

## Escape of Dungeness Crabs from Pots

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**ABSTRACT**—*Dungeness crab, Cancer magister, unable to escape from derelict pots (traps whose buoylines have parted) could be confined until death and lost to the fishery. Therefore, the National Marine Fisheries Service, in cooperation with the Washington Department of Fisheries and the Fish Commission of Oregon, conducted four experiments to determine whether Dungeness crabs could escape from standard ocean- and bay-style pots. Divers placed marked crabs into pots set without surface buoys on a sand bottom in Puget Sound, Wash. Female crabs and sublegal (carapace less than 6¼ inches across) and legal size male crabs escaped quickly from pots having escape rings open and triggers raised (inoperative). Pots with functional (operative) triggers and open escape rings allowed less escapement, especially for larger crabs. Crabs confined in pots having escape rings closed and with functional triggers were observed at intervals for 74 days, at which time 21 percent of the large and 67 percent of the small crabs had escaped. Of those crabs remaining alive, nearly all escaped within 3 days after the triggers were raised. Study results indicate that 1) escapement is directly related to availability of openings large enough to pass a crab and that 2) triggers are an effective means for reducing escapement.*

### INTRODUCTION

Numerous pots (i.e., traps) that are used in Dungeness crab, *Cancer magister*, fisheries are lost each year in coastal waters from Alaska southward to central California. Because they may continue to catch crabs for long periods it is desirable to know whether confined crabs can escape. Also, pots set in exposed shallow waters are often buried in sand during storms and unless crabs promptly escape from these pots, they will be killed during the sanding-in process<sup>1</sup>.

As part of an effort to estimate the

<sup>1</sup>Tegelberg, Herb C. 1974. Coastal Dungeness crab study. Wash. Dep. Fish., Olympia, Proj. Prog. Rep., Proj. 1-92-R, Contract 04-4-208-55 with U.S. Dep. Commer., Natl. Oceanic Atmos. Admin., Natl. Mar. Fish. Serv., Aug. 5, 1974, 27 p. Processed report.

Figure 1.—Marked crabs were carried by divers to the pots already set on the sea floor.

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potential loss of crabs in derelict pots (pots whose longlines have parted) and sanded-in pots, the National Marine Fisheries Service, in cooperation with the Washington State Department of Fisheries and the Fish Commission of Oregon<sup>2</sup>, conducted four experiments from October 1974 to January 1975. Our aim was to learn whether Dungeness crabs could escape from commercial-style crab pots. Specifically, we wanted to learn how rapidly crabs could exit pots having 1) tunnel triggers functional and escape rings open (normal fishing configuration), 2) triggers functional and escape rings sealed, and 3) no tunnel triggers and escape rings open.

### METHODS AND MATERIALS

Before discussing the specific experiments in detail, a general description of the methods, experimental pots, and handling of test crabs is presented.

Scuba diving investigators carried crabs into unbaited pots already placed on the sea floor and made periodic observations in situ (Fig. 1). Without

<sup>2</sup>The Fish Commission of Oregon and the Oregon Wildlife Commission have since been merged as the Oregon Department of Fish and Wildlife.



bait, the pots simulated a condition common among crab pots which are lost.

### Description of Gear

The two crab pot styles used in these experiments, ocean and bay pots, were borrowed from commercial fishers and numbered for identification. The ocean pots were 40 inches in diameter, 12½ inches deep, and weighed 73 pounds (Fig. 2). The stainless steel wire

orifices, escape rings, and mesh openings; the working arrangement of the two triggers were unison versus independent.

### Source of Crabs

Crabs used in the experiment were obtained from two sources. Initially, they were purchased from a commercial fisher operating a string of pots in Puget Sound off Everett, Wash. The crabs were held on the fishing vessel's

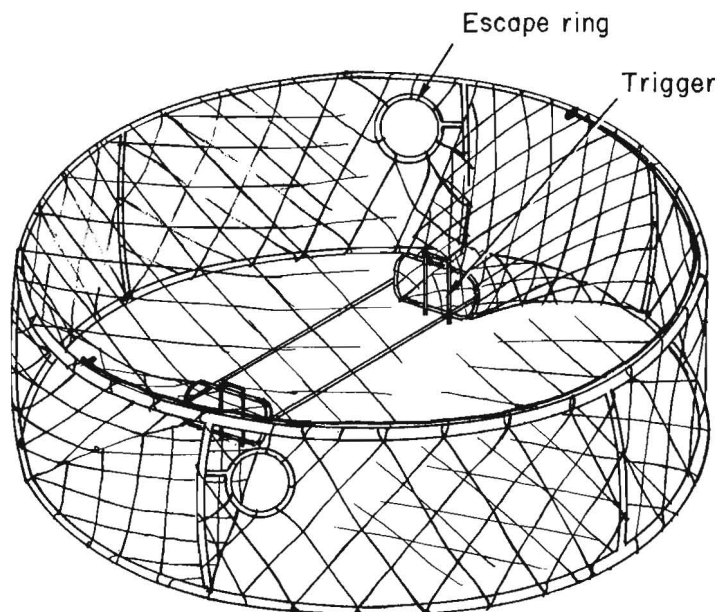


Figure 2.—A typical Dungeness pot showing the triggered tunnel opening and crab escape rings.

meshes had maximum openings of 3⅝ × 3¼ inches. One circular escape port (ring), 4⅛ inches inside diameter, was located on the side of each pot for egress of undersized crabs (Hipkins, 1972). The oval tunnel orifices were 8¼ × 3⅞ inches and had two vertical triggers working in unison (Fisher, 1970).

Bay pots are essentially a smaller version of the ocean pot. Each weighed 50 pounds with dimensions of 33 inches across and 10½ inches deep. Maximum mesh size was 4 × 3⅓ inches. Escape rings were 4¼ inches inside diameter. Tunnel orifices were slightly larger than on ocean pots, 8⅝ × 4⅝ inches. Each orifice has two vertical triggers working independently of each other.

Construction differences between the ocean and bay pots which might contribute to a differential crab escapement included sizes of pots, tunnel

deck in a cool, moist box for about 1½ hours, until all pots were lifted. They were then transferred to tubs filled with seawater and transported to the site of the experiment, which was located off Seattle about 20 miles from Everett. Water in the tubs was changed several times. From time of capture, the crabs were held for less than 3 hours before introduction into test pots.

Other experimental crabs were collected in Willapa Bay on the western coast of Washington by scientists of the Washington Department of Fisheries. The crabs were confined in mesh bags and held in the bay overnight. The following morning, the crabs were transported about 130 miles to Seattle and Puget Sound in an open truck. Only three of these crabs were rejected because of poor condition.

### Marking Test Crabs

Marks were placed on each carapace so investigators could readily identify the three study groups—female crabs and sublegal size male (less than 6¼ inches across the carapace measured ahead of the extreme points) and legal size male crabs—without handling during the experiment. Orange plastic "disc" tags were imbedded into a small amount of an epoxy-based putty normally used for marine repairs under wet or dry conditions, and placed on the left, middle, or right side of the carapace. In some experiments, the putty was strategically applied without tag discs. Before applying the putty, the carapace was rubbed with a rag to remove excess moisture and organic matter that might hinder it from adhering to the shell.

### Study Site

The experiment was conducted in Puget Sound near Seattle and NMFS's Northwest Fisheries Center to facilitate observations. Buoys were not used to prevent recreational boaters and commercial fishers from disturbing the gear. Buoys were not needed, however, because accurate soundings of water depth and bearings of landmarks permitted ready return to the pots.

## EXPERIMENTAL PLAN AND RESULTS

Four experiments were conducted to identify the escape rate and possible exit points for Dungeness crabs. Procedure and results for each experiment are reported together as a convenience to the reader. The numbers of pots and crabs used in each experiment are shown in Table 1. When determining escapement, all crabs that died in the pots were considered to have remained in the pot during the experiment. Consequently 100 percent escapement was not possible when mortalities occurred.

### Experiment A: Ocean Pots with Tunnels and Escape Rings Open

This experiment commenced 10 October 1974 to determine crab escapement from ocean pots having the triggers tied up (inoperative) and escape rings open.

Table 1.—Number of crabs by sex and size in each experiment.

Experiment	Number of pots used	Pot features	Number of crabs		
			Female	Sublegal <sup>1</sup> male	Legal <sup>2</sup> male
A	2	Ocean pots—triggers raised, escape rings open	12	12	12
B	4	Ocean pots—triggers functional, escape rings open	20	22	22
C	4	Ocean pots—triggers functional, escape rings closed	0	12	24
D	3	Bay pots—triggers functional, escape rings closed	0	9	18

<sup>1</sup> Sublegal size crab—less than 6¼ inches across carapace.  
<sup>2</sup> Legal size crab—6¼ inches or more.

Table 2.—Summary of escapement and mortality by experiment for female, sublegal and legal size male crabs.

Experiment	Sex and size of crabs	No. of crabs	Days soaked held	Total escape		In-pot survival		In-pot mortality	
				No.	Percent	No.	Percent	No.	Percent
A	Female	12	11	9	75	2	17	1	8
	Sublegal size male	12	11	11	92	0	0	1	8
	Legal size male	12	11	12	100	0	0	0	0
B	Female	20	12	13	65	5	25	2	10
	Sublegal size male	22	12	17	77	1	4	4	18
	Legal size male	22	12	10	45	7	32	5	23
C	Sublegal size male	12	74	8	67	3	25	1	8
	Legal size male	24	74	4	17	14	58	6	25
D	Sublegal size male	9	74	6	67	1	11	2	22
	Legal size male	18	74	5	28	8	44	5	28

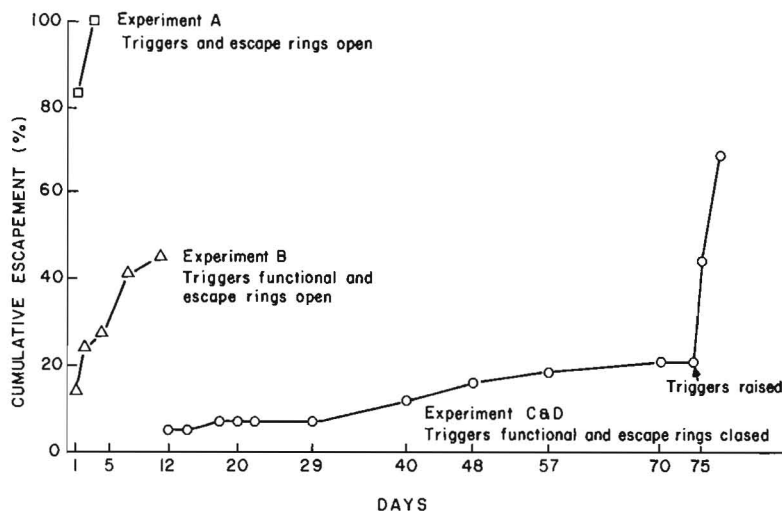


Figure 3.—Escapement of legal size male crabs in Experiments, A, B, C, and D during the study period.

Fishing for test crabs off Everett was poor; consequently, the number available for use was limited. Most of those captured were small with none of

the legal size males exceeding 6¼ inches across the carapace.

All crabs collected the first day were marked and carried by divers into two

ocean pots. Four visits to the pots to record escapement were made during the subsequent 11 days.

Both male and female crabs quickly exited the two pots having open tunnels and escape rings (Table 2). Of the 36 crabs, 27 (75 percent) were gone after 24 hours and 2 (6 percent) died in the pots. By the third day, all legal size males had escaped (Fig. 3), no additional mortalities occurred, and only two female crabs remained for the final 8 days.

### Experiment B: Ocean Pots in Fishing Condition—Tunnel Triggers Functional and Escape Rings Open

On 9 October 1974, four ocean pots were set with tagged crabs from off Everett to obtain estimates of crab escapement from pots having the triggers functional and the escape rings open (normal fishing configuration). Like experiment A, legal size male crabs were relatively small and female crabs were generally larger than the sublegal males. The experiment was terminated after 12 days when only 20 percent of the original crabs remained alive in the four pots.

Different escape rates were observed for the three groups (Fig. 4).

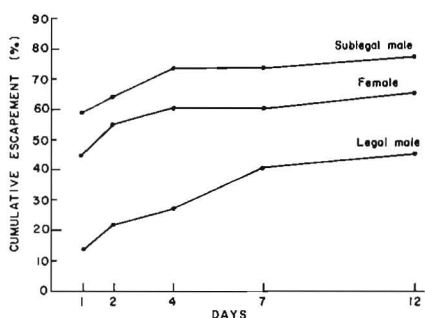


Figure 4.—Cumulative escapement of female, sublegal and legal size male crabs from pots having functional triggers and open escape rings.

Seventy-seven (77) percent of the sublegal male crabs escaped from pots having open escape rings and functional triggers in 12 days. Sixty-five (65) percent of the female crabs escaped while only 45 percent of the legal size males exited. Although no crabs were observed completing their escape, individuals from all three groups were seen maneuvering with their bodies, having nearly passed

through the escape ring. During the 12-day confinement, 11 (17 percent) of the crabs died. Octopuses were observed at the pots and may have influenced escapement.

**Experiments C and D: Ocean and Bay Pots with Tunnel Triggers Functional and Escape Rings Closed.**

These were planned to obtain estimates of the escape rate of crabs from ocean and bay pots having escape rings closed and triggers functional. They began after experiments A and B were terminated and the pots moved to a new location on commercial crab grounds about three-fourths of a mile away.

Crabs measuring up to 7 inches across the carapace from Willapa Bay were used. They were generally larger than those crabs taken from Puget Sound for experiments A and B. No female crabs were available.

The experiments continued uninterrupted for 74 days, after which all triggers were tied open to learn whether crabs remaining in the pots were still willing or able to escape if an easier means of egress were available.

During the first 4 weeks, the crabs became agitated when the investigators swam close to the pots. This response diminished with time and on later visits it was sometimes necessary to prod a particular crab to confirm that it was still alive and could move.

Percentage escapement for small crabs was 67 percent in both experi-

ments while the escapement for legal size crabs, 17 percent and 28 percent, was not significantly different. Therefore experiment C and D data were combined.

Fourteen observations were made during the 74-day test. Small crabs escaped more rapidly than legal size individuals (Fig. 5). After 74 days, 67 percent sublegal and 21 percent legal size male crabs had exited through the tunnels. Of the original 64 crabs, 26 remained alive in the pots when the triggers were raised; one day later, 54 percent of these 26 remaining individuals were gone and by the third day, all but 2 had escaped.

**RELATED OBSERVATIONS**

In addition to reporting specific experimental results, data dealing with tags, predation, recoveries, and fish captures are presented here.

**Mark Retention**

The epoxy putty used for marking the crab carapace eroded with time. Some crabs lost portions of the putty lump within a few days. After soaking 74 days, about 25 percent of those crabs remaining had lost most or all of the putty mark. This did not cause a problem as crabs that lost the mark could be distinguished from several new local entries by their light color and sluggish behavior.

**Octopus Predation**

On the second day after commencing experiment B, the investigators dis-

covered an octopus (about 35 pounds) on top of one pot (Fig. 6). The octopus was observed for several minutes attempting to capture crabs inside the pot. Individual arms placed through the top and side meshes readily seized various crabs which were then drawn to the meshes. The crabs were highly excited. The octopus was not observed to use two or more of its arms in a coordinated effort to move the crabs closer to its beak.

The octopus ignored all advances made by the divers and continued to probe for crabs. After forcibly removing the octopus from the pot, one dead marked crab was found held firmly against the base of the arms near its mouth. We presume it had been pulled out through the top pursed dumping hole. Two more dead crabs held up against the top meshes dropped away from the animal inside the pot.

No evidence of octopuses was found on the next visit 2 days later, but again on the seventh soaking day, octopuses weighing about 20 and 35 pounds were observed on top of two pots. Neither animal had possession of any crabs and no crabs in the pots appeared to have been killed by the animals. Again the octopuses were reluctant to be driven away.

Two octopuses were known to inhabit a small shipwreck about 150 feet from the pots. The dens were inspected after each visit to the pot string. Crab shells were observed but none had putty marks, suggesting that the octopuses which occupied these dens had not eaten crabs from the experimental pots.

At the close of experiment B, 13 marked crabs were released. Several days later, three marked shells appeared at one octopus den. There was no evidence that octopuses visited pots moved to a new site for experiments C and D.

**Crab Recoveries**

Some marked crabs were recovered. A total of 12 (17 percent) of those crabs which escaped during experiments A and B were recovered by local fishers. One marked crab escaped, then entered an unused pot stored among those in the study. Since we did not anticipate commercial fishing near the site of the

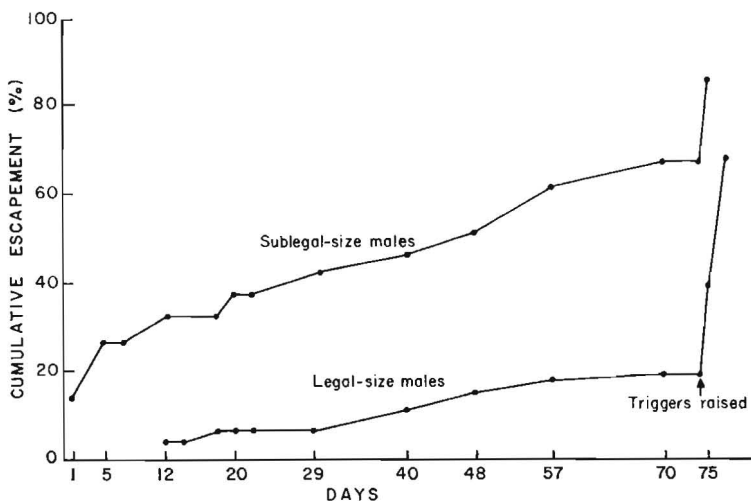


Figure 5.—Cumulative escapement of sublegal and legal size male crabs in Experiments C and D.

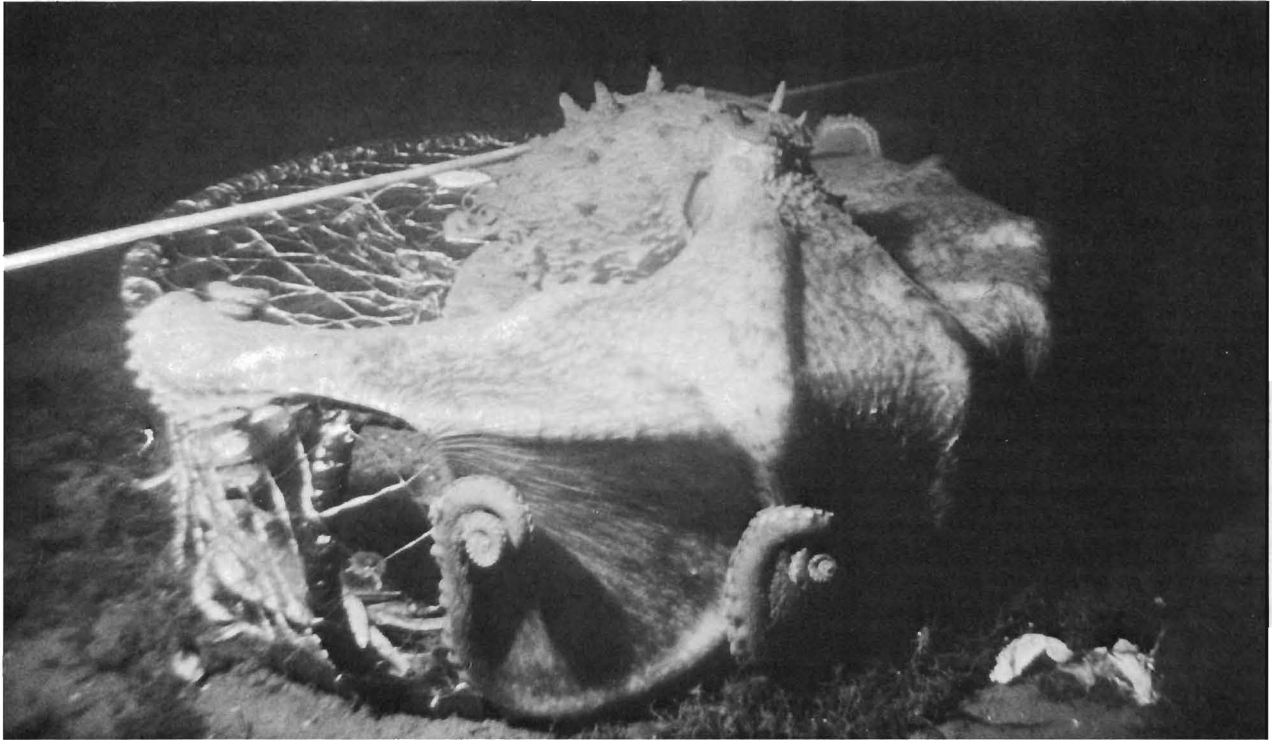


Figure 6.—An octopus is shown on top of one study pot, harrassing the crabs. The creature managed to capture three crabs.

experiment, appropriate tags for easy identification and return were not used. This relatively high incidental recovery implies that they escaped from the pots rather than being removed by octopuses or other predators.

#### Fish Captures

Two Pacific cod, *Gadus macrocephalus*, were found alive in separate pots containing crabs. The cod remained for several days and then apparently escaped.

#### CONCLUSIONS

These four experiments contribute to the general conclusion that, given an opening of sufficient size, crabs will

find their way out of pots. All legal size male crabs escaped from unbaited open pots in 3 days. Escapement was reduced to 45 percent in 12 days for those required to exit through the escape ring or past triggers. With the escape ring closed, only 21 percent escaped after 74 days. Apparently those Puget Sound fishers who use open-tunneled pots (without triggers) rely on the presence of bait to "hold" crabs for short soaking periods.

It is likely that triggered pots which contain large crabs at the time of the pots' loss and those lost pots which attract large crabs will retain many until their death. Similarly, sublegal crabs egress past triggers at a rela-

tively low rate and are subject to extended confinement.

Although we have obtained estimates of the escape rate for Dungeness crabs from pots, as yet we do not know how frequently crabs enter unbaited lost pots and become trapped. Therefore appropriate studies should be conducted on coastal commercial grounds to gather this information and to compare escape rates there with what is reported here.

#### LITERATURE CITED

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