2A93-02

TESTS OF GALVANIC RELEASE FOR ESCAPE DEVICES IN CRAB POTS

by

J. M. Paul and A. J. Paul

and

Al Kimker

REGIONAL INFORMATION REPORT[1] NO. 2A93-02

Alaska Department of Fish and Game
Division of Commercial Fisheries
333 Raspberry Road
Anchorage, Alaska 99518-1599

January 1993

1 Contribution from the Homer area office. The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate timely reporting of recently collected information, reports in this series undergo only limited internal review and may contain preliminary data; this information may be subsequently finalized and published in the formal literature. Consequently, these reports should not be cited without prior approval of the author or the Division of Commercial Fisheries.

TABLE OF CONTENTS

LIST OF TABLES

ABSTRACT

The effectiveness of galvanic timed release (GTR) devices were tested under a variety of temperature and salinity conditions, found on Alaskan fishing grounds, to examine their potential use as devices to trigger escape panel release in lost crab pots. In most trials there was at least one test model that separated within 2-3 days of the date specified by the manufacturer. All of the experimental GTRs produced for this study had linear decay rates over time. Thus, the experiments show that GTR size can be fine-tuned for Alaskan conditions so that they separate at virtually any number of days at sea deemed necessary to reduce crab mortality from lost gear.

INTRODUCTION

Alaskan crab fisheries are an important part of our economy creating numerous jobs in the fishing, processing and marketing sectors of the industry. In 1990 the harvest of all species of crabs was worth $310 million at first sale.

Pots are the only legal gear type utilized in most Alaskan crab fisheries. A growing groundfish pot fishery is developing in Alaska; thus increasing the number of pots used in Alaskan fisheries. Unfortunately pot loss has become an increasing problem. In the southeastern Bering Sea the Alaska Department of Fish and Game (ADF&G) estimates that 20,000 crab pots are lost each year (ADF&G staff testimony March, 1991 Alaska Board of Fisheries meeting). In Alaska crab pot loss may be 20% of the number of pots fished (Kruse, 1992).

In the process of fishing, considerable numbers of pots are lost both through negligence and unavoidable accidents. The lost (ghost) pots continue to capture crabs and fish, which eventually die in the pots due to a combination of factors such as starvation, predation and stress. These dead fish and crabs in lost or untended pots become bait that attract additional crabs and fish. This process continues until the gear degrades and an opening large enough for the crabs to exit is created.

In 1976 the State of Alaska passed legislation which addressed the aforementioned mortalities and required all pots to have a biodegradable termination device which in time breaks down and allows crabs and fish to escape. In 1978 a companion Alaska Board of Fisheries regulation was adopted prescribing 100 percent cotton twine as the biodegradable weak link comprising the escape panels in pots. For all pots (except for shrimp and Dungeness crab) an 18 inch cut parallel to the bottom of the pot is secured together by a single length of untreated 100% cotton twine no larger than 30 thread. In Dungeness pots the lid tie-down straps must be secured at one end by a single loop of 100 percent cotton twine no larger than 60 thread.

Fishing experience has shown that it is virtually impossible to visually assess the status of degradation of the cotton escape device. Therefore, fishermen must either change the cotton twine at regular intervals or run the risk of losing legal crabs from the pots after unanticipated degradation during the fishery. A device that can be readily inspected as it deteriorates would allow for maximum utilization of that device's life expectancy and also eliminate unplanned loss of crabs during fishing.

Galvanic timed release (GTR) devices have been employed or are under consideration for use as escape mechanisms in a number of pot fisheries worldwide. For example, the *Chionoecetes opilio* fishery off the coast of eastern Canada may soon require GTRs in the gear. The Dungeness crab, *Cancer magister,* fishery off western Canada may also require utilization of the GTR in the future.

Galvanic timed release devices are composed of an active metal cylinder functioning as an anode, joining together two stable metal eyelets which function as cathodes. When these two metals are immersed in salt water conductivity produces galvanic corrosion of the anode while cathodic corrosion is slowed (Baboian, 1986). The electrical conductivity of seawater is very sensitive to temperature and salinity (Duxbury, 1977). Manufacturers of the GTR advertise a specific time, for a specified temperature and salinity, at which disintegration of the anode allows the eyelets to separate and release whatever was being held together.

The Alaska Board of Fisheries has directed Alaska Department of Fish and Game to evaluate GTRs for future incorporation into the existing regulation "5 AAC 39.145 ESCAPE MECHANISM FOR SHELLFISH AND BOTTOMFISH POTS." These devices may prove to be more affective than cotton twine as an escape device for Alaskan pot fisheries. User friendly release mechanisms would encourage greater compliance with the regulations. Also, the GTR may improve enforcement because Fish and Wildlife Protection officers will be able to visually determine whether pots have adequate escape panels and release mechanisms. The GTR is easily identified because visual evidence of its chemical reaction is apparent when it is placed in salt water.

The purpose of this study was to identify how useful GTRs would be in Alaskan waters by testing galvanic time releases at typical temperatures and salinities found in Alaska.

METHODS

The GTRs produced for this experiment by International Fishing Devices, Inc. were experimental models donated to the project. Their specific construction materials are a trade secret and cannot be detailed in this report. For each trial at a prescribed temperature and salinity three different sized (cm^3) GTRs were produced. The intention was to bracket the described target date of release so that the effect of GTR size on the number of days before its release could be established. Thus, it was not expected that all the GTRs would release exactly in the number of days for which they were nominally designed. These trials provide insight into the predictability of deterioration times of GTRs used in this study.

Experiments to describe the response surface (Montgomery, 1984) of GTRs to different levels of temperature and salinity were conducted in a temperature controlled room, off the dock at the University of Alaska Seward Laboratory during different times of the year, and in a salt water shore-based pond fed with sea water from 80 m depth from Resurrection Bay off Seward, Alaska. GTRs were held in plastic frames with rubber tension bands with mean pulling of 5.0 kg or 11 lbs. (sd = 0.7 kg) on the GTR eyelets. The GTRs in the temperature controlled room were held in 30 gallon plastic pails in which the sea water was changed every three days. GTRs were checked once each morning and once each afternoon during 8 a. m. to 5 p. m. Release time was defined as the time at which the GTR cylinder decayed enough for the screw eyelets to separate.

To determine relationship between GTR size (cm^3) and time (days) before release, linear models were fit to data for each trial by least squares methods. In each case, we calculated the coefficient of determination (r^2), and we compared the correlation coefficient (r) to a table of critical values (Table D.21 and Zar 1974). However, we emphasize that our purpose was <u>not</u> to determine extremely precise statistical relationships unique to specific metal composition "recipes" used by individual GTR manufacturers. Instead, we wanted to establish that GTRs could be made for various temperature and salinity combinations, and that GTR size could be varied to fine-tune their disintegration time. To achieve this under pressing time constraints and laboratory space limitations, we conducted multiple trials under varied environmental conditions possible in Alaska albeit each with small sample size (n=3), rather than select only a few temperature-salinity conditions each with large sample size adequate for significance testing.

It seemed plausible that the presence of metal, such as the wire mesh used on some crab pots, might modify the time the GTRs disintegrate and release. To determine the effect of wire mesh on GTR release time, a 50 day GTR was tied with string to the stainless steel wire of a commercially built Dungeness pot. The string was wrapped around the GTR and the crab pot wire to insure contact between the two metals. Pressure on the eyelet of the GTR was supplied by the rubber pot lid release. Two 50 day GTRs were put on plastic frames with no metal contact to serve as controls. The crab pot and the plastic frames were put together into a 1000 liter running seawater tank. The mean daily temperature of the seawater was 7.4°C (sd = 0.7). Salinity was 31.0 ppt (sd = 0.7).

One experiment was done using smaller GTRs (size A2), designed for one day release (manufactured for a salinity of 31 - 34 ppt and 4.4 to 7.2°C). Six A2's were touching the stainless steel wire of a Dungeness pot and five identical control GTRs were attached to the plastic frames. The salinity was either 15 or 33 ppt and 7.5°C in this experiment. These GTRs were checked hourly for the time of release.

RESULTS

Tables 1, 2, 3, 4, 6, and 7 show results of trials for GTRs that were held under temperature and salinity conditions near those for which they were designed. Decay rates were similar to those predicted by the manufacturer. Most test models had one size GTR that separated within 2 or 3 days of the target date.

Considering small sample size and the fact that GTRs were inspected daily rather than hourly, linear models fit these data rather well. Critical values of r^2 corresponding to commonly used significance levels with one degree of freedom (DF) are: 0.994 for the 0.05 level, 0.976 for the 0.10 level, and 0.904 for the 0.20 level. All fits were significant at the 80% confidence level and half of these were also significant at the 90% level.

Even at sea surface (Table 5) where salinity was highly variable and much lower than the value for which the GTRs were designed, the GTRs disintegrated at a predictable rate ($r^2 = 0.96$). Separation times of one day GTRs held at salinities of 33 to 12 ppt at 7.0 °C increased with decreasing salinity (Table 8). The corresponding relationship between salinity and time of release was linear ($r^2 = 0.96$, DF = 3, $P \approx 0.01$). Decreasing salinity markedly increased the time of release of the test GTRs (Table 9), but the experiments show that GTRs can be produced for Alaskan conditions that will separate near the desired time.

The one 50 day GTR in contact with the wire of a Dungeness crab pot released on day 51 while the two controls on plastic frames released on days 49 and 52 respectively. At 7.5°C and 33 ppt release times of both one day GTRs in contact with the wire of a Dungeness pot were 18 hours and both controls on plastic frames also released during the 18th hour (Table 9). At 15 ppt one day GTRs took 34 to 36 hours to release. Whether the GTR was touching the wire of the pot did not markedly modify the time required for release. Thus the stainless steel wire and other metal in the crab pot had little, if any, affect on the time the GTR disintegrated.

DISCUSSION

On the Atlantic coast of Canada GTRs have been tested in the past. In waters of 0.0 to 2.0°C and 31.7 to 33.6 ppt salinity, Gagnon and Boudreau (1991) found the release time to increase for a 50 day GTR to 54.6 days and an 110 day GTR to 114.5 days. This was the magnitude of variation in the time of release seen during this study with experimental GTRs. However, the linear equations describing GTR size and release date (Tables 1-7) indicated that GTRs can be manufactured for Alaskan conditions that decay at desired rates once temperature and salinity parameters are specified. It is likely that the r^2 values (Tables 1-7) would be even higher if the GTRs had been checked hourly instead of just once in the morning and once in the afternoon during the daytime, 8 A.M. to 5 P.M. We also anticipate that significance levels would increase with larger sample size.

Decreased salinity retards the disintegration of GTRs made for 33-34 ppt (Table 8). King and Tanner crab are normally captured in deep water so low salinities are not encountered in those fisheries. Dungeness crabs are found in salinities from 12 to 35 ppt (Cleaver, 1949; Robinson and Potts, 1979). If GTRs are to be used by Dungeness crab fishermen they will have to be manufactured to deteriorate reliably under a range of salinities.

The material composition of the GTR will markedly affect the time it takes it to decay, so the results of these experiments (Tables 1-9) are specific for the experimental models designed by International Fishing Devices, Inc. The material chemistry of the tested GTRs were not provided by their builders to minimize copying by competitors, so our tests only confirm that reliable GTRs can be produced. If GTR use in Alaska is mandated by law, each model type of GTR marketed to fishermen will have to be tested separately to determine reliability under Alaskan conditions unless some standard material composition can be required.

AUTHORS

J.M. Paul and A.J. Paul, Institute of Marine Science, University of Alaska, Seward Marine Center, P.O. Box 730, Seward, Alaska 99664

Al Kimker, Alaska Department of Fish and Game, Division of Commercial Fisheries, 3298 Douglas Street, Homer, Alaska 99603

ACKNOWLEDGMENTS

This paper is funded by a grant from the Alaska Science and Technology Foundation. The views expressed herein are those of the authors and do not necessarily reflect the views of the Alaska Science and Technology Foundation. The ASTF project number was 91-2-104. The Alaska Fisheries Development Foundation Inc. also supported the project.

LITERATURE CITED

Baboian, A.L., 1986. Galvanic corrosion. In Encyclopedia of materials science and engineering. M.B. Bever (ed), Pergamon Press, Cambridge, Mass. p 880-881.

Cleaver, F. 1949. Preliminary results of the coastal crab (*Cancer magister*) investigation. Dept. Fish. Wash. State. Biol. Report 49A, p.47-82.

Duxbury, A.C., 1977. The earth and its oceans. Addison-Wesley Publishing Co. Menlo Park, CA.

Gagnon M. and M. Boudreau, 1991. Sea trials of a galvanic corrosion delayed release mechanism for snow crab traps. Department of Fisheries and Oceans, Canadian Technical Report of Fisheries and Aquatic Sciences, 1803.

Kruse, G. 1992. Biological perspectives on crab management in Alaska. Alaska Department of Fish and Game, Division of Commercial Fisheries Contribution Juneau PP-071, 38 pp.

Montgomery, D.C., 1984. Design and analysis of experiments. 2nd edition, John Wiley and Sons, New York.

Robinson, G. and W. Potts, 1979. Ion fluxes and diffusion potentials in the Dungeness crab (*Cancer magister*). J. Comp. Physiol. 131: 285-292).

Zar, J.H. 1974. Biostatistical analysis. Prentice-Hall, Inc., Englewood Cliffs, New Jersey. 620 p.

1. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 23 ppt and 3°C held in thirty gallon static plastic pails in a controlled temperature chamber.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
3.1 (0.2)	23.0 (0.0)	21	3.51
3.4 (0.2)	23.0 (0.0)	25	4.09
3.3 (0.3)	23.0 (0.0)	28	4.68

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 5.980X + 0.187$; $r^2 = 0.992$, $DF = 1$, $P \approx 0.05$.

2. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 33 ppt and 3°C held in thirty gallon static plastic pails in a controlled temperature chamber.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
3.0 (0.2)	31.0 (0.0)	21	4.32
3.2 (0.2)	31.0 (0.0)	25	5.04
2.9 (0.2)	31.0 (0.0)	27	5.76

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 4.167X + 3.333$; $r^2 = 0.964$, DF = 1, $0.10 < P < 0.20$.

3. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 23 ppt and 7°C held in thirty gallon static plastic pails in a controlled temperature chamber.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
7.0 (0.1)	23.0 (0.0)	28	4.97
7.0 (0.2)	23.0 (0.0)	33	5.56
6.9 (0.2)	23.0 (0.0)	38	6.14

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 8.547X - 14.492$; $r^2 = 1.000$, DF = 1, $P < 0.001$.

4. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 33 ppt and 7° held in thirty gallon static plastic pails in a controlled temperature chamber.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
7.1 (0.2)	31.0 (0.0)	26	6.12
7.0 (0.1)	31.0 (0.0)	32	6.84
6.9 (0.1)	31.0 (0.0)	34	7.56

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 5.556X - 7.333$; $r^2 = 0.923$, DF = 1, $0.10 < P < 0.20$.

5. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 23 ppt and 7° held in surface water of Resurrection Bay off the dock at the University of Alaska Seward Marine Center Laboratory.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
10.0 (1.1)	9.6 (6.6)	33	4.97
10.0 (1.1)	9.6 (6.6)	36	5.56
10.0 (1.1)	10.2 (6.7)	40	6.14

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 5.980X + 3.103$; $r^2 = 0.992$, DF = 1, $P \approx 0.05$.

6. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 33 ppt and 7° held just off the bottom (15 m depth) in Resurrection Bay from the dock at the University of Alaska Seward Marine Center Laboratory.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water Mean (sd)	Day of Release for GTR	GTR Size cm^3
7.5 (0.7)	31.0 (0.5)	30	6.12
7.4 (0.7)	31.0 (0.5)	38	6.84
7.4 (0.7)	31.0 (0.5)	42	7.56

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 8.333X - 20.333$; $r^2 = 0.964$, DF = 1, $0.10 < P < 0.20$.

7. Separation times of 30 day Galvanic Timed Releases manufactured by International Fishing Devices, Inc. for a salinity of 33 ppt and 7°C held in a large saltwater pond at the University of Alaska Seward Marine Center Laboratory.

Temperature of Sea Water Mean (sd)	Salinity of Sea Water (sd)	Day of Release for GTR	GTR Size cm^3
8.8 (0.5)	31.0 (0.7)	27	6.12
8.8 (0.4)	31.0 (0.7)	34	6.84
8.8 (0.4)	31.0 (0.7)	39	7.56

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = 8.333X - 23.667$; $r^2 = 0.991$, $DF = 1$, $P \approx 0.05$.

8. Separation times of one day Galvanic Timed Releases (size A2 0.183 cm^3) manufactured by International Fishing Devices, Inc. held in thirty gallon static plastic pails containing seawater of different salinities in a controlled temperature chamber at 7.0°C.

	SALINITY (ppt)	RELEASE TIME FOR GTRs (hours)
1	33	16.25
2	29	16.75
3	25	22.00
4	23	23.00
5	12	30.00

Equation describing GTR size (X) vs. number of days before its release (Y): $Y = -0.693X + 38.521$; $r_2 = 0.96$, DF = 3, $P \approx 0.01$.

9. Separation times of one day Galvanic Timed Releases (size A2 0.183 cm^3) manufactured by International Fishing Devices, Inc. Six GTRs were in contact with the wire mesh Dungeness crab pots. The pots were held in a saltwater tank (7.5°C and salinity 33 or 15 ppt). Five GTRs with the same specifications were held in plastic frames so they had no contact with metal.

	GTRs in contact with metal	GTRs on plastic frames	Salinity (ppt)
	RELEASE TIME FOR GTRs (Hours)		
1	18.0	18.0	33
2	18.0	18.0	33
3	34.0	34.0	15
4	34.2	34.0	15
5	34.4	36.1	15
6	34.8	no date	15

The Alaska Department of Fish and Game operates all of its programs and activities free from discrimination on the basis of race, religion, color, national origin, sex, or handicap. Becasue the department receives federal funding, any person who believes he or she has been discriminated against should write to: O.E.C., U.S. Department of the Interior, Washington, D.C. 20204.