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SOUTHEASTERN ALASKA PINK SALMON (Oncorhynchus gorbuscha)

STREAM LIFE STUDIES, 1983

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ABSTRACT

In 1983, the Alaska Department of Fish and Game's Pink (*Oncorhynchus gorbuscha*) and Chum (*O. keta*) Salmon Research Project in Southeastern Alaska initiated stream life studies on pink salmon in three stream systems in the Region as part of a U.S./Canada Salmon Stock Interception cooperative research program. The stream life information generated by this study will be used to improve estimates of pink salmon total escapements derived from multiple surveys on major pink salmon systems in Southeastern Alaska. Overall, the 50% stream life of pink salmon was 14 days, 29 days, and 33 days for Salmon Creek near Juneau, Starrigavan Creek near Sitka, and White River near Ketchikan, respectively.

KEY WORDS: pink salmon, *Oncorhynchus gorbuscha*, Southeastern Alaska, stream life, population dynamics, abundance estimation.

INTRODUCTION

Stream life studies of pink salmon (*Oncorhynchus gorbuscha*) were initiated in 1983 in Southeastern Alaska by the Alaska Department of Fish and Game (ADF&G) as part of a U.S./Canada Salmon Stock Interception negotiations cooperative research program. These studies were designed to measure the length of time, in days, that pink salmon remain alive after they enter a stream to spawn. The stream life data from several representative streams were then to be used to calculate actual total pink salmon escapements to Southeastern Alaska streams by adjusting aerial and foot counts made throughout the spawning season. These adjustments would consider two things: (1) that some portion of the live fish counted during a stream survey were fish that had entered the stream since the previous survey and (2) that other fish which had been in the stream during the previous survey had since died and were now absent from the stream. The ultimate goal of these studies is to adjust and greatly refine the standard peak aerial and foot escapement counts throughout the season, arriving finally at good estimates of actual total escapements by stream and, hence, by district.

To date, the only other stream life work in the region was done in 1964 by the National Marine Fisheries Service in Olsen Creek, Prince William Sound (Helle et al. 1964) and in 1976 by ADF&G in Traitors River near Ketchikan, and Katlian River near Sitka. That year, the Pink and Chum Salmon Project tagged a total of 2,387 pink and 519 chum salmon (*O. keta*) in Traitors River and 198 pink and 493 chum salmon in Katlian River (Kingsbury 1977). McNeil (1964) measured spawning ground residence time of pink salmon in the Harris River, Southeastern Alaska.

METHODS

In 1983, stream life studies were conducted on three streams in Southeastern Alaska: (1) Salmon Creek, a small stream in the Juneau area; (2) Starrigavan Creek, a medium-sized stream in the Sitka area; and (3) White River, a medium-sized stream in the Ketchikan area (Figure 1). Adult pink salmon were tagged in the intertidal area of each stream with colored plastic "spaghetti" tags. A different color was used for each of 3 weeks in Salmon Creek and Starrigavan Creek and each of 4 weeks in White River (Table 1). We attempted to tag for a fourth week in Salmon Creek, but heavy rains and resulting high water levels prevented this. Fish were collected with beach seines in each stream and released immediately after tagging.

Stream recovery efforts consisted of daily foot surveys in each stream to collect tags from the pink salmon carcasses. Heavy rain and resulting high stream water levels prevented surveys on a few days. Each survey was conducted from the lowest tide stage possible to the upper limit of fish presence and recorded the location and color of each tag recovered. Water level was recorded in Salmon Creek only. The approximate number of live fish remaining in the stream was also noted. Each stream was walked by two persons each time (except Salmon Creek, by one person on Saturday and Sunday). Surveys continued until no live tagged fish were seen in the stream and no tags had been recovered from carcasses for several days.

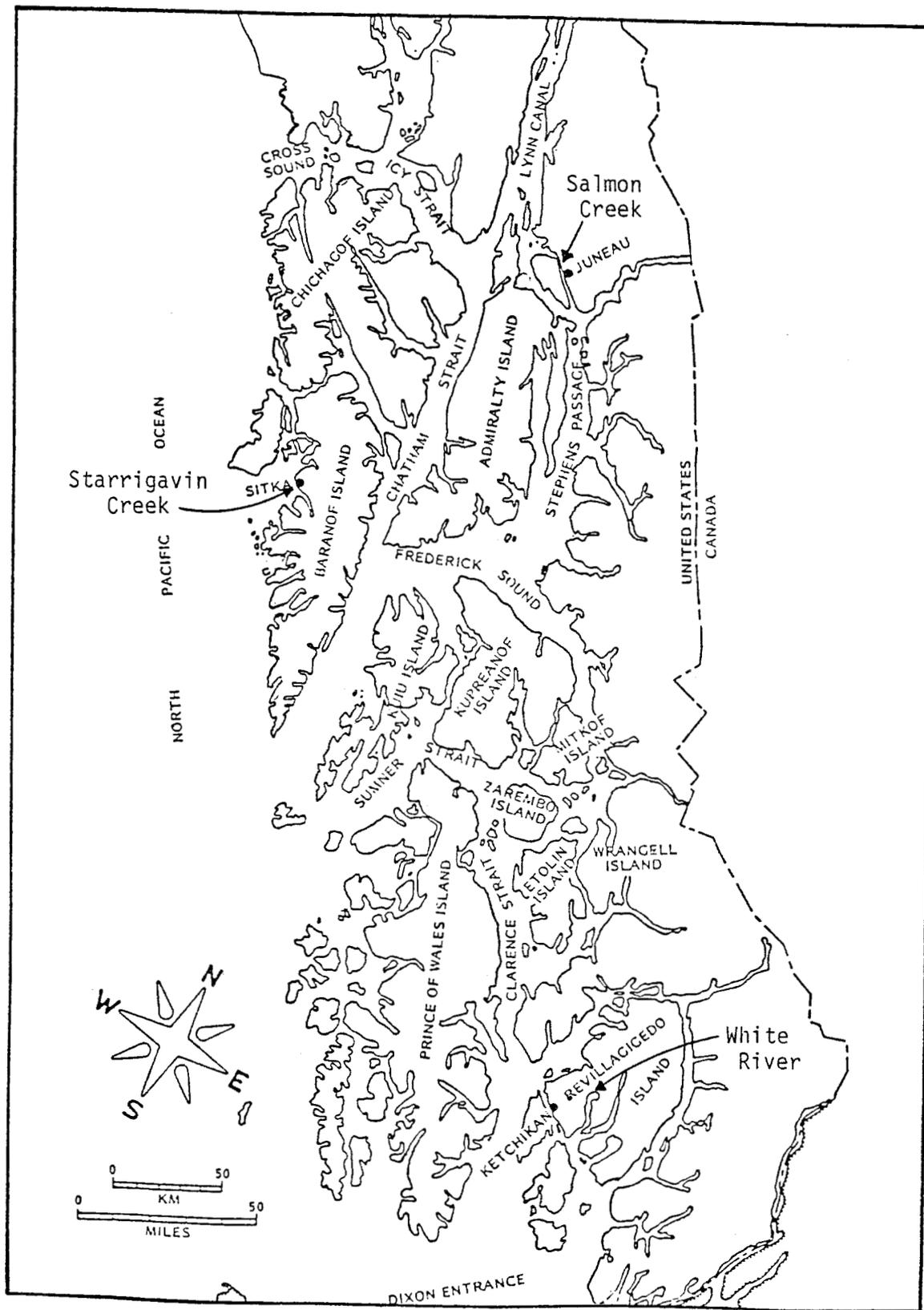


Figure 1. Map of Southeastern Alaska, showing locations of the three streams used in stream life studies, 1983.

Table 1. Stream life of pink salmon in three streams of Southeastern Alaska, 1983.

Location	Color ¹	Dates Tagged	Streamlife (in days)		
			Modal	Weighted Mean	50% Mortality
Salmon Creek (Juneau)	Y	Aug. 2-4	13	14.5	14
	O	Aug. 8	15	17.2	17
	R	Aug. 16-17	12	13.4	13
	Total		14	15.0	14
Starrigavin Cr. (Sitka)	O	Aug. 3	23 & 29 ²	33.1	29
	W	Aug. 10	34	29.4	30
	P	Aug. 17	25	27.0	26
	Total		29	30.0	29
White River (Ketchikan)	B	July 19-20	41	40.5	41
	G	July 28	37	38.2	38
	P	Aug. 9	33	30.3	31
	Y	Aug. 18	23	24.7	24
	Total		33	33.1	33

¹ Y = Yellow, O = Orange, R = Red, W = White, P = Pink, B = Blue, G = Green.

² 10 tags recovered on each of 2 days.

A tag recovery was considered good if it was a recently spawned fish. Recoveries of fish killed prematurely by bears, weirs, or artificially induced causes were recorded (Table 2), but excluded from analysis of stream life. The good recoveries were arranged by numbers of days after recovery (Appendix Tables 1, 2, and 3). Mean stream life was computed by three different methods (Table 1). The first (modal) was the days after tagging where the recoveries were maximum. The second (weighted mean) was the average of the days after tagging of recovery weighted by the numbers recovered. The third (50% mortality) was the day on which 50% of the total tags recovered occurred.

RESULTS

Salmon Creek - Juneau Area

Calculated Stream Life

Stream life of pink salmon in Salmon Creek peaked at 13, 15, and 12 days for fish with yellow (earliest), orange, and red (latest) tags, respectively (Table 1). The peak was at 14 days for all three tag colors combined. These were modal values, i.e., the day after tagging on which the most tags were recovered.

The weighted average stream life was 14.5 days for yellow, 17.2 days for orange, and 13.4 days for red-tagged fish (Table 1). The overall weighted average for all three colors combined was 15.0 days. Average stream life was longer than modal stream life because the frequency distribution of stream life days is skewed to the right, i.e., there were more fish that lived longer than the modal stream life than there were fish that lived less than the modal stream life.

Another way to consider stream life is to calculate the number of days it takes to recover 50% of the total recovered tags, i.e., how long does it take half of the salmon in the stream to die? These 50% stream life values were 14, 17, and 13 days for yellow, orange, and red-tagged fish, respectively, and 14 days for all three colors combined; practically identical to the weighted average stream life values (Table 1). Stream life of individual fish ranged from 4 to 38 days.

Tag Recovery Rates

Recovery rates of tags varied among colors, between the sexes of fish and with water levels (Table 2). We recovered 52.0% (49.2%)¹ of the yellow (earliest) tags in Salmon Creek, the highest recovery of the three colors used there. Only 37.1% (33.2%) and 35.0% (27.9%) of the orange and red tags were recovered, respectively. We also recovered a higher percentage of tags from females (53.9%) than from males (37.6%).

¹ Percentage figures in parentheses are those for "good" recoveries, i.e., only those fish which were very recently spawned-out and dead. Therefore, this does not include recoveries from fish killed by bears, at weirs, or other artificially-induced causes. See Table 1, footnotes #2 and #3.

Table 2. Tag application and recovery information, pink salmon stream life studies, Southeastern Alaska, 1983.

Location	Color ¹	Dates Tagged	#Tags Applied, by Sex			#Tags Recovered, by Sex ²			%Tags Recovered, by Sex			#"Good" Tags Recovered ³	% "Good" Tags Recovered
			M	F ⁴	Total	M	F	Total	M	F	Total		
Salmon Creek (Juneau)	Y	Aug. 2-4	395	97	492	190	66	256	48.1	68.0	52.0	242	49.2
	O	Aug. 8	369	95	464	124	48	172	33.1	50.0	37.1	154	33.2
	R	Aug. 16-17	365	144	509	111	67	178	30.4	45.6	35.0	142	27.9
Total			1,129	336	1,465	425	181	606	37.6	53.9	41.1	538	36.7
Starrigavin Cr. (Sitka)	O	Aug. 3	293	214	507	89	56	145	30.4	26.2	28.6	90	17.8
	W	Aug. 10	261	239	500	48	42	90	18.4	17.6	18.1	59	11.8
	P	Aug. 17	248	252	500	56	44	100	22.6	17.5	20.0	69	13.8
Total			802	705	1,507	193	142	335	24.1	20.1	22.2	218	14.5
White River (Ketchikan)	B	July 19-20	-	- ⁵	169	-	-	-	-	-	-	46	27.2
	G	July 28	-	-	519	-	-	-	-	-	-	111	21.4
	P	Aug. 9	-	-	457	-	-	-	-	-	-	111	24.3
	Y	Aug. 18	-	-	258	-	-	-	-	-	-	71	27.5
Total			1,403									339	24.2

¹ Y = Yellow, O = Orange, R = Red, W = White, P = Pink, B = Blue, G = Green.

² Includes some recoveries from fish killed prematurely, e.g., by bears, weir, or artificially-induced causes, or fish that had not died very recently, but from which sex information could still be gathered.

³ Legitimate recoveries only from very recently spawned-out, dead fish. Does not include recoveries from fish killed by weir, bears, or artificially-induced causes. These recoveries are those used for stream life calculations.

⁴ M = Male, F = Female

⁵ No sex determinations made.

Heavy precipitation and resulting high stream water levels apparently increased mortality and shortened stream life in Salmon Creek. The number of tags recovered increased dramatically one or two days immediately following a period of heavy rain and high water. Very high and very fast water in the creek, the result of overflow from an upstream reservoir (an increase of over 500 cfs in just a few hours), effectively flushed the creek of nearly all carcasses and most live fish that were in a weakened condition from spawning. This inundation was probably responsible, in part, for the lower recovery rates of the orange and red tags, which at the time were the predominant tag colors in the creek.

Starrigavan Creek - Sitka Area

Calculated Stream Life

In Starrigavan Creek, the peak days of stream life (i.e., the modal values) for each of the three colors of tags used were as follows: orange (earliest) - 23 and 29 (10 tags each day), white - 34, and pink (latest) - 25 (Table 1). Considering all three tag colors combined, the greatest number of tags (23) were recovered on the 29th day after tagging occurred.

The weighted average stream life was: orange - 33.1 days, white - 29.4 days, and pink - 27.0 days; for all three colors - 30.0 days.

The number of days that elapsed to recovery of 50% of the tags of each color were: orange - 29 days, white - 30 days, and pink - 26 days; for all three colors 50% recovery occurred at 29 days.

Stream life of individual fish ranged from 6 to 55 days.

Tag Recovery Rates

In Starrigavan Creek, as in Salmon Creek, recovery rates varied among tag colors and between male and female fish. The tags applied earliest (orange) were recovered at the highest rate 28.6% (17.8%), as occurred in Salmon Creek (Table 2). However, in contrast to Salmon Creek, we recovered a greater percentage of tags from males of all colors combined (24.1%) than from females (20.1%). Overall, combining all three colors of "good" tags, i.e., those used in stream life calculations only, the tag recovery rate in Starrigavan Creek (14.5%) was only 39.5% of that in Salmon Creek (36.7%).

White River - Ketchikan Area

Calculated Stream Life

In the White River, peak days of stream life, or modal values, for each of the four colors of tags were as follows: blue (earliest) - 41 days, green - 37 days, pink - 33 days, and yellow - 23 days (Table 1). For all four tag colors combined, the greatest number of tags (30) were recovered on the 33rd day after tagging.

Weighted average stream life was: blue - 40.5 days, green - 38.2 days, pink - 30.3 days, and yellow - 24.7 days; for the four colors combined, the weighted

average was 33.1 days (Table 1).

The "50% mortality" days of stream life were: blue - 41 days, green - 38 days, pink - 31 days, yellow - 24 days, and 33 days overall (Table 1).

Stream life of individual fish ranged from 15 to 52 days.

Tag Recovery Rates

Recovery rates of tags in White River did not vary as much as in the other two streams (range, 21.4% - 27.5%), and the recovery rates were higher than in Starrigavan Creek, but lower than in Salmon Creek (Table 2). No sex ratio data were gathered in White River, therefore, all tag recovery data is for "good" tags only. Results showed that the earliest and latest groups of fish tagged had nearly identical recovery rates (27.2% vs 27.5%), unlike the other two streams in which early-tagged fish had the highest recovery rate. The overall "good" tag recovery rate for White River (24.2%) was 1.7 times that of Starrigavan Creek but only 66% of that of Salmon Creek.

DISCUSSION

The 50% stream life of pink salmon in Salmon Creek, Juneau, was 14 days; stream life in Starrigavan Creek, Sitka, was nearly twice this at 29 days; and in White River, Ketchikan, it was even longer at 33 days (Table 1). In all three streams, the fish tagged latest had the shortest stream life (Table 1). This may have been because the latest-tagged fish had been milling near the mouths of the creeks for some time prior to tagging. Only in the White River did the earliest-tagged fish have the longest stream life, and each group of progressively later-tagged fish there had progressively shorter stream life.

In Salmon Creek and Starrigaven Creek, the tags applied to the fish earliest had the highest recovery rate; in White River, however, the tag recovery rate was fairly uniform throughout the study period for all colors of tags used (Table 2). Sex composition data gathered in Salmon and Starrigavan Creeks showed that in Salmon Creek the percentage of tags recovered from females was significantly higher than the percentage of tags applied to females. (Chi-square - 16.49, $P < .005$); however, recoveries in Starrigavan Creek showed a higher percentage of males than the percentage of males that were tagged, though this was not significant (Chi-square = 2.70, $P = .1015$).

For comparison, stream life studies conducted in 1976 in Traitors River and Katlian Creek gave the following results:

Traitors River:

Pink Salmon. Modal stream life - 23 days; weighted mean stream life 23.1 days; and 50% mortality stream life - 22 days (range 11-43 days).

Chum Salmon. Modal and 50% mortality stream life - 20 days, weighted mean stream life - 20.8 days (range 10-33 days). Thus, stream life of pink

salmon in Traitors River was longer than in Salmon Creek but shorter than in either Starrigavan or White River.

Katlän Creek:

Recovery data was very limited from Katlian Creek with only 5 tagged pink salmon and 35 tagged chum salmon recovered, but weighted mean stream life was 21.8 days for pink salmon; 20.5 days for chum salmon. This is very similar to the stream life found for Traitors River.

To our knowledge, information on stream life of salmon is very limited. Helle et al. (1964), in Olsen Creek, Prince William Sound, Alaska, found stream life of pink salmon varied from nearly 1 month, early in the season, to only 5 days at season's end, with a significant negative relationship between stream life and time of entry into the creek. The earlier a pink salmon spawner entered the creek, the longer was its stream life, similar to our experience, especially in the White River. Overall average stream life in the study of Olsen Creek was only 11.1 days, even shorter than our shortest stream life of 14-15 days in Salmon Creek. McNeil (1964) estimated pink salmon female spawning ground residence time at 10.8 days in the Harris River, Southeastern Alaska, from observations of 38 tagged females.

Neilson and Geen (1981) showed that for chinook salmon (*O. tshawytscha*) in the Morice River, British Columbia, Canada, stream residence time of early-arriving females (13.1 days) was significantly longer than for late-arriving females (7.7 days). Residence time varied from 4 to 18 days overall. Stream life data from their study has been incorporated as a correction factor to refine estimates of total escapements of chinook salmon in the Morice River. Neilson and Banford (1983) found a similar pattern for chinook females in the Nechako River, British Columbia, with residence time varying from 6 to 25 days overall.

Neilson and Geen (1981) also found that female chinook salmon had a longer period of residence on the redds than males, and this agreed with results of Burner (1951) for Columbia River chinook salmon. This difference between the sexes is one aspect which can and should be examined from our Southeastern Alaska data on pink salmon stream life.

Killick (1955), Gangmark and Fulton (1952), and Craddock (1958) conducted research on sockeye salmon (*O. nerka*) redd life in the Pacific Northwest to refine escapement estimates. Killick (1955) noted that the first Fraser River sockeye of a particular stock to arrive at a spawning ground had a longer residence time than the late arrivals. Average stream life of females was 12.7 days (range 8.4-13.6 days), and that of males 12.0 days (range 9.8-12.4 days).

The average spawning ground life for coho salmon (*O. kisutch*) in some Oregon streams was determined to be 11 days (Willis 1954, Beidler and Nickelson 1980).

Our overall average tag recovery rate for all three river systems in Southeastern Alaska was 25.1%. Individual stream recovery rates were 14.5% (Starrigavan Creek), 24.2% (White River), to a high of 36.7% in Salmon Creek (Table 2). These values compare favorably with the 29% recovery rate for pink salmon in Prince William Sound, Alaska found by Helle et al. (1964), and are much higher than the 4.4% recovery rate reported by Kingsbury (1977) for another Southeastern Alaska stock of pink salmon.

All three stream systems had freshets early in the spawning cycle which could have resulted in an overestimate of actual stream life. Had the freshets occurred late in the cycle an underestimate of stream life would have resulted. Therefore, timing of freshets can strongly affect estimates of stream life.

CONCLUSIONS

Because we found that pink salmon stream life varies so much among streams and freshet events are a natural occurrence in Southeastern Alaska, more stream life data will be required from several more streams before this information can be reliably used to improve estimates of pink salmon total escapements in Southeastern Alaska. Future stream life studies should make every effort to obtain stream life information from other species of salmon in addition to pink salmon, for this data should be useful for the management of these other species as well.

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APPENDICES

Appendix Table 1. Number of days after tagging that tags of various colors were recovered from pink salmon carcasses, Salmon Creek Stream Life Studies, 1983.

Day	Orange	Red	Yellow	Total
4	0	1	0	1
6	3	6	0	9
7	3	4	0	7
8	4	13	2	19
9	2	10	7	19
10	2	7	19	28
11	2	8	23	33
12	4	16	30	50
13	9	10	35	54
14	17	15	24	56
15	22	10	16	48
16	8	6	18	32
17	15	6	16	37
18	10	13	10	33
19	5	2	13	20
20	7	4	19	30
21	11	6	6	23
22	4	2	2	8
23	9	0	1	10
24	6	1	0	7
25	1	1	0	2
26	3	0	0	3
27	3	0	0	3
29	1	1	0	2
30	2	0	0	2
31	0	0	1	1
38	1	0	0	1
Total	154	142	242	538

— Modes

Appendix Table 2. Number of days after tagging that tags of various colors were recovered from pink salmon carcasses, Starrigavan Creek Stream Life Studies, 1983.

Days	Pink	White	Orange	Total
6	0	0	0	0
7	0	0	0	0
8	0	0	0	0
11	0	0	0	0
12	0	0	0	0
13	2	0	0	2
14	2	0	0	2
15	2	0	0	2
16	0	2	1	3
17	2	0	1	3
18	0	2	0	2
19	0	2	0	2
20	0	4	0	4
21	1	2	1	4
22	4	2	1	7
23	3	0	10	13
24	4	3	4	11
25	9	0	5	14
26	6	0	7	13
27	6	1	2	9
28	6	2	4	12
29	4	5	10	19
30	1	5	0	6
31	1	4	3	8
32	1	4	1	6
33	2	4	0	6
34	1	6	3	10
35	4	3	0	7
36	1	3	1	5
37	2	1	2	5

-Continued-

Appendix Table 2. Number of days after tagging that tags of various colors were recovered from pink salmon carcasses, Starrigaven Creek Stream Life Studies, 1983 (continued).

Days	Pink	White	Orange	Total
38	1	0	6	7
39	0	1	4	5
40	2	1	6	9
41	2	0	4	6
42	0	0	1	1
43	0	0	3	3
44	2	0	0	2
45	2	0	3	5
46	1	0	0	1
47	0	1	2	3
49	0	0	1	1
50	0	1	0	1
51	0	0	2	2
52	0	1	2	3
55	0	0	1	1
Total	74	60	91	225

Appendix Table 3. Number of days after tagging that tags of various colors were recovered from pink salmon carcasses, White River Stream Life Studies, 1983.

Day	Blue	Green	Pink	Yellow	Total
15	0	0	0	0	0
16	0	0	0	2	2
17	0	1	0	3	4
18	0	0	0	3	3
19	0	0	0	2	2
20	0	1	0	2	3
21	1	0	8	4	13
22	1	0	2	4	7
23	0	0	3	9	12
24	0	2	2	7	11
25	1	1	10	6	18
26	0	1	11	3	15
27	0	0	6	6	12
28	0	0	1	5	6
29	0	0	5	0	5
30	0	0	5	7	12
31	1	0	8	4	13
32	1	3	7	1	12
33	1	12	14	3	30
34	4	6	7	0	17
35	0	4	4	0	8
36	0	1	3	0	4
37	0	15	4	0	19
38	0	14	0	0	14
39	0	6	3	0	9
40	3	1	1	0	5
41	12	10	5	0	27
42	5	12	2	0	19
43	3	1	0	0	4
44	0	2	0	0	2
45	5	2	0	0	7
46	1	6	0	0	7
47	1	0	0	0	1
48	1	4	0	0	5
49	4	3	0	0	7
50	1	0	0	0	1
52	0	2	0	0	2
Total	46	111	111	71	339

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