

REPORT TO THE ALASKA BOARD OF FISHERIES
MARCH 1983

RECOVERY DISTRIBUTION OF CHUM SALMON TAGGED OFFSHORE
IN THE NORTH PACIFIC IN THE VICINITY OF THE ALASKA
PENINSULA AND EASTERN ALEUTIAN ISLAND CHAIN

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Recovery Distribution of Chum Salmon Tagged Offshore in the North Pacific in the Vicinity of the Alaska Peninsula and Eastern Aleutian Island Chain

ABSTRACT

The International North Pacific Fisheries Commission (INPFC) has for many years sponsored an extensive program to tag salmon on the high seas and in areas of interception to develop an understanding of salmon distribution and pattern of movements. Chum salmon were tagged by INPFC member countries in the vicinity of the Alaska Peninsula and Eastern Aleutian Island chain from 1956 to 1966. The greatest tagging effort within this study area occurred in the Pacific Ocean offshore of Umnak and Unalaska Islands. Recoveries from these tag releases were made throughout Western Alaska and along the Asia coast. Differences in arrival time could be discerned for the various chum salmon stocks being tagged. Summer run chum salmon from the Yukon River dominated the recoveries from May and early June releases. Norton Sound and Kuskokwim Bay chum salmon stocks were available for tagging throughout June. Bristol Bay chum salmon stocks appeared somewhat later with most recoveries made from mid to late June releases. It was found for the Yukon River that the fall run chum salmon were available for tagging in mid to late June. Tag recoveries of Kotzebue chum salmon were from releases made mid June to early July. The percent recovery by area can not be applied directly to determine the stock composition in the tagging area due to the failure to meet several important assumptions. Some of these assumptions are: 1) all stocks must be equally vulnerable to capture for tagging; 2) equal recovery rates must be applied in all areas and 3) post-tagging mortality and tag loss must be similar for all stocks.

Recovery Distribution of Chum Salmon Tagged Offshore in the North Pacific in the Vicinity of the Alaska Peninsula and Eastern Aleutian Island Chain

INTRODUCTION

Prior to the 1960's, chum salmon were used primarily for subsistence in Western Alaska mainly as food for sled dogs. Commercial fisheries for Western Alaska chum salmon expanded in the 1960's as fishing effort increased, processing capabilities improved and new markets were established in Japan. The largest catches, north of Bristol Bay, have occurred in the Yukon River which supports both summer and fall chum stocks. A dramatic increase in the Yukon River commercial chum salmon catch took place in 1969 with a steady increase thereafter (Table 1). The largest Yukon River catch occurred in 1981 when 1.7 million chum salmon were harvested. Combined catches in the Kotzebue-Norton Sound area have greatly increased reaching 847,000 fish in 1981. The commercial chum salmon fishery in the Kuskokwim area expanded sharply in the 1970's, and has produced an average catch of 390,000 chum salmon during the 1978-1982 period. In Bristol Bay, the commercial catch of chum salmon increased dramatically in 1976, staying near a million thereafter. The expanded Western Alaska chum fisheries are expected to fully utilize the resource in the 1980's. Presently, competition between fishermen has resulted in increased efficiency while fishing time allowed per season by the management agency has decreased in most areas.

Additional pressure is exerted on Western Alaska chum salmon stocks by several interception fisheries. The Japanese mothership salmon fishery operates in the Bering Sea as well as in the North Pacific Ocean. Their annual harvest of 2-4 million fish may include Western Alaska chum salmon. In addition, domestic fisheries along the Alaska Peninsula intercept non-local stocks in June. Most noteworthy are the South Unimak and Shumagin Island fisheries which have been in operation since 1911. The combined average June chum salmon harvest from South Unimak and the Shumagin Islands has been 469,000 fish for the 1978-1982 period, an increase over the historic average of 307,000 for 1962-1982 (Table 1). June sockeye salmon guideline harvest levels for the South Unimak and Shumagin Island fisheries are currently established as 6.8% and 1.5% respectively of the latest projected Bristol Bay inshore sockeye salmon harvest. While most fishermen target upon the more valuable sockeye salmon, chum salmon are taken incidentally and all time record catches of 875,000 and 140,000 chum salmon were made in the South Unimak and Shumagin Islands respectively in 1982.

Increased harvest pressure in both the terminal and interception areas has placed additional allocation responsibility on those managing these fisheries. Considerable user group controversy could develop if the recent increased harvest levels in the interception fisheries are not coupled with the achievement of high harvest levels in terminal areas. The extremely large interception harvest on the Alaska Peninsula in 1982 and the fact that average to poor chum salmon harvests were attained in some Western Alaska fisheries has focused considerable attention upon the South Unimak and Shumagin Islands salmon fisheries. Two explanations have been proposed for the large interception catches. One is that the fishery is somehow targeting on chum salmon whose harvest is not limited by guideline harvest levels. An

alternative explanation proposes that the chum salmon catch is purely incidental to the taking of sockeye salmon. The recent large sockeye salmon returns to Bristol Bay have greatly increased the allowable sockeye salmon catches increasing the incidental chum catch. Any future allocation scheme for chum salmon must be based on the knowledge the migration routes, timing differences, run strength and final destination of the chum salmon passing through the interception fisheries.

Limited tagging studies conducted along the Alaskan Peninsula and Aleutian Islands (Gilbert and Rich 1925, Thorsteinson and Merrell 1964), indicate that most of the sockeye and chum salmon available in June to the South Unimak and Shumagin Island fisheries are of a non-local origin. Gilbert and Rich (1925) tagged chum salmon in early July off Unga Island which were recaptured over most of Western Alaska and Kamchatka. In contrast the only recoveries of chum salmon tagged during the second week in July off Unimak Island and the southwest shore of the Alaska Peninsula were all local. U.S. Fish and Wildlife Service tagging studies conducted in this area in 1961 resulted in a similiar recovery pattern (Thorsteinson and Merrell 1964). The 1961 tagging was conducted from June 15 to July 14 along Unimak Island and the southwest shore of the Alaska Peninsula. Recoveries were made from distant areas such as Norton Sound, the Yukon and Kuskokwim Rivers and from nearby locations along the southern shore of the Alaska Peninsula (Table 2). Neither the time span over which tagging was conducted nor the magnitude of the recoveries allows an analysis of differences in timing for the various stocks.

In addition to the previously mentioned tagging studies conducted by U.S. agencies, extensive research has been conducted under the coordination of an international organization. The International North Pacific Fisheries Commission (INPFC) was established by the International Convention for the High Seas Fisheries of the North Pacific. Participating nations include Canada, Japan, and the U.S. The three member countries have joined in major research programs to study salmon on the high seas. An extensive program has been underway for many years to tag salmon on the high seas and in areas of interception to develop an understanding of their distribution and pattern of movements. This report will present the results of chum salmon tagging studies in the vicinity of the southwest portion of the Alaska Peninsula and the eastern portion of the Aleutian Island chain.

INPFC Tagging of Chum Salmon

Release and recovery information is available from high seas tagging conducted over the period 1956-1979 (Aro et.al 1971, Aro 1972, 1974, 1977 and 1980). The tag release area of interest has been defined as a rectangle enclosing the southwest portion of the Alaska Peninsula and Eastern Aleutian Island chain (Fig. 1). However, the greatest tagging effort within the study area occurred in the Pacific Ocean between longitude 166°W and 169°W. Historically the minimum of release data available has consisted of IBM listings of date, latitude, longitude, agency code, gear type used for capture and tag number of all recoveries made. Recovery data have consisted of date, latitude, longitude and the recapture gear type. Biological data were also collected when possible at the time of release and recovery. This included species, length, age determination by examination of scales, sex, weight, and gonad weight.

Recoveries of chum salmon tagged in the study area were grouped as to the following recovery areas for purposes of this report:

- Kotzebue Sound: includes recoveries along the shore and within systems draining into the area north of Cape Prince of Wales.
- Norton Sound: includes recoveries from alongshore and within drainages from Cape Prince of Wales to Stuart Island.
- Yukon River: includes recoveries in the Yukon River mouth and upstream. Two offshore recoveries near the mouth of the Yukon River were allocated to High Seas as they could be bound for Kotzebue or Norton Sound and therefore would be of an interceptive nature.
- Kuskokwim Bay: includes recoveries in the Kuskokwim Bay, River and minor systems draining into the bay.
- Bristol Bay: includes recoveries made from Cape Newenham to Ugashik Bay including all systems draining Bristol Bay within this region.
- North Alaska Peninsula: includes recoveries made west of Ugashik Bay to Unimak Pass on the north side of the peninsula.
- South Alaska Peninsula: includes recoveries west of Shelikof Strait off Kodiak Island to Unimak Pass on the south side of the Alaska Peninsula.
- Asia Coast and Japan: includes recoveries made off the Western Pacific Ocean and Bering Sea Coasts or the drainages of Russia and Japan.
- High Seas: includes all recoveries made on the high seas and Aleutian Island chain west of Unimak Pass. This area also includes two recoveries not falling into any other grouping.

Substantial recoveries have only been made from tagging conducted in the study area from 1956 to 1966. Ninety percent of the recoveries were from tagging conducted by the Fisheries Research Institute (FRI) of the University of Washington under contract to the Bureau of Commercial Fisheries of the United States Fish and Wildlife Service. The remaining recoveries were of tags placed by the Fisheries Agency of Japan with only two recoveries made from Canadian studies. The primary method of capture used by FRI was a purse seine while longline gear was used by the Japanese Fisheries agency. A total of 309 recoveries was made of which 90% occurred in the same year of tagging. Thirty tags were recovered in subsequent years of which 43% were taken on the high seas implying that some immature fish were present in the study area. All discussion on the recovery distribution is based on recoveries made in the year of tagging unless otherwise specified.

Recovery Distribution from INPFC Tagging Studies

Recoveries of tagged chum salmon were grouped by the recovery areas previously defined to evaluate their distribution. The greatest number of recoveries (Table 3) were made along the Asia Coast and Japan followed by the Yukon River and Bristol Bay. A comparison of the Asian and Alaskan recoveries shows that 174 were Alaskan recoveries comprising 67% of the total (high seas recoveries were excluded). The percent recovered by area varied greatly between years (Table 4) which is to be expected with the low number of recoveries for several years. When data from all years were pooled, three areas of recovery dominated with the Yukon River comprising 21%, Bristol Bay 20% and the Asia coast and Japan 31%. No recoveries were documented from the southern shore of the Alaska Peninsula and few along it's northern shore.

To better compare the recovery distribution with other studies, all years were pooled and viewed by time period for which total release numbers were available. In Table 5 each month was divided into three periods of ten days for May through July. The seasonal duration of the INPFC tagging was far greater than in other studies (Gilbert and Rich 1925, Thorsteinson and Merrell 1964) ranging from May 1 through September. Timing differences for tag placement can be seen for chum salmon from the various recovery areas. Throughout the May release periods, the Yukon River was the predominant area of tag recovery, while in the first period of June nearly an equal number of recoveries were made in the Yukon River and Asia Coast areas. A similar level of recovery was made in Bristol Bay and the Asia Coast areas from tagging throughout the remainder of June. Tagging in the month of July resulted in few recoveries (Table 6).

Differences in time of release between recovery areas are discernable in Tables 5 and 6. From these data the mean date of release was calculated (Table 7) by first coding the release dates (CD), as May 1 = 1, May 2 = 2, May 3 = 3, ..., n for each recovery for a given area. The coded mean date of release (CMD) for that recovery area then became:

$$CMD = 1/n \sum_{i=1}^n CD_i$$

where the standard deviation (SD) gives a measure of scatter about this mean as:

$$SD = \sqrt{\sum_{i=1}^n \frac{(CD_i - CMD)^2}{(n-1)}}$$

Table 7 presents the mean date of release for each recovery area in chronological order. The Yukon River (summer and fall runs combined) had the earliest mean (June 10) and the Kotzebue area the latest (June 24). It is also important to note the magnitude of the standard deviations. Recovery areas which include a large region with many differently timed stocks would be expected to have a large variance. Therefore one would expect the Asia Coast to have a large variance (Table 7) as would the Yukon River with its distinct summer and fall chum salmon runs.

The comparatively large number of chum salmon recoveries from the Yukon River made it possible to separate early and late stocks. Summer chum salmon were defined for the purposes of this study as those which enter the Yukon River prior to July 15 and fall chum salmon as those which enter thereafter. Upriver recoveries were assigned as fall or summer chum salmon when possible by using information available on probable migration rate, time and location of recovery. The recoveries designated as fall or summer chum salmon were then analyzed by period of release to determine if the mean date of release differs (Table 8) and if so which would be most vulnerable during June. These results show that summer run chum salmon were available for tagging earlier than the fall run with a two week difference in their mean release dates. Overall, it appeared that the fall chum salmon were more vulnerable to tagging in June where a good portion of the summer chum run may have passed through the area in May. With the exception of Yukon River summer stocks, the mean tagging dates of all other Western Alaska chum salmon stocks appear to fall well into June.

Stock Composition in the Release Area

Ideally, the percent recovered by area would be applied directly to determine the actual stock composition at the time and place of release. Yet in doing so several strong assumptions must be fulfilled if the relative abundance of each stock at the time of tagging is to be based on its relative contribution to total recovery. Initially, during tagging all stocks must have been equally vulnerable to capture (Seber 1973) with the result being that for a given area and time the number of fish tagged from each stock is in proportion to their relative abundance. A second assumption involves the loss of tagged fish. This would occur from natural mortality, a tagging stress induced mortality or tag loss. The analysis is not affected if tagged fish have a higher overall mortality than untagged fish as long as mortality is equal for all recovery areas. In addition, initially tag loss would most likely be shared equally amongst the different stocks being tagged and would not alter the relative frequency of recovery. It is likely however, that mortality and the shedding of tags are time dependent, often being modeled as exponential decay processes. Therefore, the greater the time between release and recovery the greater the mortality and tag loss in absolute numbers. This would infer that a recovery area distant to the release area, such as the Asia Coast and Kotzebue, would be under-represented in the total recoveries in comparison to nearby areas, having lost more fish through mortality or tag loss. If different levels of mortality or tag loss is suffered by the tagged groups the similarity between the recovery distribution and the stock composition in the release area is weakened.

One of the most important assumptions involves tag recovery and reporting. To determine relative stock strength from the recovery distribution it must be assumed that all tags recovered were reported. In addition the recovery rate must be equal or known for all areas. For recovery rates to be equal it requires that similar percentages of each stock were surveyed for recoveries or that a tagged fish has a similar probability of recapture for each area. If recovery rates are unequal but known, adjustments can be made to the number of recoveries by area to make them comparable. If one area has a far superior tag recovery program it may provide a disproportionately high number of recoveries to the total. This assumption is most likely violated in this analysis as several features of the recovery areas indicate this. Japan may

have an adequate recovery program yet Russia's remoteness indicates a very weak recovery program. In the U.S., tagging conducted by FRI was followed up by a tag recovery program and a reward system for returns. Yet Western Alaska commercial chum salmon fisheries were not well developed during this period and most tag returns were obtained from subsistence fishermen and research projects conducted by federal and state agencies. In addition, the problem of overlooking tags in large catches would be greatest in the Bristol Bay commercial salmon fishery where chum salmon are far less abundant than sockeye salmon. Sockeye salmon virtually saturate the fishery during peak cycle years. How these factors interact is unknown though it would not be safe to assume a constant recovery rate for all areas and adjustments cannot be made as actual recovery rates are unknown.

In summary, the percent recovery by area (Tables 4,6) can not be applied directly to determine the stock composition in the tagging area. The assumptions previously discussed are unlikely to be met with the most obvious violation being that recovery rates were not constant in all areas.

SUMMARY

Chum salmon tagged in the vicinity of the Alaska Peninsula and Eastern Aleutian Island chain, 1956-1966, were recovered throughout Western Alaska and along the Asia coast (Table 3). Fish were tagged from May through July and differences in arrival times for the various chum salmon stocks were apparent from the differing mean dates of release (Table 7). Summer run chum salmon from the Yukon River dominated the recoveries from May and early June releases. Most recoveries from tagging throughout June were from the Bristol Bay and the Asia coast. It was found for the Yukon River that the fall run chum salmon were available for tagging in mid to late June. The latest Western Alaska stock to be tagged was from Kotzebue with a June 24 mean date of release.

The stock composition at the time and place of tag release could not be based on the percent recovered from each area. Recovery rates were not known to be equal. This then severely weakens any conclusions drawn in regards to the similarity between the release and recovery distributions. In addition, the presence of time dependent mortality or a tag shedding process would negate the comparison of recoveries in nearby and distant areas.

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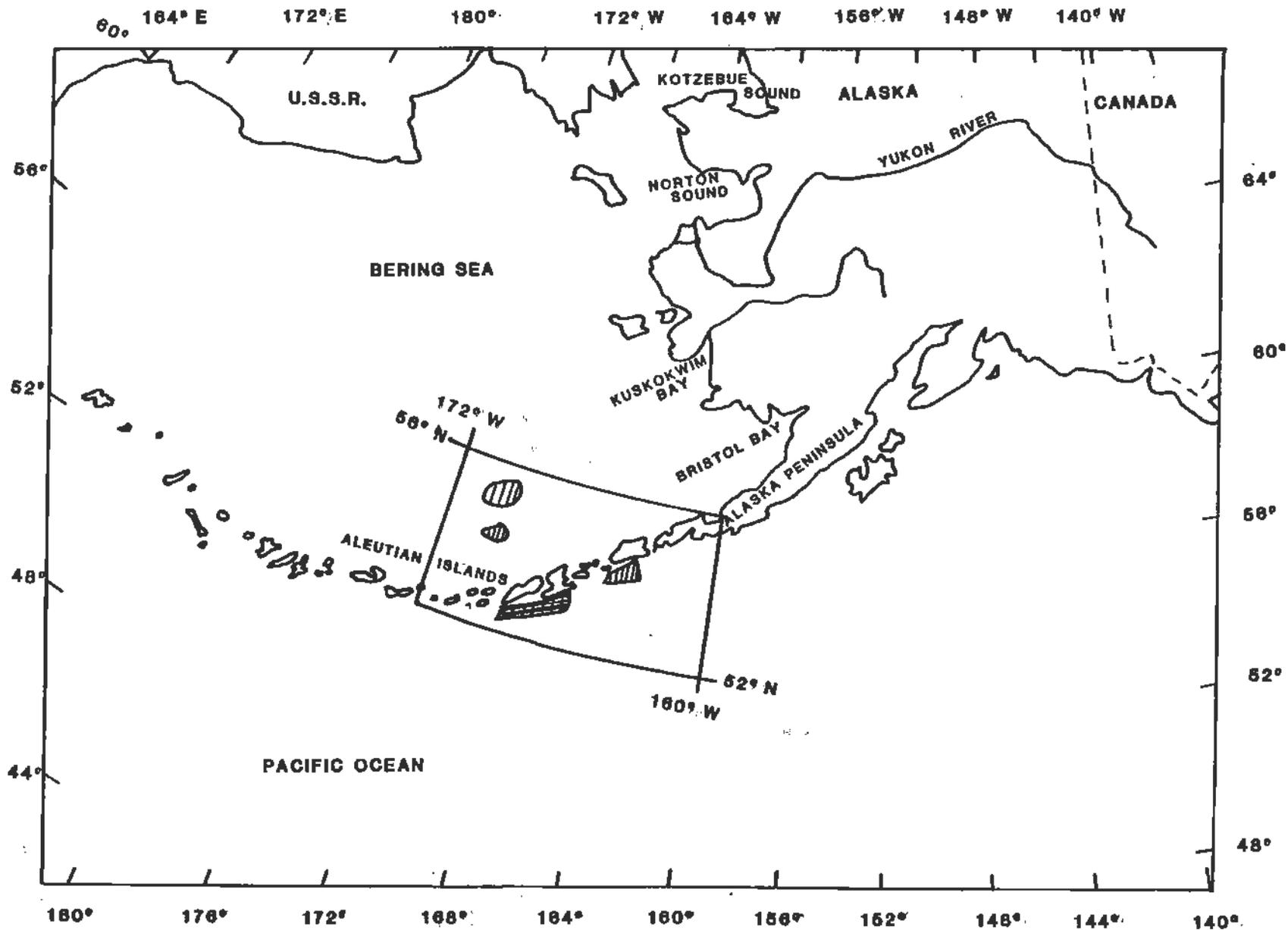


Figure 1. Area of interest for distribution analysis of INPFC tagging studies, 1956 - 1966. The cross-hatched regions represent areas of greatest tagging effort. The more dense the shading the greater the relative effort.

Table 1. Commercial catch of chum salmon by area for Western Alaska, 1961-1982. (Thousands of fish).

Year	Kotzebue	Norton Sound	1/ Yukon River	2/ Kuskokwim Bay	Bristol Bay	June Fisheries Shumagin	Unimak
1962	130	183	53	46	668	61	209
1963	54	155	0	0	370	36	81
1964	76	149	8	1	803	67	161
1965	40	37	23	4	361	45	121
1966	31	80	71	3	343	17	215
1967	29	42	49	8	476	51	73
1968	30	45	67	20	364	51	115
1969	59	83	192	50	333	13	254
1970	160	107	347	61	718	49	403
1971	155	131	290	99	677	115	554
1972	170	101	288	97	657	108	468
1973	375	119	518	184	684	23	189
1974	628	162	879	196	286	0	15
1975	563	212	985	224	325	36	65
1976	160	96	762	232	1,329	74	327
1977	196	200	798	299	1,598	22	93
1978	112	189	1,289	282	1,158	18	105
1979	142	141	1,166	297	907	41	64
1980	367	181	1,356	561	1,405	71	457
1981	677	170	1,678	486	1,475	54	521
1982	418	183	839	325	941	140	875
Average (62-82)	218	131	555	165	756	52	255
5 year Average (78-82)	343	173	1,266	390	1,177	65	404

1/ Does not include Canadian catches.

2/ Includes catches made in the Kuskokwim River, Kuskokwim Bay, Quinhagak Bay and Goodnews Bay.

Table 2. Chum salmon release and recovery data from tagging conducted offshore from Unimak Island and the southwestern coast of the Alaska Peninsula in 1961 (Thorsteinson and Merrel 1964)

Tagging location	Inclusive tagging dates	Number released	Number of Recoveries by Area							Total Recovered
			Norton Sound	Yukon River	Kuskokwim Bay	Bristol Bay	Alaska North	Peninsula South	Japan	
Cape Lutke	June 16- July 4	689	0	4	4	17	3	2	0	30
Unimak Bight	June 19	33	0	1	1	0	0	3	0	5
Cape Lazaref	June 15-16	19	0	1	0	2	1	0	0	4
Cape Pankof	June 16- July 4	162	1	3	1	0	1	4	0	10
Ikatan Bay	July 6-13	26	0	0	0	0	0	2	1	3
Morzhovoi Bay	July 8-14	8	0	0	0	0	0	2	0	2
Deer Island	June 28- July 12	56	0	0	0	1	1	4	0	6
Total		996	1	9	6	20	6	17	1	60
Percent of Recoveries			2	15	10	33	10	28	2	

Table 3. INPFC chum salmon release and recovery data from tagging studies conducted in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956 - 1966. Only recoveries made in the year of tagging are presented.

Year Tagged	Number Released	Number of Recoveries by Area									Total Recovered
		Kotzebue	Norton Sound	Yukon River	Kuskokwim Bay	Bristol Bay	Alaska North	Peninsula South	Asia coast and Japan	High Seas	
1956	1,093	0	0	9	9	8	2	0	4	2	34
1957	793	0	0	0	1	0	2	0	5	0	8
1958	1,607	0	0	0	0	0	0	0	4	0	4
1959	268	0	1	4	2	0	0	0	2	0	9
1960	3,463	11	1	19	8	25	4	0	25	6	99
1961	1,740	5	5	9	1	15	1	0	19	1	56
1962	966	3	2	12	2	7	0	0	26	3	55
1963	147	0	0	1	0	0	0	0	0	0	1
1964	39	0	0	0	0	0	0	0	1	2	3
1965	129	0	0	3	0	1	0	0	1	4	9
1966	11	0	0	1	0	0	0	0	0	0	1
Total	10,256	19	9	58	23	56	9	0	87	18	279

Table 4. INPFC chum salmon release and recovery data in percentages from tagging studies conducted in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956 - 1966. Only recoveries made in the year of tagging are presented.

Year Tagged	Percent Recovered By Area								
	Kotzebue	Norton Sound	Yukon River	Kuskokwim Bay	Bristol Bay	Alaska North	Peninsula South	Asia Coast and Japan	High Seas
1956	0	0	26	26	24	6	0	12	6
1957	0	0	0	13	0	25	0	62	0
1958	0	0	0	0	0	0	0	100	0
1959	0	11	45	22	0	0	0	22	0
1960	11	1	19	8	25	4	0	25	6
1961	9	9	16	2	27	2	0	34	2
1962	5	4	22	4	13	0	0	47	5
1963	0	0	100	0	0	0	0	0	0
1964	0	0	0	0	0	0	0	33	67
1965	0	0	33	0	11	0	0	11	45
1966	0	0	100	0	0	0	0	0	0
All Years	7	3	21	8	20	3	0	31	7

Table 5. INPFC chum salmon release and recovery data from tagging studies conducted in the area adjacent to the Alaska Peninsula and Aluetian Island chain, 1956 - 1966. Only recoveries made in the year of tagging are presented.

1/ Release Period	Number Released	Number of Recoveries by Area									
		Kotzebue	Norton Sound	Yukon River	Kuskokwim Bay	Bristol Bay	Alaska North	Peninsula South	Asia Coast and Japan	High Seas	Total Recovered
May 1	9	0	0	1	0	0	0	0	0	0	1
May 2	36	0	0	1	1	0	0	0	0	4	6
May 3	248	1	0	13	1	1	1	0	6	0	23
June 1	777	1	4	13	4	5	1	0	12	4	44
June 2	2,639	8	3	17	13	24	3	0	31	6	105
June 3	2,326	3	2	11	4	22	1	0	20	2	65
July 1	3,580	6	0	2	0	3	3	0	17	0	31
July 2	193	0	0	0	0	1	0	0	0	0	1
July 3	99	0	0	0	0	0	0	0	0	1	1
2/ Aug.	318	0	0	0	0	0	0	0	1	1	2
Sept.	31	0	0	0	0	0	0	0	0	0	0
Total	10,256	19	9	58	23	56	9	0	87	18	279

1/ Where:

1 < 11th day of the month

2 = 11 to 20th day of the month

3 > 20th day of the month

2/ Data were pooled by month for August and September.

Table 6. INPFC chum salmon release and recovery data in percentages from tagging studies conducted in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956 - 1966. Only recoveries made in the year of tagging are presented.

1/ Release period	Number released	Number recovered	Percent Recovered By Area										% Recovered of Total Release
			Kotzebue	Norton Sound	Yukon River	Kuskokwim Bay	Bristol Bay	Alaska North	Peninsula South	Asia Coast and Japan	High Seas		
May 1	9	1	0	0	100	0	0	0	0	0	0	0	11.1
May 2	36	6	0	0	17	17	0	0	0	0	0	67	16.7
May 3	248	23	4	0	57	4	4	4	4	0	26	0	9.3
June 1	777	44	2	9	30	9	11	2	2	0	27	9	5.7
June 2	2,639	105	7	3	16	12	23	3	3	0	30	6	4.0
1- June 3	2,326	65	5	3	17	6	34	2	2	0	31	3	2.8
July 1	3,580	31	19	0	6	0	10	10	10	0	55	0	0.9
July 2	193	1	0	0	0	0	100	0	0	0	0	0	0.5
July 3	99	1	0	0	0	0	0	0	0	0	0	100	1.0
2/ Aug.	318	2	0	0	0	0	0	0	0	0	50	50	0.6
Sept.	31	0	0	0	0	0	0	0	0	0	0	0	0.0
All years	10,256	279											2.7

1/ Where:

- 1 < 11th day of the month
- 2 = 11 to 20th day of the month
- 3 > 20th day of the month

2/ Data : pooled by month for August and September

Table 7. Timing statistics for INFFC tag releases of chum salmon in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956 - 1966.

Area of Recovery	Mean Date of Release	S.D. ^{1/}	Number of Recoveries ^{2/}
Yukon River	June 10	13.0	58
High Seas	June 14	19.4	18
Kuskokwim Bay	June 14	9.9	23
Norton Sound	June 14	6.5	9
Asia Coast and Japan	June 19	12.4	87
North Alaska Peninsula	June 19	12.9	9
Bristol Bay	June 21	8.6	56
Kotzebue	June 24	9.7	19

1/ S.D. = Standard deviation of coded data, where May 1=1.

2/ Recaptured in the same year as tagged.

Table 8. INPFC tag release and recovery data for Yukon River chum salmon by time period, 1956 - 1966. Recoveries are from the year of tagging only.

1/ Release Period	Yukon River Chum Salmon		Percent Recovered		Total Recovered
	Run Designation Summer	Fall	Summer	Fall	
May 1	1	0	100	0	1
May 2	2	0	100	0	2
May 3	10	1	92	8	11
June 1	9	2	73	27	11
June 2	7	9	44	56	16
June 3	1	9	10	90	10
July 1	0	2	0	100	2 ^{2/}
Total	30	23	57	43	53 ^{2/}
Mean date of release	June 4	June 20			
3/ S.D.	11.8	9.0			

1/ Where:

- 1 < 11th day of the month
- 2 = 11 to 20th day of the month
- 3 > 20th day of the month

2/ Does not include five recoveries for which run could not be assigned.

3/ S.D. = Standard deviation of coded data, where May 1 = 1.

APPENDIX A

Date and location data for each chum salmon recovered from INPFC tagging studies conducted in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956-1966.

Appendix Table 1. Description of recovery area codes. (From Aro et. al. 1971)

Area Number	Area Name
	<u>Asia</u>
01	Honshu Island
02	Hokkaido Island
03	Kuril Islands
04	Japan Sea Coast of U.S.S.R., south of Reineke Island
05	Amur River
06	Sakhalin Island
07	Okhotsk Sea Coast, Reineke Island to Cape Tolstoi
08	Shelekhova Bay, Cape Tolstoi to Cape Yuzhnyi
09	West Kamchatka, South of Cape Yuzhnyi
10	East Kamchatka, South of Cape Afrika
11	Kamchatka River
12	Karaginskii District, Cape Afrika to Cape Olyutorskii
13	Siberian Coast, North of Cape Olyutorskii
14	Anadyr River
15	U.S.S.R. Unknown
16	Asian Coastal - Other
17	Asian Coastal - Unknown
	<u>High Seas</u>
20	Sea of Japan
21	Okhotsk Sea
22	Bering Sea West of 170°E
23	Bering Sea 170°E - 175°E
24	Bering Sea 175°E - 180°
25	Bering Sea 180° - 175°W
26	Bering Sea East of 175°W
27	North Pacific South of 48°N and West of 165°E
28	North Pacific South of 48°N 165°E - 175°W
29	North Pacific South of 48°N and West of 160°E
30	North Pacific South of 48°N 160°E - 165°E
31	North Pacific South of 48°N 165°E - 170°E
32	North Pacific South of 48°N 170°E - 175°E
33	North Pacific South of 48°N 175°E - 180°
34	North Pacific South of 48°N 180° - 175°W
35	North Pacific 160°W - 175°W
36	North Pacific 145°W - 160°W
37	North Pacific North of 50°N and East of 145°W
38	North Pacific South of 50°N and East of 145°W
39	High Seas - Unknown

Appendix Table 1. (Continued)

Area Number	Area Name
<u>Alaska</u>	
40	North of Cape Prince of Wales (Kotzebue Sound)
41	Norton Sound Area (Cape Prince of Wales to Stuart Island)
42	Yukon River
43	Yukon River to Kuskokwim River (Cape Romanzof to Cape Avinof)
44	Kuskokwim River and Bay
45	Togiak Vicinity (Cape Newenham to Cape Constantine)
46	Nushagak Vicinity
47	Naknek-Kvichak
48	Egegik
49	Ugashik
50	Ugashik to Unimak Pass (North side of Alaska Peninsula)
51	Bristol Bay Unknown (Somewhere within areas 45-49)
52	Aleutian Islands (West of Unimak Pass)
53	South side of Alaska Peninsula West of 159°W
54	South side of Alaska Peninsula East of 159°W
55	Kodiak Island, Shelikof Strait side
56	Kodiak Island, Gulf of Alaska side
57	Cook Inlet (Cape Douglas to Gore Point)
58	Southeast side Kenai Peninsula (Gore Point to Cape Fairfield)
59	Prince William Sound (Cape Fairfield to Point Steele, Hitchinbrook Island)
60	Copper River and Bering River
61	Yakutat District
62	Southeastern Alaska, Icy Strait District
63	Southeastern Alaska, Chatham District
64	Southeastern Alaska, Petersburg District
65	Southeastern Alaska, Prince of Wales District
66	Southeastern Alaska, Ketchikan District
67	Southeastern Alaska - Unknown
68	Alaska - Other
69	Alaska - Unknown
<u>British Columbia</u>	
70	Queen Charlotte Islands
71	Nass River
72	Skeena River
73	Central British Columbia
74	Rivers - Smith Inlets
75	Queen Charlotte Strait - Johnstone Strait
76	Strait of Georgia
77	Fraser River and Strait of Juan de Fuca (Canadian waters)
78	West Coast of Vancouver Island
79	British Columbia - Other and Unknown

Appendix Table 1. (Continued)

Area Number	Area Name
<u>Washington, Oregon, Idaho, and California</u>	
80	Strait of San Juan de Fuca (United States waters)
81	Salmon Bank Area
82	Skagit River
83	Puget Sound
84	Outer Washington Coast South of Cape Flattery
85	Columbia River (Including entire Columbia River drainage)
89	Washington State - Unknown
90	Oregon (excluding Columbia River drainage)
91	California
<u>Other Areas</u>	
98	North America Coastal - Unknown
99	Entirely Unknown

Appendix Table 2. Date and location of release and recovery of each chum salmon recovered from INPFC tagging studies conducted in the area adjacent to the Alaska Peninsula and Aleutian Island chain, 1956-1966. Only recoveries made in the year of tagging are presented. (from Aro et. al.1971).

Release			Recovery			
Location 1/ Lat. Long.	Date		Area 2/ Area	Location Lat. Long.	Date 3/ Date	
5225N 16823W	061562		40	6652N 16238W	0730	
5250N 16824W	062860		40	6650N 16110W	0805	
5250N 16824W	062860		40	6650N 16110W	0920	
5253N 16825W	062960		40	6650N 16110W	0826	
5247N 16825W	060961		40	6650N 16110W	0805	
5238N 16846W	053162		40	6652N 16238W	0809	
5233N 16917W	070660		40	6650N 16110W	0909	
5233N 16917W	070660		40	6650N 16110W	0917	
5320N 16712W	062161		41	6355N 16050W	0813	
5301N 16751W	061862		41	6356N 16050W	0720	
5301N 16751W	061862		41	6355N 16050W	0719	
5253N 16816W	060960		41	6430N 16300W	0132	
5250N 16822W	061061		41	6355N 16050W	0132	
5248N 16830W	060961		41	6328N 16200W	0705	
5249N 16831W	060459		41	6430N 16300W	0708	
5246N 16836W	061261		41	6440N 16120W	0132	
5330N 16515W	052460		42	6205N 16330W	0701	
5330N 16610W	052760		42	6635N 14415W	0132	
5300N 16700W	051860		42	6500N 15731W	0717	
5322N 16702W	061956		42	6420N 16440W	0715	
5322N 16702W	061456		42	6250N 16350W	0723	
5319N 16710W	062161		42	6232N 16455W	0803	
5318N 16711W	070361		42	6232N 16455W	0807	
5312N 16721W	062961		42	6500N 15731W	0822	
5318N 16721W	062961		42	6420N 16440W	0724	
5254N 16726W	052862		42	6200N 16310W	0629	
5254N 16726W	052862		42	6212N 16352W	0626	
5257N 16726W	052862		42	6240N 16440W	0623	
5257N 16726W	052862		42	62—N 163—W	0625	
5259N 16742W	052962		42	6155N 16256W	0627	
5259N 16742W	052962		42	6235N 16450W	0628	
5301N 16751W	061862		42	6515N 15200W	0800	
5301N 16751W	061862		42	6155N 16256W	0717	
5305N 16804W	060956		42	6245N 16010W	0719	
5307N 16806W	060856		42	6210N 16150W	0712	
5257N 16810W	061060		42	6232N 16455W	0132	
5255N 16814W	061060		42	6450N 14915W	0909	
5255N 16814W	061060		42	6300N 16350W	0703	
5255N 16818W	061760		42	6244N 16428W	0715	
5255N 16818W	061760		42	6445N 15800W	0802	

Appendix Table 2. (Continued)

Release			Recovery		
Location	Date	Area	Location	Date	
Lat. Long.			Lat. Long.		
5255N 16819W	061160	42	6210N 16300W	0709	
5255N 16819W	061160	42	6500N 15731W	0905	
5254N 16821W	061660	42	6635N 14415W	0929	
5254N 16821W	061660	42	6430N 14905W	0929	
5254N 16821W	061660	42	6445N 15530W	0823	
5254N 16822W	061462	42	62—N 164—W	0710	
5225N 16823W	061562	42	6235N 16450W	0804	
5250N 16824W	062860	42	6210N 15945W	0810	
5250N 16824W	062860	42	6240N 16440W	0912	
5247N 16828W	060856	42	6150N 16255W	0715	
5251N 16829W	062960	42	6240N 16440W	0920	
5251N 16829W	062960	42	6445N 15700W	1001	
5248N 16830W	060961	42	6235N 16450W	0703	
5248N 16830W	060961	42	6212N 16352W	0710	
5249N 16831W	060459	42	6200N 16300W	0132	
5249N 16831W	060459	42	6212N 16352W	0703	
5249N 16831W	060459	42	6150N 16200W	0630	
5249N 16831W	060459	42	6145N 16130W	0706	
5247N 16838W	061461	42	6240N 16440W	0724	
5247N 16838W	061561	42	6242N 16432W	0824	
5244N 16845W	053162	42	6240N 16440W	0620	
5244N 16845W	053162	42	6212N 16352W	0725	
5302N 16519W	051565	42	6250N 16440W	0703	
5302N 16519W	051565	42	6220N 16420W	0622	
5323N 16632W	060765	42	6212N 16352W	0924	
5301N 16727W	052862	43	6230N 16520W	0626	
5301N 16727W	052862	43	6153N 16547W	0628	
5325N 16606W	061162	44	6003N 16212W	0714	
5340N 16612W	061656	44	6130N 16050W	0730	
5340N 16612W	061656	44	6135N 15918W	0731	
5338N 16613W	061556	44	6047N 16144W	0711	
5323N 16659W	061456	44	6047N 16144W	0718	
5300N 16700W	051860	44	6130N 16050W	0616	
5322N 16702W	061956	44	6130N 15940W	0717	
5253N 16816W	060960	44	6130N 16050W	0714	
5255N 16819W	061160	44	6130N 15940W	0716	
5255N 16819W	061160	44	6047N 16144W	0702	
5254N 16821W	061660	44	6045N 16130W	0720	
5254N 16822W	061462	44	6010N 16220W	0725	
5254N 16823W	061760	44	6130N 16050W	0700	
5246N 16830W	060961	44	6135N 15922W	0810	
5249N 16831W	060459	44	6047N 16144W	0630	
5249N 16831W	060459	44	6135N 15918W	0715	
5340N 16612W	061656	45	5901N 16028W	0724	
5314N 16644W	070460	45	5901N 16028W	0730	
5319N 16710W	062161	45	5901N 16025W	0718	
5318N 16721W	062961	45	5901N 16025W	0727	
5255N 16814W	061060	45	5901N 16028W	0714	

Appendix Table 2. (Continued)

Release			Recovery			
Location 1/ Lat. Long.		Date	Area 2/	Location Lat. Long.		Date 3/
5255N	16818W	061760	45	5901N	16028W	0721
5254N	16821W	061660	45	5901N	16028W	0712
5246N	16836W	061261	45	5901N	16028W	0814
5323N	16659W	061456	46	5845N	15840W	0132
5309N	16703W	061362	46	5845N	15840W	0712
5318N	16713W	062961	46	5845N	15840W	0715
5318N	16721W	062961	46	5845N	15840W	0719
5301N	16751W	061862	46	5845N	15840W	0707
5254N	16820W	061760	46	5845N	15840W	0713
5247N	16830W	062365	46	5845N	15840W	0713
5309N	16703W	061362	47	5845N	15710W	0709
5319N	16710W	062161	47	5845N	15710W	0713
5319N	16710W	062161	47	5845N	15710W	0711
5319N	16710W	062161	47	5845N	15710W	0715
5303N	16757W	062056	47	5845N	15710W	0711
5303N	16804W	060956	47	5845N	15710W	0710
5255N	16814W	061060	47	5845N	15710W	0702
5253N	16819W	063060	47	5845N	15710W	0725
5254N	16820W	061760	47	5845N	15710W	0708
5254N	16823W	061760	47	5845N	15710W	0709
5247N	16825W	060961	47	5845N	15710W	0724
5251N	16829W	062960	47	5845N	15710W	0728
5253N	16832W	070661	47	5845N	15710W	0727
5250N	16837W	061761	47	5845N	15710W	0718
5247N	16838W	061561	47	5845N	15710W	0706
5244N	16845W	053162	47	5845N	15710W	0706
5304N	16713W	061362	48	5815N	15735W	0712
5248N	16830W	060961	48	5815N	15735W	0629
5324N	16616W	061162	49	5735N	15740W	0706
5318N	16647W	070860	49	5735N	15740W	0726
5326N	16605W	061357	50	5610N	16025W	0710
5312N	16649W	070360	50	5600N	16040W	0725
5255N	16819W	061160	50	5630N	15945W	0801
5253N	16819W	063060	50	5600N	16120W	0728
5246N	16830W	060961	50	5620N	16015W	0720
5246N	16836W	061261	51	0000	10000	0707
5309N	16711W	080260	76	4949N	12436W	1017
5246N	16838W	072161	83	4733N	12302W	1221
5535N	16335W	062461	46	5845N	15840W	0718
5558N	16459W	071562	47	5845N	15710W	0724
5432N	16363W	070156	42	6240N	16440W	0825
5428N	16464W	061955	42	6212N	16352W	0710
5423N	16411W	062156	42	6150N	16200W	0725
5423N	16411W	062156	42	6240N	16440W	0713
5447N	16251W	062356	44	6047N	16144W	0713
5426N	16409W	061956	44	6130N	15940W	0721
5426N	16409W	061956	44	5930N	16218W	0729
5429N	16411W	062956	44	6135N	15918W	0700
5432N	16244W	062456	46	5845N	15840W	0717
5429N	16411W	062956	46	5845N	15840W	0713
5425N	16413W	062056	46	5845N	15840W	0709

Appendix Table 2. (Continued)

Release			Recovery			
Location 1/ Lat. Long.		Date	Area 2/	Location Lat. Long.		Date 3/
5425N	16413W	062056	46	5845N	15840W	0705
5432N	16303W	070156	50	5530N	16230W	0802
5432N	16303W	070156	50	5445N	16325W	0705
5500N	17010W	062061	02	4404N	14512E	0909
5500N	17010W	062061	40	6700N	16025W	0704
5500N	17010W	062061	40	6648N	16105W	0804
5233N	17035W	070657	02	4406N	14415E	1027
5233N	17035W	070657	02	4406N	14415E	1127
5233N	17035W	070657	03	4400N	146—E	1109
5449N	16940W	062361	02	4424N	14520E	1016
5500N	16955W	062261	02	4404N	14512E	1024
5511N	16950W	062161	02	4214N	14019E	1115
5511N	16950W	062161	02	4233N	14022E	1020
5416N	16936W	062860	10	5600N	16230E	0132
5545N	16625W	062361	40	6740N	16255W	0927
5500N	16955W	062261	40	6700N	16234W	0926
5500N	16955W	062261	41	6445N	16155W	0715
5438N	16849W	062960	42	6500N	15731W	0908
5449N	16940W	062861	42	6212N	16352W	0132
5422N	16938W	063060	44	6139N	15944W	0803
5422N	16938W	063060	44	6133N	16023W	0731
5416N	16936W	062860	45	5901N	16028W	0715
5438N	16849W	062960	46	5857N	15827W	0720
5416N	16936W	062860	46	5857N	15827W	0717
5422N	16938W	063060	46	5857N	15827W	0711
5416N	16936W	062860	47	5845N	15710W	0716
5422N	16938W	063060	47	5845N	15710W	0720
5422N	16938W	063060	48	5815N	15735W	0718
5422N	16938W	063060	49	5735N	15740W	0717
5422N	16938W	063060	51	58—N	160—W	0722
5325N	16851W	062060	02	4300N	14416E	1026
5325N	16851W	062060	11	5615N	16230E	0824
5325N	16851W	062060	42	6635N	14415W	0922
5326N	16935W	062060	46	5845N	15840W	0713
5326N	16935W	062060	46	5845N	15840W	0712
5326N	16935W	062060	46	5845N	15840W	0709
5325N	16851W	062060	47	5845N	15710W	0714
5326N	16935W	062060	49	5735N	15740W	0705
5325N	16851W	062060	50	5500N	16400W	0708
5312N	16721W	062961	01	—N	1—W	1210
5254N	16814W	062162	01	3926N	14200E	1121
5247N	16838W	061461	01	3738N	14110E	1010
5246N	16838W	062660	01	3940N	14155E	1126
5314N	16644W	070460	02	4402N	14512E	1109
5320N	16649W	070260	02	4410N	14404E	1211
5312N	16649W	070360	02	4404N	14458E	1027
5313N	16650W	070360	02	4322N	14513E	1009
5313N	16650W	070360	02	4245N	14342E	1010
5313N	16650W	070360	02	4402N	14510E	1114

Appendix Table 2. (Continued)

Release			Recovery			
Location 1/ Lat. Long.		Date	Area 2/	Location Lat. Long.		Date 3/
5321N	16701W	081356	02	4405N	14500E	1108
5309N	16703W	061362	02	4355N	14440E	1015
5309N	16703W	061362	02	4331N	14456E	0909
5318N	16713W	062961	02	4408N	14403E	1102
5304N	16713W	061362	02	4401N	14512E	1003
5239N	16719W	070560	02	4410N	14404E	1127
5318N	16721W	062961	02	4200N	14310E	1108
5257N	16726W	052862	02	4402N	14512E	1013
5302N	16730W	070258	02	4345N	14440E	1026
5302N	16730W	070358	02	4345N	14505E	1027
5302N	16730W	070258	02	4405N	14500E	1012
5302N	16730W	070258	02	4345N	14440E	1028
5250N	16809W	060362	02	4407N	14408E	1006
5256N	16815W	062162	02	4244N	14345E	1006
5253N	16816W	060960	02	4247N	14335E	1026
5255N	16819W	061160	02	4227N	14326E	0710
5253N	16819W	063060	02	4410N	14404E	1026
5252N	16822W	061762	02	4208N	14254E	1120
5252N	16822W	061762	02	4408N	14404E	1025
5250N	16824W	062860	02	4357N	14402E	1127
5253N	16825W	062960	02	4355N	14427E	1005
5247N	16825W	060961	02	4245N	14345E	1014
5246N	16836W	061261	02	4315N	14530E	1021
5250N	16837W	061761	02	4355N	14440E	1015
5247N	16838W	061561	02	4230N	14020E	1107
5247N	16838W	061461	02	4328N	14515E	1008
5246N	16838W	062626	02	4355N	14404E	1028
5245N	16845W	070660	02	4422N	14318E	1129
5245N	16845W	070660	02	4353N	14442E	1102
5247N	16830W	062365	03	4345N	14645E	1108
5249N	16736W	062562	06	5200N	14310E	0802
5255N	16818W	061760	06	5330N	14230E	1011
5338N	16613W	061556	10	—N	1—E	0000
5254N	16821W	061660	10	5304N	15834E	0132
5254N	16823W	061760	10	—N	1—E	0816
5319N	16710W	062161	11	5615N	16220E	0819
5302N	16742W	061862	11	5615N	16220E	0811
5230N	16803W	061762	11	5615N	16220E	0821
5250N	16809W	060362	11	5615N	16220E	0826
5253N	16816W	060960	11	5610N	16230E	0818
5255N	16819W	061160	11	5610N	16230E	0912
5252N	16822W	061762	11	5615N	16220E	0917
5247N	16825W	060961	11	5615N	16220E	0809
5304N	16713W	061362	12	6100N	17020E	0812

Appendix Table 2 (Continued)

Release			Recovery			
Location 1/ Lat. Long.		Date	Area 2/	Location Lat. Long.		Date 3/
5303N	16757W	062056	12	5951N	16325E	0814
5254N	16815W	061060	12	6026N	16936E	0830
5249N	16831W	060459	12	6000N	16540E	0132
5249N	16831W	064059	12	6000N	16540E	0132
5238N	16846W	053162	12	6010N	16520E	0820
5325N	16606W	061162	14	6445N	17740E	0132
5325N	16606W	061162	14	65—N	177—E	0820
5309N	16730W	061362	14	65—N	177—E	0132
5304N	16713W	061362	14	6400N	17800E	0132
5304N	16713W	061362	14	6445N	17740E	0132
5257N	16726W	052862	14	6500N	17500E	0132
5307N	16806W	060856	14	6450N	17600E	0821
5244N	16811W	061061	14	6453N	17615E	0812
5255N	16819W	061160	14	6450N	17600E	0132
5250N	16822W	061061	14	6450N	17600E	0820
5254N	16822W	061462	14	6445N	17740E	0132
5253N	16832W	070661	14	6450N	17600E	0808
5238N	16846W	053162	14	6445N	17740E	0132
5236N	16700W	060664	14	64—N	17730E	0802
5309N	16703W	061362	21	5300N	15458E	0807
5300N	16700W	051860	22	5827N	16652E	0703
5303N	16757W	062056	22	5834N	16736E	0723
5236N	16700W	060664	23	5837N	17448E	0704
5302N	16519W	051565	25	5836N	17629W	0701
5312N	16647W	060765	25	5836N	17759W	0719
5254N	16820W	061760	25	5830N	17549W	0703
5254N	16821W	061660	25	5752N	17750E	0707
5254N	16821W	061660	25	5738N	17625W	0703
5254N	16823W	061760	25	5731N	17616W	0706
5247N	16830W	062365	25	5818N	17723W	0719
5248N	16830W	062365	32	5018N	17217E	0725
5307N	16806W	060856	33	5112N	17829E	0623
5318N	16647W	070360	40	6650N	16110W	0827
5320N	16649W	070260	40	6630N	16300W	0731
5313N	16650W	070260	40	6650N	16110W	0905
5239N	16719W	070560	40	6700N	16234W	0920
5256N	16815W	062162	40	6735N	16304W	0804
5253N	16819W	063060	40	6730N	16300W	0929
5254N	16821W	061660	40	6650N	16110W	0800
5315N	16330W	052757	11	55—N	162—E	0816
5340N	16345W	052757	14	6450N	17600E	0808

Appendix Table 2. Continued)

Release			Recovery			
Location 1/		Date	Area 2/	Location		Date 3/
Lat.	Long.			Lat.	Long.	
5326N	16110W	060564	25	5920N	17805W	0702
5325N	16100W	053063	42	6235N	16450W	0625
5314N	16257W	050466	42	6155N	16256W	0710
5345N	16410W	052957	44	6130N	16050W	0715
5340N	16345W	052757	50	5500N	16230W	0132

1/ Location:

Lat. = Degrees and minutes of north latitude, e.g. 15630E=51°23' North.

Long. = Degrees and minutes of east or west longitude, e.g. 15630E=156°30' East.

2/ For area code description see Appendix Table 1.

3/ Recoveries are in the same year as release where the first two digits indicate the month and the last two digits indicate the day. The month is indicated as follows:

00 = Recovery month and year unknown

01 = Recovery year is known but month and day are unknown

02-31 = Recovery month in year of tagging

The day of recovery is indicated as follows:

00 = Day of month unknown

01-31 = Day of month

32 = Day and month unknown but year known

100
100
100
100
100
100
100
100
100
100

