MOVEMENTS OF TAGGED DUNGENESS CRABS [1/]

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INTRODUCTION

It was pointed out in the initial proposal of the State/Federal Dungeness crab management program that "the contribution to the fishery, of segments of the resource found in shallow or deep water is not well understood, nor is the potential exchange between fishing areas along the coast." A better understanding of these relationships is needed to evaluate the potential impact of management options on the different crab fisheries.

Presented here is a summary of the available information dealing with Dungeness crab movements in waters off British Columbia, Washington, Oregon, and California.

BRITISH COLUMBIA

MacKay (1942) reported that during the summer of 1930, 477 large crabs of both sexes were tagged with "chicken tags" and released in the vicinity of Prince Rupert. However, only 11 tags were recovered and the longest distance traveled was 1 mile by one crab. In 1931, 744 crabs were tagged and released in Boundary Bay, British Columbia. Only crabs that had molted a short time before were tagged. Even though Boundary Bay was intensively fished, only 13 recoveries were reported. The longest movement recorded was by one crab that traveled 6 miles (days the crab was at liberty not given). One crab that was at liberty 234 days was recaptured less than 1 mile from the place of release. The remaining recoveries traveled 2 to 3 miles, and except for one crab, were at liberty from 5 to 63 days.

Several tagging studies have been carried out in Naden Harbor and off the north and east coasts of Graham Island in the Queen Charlotte Island group. McMynn

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1/ Prepared for the State/Federal Dungeness Crab Management Program. August 1974.

(1951) reported that in 1947 and 1948, 4,317 male crabs of 6½ inches or more in carapace width were tagged with disc tags and released in the three areas (Table 1). A total of 474 (11 percent)of the tags were recovered. The overall average distance traveled by tagged crabs recaptured during the season they were tagged was 2.6 miles. The average distance traveled by crabs caught the year following tagging was 5.2 miles and 7.5 miles in the north and east coast areas, respectively. One crab was recovered over 20 miles from the place of release. McMynn also presents data on the directional movement of crabs which indicates that movement was random in all three areas.

Butler (1951) studied movement of tagged legal-sized male crabs (6½ inches or larger) in the same areas of Graham Island during 1949 and 1950. Neither the type of tag used or the number of crabs tagged was given in this paper. However, Butler reported elsewhere that Peterson disc tags were used. The percent recoveries were 34 and 34 from Naden Harbor, 5 and 11 from the north coast area, and 9 and 22 from the east coast area for the two years, respectively. In addition, 3 crabs tagged in 1947 and 54 crabs tagged in 1948 were recovered in 1949 and 12 crabs tagged in 1948 were recovered in 1950. These recoveries appear to be crabs that were tagged in earlier studies by McMynn (1951). Butler's summary of movement of tagged crabs reads as follows:

> Recoveries of season tags during 1949 failed to show evidence of "directed" movement within the north or east coast areas. Movements were more of a random nature. However, in the Naden Harbour fishery, recoveries of crabs tagged inside were made out in Virago Sound. Since the crabs were tagged inside the harbour in June, and recovered in Virago Sound during September and October, the movement is interpreted as a seasonal migration. Virago Sound was not fished during 1950, so it was not possible to determine whether seasonal migration had occurred.
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> A seasonal migration is evident from recoveries of tags from the east coast during 1950. Tags were released during May and June along trap gear about six miles offshore. Recoveries of these tags were reported from traps situated about a mile offshore during July and August. The availability of crabs to the fishery was correlated with

Table 1. Summary of Graham Island Tagging Studies, 1947-48. (Adapted from McMynn, 1951)

Area	Observation	Year 1947	1948
Naden Harbor	Tagging period	Aug.-Sept.	Aug.-Sept.
	Recovery period	Autumn [1]	Autumn [1]
	Crabs tagged	358	508
	Tags recovered	121	176
	Percent recovery [2]	34	35
	Average distance traveled	3.5 miles	2.3 miles
	Tags recovered from previous year tagging	-	9
North Coast	Tagging period	June-Aug.	June-Sept.
	Recovery period	July-Oct.	July-Oct.
	Crabs tagged	679	815
	Tags recovered	35	29
	Percent recovery [2]	5.2	3.6
	Average distance traveled	1.6 miles	2.1 miles
	Tags recovered from previous year tagging	-	44
	Average distance traveled by crags tagged previous year	-	5.2 miles
East Coast	Tagging period	June-Aug.	June-Aug.
	Recovery period	July-Sept.	June-Aug.
	Crabs tagged	744	1,213
	Tags recovered	30	23
	Percent recovery [2]	4.0	1.9
	Average distance traveled	2.2 miles	3.8 miles
	Tags recovered from previous year tagging	-	7
	Average distance traveled by crabs tagged previous year	-	7.5 miles

1/ McMynn only reports that the tags were recovered during the autumn fishery.

2/ Percent recovery does not include those tags that were recovered the following year.

movement of crabs, indicating that a body of crabs had migrated into the inshore waters. Then, after August, the reverse was noted. Crabs tagged one mile offshore were recaptured six miles offshore as the season advanced. American vessels fishing about twelve miles offshore during September and October reported recoveries (no tagging done at this location). Finally, over the winter months tags were recovered by trawlers operating along the eastern edge of Hecate Strait. It is evident that a part of the population, at least, spends the winter in the deep water on the east side of Hecate Strait.

In the north coast area during 1950 the picture of seasonal migration was less clear. No summer inshore migration of crabs was noted. Tags released along inshore gear in the months of July and August were recovered late in September and October offshore. Correlated with this offshore movement of tagged crabs was a decline in availability along inshore gear.

Butler also presents data from tagged crabs recovered one and two years after release which indicate there is some movement of crabs between the north and east coast areas, but no evidence of crabs moving between Naden Harbor and these two areas was found.

Butler (1957) reported the results of an additional tagging study done in the Graham Island area in 1955. During the period May to September 1,462 sub-legal (some as small as 3 7/8 inches) and 632 legal male crabs were tagged with "suture" tags and release in Hecate Strait, McIntyre Bay, and Naden Harbor. Butler has summarized the results of this study as follows:

Recoveries During 1955 of Tags Released in 1955

The number of tags released and recovered according to area and size during 1955 are shown in Table I.

Table I. Numbers of tags released and recovered according to area and size during 1955.

Area	Sub-legal-size			Legal-size males		
	Tagged	Recoveries		Tagged	Recoveries	
	No.	No.	%	No.	No.	%
Hecate Strait	662	123	18.6	241	100	41.5
McIntyre Bay	640	95	14.8	279	107	38.4
Naden Harbour	160	3	1.9	112	5	4.5

Hecate Strait. Of the 123 recoveries of sub-legal-size male crabs, 61 showed evidence of a movement. The remainder were recovered at the place of tagging. Movement was mostly of a random nature within the fishing areas, but there was an indication of an offshore (west-to east) movement related to season. Eight tags were recovered after moving from 15 to 19 miles across Hecate Strait.

There were 100 recoveries of legal-size crabs and definite information regarding locality of recapture accompanied 38 of their tags. With the exception of four, all these tags were taken in the tagging area, after an average movement of about 5 miles. Three tags were recovered in the eastern part of Hecate Strait 13 to 22 miles away from the tagging locality; and one tagged crab had moved an indefinite distance from Hecate Strait to McIntyre Bay.

McIntyre Bay. Of the 95 recoveries of sub-legal-size crabs, 24 showed evidence of movement. Nineteen of them were recaptured in the area after moving an average distance of about 4 miles. There were five recoveries which showed a movement around Rose Spit into Hecate Strait, a distance of about 19 miles.

Recoveries of legal-size crabs totalled 107; of these, 28 had definite recovery data to indicate movement. The most significant movement within McIntyre Bay was eastward (toward Rose Spit), with sixteen recoveries showing an average movement of about 17 miles. Two recoveries were made in Hecate Strait, and the tagged crabs moved an average distance of 17 miles.

Naden Harbour. No information regarding movements of tagged crabs was obtained from the recoveries of either size groups. It is believed that the low number of recoveries was due to the slight fishing effort during the 1955 fall season in Naden Harbour.

Recoveries During 1956 of Tags Released in 1955

In Table II are shown the recoveries according to area and size in 1956 of tags released in 1955. The numbers of tagged crabs at large at the start of the 1956 season were calculated by subtracting the 1955 recoveries from the numbers released during that season. Natural mortality is disregarded in thses calculations.

Table II.-Recoveries in 1956 of tags released in 1955.

Area	Sub-legal-size males			Legal-size males		
	At large start of 1956	Recoveries		At large, start of 1956	Recoveries	
	No.	No.	%	No.	No.	%
Hecate Strait	539	68	12.6	141	17	12.1
McIntyre Bay	545	56	10.3	172	36	20.9
Naden Harbour	157	5	3.2	107	1	0.93

Hecate Strait. Of the 68 recoveries of sub-legal-size crabs, 42 had definite recovery information to demonstrate movement. All these tags were recovered within this fishing area.

Eleven of the seventeen recoveries of legal-size tagged crabs showed evidence of movement. No tag was recovered outside the Hecate Strait area.

McIntyre Bay. Recoveries of sub-legal-size males totalled 56; of these, 30 had definite recovery data to indicate movement. Eight were recaptured on this fishing ground. There were 22 recoveries in Hecate Strait; the average distance travelled by these crabs was about 14 miles.

Of the 36 recoveries of legal-size males, ten showed evidence of movement. Nine were recaptured in McIntyre Bay, and one moved into Hecate Strait, a distance of 14 miles.

Naden Harbour. Two of the sub-legal-size crabs tagged in Naden Harbour were recaptured in Virago Sound; the distance travelled was about 5 miles.

It is noteworthy that in this study the tag recoveries indicate that sublegal-size male crabs move about as much and in some cases more than legal-size male crabs.

WASHINGTON

The movement of tagged crabs in Washington waters has been studied by Cleaver (1949). During the period December 1966 through April 1948, 9,195 crabs were tagged with Peterson disc tags and released at depths ranging from 2 to 43 fathoms in the areas of Long Beach, Willapa Bay, Grayland Beach, Grays Harbor, Copalis Beach, and Destruction Island. The majority of the crabs tagged were males ranging in size from 155 to 209 mm. Approximately 70 percent of the tagged crabs were released during the months of November, December, and January. It is not clear as to what the actual total recovery was. Cleaver gives the number of recoveries through August 1948 as being 4,859 (53 percent). Later in the report he presents data collected from crabs that were recovered after August 1948 but does not indicate how many were recovered. The "calculated" number of tag returns was 2,800 and 3,672 for 1947 and 1948, respectively, for an estimated total return

of approximately 70 percent. The calculated returns took into account those tagged crabs caught by fishermen but were not recovered by samplers.

Cleaver reported that "crabs which were caught and tagged in 40 to 50 fathoms of water in early January, 1947, appeared in the inshore fishery during February and March of that year. Unfortunately there was little opportunity for tags released in depths ranging from 5 to 15 fathoms to be recaptured in deeper waters. A few were returned by the trawl fleet, but the numbers were too small to be useful." Distribution of calculated tag returns shows that in most instances the majority of crabs that had moved from the tagging area were taken to the north of the area of release (Table 2). Cleaver pointed out that "this movement coincides with the intensity of the fishery in every case excepting Destruction Island, where the movement, while still northward, was into an area with a lesser intensity than the one immediately to the south." During 1947 there were relatively few tags that had been released in Willapa Bay and Grays Harbor recovered in the ocean. However, during 1948 a greater percentage of the recoveries of crabs released in these areas was taken in the ocean fishery - particularly of those crabs released in Willapa Bay. Cleaver attributes the larger outside recovery from Willapa Bay in 1948 to a large percentage of the tagged crabs being released near to the bay entrance. There was some movement of crabs from the ocean into each area both years.

Most of the crab movement appeared to take place within about 6 months after tagging (Table 3). The average distance traveled by tagged crabs after 6 months at liberty was approximately 13 and 10 miles for crabs tagged in 1947 and 1948, respectively. However, several crabs that were at liberty from 3 to 7 months traveled distances of 20 to 60 miles and one crab traveled from outside Grays Harbor to Tillamook Bay on the Oregon coast, a distance of 81 nautical miles in 6 months. There was also some indication that crabs between 155 and 169 millimeters traveled farther as a group than did larger crabs.

Table 2. Number of Tagged Crabs Recovered by Area in Washington Waters - Calculated Returns. (Original Table 17 from Cleaver, 1949)

	1947						
Tagged	Northern Oregon	Long Beach	Willapa Bay	Grayland Beach	Grays Harbor	Copalis Beach	Destruction Island
Long Beach	37	194	14	113	1	23	-
Willapa Bay	1	7	98	2	-	1	-
Grayland Beach	25	124	40	496	13	364	1
Grays Harbor	-	2	5	17	208	27	-
Copalis Beach	2	27	5	73	17	862	1
Destruction Island	-	-	-	-	-	-	-

	1948						
Tagged	Northern Oregon	Long Beach	Willapa Bay	Grayland Beach	Grays Harbor	Copalis Beach	Destruction Island
Long Beach	19	349	33	140	-	188	-
Willapa Bay	4	48	210	53	1	47	-
Grayland Beach	4	64	35	233	20	464	6
Grays Harbor	-	5	-	11	219	54	10
Copalis Beach	2	23	11	61	22	887	-
Destruction Island	-	-	-	-	-	8	441

Table 3. Distances Traveled by Tagged Crabs in Relation to the Time at Liberty off the Coast of Washington. 1/
(Adapted from Cleaver, 1949)

	1947 Tagging															
Distance (miles)	Number of Recoveries by Month Following Tagging															
	0	1	2	3	4	5	6	7	10	11	12	13	14	15	16	17
0.0-4.9	61	133	202	149	108	52	6	1			1	1	1		1	
5.0-9.9	6	38	105	124	82	26	8		1			1	1			
10.0-14.9	1	27	68	81	95	65	19	5		1		1				
15.0-19.9		7	23	42	48	21	6	2						2		
20.0-24.9		1	20	16	22	25	3									
25.0-29.9		1	1	4	16	11	6						1			
30.0-34.9			3	3	6	4	1									1
35.0-39.9		1	3	2	1	3										
40.0-44.9				3		1										
45.0-49.9		1	1		2											
50.0-54.9					2											
55.0-59.9							1									
60.0-64.9																
65.0-69.9																
70.0-74.9																
75.0-79.9																
80.0-84.9							1									
Total Recoveries.	68	209	425	424	382	208	51	8	1	1	1	3	3	2	1	1
Average Miles Traveled	3.1	5.8	7.7	9.0	11.2	12.8	16.7	12.5	7.2	12.5	13.8	7.5	12.5	17.5	0.0	32.5

Table 3. (Continued)

1948 Tagging

Distance (miles)	Number of Recoveries by Month Following Tagging												
	0	1	2	3	4	5	6	7	8	9	10	11	12
0.0-4.9	121	213	219	166	116	60	30	8	2	1	2		
5.0-9.9	11	65	99	88	66	54	17	5	5	1			2
10.0-14.9	2	27	68	84	50	36	18	2	2	2			
15.0-19.9		12	36	64	48	31	6	2	1	2			
20.0-24.9		7	25	29	23	13	11	2			3		
25.0-29.9		3	9	19	16	11	2			1			
30.0-34.9		1	4	6	7	3	1						
35.0-39.9			1	8	9	4	1						
40.0-44.9			1	3	2	3		1					
45.0-49.9				3	1	2							
50.0-54.9						1							
55.0-59.9					1								
60.0-64.9													
65.0-69.9													
Total Recoveries	134	328	462	470	339	218	86	20	10	7	5		2
Average Miles Traveled	2.9	5.3	8.4	9.4	10.8	10.3	10.1	5.7	9.4	12.5	12.5		7.5

1/ Cleaver indicates the data is from "outside only." It is not known if he included crabs released in Willapa Bay and Grays Harbor that were recovered in the ocean.

OREGON

Movement of tagged crabs in Oregon waters was first investigated by Waldron (1958). During the period November 1947 to January 1950, 6,248 crabs were tagged with Peterson disc tags and released in five different offshore fishing areas along the coast from Grays Harbor, Washington to just north of the Rogue River and in four bays. Neither the size or sex of crabs tagged was given by Waldron, but reportedly only legal size males were tagged (C.D. Snow, personal communication). Most of the tagged crabs were released during the months October to March.

Over 2,100 tags were recovered from all areas (Table 4). There were 1,042 recoveries from offshore releases for which distance traveled could be determined. The average distance traveled by these crabs was 8.3 nautical miles (range 0-133 miles) in an average time of 80 days. Approximately 90 percent of the recoveries of offshore releases were made within 6 months (Table 5). However, three crabs were out more than a year, one of which was at liberty 878 days. Eighty-eight percent of the recoveries from offshore releases were from offshore areas, while 3 percent of the recoveries were from bays. The recovery area was not determined for 9 percent of the recoveries. Fifty-seven percent of the recoveries showed no directional movement (4 miles or less), 24 percent moved north, and 19 percent moved south from the points of release (Table 6). There was some interchange of crabs between Areas I and II (8 crabs) and Areas III and IV (24 crabs). One crab released in Area III moved to north of Willapa Bay in Area I. There was no movement of tagged crabs into or out of Area V which is south of Cape Blanco. Tagged crabs were released in Area V very close to the Cape and fishing took place north and south of the release area but no tagged crabs were recovered north of Cape Blanco. This led Waldron to conclude that Cape Blanco was an apparent barrier to crab movement.

Based on movement alone, Waldron suggested that one might define three crab areas along the Oregon coast: (1) north of Cascade Head, (2) Cascade Head to

Table 4. Numbers of Tagged Crabs Released and Recovered According to Area Along the Oregon Coast During 1947-1950. (Adapted from Waldron, 1958)

Tagging Area	No. Crabs Released	No. Crabs Recovered	Percent Recovered
Offshore			
Area I. SeaLion Rock to Tillamook Head	1,080	321	29.7
Area II. Tillamook Head to Cascade Head	572	122	21.3
Area III. Cascade Head to Siuslaw River	864	375	43.4
Area IV. Siuslaw River to Cape Blanco	815	279	34.2
Area V. Cape Blanco to Ore.-Calif. Border	761	388	51.0
Bay			
Columbia River	501	77	15.4
Netarts Bay	278	78	28.1
Yaquina Bay	622	160	25.7
Coos Bay	755	364	48.2
Total	6,248	2,164	34.6

Table 5. Average Miles Traveled and Days at Liberty for Crabs Released in Offshore Waters of Oregon, 1947-1950. (Original Table 4 from Waldron, 1958)

Tagging Area	Tagging Season	Shell Condition 1/	Missing Appendates		Days at Liberty 0-19	20-39	40-59	60-79	80-99	100-119	120-139	140-159	160-179	180-199	200-219	220-239	240-259	260-279	280-299	300-319	320-339	340-359
I	47-48	1	None	Miles	2.0	2.0	14.9	14.1	19.6	13.8	18.3	17.8	21.3	--	--	--	37.0	--	--	--	--	--
				Frequency	1	1	12	7	27	19	8	6	7	--	--	--	1	--	--	--	--	--
		1	Some	Miles	--	7.0	27.0	12.0	7.0	17.0	44.5	7.0	--	22.0	37.0	--	--	--	--	--	--	--
				Frequency	--	1	1	4	1	4	2	1	--	2	1	--	--	--	--	--	--	--
	49-50	1	None	Miles	2.0	7.0	4.0	5.0	3.7	5.7	4.0	7.0	5.3	9.5	--	--	--	--	--	--	--	--
				Frequency	11	3	5	5	3	15	10	3	3	2								
		1	Some	Miles	2.0	7.0	2.0	--	17.0	14.3	2.0	4.5	--	--	--	--	--	--	--	--	--	--
				Frequency	3	1	1	--	2	3	1	2	--	--	--	--	--	--	--	--	--	--
		2	None	Miles	2.0	2.0	2.0	23.0	2.0	19.5	5.7	14.5	12.0	12.0	--	--	--	--	--	--	--	--
				Frequency	1	1	1	5	2	2	8	2	2	1								
II	47-48	1	None	Miles	2.0	5.3	4.1	2.0	2.0	4.5	--	2.0	13.2	--	7.0	--	7.0	--	--	--	--	--
				Frequency	1	3	12	13	5	10	--	2	4	--	1	--	1	--	--	--	--	--
		1	Some	Miles	2.0	2.0	3.7	4.5	3.0	2.0	--	--	2.0	7.0	--	--	--	--	--	--	--	--
				Frequency	1	1	3	2	5	1	--	--	1	1	--	--	--	--	--	--	--	--
III	48-49	1	None	Miles	4.1	3.3	3.8	4.2	8.0	11.6	22.0	12.0	2.0	5.8	7.0	42.0	9.5	12.0	4.5	2.0	--	12.0
				Frequency	52	51	74	47	21	14	5	1	1	4	1	2	2	1	2	1	--	1
		1	Some	Miles	4.4	4.1	3.4	3.2	5.8	4.5	9.0	--	12.0	7.0	12.0	--	--	--	--	--	--	--
				Frequency	27	7	13	4	4	6	5	--	1	2	1	--	--	--	--	--	--	--
IV	48-49	1	None	Miles	--	7.0	--	4.1	24.5	12.0	12.0	2.0	34.5	--	--	--	--	--	--	--	--	--
				Frequency	0	1	0	7	2	3	1	1	2	--	--	--	--	--	--	--	--	--
	49-50	1	None	Miles	2.0	9.5	18.0	12.4	12.7	17.5	8.4	10.3	7.5	16.3	--	--	--	--	--	--	--	--
				Frequency	1	2	5	12	22	19	21	9	5	7	--	--	--	--	--	--	--	--
		1	Some	Miles	--	--	--	7.0	11.3	12.0	17.0	2.0	7.0	9.5	17.0	22.0	--	--	--	--	--	--
				Frequency	--	--	--	2	7	6	2	1	1	2	1	1	--	--	--	--	--	--
V	49-50	1	None	Miles	5.8	2.2	3.4	3.9	6.2	2.0	4.0	2.0	--	2.0	--	--	--	--	--	--	--	--
				Frequency	4	26	62	34	6	9	10	4	--	2	--	--	--	--	--	--	--	--

1/ Shell Condition: 1 - Carapace very rigid, exoskelton of legs rigid or slightly pliable.
2 - Carapace slightly to moderately flexible.

Table 6. Movement of Crabs Released in Offshore Waters of Oregon, 1947-1950
(Original Table 5 from Waldron, 1958)

Area	Season	Number of Recoveries with Movement Data Recorded	Non-directional Movement 1/		Directional Movement								Crabs Moving Out of Area			
					Average						Maximum					
					North			South			North	South	North		South	
			No.	%	Miles	No.	%	Miles	No.	%	Miles	Miles	No.	%	No.	%
I	1947-48 2/	127	22	17.3	25.0	79	62.2	14.8	26	20.5	71	57	0	0	3	2.4
	1949-50	121	78	64.5	18.1	31	25.6	11.6	12	9.9	41	12	0	0	0	0
II	1947-48	70	52	74.3	9.0	11	15.7	11.6	7	10.0	28	25	1	1.4	0	0
	1949-50	9	5	55.6	30.8	4	44.4	0	0	0	73	0	4	44.4	0	0
III	1948-49	352	239	67.9	12.7	55	15.6	13.8	58	16.5	133	89	1	0.3	5	1.4
IV	1948-49	30	14	46.7	22.0	6	20.0	20.2	10	33.3	55	38	1	3.3	0	0
	1949-50	161	44	27.3	16.7	39	24.2	18.0	78	48.4	37	35	18	11.2	0	0
V	1949-50	172	139	80.8	9.9	24	14.0	8.7	9	5.2	19	11	0	0	0	0
	Total	1,042	592	56.9	17.5	249	23.9	15.5	200	19.2	--	--	25	2.4	8	0.8

1/ Non-directional indicates a movement of 4 miles or less.

2/ Area I, 1947-48: Crabs captured in otter-trawl and released 5 miles or more from main fishing grounds.

Cape Blanco, and (3) south of Cape Blanco. However, as Waldron pointed out the area divisions are arbitrary because the results obtained were at least partially dependent upon numbers of crabs tagged, proximity to adjacent areas and grounds, and size of the study areas.

There were 606 recoveries from releases in all bays for which movement information was obtained. The average distance traveled by these crabs was 4.2 nautical miles. The greatest distance traveled was 81 miles by two different crabs, one traveled from Yaquina Bay to Coos Bay in 152 days and the other from Coos Bay to Yaquina Bay in 92 days. Eighty-four percent of the recoveries of bay releases were made within 4 miles of where they were released. Seventy-four percent of all recoveries were from the same bay in which the crabs had been released, 18 percent were from the ocean, and 2 percent were from other bays. The recovery area was not determined for 7 percent of the recoveries. Waldron states that "fishing intensity, which would be a factor in the recovery of tags from the bay and offshore fishing areas, cannot be evaluated from data on hand. Because of this factor it is difficult to say precisely what the relationship is between movement of crabs in and out of the bays of Oregon. It is only possible to state that crabs do move in and out of bays at an unknown rate and that they will occasionally move from one bay to another."

Jow (1965) has summarized the results of a crab tagging program done in the California-Oregon border area during November and December 1962. Groups of 825 and 76 legal-size male crabs were tagged with Peterson disc tags and released in depths of 10 to 17 and 13 to 22 fathoms in Pelican Bay off Brookings, Oregon and off the Klamath River in California, respectively.

During the period December 1962 through July 1963 and in December 1963, 471 recoveries were made that had usable information on movement. Of 438 recoveries of tagged crabs released in Pelican Bay, 416 were recovered near the release sites.

One tagged crab was recovered 12 miles north of Pelican Bay, 3 were recovered off Crescent City, and 17 were recovered between the Klamath River and Big Lagoon. One crab traveled to Table Bluff, a distance of 70 miles. Of the 33 recoveries of tagged crabs that had been released off the Klamath River, 20 had moved slightly inshore from where they had been released, 2 were recovered off Crescent City, and 10 were recovered between Redding Rock and Big Lagoon. It is interesting that none of the tagged crabs released off the Klamath River were recovered in Oregon waters, for Jow states that "tagged crabs released in areas between Eureka and the Klamath River in previous experiments of 1956 and 1958 (Dahlstrom and Jow, unpublished data) were recovered off Brookings and other southern Oregon locations."

The results of Jow's study along with those from previous studies cited by Jow indicate there is no definite pattern to coastal movement of crabs and that crabs move between the two states in both directions.

Snow and Wagner (1965) present data on movement of tagged crabs released in Yaquina Bay, Oregon during August 1961. They tagged 966 male crabs ranging in size from 77 to 179 mm in shoulder width with spaghetti or dart tags and released them in the Sally's Bend area of Yaquina Bay. Between August 1961 and September 1963, 95 of the tagged crabs were recovered. Seventy-two of the recoveries came from within the bay close to where the crabs had been released, 6 came from Alsea Bay which is about 10 miles south of Yaquina Bay, and 17 came from ocean waters. The distance traveled by tagged crabs recovered in the ocean ranged from 3.5 to 34.0 miles and averaged 14.7 miles. Ten of the 23 recoveries had been at liberty more than a year and one recovery from Alsea Bay had been at liberty for 714 days. All but one of the recoveries from outside Yaquina Bay had moved south. However, the authors point out, "since most of the Newport-based crab fishing vessels fish south of Yaquina Bay, this was expected and may not indicate the actual dispersion."

Demory (1971) reported the results of a tagging study done at Port Orford on the southern Oregon coast in March and April 1965. The purpose of this study was to evaluate movement of crabs around a headland area. Port Orford is exposed from the south and completely protected from the west and north by a headland known as The Heads (Demory, 1971) and is located approximately 8 miles south of Cape Blanco which Waldron (1958) considered a natural barrier to crab movement.

Crabs were taken from two areas, one area 6 miles north of Port Orford off Elk River and the other 11 miles south of Port Orford off Frankport, tagged with spaghetti tags and released at Port Orford. The crabs were all less than 159 mm in carapace width when tagged and included 3,004 males and 1,001 females.

Of the 4,005 tagged crabs released (2,674 from Elk River and 1,331 from Frankport), only 113 (108 males and 5 females) were recovered and of these only 71 provided data on movement. This included 52 recoveries from the group of crabs tagged from the Elk River area and 19 recoveries from the group tagged from the Frankport area. Of the 71 usable recoveries, 12 were taken near the release site (within 2 miles), 33 were taken north of Port Orford, and 26 were taken south of Port Orford. The average distance traveled by 22 crabs from the Elk River group and 11 crabs from the Frankport group that were recovered north of Port Orford was 14.9 miles (range 2 - 90 miles) and 10.6 miles (range 2 - 27 miles), respectively. The average distance traveled for 21 crabs and 5 crabs from the Elk River and Frankport areas that were recovered south of Port Orford was 14.4 miles (range 5 - 56 miles) and 20.2 miles (range 11 - 35 miles), respectively.

Demory points out that the results of the Port Orford study may not be conclusive because of poor tag returns. However, several tagged crabs were recovered north of Cape Blanco which indicates the Cape may not be an important barrier to crab movement as Waldron (1958) suggested.

CALIFORNIA

Several crab tagging programs have been carried out in California waters. However, except for the study by Jow (1965) which was cited earlier in this report, the results of these studies have not been published (W.A. Dahlstrom, personal communication). In light of this W.A. Dahlstrom, California Department of Fish and Game, kindly prepared a summary of California tagging studies for inclusion in this report. His summary reads as follows:

> Tagging of Dungeness Crab in California since 1956 has shown that there has been no exchange of tagged crabs between major fishing areas. The fishing areas of Eureka-Crescent City, Fort Bragg and San Francisco have discrete populations. However, larval drift and eventual setting between the California areas and into Oregon is a strong possibility.
>
> Tag recoveries have indicated that migration patterns have generally been random and most crabs have been recovered a few miles from the point of release. Movements of 20 to 30 miles are quite common, but movements of longer distances are in the minority. However, a few crabs which were tagged in the Eureka-Crescent City area have traveled from 40 to 90 miles. Three crabs, which were tagged off Big Lagoon, California were caught in fishermen's traps off Elk River, Oregon - a distance of 94 to 98 miles in 150 to 188 days. However, these long movements are the exceptions and judging from tag recovery information, the interchange of crabs between California and Oregon appears negligible. Only in the border fishing areas of Brookings, Oregon and Crescent City, California might some interchange take place, but this appears to be a single population.
>
> Some of the crabs have been recovered inshore and also offshore from the point of release but usually with no significant depth difference. At times there appears to be a noticeable depth and directional movement depending upon time of the year.

SUMMARY

This report provides a summary of the published information on movements of tagged Dungeness crabs along the Pacific coast from British Columbia to California. More than 28,000 crabs have been tagged and released in ocean and bay waters in nine separate studies. Of these more than 7000 crabs have been recovered that had usable information on movement. In general, the results of these studies show the following:

1. There is no definite pattern to coastal movement of crabs. In some local areas there has been a tendency for tagged crabs to move predominately in one direction but on a coastwise basis it appears movements are more random in nature.
2. Crabs do not move in any significant number between major fishing areas. Tagged crabs have traveled distances of more than 100 miles, but most recoveries have been made within a few miles of where they were released.
3. There appears to be some onshore-offshore movement, with crabs tending to move inshore in the spring and summer and offshore in the fall and winter. However, it is not clear what percentage of the population may move or how extensive this movement may be coastwide.
4. Crabs move in and out of bays and in some cases from bay to bay, but the rate at which this interchange takes place is not known.
5. Crabs tend to move freely between the waters of each state in the California-Oregon border area and the Oregon-Washington border area, indicating a single population occurs in each area.
6. Data is not available to evaluate movement patterns of crabs found in deep water (50 fathoms or more).

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