Canadian Technical Report of

Fisheries and Aquatic Sciences No. 1367

January 1985

TERMINAL TRAVEL RATES FOR ALBERNI INLET SOCKEYE SALMON (*ONCORHYNCHUS NERKA*)

by

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Cat.No.Fs 97-6/1367E ISSN 0706-6457

Correct citation for this publication:

Manzer, J. I., R. B. Morley and D. J. Girodat. 1985. Terminal travel rates for Alberni Inlet sockeye salmon (<u>Oncorhynchus nerka</u>). Can. Tech. Rep. Fish. Aquat. Sci. 1367: 19 p.

ABSTRACT

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Travel times for adult sockeye migrating from the entrance to Alberni Inlet to Sproat Lake and Great Central Lake on Vancouver Island in 1979 were estimated from a total of 1530 sockeye tagged with Peterson tags on 6 weekly fishery closures between 17 June and 22 July. Of the sockeye tagged, 214 and 89 were subsequently sighted upon entry into Sproat Lake and Great Central Lake, respectively. Mean travel times for the respective stocks were estimated to be 7 and 9 days, or 6.1 km per day. By comparing proximal peaks in the temporal distribution of sightings of tagged sockeye from individual releases with those in the daily escapement estimates of sockeye it appears that activities associated with tagging operations can delay travel times by as much as 2 days, on average.

RÉSUMÉ

Manzer, J. I., R. B. Morley and D. J. Girodat. 1985. Terminal travel rates for Alberni Inlet sockeye salmon (Oncorhynchus nerka). Can. Tech. Rep. Fish. Aquat. Sci. 1367: 19 p.

Le temps nécessaire pour se rendre de l'entrée de l'inlet Alberni aux lacs Sproat et Great Central (île Vancouver) a été calculé pour 1530 saumons rouges adultes amontants auxquels des étiquettes Peterson ont été fixées au cours de six fermetures hebdomadaires de la pêche entre le 17 juin et le 22 juillet 1979. Des saumons étiquetés, 214 et 89 ont respectivement été observés à leur entrée dans les lacs Sproat et Great Central. Le temps moyen de déplacement pour les stocks respectifs a été estimé à 7 et à 9 jours, ou 6.1 km par jour. Suite à une comparaison des pointes proximales de la répartition temporelle des observations de saumons étiquetés, déterminée à partir des lâchers individuels, et des pointes de la remonte quotidienne calculée, il semble que les activités reliées aux opérations d'étiquetage peuvent prolonger jusqu'à deux jours en moyenne le temps de déplacement.

The Alberni Inlet watershed contains three sockeye salmon (*Oncorhynchus nerka*) stocks: Great Central, Sproat and Henderson lakes. In recent years these stocks have increased significantly in size and have supported an intensive commercial gillnet fishery in Barkley Sound and purse seine fishery at the seaward end of Alberni Inlet, while enroute to respective spawning grounds. The stocks are also exploited to a lesser extent by recreational and native food fisheries. Since the early 1970's the stocks have been investigated by the Pacific Biological Station, Nanaimo, British Columbia, under the Lake Enrichment Program. The objective of this program is to assess the effects of controlled additions of inorganic phosphorous and nitrogen to oligotrophic nursery lakes on sockeye production.

In 1979, the Field Services and Resource Services (i.e. Fisheries Research) Branches of the Canadian Department of Fisheries and Oceans conducted co-operative studies on the occurrence of these stocks in areas open to commercial fishing, and on their migration rates from these areas to the spawning grounds. The information derived from these studies in conjunction with reliable commercial catch and escapement statistics are of considerable value in formulating fishing strategies for the individual fisheries, with equitable and optimal resource use in mind. Additionally, reliable information on these various aspects provides the basis for estimating timing and progress of each run through the fishing areas. This report provides information on terminal travel rates for sockeye migrating to Great Central and Sproat lakes, as determined from tagged individuals.

DESCRIPTION OF STUDY AREA

General

The Alberni watershed is situated in the southwest area of Vancouver Island and drains to the open Pacific Ocean through Barkley Sound via Alberni Inlet (Fig. 1). Alberni Inlet is a typical fjord, approximately 55 km in length and 1.5 km in width, with its longitudinal axis lying in a north-south direction, and extending almost one-half the way across Vancouver Island. Morris and Leaney (1981), referring to vast and diverse sources of information in the literature, provide a thorough description of environmental knowledge (e.g. geological, climatological, hydrological, etc.) to 1980 for the area with particular emphasis on the head of the inlet and adjacent territory. Information on the oceanography of Alberni Inlet is reported by Tully (1949) in a monograph on his classical research, and by Pickard (1963). Briefly, Alberni Inlet is a two-layered system with the upper layer being low in salinity and of rather uniform thickness throughout the length of the inlet. This layer is maintained largely by freshwater input from the Somass River at the head of the inlet. As the surface water flows seaward seawater is entrained from below, and salinity increases with distance down inlet. Factors such as winds, tides, and local run-off reduce or accelerate the distribution of the various inlet properties, some of which can be expected to influence sockeye migrations.

Apart from surface run-off and outflow from several small streams into the inlet throughout its length, freshwater entering Alberni inlet originates mainly from 4 lakes: Great Central (52 km^2), Sproat (44 km^2), Henderson (24 km^2) and Nahmint (12 km^2), the latter being devoid of sockeye salmon. These lakes are long, narrow, and situated among relatively steep mountains.

Great Central and Sproat lakes are drained by the Stamp (15 km) and Sproat (3.5 km) rivers, respectively. These rivers merge to form the mainstem Somass River (7 km) which empties into the head of Alberni Inlet. Waterfalls which present severe obstacles to upstream migrating salmon are present on the Stamp and Sproat rivers but these have been made passable by the construction of vertical slot fishways. The fishway on the Sproat River is located along the North River bank adjacent to the falls approximately 0.5 km below the outlet of Sproat Lake, and is 49 m long and has 15 baffles. Under low to moderate water discharge rates a varying but small proportion of returning adult sockeye successfully ascend the falls, thus by-passing the fishway. Two fishways are present on the Stamp River. One (19 baffles) is located at the outlet of Great Central Lake adjacent to a dam constructed across the river. The other (149 m long and with 37 baffles) is located at Stamp Falls. Water levels and flows on both rivers fluctuate in response to variable rainfall through the year but can be regulated to some extent, by a dam at the lake outlets, especially the Stamp River.

Henderson Lake empties into Uchucklesit Inlet at the lower end of Alberni Inlet at its western shore. Some sockeye have been observed to spawn along the beaches, particularly at the upper end of the lake, but the major portion of the run moves through the lake and into Clemens Creek at the head of the lake. Clemens Creek is approximately 10 km long and in recent years sockeye have been observed to spawn mainly in the lower half.

Since the four lakes are situated in mountainous areas of high annual rainfall, water levels and discharge rates are subject to rapid and extreme fluctuations. Extreme conditions during the sockeye migration and spawning times can occur for periods ranging from a few to several days, thus rendering observations on salmon difficult. This is particularly true of Clemens Creek and Sproat River, but less true for the Stamp where flow can be regulated at the dam under most conditions. In 1979, water levels on the Stamp and Sproat were rather uniform, 1.5 m and 1.1 m respectively, except for approximately one week in early July when maximum levels were reached (Stamp = 2.4 m; Sproat = 1.8 m) and during the first week of September when a lesser increase occurred (Morley 1981).

COMMERCIAL SOCKEYE FISHERY IN 1979

The commercial fishery for sockeye in 1979 spanned a 10 week period, opening on 4 June and closing on 14 August. Fishing was permitted during the early part of each week and the number of fishing days varied from 2 to 4 in accordance with fishery regulations designed to achieve minimal target escapements to Great Central and Sproat Lakes. Initially, the fishery was carried out by gillnet vessels in Barkley Sound and by purse-seine vessels in a relatively confined area of Alberni Inlet seaward of Pocohontas Point excluding Uchucklesit Inlet (Fig. 1). From 23 July until closure, in addition to their regular fishing area, purse seiners were permitted to fish farther up the Inlet in areas which during successive weeks contracted towards its head. The total reported landing of sockeye for 1979 was 755,564 pieces (Table 1). Just over one-half (398,364 pieces or 52.7%) of the landings was made during 2 weeks ending 29 July. Purse seine vessels accounted for 90% of the landings for this period.

METHODS

The occurrence of sockeye stocks in Barkley Sound and their rates of travel to respective spawning grounds were determined from sockeye tagged at the entrance to Alberni Inlet in the immediate vicinity of Pocohontas Point and subsequently sighted prior to entry to nursery lakes (Sproat and Great Central lakes), or on spawning grounds (Henderson Lake). Sockeye for tagging were caught by a commercial salmon purse seine vessel fishing under contract during 6 weekly fishery closures from 17 June to 22 July. A total of 1530 sockeye were tagged with Peterson disc tags made from laminated plastic and measuring 22 mm in diameter. The tag was attached to the fish's body in the dorsal area immediately behind the dorsal fin. The number of sockeye tagged weekly ranged from 200 to 325. Each week's releases was specifically color-coded to allow identification of tagging period. Tagging dates, numbers of sockeye tagged on each date, and associated tag colors are given in Table 2.

Sockeye salmon returning to Sproat Lake were counted and observed for tagged individuals at a site located 0.4 km below the Lake outlet. The river at this site under normal conditions is approximately 15 m wide and 1-2 m deep, and clear. Migrating salmon were easily observed from a vantage point 5 m above stream level as they swam over a white painted strip across the width of the riverbed. The strip was formed from bulldozer tracks (25 cm wide) and iron plates (76 cm x 122 cm) secured to the riverbed by cable, and from bedrock. Visibility conditions were usually excellent but deteriorated during heavy rainfall and high water levels.

Sproat River initially was checked every few days for returning adult sockeye. The first sighting occurred on 27 May. From this date until 15 September, when the run was considered virtually complete, the site was manned daily by a crew of 2 persons. Normally only one person counted at a time over a 3 h shift to avoid fatigue. Crews were changed every 5 days. A normal counting day was from 0500 to 2300 h. On 13 occasions observations were made over a 24 h period with the aid of red floodlights at 2.5 m intervals suspended about 2.5 m above the water surface to determine the extent of migration during hours of darkness. The method of making observations is described in more detail by Morley (1981).

Observations on Great Central Lake sockeye were made at the dam as fish entered the lake upon emergence from the fishway. The routine for counting and observing sockeye for tagged individuals was not as comprehensive as that employed on the Sproat River. Intermittent scouting for short periods during early June resulted in the first sockeye being observed on 7 June. Visual observations began on this date and continued daily until 7 July, usually beginning at daybreak (0500 or 0600 h) and continuing for 7 to 8 h, thus spanning the peak period of daily migration. Frequently, during this period observations were also made for one hour during the early evening. On 8 July and thereafter effort to observe sockeye was considerably reduced following installation of a programmable electronic fish counter in the exit bay of the fishway. Counts of adult salmon were recorded continuously on an hourly basis for the duration of the season (Morley 1981). During counter operation efforts to observe tagged sockeye were limited to periods ranging from 1.5 to 10 h on each day except 6 during July, and thereafter infrequently and intermittently for periods at most times for less than 1 h until 5 October when counting ceased. Counter accuracy was determined by measuring the relationship between visual counts and machine counts based on 79 comparable time periods ranging from 15 min. to 1.10 h from 23 June to 29 August, using regression analysis. On average, machine hourly counts were adjusted by a factor of 1.02 to obtain corrected numbers of migrants. Details of the method for adjusting machine hourly counts for error to obtain daily totals are described by Hyatt et al. (in preparation).

Average travel times for each stock were estimated by two different methods. One method adjusted the number of tagged sockeye observed daily on each system to a standard sighting day of 18 h (i.e. standard method) to compensate for variability in sighting effort. The other method calculated the number of tagged sockeye for a 24 h period based on the ratio of fish observed to the estimated total daily escapement (i.e. ratio method). Daily salmonid escapements to both systems were adjusted to exclude coho salmon (*O. kisutch*), chinook salmon (*O. tshawytscha*) and steelhead trout (*Salmo gairdneri*) on the basis of visual species identification or on information on species composition derived from routine sampling of the escapements for biological information. The first non-sockeye salmonid to Great Central Lake was noted on 1 August and to Sproat Lake on 14 August.

Sightings of sockeye bearing different colored tags provided data on travel rates for various segments of each run. Major peaks in daily sightings of tagged sockeye were compared with fluctuations in daily estimates of the escapement, especially peaks, to determine the delaying effect of tagging on migration rates.

The search for tagged Henderson Lake sockeye was conducted in conjunction with spawning stream surveys carried out on 3 and 16 October by 3 experienced personnel. Except under flood conditions the stream can be inspected across its width by observers working either bank. In 1979, a distance of 4 km was covered during spawning surveys.

RESULTS AND DISCUSSION

Of the 1530 sockeye tagged from 7 June to 22 July at the entrance to Alberni Inlet in Barkley Sound 304 or 19.9% were subsequently sighted: 14.0% on the Sproat River, 5.8% enroute to Great Central Lake, and <0.01% (one unconfirmed tag) in Clemens Creek (Table 3). Sightings of tagged sockeye on the Sproat River from individual taggings ranged from 33.8% (8 July) to 1.3% (15 July); to Great Central Lake, from 15.4% (17 June) to nil (15 and 22 July). Interestingly, the percentage of tags sighted from weekly taggings fluctuated similarly for both stocks. The unconfirmed solitary tagged sockeye sighted in Clemens Creek was believed to have a white tag and therefore was tagged on 8 July.

In a mixed stock situation several factors influence the likelihood of sockeye belonging to a particular stock being tagged and subsequently sighted. Regarding prospects for being tagged, perhaps the most important factors are the number and relative abundance of the stocks present, and the degree to which these are mixed and available to capture during different tagging periods. Factors influencing sighting of tagged individuals include sighting effort, loss of tagged individuals through natural causes or death resulting from procedures associated with capture, handling and tag application, or from removal by different fisheries. Also, under some circumstances, tagged individuals may go unnoticed as a result of tag color or stream visibility conditions. These and other problems which have an important bearing on the analysis of tagging data have been discussed in greater detail by Killick (1955) and Verhoeven and Davidoff (1962) when studying the migration of Frazer River sockeye. In the present study, except possibly for sighting effort, solid quantitative information on the influence of the above factors on tag sightings is lacking.

Tag sightings suggest that sockeye in the tagging area by mid-June were mainly Sproat and Great Central Lake sockeye. Sproat sockeye were still present when tagging ceased on 22 July. Failure to sight tagged Great Central Lake sockeye from 15 and 22 July taggings is probably due to greatly reduced sighting effort on the fishway rather than to a reduction or absence of Great Central sockeye in the tagging area. The solitary tag sighted in Clemens Creek, if indeed valid, suggests that Henderson sockeye, although present in the tagging area by 8 July, were not abundant when compared to the Great Central and Sproat stocks, at least until 22 July when tagging ceased. The later appearance of Henderson sockeye in Barkley Sound by comparison with Sproat and Great Central sockeye has since been more definitively established from results of studies on stock-specific parasites (Dr. L. Margolis, Pacific Biological Station, Nanaimo pers. comm.).

The number of tagged sockeye from individual releases sighted daily and about to enter Sproat and Great Central lakes is given in Appendix table 1, along with daily sighting effort. Sightings of tagged sockeye on both systems were relatively few or nil from releases on 1, 15 and 22 July. The low number of sightings of sockeye tagged on 1 July in relation to sightings of sockeye tagged on 17, 24 June and 8 July cannot be reliably explained from the available data. Rapidly increasing water levels during 8-13 July (Morley 1981) as a result of heavy rains would not appear to have affected ability to sight tags since 55 white tags were seen on the Sproat River on 13 July.

A large proportion of the sockeye present in Barkley Sound about 1 July could be expected to be migrating past the vantage points approximately one week later, judging from travel rates to be described later. The reason for not sighting more tagged Sproat sockeye or any Great Central sockeye from taggings on 15 and 22 July also is not known. Although sighting effort on Great Central Lake was considerably reduced after 24 July, effort on the Sproat River remained comparable to that of earlier periods and a considerable reduction in tag sightings still occurred. The most likely explanation for the few sightings from these two taggings is the interception and removal of tagged individuals by the large efficient purse seine fleet which was concentrated in the Upper Alberni Inlet after 22 July. Additionally, the number of days fishing per week was increased from 2 to 4. It is known that the fisheries recovered some tagged sockeye, but unfortunately the vessels were not canvassed nor were landings thoroughly searched for recoveries. The number therefore, of tagged sockeye removed by the fishery cannot be estimated and appropriate adjustments to numbers of sockeye available for sighting are not possible. However, it would seem reasonable to believe that the increased fishing effort during the last two weeks of July, which accounted for just over 50% of the season's landings (Table 1), would include a substantial number of tagged sockeye, assuming that untagged and tagged individuals were equally available to capture.

The 55 white tags, by far the largest number of tags seen on any single day on either river, recorded for the Sproat River on 13 July (Appendix Table 1) deserves special notation. Water discharge rates during this time were high and rendered sighting difficult. Since Pacific lamprey (Lampetra tridentata) were present in the river and are known to attack sockeye salmon, it is possible that some sockeye with lamprey scars or wounds may have been mistaken to have white tags. However, Pacific lamprey tend to attack the ventral and anterior body areas of their prey (Beamish 1980), areas distinctly removed from that used for tag application, namely posterior to the dorsal fin. Accordingly, it is believed that misidentification of wounds as tags on sockeye on 13 July is not a serious source of error, particularly when it is noted that relatively large numbers of white tags were also sighted on the Stamp River on 17 (8) and 18 July (15) under somewhat better sighting conditions.

The minimal and maximal number of days required for sockeye of each stock to travel from the tagging areas in Barkley Sound to the respective sighting locations are given in Table 4. Also given are mean travel times estimated according to the "standard" and "ratio" methods. Since no tagged sockeye from the 15 and 22 July taggings were observed to enter Great Central Lake, comparions of travel times for Great Central and Sproat sockeye are limited to sightings from weekly taggings between 17 June and 8 July. The results indicated that Sproat sockeye required an average minimal time of 5 days to complete their migration compared with 8.5 days for Great Central Lake sockeye. This difference is similar in order and magnitude to that indicated by a comparison of the dates of the primary peaks in the escapement estimates for the two stocks (Great Central = 17 July, Sproat = 13 July) (Fig. 2). Mean maximal travel times were 25.3 and 20.3 days, respectively. The mean times based on the combined results for the 4 taggings using the standard method was 9.3 days for Sproat sockeye and 11.2 days for Great Central sockeye. These mean values agree closely with those obtained by the ratio method:

Sproat = 9.3 days, Great Central = 10.8 days. When all sightings from all taggings (17 June-22 July) are considered for Sproat sockeye, the mean travel times calculated according to the two methods is 6.8 and 9.7 days, respectively.

Mean travel rates for Sproat sockeye in the tagging area on 15 and 22 July apparently are considerably slower that those present during earlier tagging periods. The estimates of travel rates for the last two taggings are based on only 3 sightings each which are probably insufficient numerically to be indicative of reliable travel rates for sockeye migrating from Barkley Sound during the latter half of July. Migration of sockeye during this time may have been impeded by declining and low water levels which occurred during late July and August. Morley (1981) showed that the numbers of sockeye migrants to both Sproat and Great Central increased significantly and concurrently when water levels in the Sproat and Stamp rivers rose following heavy rains.

Schaefer (1951), on the basis of tagging studies on the Birkenhead sockeye (Fraser River system), observed that tagged sockeye do not take appreciably longer than untagged sockeye to complete their spawning migration, although he acknowledged that his data were inadequate for any final conclusion. Killick (1955), reported that between Hell's Gate on the Fraser River and Bowren Lake, a distance of 855 km, that tagged sockeye took one to two days more than untagged sockeye to cover this route, and that the difference in travel times for the two groups would probably be greater over shorter distances. For Sproat and Great Central sockeye the dates of peak sightings of tagged sockeye, adjusted to 18 hours, were compared with dates of prominent peaks in the estimated daily escapement. Proximal peaks differed by as much as 3 days. In 5 of the 7 possible comparisons peaks in the sightings followed or were synchronous with prominent peaks in the daily escapement (Fig. 2; Table 5). Exceptions to this general observations are the sightings of sockeye to both systems which were tagged on 24 June. It could be argued, at least for Sproat sockeye, that the tagged individuals sighted on 10 July could be just as easily associated with the 4-5 July peak as that on 13 July. Nevertheless it seems reasonable to presume that the difference between peak dates for sightings and daily escapements of 0-2 days given in Table 4 may be a measure of the delaying effect of tagging on speed of travel. If so, on average, travel times of 7 and 9 days for Sproat and Great Central sockeye, respectively, may be more accurate, and represent an average travel rate of 6.1 km per day for each stock.

CONCLUSIONS

1. Great Central and Sproat sockeye precede Henderson Lake sockeye in their occurrence in Barkley Sound at the seaward end of Alberni Inlet, since the latter stock did not appear to be abundant during tagging operations (17 June-22 July).

2. Sproat sockeye on average require a minimum of 5 days to travel from the seaward end of Alberni Inlet to a point on the Sproat River located 0.4 km below the lake outlet, a distance of 55 km. Great Central lake sockeye require on average 8.5 days to reach Great Central Lake (67 km). Estimated mean travel times for the respective stocks are 9 and 11 days, representing an average rate of travel of 6.1 km per day.

3. It is possible that activities associated with capturing, handling, and tagging sockeye may impose as much as a 2 day delay in the migration times of sockeye. If so, the best estimates of mean travel times would be 7 days for Sproat sockeye and 9 days for Great Central sockeye.

ACKNOWLEDGEMENTS

This study would not have been possible without the co-operation and diligence of many individuals. Captain P. Charleson and his crew were responsible for obtaining sockeye for tagging. Messers J. Mitchell, A. M. Cowan, B. McDonald and T. Mulligan at various times participated in tagging operations. Mr. A. Coburn and his crew obtained daily escapement and sighting data on the Sproat River. B. Kanester and staff of the Robertson Creek hatchery assisted in similar duties on the Great Central Lake fishway, especially prior to installation of the electronic counter.

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Table 1. The weekly reported commercial fishery landings (gillnet + purse seine) of sockeye salmon in Barkley Sound in 1979.

Week ending	Landing (pieces)	% of total
10 June	2,589	0.3
17	12,223	1.6
24	44,471	5.9
1 July	76,209	10.1
8	105,135	13.9
15	74,482	9.9
22	140,852	18.6
29	257,832	34.2
5 August	29,936	4.0
12	10,882	1.4
Total	755,564	100.0

Table 2. Tagging dates, number of sockeye tagged and tag colors used in Barkley Sound.

Tagging date	No. of sockeye tagged	Tag color
17 June	201	Yellow
24 June	300	Blue
1 July	325	Orange
8 July	275	White
15 July	229	Red
22 July	200	Green
Total	1530	

Table 3. Numbers of sockeye salmon tagged in Barkley Sound by date, and subsequently sighted according to stock. Percent values are given in parentheses.

Tagging date	Number tagged	Sighted by stock: Sproat	Great Central	Henderson	Total
17 June	201	48 (23.9)	31 (15.4)	-	79 (39.3)
24 June	300	52 (17.3)	19 (6.3)	-	71 (23.7)
1 July	325	15 (4.6)	2 (0.6)	-	17 (5.2)
8 July	275	93 (33.8)	37 (13.4)	1 (0.4)*	131 (47.6)
15 July	229	3 (1.3)	-	-	3 (1.3)
22 July	200	3 (1.5)	-	-	3 (1.5)
Total	1530	214 (14.0)	89 (5.8)	1 (0.1)	304 (19.9)

*Unconfirmed.

Table 4. Minimal, maximal and mean number of days for sockeye to migrate from tagging locations in Barkley Sound to observation sites on Sproat River and Great Central Lake, by tagging date.

Tagging	Minimal		Maximal		Mean			
					Sproat		GCL	
date	Sproat	GCL	Sproat	GCL	Standard	Ratio	Standard	Ratio
17 June	4	7	21	26	7.8	7.8	9.1	9.1
24 June	5	8	20	27	14.7	14.8	17.4	17.5
1 July	7	15	23	16	11.4	11.8	14.5	15.3
8 July	4	8	37	22	6.7	6.6	10.3	9.7
15 July	19	-	31	-	24.0	26.7	-	-
22 July	25	-	25	-	25.0	25.0	-	-
Mean								
17 June-8 July	5.0	8.5	25.3	20.3	9.3	9.3	11.2	10.8
17 June-22 July	10.7	-	26.2	-	6.8	9.7	-	-

Table 5. Peak dates for sightings of tagged sockeye from weekly taggings in Barkley Sound, and for daily escapements to Sproat and Great Central Lakes.

	Sproat			G.C.L.		
Tagging date	Tag sightings (1)	Escap. (2)	1-2 (days)	Tag sightings (1)	Escap. (2)	1-2 (days)
17 June	23 June	21 June	2	24 June	23 June	1
24 June	10 July	13 July	-3	5, 18-20 July	7, 17 July	-2,2
1 July	14 July	13 July	1	-	-	-
8 July	13 July	13 July	0	18 July	17 July	1

Appendix Table 1. Actual numbers of tagged sockeye observed daily upon entry into Sproat and Great Central Lakes, according to various tagging dates. Sighting effort is also given.

	Sproat							Great Central Lake						
	Sighting effort	Tagging date						Sighting effort	Tagging date					
Sighting date	(hrs)	17 June	29 June	1 July	8 July	15 July	22 July	(hrs)	17 June	24 June	1 July	8 July	15 July	22 July
June 17	20							10						
18	23							3						
19	18							9.5						
20	18							8						
21	18	4						5						
22	18	12						6.5						
23	18	6						2						
24	18	10						1.25	3					
25	18	3						6	5					
26	23	1						2.75	5					
27	18	2						7	10					
28	18	4						6.5	3					
29	19	1	3					8	2					
30	23	1	1					7	1					
July 1	18							7	1					
2	18							7		1				
3	18	2						8	1	2				
4	18		1					7		1				
5	18		6					7		6				
6	18	1	3					7						
7	19							10		2				
8	24	1	2	3				10						
9	18		3	1				4.25						
10	18		15					8						
11	19		9	1				5						
12	24		4	1	9			6		1				
13	18		3	2	55			0						
14	18		2	6	8			1.5						
15	18				10			1.75						

Appendix table 1 (cont'd)

	Sproat							Great Central Lake						
Sighting date	Sighting effort (hrs)	Tagging date						Sighting effort (hrs)	Tagging date					
		17 June	29 June	1 July	8 July	15 July	22 July		17 June	24 June	1 July	8 July	15 July	22 July
16	18				2			3			1	6		
17	18				2			6.5		2	1	8		
18	19				1			5.0		1		15		
19	23				1			4.5		2		4		
20	18							4				3		
21	18							2		1				
22	18							0						
23	18							7						
24	18							5						
25	18							3						
26	19			1				2						
27	24				1			0						
28	18							0						
29	18							0						
30	18							5				1		
31	18							0						
August 1	18							0						
2	18				2			0						
3	18					1		0						
4	18							0						
5	19							0						
6	24							0						
7	18				1			3						
8	18							0						
9	18							0						
10	18							0						
11	18							0						
12	18							0						
13	18							?						
14	19				1	1		?						

Appendix table 1 (cont'd)

Sighting date	Sproat: Sighting effort (hrs)	Sproat Tagging date: 17 June	29 June	1 July	8 July	15 July	22 July	Great Central Lake: Sighting effort (hrs)	Great Central Lake Tagging date: 17 June	24 June	1 July	8 July	15 July	22 July
15	24					1		0						
16	18						3	0						
17	18							0						
18	18							0						
19	18							0						
20	18							?						
Total		48	52	15	93	3	3		31	19	2	37	0	0

Figure 1. Map of Alberni Inlet watershed with names of locations mentioned in text.

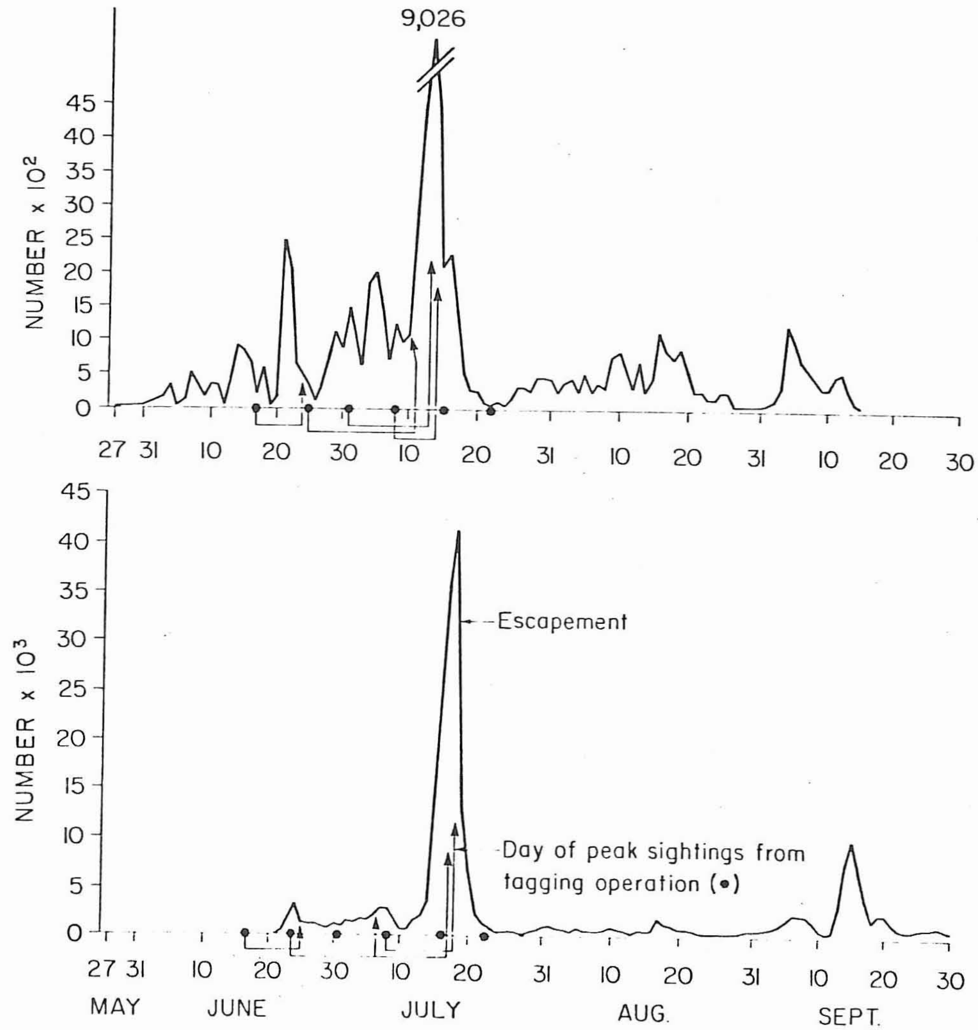

Figure 2. Comparison between dates of proximal peaks in estimates of daily escapements of sockeye to Sproat Lake (top panel) and Great Central Lake and in sightings of tagged sockeye from individual tagging dates (arrowheads). Escapement estimates for Sproat sockeye are from Morely (1981).