditioning, Transporting and Maintaining of Sea Turtles for TED Certification Trials in Spring 1995"* prepared by NMFS Galveston.

During the testing period, turtles were maintained and handled on and off the vessel by NMFS Galveston personnel.

Each day during the test, approximately 16 turtles were removed from the pen and placed aboard the *R/V Caretta* for transport to the test area. While aboard the vessel, the turtles were held in individual plastic tubs filled with sea water. Sea water in the tubs was monitored for temperature and changed as necessary. The turtles were shaded from sun exposure using a canopy suspended from the vessel rigging. On several occasions, turtles were transported to the vessel via small boat at midday.

Turtle Behavior

The turtles used for this test exhibited a great deal of vigor during their underwater exposure period. The turtles exhibited an ability to adjust their buoyancy rapidly for the enforced submergence. This was indicated as many of the turtles dove to the bottom of the trawl after being released.

Post Test Release of Turtles

Turtles, which were not released during the course of the TED tests, were released at the conclusion of the test in the Gulf of Mexico approximately 6 miles west of the Panama City Ship Channel in 30 meters of water. The turtles were transported to the release site by the Panama City Marine Institute aboard the *R/V Guardian Angel.* A complete list of the released turtles is available in a summary report prepared by the NMFS Galveston field party chief.

Recaptured Turtles

Some turtles were recaptured for blood sampling after being used in a test. Recapture was facilitated by attaching a 6-inch x 8-inch football float to the posterior marginal scutes of the turtle before it was released from the trawl. The turtle was captured with a dip net at the surface by a support Zodiac and returned to the vessel. Recaptured turtles were allowed a minimum 48 hour recovery period before being reused for TED testing.

Test design

In order to establish control data, a complete test of 25 turtle exposures was conducted using the NMFS TED. The NMFS TED has a record of proven effectiveness and scored a 95%, 84%, 92% and 88% turtle exclusion rate during testing in 1988, 1989, 1991 and 1994 respectively. In 1993, NMFS TED test data (n=10) were pooled with historical data sets to arrive at a 90% turtle exclusion rate.

Each candidate TED was scheduled to be tested for small turtle exclusion a total of 25 times. Based on the performance of the NMFS TED, testing of a candidate TED could be terminated before 25 turtles were released if the candidate TED displayed a significantly lower escape rate. This method was employed to insure that a sufficient number of turtles would be available to complete the proposed test schedule.

Turtles were transferred from the surface to divers on the trawl via a 1/8-inch stainless steel wire which was spliced into the trawl bridle split and attached to the center of the trawl head rope. Turtles were placed inside a weighted 25-inch x 25-inch mesh bag at the surface, attached to the messenger wire with

a snap clip and sent underwater to divers on the trawl. Transit time for the turtle from the surface to the trawl was approximately 1 minute.

Three scuba divers were used to monitor each test. Diver #1 released the turtle into the trawl, then took position at the TED to recapture the turtle, diver #2 monitored the turtles passage through the net, recorded escape time and noted turtle activity level and, diver #3 recorded each test using an underwater video camera. After release into the trawl, each turtle was allowed 5-minutes to escape through a candidate TED. If at the end of 5 minutes the turtle was still within the trawl, it was removed by a diver and released. If a turtle was determined to be overly stressed during the five-minute exposure period , it was removed from the trawl, returned to the vessel immediately, and not counted in the sample.

Statistical Methods

An outline of the statistical procedure used in conducting the small turtle TED test is provided below:

1. A control (NMFS TED) was tested using a sample of 25 turtles.

2. Null Hypothesis (Ho) = exclusion rate of the candidate TED is equal to or greater than that of the control TED. Alternate hypothesis (Ha) = exclusion rate of the candidate TED is less than that of the control TED.

3. To derive the number of turtle captures required to reject a candidate TED using a sample of 25 turtles, the probabilities of committing Type I and Type II error must be considered (Appendix 1, Table 5). These errors are defined as:

   Type I Error (α): Rejection of a candidate TED which is as good or better than the NMFS TED.

   Type II Error (ß): Acceptance of a candidate TED which is inferior to the NMFS TED.

NOTE: An inverse relationship exists between Type I error and Type II error probabilities with a fixed sample size .

4. Based on the performance of the NMFS TED (1995 test = 1 capture in 25 releases), and the associated Type I and Type II error probabilities, it was determined that testing of a candidate TED could be terminated after it had failed to release four turtles. This capture rate corresponded to an 8% risk of rejecting a candidate TED which was as good as or better than the NMFS TED.

GEAR DESCRIPTION

Project operations were conducted aboard the *R/V Caretta*, a 60-ft steel hull shrimp trawler operated by the NMFS Southeast fisheries Science Center, Mississippi Laboratories, Pascagoula Facility. Tests and evaluations were conducted towing a single TED equipped trawl at 2.5 knots directly astern of the vessel.

NMFS TED (control)

Top opening door, non-collapsible model with accelerator funnel and finfish excluder side openings.

Trawl Type/Size: 50-ft flat net
Door Size: 8-ft x 40-in

Top and Bottom Opening Super Shooter TED (Figures 1-3)

A mid-sized aluminum frame Super Shooter TED was used in the testing of a new test control. The TED was tested in a top opening and bottom opening configuration. In a bottom opening mode, a single K-50 spongex float was attached to the top of the TED frame providing approximately 10 lbs. of positive floatation.
No floats were attached to the top opening TED. Both top and bottom opening forms were fitted with an accelerator funnel. For details on material specifications and installation of the TED frame and associated components refer to "Super Shooter TED Construction (mid-size) a NMFS Harvesting Systems Branch brochure.

Trawl Type/Size: 50-ft flat net
Door Size: 8-ft x 40-in

Moore Ramp (Figure 4)

The purpose of the ramp is to direct shrimp away from the TED exit hole in much the same way as an accelerator funnel. The ramp was sponsored by Mr. Richard Moore of Galveston, TX.

Initial testing of the Moore ramp was conducted with the modification installed in a weedless-type TED design. Due to an inability of turtles to escape from the TED due to a design flaw in the TED frame, the Moore ramp was reinstalled in a mid-sized Super Shooter (See Resultsand Discussion sections).
A certification test was conducted on a bottom opening Super Shooter TED with a ramp modification. The ramp was constructed of 1-1/2-inch stretched mesh, #24 nylon webbing. The leading edge of the ramp (30M) was sewn to 48M of the leading edge of the TED flap. The 25M sides of the ramp were sewn along bars of the TED extension. Thee trailing edge of the ramp was measured at 4 mesh step up from the flap seam.

When in a fishing configuration, the space between the trailing edge of the ramp and the TED deflector bars was measured as follows: 8-inch clearance at center, 5-inch clearance at the sides. The angle of the TED frame was measured a 45° under tow. The ramp was installed in a bottom opening mid-size super shooter with flap dimensions identical to that shown in Figure 2.

Trawl Type/Size: 50-ft flat net
Door Size: 8-ft x 40-in

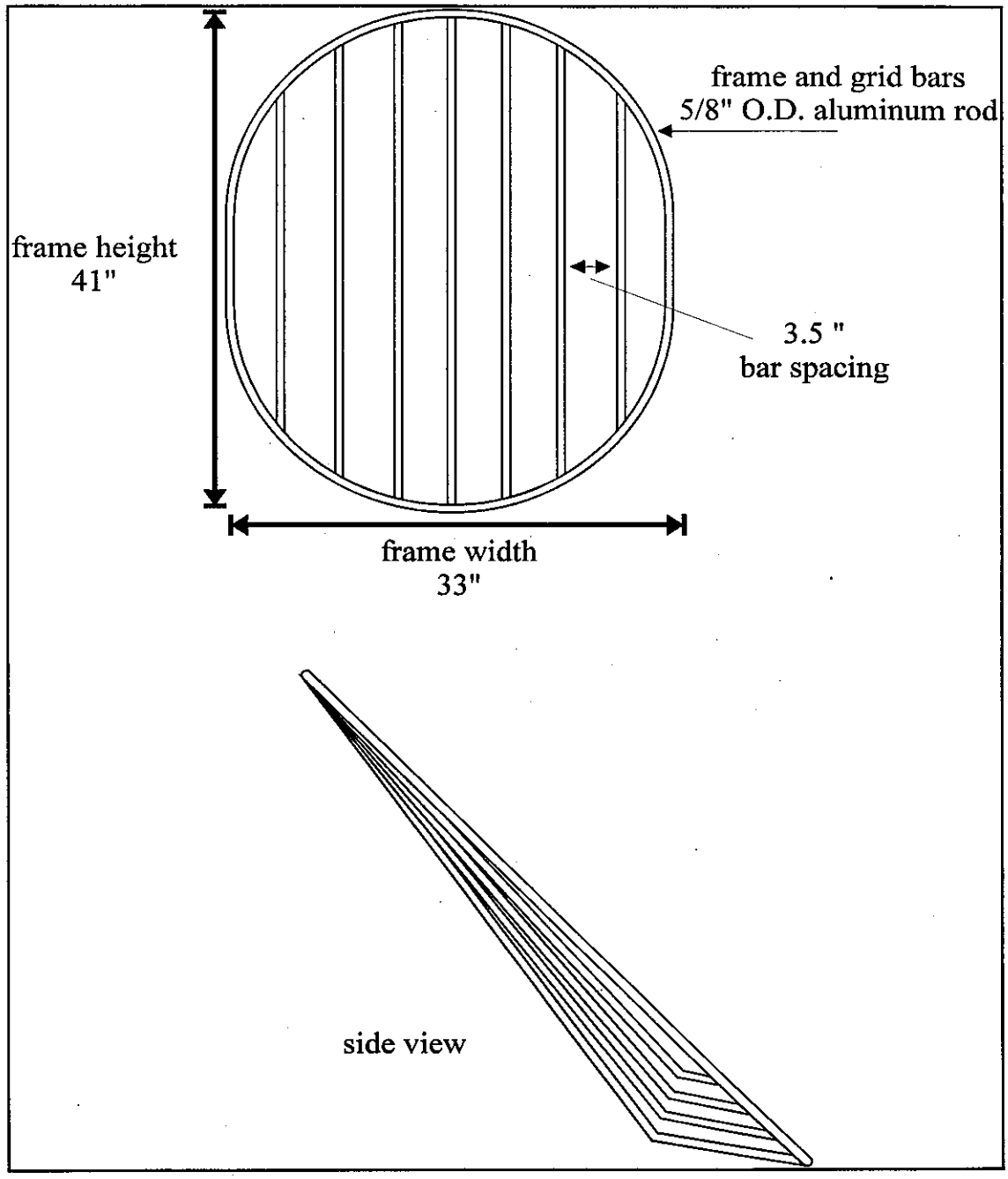

Figure 1 Dimensions of mid-size Super Shooter frame used in 1995 TED Tests

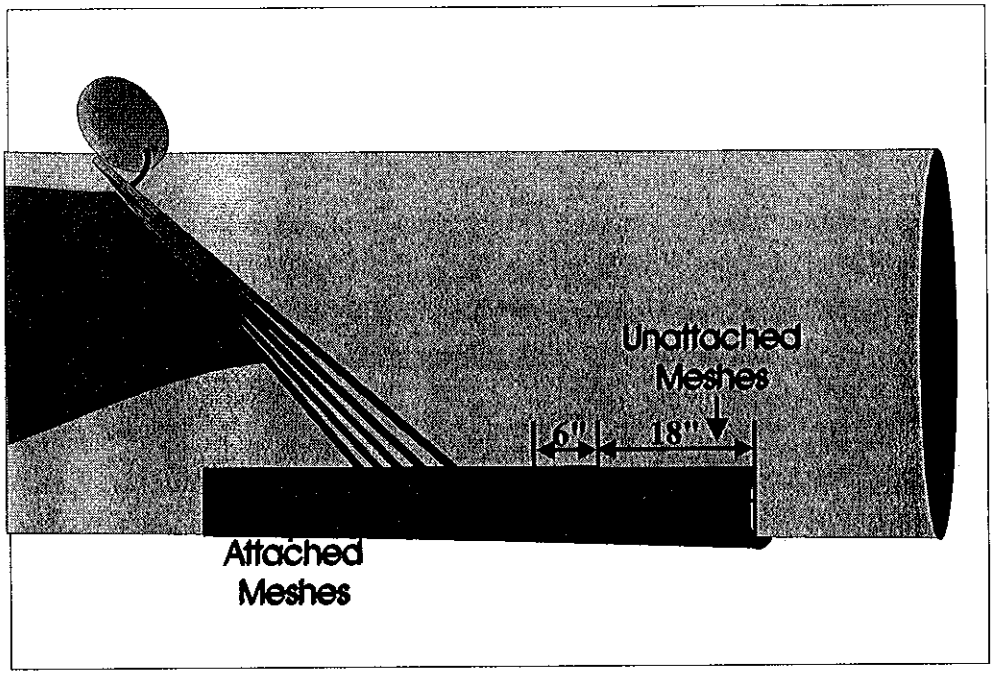

Figure 2 Detail of extended flap used on top and bottom opening mid-size Super Shooter in 1995 TED Tests.

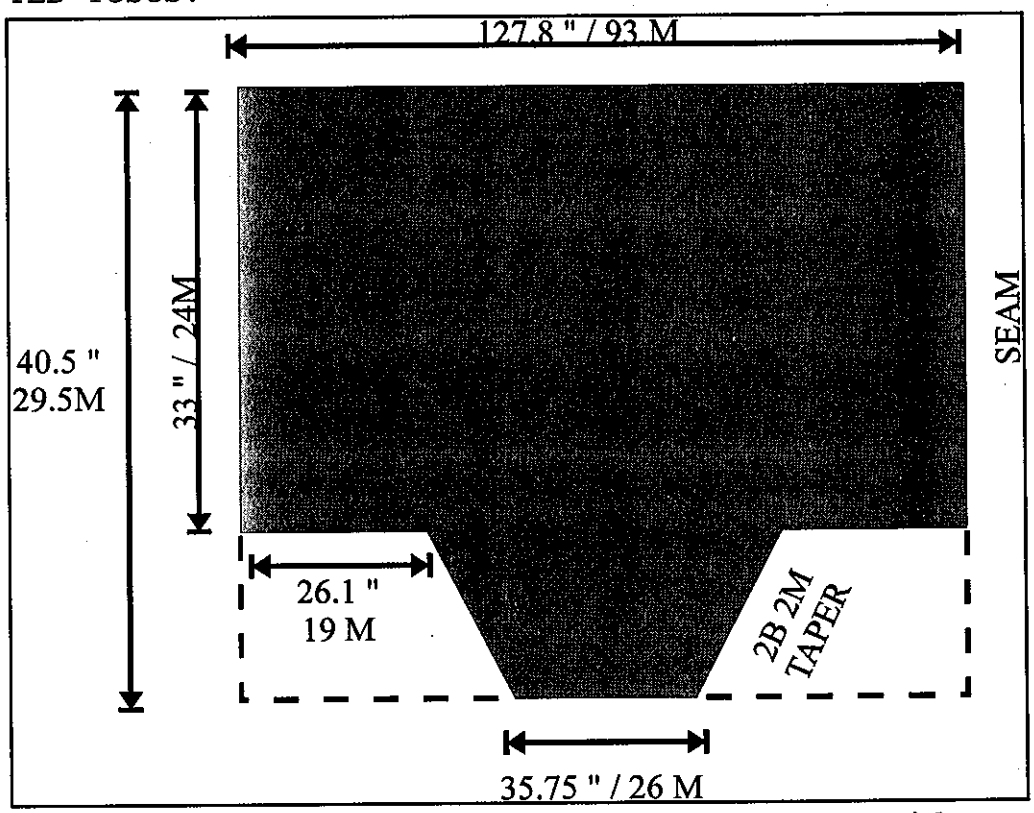

Figure 3 Accelerator funnel dimensions for mid size Super Shooter uin 1995 TED Tests

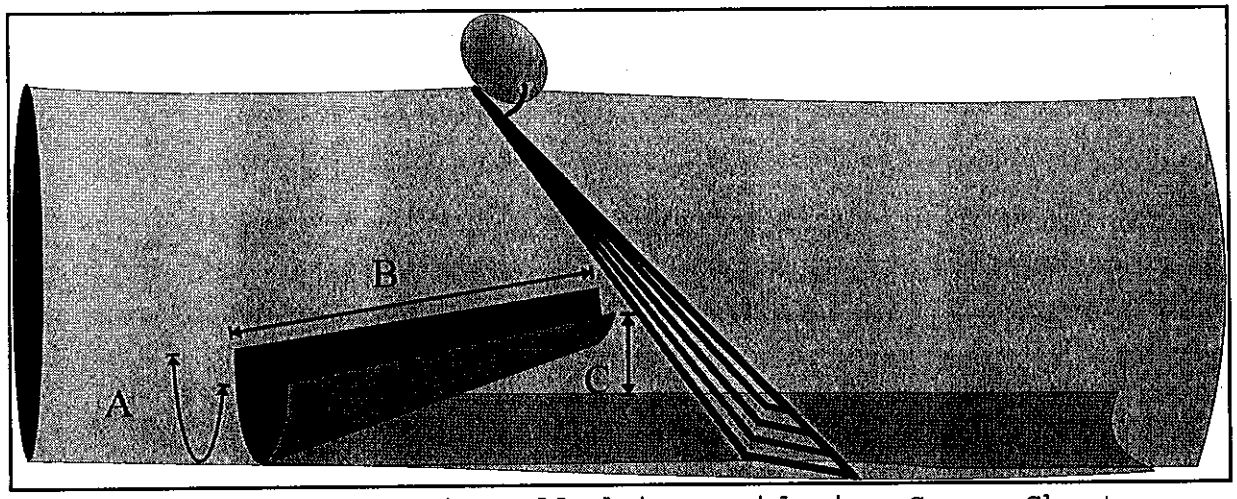

Figure 4 Moore Ramp installed in a mid-size Super Shooter TED. 1995 TED Test. A = Leading edge of ramp panel: 30M of ramp panel attached to 48M of flap. B = 25M edge of ramp panel attached to 20 bars of TED extension, 5 meshes left unattached. C = Trailing edge of ramp stepped up 4 meshes from flap seam.