

Testing of a Low Profile Excluder Dredge For Winter Flounder Bycatch Reduction

**“Challenge Grant Program for Conservation Engineering
Projects -
Winter Flounder Bycatch Reduction”
NOAA Award Number NA09NMF4720414
Part II: Full Proposal**

February 2011
Revised April 2011
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Project Summary

The low profile scallop dredge frame will be constructed in two sizes; a 9-foot wide version for the LAGC fleet and a 15-foot wide version for the LA offshore fleet. The dredge will be taken to sea on dedicated research trips; 15 DAS for the small dredge and 21 DAS for the larger dredge. The gear will be tested in areas of high concentrations of winter flounder. In addition about 5 DAS will be dedicated to studying winter flounder behavior using an ROV.

Project Goals and Objectives

The objective is to gather comparison fishing data on the low profile dredge design for both inshore and offshore fleets. In addition, behavioral data will be collected using the ROV to ascertain how winter flounder can be encouraged to avoid capture, or to escape once caught, in scallop dredges and other gear types. The resulting information will be used to improve the low profile scallop dredge frame and possibly other gear types.

Project Management

Ronald Smolowitz, Matt Weeks	Project management, data analysis, reporting
Ronnie Enoksen, Peter Anthony	Large dredge/scallop bag construction; vessel provision
Michael L. Marchetti	Coordination with LAGC vessels; small dredge design

All the participants will work closely with each other on all aspects of the project; the purpose of the above list is to indicate the key roles of the participants.

Project Duration April 2011 through April 2012

Background

A new concept for construction of a New Bedford style sea scallop (*Placopecten magellanicus*) dredge frame recently been designed and tested with the goal of keeping loggerhead sea turtles (*Carretta carreta*) from snagging on top of the dredge frame and becoming trapped under the dredge bale while the gear is towed ([Milliken et al, 2007](#); [Smolowitz et al, 2010](#)). The dredge frame was designed to smoothly guide turtles over the top of the dredge primarily by moving the cutting bar forward and eliminating most of the bale bars.

From May 2006 until November 2009 a total of thirty-three trips were made on thirteen different commercial scallop vessels to test dredge modifications for impacts on scallop catch, fish bycatch, and frame durability. Five general design modifications were tested by conducting paired tows using the modified dredge design along side a standard New Bedford dredge as a control. Both the modified dredge and control dredges were fished using identical tow parameters. A total of 4,059 paired tows were conducted in which tow data and scallop catch were recorded; total catch was quantified from 40% of these tows. In addition, flume tank testing was utilized for flow characterization to determine if there were any

significant differences in cutting bar and frame hydrodynamics between the various design options (Smolowitz and Weeks, 2008).

The final dredge frame design, the Cfarm turtle excluder dredge, tested in the study held up to the rigors of commercial fishing on most scallop grounds, maintained commercially acceptable levels of scallop catch, had significantly lower bycatch of several species, while applying features that could reduce injury to sea turtles. In addition, this dredge design was found to be readily acceptable and applied by fishers with no increase in costs or labor.

Overall the experimental dredge design concept (cutting bar forward of depressor plate, 45° cutting bar and strut angle, doubled outer bale, and reduced number of bale bars) increased the catch of scallops while decreasing the retention of important bycatch species. Of the 1,632 observed tows analyzed (student's t test for paired means $\alpha=0.05$) relative to the standard New Bedford dredge, the experimental dredges increased scallop catch by 3% ($P = 0.0000$) while having significant decreases in summer flounder (-11%, $P= 0.003$), yellowtail flounder (-46%, $=0.0000$), winter flounder (-69%, $P=0.0000$), barndoor skate (-18%, $P= 0.0000$), winter skate (-20%, $= 0.005$), sand dab (-47%, $P=0.0000$), and fourspot flounder (-20%, $P=0.0000$). Interestingly there were no significant difference in the catch of little skate (-0.3%, $= 0.404$) and monkfish (1%, $P= 0.309$).

Flume tank tests and video observations suggest some advantages to widening the pressure plate in the forward cutting bar design in that increased lift is created behind the cutting bar. A wider cutting bar may also decrease the amount of fish entering the dredge above the cutting bar. There is a continuing need to further develop the dredge frame design, especially design efforts focused on the relationship of the cutting bar to the depressor plate in developing a strong lifting stream to improve efficiency on scallop capture. An analogy would be the relationship of a jib and main sail on a sailing vessel. There is also great room for other improvements in the hydrodynamic characteristics of the dredge frame. The depressor plate is of poor hydrodynamic design with lift to drag ratio of approximately one. This ratio can easily be increased by changing the angle, for example, changing the 45 degree angle of attack to 22.5 degrees gives a lift to drag ratio of 2.4 which should save fuel.

Our operating hypothesis is that the excluder dredge reduces flatfish bycatch in that the forward cutting bar design encourages the fish to swim upwards and over the dredge (see Figures 1-3). The newer idea, the low-profile excluder dredge, is to lower the profile of the Cfarm turtle excluder dredge to make it easier for fish to swim over the oncoming frame. This was accomplished by changing the frame angle, on a 15-foot wide dredge, from 45° to 22.5° and lowering the dredge frame height by four inches. The resulting low profile dredge frame has a shoe 22 inches long compared to the existing standard dredge shoe of 15 inches. We maintained the Cfarm turtle excluder dredge strut spacing of 9 inches, the reduced number of bale bars, the doubled outer bale, and the 45° cutting bar angle.

Additionally, the scallop bag was slightly modified to accompany the reduced height of the frame. Interestingly, the lower height of the frame and bag might aid in the escapement of fish that enter the dredge. To prevent a loss of scallops we may have to have the apron rings overhang the sweep which is still a common practice in the fleet.

Under the CFRF Challenge Grant Program Part I a four day research trip onboard the F/V Tradition was conducted using dredge mounted video cameras (Figure 1) to ascertain how

winter flounder react to a scallop dredge. Two dredges were utilized; a standard New Bedford dredge and a new low-profile dredge. In addition the catches from 32 paired tows by the two dredges were compared. The dredges caught similar amounts of scallops but the low profile dredge significantly reduced the bycatch of winter flounder, *Pseudopleuronectes americanus*, (122%), little skate, *Leucoraja erinacea*, (88%), summer flounder, *Paralichthys dentatus*, (55%), and sand dab, *Scophthalmus aquosus*, (116%). On a commercial fishing trip conducted by the F/V Celtic, the new low-profile dredge caught about the same amount of scallops as the Cfarm turtle excluder dredge in an area with few fish present.

Statement of Work

The 15-foot version of the low profile dredge will be designed by the project participants and constructed at Dockside Repair, Inc in New Bedford. The smaller version will undergo a similar design process and will be built by Blue Fleet Welding of New Bedford. There will be several modifications to the design from the one build for the challenge grant. The changes will include a center I-beam to replace the bar stock and a wider depressor plate bolt-on option.

Under this proposed project, we would take the larger version of the dredge out to sea on three seven day trips to areas where the fleet and surveys are reporting the highest catches of winter flounder. These will be directed research trips with no retained catch in order to fish areas with high bycatch ratios. On all trips the low profile and standard dredges will conform to all existing regulations. We will compare a standard New Bedford control dredge to the low profile excluder dredge. The trips will occur between April 1 2011 and April 31, 2012.

Two dredges will be towed simultaneously during all three trips. Towing speeds will be maintained at 4.5 knots and wire scope will be four to one. On all directed research trip tows the entire scallop catch will be counted in bushel baskets and a one basket sub-sample measured in 5 mm increments. A one bushel sample has been found to accurately represent the size of the scallops in a commercial catch (4-inch ring dredge bag) based on our previous research. The fish catch will be counted and measured, in one cm increments, by species. **All scallops and fish will be returned to the sea.** We will accomplish a minimum of 80 fully documented tow pairs per vessel per trip. For each area a standard tow time will be chosen based on catch rates. Particular attention will be paid to minimize variability between tows on any given trip. We may consider testing 30 minute versus 60 minute tow times (alternating tow times) to document the impact of tow time on bycatch rates. We will also try to standardize haul direction relative to tide. On one of the three offshore trips we will test the wider depressor plate on half the tows (40) for a preliminary evaluation.

Data from this project will be analyzed to determine differences in catch rates between dredges of target and non-target species and any differences in size selectivity of the target and non-target catch. A paired t-test at the $\alpha=0.05$ level will be used to test for significance in catches between the standard control and experimental dredge. Multivariate problems will inevitably exist due to weather and geographic variability but the experimental design of this project limits the variance between gears by pairing tows and using newly constructed gear. We also plan to switch gear between sides at least once per trip. In addition to the paired t-test, other non-parametric statistical tests could be performed to avoid assumptions such as homogeneous distribution of the resource.

The testing of the smaller dredge design, using the smaller inshore LAGC vessels, will take place over a period of 15 DAS using two or three vessels. The major difference in the research design is that only one dredge can be towed at a time. The alternate tow strategy will be chosen based on weather and area at the time of testing. The vessels will be able to keep their catch as this is an ITQ fleet.

Additionally, five DAS will be dedicated to using an ROV to study winter flounder behavior. The area and season for the study will be chosen to provide the highest likelihood of encountering and observing winter flounder. Our current thinking is to utilize day trips during the late winter into areas of spawning concentrations in about 15 fathoms of depth just off the coast of SNE and Cape Cod. The ROV is an excellent tool for observing the behavior of a fish to an approaching object; an example, from our research on sea turtles using a Stingray ROV, can be found on the below link:

<://www.youtube.com/watch?v=>

A final report will be submitted upon completion of the project. Ronald Smolowitz is the Technical Advisor to the Fisheries Survival Fund (FSF), the primary industry organization for the vast majority of the limited access sea scallop fleet. The results of this project will be disseminated to all members of the FSF. Ronnie Enoksen is the leading dredge builder in New Bedford and we expect that improvements in dredge design will be utilized by his shop and others will follow. Tor and Hans Bendiksen are the leading twine top builders in the New Bedford area and will similarly apply successful results. An article will be prepared for Commercial Fisheries News and a publication will be prepared for the peer reviewed literature as results warrant.

Vessels: Three of the below named LA vessels will be utilized depending on availability:

F/V Celtic	Captain Charles Quinn
F/V Westport	Captain Edward Welch
F/V Diligence	Captain Scott Larsen
F/V Tradition	Captain Ronnie Shrader

Two or three of the below LAGC vessels will be utilized:

F/V Foxy Lady	Captain Wally Gray
F/V Mister G	Captain Mike Marchetti
F/V Brooke C	Captain Peter Spang

Specific Exemptions Requested:

An LOA will be required to exempt the LA vessels from DAS. The vessels will be under the control of Coonamessett Farm Foundation, Inc, a Massachusetts non-profit research and education entity classified by the IRS as a 501c (3) corporation. No catch will be retained for sale.

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Figure 1: Comparison of the low profile dredge to the Cfarm Turtle Excluder Dredge.



Figure 2: Low-profile dredge showing the placement of cameras during CFRF Challenge Grant video trials.



Figure 3: A yellowtail flounder going up and over the Cfarm turtle excluder dredge frame; this escape pathway should be easier on the low profile dredge.



Table 1: Catch results form a commercial trip Celtic 2010-1

Tow #	Turtle Dredge			Low-profile Dredge		
	Scallops (bu)	Skate	Fish	Scallops (bu)	Skate	Fish
1	6	50	8	4	30	4
2	5	41	14	4	30	4
3	4	28	10	3	1	8
4	5	34	8	5	42	14
5	3	46	7	3	40	3
6	3.5	45	9	4	37	7
7	3.25	21	3	3	30	4
8	2	41	7	2	44	3
9	3	56	7	3.5	63	6
10	3	32	6	3.25	22	10
11	4	42	9	3	56	9
12	3	13	8	3	17	8
13	3	25	10	4	20	8
14	3	42	3	2.5	25	4
15	5	74	3	5	45	2
16	3	29	4	3	29	6
17	5	59	10	3.25	47	7
18	4.25	34	6	1.5	30	5
19	4	93	4	4	94	7
20	5.5	118	2	4	125	2
21	5	86	7	4	55	5
22	4	79	4	3	37	3
23	4	33	2	4	31	2
24	4	20	4	4	19	4
25	4	24	5	3	15	2
26	3	23	3	3	15	3
27	4	28	2	4.5	20	1
28	4	13	2	4	20	1
29	3.5	16	0	3.5	7	3
30	4	11	2	4	21	2
31	4	25	4	4	17	3
32	3.25	36	6	3.5	26	6
33	4	31	0	4	16	0
34	4	18	3	4	23	3
35	4	10	6	4	18	6
36	3	16	1	3	15	2
37	3	18	1	3.25	34	5
38	3	19	3	3	34	4
39	3.5	40	2	4	60	7
40	3	72	6	3	70	4
41	3	40	1	3	39	0
42	3	11	3	3	10	3
43	4	43	5	4	40	0
44	2.75	26	4	3.5	31	5
45	2.75	25	4	4	13	3
46	3	29	0	1	7	2
47	3.75	98	5	3	97	4
48	4	13	0	1.5	7	4
49	3	20	3	2	12	7
50	3	13	5	4	17	3
51	2	25	0	3	19	4
52	5	26	0	5	20	8
53	4.5	20	2	4.5	21	8
54	4.25	17	0	5	18	4
55	4	23	2	4	15	4
56	5.75	20	0	5.75	17	1
57	2.75	20	0	3.5	16	0
58		10	2	4	16	5
59	1.25	9	5	1.5	13	6
60	6	12	4	5	17	9
61	3	12	4	2.5	7	4
62	7.25	7	4	6.25	10	2
63	3.75	9	4	5	11	4
64	6	13	2	6.25	13	1
65	4	11	3	1.5	9	1
66	6	12	2	7.5	13	1
67	6	12	3	5	13	2
68	5.5	13	4	7	10	1
69	3.5	10	2	3	8	1
70	3.2	10	2	4	7	3
71	2	8	2	2	6	1
72		10	4	3	7	5
73	2	22	5	3	28	3
Totals	271.7	2190	287	267	1967	296

Table 2: Tow data for F/V Tradition 2010-1.

Tow #	Date	start time	end time	Start Position		End Position		Vessel Speed	Depth Fms	Wire Out Fathoms	Tide	Sea State	Vessel Heading	Wind
				Lat	Long	Lat	Long							
1	09/23/10	22:15	22:40	4101.670	7112.214	4100.888	7110.300	4	25	60	N	3-5		
2	09/23/10	22:46	23:00	4100.792	7110.010	4100.117	7108.910	4	25	75	N	3-5		
3	09/23/10	23:08	23:40	4100.040	7108.762	4058.366	7110.916	5	26	75	N	3-5		
4	09/24/10	6:42	7:55	4058.491	7111.123	4058.418	7110.89	5	29	75	N	3-5		
5	09/24/10	8:15	9:22	4058.795	7110460	4058.649	7110.600	4.9	29	80	N	3-5		
6	09/24/10	9:32	10:40	4058.653	7110.589	4058.474	7111.083	4.9	29	75	NE	1-3		
7	09/24/10	11:36	11:50	4058.706	7110.383	nk	nk	4.7	28	75	NE	1-3		
8	09/24/10	13:40	14:32	4058.888	7109.625	4058.912	7108.175	4.8	28	75	slack	1-3		
9	09/24/10	15:12	16:15	4058.850	7108.323	4058.955	7109.851	4.8	28	75	slack	1-3		
10	09/24/10	16:25	17:19	4058.933	7109.938	4059.240	7109.001	4.8	28	75	WNNW	1-3		
11	09/24/10	17:33	18:33	4059.251	7108.982	4050.00	7102.11	5.0	26	75	S	1-3		
12	09/24/10	18:43	19:35	4100.23	7103.12	4100.35	7158.10	5.0	26	75	slack	1-3		
13	09/25/10	6:41	19:30	4100.142	7056.354	4101.539	7051.520	5.0	25	65	N	8-10		
14	09/25/10	7:43	7:43	4101.620	7051.23	4103.547	7045.556	5.0	25	60	N	8-10		
15	09/25/10	9:25	10:35	4103.876	7044.290	4103.551	7039.885	5.0	24	60	N	8-10		
16	09/25/10	10:58	12:00	4103.389	7039.410	4102.992	7034.677	5.0	22	50-55	N	8-10		
17	09/25/10	12:18	13:20	4103.045	7034.266	4103.352	7033.370	5.0	22	55	NE	8-10		
18	09/25/10	13:43	14:50	4103.65	7031.905	4100.686	7028.697	5.0	22	55	NE	8-10		
19	09/25/10	15:09	15:38	4100.627	7028.521	4100.554	7027.541	5.0	22	55	NE	8-10		
20	09/25/10	16:20	17:15	4059.885	7027.946	4057.123	7027.292	5.0	22	55	ENE	8-10		
21	09/25/10	17:15	18:20	4057.018	7027.395	4057.217	7029.066	5.0	24	65	NE	3		NE 10-15
22	09/25/10	18:28	19:20	4057.631	7029.371	4001.240	7031.398	5.0	24	65	N	3	350	NE 10-15
23	09/25/10	19:30	18:20	4001.687	7031.656	4001.13	7032.625	5.0	24	65	N	3	338	NE 10-15
24	09/25/10	18:28	19:18	4000.751	7033.015	4000.935	7035.836	5.0	24	65	N	3	237	NE 10-15
25	09/26/10	6:11	7:00	4101.165	7038.513	4004.485	7040.469	5.0	23	60	N	3	348	NE 10-15
26	09/26/10	7:12	8:01	4104.796	7040.733	4106.386	7045.347	5.0	23	60	N	3	340	NE 10-15
27	09/26/10	8:10	8:50	4106.218	7045.662	4104.311	7048.670	5.0	21	55	NN	3	231	NE 10-15
28	09/26/10	9:41	10:30	4104.279	7049.100	4106.700	7045.327	5.0	21	55	N	3	90	NE 10-15
29	09/26/10	10:51	11:43	4106.560	7044.980	4105.553	7039.833	5.0	22	60	NE	3	136	NE 10-15
30	09/26/10	12:17	13:00	4105.212	7040.241	4103.856	7045.124	4.5	23	60	ENE	3	267	NE 10-15
31	09/26/10	1:24	14:18	4103.824	7045.373	41037.44	7050.168	4.5	23	60	ENE	3		NE 10-15
32	09/26/10	2:46	15:40	4103.713	7050.378	4105.623	7046.016	5.0	20	55	ENE	3	79	NE 10-15

Table 3: Catch results of the Tradition 2010-1 video camera study.

Tow #	Date	Scallop (bu)	Skate	Winter Skate	Winter Flid.	Yellowtail	Fluke	Sand Dab	Four Spot	Barndoor Skate	Monkfish
		Low-profile	Low-profile	Low-profile	Low-profile	Low-profile	Low-profile	Low-profile	Low-profile	Low-profile	Low-profile
1	09/23/10	0.25	96	4	0	1	5	1	0	0	1
2	09/23/10	0.25	29	0	0	0	0	0	0	0	0
3	09/23/10	0.25	162	2	8	1	2	0	1	1	1
4	09/24/10	0.5	171	4	4	1	0	0	0	5	5
5	09/24/10	0.25	90	3	4	0	4	2	1	1	2
6	09/24/10	0.5	131	2	5	1	2	1	3	4	3
7	09/24/10	0.01	31	0	0	0	0	0	0	0	1
9	09/24/10	0.5	153	3	4	0	1	0	0	6	4
10	09/24/10	1	186	5	4	4	3	1	1	1	1
12	09/24/10	2.25	71	6	2	2	2	8	0	2	2
13	09/25/10	0.75	43	11	1	0	3	6	0	0	0
14	09/25/10	1.5	111	17	1	2	2	6	1	1	8
15	09/25/10	0.5	143	17	2	1	12	8	0	3	5
16	09/25/10	0.1	207	13	3	7	11	17	7	7	9
17	09/25/10	0.1	300	10	6	0	7	6	0	0	15
18	09/25/10	0.1	121	9	1	0	4	4	0	1	6
19	09/25/10	0.01	117	5	1	0	1	2	0	0	1
20	09/25/10	0	158	7	1	0	10	3	0	1	4
21	09/25/10	0	187	7	1	0	0	1	0	4	5
22	09/25/10	0	144	6	1	0	2	2	0	1	14
23	09/25/10	0.1	151	7	3	2	7	6	0	3	5
24	09/25/10	0.1	201	7	2	0	2	4	0	2	4
25	09/26/10	0.1	106	12	4	0	8	7	0	3	2
26	09/26/10	0.3	63	6	2	0	1	8	1	0	4
27	09/26/10	2	84	7	2	1	6	19	0	0	4
28	09/26/10	2.25	123	8	4	0	2	24	0	0	4
29	09/26/10	0.25	125	6	1	0	2	14	1	0	2
30	09/26/10	0.01	46	3	0	1	2	6	0	0	2
31	09/26/10	1.75	29	9	0	1	1	2	1	0	4
32	09/26/10	3	93	7	0	0	7	25	1	0	5
SUM:		18.68	3672	203	67	25	109	183	18	46	123
DIFFERENCE:		-2.48	-3245	-55	-82	-2	-60	-212	-13	-14	14
% DIFFERENCE:		-13%	-88%	-27%	-122%	-8%	-55%	-116%	-72%	-30%	11%
p (a =0.05):		0.04	0.00	0.09	0.01	0.41	0.00	0.00	0.13	0.05	0.22

Tow #	Date	Scallop (bu)	Skate	Winter Skate	Winter Flid.	Yellowtail	Fluke	Sand Dab	Four Spot	Barndoor Skate	Monkfish
		Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard	Standard
1	09/23/10	0.25	72	0	1	0	1	2	0	0	1
2	09/23/10	0.9	41	2	0	2	1	1	0	0	1
3	09/23/10	0.5	173	4	10	0	1	1	0	0	2
4	09/24/10	0.75	427	1	9	4	5	3	6	5	4
5	09/24/10	0.25	304	5	0	0	2	0	1	1	2
6	09/24/10	0.5	229	6	0	1	7	0	0	3	4
7	09/24/10	0.5	77	2	2	0	2	0	0	4	1
9	09/24/10	0.3	303	7	7	0	3	0	1	10	7
10	09/24/10	1.1	238	7	1	3	5	6	0	2	3
12	09/24/10	2	107	7	2	0	4	7	0	1	4
13	09/25/10	1	76	7	1	2	4	8	0	0	7
14	09/25/10	1.5	162	6	2	5	4	12	4	3	5
15	09/25/10	0.5	144	7	2	2	14	12	1	2	4
16	09/25/10	0.1	340	17	17	2	22	39	1	5	6
17	09/25/10	0.1	620	15	25	1	11	21	0	3	7
18	09/25/10	0.1	348	18	2	0	4	16	0	2	8
19	09/25/10	0.25	195	6	4	0	2	8	1	1	3
20	09/25/10	0	285	9	6	0	6	6	2	3	2
21	09/25/10	0	251	16	3	1	5	2	0	5	3
22	09/25/10	0	451	7	10	0	3	4	0	2	4
23	09/25/10	0.1	675	26	11	0	8	19	1	1	6
24	09/25/10	0.1	463	17	11	0	6	8	0	0	7
25	09/26/10	0.1	226	16	5	2	13	24	2	4	1
26	09/26/10	0.25	109	2	6	0	4	17	5	0	2
27	09/26/10	2	95	7	1	0	2	37	0	0	7
28	09/26/10	2	158	7	2	0	9	47	0	0	3
29	09/26/10	0.5	91	8	2	0	6	26	1	1	0
30	09/26/10	0.01	79	4	5	1	7	20	3	0	1
31	09/26/10	2	66	12	0	1	4	10	1	1	3
32	09/26/10	3.5	112	10	2	0	4	39	1	1	1
SUM		21.16	6917	258	149	27	169	395	31	60	109