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U.S. DEPARTMENT OF COMMERCE

AFSC PROCESSED REPORT 93-06

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August 1993

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UNDERWATER OBSERVATIONS ON BEHAVIOR OF KING CRABS ESCAPING FROM CRAB POTS

by

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August 1993

ABSTRACT

In order to study the process and impacts of ghost fishing, 111 king crabs (*Paralithodes camtschaticus*) were distributed among four unbaited crab pots and observed using a remotely operated vehicle carrying a video camera. Twenty escapes were observed. Most crabs escaped from a position below the tunnel eye, and observations indicated that larger crab size improved the ability to escape. Once the crab located the exit opening, escape was rapid, requiring less than a minute. Observations of crabs entering two baited pots indicated that entry was a slower and more deliberate process. Some suggestions are made concerning crab pot design to reduce ghost fishing.

INTRODUCTION

"Ghost Fishing" is what happens when lost fishing gear continues to trap or entangle fish or shellfish resulting in subsequent mortalities (Breen 1990). The impact of ghost fishing depends on both the species considered and the design of fishing gear used. Studies on Dungeness crab (*Cancer magister*) indicate that 55-80% of legal-sized crabs remain in lost pots with mortalities up to 25% after 74 days (High 1985). Similar studies on king crab (*Paralithodes camtschaticus*) showed that 20% of legal crabs remained after 16 days, with mortalities up to 12%, and that crabs which escaped after prolonged enclosure were recaptured at lower rates than those which escaped quickly (High and Worlund 1979). In contrast, Hawaiian spiny lobster (*Panulirus marginatus*) and slipper lobster (*Scyllarides squamosus*) can readily escape traps without suffering significant mortalities (Parrish and Kazama 1992). A variety of other studies (see review by Breen 1990) indicate that many other species of fish and shellfish suffer high mortalities in derelict traps. When animals in traps die, they "re-bait" the pot, attracting other animals inside. In many cases there is a continuous rate of entry and exit leading to a "steady-state" of continuous low-level occupancy. The addition of escape ports to pots can be very effective in reducing the catch of sublegal Dungeness crabs, (Jow 1961), and spiny lobsters, (Paul 1984), but they do not eliminate the problem.

About 100,000 crab pots are used in the Bering Sea each year, and estimates of pot loss are around 10-20% (Bill Nippes, Alaska Dept. Fish and Game, 211 Mission Rd., Kodiak, Alaska, pers. commun, 1992). Therefore the potential for mortality to king crab, Tanner crab (*Chionoecetes bairdi*) and snow crab (*C. opilio*) from lost gear is high. The present study was designed to gain a better understanding of how crabs escape from traps. We considered that in situ observations of crabs attempting to escape from traps might provide some insight into how pot design could be improved. To achieve this objective, we decided to employ a remotely operated vehicle (ROV) carrying a video camera, which could be monitored from the surface. Such a device would allow us to observe crabs in pots from a variety of angles, and to move around the pots when necessary, in order to better observe crab behavior.

MATERIALS AND METHODS

King crabs were captured in baited crab pots set in 60 m of water in Kalsin Bay, Kodiak Island, Alaska, during the week of 13-19 April 1993 and held in crab pots until 19 April. On that date, all crabs were retrieved, measured and tagged, then stored overnight. On 20 April, crabs were retrieved and placed into three crab pots. Pot 1 was normally rigged, with both tunnel eyes open and vertically oriented. Pots 2 and 3 initially had cod-fingers (stiff plastic fingers pointing inward) in each tunnel, effectively preventing crab escape. Each pot contained 25-26 legal male king crabs;

Pots 1 and 2 also contained 5 sublegal males and 7-8 females each (Table 1). All three pots were placed at a depth of 21 m in Woody Island channel near Kodiak City by 1200 on 20 April. Visibility by secchi disk was 7.5 m. The ROV used was a Phantom HD2 (Deep Ocean Engineering, San Leandro, CA)[1], employing a standard video camera with high-intensity lights. The ROV was deployed from the R/V *Resolution*, on which the control console and monitors were placed. After initially observing all three pots with the ROV to ascertain that they were upright and observable, three tests were conducted (Table 1). Pot 1 was observed during the first day and night since all other pots were considered inescapable. On 23 April, divers removed the fingers from Pots 2 and 3 so that crabs could escape. Pot 3 was watched for 8 hours over the next 2 days, then Pot 2 was watched for 9.5 hours including night observations. During each observation period, the ROV was placed in a stationary position about 1 m from the pot entrance, usually offset slightly so the pot was viewed at a slight angle. In daylight, both tunnels could be observed, so crabs exiting the opposite side could be seen. At night, only the nearest tunnel could be seen. When a crab escaped, the ROV followed the crab until its tag number could be read. After most of the crabs had escaped the first set of pots, baited pots were set and observed for up to 4 hours each in Kalsin Bay on 27 April (Pot 4, 60 m depth), and in Womans Bay on 28 April (Pot 5, 20 m depth). Due to poor visibility, the ROV was placed

[1] Reference to trade names in this document does not imply endorsement by the National Marine Fisheries Service, NOAA.

within 0.5 m of the entrance with lights on, and only the closest tunnel was visible. Eight crabs captured on those two dates, plus three crabs remaining in Pots 1-3 were then placed in Pot 6 on 29 April and observed for 5 hours.

All escapes were recorded on videotape, and behaviors classified. ROV position was classified as to the left, right, or on the opposite side of the tunnel used for escape. Crabs were coded as being legal (i.e., >135 mm carapace length (CL)) or sublegal. Crab starting positions were below, on top of the tunnel, or from the left or right side. The first leg inserted into the tunnel exit during the escape was recorded. Direction of escape movement was leftward, rightward, or forward. Crosstabulation of escape direction with other variables was conducted using the G-statistic. The G-statistic was also used to determine if escapement was dependent on size using only data from Pots 1, 2, and 6, which were observed for up to 6 hours immediately after placement or removal of obstructions preventing escape. Since some crabs may have escaped unobserved in this time period (due to time lag between pot placement and ROV placement), these represent minimum estimates only.

RESULTS

Twenty king crabs were observed escaping from the pots. All observed escapes occurred during daylight hours, within 6 hours of either pot placement or removal of obstructions preventing escape. Escapement was not dependent on size; while 7%

(1 of 15) of sublegal crabs escaped via the tunnel, and 22% (13 of 59) of legal crabs escaped this way, the G-statistic (2.21, P>0.1) was not significant. Some sublegal crabs probably escaped through a panel of large "escape mesh" on one side of the pot. Crabs in pots were observed during all times of day except 0730-0930. No escapes were observed at night, possibly because only one tunnel could be viewed. Crabs did not appear to be more active at any particular time of day. Many crabs probed the tunnel opening several times before they began a successful escape. All successful escapes required less than 1 minute from the time the crab placed its first leg into the tunnel opening, to the time the crab was completely outside the pot.

Within the pots, crabs appeared to move randomly about, climbing the side walls, and eventually aggregating in the corners where they had mesh on two sides of them. Crabs appeared to move into the prevailing current direction, as the majority of crabs were on the upstream side of the pot. Otherwise, movement within the pot appeared more or less random. Fifteen escapes (75%) occurred through the observed tunnel, with the remainder out the opposite side (Table 2). Sixteen crabs (80%) first began their escape from a position on the bottom of the pot below the tunnel, and the remainder came from the sides or top of the tunnel. Although crabs were observed crawling over the tunnels and probing the exit from the top, most crabs attempting to exit from that position eventually fell to the bottom of the pot and either escaped from that position or gave up. Eleven crabs (55%) first entered the tunnel exit with their second (and longest) leg, whereas the remainder were about equally split between the chela and the third leg. The direction of escape movement down the tunnel was apparently random, as there was no preference for any particular direction.

Position of the ROV had no influence on direction of crab escape. Crosstabulation of ROV position with escape direction indicated no dependence ($G=3.485$, $P=0.480$). Therefore, crabs were equally likely to exit the tunnel facing the ROV, oblique to it (i.e., forward), or with their backs to it. However, size of the crab had a strong influence on escape direction ($G=8.717$, $P=0.013$). Only 3 of 12 legal crabs (25%) escaped in a forward direction, whereas 4 of 7 sublegal crabs (57%) did, probably due to the confining shape and size of the tunnel. Escape direction was not dependent on crab starting position ($G=4.24$, $P = 0.374$) or on the first leg used ($G=1.481$, $P=0.830$).

During observations of baited pots, three crabs of unknown size were observed entering pots, and several others were seen to enter the tunnel and move about near the pot entrance without subsequently entering. One crab which escaped immediately turned around and reentered the pot. Another crab was observed entering and immediately escaping. Crabs observed attempting to enter pots moved about quite a bit on the tunnel ramp, moving up and back down, or from side to side prior to entering. Such movements were generally slow and deliberate, as if the crab were trying to find the entrance to the pot, or the source of the bait odor, or as if they were undecided about entering the pot.

DISCUSSION

The majority of legal crabs which escaped from the pots did so by starting from a position below the tunnel opening. This could only be done if they could reach up into the opening with one leg. Most (55%) of the time they used the second leg, which is also the longest. Although escape was not dependent on size, size may still be an important parameter in predicting escapement since larger crabs have longer legs and may be able to reach the tunnel opening easier than smaller ones. In more densely occupied pots, though, smaller crabs could gain an advantage by stepping on top of another crab; this was observed at least once during the experiment. Crab escape was a much more rapid process than entrance to the pot. Apparently the crabs wanted out more urgently than they wanted in.

One objective of the study was to determine which behaviors might lead to greater escapement from derelict pots. To meet this end, the pot must be designed to retain crabs over the short term (24-48 hours), but to allow escape after longer periods. The pots that we used were well designed for retaining crabs. Pots which were modified by the addition of "cod fingers" appeared virtually inescapable since they were still full of crabs after several days. One method of improving escapability would be to make part of the pot degradable. Alaska commercial shellfish regulations (5 AAC 39.145) require that each pot have at least one escape opening secured by cotton thread, but the degradation time for such thread is unknown and probably quite variable. A better approach is to have some part of the pot secured by a galvanic timed release (GTR), which can be manufactured to degrade after a predetermined time interval with fair accuracy (Paul et al. 1993).

The question which remains is where to place such a device. Inclusion as part of the door tie-down strap might not be effective since the doors generally open upward. Greater success might be obtained if GTRs were placed on a collapsible panel in the sidewall near the bottom of the pot, perhaps in the corner, since crabs tended to congregate at that location. Another simple solution might be to rig the tunnel such that it would drop to a lower position after the GTR degrades so that more crabs could reach the exit.

This study was designed primarily to observe crab escape behavior so that hypotheses could be formulated for further work. It also showed that an ROV could be effectively used to make such observations and allowed us to observe crabs in different parts of the pot and from several different angles to determine the best point of view. The results of this study suggest several avenues for further research: Where should a GTR be placed to improve escapability of the pot? Can pots be designed that would prevent entry after an escape opening is opened? How do crabs escape from pots with upturned tunnel eyes?

Future underwater observations could be improved by use of a low-light silicon-intensified transistor(SIT) video camera rigidly fixed to a frame outside of the tunnel entrance and set to record at fixed intervals (e.g., 0.5 seconds every 6 seconds.). A 2-hour videotape could then be used to record observations over a 24-hour period after setting the pot since the majority of escapes occur within the first 24 hours. Pots could be retrieved daily and the videotape and crabs replaced at the same time.

ACKNOWLEDGMENTS

We greatly appreciate the assistance provided to us in this endeavor by Capt. Ron Kutchik of the R/V *Resolution*, and his crew, and by Tom Mayhew of Martech USA, who operated the ROV for us. We also thank Bill Jacobsen for loaning us the four crab pots used in this study, and Eric Munk and Susan Payne (NMFS, Kodiak) for assistance with diving operations.

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Table 1. Dates and times of crab pot observations. Crabs were intentionally placed in Pots 1, 2, 3, and 6. Pots 4 and 5 were baited. L/S refers to number of legal and sublegal sized crabs in pot at start of experiment, or which were observed escaping.

Test No.	Pot	L/S	Start Date	Start Time	End Time	Total Hours	Escapes (L/S)
1	1	25/12	4/20	1243	2000	5:40	4/1
	1		4/21	0000	0430	4:30	0/0
2	3	26/0	4/23	1120	1520	4:00	6/6
	3		4/24	0945	1345	4:00	0/0
3	2	25/13	4/24	1405	2340	7:20	0/0
	2		4/25	0530	0730	2:00	0/0
4	4	0/0	4/27	1035	1420	3:45	0/0
5	5	0/0	4/28	1220	1520	3:00	0/6
6	6	8/3	4/29	1040	1530	4:50	3/0

Table 2. Data describing escape behavior of crabs. ROV position was on the left (L), right (R), or opposite (O) side of tunnel used for escape. Crab sizes were legal (L; CL>135 mm) or sublegal (S). Crab starting positions were below (B), or on top (T) of tunnel, or from left (L) or right (R) side. First leg inserted into the tunnel exit was first (F=chela), second (S) or third (T). Direction of escape was left (L), right (R), or forward (F).

No.	ROV Pos.	Crab Size	Crab Pos.	First Leg	Direction of escape
1	L	L	B	S	L
2	O	L	B		L
3	L	L	B	T	R
4	R	S	L	F	R
5	O	L	B	T	R
6	R	L	B	T	L
7	R	L	B	T	L
8	O	L	B	S	F
9	O	L	T	S	
10	L	L	B	F	L
11	O	L	B	S	F
12	L	S	B	F	F
13	L	S	B	S	R
14	L	S	B	S	F
15	L	S	B	T	F
16	L	S	B	S	F
17	L	S	B	S	R
18	R	L	B	S	F
19	R	L	L	S	L
20	R	L	R	S	L
Summary	9L 6R 5O	13L 7S	2L 1R 1T 16B	4F 11S 5T	7L 5R 7F