FINAL REPORT

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Development of an off-bottom scallop drag

Northeast Consortium Project #03-174

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Other participants: Frank Genthner, crewman, New Harbor, Maine; Phil Averill, gear technician and grant administrator, Bristol, Maine; Kevin Verney, welder, Sheepscot, Maine, plus video team of Nate Hanna, Round Pond, Maine; Larry Holmes, Bristol, Maine and Scott Feindel and Rob Russell of Maine DMR.

Project Objectives: To develop a scallop drag which catches scallops but reduces the impact of the gear on the bottom. It uses a new concept involving a hydrodynamic wing that causes a turbulent lifting force behind it as it is towed over the bottom. The catch is lifted into a solid cage rather than a ring bag. The whole rig rides on skis which are the only part that touches the bottom. Everything else is at least 3 inches off the bottom.

Results: Scallops are now harvested using various versions of the chain sweep drag seen in Figure 1. Rock chains, a cutter bar and the ring bag itself are all towed over, and sometimes, through the bottom of the ocean. Logic would dictate that any plant or animal in the path of this equipment (which weighs from 500 to 10,000 lbs. in air, depending on the drag size) would be obliterated by the drag. However, many studies have shown this to not be the case when the drag is towed in a commercial manner (Wion and McCanaughey, 2000). While species assemblages may be altered and overall biodiversity affected in the short term, long term effects have been harder to discern. The fact that certain scallop beds are towed intensively during scallop season year after year and are then places to catch lobsters and sea urchins the day after scallop season closes shows that drags are not as destructive as they first appear. Still, it stands to reason that efforts should be made to reduce bottom impacts whenever possible, as long as catch efficiency can be maintained. This project sought to determine if this new concept in harvest technology could lead to a better drag.

The design of the drag was based on work done at the Maine DMR in the mid-1980's by the Fisheries Technology Service. At that time, a prototype wing drag was made and towed. Catch was obtained but commercial type tows were never made on scallop beds so its efficiency on scallops was never determined.

The minor success of that work led to the hydrodynamic wing concept being passed on to the mechanical engineering department at U. Maine, Orono. A couple of undergrads took it on as a design project and produced a report with a proposed wing design based on some model work in a flume tank (Bloxam and Bywaters, 1986).

A 6' wide drag was built based on the UMO work with modifications proposed by Phil Averill, David Autio and Kevin Verney. The final product is shown in Figure 2. It involved a pre-foil of a flat piece of steel, 7" wide, set at a 45° angle. Behind that was the main foil that had an adjustable angle from 27° to over 45° in 4° increments. Dimensions used came directly from the UMO work (Figure 3). A cage to retain the catch followed the main foil and was based on the design of an Australian cage drag (see Figure 4) found in a gear design book (FAO, 1975).

Over two days in December of 2002, 18 tows were made with the gear in shallow (8-10 fathom) water on a known scallop bed. These tows were designed to perfect onboard handling of the gear, scope, speed, wing angle, setting out procedure, etc. Some scallops were caught (see Figure 5) but it was not until later in the project that we were able to compare the catch to a conventional drag. These comparative tows showed the wing drag to be much less efficient in scallop harvest than we had hoped.

One trip was made offshore to a deep site (56 fathom). We were concerned that the drag was not heavy enough to go that deep but we felt that the downward force of the huge wing would get it to bottom. The lack of catch except for a few scallops, flounders and monkfish indicated that the drag only hit bottom at the beginning and end of the tow. Significantly more weight would be needed to get that rig on

Tow By Tow Data

#	place	depth	wire	time	rpm	speed	gear	wing	mesh	catch - sc=scallops, sd=sand dollars, cr=crab,
		(fm)	out (fm)	(min)		(kts)		angle	size (in)	mt=empty shells, st= 2" stones
1	Marsh Hbr	6	25	5	1030	3.3	wing drag	27	1.5	8 sd, 4 cr, 8 mt, lots of eelgrass
2	"	6	25	3	1375	4.2	"	27	1.5	1 sc, 10 sd, 4 cr, 5# mt, 10 st
3	"	6	25	3	1475	5.1	"	27	1.5	6 cr, 5# mt, 10 st,
4	"	6	25	5	1300	4.5	"	27	1.5	2 cr, 5# mt, fish tray of mud
5	Pond Is.	12	50	4	1300	4.5	"	27	1.5	11 sc,10# sd, 4 cr, 5# mt, 8# st
6	Wreck Is.	11	50	5	1310	4.6	"	27	1.5	15 sc, 20 cr, 10# mt, 1 tray rocks, 4 trays sponge
7	Clam Is.	6	25	2	1275	4.3	"	27	1.5	2 trays mt, 2 trays rocks - too rocky to tow
8	Muscongus Hbr.	5	25	6	1500	6.4	"	27	1.5	6 cr, 15# mt, plugged with mini-cucumbers
9*	Pond Is.	10	50	5	1250	4.4	"	27	1.5	28# sd,mt, st
10	"	10	50	4	1250	4.4	"	27	1.5	2 sc, 4 cr, 22# sd, mt, st
11	"	10	50	5	1250	4.4	"	27	1.5	7 sc, 7 cr, 32# sd, mt ,st
12	"	10	50	4	1350	5.2	"	27	1.5	2 sc, 4 cr, 35# sd, mt, st
13	"	10	50	5	1350	5.2	"	27	1.5	6 sc, 51# sd, me, st, 8 starfish
14	"	10	50	5	1350	5.2	"	27	1.5	6 sc, 84# sd, mt, st, 8 starfish
15	"	10	50	5	1350	4.9	"	31	1.5	8 sc, 11 cr, 36# sd, mt, fewer st, 6 starfish
16	"	10	50	5	1350	4.9	"	31	1.5	6 sc, 8 cr, 30# sd, mt, fewer st, 4 starfish
17	"	10	50	5	1350	4.9	"	31	1.5	19 sc, 6 cr, 48# sd, mt ,fewer st, 2 starfish
18*	E of Monhegan	56	250	30	1350	5.3	"	27	3.8	1 sc, 4 cr, 2 mt, 1 founder, 1 monktail, many brittle and mud stars
19	"	56	250	15	1225	4.8	"	31	3.8	2 sc, 1 cr, 1 founder,1 monktail, 1 skate, many brittle and mud stars
20	"	56	250	30	1250	4.6	"	31	3.8	4 cr, 2 mt, 1 flounder
21	Pond Is.	10	50	5	1350	4.6	tow higher up	31	3.8	2 sc, 1 cr, 2 mt, 1 flat rock
22	"	10	50	4	1350	4.6	"	31	3.8	3 mt, some horse mussels with kelp
23	"	10	50	5	1350	4.8	tow low point	31	3.8	3 sc, 8 mt, 2 st
24*	" w/divers	8	50	4	1350	4.7	"	31	3.8	1 sc, 1 cr, 4 mt, 1 starfish
25	"	8	50	5	1350	4.7	"	27	3.8	1 cr, 3 mt, 1 sponge
26	"	8	50	6	1350	4.7	"	35	3.8	1 sc, 1 cr, 7 mt, 1 starfish
27	"	8	50	5	1350	4.6	"	39	3.8	4 mt, 10 st
28	"	8	50	6	1350	4.6	"	27	3.8	5 sc, 2 cr, 6 mt, 1 flounder, 1 starfish
29*	"	10	50	5	1500	5.2	chain sweep	n/a	3.5	59 sc, 6 cr, 50# mt, 3 trays of sand/ shell hash
30	"	10	50	5	1500	5.2	"	n/a	3.5	73 sc, 2 cr, 20# mt, 1 flounder
31	"	10	50	5	1500	5.2	"	n/a	3.5	55sc, 8 cr, 25# mt
32*	"	10	50	5	1525	5.2	3 ticklers	27	3.8	4 mt
33	"	10	50	4	1700	6.3	"	27	3.8	2 mt, 1 dead crab
34	"	10	50	5	1350	4.8	"	27	3.8	3 starfish
35	"	10	50	6	1200	4.5	"	27	3.8	zip
36	"	10	50	5	1500	5.1	tow high up	35	3.8	zip

bottom. A couple of railroad rails slid up into the space within the skis would have made a big difference.

Having learned all we could by towing the thing around and looking at the catch, it was time to put some eyeballs on the drag to see what was going on. A call to the Maine DMR to borrow an underwater video camera produced two divers and three cameras. Working with two commercial divers, the state divers produced valuable video footage and direct observations. One camera was placed inside the drag as it was towed and another was used in a handheld mode to video the tow area before and after the drag was towed over a buoyed course. The direct observations of painted scallop shells placed in the drag path gave us important insight into the drag's effects. Wing angle was changed for each tow and the proper angle to use soon became evident (27° to 31°).

The diver observations caused us to modify the drag design in a number of ways. There was concern that there was not enough space between the wing and the leading edge of the cage (16") to let the scallops rise up into the cage. The plastic mesh of the bottom of the cage was cut back 12" to allow more room for the scallops to rise (see figure 6).

To further aid scallop harvest, we modified our total off-bottom idea for a few tows and added three tickler chains to get the scallops moving before the wing came along (see figure 6). Also, higher tow speeds were tried during these trials in an attempt to increase scallop harvest. It was interesting to note that even though the gear rode on skis, it towed as hard as a conventional drag, especially at speeds over 5 knots. Increasing engine speed above 1400 rpm did not result in significantly higher tow speeds due to this increase in drag.

All these modifications failed to improve scallop harvest. While results varied among the tows, basically, the wing drag caught 5 scallops for every 50 scallops caught by the chain sweep.

We feel the wing concept has merit but much more engineering work is needed. Models and full-size mock-ups need to be observed in a flume tank where wing design and angle can be perfected. Engineers who design trawl doors should be consulted since they are trying to achieve a similar effect, only sideways.

Certainly, replacing the ring bag with a solid cage on skis or sledges will greatly reduce bottom impacts. It also opens up the use of rocket launcher type gear handling systems that are much safer on deck that the conventional mast and boom arrangement. Even if a cage is not used, just putting sledges under the bag or rollers on the ends of the clubstick will raise the bag off bottom, reducing bottom impact and more effectively releasing undersize catch. These changes in gear design are discussed in Appendix 1.

Fisherman/Scientist Partnership : This partnership worked well for a number of reasons. First, the fisherman and the scientist were good friends long before the project began. This trust in each other got us past the usual initial skepticism and need to prove oneself to the other.

Second, the fisherman in this project is naturally curious and always willing to try something new. While many fishermen are like that, these types of projects need someone who has bought into the concept being tried and is not just putting time in until he can go do some "real" fishing.

Third, by day 3, it was time to "go fishing". Experimental tows are nice but a fisherman, by nature, is out there to catch fish. Even though he is being paid for his time no matter what he catches during the project period, the scientist needs to recognize the desire for the fisherman to see a real level of catch coming aboard. In this case, it was a day doing comparative tows with the conventional drag that relieved the frustration of poor catches with the wing drag.

Fourth, and maybe most important, is the involvement of the crew on the vessel. Scientists often deal exclusively with the captain and sometimes never even venture on deck. However, it is the crew handling the gear, picking over the catch, recording the numbers, weighing the baskets, etc. that are doing the real work. Unless they are involved in the project from the beginning and feel that sense of ownership, the project will not continue very long. If the crew is frustrated, the captain will find an excuse to come home. The crew on deck are often the ones with the best ideas on how to rig new gear, get it aboard safely and interpret what the gear is doing on bottom by its condition as it comes aboard. This was certainly the true in this project, with great advice coming from Frank Genthner.

Project Implementation Strategies: One obstacle this project experienced was the delay in getting the funds sent after expenditures had been made. Fishermen are used to getting paid the day they land their catch or maybe at the end of the week if they sell to a regular buyer. They are not accustomed to nor are they financially equipped to wait 30 days for reimbursement for expenses made. Since project funds had already been reviewed and approved, it would have been much smoother if funds could have been advanced to the grant administrator in anticipation of upcoming expenses. Again, in this project, this is where the friendship and trust that pre-existed allowed this project to succeed. Most other projects would not have this advantage. Even in this case, on one occasion, the grant administrator had to use $900 of his own funds for an immediate payment while he waited for the UNH check to arrive.

Next steps: It is hoped that work on hydrodynamic drags will continue with a larger, more sophisticated project involving more engineering. One approach would be to use the wing shape on the cutter bar of a conventional scallop drag. At the least, we hope fishermen will consider using devices such as sledges and clubstick rollers to get the conventional ring bag off the bottom (see Appendix 1).

Having this project occur in New Harbor, a place that has not seen a lot of this type of work, has gotten the wheels turning with local fishermen. Already, three fishermen have approached the grant administrator about ideas they have and the possibility of future cooperative research projects. Also, interest by local fishermen in the power of underwater video of their fishing grounds has increased.

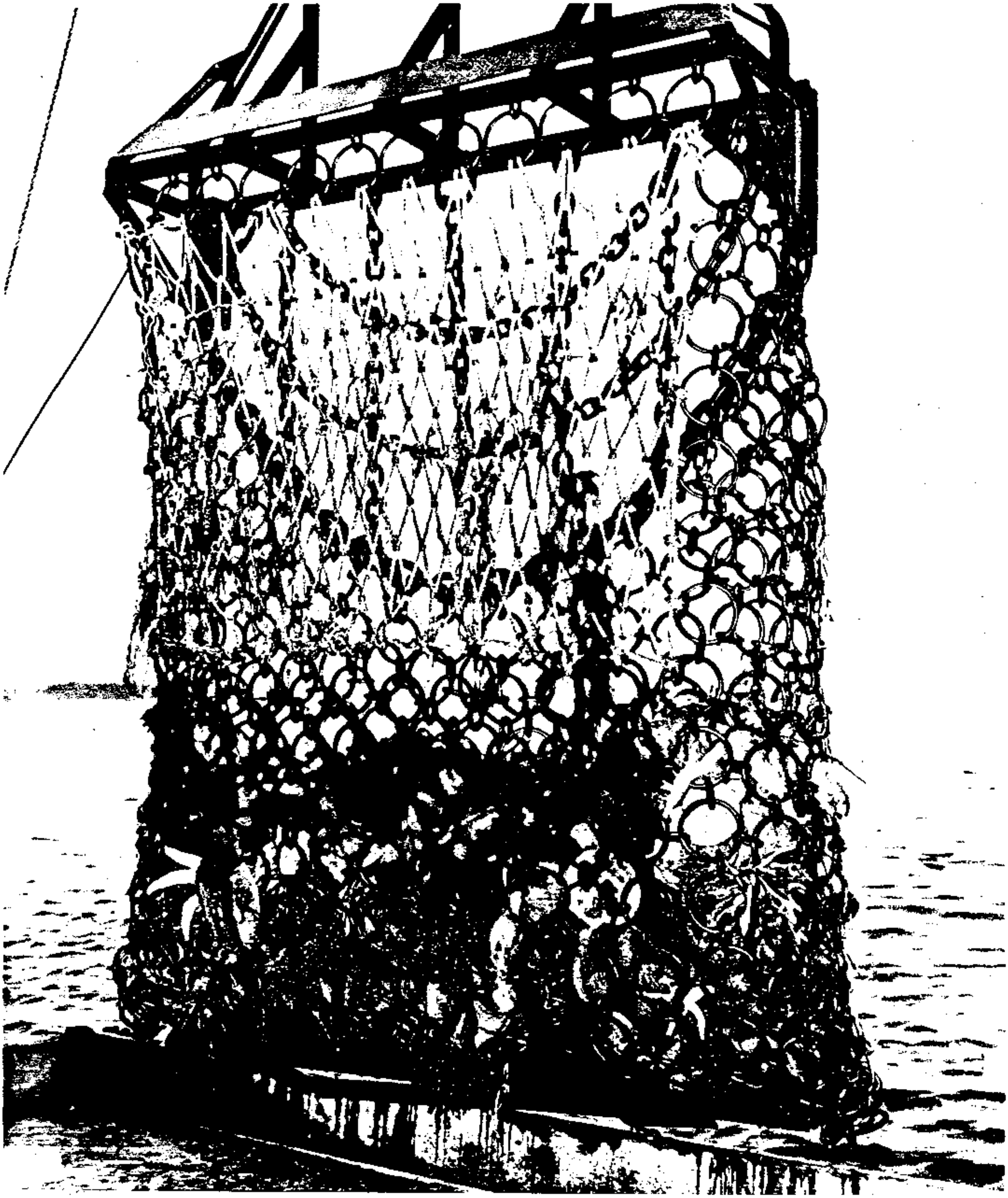
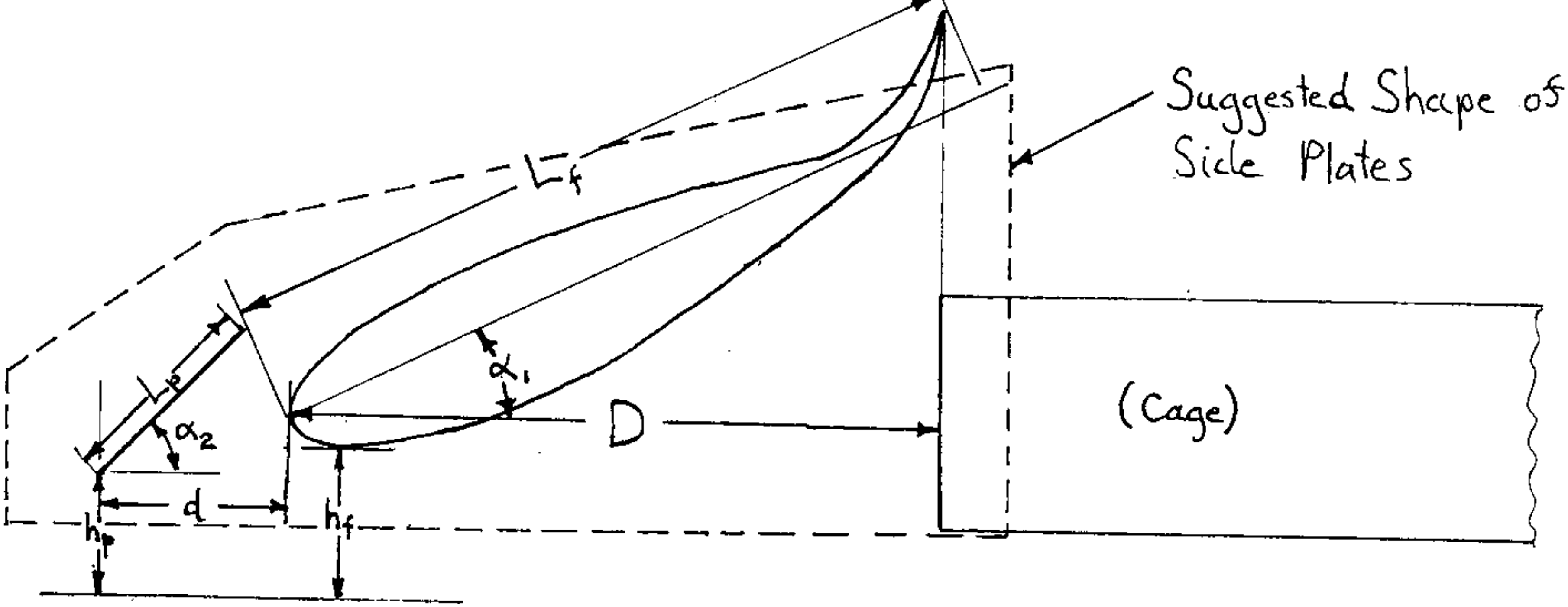


Figure 1 Conventional chain sweep drag

Figure 2 Wing drag



Main Foil Parameters	Flat Plate Parameters
L_f = Chord Length = 2′	L_p = Chord Length = 7″
α_1 = Angle of Attack = 25°	α_2 = 45°
D = Distance ahead of cage = 1′4″	d = Distance ahead of foil = 6¼″
h_f = Height of Leading Edge off Bottom = 5″	h_p = Height off Bottom = 4″

Figure 3 Foil parameters from UMO report

Figure 4 Australian cage drag

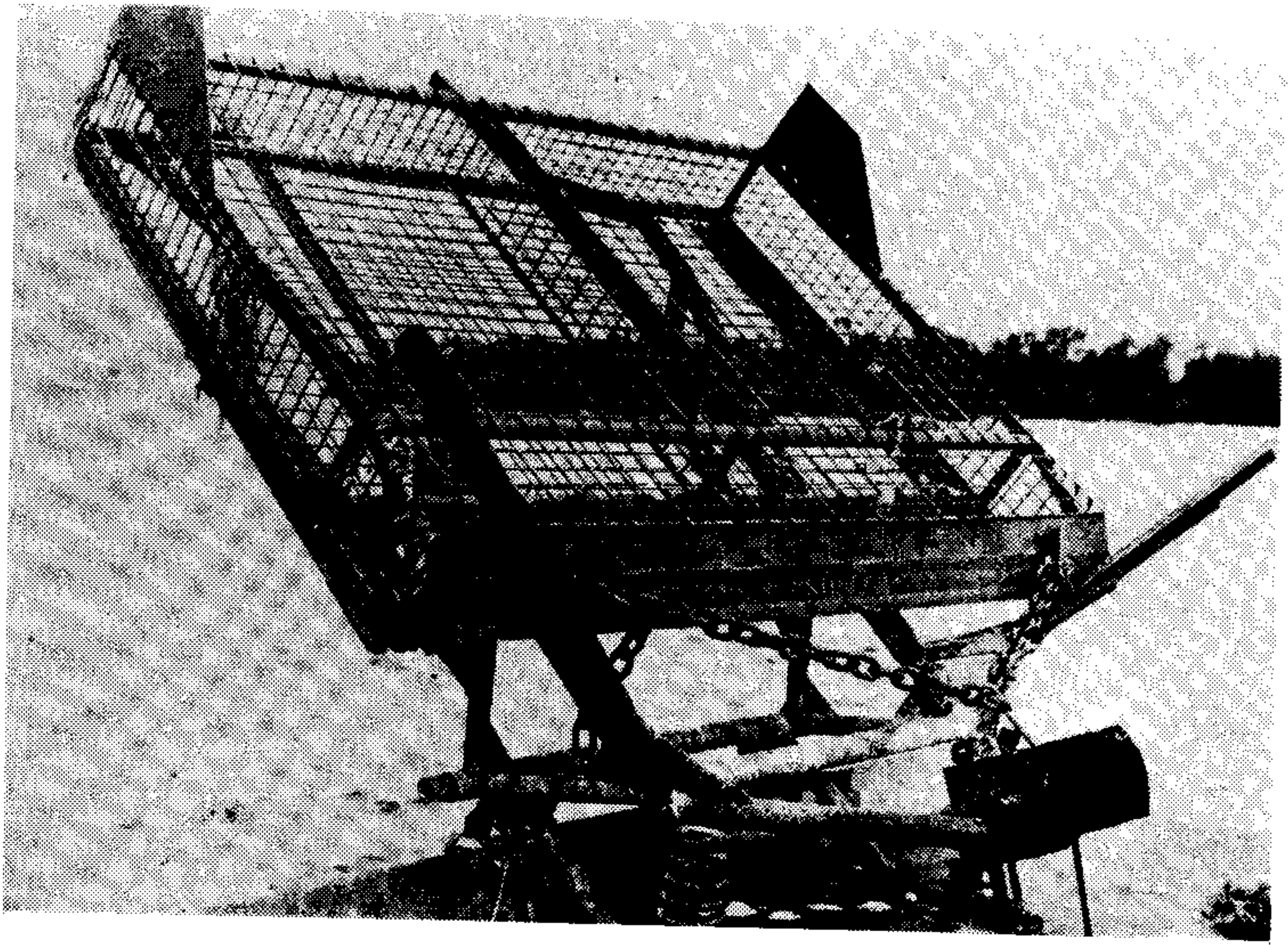


Figure 5 Photo of catch with wing drag

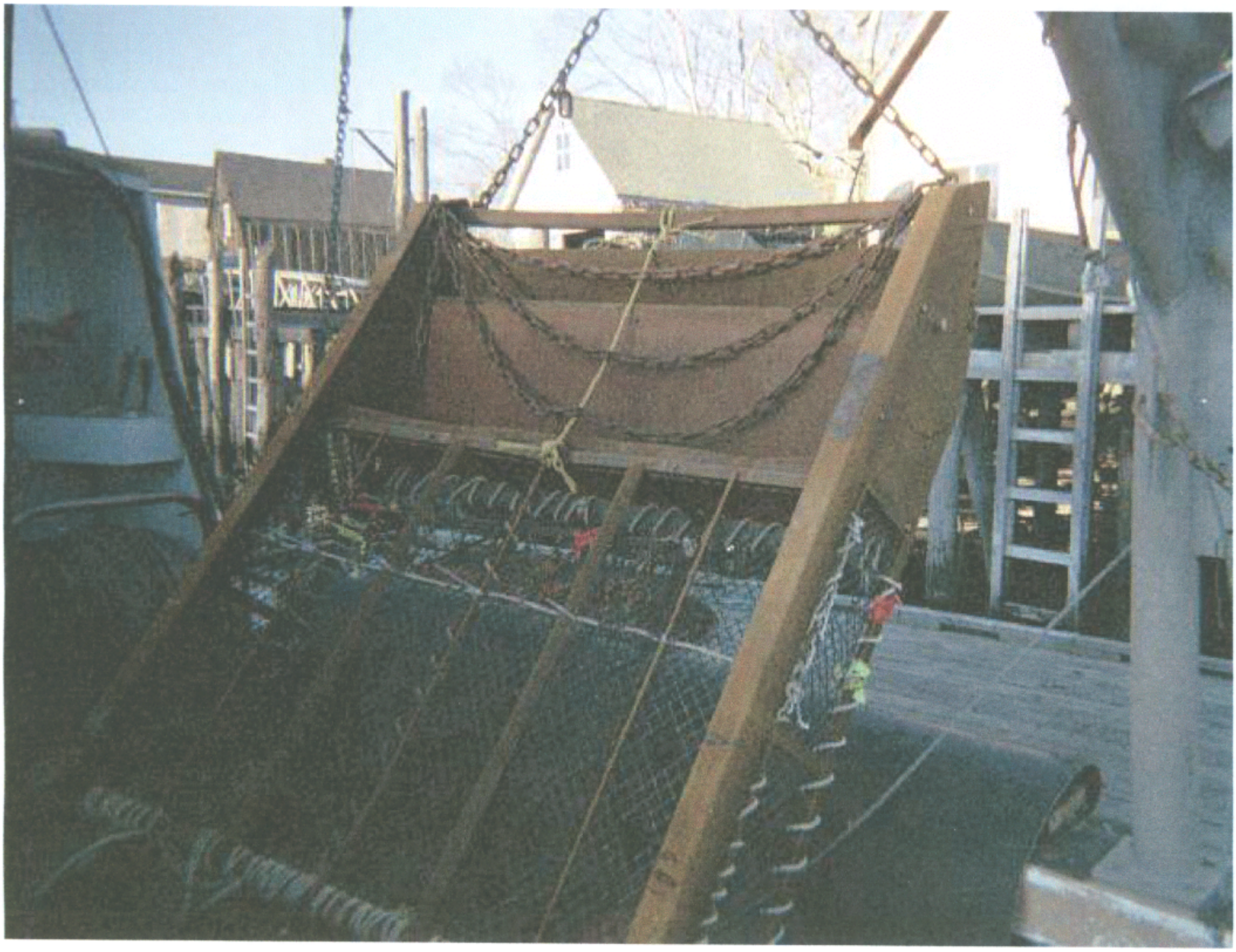


Figure 6 Photo of underside of wing drag after cage bottom cut back and tickler chains added.

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Appendix 1

A variety of studies have looked at the impact of scallop drags on the benthic habitat. Many have opined that it is the ring bag and not so much the bale, cutter bar or sweep chain that cause the most habitat disruption. Basically, a drag track is evidenced by a smoothing or leveling of the bottom plus the displacement of any flocculent layer on the surface of the sediment. While the forward parts of the drag certainly roll rocks and knock the tops off sand humps, it is the bag dragging over the bottom that sands things smooth. Elevating the ring bag off the bottom would reduce this effect without affecting the gear's efficiency. Actually, elevating the bag may improve efficiency since sand, shells and sublegal scallops will have an easier time exiting the bag through the bottom rings into the space below. The bag will fill up with scallops, not sand and broken shell like they do now. Also, the rings will last much longer since they won't be dragging over the bottom continuously.

Two ways to elevate the bag off bottom come to mind. One is to use two or more sledges to hold the bag up and allow it to slide along more easily. Sledges can be easily made from two pieces of 5/8" plate, 4" wide and welded at the ends with 2" spacers in the middle. Holes in the top plate would accept links to hold the whole thing onto the bag. Hardface could be applied to the bottom of the sledge. The forward edge of the sledge should be back to about the third row of rings on the bag to give some flexibility between the bale and the bag. This will improve bottom contact and make it easier to break the gear over the rail as it comes aboard.

Another approach would be to add trawl rollers to the end of the clubstick. If no clubstick is used, a piece of shafting could be linked to the aft end of the bag. These rollers hold the bag off bottom and make the whole rig tow more easily. A few fishermen in the Cobscook Bay area of eastern Maine use this arrangement. The rollers need to be big enough to hold the bag off bottom but not so big they raise the bag enough to dump the catch out the mouth of the drag.

Appendix 1 Figures A) two or three sledges under bag will hold it off the bottom, extending life of the bag, allowing bycatch to be released more easily and reducing bottom impact

B) trawl rollers on the rear of the bag lift the bag off bottom and make it tow easier