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A Preliminary Study of Timed Release Mechanisms for Lobster Traps

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ABSTRACT—Possible solutions to the lost ("ghost") pot problem in the offshore lobster fishery of New England are examined in this study. The object was to devise a release so lobsters could escape from ghost pots after a predetermined length of time. The method of release, the release timer, and the release mechanisms were all investigated and tests were conducted on degradable materials to be used for the timing device. The results showed that jute twine and steel wire deserve further consideration, and in situ tests on commercial pots are recommended.

INTRODUCTION

This study was conducted by the Fisheries Engineering Investigation of the Northeast Fisheries Center from January 1973 to August 1974. It was an investigation of possible solutions to the "ghost" pot problem. For this study, ghost pots were defined as lobster pots lost by fishermen which cannot be hauled to the surface because of severed buoy lines. The problem with ghost pots is that they might capture lobsters which die and act as bait for other lobsters, i.e., they are self-baiting death traps. The objective was to devise a "timed release" which would allow the lobster to leave the pot after it had been on the bottom a predetermined length of time.

Three specific problems had to be solved to devise a timed release. They were: 1) What is the method of release? 2) How is the release timed? and 3) How is the release mechanism constructed?

Method of Release

Four release methods were considered: 1) Degradation of natural twine webbing, 2) corrosion of pot-lid hooks, 3) destruction of a wood lath by marine borers, and 4) opening a hinged door with a timed release mechanism. Method number four was selected as the best. The reasons for the selection are covered in the discussion section of this paper.

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Release Timer

After selection of the hinged door as the release method, a timing device had to be found which would open the door after a predetermined time. A time interval of 60-90 days was arbitrarily selected because at the outset there was very little information on lobster mortality in ghost pots. The timing device had to meet other criteria as well. The device had to: 1) Be easily checked and reset when the pot was hauled, 2) be strong enough to keep the door closed during hauling, 3) provide consistent opening time, 4) be dependable enough to minimize the loss of catch, 5) be low in cost, and 6) be readily available.

The candidate timing device decided upon was a degradable material which would be tied or twisted around part of the door and part of the lobster pot. This degradable material would act as a latch allowing the door to open when the material failed. Most of the time spent on this project was involved with determining the failure times of materials for this "latch." The materials were chosen for ready availability, low cost, and ease of attachment. The failure mechanisms were biodegradation, corrosion, and dissolution. The latch-material tests were conducted in Boothbay Harbor, Maine, from January 1973 to September 1973, and in Woods Hole, Mass., from March 1973 to August 1974.

Release Mechanism

In addition to testing the latch material, testing of the release mechanism, i.e., the catch-escape door, also took place. Plastic-coated wire-mesh doors were used in conjunction with the latch-material tests in Boothbay Harbor, and later doors of several material were tested during the Woods Hole pot test. The later doors were designed to include an opening called a sublegal escape vent which allows small lobsters to escape. Sublegal escape vents were being studied by other investigators concurrently with this study.

PROCEDURE

Release Timer

The tests of candidate materials for the degradable latch were intended to indicate ranges of failure times and to show which materials deserved further consideration. The test procedures used were: 1) Boothbay Harbor in situ test rack (TR1) and Woods Hole in situ test rack (TR2), 2) Boothbay Harbor pot test (1973), 3) Woods Hole laboratory test rack (TR3), and 4) Woods Hole pot test (1974).

In Situ Test Racks (TR1 and TR2)

The first procedure entailed setting up nine samples of each of the seven candidate materials in a test rack placed on the bottom in 40 feet of water off Damariscove Island, Boothbay Harbor, Maine, on 27 February 1973. This test rack (TR1) was ballasted and anchored on the bottom. The condition of the materials was checked by the Northeast Fisheries Center diving team during the Boothbay Harbor field tests. An identical test rack (TR2) was placed in 10 feet of water in Great Harbor, Woods Hole, Mass., on 1 March 1973. Test rack TR2 was surface-hauled to check the sample condition. Temperature and dissolved oxygen measurements were periodically made at each location.

Four samples of each material were near the sea bottom and four were about 35 cm (13.7 inches) off the bottom. The last sample of each material was used to hold a wire-mesh door closed. All samples were held in tension by rubber bands.

The materials tested were: 1) 21-thread cotton with 18.8 kg (41.5 pounds) breaking strength; 2) pure virgin knitted worsted wood—used double; 3) chrome tanned cowhide leather, approximately 0.95 cm ×0.11 cm (0.375 inches ×0.045 inches); 4) polished India jute, No. 36; 5) black annealed steel wire, 18 gauge, 0.12 cm (0.047 inch); 6) 18-gauge steel wire with copper wire twisted around it to produce a galvanic corrosion cell; and 7) strands of manila.

Pure manila twine could not be found at the outset of the project, so ¼-inch diameter, three-strand manila rope (six-thread) was untwisted, and one of the three strands was in turn untwisted into its two component strands. What was left was one-sixth of the original ¼-inch rope, and that was used in the tests.

Pot Test—Boothbay Harbor (1973)

The second procedure was to use the candidate materials to secure catch-escape doors on openings (vents) in 20 pots in Phases I and II of the pot tests at Boothbay Harbor, between January and September 1973. This test was designed to determine the difference in performance between those samples on test racks and those on pots, under the same environmental conditions. Three openings, or vents, were cut in the wire mesh of each pot, one on each side of the parlor and one on the parlor end. The doors were made of wire mesh and were held in tension by rubber bands. Cotton, manila, and steel wire were each used for eight latches, and there were six latches of steel wire in contact with copper wire. The materials were tied or twisted around a bar of the door and a bar of the pot. Ten of the pots were surface-hauled and 10 were left on the bottom for the duration of the test (ghost fished). These pots were concurrently used to study ghost-pot mortality. The results of that study are reported by Pecci et al. (1978).

Laboratory Test Rack—Woods Hole (TR3)

Another test rack, TR3, was constructed for additional material experiments in the laboratory at Woods Hole. Samples were tied vertically in the rack and were attached with rubber bands to keep them in tension. Initially, TR3 was used to test absorbable surgical sutures. Four samples of each of 20 grades of sutures were tested. The sutures are round strands manufactured from mammalian collagen. When used surgically, the body's enzymes dissolve the collagen. Although this process could not be expected to occur in seawater, it was believed that the sutures would dissolve in time. Three types of sutures were tested—medium and extra-chromic types which are tanned to decrease the rate of dissolution and prolong the life of the suture, and plain which is untreated. Suture diameter tolerances are given in Table 1.

Table 1.—Suture diameter tolerances from U.S. Pharmacopeial Convention, Inc. (1955).

Gauge	Diameter (mm) Min.	Diameter (mm) Max.	Diameter (in) Min.	Diameter (in) Max.
4/0	0.179	0.241	0.0070	0.0095
3/0	0.241	0.318	0.0095	0.0125
2/0	0.318	0.406	0.0125	0.0160
0	0.406	0.495	0.0160	0.0195
1	0.495	0.584	0.0195	0.0230
2	0.584	0.673	0.0230	0.0265
3	0.673	0.762	0.0265	0.0300

After completion of the suture test, TR3 was used to test three diameters of special high-grade, 99.99 percent pure, zinc wire. The diameters of the wires used were 0.14 cm (0.057 inch), 0.16 cm (0.064 inch), and 0.23 cm (0.091 inch). Eight samples of each size were tested, and half of the samples of each size were in contact with copper wire to set up a galvanic corrosion cell.

Also tested on TR3 were eight 18-gauge annealed steel wire samples, four of which were in contact with copper. The black coating on annealed steel is an oxide layer which may reduce the rate of corrosion, and the copper wire had a varnish coating on it, so the samples of steel and copper on TR3 were sanded clean before testing to ensure that the corrosion process was not inhibited.

The rack, TR3, was placed in a fiberglass tank in the Northeast Fisheries Center's Woods Hole Laboratory to allow daily observations of sample condition. The tank is in the open circuit seawater system. The exchange frequency for the tank's total volume is twice per hour. The seawater is pumped from the harbor into a standpipe, and from there is gravity fed without filtering to the nearby aquarium and laboratories. Aquarium records show the difference in temperature, salinity, and dissolved oxygen between the water in the seawater system and in the harbor to be negligible.

Release Mechanism and Release Timer

Tests of catch-escape doors and latch materials were conducted during Phase III of the field experiment at Woods Hole in 1974. Doors were installed on each of 20 ghost pots and on 20 surface-hauled pots. Ten of the doors in each category were rendered nonfunctional by tying them closed with nylon twine. The remaining 10 in each category were functional and were latched with wool. Wool was chosen because its mean time to failure in the Woods Hole rack was 92 days and the range of failure times was only 12 days. A catch-escape door was designed which incorporated a sublegal escape vent (Fig. 1). This ensured that all sublegal vents were the same size. The door size allowed large identification numbers to be painted on it. The doors were located on the sides of the parlor section of the pot (Fig. 2). Four door materials were tested: 26-gauge (0.0455 cm, 0.0179 inch) cold rolled sheet steel; 16-gauge (0.161 cm, 0.0635 inch) galvanized steel sheet; ⅛-inch (3 mm) polyvinyl chloride (PVC) sheet; and ¼-inch thick (6 mm) exterior plywood.

RESULTS

Release Timer

The results of the release-material tests are given by the mean time to failure (MT) of all the samples of a material which were tested by the same method. For each sample failure there was a time interval, between observations, during which the material failed. The time of failure was taken as the center of the interval. The range of failure times is also given for each set of samples. When an experiment was terminated before all the samples had failed, the number of failures is given, but mean time to failure is not. Due to the small number of samples, no statistical analysis was performed.

In Situ Test Racks (TR1 and TR2)

Unfortunately the Boothbay Harbor test rack, TR1, was filled with seaweed and smashed by a storm 5 weeks after it was emplaced. No failures were observed to have occurred, and testing was discontinued due to the condition of the rack. No problems were encountered with test rack TR2, located in Great Harbor at Woods Hole, even after being in the water for 287 days. The mean failure times for TR2 materials are shown in Table 2. The difference in mean failure times between those samples on top and those on the bottom was only significant for two materials. The bottom wool samples had failure times 14 percent longer than the top samples. The bottom steel-copper specimens had failure times 39 percent longer than those at the top. A reduction in available oxygen near the bottom because of lower water velocities could have contributed to this difference. It has been shown that the corrosion rate of steel doubles as the water velocity goes from 0 to 1.5 knots (Tuthill and Schillmoller 1966). Tidal currents in the area of the test rack varied from 0 to about 2 knots.

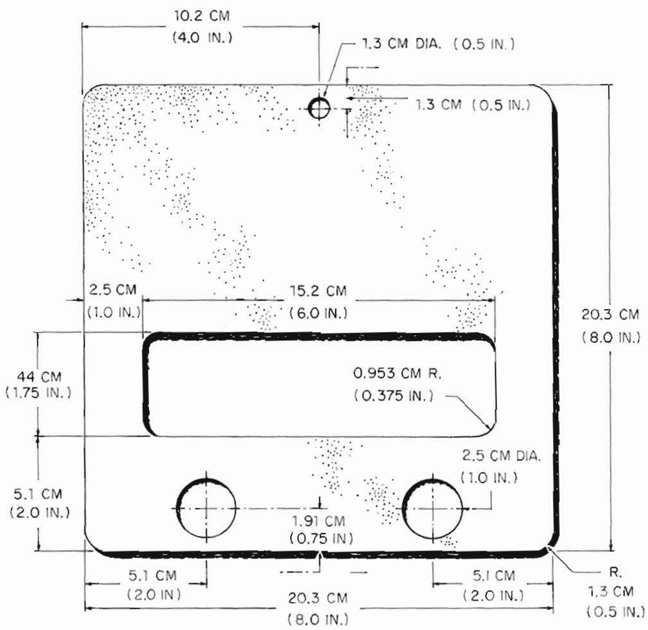

Figure 1.—Catch escape door with sublegal escape vent—Woods Hole pot test.

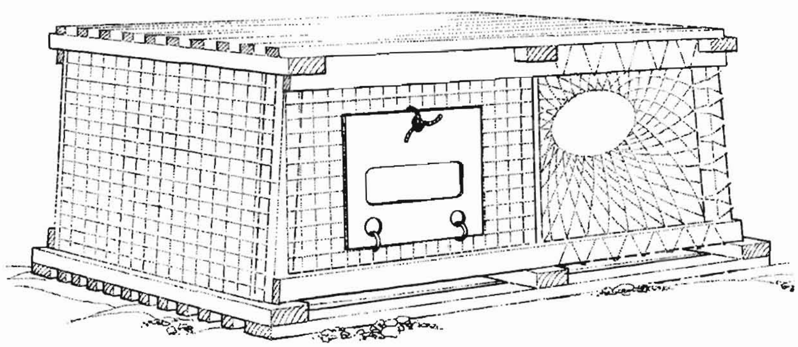

Figure 2.—Catch escape door installed on pot in Woods Hole pot test (1974).

Pot Test—Boothbay Harbor (1973)

The results of the material tests from both phases of the Boothbay Harbor pot experiment are shown in Table 3. No mean failure times are given because in no case did all samples of a material fail before the tests were terminated. The ranges given are for those samples that failed. Phases I and II were discontinued at 115 days and 90 days, respectively, for reasons unrelated to the material tests. No material showed a significant variation in failure times between the surface-hauled pots and those that ghost fished.

Laboratory Test Rack—Woods Hole (TR3)

The results of the suture tests from TR3 are given in Table 4. Mean time to

Table 2.—Mean failure times of materials tested in the Woods Hole in situ test rack, TR2[1].

Material	No. of samples	No. of failures	MTTF[2] in days	Range in days
Wool	8	8	92	86-98
Wool escape door	1	1	122	
Manila	8	8	150	136-169
Jute	8	8	177	169-184
Jute escape door	1	1	184	
Steel-copper escape door	1	1	184	
Manila escape door	1	1	197	
Steel-copper	8	8	221	158-272
Steel escape door	1	1	227	
Cotton	8	7		204
Steel	8	3		235
Cotton escape door	1	0		
Leather	8	0		
Leather escape door	1	0		

[1]The Woods Hole in situ test rack experiment was terminated after 287 days.
[2] MTTF is mean time to failure.

Table 3.—Range of failure times for the failed samples of materials tested in Phases I and II of the Boothbay Harbor pot tests.

		Phase I		Phase 2	
Material	No. of samples	No. of failures	Range in days	No. of failures	Range in days
Wool	8	7	64-71	6	51-71
Steel-copper	6	3	58-99	5	65-72
Steel	10	5	71-112	6	71-81
Cotton	10	2	71-112	5	65-88
Manila	10	0		2	81-82
Jute	8	0		1	72
Leather	8	0		0	

failure is not calculated for 3/0 extrachromic and 1 plain because only three failures were recorded for each. Table 4 also indicates the dependence of suture-failure time on suture diameter. Failure time did not exhibit a dependence on treatment. None of the sutures that were tested met the preliminary objective of 60-90 days duration. However, the suture failure time is dependent on size and larger sizes are available.

The subsequent test of zinc in TR3 was ended after 218 days. At the termination of the experiment not all the samples had failed. The results are shown in Table 5.

The failure of the 0.16-cm diameter samples before the 0.14-cm samples may be insignificant due to the small difference in diameter and the small number of specimens. However, it could have been caused by changes in the composition between the sizes. The manufacturer states that each size is special high-grade, 99.99 percent pure zinc, but small amounts of impurities can have a marked effect on the corrosion rate of zinc, and this may make zinc a poor candidate for a timing device. The corrosion rate in seawater of a sheet of 99.1 percent pure zinc is reported by LaQue (1948) as 0.0011 inch per year (ipy), while the rate for a bar of commercial zinc with 1.12 percent lead is 0.0036 ipy. Brown (1969) states that the corrosion rate of uncoupled zinc is from 0.0005 to 0.001 ipy. Assuming uniform corrosion at a rate of 0.001 ipy, complete destruction of the smallest zinc wire which was tested should occur in approximately 28 years. This illustrates the great difficulty in estimating failure times from empirical corrosion rates which were determined under different conditions.

Most failures of zinc and zinc-copper occurred at the end of the sample where it was bent around the frame of the test rack. This may have been caused by crevice corrosion occurring in small cracks at the bend or stress-corrosion cracking induced by bending. Brown (1969) reports the crevice-corrosion rate of zinc to be 10 times the normal rate. Failure at the bend contributed to the great discrepancy between predicted and actual failure times.

It is also necessary to take into consideration the strength of the partially corroded material. Some residual strength is necessary for the sample to resist the load placed on it by the door or the rubber band, and it will fail when corrosion has proceeded to the point that the minimum necessary strength has been reached. Table 5 also shows that in each case the zinc-copper samples failed before the zinc samples of the same size.

As the zinc was being tested, steel and steel-copper combination specimens were also tested on TR3; however, the zinc and steel tests were at opposite ends of the test rack to prevent interaction. These steel and copper wires were sanded to remove oxide and varnish coatings. Three of the four samples each of the steel and steel-copper failed before the test was terminated at day 339. The failure times for the steel-copper samples were between 244 and 339 days. The test was not continued beyond 339 days because longer failure times were not reasonable.

A careful look at Tables 2 and 3 shows the failure times of the materials in the Woods Hole test rack were longer than those in the Boothbay Harbor pot test for each material. In the case of steel, the Woods Hole samples began to fail at 235 days, while in both phases of the Boothbay pot test steel began to fail at day 71, and half or more of the samples had failed in 112 days. LaQue (1948) reported the pitting-corrosion rate of steel over short periods of less than a year can be from 0.04 to 0.1 ipy. Using a rate of 0.1 ipy, the predicted failure due to pitting of the steel wire would occur in 173 days.

This shows that the results from the test-rack experiments cannot be used to reliably predict failure times at other locations, because of variations in temperature, dissolved oxygen, and current velocities. However, the results should be a guide for further testing. The significant differences in the tests were the higher dissolved oxygen content of the Boothbay Harbor waters and that the materials were tested on catch-escape doors in Boothbay Harbor but not in Woods Hole. The doors became clogged with weed, and a storm with winds to 55 mph occurred the week before 3 April 1973, creating strong subsurface surges which persisted for 2 or 3 days. When the pots were checked on 3 April, day 71, 7 of the remaining 56 doors had opened. This accounted for some of the materials failing earlier in the Boothbay Harbor pot tests than in the Woods Hole test rack. The organic fibers all exhibited earlier failures in the second phase of the pot tests than in the first. This was attributed to more rapid degradation of the fibers due to increased biological activity. This increase in activity was caused by the dissolved oxygen content of the water remaining relatively high while the water temperature warmed up over the summer.

Table 4.—Variation of mean failure times of sutures tested in the Woods Hole Laboratory test rack, TR3, in relation to suture diameter[1].

Type of treatment	Gauge[2]	MTTF[3] in days	Range in days
Extra-chromic	4/0	3	2- 4
	3/0	(4)	9
	2/0	20	16-27
	0	33	27-35
	1	51	46-53
	3	50	30-64
Medium-chromic	4/0	6	4- 9
	3/0	13	9-16
	2/0	16	14-17
	0	25	24-26
	1	32	25-40
	2	33	18-43
	3	33	27-40
Plain	4/0	12	9-16
	3/0	10	9-13
	2/0	19	16-23
	0	21	18-23
	1	(4)	23
	2	30	23-40
	3	38	23-50

[1]Four samples of each were tested.
[2]Diameters are given in Table 1.
[3]MTTF is mean time to failure.
[4]Only three failures were recorded for this size, and MTTF was not calculated.

Table 5.—Mean failure times of zinc and zinc-copper samples tested in the Woods Hole Laboratory test rack, TR3[1].

Diameter (cm)	Material	MTTF[2] in days	Range in days
0.16	zinc-copper	117	56-150
	zinc	132	89-198
0.14	zinc-copper	(3)	123
	zinc	(4)	150
0.23	zinc-copper	(3)	150
	zinc	(3)	177

[1]Four samples of each were tested.
[2]MTTF is mean time to failure.
[3]Only two failures occurred.
[4]Only three failures occurred.

Release Mechanism and Release Timer—Pot Test, Woods Hole (1974)

Eight of the 10 latches on the normally fished pots failed, whereas none of the 10 latches on the ghost pots failed in the 81 days they were on the bottom. This indicated that the wool samples did not have the necessary strength to withstand the load imposed on them by the hydrodynamic drag on the door during hauling. All five of the wool latches on the 26-gauge steel doors failed. The range of failure times was 20-77 days. The 26-gauge material was very thin, 0.0455 cm, and chafing of the latch material probably hastened its failure. Three of the five wool latches on the ⅛-inch thick PVC doors failed at days 41, 57, and 60.

The 26-gauge steel was unacceptable as a door material because it was too thin and bent easily during handling. Plywood was also unacceptable due to delamination of the plies, and because the edges of the sublegal escape vent were gouged and worn by the captured animals. Templeman (1958) referred to the problem of wearing or "chewing" of wood laths which were spaced far enough apart to provide sublegal escape vents. The wood was "chewed" until legal-size lobsters could escape. Because of this a more durable material is needed. The PVC performed well, but became heavily fouled with barnacles. The cost of ⅛-inch thick PVC sheet was $1.25 per square foot in December 1974. The 16-gauge galvanized steel also performed satisfactorily. Its zinc coating prevented fouling, and in March 1974 it cost $0.63 per square foot. Of the materials tested, galvanized sheet steel was best. However, the galvanized steel would influence the corrosion rate and failure time of a corrodible latch.

DISCUSSION

Method of Release

Natural Twine

As stated in the introduction, four release methods were considered for this study. The first was to replace a section of the side panel or the head with natural webbing or to tie ("hang") synthetic webbing with natural twine which would rot and release the captured lobsters. This approach has been tried in the sablefish (blackcod), *Anoplopoma fimbria* and the king crab, *Paralithodes camtschatica,* pot fisheries. Hipkins and Beardsley[1], in their sablefish pot study, estimated that 21-thread cotton-webbing panels would last 5 months, and recommended that the panel be replaced regularly to prevent loss of catch.

In 1970, the State of Washington enacted a regulation stating that a section of one side of a "bottom-fish pot" must be of cotton webbing or hung with cotton twine. The twine size was not specified. However, R. M. Meyer (pers. commun.[2]) found, while studying the king crab ghost-pot problem, that degradable panels were not acceptable to fishermen due to the possibility of catch losses and the time lost repairing the panels. The same problems have surfaced in the west coast sablefish fishery. Even with materials lasting 6 months, some Washington fishermen regard panel repair as an irritating chore (S. Jaeger, pers. commun.[3]). Extension personnel from Humbolt State College express the same reservations about the use of panels in the Dungeness crab fishery (S. Ludwig, pers. commun.[4]). It is likely that east coast fishermen would voice similar objections to degradable twine hangings, especially if the time to failure is 3 months instead of the 5-6 months recommended on the west coast.

Pot-Lid Hooks

Another method suggested by west coast fishermen was to use a corrodible metal hook on a rubber band to hold the pot lid closed. On a lost pot the hook would deteriorate, release the lid, and allow the captured animals to push the lid up and escape (W. Dahlstrom, pers. commun.[5]). However, due to the weight of many of the offshore pot lids, this would not ensure the escape of the animals, although the hook would be considerably easier to replace than a natural twine panel.

Wood Laths

The third technique considered was to have a wood lath nailed over an opening large enough for lobsters to pass through. If the lath was destroyed by marine borers, the lobsters would escape. Failure times would depend on the availability of borers in the fishing area. One report states that offshore oak pots can be destroyed in 3 months by borers (Doliber, 1973), while another says it is not unusual to have one-third of the pots in a string ruined after 4-5 months (New England Marine Resources Information Program, 1972). If all pots broke up this quickly there would be no need for catch-escape mechanisms; however, many pots are treated to reduce borer damage. Brushing a 2 percent solution of TBTO, bis(tri-n-butylin) oxide, in mineral spirits or kerosene, on dry wood is reported to give 2-year protection in Canadian inshore waters (Thomas, 1968). Florida has enacted legislation which requires pots to be constructed of wood laths to ensure rapid deterioration if lost (Seaman and Aska, 1974), but New England fishermen have turned to composite pots with oak frames and plastic-coated wire-mesh sides to increase the life of the pot and reduce the weight and cost of construction. Replacement of wood-lath escape mechanisms on these pots would be a time-consuming interruption to the normal hauling and setting of the offshore pot strings.

Hinged Door

The last approach considered was to cover an opening in the side of the pot

[1]Hipkins, F. W., and A. J. Beardsley. 1970. Development of a pot system for harvesting blackcod (*Anoplopoma fimbria*). A progress report. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Seattle, 31 p. On file at the Northwest and Alaska Fisheries Center, NMFS, NOAA 2725 Montlake Boulevard East, Seattle, WA 98112.

[2]Alaska Outer Continental Shelf Office, Bureau of Land Management, U.S. Department of Interior, P.O. Box 1159, Anchorage, AK 99510.

[3]North Pacific Fishing Vessel Owner's Association, Fishermen's Terminal, Seattle, Wash.

[4]Director, Marine Advisory—Extension Service, Humbolt State College, Arcata, CA 95521.

[5]Marine Resources Laboratory, California Department of Fish and Game, 411 Burgess Drive, Menlo Park, CA 94025.

with a hinged-catch escape door kept closed by a latch made of degradable material. This was the release mechanism which was tested (Fig. 1).

Release Mechanism

Doors would be easy for fishermen and enforcement agents to check, and replacement of the latch material would be convenient, whether it be knotting a piece of twine or twisting a wire. Another advantage was that a sublegal escape vent could be easily incorporated in a door by cutting the appropriate size opening in it. Templeman (1958) has reported the enlargement of sublegal vents by "chewing" of the wood laths. If the door material were not wood, this would be eliminated. Jaeger (footnote 3) and Ludwig (tootnote 4) think that escape doors would be a better solution to the ghost-pot problems than degradable webbing.

The location of an escape door in a pot is important. Jaeger has reported the loss of catch when degradable webbing in the end of a pot failed during hauling. This could also occur with a door in the lower end. Escape doors should be installed on the side of the pot or the end where the ganglion attaches, to decrease the load on the latch material during hauling. Door location also determines its opening direction. In trapezoidal and half-round pots, a side door has to open inward so it will fall open when the material fails. On a trap with vertical sides, the door should open out, allowing it to be pushed open by the entrapped animals. This eliminates the need for any additional mechanism to open the door after latch failure.

CONCLUSIONS

The results of these tests have provided the basis for eliminating some of the candidate materials, and indicated those which deserve further consideration and testing. Neither wool nor leather met the requirements. Wool was too weak and failed too soon, while leather did not fail. Jute and manila exhibited failure times which seem reasonable to solve the problem and not penalize the fisherman. The range of failure times of jute was smaller than manila, but it may be difficult to obtain uniform-size jute. If longer failure times are desirable, readily available cotton twine can be used.

The sutures exhibited predictable behavior with an increase in failure time with increasing suture size. However, none of the failure times was long enough to suit our current requirements. Sutures are manufactured in larger sizes which might meet the requirements, but they were not available during testing.

Of the corrodible materials, steel is the best choice. Assuming that the pitting-corrosion rate of 0.1 ipy applies, steel wire of 24-gauge should be tested for a 90-day release time. Steel has the advantages of being readily available and not as subject to changes in composition as organic fibers. The cost of steel wire is approximately the same as that of jute, less than one cent per yard. A bimetallic latch is not recommended because of the cost of having a material specially manufactured. The steel-copper combination did result in a 20-day reduction in failure time compared with the all-steel sample, but a similar reduction can probably be accomplished with smaller-size wire.

Zinc exhibited an unpredictable relationship between diameter and failure time, indicating that more study is needed before a decision on its usefulness can be reached. An uncoated steel door could be used with a zinc latch to produce a galvanic couple, but fouling of the steel would radically change the expected corrosion rate and extend the life of the zinc. As of January 1975, zinc wire cost about three times as much as steel.

The 16-gauge galvanized sheet catch-escape door meets the criteria of cost and durability and is recommended for use if a biodegradable latch is used. If a corrodible latch is used, a nonmetallic door probably will be needed.

Additional studies on jute and steel wire are recommended. These should consist of in situ tests of the materials used as actual latches for catch-escape doors on fished pots. The tests should be conducted in various locations offshore. Inshore tests might be misleading due to differences in dissolved oxygen content, the availability of bacteria which degrade organic fibers, or low temperatures (Klust, 1973). Also, additional strength may be necessary to withstand the load imposed by hauling at high speeds from offshore depths. These are some of the questions which need to be answered in future research.

LITERATURE CITED

Brown, B. F. 1969. Corrosion behavior. *In* J. J. Myers (editor),Handbook of ocean and underwater engineering. McGraw-Hill, N.Y., p. 7-26 to 7-30.

Doliber, E. L. 1973. Lobstering inshore and offshore. Assoc. Press, N.Y., 108 p.

Klust, G. 1973. Netting materials for fishing gear. Fish. News (Books), Surrey, Engl., 173 p.

LaQue, F. L. 1948. Behavior of metals and alloys in seawater. *In* H. H. Uhlig (editor), The corrosion handbook, p. 383-430. John Wiley and Sons, N.Y.

New England Marine Resources Information Program. 1972. Forget the mice! It's a better lobster trap that's needed. New Engl. Mar. Res. Inf. Sea Grant No. RIU-2-72-34, p. 1-2.

Pecci, K. J., R. A. Cooper, C. D. Newell, R. A. Clifford, and R. J. Smolowitz. 1978. Ghost fishing of vented and unvented lobster, *Homarus americanus*, traps. Mar. Fish. Rev. 40(5-6):10-43.

Seaman, W., Jr., and D. Y. Aska (editors). 1974. Conference proceedings: Research and information needs of the Florida spiny lobster fishery. Mar. Advis. Program, Univ. Fla., Gainesville, SUSF-SG-74-201, 64 p.

Templeman, W. 1958. Lath-spacing in lobster traps. Fish. Res. Board Can., Prog. Rep. Atl. Coast Stn. 69:22-28.

Thomas, M. L. H. 1968. Test new treatment to protect wood from marine borers. Fish. Res. Board Can., Biol. Stn., St. Andrews, Gen. Ser. Circ. 53, p. 17-22.

Tuthill, A. H., and C. M. Schillmoller. 1966. Guidelines for selection of marine materials. Int. Nickel, N.Y., 36 p.

U.S. Pharmacopeial Convention, Inc. 1955. The pharmacopoeia of the United States of America, 15th rev. Mack Publ. Co., Easton, Penn., 1,178 p.

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