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**THE MIGRATION, COMPOSITION, EXPLOITATION AND
ABUNDANCE OF ODD-YEAR PINK SALMON RUNS
IN AND ADJACENT TO THE FRASER RIVER
CONVENTION AREA**

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By Authority of
PINK SALMON CO-ORDINATING COMMITTEE
Appointed Pursuant to Article VI of the Pink Salmon Protocol
Between Canada and the United States for the Co-ordination of
Investigation of Pink Salmon Stocks Entering Fraser River
Convention Waters

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PREFACE

This co-operative investigation was carried out under the direction of the Pink Salmon Co-ordinating Committee appointed by the Governments of Canada and the United States to fulfill the requirements of Article VI of the Pink Salmon Protocol which amended the Sockeye Salmon Fisheries Convention effective July 3, 1957.

Article VI of the Protocol called for "... a co-ordinated investigation of pink salmon stocks which enter Convention waters for the purpose of determining the migratory movements of such stocks." In 1964, the Committee authorized the publication of a report entitled, "The Migration and Exploitation of Pink Salmon Runs in and Adjacent to the Fraser River Convention Area in 1959", which embodied the results of a very extensive co-operative investigation of the 1959 run.

To assess the extent to which the characteristics of pink salmon runs to this area might be expected to vary from those of the 1959 run, the Committee also provided for a more restricted investigation of the 1961 run. The present report compares the results of this program with those of 1959 as well as with such information as is available for the runs in other years.

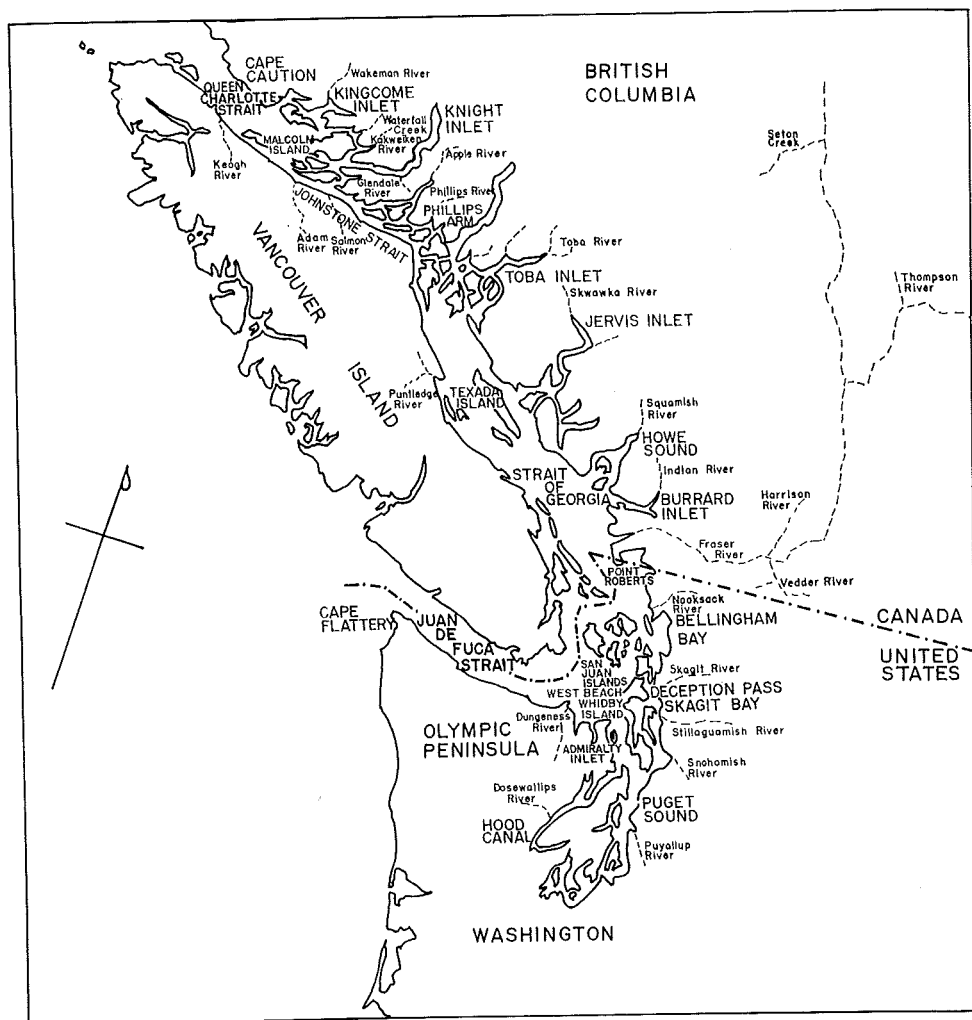
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Frontispiece—Major geographic locations in the area of study.

TABLE OF CONTENTS

INTRODUCTION	1
THE 1961 RUN	3
The Fisheries	3
Abundance of Spawners	9
Reliability of estimates of spawning populations	15
Abundance of spawners by stock	18
Times of Passage Through the Major Fishing Areas	18
Abundance of Northern and Southern Approach Runs to Canada Non-Fraser, Fraser River and United States Streams	20
Catches by stock group and preliminary estimates of abundance of the run entering via the Northern Approach	23
Catches by stock group and preliminary estimates of abundance of the run entering via the Southern Approach	33
Abundance of Northern and Southern Approach fish in the catches and spawning escapements	47
Description of the 1961 Pink Salmon Run to the Study Area	51
Abundance and migration routes of Northern and Southern Approach runs	51
Abundance and exploitation of major stock groups	53
Review of the 1961 Run in Terms of Catches in the Canadian, United States and Convention Areas	55
Summary and Comparison of the Basic Characteristics of the 1961 and 1959 Runs	57
ANNUAL VARIABILITY IN PINK SALMON RUNS TO THE STUDY AREA	61
Timing of the Runs to the Three Terminal Areas	65
Migration Routes of the Runs to Canada Non-Fraser, Fraser River and United States Streams	78
Composition of the Run	78
Rates of Removal	84
Abundance of the Run and its Various Components	86
Summary of Annual Variability	90

ACKNOWLEDGMENTS	93
LITERATURE CITED	94
APPENDICES	95
A. Pink Salmon Catches in the Study Area in 1961	95
B. Pink Salmon spawning Populations Enumerated by Visual Surveys in 1961	123
C. Recoveries of Enumeration Tags by Stream Section, by Week of Recovery and by Week of Tagging	128
D. Comparison of Fishing Effort in Johnstone Strait in 1961 With That for a "1961 Type" Fishery in 1959	132
E. Estimation of the Numbers of Pink Salmon Which Escaped the Johnstone Strait Fishing Area and Were Destined for United States Streams in 1961	134
F. Assessment of the Accuracy of the Estimates of the Proportions of Northern and Southern Approach Pinks in the Strait of Georgia and Fraser River Terminal Areas in 1961	137
G. Pink Salmon Spawning Populations in the Canadian Study Area in 1963	146
H. Major Pink Salmon Fisheries and Catch Data for Cycle Years prior to 1959	150

THE MIGRATION, COMPOSITION, EXPLOITATION AND ABUNDANCE OF ODD-YEAR PINK SALMON RUNS IN AND ADJACENT TO THE FRASER RIVER CONVENTION AREA

INTRODUCTION

In 1957, Canada and the United States ratified a Protocol to the existing Fraser River salmon treaty¹ to bring the management of pink salmon fisheries in the Fraser Convention area under international control. Under Article VI of this Protocol, the two countries agreed to conduct ". . . a co-ordinated investigation of pink salmon stocks which enter Convention waters for the purpose of determining the migratory movements of such stocks." A detailed study of the migratory movements of the pink salmon run in this area was carried out in 1959 (Vernon, Hourston and Holland, 1964²). An important aspect of the description of the migratory movements of pink salmon not dealt with in the report on the 1959 study is the extent to which the characteristics of the runs vary from year to year.

In 1959, pink salmon spawning in the Fraser River system approached the river in their onshore spawning migration through Queen Charlotte and Johnstone Strait from the north and through Juan de Fuca Strait from the south. During their migration on either approach they were mixed with pinks destined for other Canadian streams and for streams in the State of Washington. Quantitative estimates of abundance were obtained for each of the various stocks entering on either approach and for the contributions of these stocks to the catches in the various fishing areas and spawning escapements.

Information on the migration, abundance, and exploitation of odd-year³ pink salmon runs to this area in years prior to 1959 is limited. Catch data are available for relatively large fishing areas but these catches contained mixtures of fish destined for Canada Non-Fraser, Fraser River, and United States streams. Some information on the migration routes and times of passage through the major fishing areas of the runs to the Fraser River and to other Canadian and United States streams is available from tagging programs in a few years in Johnstone and Juan de Fuca Straits (Pritchard, 1932; Pritchard and DeLacy, 1944; DeLacy and Neave, 1948; Manzer, 1958; Milne *et al.*, 1959). However, this information is not sufficiently complete in any year to estimate the abundance of the three runs on either approach. Visual estimates of spawning escapements are also available for some areas since 1951, but these data do not indicate even gross variations in the larger stocks. Thus, for no year prior to 1959 is there sufficient information for more than general comparisons of relative abundance between years.

¹ Summarized in detail in the Annual Report of the International Pacific Salmon Fisheries Commission for 1957, pp. 5-9.

² All information on the 1959 run included or referred to herein is from this paper.

³ Since virtually all pink salmon spawning in this area mature at two years of age, the even-year runs essentially form separate populations from the odd-year runs and are not considered in this report. The numbers of pink salmon which enter Convention waters during the even years have been negligible, as far back as historical records are available, rendering a comparable study of even-year runs of no practical importance.

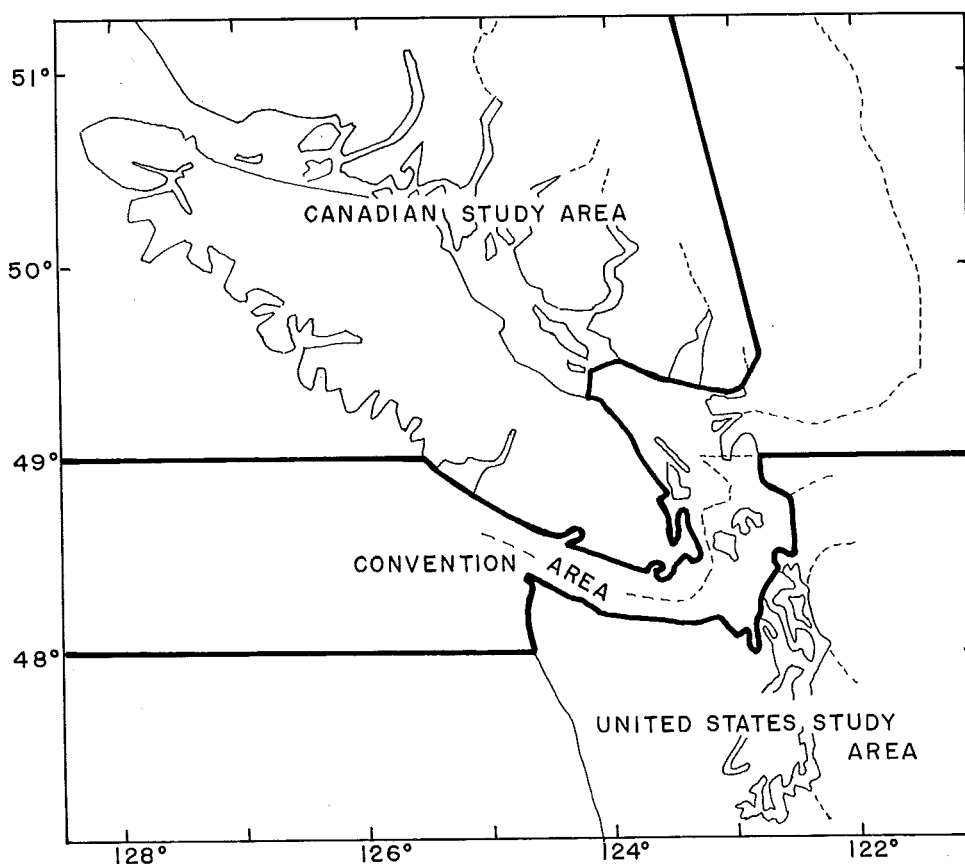


FIGURE 1. Study areas for the 1961 pink salmon investigation.

To estimate quantitatively the extent of variability in the abundance of the total run, of its Northern and Southern Approach components and of the three stock groups, quantitative estimates of catches and escapements for each of these categories would be required for other years. As a minimum step in this direction, a field program similar to that in 1959, but less extensive, was conducted in 1961 to provide a census of the run in a second year. The results of this program are described and compared with those for the 1959 run in the following section. Following this a general description of the 1961 run is developed using these data and some general features of the run deduced from the 1959 analysis. In the final section, more qualitative information available for cycle years from 1963 back to 1937 is assessed on the basis of the quantitative information for 1959 and 1961 to provide gross estimates of the extent of the variability in these quantities over a longer, more representative period.

The 1961 study, like that in 1959, was carried out under the direction of the Pink Salmon Co-ordinating Committee composed of representatives of Canada, the United States and the International Pacific Salmon Fisheries Commission. Each of the three groups again undertook responsibility for those portions of the joint program carried out in its area (FIGURE 1). The Department of Fisheries and the Fisheries Research Board of Canada gathered information on catches in

individual fishing areas and the abundance of spawners in streams in Canadian waters outside the Convention area, the Washington State Department of Fisheries gathered this information for United States waters outside the Convention area and the International Pacific Salmon Fisheries Commission provided this information for Convention waters. The Fisheries Research Board again undertook the major responsibility for analyses of information on the run migrating through Johnstone Strait (Northern Approach) and the Salmon Commission for analyses of information on the run migrating through Juan de Fuca Strait (Southern Approach).

THE 1961 RUN

The Fisheries

Methods of compiling pink salmon catch data in the Study Area in 1961 were virtually the same as those employed in 1959. The slight changes in procedure are given, along with detailed catch data, in APPENDIX A.

A total of 3,274,000⁴ pink salmon were captured in the combined Study Area in 1961. Of this total 3,146,000 were taken in the commercial fisheries, 99,000 by sport fishermen and 29,000 by the Indian subsistence fishery in the Fraser River (TABLE 1). The total commercial catch in 1961 was only 42 per cent of that in 1959 (TABLE 2), which in turn was considerably below the total catch in each of the three previous cycle years (Vernon, Hourston and Holland, 1964).

As in 1959, pink salmon entering the Study Area were exploited first by fisheries (almost exclusively troll) operating off the West Coast of Vancouver Island and Washington State (FIGURE 2 and TABLE 3). The catch in these fisheries (215,000 fish) amounted to 7 per cent of the total Study Area catch. Canadian fishermen took 65 per cent of the West Coast troll catch. A further catch of 92,000 pinks, or 3 per cent of the Study Area catch, was taken in Queen Charlotte Strait at the north end of Vancouver Island (TABLE 1).

On the Northern Approach the principal Canadian net fishery, operating in the Malcolm Island and Johnstone Strait areas took 1,203,000 pinks (TABLE 1), or 37 per cent of the Study Area catch. Seiners took 82 per cent of this catch while gill-netters and trollers took approximately equal proportions of the remainder. Substantial catches were made between the weeks ending July 15 and September 9 (TABLE 3). The peak catch was made in the week ending August 19 nearly three weeks earlier than in 1959.

Fisheries in Georgia Strait north of the Convention area (Texada Island, Cortes and Comox) took only 11,000 pinks mostly by means of gill nets.

Local inlet fisheries adjacent to the Northern Approach route produced a total catch of 449,000 pinks in 1961 (TABLE 1) or 14 per cent of the Study Area catch.

On the Southern Approach the Canadian Juan de Fuca Strait fishery took 359,000 pinks or 11 per cent of the Study Area catch in 1961 (TABLE 1). Seiners accounted for 87 per cent of this catch (313,000 fish) while gill-netters took 32,000, trollers 10,000 and sportsmen 4,000 pinks. Moderate catches were made between

⁴ Except for those used in direct calculations, figures in the text are rounded to the nearest thousand.

TABLE 1. Pink salmon catches in the Study Area in 1961.

FISHING AREA	COMMERCIAL	SPORT	TOTAL
CANADIAN STUDY AREA			
West Coast Troll	85,875	—	85,875
Queen Charlotte Strait	91,902	900	92,802
Malcolm Island	493,001	—	493,001
Upper Johnstone Strait	456,818	—	456,818
Lower Johnstone Strait	252,310	995	253,305
Cortes Island	322	11 ^c	333
Texada Island	9,253	64 ^c	9,317
Comox	1,021	425	1,446
Kingcome Inlet	18,693	—	18,693
Knight Inlet	306,273	—	306,273
Phillips Arm	12,851	—	12,851
Toba Inlet	1,524	—	1,524
Jervis Inlet	95,861	185	96,046
Howe Sound	246	13,150 ^c	13,396
Total Canadian Study Area	1,825,950	15,730 ^c	1,841,680
CONVENTION AREA			
CANADA			
West Coast Troll	54,161	—	54,161
Juan de Fuca Strait	355,593	3,750	359,343
Fraser Gulf	43,560	72	43,632
Fraser River	91,814	—	91,814
Fraser River, Indian	—	29,000 ^a	29,000
Burrard Inlet	—	6,825	6,825
Total Canadian Convention Area	545,128	39,647	584,775
UNITED STATES			
West Coast Troll	63,893	—	63,893
Juan de Fuca Strait	12,264	12,261	24,525
San Juan Islands	227,779	5,940	233,719
West Beach	87,294	—	87,294
Point Roberts	117,314	—	117,314
Total United States Convention Area	508,544	18,201	526,745
Total Convention Area	1,053,672	57,848	1,111,520
UNITED STATES STUDY AREA			
West Coast Troll	10,137 ^c	700	10,837 ^c
Nooksack River	52,574	—	52,574
Skagit Bay and River	104,047	41,500	145,547
Port Susan-Port Gardner	61,118	2,668	63,786
Admiralty Inlet-Puget Sound	17,427	9,383	26,810
Puyallup River	21,228 ^b	—	21,228
Total United States Study Area	266,531	54,251	320,782
GRAND TOTAL	3,146,153	127,829	3,273,982

^a Indian subsistence fishery.^b Includes 2,131 pinks taken in Nisqually River.^c Preliminary estimates.

TABLE 2. Comparison of 1961 and 1959 commercial pink salmon catches.

FISHING AREA	1961	1959	INCREASE IN 1961
CANADIAN STUDY AREA			
West Coast Troll	85,875	131,085	—45,210
Queen Charlotte Strait	91,902	167,551	—75,649
Malcolm Island	493,001	512,751	—19,750
Upper Johnstone Strait	456,818	945,989	—489,171
Lower Johnstone Strait	252,310	530,850	—278,540
Cortes Island	322	1,288	—966
Texada Island	9,253	26,498	—17,245
Comox	1,021	6,189	—5,168
Kingcome Inlet	18,693	5,261	+13,432
Knight Inlet	306,273	119,984	+186,289
Phillips Arm	12,851	9,978	+2,873
Toba Inlet	1,524	19,083	—17,559
Jervis Inlet	95,861	105,533	—9,672
Howe Sound	246		+246
Total Canadian Study Area	1,825,950	2,582,040	—756,090
CONVENTION AREA			
CANADA			
West Coast Troll	54,161	186,296	—132,135
Juan de Fuca Strait	355,593	1,588,669	—1,233,076
Fraser Gulf	43,560	435,727	—392,167
Fraser River	91,814	102,138	—10,324
Total Canadian Convention Area	545,128	2,312,830	—1,767,702
UNITED STATES			
West Coast Troll	63,893	175,921	—112,028
Juan de Fuca Strait	12,264	61,598	—49,334
San Juan Islands	227,779	1,338,385	—1,110,606
West Beach	87,294	77,736	+9,558
Point Roberts	117,314	773,894	—656,580
Total United States Convention Area	508,544	2,427,534	—1,918,990
Total Convention Area	1,053,672	4,740,364	—3,686,692
UNITED STATES STUDY AREA			
West Coast Troll	10,137	13,427	—3,290
Nooksack River	52,574	8,106	+44,468
Skagit Bay and River	104,047	69,425	+34,622
Port Susan-Port Gardner	61,118	99,096	—37,978
Admiralty Inlet-Puget Sound	17,427	1,315	+16,112
Puyallup River	21,228	6,028	+15,200
Total United States Study Area	266,531	197,397	+69,134
GRAND TOTAL	3,146,153	7,519,801	—4,373,648

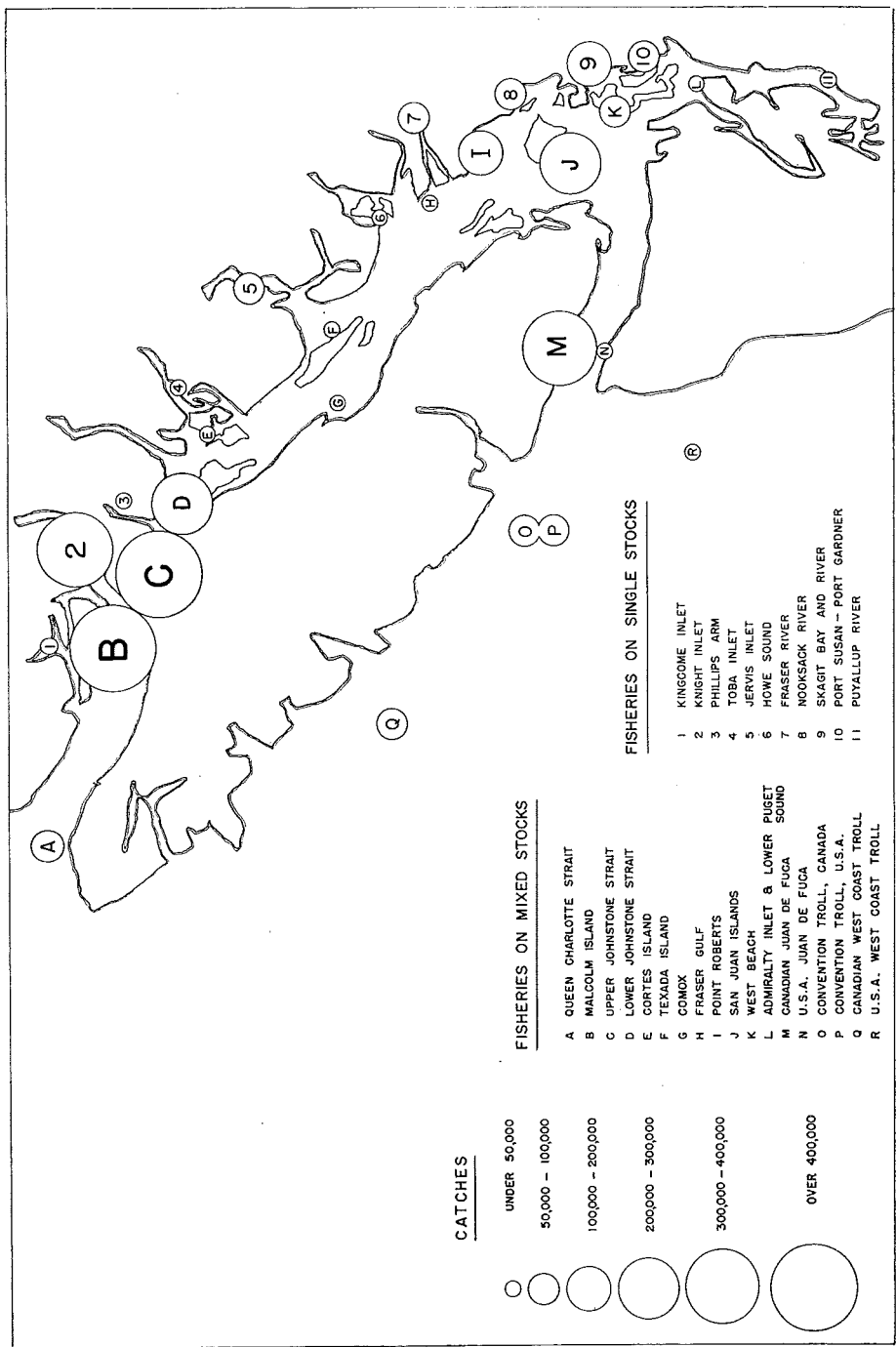


FIGURE 2. Location and general magnitude of catches for pink salmon fisheries throughout the Study Area in 1961.

TABLE 3. Weekly commercial catches of pink salmon in the Study Area in 1961.

	WEEK ENDING																	ALL WEEKS
	To June 17	June 24	July 1	July 8	July 15	July 22	July 29	Aug. 5	Aug. 12	Aug. 19	Aug. 26	Sept. 2	Sept. 9	Sept. 16	Sept. 23	Sept. 30	Oct. 7 on	
CANADIAN STUDY AREA																		
West Coast Troll	400	3,855	3,869	9,043	2,633	6,020	6,122	16,985	15,146	13,743	5,643	1,887	350	85	86	—	8	85,875
Queen Charlotte Strait	3	62	281	793	2,274	4,587	10,525	13,678	26,726	14,929	13,712	2,746	1,391	181	14	—	—	91,902
Malcolm Island	—	—	—	414	2,896	16,719	28,439	75,667	68,385	144,146	86,427	54,391	11,895	396	3,219	—	7	493,001
Upper Johnstone Strait	7	25	67	414	2,896	15,961	57,176	61,526	54,240	111,504	63,173	58,294	30,431	—	1,070	34	—	456,818
Lower Johnstone Strait	6	5	23	305	1,640	5,918	18,497	21,771	24,000	39,520	46,853	46,935	43,618	42	3,050	127	—	252,310
Cortes Island	—	—	—	1	3	1	5	5	33	9	70	146	19	8	18	—	3	—
Texada Island	2	8	7	—	20	33	279	294	3,205	306	1,468	2,573	651	18	376	13	—	9,253
Comox	16	16	63	74	25	28	25	10	194	152	200	139	18	3	55	1	—	1,021
Kingcome Inlet	—	—	—	—	—	—	11,322	4,454	2,745	172	—	—	—	—	—	—	—	18,693
Knight Inlet	—	—	—	—	—	—	6,563	20,296	52,486	161,608	60,124	1,238	616	77	18	—	—	306,273
Phillips Arm	—	—	—	111	861	2,293	—	20,296	2,745	172	60,124	1,238	616	35	18	—	—	12,851
Toba Inlet	—	—	—	—	—	—	3	16	1,924	2,905	5,792	973	1,188	—	—	—	—	1,524
Jervis Inlet	—	—	—	—	—	—	—	46	593	840	42	—	—	—	378	—	—	95,861
Howe Sound	—	—	—	—	—	—	—	373	4,075	17,609	58,982	14,444	9	—	—	—	—	246
TOTAL CANADIAN STUDY AREA	434	3,971	4,311	11,155	13,248	51,560	138,956	215,121	253,752	507,628	342,538	183,775	90,177	845	8,284	1	194	1,825,950
CONVENTION AREA																		
West Coast Troll	374	3,311	5,201	6,818	4,691	5,787	5,432	4,204	4,872	7,350	4,055	1,751	190	103	22	—	—	54,161
Juan de Fuca Strait	—	33	—	—	108	23,265	68,942	24,141	42,506	135,964	50,516	1,435	5,741	1,693	1,039	—	65	355,593
Fraser Gulf	—	—	—	3	60	111	430	1,090	48	11,668	5,248	8,747	1,865	10,882	2,319	—	1,089	43,560
Fraser River	—	—	—	—	—	2	2	28	—	406	1,531	17,541	9,543	9,200	7,677	10,910	34,974 ^a	91,814
Sub-total Canadian	374	3,344	5,201	6,821	4,859	29,165	74,806	29,463	47,426	155,388	61,350	29,474	17,339	21,878	11,057	11,055	36,128	545,128
West Coast Troll	96	208	905	2,709	3,448	6,201	5,048	6,928	13,111	15,499	6,120	2,224	594	604	197	1	—	63,893
Juan de Fuca Strait	—	—	—	—	2	1,258	3,929	2,448	4,615	1,555	2,445	—	—	—	10	2	—	12,264
West Beach	—	—	—	—	105	1,168	7,875	8,861	4,231	23,048	40,905	—	—	—	989	88	10	87,294
San Juan Islands	—	—	2	84	549	19,034	39,339	52,306	36,671	23,632	49,576	—	—	43	4,776	261	46	227,779
Point Roberts	—	—	—	35	236	5,958	13,253	22,833	22,871	17,177	31,335	—	—	—	1,260	728	1,598	117,314
Sub-total United States	96	208	907	2,842	4,340	33,619	69,534	93,376	77,499	82,311	130,381	2,224	594	647	7,232	1,080	1,654	508,544
TOTAL CONVENTION AREA	470	3,552	6,108	9,663	9,199	62,784	144,340	122,839	124,925	237,699	191,731	31,698	17,933	22,525	18,289	12,135	37,782	1,053,672
UNITED STATES STUDY AREA																		
West Coast Troll	21	33	184	1,943	1,169	372	826	990	2,525	1,419	548	59	29	18	1	—	—	10,137
Nooksack River	—	—	—	2	239	2,701	5,397	6,614	14,022	18,291	4,647	327	160	49	39	81	5	52,574
Skagit Bay and River	—	—	—	—	—	286	719	719	3,963	15,086	36,701	18,358	26,289	2,017	527	89	12	104,047
Port Susan-Port Gardner	—	—	—	—	—	318	318	788	1,892	10,443	18,074	7,788	18,896	1,475	1,016	396	8	61,118
Admiralty Inlet-Lower Puget Sound	—	—	—	—	—	—	—	—	14	5,963	11,206	—	—	166	62	6	10	37,427
Puyallup River ^b	—	—	—	—	—	—	—	10	72	342	1,538	5,447	7,643	4,224	1,532	393	27	21,228
TOTAL UNITED STATES STUDY AREA	21	33	184	1,945	1,408	3,097	6,827	9,121	22,488	51,544	72,714	31,979	53,017	7,949	3,177	965	62	266,531
GRAND TOTAL	925	7,556	10,603	22,763	23,855	117,441	209,123	347,081	401,165	796,871	606,983	247,452	161,127	31,319	29,750	13,101	38,038	3,146,153

^a 613 after October 7.

^b Includes 2,131 pinks taken in Nisqually River.

the weeks ending July 22 and August 26⁵ (TABLE 3). The peak catch was taken in the week ending August 19, about ten days earlier than in 1959. The United States Juan de Fuca Strait fishery took only 25,000 pinks (less than one per cent of the Study Area catch). About half of this catch (12,000 fish) was taken by sport fishermen and virtually all of the remainder by gill-netters.

At San Juan Islands 234,000 pinks (7 per cent of the Study Area catch) were taken by United States fishermen in 1961 (TABLE 1). Most of this catch (167,000 or 71 per cent) was made by seiners with gill-netters taking 33,000, reef nets 27,000 and sport fishermen 6,000. Moderate catches were made between the weeks ending July 22 and August 26. United States purse seiners and gill-netters also took 87,000 pinks at West Beach, mainly during the month of August. (Both these areas and Point Roberts were closed to commercial fishermen for the three weeks ending September 2, September 9 and September 16.)

In United States waters south and east of the Convention area, the fisheries in Skagit Bay (145,000 fish), Port Susan-Port Gardner (64,000 fish), Nooksack River (53,000 fish), Admiralty-Puget Sound (27,000 fish) and Puyallup River (21,000 fish) took a total of 310,000 pinks in 1961 or 10 per cent of the total Study Area catch (TABLE 1). In these fisheries, gill-nets accounted for 41 per cent of the catch, Indian beach seines 25 per cent, sport fishermen 19 per cent, Indian traps 9 per cent and purse seines 6 per cent. Most of the catch was made between the weeks ending August 5 and September 9 (TABLE 3).

United States fishermen also took 117,000 pinks (4 per cent of the Study Area catch) at Point Roberts (TABLE 1) mainly between the weeks ending July 29 and August 26 (TABLE 3). Seiners accounted for 84 per cent of the catch in this area and gill-netters almost all the remainder.

Canadian fishermen operating in the Strait of Georgia off the mouth of the Fraser captured over 43,000 pinks (TABLE 1) or one per cent of the Study Area total, mainly in the weeks ending August 19 to September 16 (TABLE 3). Since this area was closed to net fishing from August 30 to October 2, gill-netters took only 18,000 pinks and trollers virtually all the remaining 25,000.

In the Fraser River itself, Canadian gill-netters took 92,000 pinks (3 per cent of the Study Area catch) mainly in the weeks ending September 2 to October 7 (TABLE 3). During the weeks ending September 9, September 16, September 23 and September 30 the fishery was restricted to large-mesh nets for the capture of chinook salmon. The 37,000 pinks taken incidentally during these weeks were virtually all males. The Indian subsistence fishery operating in areas further upstream was estimated to have taken 29,000 pinks (TABLE 1).

In Burrard Inlet, sport fishermen were estimated to have taken 7,000 pink salmon.

Of the total Study Area catch of 3,274,000 pinks, 1,842,000 or 56 per cent were taken in Canadian waters outside the Convention area, 1,112,000 or 34 per cent in Convention waters (585,000 by Canadian and 527,000 by United States fishermen) and 321,000 or 10 per cent in United States waters outside the Convention area (TABLE 1).

⁵ This area was closed to net fishermen during the week ending September 2.

A comparison of pink salmon commercial catches in the individual fishing areas indicates that 1961 catches were greatly reduced from those in 1959 in the fisheries operating along the main migration routes on either approach (e.g., Johnstone Strait, Juan de Fuca Strait and San Juan Islands) and in the fishery operating off the mouth of the Fraser (TABLE 2). On the other hand, catches increased in most fisheries operating on local stocks in both the Canadian and United States Study Areas.

In Johnstone Strait on the Northern Approach, catches in 1961 were similar to those in 1959 during the early portion of the season to about the middle of August (FIGURE 3). In 1959 this part of the run was made up almost entirely of Canada Non-Fraser stocks while after this period increasing numbers of Fraser pinks entered this fishery. Fraser fish predominated by the end of August and made up nearly all the run after September 5. Thus the decreased catches in 1961 after the middle of August (FIGURE 3) would have resulted in a lower catch of Fraser pinks than in 1959. In Juan de Fuca Strait on the Southern Approach, 1961 catches were higher than those in 1959 up to about the middle of August (FIGURE 4). Again, on the basis of 1959 data, this portion of the run would have been made up almost entirely of Canada Non-Fraser and United States stocks. After this period, when Fraser fish would have predominated, catches in 1961 were very much reduced from the 1959 level.

Thus in general it would appear that the 1961 catches from pink salmon runs to Canada Non-Fraser and United States streams were similar or greater than those in 1959 while catches from the 1961 run to the Fraser River were much smaller than in 1959.

Abundance of Spawners

In 1961, pink salmon spawning was observed in 125 streams in the Study Area—on the northeast coast of Vancouver Island and on the Canadian and United States mainland adjacent to Vancouver Island. Following procedures employed in this area in 1959, the abundance of 18 spawning populations (including all those of more than 50,000 fish) was estimated by stream tagging and recovery programs or by weir counts (TABLE 4) while the 107 remaining populations were estimated from counts of live and dead fish made during visual surveys, by foot or by aircraft throughout the spawning and die-off periods (APPENDIX B).

Some modifications from the 1959 procedures were employed in the 1961 program. In the Canadian Study Area, the large spawning populations in the Glendale⁶ and Indian⁷ Rivers were enumerated mainly by weir counts to provide more precise estimates of the numbers of fish present. With the additional effort required for these two weir operations, field programs on 13 other streams⁸ which

⁶ The count of 164,127 pinks for the Glendale River includes 5,500 pinks estimated by visual survey to have been present below the fence when it was washed out by high water on October 8.

⁷ The actual weir count on the Indian River (56,692 pinks) was adjusted to 55,500 to account for fish that were carried downstream over the weir during four periods of high water and were thus counted more than once. This adjustment was based on the proportion of the tags applied at the weir which was subsequently counted returning through the weir. To this count were added 16,000 fish estimated by visual survey to have spawned below the weir and 4,327 pinks removed at the weir in an egg-taking operation to give a total estimate of 75,827 spawners.

⁸ Keogh, Adam, Salmon, Tsitika, Quinsam, Kakweiken, Waterfall, Phillips, Apple, Stafford, Toba, Quatani and Brem Rivers.

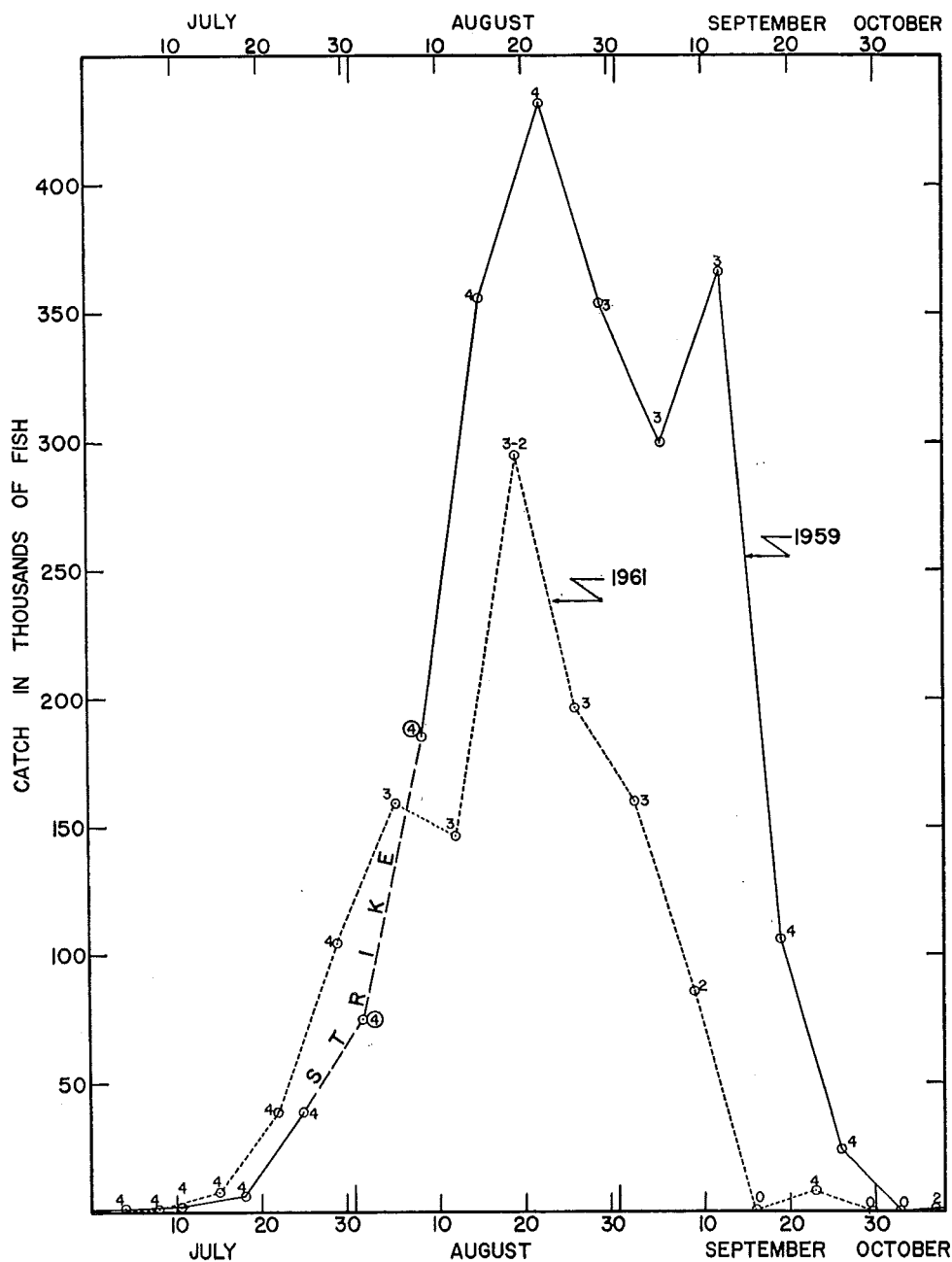


FIGURE 3. Weekly catches of pink salmon in Johnstone Strait in 1959 and 1961. Numbers beside the plotted points indicate the number of days of net fishing in each week. When regulations varied by area within the fishery the range in fishing time is shown. Numbers circled indicate the days fishing for which the potential catch was estimated during the strike period in 1959. Catches are plotted on week-end dates.

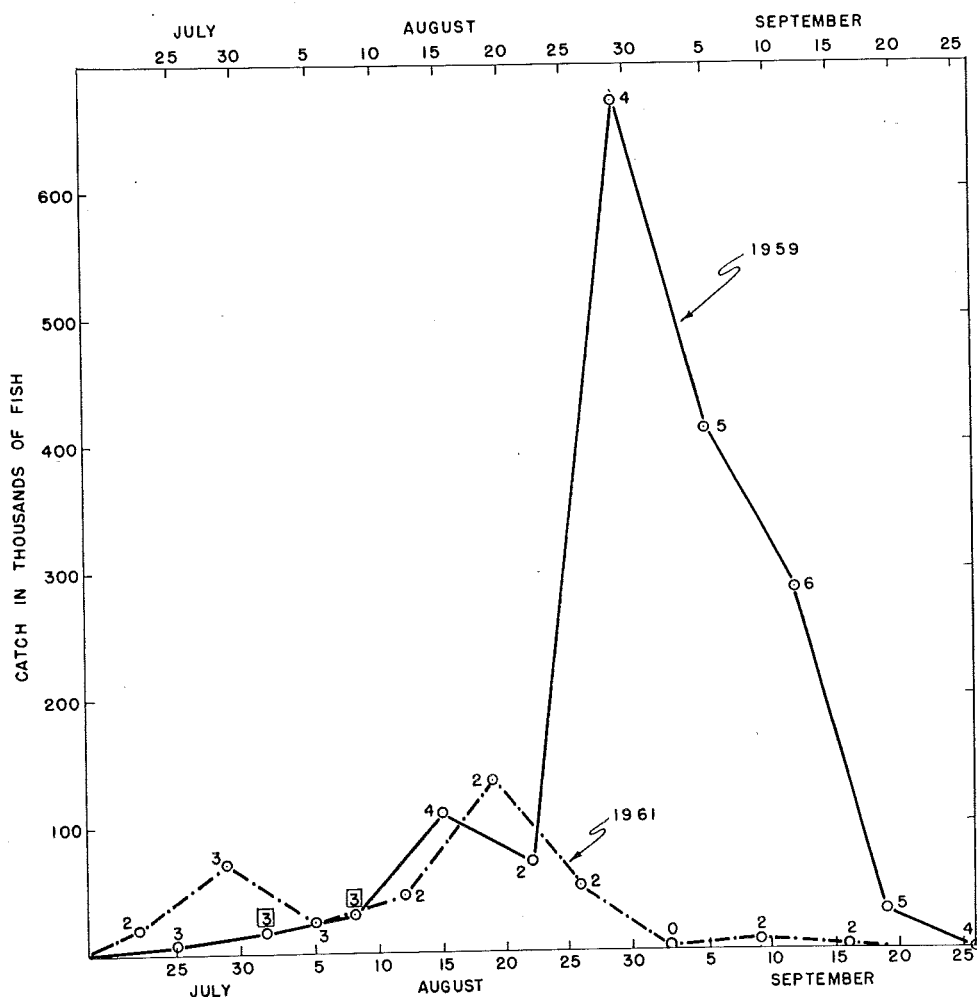


FIGURE 4. Weekly catches of pink salmon in the Canadian Juan de Fuca Strait fishing area in 1959 and 1961. Numbers beside plotted points indicate the number of days fishing in that week. Numbers in squares indicate the days fishing for which potential catch was estimated during the strike period in 1959. Catches are plotted on week-end dates.

were enumerated by stream tagging and recovery programs in 1959, were reduced to visual surveys in 1961. Spawning populations on the Skwawka and Cheakamus Rivers were enumerated by tagging as in 1959.

In the Convention area, the number of pink salmon spawning in the Thompson River in 1961 was estimated directly by a stream tagging and recovery program. (In 1959, sockeye in the Thompson system were enumerated by a tagging and recovery program and the pink population was estimated from a counted ratio of sockeye to pinks.) The procedure by which the very large spawning population in the main stem of the Fraser River (Main Fraser) was estimated in 1961 was a simplified version of that employed in 1959. In both years, the run was tagged as it left the Fraser River fishing area at Glen Valley. In 1959 the total spawning run to the Fraser River system was estimated from the proportions of all fish examined throughout the system which bore Glen Valley tags. The numbers of

TABLE 4. Summary of stream tags applied and recovered, carcasses examined, weir counts and population estimates by stream for pink salmon spawning stocks in the three Study Areas in 1961.

STOCK	STREAM	TAGS APPLIED			TAGS RECOVERED			CARCASSES EXAMINED			POPULATION ESTIMATED FROM TAGGING			WEIR COUNT	VISUAL COUNT	BEST POPULATION ESTIMATE
		Male		Total	Female		Total	Male		Total	Male		Total			
																Total
1. Kingcome Inlet 2. Upper Vancouver Island 3. Johnstone Strait	Adam River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41,800
	Salmon River	—	—	—	—	—	—	—	—	—	—	—	—	—	27,230	24,300
	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	50,000
4. Mid Vancouver Island	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	15,000
	Puntledge River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2,500
	Tsolum River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	67,500
5. Knight Inlet	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	8,700
	Glendale River	447	606	1,053	110	123	233	—	—	—	100,133	133,487	233,620	5,718	12,000	21,900
	Total	1,079	777	1,856	278	169	447	24,639	27,093	51,732	95,634	124,574	220,198	164,127 ^a	93,661	165,000
6. Phillips Arm	Kakweiken River	3,505	4,417	7,922	957	1,172	2,129	—	—	—	90,228	102,114	192,342	—	23,102	30,000
	Waterfall River	—	—	—	—	—	—	—	—	—	—	—	—	—	740	10,000
	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42,900
7. Toba Inlet	Total	5,031	5,800	10,831	1,345	1,464	2,809	24,639	27,093	51,732	285,985	380,175	646,160	164,127	117,503	247,900
	Apple River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	10,000
	Phillips River	—	—	—	—	—	—	—	—	—	—	—	—	—	—	30,000
8. Jervis Inlet	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	21,700
	Total	—	—	—	—	—	—	—	—	—	—	—	—	—	—	61,700
	Skwawka River	3,145	4,618	7,763	851	1,476	2,327	27,294	43,128	70,422	100,879	134,948	235,827	—	2,225	40,000
9. Howe Sound	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	7,100
	Total	3,145	4,618	7,763	851	1,476	2,327	27,294	43,128	70,422	100,879	134,948	235,827	—	2,225	47,100
	Squamish River	225	299	524	32	32	64	—	—	—	—	—	—	—	—	235,000
10. Burrard Inlet	Cheakamus River	2,346	2,063	4,409	317	318	635	20,503	31,533	52,036	151,743	204,555	356,298	—	—	350,000
	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	46,000
	Total	2,571	2,362	4,933	349	350	699	20,503	31,533	52,036	151,743	204,555	356,298	—	—	100
TOTAL CANADIAN STUDY AREA	Indian River	876	1,005	1,881	225	317	542	8,409	9,479	17,888	32,736	30,048	62,784	55,500 ^r	20,500 ^h	396,100
	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	76,000
	Total	876	1,005	1,881	225	317	542	8,409	9,479	17,888	32,736	30,048	62,784	55,500	20,500	76,600
TOTAL CANADIAN STUDY AREA		11,623	13,785	25,408	2,770	3,607	6,377	80,845	111,233	192,078	571,343	729,726	1,301,069	225,345	309,960	1,244,000

1. Early Fraser	Main Fraser Thompson River Seton Creek Chehalis River Other	CONVENTION AREA										616,881 ^a	389,518 ^a	227,413 ^a	6,711 ^a	5,083 ^a	13,730	542,000 ^b
		—	—	—	—	—	—	—	—	—	—							
		357	844	47	—	52	99	3,311	11,678	10,086	8,037	69,411	44,261	25,150	—	—	—	69,000
		330	584	169	146	13	315	11,477	4,726	28,496	28,496	52,019	29,608	22,411	—	—	—	58,000
		85	119	19	—	—	32	1,309	2,319	3,628	3,628	11,921	6,065	5,856	—	—	—	11,000
		—	—	—	—	—	—	3,565	4,752	8,317	8,317	—	—	—	—	—	13,730	19,000
	Total	772	1,547	285	211	446	446	24,070	40,494	64,564	64,564	750,282	469,452	280,830	—	—	11,799 ^c	689,000
	Harrison River	2,462	4,998	855	857	1,712	1,712	24,869	40,051	64,920	64,920	190,128	118,517	71,611	—	—	—	190,000
	Vedder River	1,210	2,337	332	273	—	—	22,501	29,976	52,477	52,477	194,772	112,765	82,007	—	—	4,922	194,000
	Other	—	—	—	—	—	—	743	1,238	1,981	1,981	—	—	—	—	—	—	5,000
	Total	3,672	7,235	1,187	1,130	2,317	2,317	48,113	71,265	119,378	119,378	384,900	231,282	153,618	—	—	4,922	389,000
	Total (Glen Valley Tagging)	2,655	5,201	509	508	1,017	1,017	75,572	115,081	190,653 ^c	190,653 ^c	1,135,182 ^d	700,734 ^d	434,448 ^d	—	—	11,799 ^c	1,088,000
	Total CONVENTION AREA	7,099	13,983	1,931	1,849	3,780	3,780	75,572	115,081	190,653 ^c	190,653 ^c	1,135,182	700,734	434,448	—	—	11,799 ^c	1,088,000
2. Late Fraser	Nooksack River Other	UNITED STATES STUDY AREA										112,833	62,820	50,013	—	—	900	100,000
		157	171	27	38	65	65	8,601	13,960	22,561	22,561							
		157	328	27	38	65	65	8,601	13,960	22,561	22,561	112,833	62,820	50,013	—	—	900	100,900
	Skagit River	1,247	1,645	121	153	274	274	20,155	20,654	40,809	40,809	429,777	222,064	207,713	—	—	—	400,000
	Stillaguamish River	694	835	108	137	245	245	8,812	12,527	21,339	21,339	132,976	76,351	56,625	—	—	—	125,000
	Snohomish River	742	1,554	180	134	314	314	4,805	5,752	10,557	10,557	54,662	34,855	19,807	—	—	—	50,400
	Total	2,683	5,975	409	424	833	833	33,772	38,933	72,705	72,705	617,415	333,270	284,145	—	—	—	575,000
	Puwallup River	121	149	21	28	49	49	587	1,662	2,249	2,249	12,226	8,844	3,382	—	—	3,100	10,000
	Other	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	3,100
	Total	121	270	21	28	49	49	587	1,662	2,249	2,249	12,226	8,844	3,382	—	—	3,100	13,100
	Dosewallips River	216	380	59	52	111	111	3,020	4,390	7,410	7,410	24,901	13,845	11,056	—	—	18,500	22,000
	Other	—	—	—	—	—	—	1,619	2,745	4,364	4,364	—	—	—	—	—	—	18,500
	Total	216	380	59	52	111	111	4,639	7,135	11,774	11,774	24,901	13,845	11,056	—	—	18,500	40,500
	Dungeness River	820	899	324	320	644	644	11,605	15,461	27,066	27,066	72,807	43,436	29,371	—	—	8,500	70,000
	Other	—	—	—	—	—	—	655	1,422	2,077	2,077	—	—	—	—	—	—	8,500
	Total	820	899	324	320	644	644	12,260	16,883	29,143	29,143	72,807	43,436	29,371	—	—	8,500	78,500
	Total UNITED STATES STUDY AREA	3,997	4,675	840	862	1,702	1,702	59,859	78,573	138,432	138,432	840,182	462,215	377,967	—	—	31,000	808,000
	TOTAL ALL AREAS	22,719	25,344	5,541	6,318	11,859	11,859	216,276	304,887	521,163	521,163	3,276,433	1,892,675	1,383,758	237,144	—	359,612	3,140,000

^a Estimated from Glen Valley tags applied minus tags available in all tributary populations (TABLE 6).

^b Assuming 5 per cent tag loss.

^c Includes 6,711 carcasses examined in Seton Creek spawning channel.

^d Because of different recovery rates between tributaries, these totals cannot be calculated directly from the Glen Valley data.

^e Includes 5,500 pinks estimated to have been present below the weir when it was "washed out" by high water on October 8.

^f Actual weir count (56,692 pinks) adjusted to 55,500 to account for fish carried downstream over the weir during four periods of high water (adjustment based on the proportion of tags applied at the weir which were subsequently counted through the weir). The total count (73,827) includes 16,000 pinks estimated to have spawned below the weir and 4,327 removed at the weir in an egg-taking operation.

^g Complete counts in artificial spawning channels.

^h Spawned below weir.

spawners in the tributary streams (estimated from independent tagging and recovery programs) were deducted to give a population estimate for the Main Fraser. In 1961 the number of Glen Valley tags available for recovery in each of the tributary streams was estimated (TABLE 5). These tags, plus the Glen Valley tags recovered in the commercial fishery and an allowance for tag loss of five per cent of the tags applied, were then deducted from the total number of Glen Valley tags applied to provide an estimate of the Glen Valley tags available for recovery from the Main Fraser spawning population (TABLE 6). The Main Fraser population was then estimated following the standard procedures for tagging and recovery estimates employed for other streams (TABLE 6).

In the United States Study Area, procedures were essentially the same as those employed in 1959, except that a greater proportion of the effort was concentrated on the five major spawning populations (Nooksack, Skagit, Stillaguamish, Snohomish and Dungeness Rivers).

TABLE 5. Estimation of the numbers of Glen Valley tags (male and female) which would have been recovered in tributary spawning areas if all spawners had been examined.

Spawning Population	Glen Valley Tags Recovered (A)	No. Dead Examined (B)	Population Estimate (C)	Estimated No. of Glen Valley Tags Present (AC/B)
MALES				
Thompson	13	3,311	25,150	99
Seton	88	14,866	25,800	153
Chehalis	8	1,309	5,856	36
Misc. Early	20	3,565	7,692	43
Harrison	183	24,869	71,611	527
Vedder	173	22,501	82,007	631
Misc. Late	2	743	1,851	5
TOTAL, MALES	487	71,164	216,721	1,494
FEMALES				
Thompson	10	4,726	44,261	94
Seton	71	20,341	32,930	115
Chehalis	15	2,319	6,065	39
Misc. Early	14	4,752	11,126	33
Harrison	190	40,051	118,517	562
Vedder	174	29,976	112,765	655
Misc. Late	3 ^a	1,238	3,071	7
TOTAL, FEMALES	477	103,403	327,990	1,505

^a No actual recoveries; estimated from male recoveries.

TABLE 6. Estimation of the numbers of Glen Valley tags (male and female) available for recovery in the Main Fraser population, and calculation of population estimate.

	MALES	FEMALES	TOTAL
No. of Glen Valley Tags Applied (a)	2,655	2,546	5,201
No. of Glen Valley Tags in Tributary Spawning Populations ^a (b)	1,494	1,505	2,999
No. of Glen Valley Tags Recovered in Commercial Fishery (c)	26	7	33
Estimated Tag Loss (5% of tags applied) (d)	133	127	260
Total Deductions (e)=(b+c+d)	1,653	1,639	3,292
Estimated No. Glen Valley Tags Available in Main Fraser (f)=(a-e)	1,002	907	1,909
No. of Carcasses Examined on Main Fraser (g)	4,408	11,678	16,086
No. of Glen Valley Tags Recovered on Main Fraser (h)	22	31	53
Population Estimate (gf/h)	200,764	341,676	542,440
Population Estimate Unadjusted for Tag Loss g(a-b-c)/h (i)	227,413	389,518	616,931

^a from TABLE 5.

RELIABILITY OF ESTIMATES OF SPAWNING POPULATIONS

In 1959, stream tagging and recovery programs only very generally approximated the uniform sampling procedures which are assumed when populations are estimated by this method. "Comparisons of the fish per tag ratios in sub-samples within populations showed considerable variations both by time (week of recovery) and by space (section of stream) on all major spawning streams indicating that the tags applied were not uniformly distributed in the population. Further, comparisons of sub-samples by week of tagging showed similar variations, indicating that the sample examined for tags was not representative of the population as a whole" (Vernon, Hourston and Holland, 1964, page 14). Moreover, estimates of some major populations were based on relatively few tag recoveries (e.g., 200,000 fish in the Skagit River from 53 tag recoveries). In order to approximate the pre-requisites for this type of experiment more closely, attempts were made in 1961 to tag and examine a larger portion of these populations and to distribute the effort more evenly throughout the individual populations.

The number of tags applied on 17 streams in 1961 was almost as great as for 31 streams in 1959 (TABLE 7). The number of tags recovered, the number of fish examined and the number counted through weirs was considerably greater in 1961 than in 1959 (TABLE 7). More tags were applied in 1961 than in 1959 on most of the 15 individual streams (including the Glen Valley tagging of the whole Fraser escapement) on which tagging was conducted in both years; only on the Indian River (where the tagging program was merely an adjunct to a weir count in 1961), on the Main Fraser (where the population was much smaller than in 1959) and on three of the smaller United States streams (Nooksack, Puyallup and Dosewallips) was tagging less intensive in 1961 than in 1959 (TABLE 8). The

number of fish examined for tags was also higher in 1961 than in 1959 on 11 of these 15 streams (TABLE 8); on the remaining four streams (Skwawka, Indian, Main Fraser and Puyallup) the proportion of the run examined was comparable to that in 1959.

TABLE 7. Stream tagging and recovery effort in 1961 and 1959. (Summarized from TABLE 4 and Vernon, Hourston and Holland, 1964, TABLE 4.)

	1961	1959
Number of streams where tagging was conducted	17	31
Number of tags applied	48,063	52,056
Number of tags recovered	11,859	8,863
Number of fish examined for tags ^a	512,473	355,914
Number of fish counted through weirs	225,345	41,073
Number of spawners in populations estimated by tagging	2,667,000	2,476,000

^a Excludes pinks examined for tags in streams on which enumeration tagging programs were not carried out (8,690 in 1961 and 4,221 in 1959).

A better balance in tagging and recovery effort between streams was obtained in 1961 than in 1959. On Canadian streams, except for the Cheakamus River, Main Fraser, Thompson, and Seton populations, all of which had some rather special characteristics in their field operations⁹, between 26 and 34 per cent of the tags applied were recovered as compared with between 12 and 33 per cent in 1959 (TABLE 8). Similarly on United States streams, between 16 and 20 per cent of the tags applied were recovered on four of the seven streams in 1961 (as opposed to between 8 and 30 per cent for the same streams in 1959—TABLE 8). Moreover, in the large Skagit River population the proportion of tags recovered (10 per cent) was much closer to that for the other populations than in 1959 (5 per cent).

In addition, the distribution of recoveries by week of recovery, section of stream and week of tagging (APPENDIX C) was more uniform in most of the large spawning populations in 1961 than it was in 1959 (Vernon, Hourston and Holland, 1964, APPENDIX D). Most of the 1961 spawning populations in the Glendale and Indian Rivers were counted through weirs. Although the population estimates for both these streams include visual estimates of the numbers of fish not counted through the weir, and the estimate for the Indian River includes an adjustment for fish carried downstream over the weir during four periods of high water (and thus counted more than once), these estimates are considered more precise than those obtained by stream tagging and recovery.

⁹ The Cheakamus River spawners were seven times more abundant in 1961 than in 1959. The Main Fraser population was large and more inaccessible for tag recovery than most other populations. The field program on the Thompson River was new in 1961 and tag recovery more difficult than on smaller streams. The Seton Creek population spawns in an area which is very accessible for tag recovery.

TABLE 8. Stream tags applied and recovered, per cent recovered and number of fish examined on streams enumerated by stream tagging and recovery programs in 1961. Comparable data for 1959 are given in parentheses.

STREAM	TAGS APPLIED	TAGS RECOVERED	% TAGS RECOVERED	NO. OF FISH EXAMINED
CANADIAN STUDY AREA				
Glendale ^a	10,831 (6,042)	2,809 (1,190)	25.9 (19.7)	51,732 (34,679)
Skwawka	7,763 (4,213)	2,327 (1,374)	30.0 (32.6)	70,422 (86,186)
Cheakamus	4,933 (3,641)	699 (835)	14.2 (22.9)	52,036 (18,414)
Indian ^a	1,881 (5,148)	542 (965)	28.8 (18.7)	17,888 (33,280)
TOTAL CANADIAN STUDY AREA	25,408 (19,044)	6,377 (4,364)	25.1 (22.9)	192,078 (172,559)
CONVENTION STUDY AREA				
Main Fraser	1,909 ^b (6,491) ^c	53 (215)	2.8 (3.3)	16,086 (25,516)
Thompson	844 (—)	99 (—)	11.7 (—)	8,037 (6,996)
Seton	584 (486)	315 (248)	53.9 (51.0)	28,496 (7,678)
Chehalis	119 (—)	32 (—)	26.9 (—)	3,628 (1,734)
Harrison	4,998 (4,473)	1,712 (1,031)	34.3 (23.0)	64,920 (25,635)
Vedder	2,237 (1,494)	605 (178)	27.0 (11.9)	52,477 (11,072)
TOTAL CONVENTION AREA	10,691 (12,944)	2,816 (1,672)	26.3 (12.9)	173,644 (78,631)
UNITED STATES STUDY AREA				
Nooksack	328 (351)	65 (38)	19.8 (10.8)	22,561 (4,166)
Skagit	2,892 (982)	274 (53)	9.5 (5.4)	40,809 (11,879)
Stillaguamish	1,529 (1,459)	245 (137)	16.0 (9.4)	21,339 (12,176)
Snohomish	1,554 (846)	314 (68)	20.2 (8.0)	10,557 (7,535)
Puyallup	270 (747)	49 (223)	18.1 (29.9)	2,249 (4,435)
Dosewallips	380 (951)	111 (323)	29.2 (34.0)	7,410 (6,869)
Dungeness	1,719 (808)	644 (151)	37.5 (18.7)	27,066 (7,859)
TOTAL UNITED STATES STUDY AREA	8,672 (6,144)	1,702 (993)	19.6 (16.2)	131,991 (54,919)
TOTAL ALL AREAS	44,771 (38,132)	10,895 (7,029)	24.3 (18.4)	497,713 (306,109)

^a Tagging conducted at fence in 1961 and from beach seine in 1959. Population estimate for 1961 taken from fence count plus estimate of spawners below fence.

^b Estimate of tags available for recovery on Main Fraser—TABLE 6.

^c From percentage tagged in dead recovery times population estimate, with tag recoveries adjusted for 5 per cent loss.

Thus estimates of the abundance of spawners on practically all of these 17 streams are probably somewhat more reliable for 1961 than for 1959. As for the 1959 run, these estimates must be considered high to some degree as a result of tag loss. "Best" estimates were obtained by rounding off downwards to account in part for this source of error (TABLE 4). The Tsolum River population was estimated by weir counts in both years and the estimates for the two years are considered equally reliable.

Thirteen streams whose spawning populations were enumerated by stream tagging and recovery programs or by fence counts in 1959 (accounting in that year for 212,200 spawners or eight per cent of all spawners in the Study Area) were enumerated by visual surveys in 1961. Estimates of the 1961 spawning populations in these streams must therefore be considered less precise for 1961 than for 1959. Estimates for the remaining 92 streams enumerated by visual surveys in 1961 would be of comparable accuracy to similar estimates in 1959. All estimates based on visual surveys (which accounted for 15 per cent of the spawners in 1961) are considered low since on virtually all streams some fish would have escaped detection during these surveys.

On the whole, estimates of pink salmon spawning populations in the Study Area in 1961 may be considered more accurate than those for 1959 since estimates for the 17 populations obtained from stream tagging and recovery programs or weir counts, which accounted for 85 per cent of the spawners in the Study Area, were more reliable than those obtained in 1959.

ABUNDANCE OF SPAWNERS BY STOCK

Populations of pink salmon whose spawning grounds were in close geographic proximity, and which appeared to have been closely associated throughout most of their inshore migration, were grouped into spawning stocks as in 1959 (FIGURE 5). The estimated abundance of each of these 17 spawning stocks is given in TABLE 9, along with similar estimates for 1959. With a few exceptions, the relative abundance of the spawning stocks was similar in the two years. The Knight Inlet, Howe Sound, Late Fraser, Bellingham Bay and Skagit Bay-Port Susan stocks had appreciably more spawners in 1961 than in 1959 while the Upper Vancouver Island, Burrard Inlet and Early Fraser stock contained appreciably less spawners in 1961. The abundance of spawners in 1961 was one and one-half times that in 1959 in the United States Study Area, one and one-quarter times that in 1959 in the Canadian Study Area and virtually unchanged in the Convention area. In the combined Study Area there were about one-fifth more spawners in 1961 than in 1959.

Times of Passage Through the Major Fishing Areas

Information on the times of passage of the three stock groups through the major fishing areas in 1961 is somewhat limited. In a small tagging program on the Southern Approach early in the 1961 season, 2,342 recoveries were made from 3,497 tags applied in the Juan de Fuca Strait fishing areas between the weeks ending July 30 and August 20 (Vernon, Hourston and Holland, 1964 - APPENDIX S). These recoveries indicated that Canada Non-Fraser fish made up over half the total numbers present in the weeks ending July 30 and August 6 and somewhat less than half in the week ending August 13, while United States and Fraser River

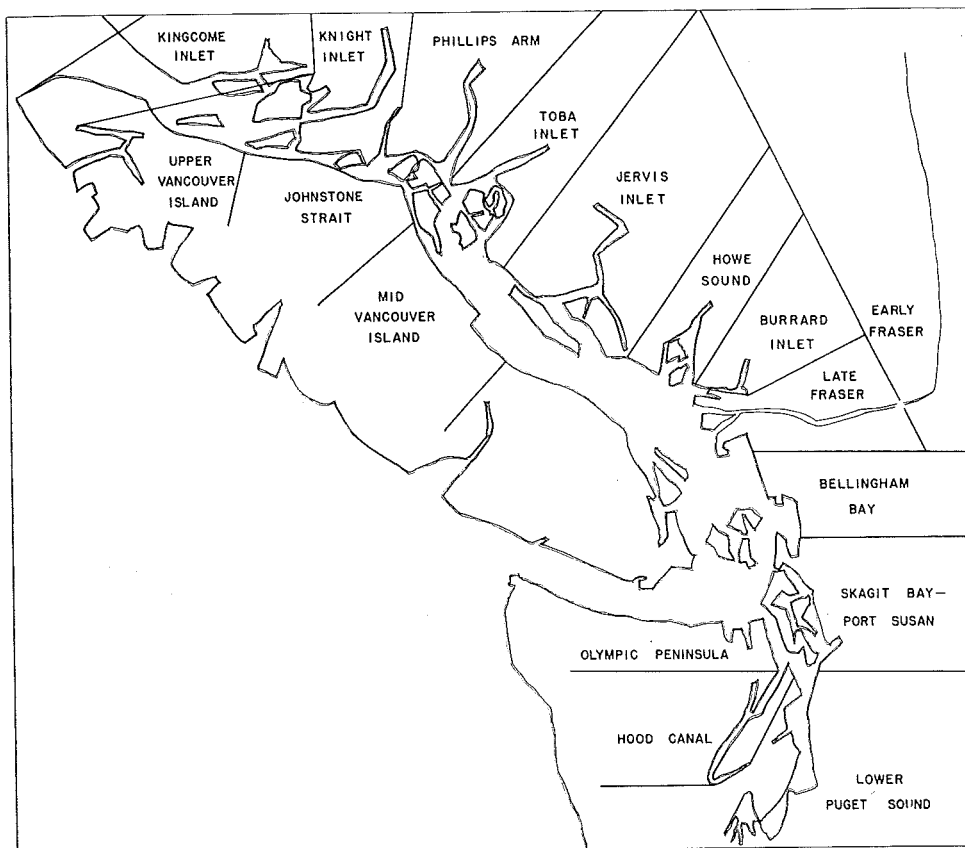


FIGURE 5. Spawning areas occupied by stocks of pink salmon in 1961.

fish increased markedly in abundance in the week ending August 20. On the basis of these data, the timing of the runs in Juan de Fuca Strait in 1961 was similar to that in 1959.

Further support for the similarity in timing between the 1961 and 1959 runs is given by the reflection of changes in relative abundance of the three stock groups in the weekly catches by fisheries on mixed stocks. As indicated above, the Fraser River stocks were relatively much less abundant in 1961 than in 1959, while the other two stocks were probably somewhat more abundant. Catches up to mid-August, when Canada Non-Fraser fish were considered to be most abundant, were higher in both Johnstone and Juan de Fuca Straits in 1961 than in 1959, even when probable catches during the strike weeks in 1959 and differences in the fishing time allowed in the two years are taken into account (FIGURES 3 and 4). On the same basis, catches from the last week in August to the end of the season, when the run was considered to be made up mainly of Fraser River fish, were much lower in 1961 than in 1959. In summary, all available evidence indicates that the timing of the Canada Non-Fraser, Fraser River and United States runs in 1961 was similar to that in 1959 (FIGURES 6 and 7).

TABLE 9. Pink salmon stocks spawning in the Study Area in 1961 and 1959.

STOCK	NUMBER OF SPAWNERS	
	1961	1959
CANADIAN STUDY AREA		
1. Upper Vancouver Island	24,300	34,600
2. Johnstone Strait	67,500	63,100
3. Mid Vancouver Island	21,900	23,200
4. Kingcome Inlet	41,800	43,500
5. Knight Inlet	247,900	196,000
6. Phillips Arm	61,700	77,200
7. Toba Inlet	47,100	47,100
8. Jervis Inlet	259,100	257,300
9. Howe Sound	396,100	100,100
10. Burrard Inlet	76,600	182,600
	1,244,000	1,024,700
CONVENTION AREA		
11. Early Fraser	699,000	873,000
12. Late Fraser	389,000	204,000
	1,088,000	1,077,000
UNITED STATES STUDY AREA		
13. Bellingham Bay	100,900	30,700
14. Skagit Bay-Port Susan	575,000	410,000
15. Lower Puget Sound	13,100	16,000
16. Hood Canal	40,500	33,000
17. Olympic Peninsula	78,500	51,000
	808,000	540,700
GRAND TOTAL	3,140,000	2,642,400

Abundance of the Northern and Southern Approach Runs to Canada Non-Fraser, Fraser River and United States Streams

Of the 6,414,000 pinks entering the Study Area in 1961 (TABLES 1 and 9) 3,140,000 reached the spawning grounds and 921,000 were taken in local fisheries (TABLE 10). Thus 63 per cent of the total run could be assigned to stock groups without further analysis. The remaining 37 per cent of the total run was taken in the more seaward areas where stocks were mixed. Thus, to determine the total abundance of each of the three stock groups, their contributions to the catches in these seaward fishing areas must be determined.

It could be assumed, on the basis of the detailed description of the 1959 run, that the 1,935,000 pinks captured or spawning north of the Strait of Georgia would have migrated via the Northern Approach (through Queen Charlotte

Strait). Similarly all but a few of the 2,155,000 pinks spawning or captured south of the Fraser River would have migrated via the Southern Approach (through Juan de Fuca Strait). Thus the direction of approach of 4,090,000 (64 per cent) of the 6,414,000 pinks entering the Study Area in 1961 is known without further analysis. The remaining 36 per cent of the run reached the Strait of Georgia area where Northern and Southern Approach fish would have been mixed in all fishing areas and spawning grounds. The numbers of pinks from each approach in the Strait of Georgia area may be determined from the ratio of the estimated escape-ments to this area from Johnstone Strait and from Juan de Fuca Strait.

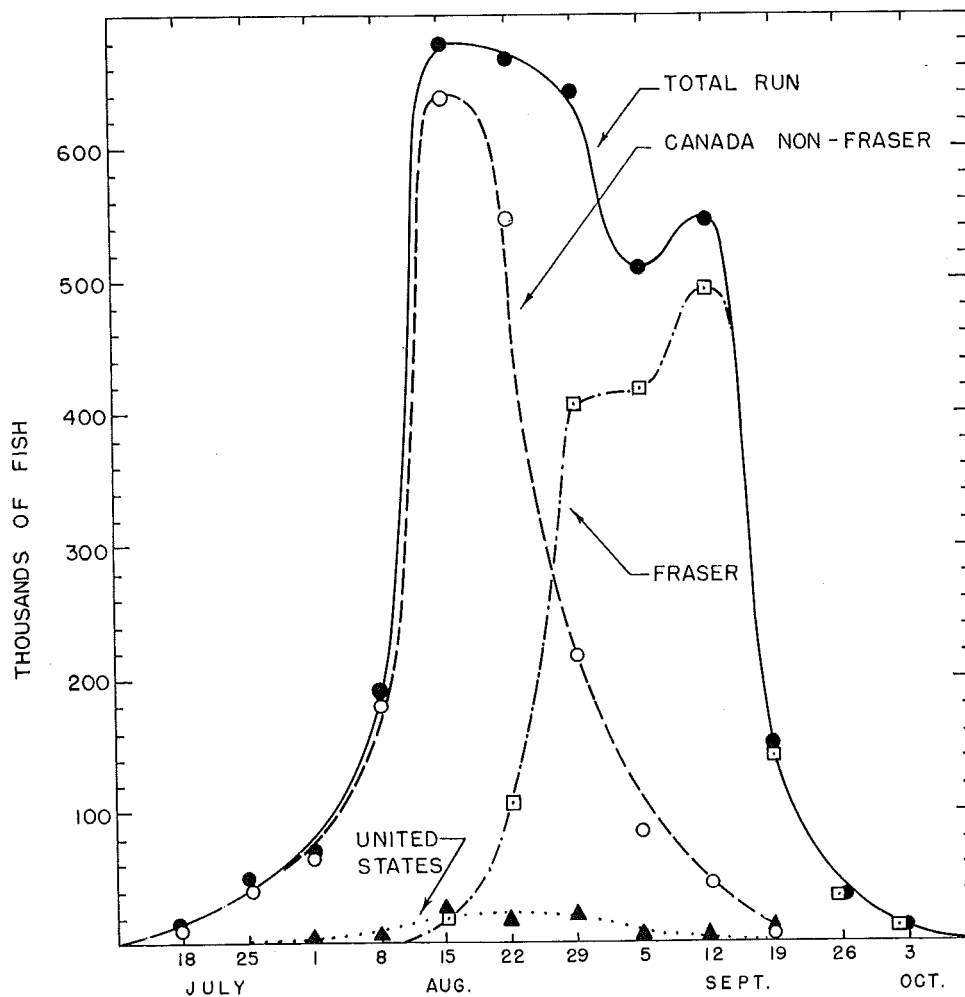


FIGURE 6. Times of passage of Northern Approach pink salmon runs to Canada Non-Fraser, Fraser and United States streams in 1959 as shown by their weekly abundance in the Johnstone Strait fishing areas.

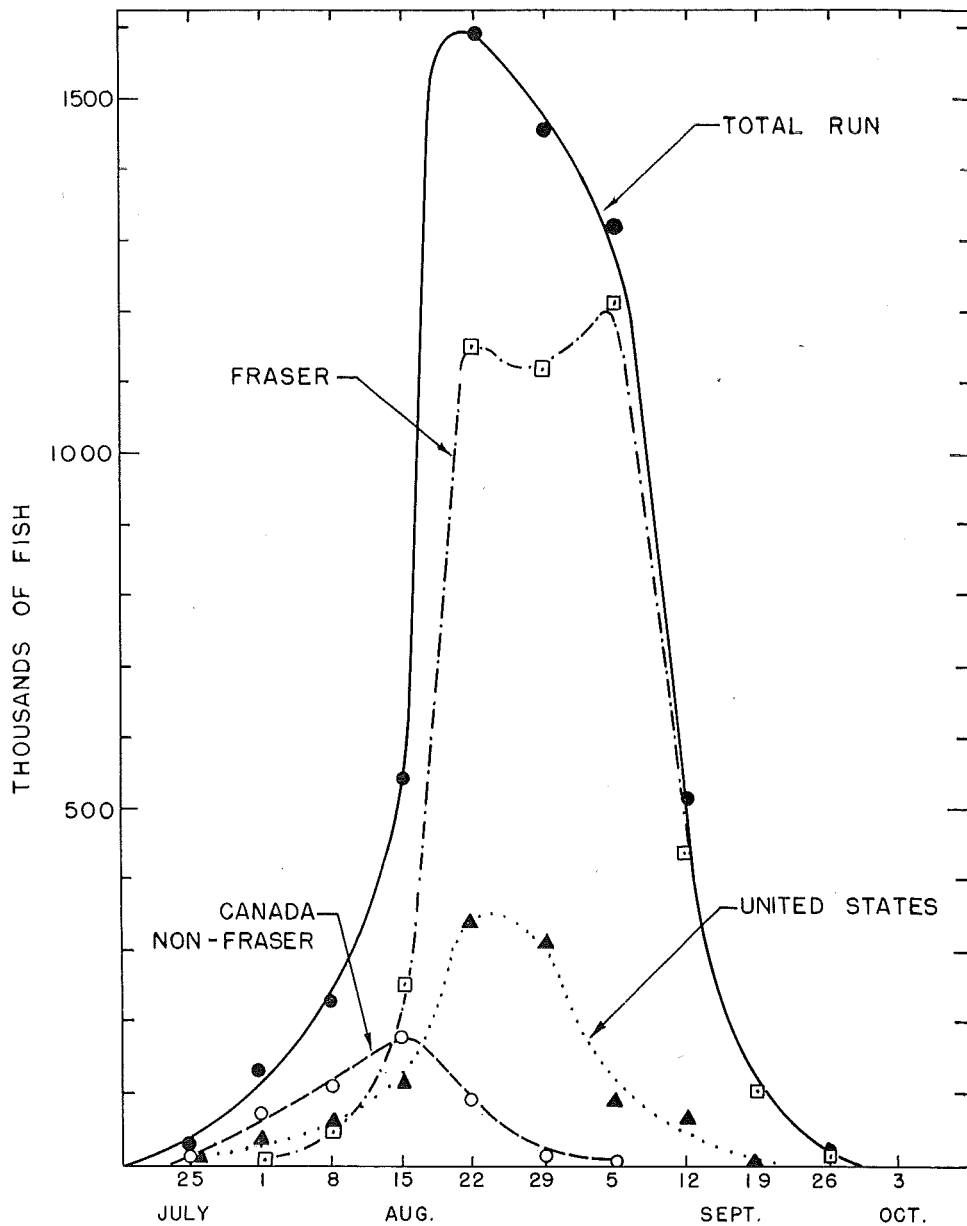


FIGURE 7. Times of passage of Southern Approach pink salmon runs to Canada Non-Fraser, Fraser and United States streams in 1959 as shown by their weekly abundance in the Juan de Fuca Strait fishing areas.

TABLE 10. Local catches in the major terminal areas in 1961.

TERMINAL AREA	FISHERY	CATCH	
Kingcome Inlet	Kingcome Inlet		18,693
Queen Charlotte Strait	Knight Inlet		306,273
Strait of Georgia	Phillips Arm	12,851	
	Toba Inlet	1,524	
	Jervis Inlet	96,046	
	Howe Sound	13,396	
	Burrard Inlet	6,825	
	Comox ^a	1,446	
	Cortes Island ^a	333	
	Texada Island ^b	8,259	
	TOTAL		140,680
Fraser	Fraser River Commercial	91,814	
	Fraser River Indian	29,000	
	Fraser Gulf ^c	24,887	
	TOTAL		145,701
United States	Nooksack River	52,574	
	Skagit Bay and River	145,547	
	Port Susan-Port Gardner	63,786	
	Admiralty Inlet-Puget Sound	26,810	
	Puyallup River	21,228	
	TOTAL		309,945
ALL AREAS			921,292

^a Although the run in these areas contained mixed stocks, the catch was considered, as in 1959, to have been made from Strait of Georgia stocks.

^b Total Texada Island catch (9,317) minus 1,058 fish taken after September 2 which were considered, on the basis of the timing of the 1959 run, to be Fraser fish.

^c Total Fraser Gulf catch (43,632) minus estimated catch of Canada Non-Fraser fish (18,555) and United states fish (190).

CATCHES BY STOCK GROUP AND PRELIMINARY ESTIMATES OF ABUNDANCE OF THE RUN ENTERING VIA THE NORTHERN APPROACH

The only major fishery on mixed stocks along the Northern Approach takes place in Johnstone Strait (the combined Malcolm Island, Upper and Lower Johnstone Strait fishing area - FIGURE 2). As indicated previously, it is likely that the time of passage of each of the three stock groups in 1961 was similar to that in 1959. Thus, if differences between the two years in the dates of weekly fishing periods and differences in the number of days fished were taken into account, the rates of removal for the various stock groups in 1959 could be applied to the 1961 catch data to provide estimates of the abundance of these stock groups in 1961. In practice the procedure followed was to estimate the catches of a fishery similar to that

in 1961 (hereafter referred to as a "1961-type" fishery) for appropriate periods in 1959 when total abundance was known, and to assume that the rates of removal so calculated would have prevailed in 1961 (APPENDIX D). This assumption is not unreasonable since the fishing grounds in Johnstone Strait form a very limited geographical area and enough gear was present in both years to fully utilize all the more productive fishing sites. Moreover, there were no significant modifications in gear or methods of fishing between 1959 and 1961 which might affect the efficiency of the fleet in catching fish.

Method of Estimating Rates of Removal in 1961

Catch statistics for the 1959 fishery in Johnstone Strait are available by day¹⁰. Consequently, the catch in any week for any number of days fishing not exceeding the number of days fished in 1959 is known. (In no weeks were there more days fishing in 1961 than during a comparable period in 1959.)

In 1961 the weeks ended approximately one-half week (3 days) earlier than in 1959 (or 4 days later). Thus the catch in 1959 (C_n) for a "1961 week" n may be estimated by:

$$C_n = \frac{c_{n-\frac{1}{2}} + c_{n+\frac{1}{2}}}{2}$$

where $c_{n-\frac{1}{2}}$ = 1959 catch for the week ending 3 days prior to 1961 week n ;

$c_{n+\frac{1}{2}}$ = 1959 catch for the week ending 4 days after 1961 week n ;

and the number of days fished is the same in weeks n , $n - \frac{1}{2}$ and $n + \frac{1}{2}$.

The rate of removal (R) by a "1961-type" fishery in 1959 is then given by:

$$R = \frac{C_1 + C_2 + \dots + C_n}{S}$$

where S = total number of fish entering the fishing area throughout the season (i.e., abundance in 1959) and C_1, C_2, \dots, C_n = catches in "1961 weeks" 1, 2 n .

Method of Estimating Abundance in Johnstone Strait

To estimate abundance (P) in 1961 using these rates of removal (R), the escapement (E) or catch (C) must be known for each stock group.

$$\text{Thus,} \quad P = \frac{E}{1-R} \quad (1)$$

$$\text{or} \quad P = \frac{C}{R} \quad (2)$$

In 1959, the Kingcome Inlet, Knight Inlet, Upper Vancouver Island and Johnstone Strait stocks were composed entirely of Northern Approach fish and are assumed to have been similarly constituted in 1961. Assuming similar migration routes to those in 1959, the Kingcome Inlet stock would not have entered the Johnstone Strait fishing area in 1961. On the other hand, some fish from the Queen

¹⁰ On file at the Nanaimo Biological Station of the Fisheries Research Board of Canada.

Charlotte Strait stocks (Knight Inlet and Upper Vancouver Island) would have entered the Johnstone Strait fishery. However, the rate of removal by the Johnstone Strait fishery for these stocks was much lower than that for the stocks migrating further to the south, since all of these latter fish had to pass through the Johnstone Strait fishing area. Since Queen Charlotte Strait fish were much more abundant in 1961 than in 1959 (TABLE 11), it was necessary to estimate the abundance of these stocks separately so that their lower rate of removal would not bias the estimates of abundance of other stocks. Since the terminal population of Northern Approach fish in the Queen Charlotte Strait area (spawners plus local catch - TABLES 9 and 10) has been determined (TABLE 11), their abundance (and hence catch) in Johnstone Strait could be calculated from Equation 1.

TABLE 11. Numbers of spawners, local catches (including catches in Strait of Georgia fisheries and sport catches) and escapements to local fisheries for major groups of stocks in 1961. Comparable data for 1959 are given below in parentheses.

STOCKS	NUMBERS OF SPAWNERS	LOCAL CATCHES ^b	TERMINAL POPULATION ^c
Kingcome Inlet ^a	41,800 (43,500)	18,693 (5,261)	60,493 (48,761)
Queen Charlotte Strait ^a	272,200 (230,600)	306,273 (119,984)	578,473 (350,584)
Strait of Georgia	930,000 (750,600)	140,680 (172,665)	1,070,680 (923,265)
TOTAL CANADIAN NON-FRASER	1,244,000 (1,024,700)	465,646 (297,910)	1,709,646 (1,322,610)
FRASER	1,088,000 (1,077,000)	145,701 (540,645)	1,233,701 (1,617,645)
UNITED STATES	808,000 (540,700)	309,945 (208,180)	1,117,945 (748,880)
GRAND TOTAL	3,140,000 (2,642,400)	921,292 (1,046,735)	4,061,292 (3,689,135)

^a Includes fish which did not enter the Johnstone Strait fishery.

^b From TABLE 10.

^c Spawners plus local catches.

TABLE 12. Escapement from Johnstone Strait of pink salmon destined for United States streams in 1961 (as estimated in APPENDIX E).

Catch in Fraser Gulf	190
Catch at Point Roberts	983
Catch at San Juan Islands	2,114
Catch at West Beach	1,101
Catch in Canadian Juan de Fuca	5,966
Catch in local Bellingham Bay and Puget Sound fisheries	8,169
Spawners in United States streams	21,008
TOTAL	39,531

The remainder of the Northern Approach run was made up of fish all of which passed through the Johnstone Strait fishing area. The escapement of United States fish from the Northern Approach was estimated for 1961 (TABLE 12 and APPENDIX E) and the abundance of this stock group in Johnstone Strait calculated from Equation 1. The remaining pinks were those destined for streams in the Strait of Georgia vicinity (the southern half of the Canadian Study Area - FIGURE 1) and the Fraser River system (Convention area). The terminal populations of Strait of Georgia¹¹ and Fraser River fish however, contain both Northern and Southern Approach fish and the abundance of these two stock groups in Johnstone Strait must be estimated from catch data. In 1959, Strait of Georgia pinks accounted for 98.1 per cent of the combined abundance of Strait of Georgia and Fraser River pinks which passed through Johnstone Strait by August 15 and 90.9 per cent of the fish from both stock groups which passed through Johnstone Strait by August 22 (TABLE 13). Thus the catch in Johnstone Strait contributed by these two groups from the beginning of the 1961 season to the week ending August 19 would have consisted almost entirely of Strait of Georgia fish. Moreover, 62.1 per cent and 83.7 per cent of the Strait of Georgia pinks had passed through Johnstone Strait by August 15 and August 22 respectively in 1959; consequently, in 1961, most of the Strait of Georgia fish would be expected to have passed through Johnstone Strait by the week ending August 19. Thus an estimate of the rate of removal of Strait of Georgia and Fraser River pinks to August 19 by a "1961 type" fishery in Johnstone Strait operating in 1959 would represent an approximation of the rate of removal of Strait of Georgia pinks in Johnstone Strait in 1961. The abundance of Strait of Georgia pinks passing through Johnstone Strait in 1961 may then be estimated by dividing the catch of Strait of Georgia and Fraser River pinks to August 19 by this estimated rate of removal (Equation 2).

Similarly, Fraser River fish made up 86.6 per cent of the combined run of Strait of Georgia and Fraser River fish from the week ending August 29 to the end of the season and 74.7 per cent of the combined run from the week ending August 22 to the end of the season (TABLE 13). Moreover, from the week ending August 29 to the end of the season, 92.6 per cent of the Northern Approach Fraser River pinks passed through Johnstone Strait; from the week ending August 22 to the end of the season the percentage was 98.9. Thus an estimate of the rate of removal of Fraser River and Strait of Georgia pinks in Johnstone Strait from the week ending August 26 to the end of the season by a "1961 type" fishery operating in 1959 would represent a reasonable approximation of the rate of removal of Fraser River pinks in Johnstone Strait in 1961. The abundance of Fraser River pinks passing through Johnstone Strait in 1961 may then be estimated by dividing the catch of Strait of Georgia and Fraser River pinks from the week ending August 26 to the end of the season by this estimated rate of removal (Equation 2).

Calculation of Abundance (Catch Plus Escapement) in Johnstone Strait

Steps in the process of calculating the abundance of the major stock groups in Johnstone Strait in 1961 are shown in TABLE 14. The abundance of the Queen Charlotte Strait and United States stocks were estimated first (rows 1 and 2

¹¹ Johnstone Strait, mid Vancouver Island, Phillips Arm, Toba Inlet, Jervis Inlet, Howe Sound and Burrard Inlet stocks (TABLE 9). (Although no Southern Approach fish were included in the pinks destined for streams in the Johnstone Strait terminal area, these fish were included in the Strait of Georgia terminal population since their rate of removal, which is the basic parameter in this analysis, was similar to that for the various Strait of Georgia stocks in 1959.)

TABLE 13. Numbers and relative proportions (expressed as percentages) of Strait of Georgia and Fraser River pinks which passed through Johnstone Strait before and after August 15 and August 22 in 1959 (Data from Vernon, Hourston and Holland 1964, TABLE 74).

	TO AUG. 15	AFTER AUG. 15	TO AUG. 22	AFTER AUG. 22	SEASON TOTAL
		NUMBERS OF FISH			
Strait of Georgia	889,398	543,181	1,199,437	233,142	1,432,579
Fraser River	17,310	1,606,370	120,443	1,503,237	1,623,680
Total	906,708	2,149,551	1,319,880	1,736,379	3,056,259
		PERCENTAGE BY STOCK GROUP			
Strait of Georgia	98.1	25.3	90.9	13.4	—
Fraser River	1.9	74.7	9.1	86.6	—
Total	100.0	100.0	100.0	100.0	—
		PERCENTAGE BY PERIOD			
Strait of Georgia	62.1	37.9	83.7	16.3	100.0
Fraser River	1.1	98.9	7.4	92.6	100.0

TABLE 14. Estimation of abundance of Queen Charlotte Strait, Strait of Georgia, Fraser River and United States pinks in the Johnstone Strait area^a in 1961.

	1959			1961		
	(1) ABUNDANCE (ACTUAL)	(2) "1961 TYPE" CATCH	(3) RATE OF REMOVAL	(4) CATCH	(5) ABUNDANCE	(6) ESCAPEMENT
1) Queen Charlotte Strait	455,098 ^b	91,532	.201	145,523	723,996 ^b	578,473 ^b
2) United States	86,320	41,452	.480	36,490	76,021	39,531
3) Strait of Georgia	1,432,579	644,899	.450	671,269	1,491,709	820,440
4) Fraser River	1,623,680	884,268	.545	349,842	641,912	292,070
TOTAL	3,597,677 ^b	1,662,151	—	1,203,124	2,933,638 ^b	1,730,514 ^b

^a Malcolm Island and Upper and Lower Johnstone Strait fishing areas.

^b Includes some fish which did not enter the Johnstone Strait area but migrated directly from the Queen Charlotte Strait fishing area to their terminal area.

respectively). The numbers of fish from each of these two stock groups that entered the Johnstone Strait fishing area in 1959 (TABLE 15) were entered in Column 1. The catches from these stocks by a "1961 type" fishery operating in 1959 were estimated (TABLES 16 and 17) and entered in Column 2. The rate of removal (catch/abundance) was then calculated (Column 3). Estimates of the 1961 escapement from Johnstone Strait (TABLE 11 for Queen Charlotte Strait stocks and TABLE 12 for United States stocks) were entered in Column 6. Substituting these values in Equation 1, the abundance was calculated (Column 5). The catch (Column 4) was then given by abundance minus escapement.

TABLE 15. Abundance of pink salmon in the major groups of stocks in Queen Charlotte Strait in 1959 (escapement from the Queen Charlotte Strait troll fishery). (From Vernon, Hourston and Holland 1964, TABLE 64.)

STOCKS	NUMBERS OF FISH	
Kingcome Inlet	48,761	
Queen Charlotte Strait	455,098	
Strait of Georgia	1,432,579	
CANADIAN NON-FRASER		1,936,438
FRASER		1,623,680
UNITED STATES		86,320
GRAND TOTAL		3,646,438

The abundance of Strait of Georgia and of Fraser River fish was estimated using Equation 2. In estimating catch and rate of removal for this purpose, the catch of Strait of Georgia plus Fraser River pinks to August 19 was considered to approximate the catch of Strait of Georgia fish while the catch from these two stock groups after August 19 was considered to approximate that of Fraser River fish. In 1959, the catch of Strait of Georgia fish by a "1961 type" fishery (K_S) was given by:

$$K_S = K_T - K_{QCS} - K_{US}$$

where K_T = total catch to August 19

K_{QCS} = catch of Queen Charlotte Strait fish to August 19

K_{US} = catch of United States fish to August 19.

Similarly, the catch of Fraser River fish by a "1961 type" fishing (K_F) was given by the same equation using catches after August 19. Substituting the appropriate values (TABLES 16-18),

$$K_S = 704,091 - 41,683 - 17,509 = 644,899$$

$$\text{and } K_F = 958,060 - 49,849 - 23,943 = 884,268.$$

These values were entered in Column 2 of TABLE 14 (Rows 3 and 4 respectively) and the abundance estimates for 1959 for these two stock groups (TABLE 15) were entered in Column 1. Rates of removal were then calculated as above (Column 3).

TABLE 16. Estimation of catch in Johnstone Strait from Queen Charlotte Strait stocks in 1959 by a "1961 type" fishery (i.e., a fishery operating on the same calendar days as the 1961 fishery).

1961 WEEK n	DAYS FISHING IN 1961	1959 CATCH IN WEEKS ^a		CATCH IN 1959 BY "1961 TYPE" FISHERY	
		n — ½	n + ½		
July	1	—	—	—	
	8	—	—	—	
	15	—	236	118	
	22	236	829	533	
	29	4	829	1,789 ^b	1,309
August	5	1,415 ^b	6,134 ^b	3,775	
	12	3	6,134 ^b	7,036	6,585
	19	3-2	7,036	51,689	29,363
		Sub-total to Aug. 19		41,683	
	26	3	51,689	18,496	35,093
September	2	3	18,496	6,123	12,310
	9	2	4,652	239	2,446
	16	0	—	—	—
	23	4	—	—	—
		Sub-total after Aug. 19		49,849	
GRAND TOTAL				91,532	

^a For the same number of days fishing as in 1961.^b Strike week — estimate.

TABLE 17. Estimation of catch in Johnstone Strait from United States stocks in 1959 by a "1961 type" fishery (i.e., a fishery operating on the same calendar days as the 1961 fishery).

1961 WEEK n	DAYS FISHING IN 1961	1959 CATCH IN WEEKS ^a		CATCH IN 1959 BY "1961 TYPE" FISHERY	
		n — ½	n + ½		
July	1	—	—	—	
	8	—	—	—	
	15	—	—	—	
	22	—	—	—	
	29	4	—	579 ^b	290
August	5	3	465 ^b	1,338 ^b	902
	12	3	1,338 ^b	10,451	5,895
	19	3-2	10,015	10,828	10,422
Sub-total to Aug. 19				17,509	
	26	3	11,133	12,832	11,982
September	2	3	12,832	4,061	8,447
	9	2	3,297	2,366	2,832
	16	0	—	—	—
	23	4	1,363	—	682
Sub-total after Aug. 19				23,943	
GRAND TOTAL				41,452	

^a For the same number of days fishing as in 1961.^b Strike week — estimate.

TABLE 18. Estimates of weekly catches in Johnstone Strait in 1959 by a "1961 type" fishery (i.e., a fishery operating on the same calendar days as the 1961 fishery.

1961 WEEK n		DAYS FISHING IN 1961	1959 CATCH IN WEEKS ^a		CATCH IN 1959 BY "1961 TYPE" FISHERY
			n — ½	n + ½	
To June	10	4	1	0	1
	17	4	0	14	7
	24	4	14	627	321
July	1	4	627	845	736
	8	4	845	2,189	1,517
	15	4	2,189	6,479	4,334
	22	4	6,479	39,214	22,846
	29	4	39,214	75,047 ^b	57,131
August	5	3	62,000 ^b	153,034 ^b	107,517
	12	3	153,034 ^b	273,625	213,329
	19	3-2	263,941	328,764	296,352
Sub-total to Aug. 19					704,091
September	26	3	334,620	353,960	344,290
	2	3	353,960	299,540	326,750
	9	2	199,673	244,508	222,090
	16	0	—	—	—
	23	4	106,168	23,691	64,930
October	30	0	—	—	—
	7	0	—	—	—
	14	0	—	—	—
	21	0	—	—	—
Sub-total after Aug. 19					958,060
GRAND TOTAL					1,662,151

^a For the same number of days fishing as in 1961.

^b Strike week — estimate.

Next the estimated total catches of Queen Charlotte Strait and United States fish in 1961 (145,523 and 36,490 fish respectively) were divided between the periods to and after August 19 according to the proportions of the catch by a "1961 type" fishery in 1959 during these two periods (TABLES 16 and 17). Thus the 1961 catch to August 19 of Lower Queen Charlotte Strait fish (K_{LQC}) was given by:

$$K_{LQC} = \frac{41,683}{91,532} \times 145,523 = 66,270$$

and the catch after August 19 (K'_{LQC}) was given by:

$$K'_{LQC} = \frac{49,849}{91,532} \times 145,523 = 79,253.$$

Similarly, the 1961 catch to August 19 of United States fish (K_{US}) was given by:

$$K_{US} = \frac{17,509}{41,452} \times 36,490 = 15,413$$

and the catch after August 19 (K'_{US}) was given by:

$$K'_{US} = \frac{23,943}{41,452} \times 36,490 = 21,077.$$

The catch of Strait of Georgia and Fraser River fish to August 19 (K_{SF}) and after August 19 (K'_{SF}) was then given by the catch from all stocks for these two periods (752,952 and 450,172 respectively—TABLE 19) less their Queen Charlotte Strait and United States components. Thus

$$K_{SF} = 752,952 - 66,270 - 15,413 = 671,269$$

$$\text{and } K'_{SF} = 450,172 - 79,253 - 21,077 = 349,842.$$

The values K_{SF} and K'_{SF} represent the 1961 catch of Strait of Georgia and Fraser River fish respectively and were entered in Column 4 of TABLE 14. For each of the two stock groups, the rates of removal (Column 3) and the catch (Column 4) were substituted in Equation 2 to give an estimate of abundance (Column 5).

TABLE 19. Weekly catches of pink salmon in Johnstone Strait in 1961.

WEEK ENDING		FISH
To July	1	133
	8	1,143
	15	7,452
	22	38,628
	29	104,187
August	5	159,114
	12	146,825
	19	295,470
Sub-total to August 19		752,952
September	26	196,553
	2	159,640
	9	85,984
	16	488
	23	7,339
October	30	—
	7 on	168
Sub-total after August 19		450,172
GRAND TOTAL		1,203,124

A preliminary estimate of the escapement from Johnstone Strait for each of the two stock groups (Column 6) was then obtained by subtracting catch (Column 4) from abundance (Column 5).

The numbers of fish from each of the major stock groups which were taken by the 1961 Johnstone Strait fishery have now been estimated (TABLE 14, Column 4). Preliminary estimates of the escapement from Johnstone Strait for each of these stock groups (Column 6) will be used, along with comparable information for the Southern Approach, in estimating the abundance of Northern and Southern Approach fish in terminal populations in a subsequent section.

CATCHES BY STOCK GROUP AND PRELIMINARY ESTIMATES OF ABUNDANCE OF THE RUN ENTERING VIA THE SOUTHERN APPROACH

The first major fishery encountered by the run entering from the south takes place in Juan de Fuca Strait. Unlike the run in Johnstone Strait, the run in this fishing area in 1961 would be expected, on the basis of the analysis of 1959 run, to be composed of appreciable numbers of Canada Non-Fraser, Fraser River and United States fish. Moreover, the times of passage of these stock groups through the fishing area would be expected to overlap to a considerable degree (FIGURE 7). As a result, the stock groups could not be segregated readily on the basis of timing as was done for Johnstone Strait. Also, partly as a result of fishing restrictions, there was no catch in the week ending September 2 and catches in most other weeks were exceedingly small (FIGURE 8) making estimates of abundance based on exploitation rates extremely tenuous. Consequently, the analytical procedures employed to estimate the abundance of the stock groups in this area were different from those used in the Johnstone Strait analysis.

A reasonably reliable estimate could be made of the numbers of pinks destined for United States streams which escaped from the Juan de Fuca Strait fishing areas in 1961, since, on the basis of migration routes established for the 1959 run, these fish would not have intermingled to any great extent with other runs in the more shoreward areas. Therefore the analysis of the Southern Approach run was based on first estimating the relative abundance in Juan de Fuca Strait of the runs to Canada Non-Fraser, Fraser River and United States streams and then estimating the escapement of these runs from this area from the known escapement of the United States run. After estimating the abundance of the three runs at this point on the migration route, the contributions of these runs to catches in other areas along the route and to spawning escapements could be determined.

Weekly Relative Abundance of the Combined Run in Juan de Fuca Strait

The best available measure of weekly relative abundance in Juan de Fuca Strait in 1961 was considered to be one based on the weekly purse seine catch in the Canadian fishing area. Seiners in this area took 82 per cent of the 1961 pink salmon catch in Juan de Fuca Strait, (APPENDIX A). Since curtailed fishing times held the catch to low levels in all but the early part of the season (FIGURE 8), catch per unit of effort (i.e., catch per delivery by the Canadian seiners) was considered to be a better index of abundance than the actual catch.

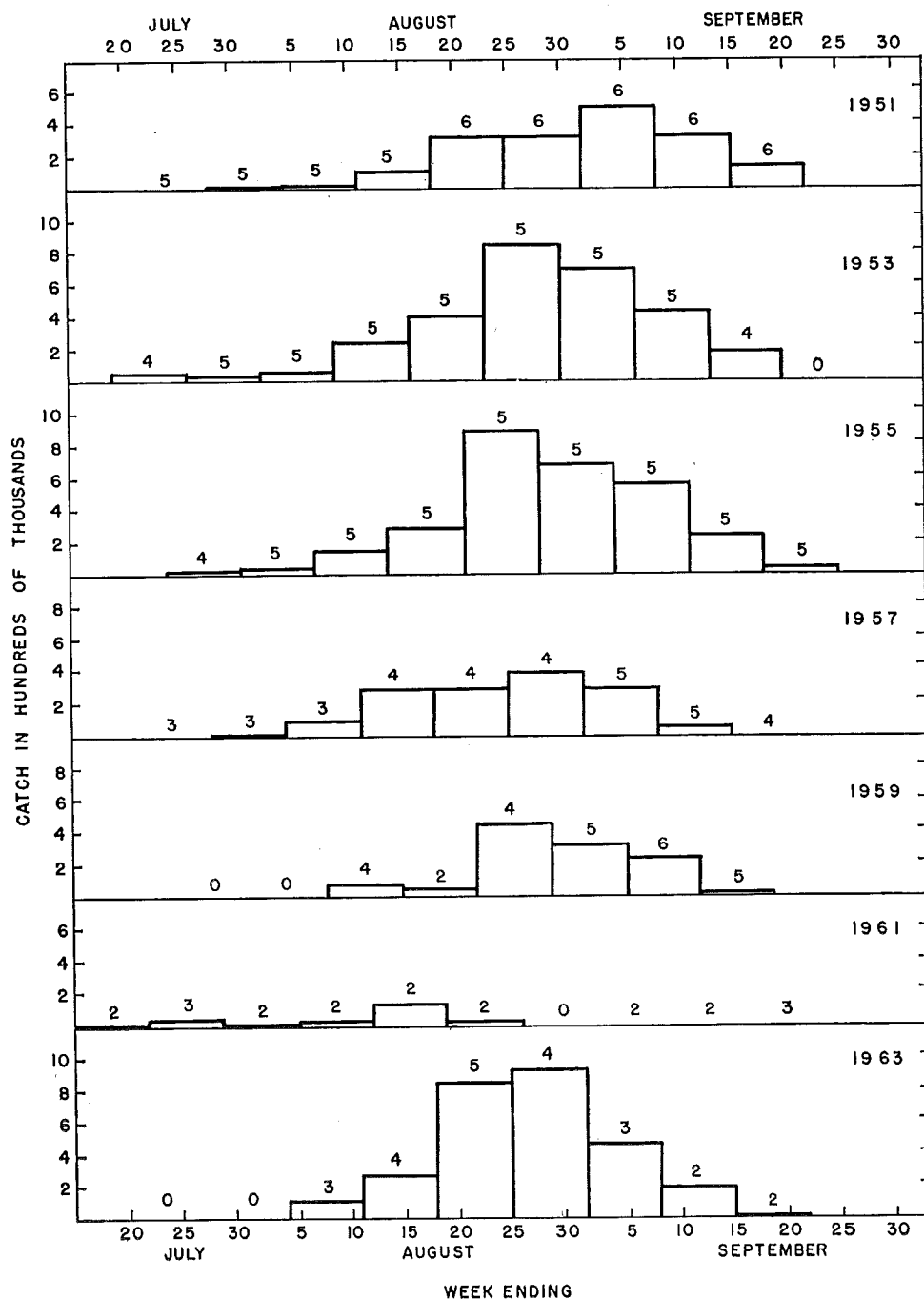


FIGURE 8. Weekly purse seine catches of pink salmon in the Canadian Juan de Fuca Strait fishing area during the odd-numbered years from 1951 to 1963 and the number of days fishing each week.

Daily catch data indicate that except when the abundance of the run is increasing rapidly the catch per unit of effort tends to decrease each day following the first day of fishing in any week. The shortest fishing week in this area in 1961 was two days and therefore data employed in the calculations of catch per delivery were restricted to the first two days fishing in each week to make the resulting weekly estimates more comparable.

An index of weekly relative abundance, based on seine catches per delivery in the Canadian Juan de Fuca Strait fishing area, was first computed for the 1959 run so that it might be compared with the actual weekly abundance calculated from the more complete data available in that year. Since catches employed were for the first two days of the week, catch per delivery in any one week was considered to represent relative abundance during the first two days of that week. Relative abundance during the remaining five days of the week was considered to have been represented by the mean of the catch per delivery for that week and the following week. Weighting the measures of relative abundance for the first two days and last five days of the week to the numbers of days involved, the relative abundance (R_n) in any week n was estimated by:

$$R_n = 2/7 CD_n + 5/7 \frac{CD_n + CD_{n+1}}{2}$$

where CD_n = catch per seine delivery in week n ;

CD_{n+1} = catch per seine delivery in the following week ($n + 1$).

These estimates of weekly relative abundance in 1959 (TABLE 20) indicated trends in weekly abundance during the early and late portions of the season which followed closely the trends of the curve for actual calculated abundance (FIGURE 9). The peak of the run as indicated by the relative abundance estimates was however, sharper and higher than that for the calculated abundance (taken from FIGURE 7). The relative abundance estimate for the week ending August 22 was about 15 per cent lower than the calculated abundance while this situation was reversed in the following week. Only in the week ending September 5 did the relative abundance estimate differ appreciably (about half as great) from the actual abundance.

The relative weekly abundance of the run in Juan de Fuca Strait in 1961 was then estimated from catch per delivery data following the procedures employed above for the 1959 data (TABLE 21). The resulting estimates were compared with those for 1959 (FIGURE 9). Since the estimates for both years were representative of abundance for each week as a whole, they were plotted on midweek dates. Three major differences between the two runs were indicated.

1. The total run in 1961 was much smaller than that in 1959. This difference appears reasonable since the combined catch in 1961 for the Juan de Fuca Strait, San Juan Islands, West Beach and Point Roberts areas, which amounted to 68 per cent of the Southern Approach run in 1959, was only one-third that of 1959. Moreover, the combined terminal population in the Fraser River and United States areas (which would consist mainly of Southern Approach pinks escaping from these fisheries) was slightly less in 1961 than in 1959 (TABLE 11).

TABLE 20. Estimation of relative weekly abundance in Juan de Fuca Strait in 1959 from catch per delivery in the Canadian seine fishery during the first two days of each fishing week.

WEEK ENDING	CATCH	DELIVERIES	CATCH PER DELIVERY	RELATIVE ^a ABUNDANCE
July 25	2,253	76	30	20 ^b
August 1	STRIKE			
8	STRIKE			
15	41,562	133	312	504
22	50,063	59	849	1,354
29	384,330	170	2,261	1,712
September 5	175,921	243	724	691
12	112,117	178	630	477
19	21,864	108	202	135
26	55	4	14	9

^a Two-sevenths of catch per delivery for that week (CD_n) plus five-sevenths of the average catch per delivery for that week (CD_n) and the following week (CD_{n+1}).

^b Estimated by extrapolation of the relative abundance curve.

TABLE 21. Relative weekly abundance in Juan de Fuca Strait in 1961 as estimated from catch per delivery in the Canadian seine fishery during the first two days of each fishing week.

WEEK ENDING	CATCH	DELIVERIES	CATCH PER DELIVERY	RELATIVE ^a ABUNDANCE
July 22	19,780	169	117	152
29	41,384	192	216	175
August 5	19,698	195	101	143
12	37,026	169	219	449
19	132,178	153	864	657
26	43,306	152	285	240
September 2 ^b	475	3	158	140
9	2,902	27	107	112
16	480	4	120	79
23	315	58	5	3

^a Two-sevenths of the catch per delivery for that week (CD_n) plus five-sevenths of the average of the catch per delivery for that week (CD_n) and the following week (CD_{n+1}).

^b Test fishing August 28, 29, 30.

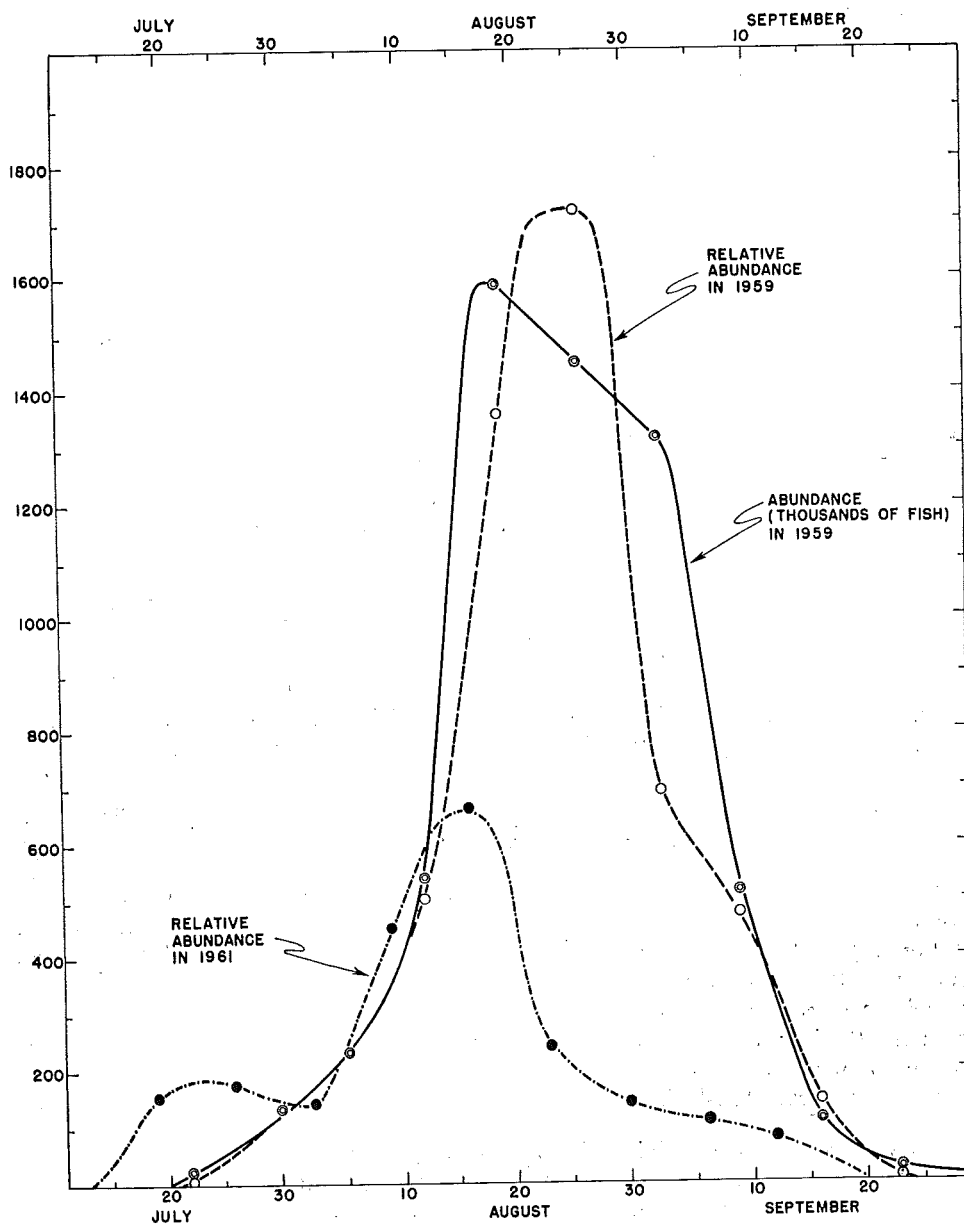


FIGURE 9. Estimated weekly abundance of pink salmon in Juan de Fuca Strait in 1959 and indices of relative weekly abundance in 1959 and 1961 based on seine catch per delivery during the first two days fishing each week in the Canadian fishing area. Points are plotted on mid-week dates.

2. The very early part of the run (July) was appreciably more abundant in 1961 than in 1959, reflecting the much larger spawning escapements in 1961 of the very early¹² Howe Sound and Bellingham Bay runs (four times and three times those of 1959, respectively—TABLE 9).
3. The greatest difference in abundance between the two years occurred after mid-season when the 1961 run was much smaller than that of 1959. This is the period during which Fraser fish would be most abundant (FIGURE 7). In spite of a much reduced fishing effort during this period in 1961 (0 to 2 days per week vs. 4 to 6 days in 1959—FIGURE 4), the terminal population of Fraser fish was smaller in 1961 than in 1959 (TABLE 11). Thus a difference in abundance between the two years of the order shown is not unreasonable.

Abundance of Canada Non-Fraser, Fraser River and United States Pinks in the Canadian Juan de Fuca Strait Fishing Area

The *relative abundance* of the three stock groups in the Canadian fishing area during the early part of the 1961 season may be estimated from the recoveries of tags applied in this area in the weeks ending July 30 through August 20¹³. Following procedures employed in the analysis of the 1959 data, spawning ground recoveries were weighted to include tags estimated to have been available from fish in each spawning population which were not examined for tags. These weighted recoveries, and the recoveries from local fisheries were assigned directly to stock. In the more general groupings of stocks employed in the 1961 analysis, the Puget Sound and Texada Island fisheries could be considered local fisheries on United States and Canada Non-Fraser stocks respectively. Since fish bound for United States streams made up 99 per cent of the catch at West Beach in 1959, this fishery was considered to have operated entirely on United States stocks in 1961. In the remaining fishing areas from which recoveries were made (San Juan Islands, Point Roberts and Fraser Gulf), the Southern Approach run was made up virtually exclusively of fish bound for Canadian streams in 1959. Accordingly, for each week of tagging in 1961, recoveries in these fishing areas were assigned to the two Canadian stock groups in proportion to the numbers of recoveries in the Canada Non-Fraser and Fraser River terminal areas. On this basis the 1,613 recoveries from the tagging in the Canadian Juan de Fuca Strait fishing area were assigned to the three stock groups and the weekly percentage composition of the run in this area was calculated (TABLE 22).

The tagging periods (Thursday to Sunday) were centered around Friday or Saturday of each week. Consequently the relative abundance in the Canadian Juan de Fuca Strait fishing area during each weekly tagging period was estimated from FIGURE 9 by interpolation and divided amongst the three stock groups (TABLE 23) according to the percentage composition estimated previously (TABLE 22). The resulting estimates of relative abundance by stock group were plotted and joined by visually smoothed curves (FIGURE 10). The curve for the Canada Non-Fraser pinks reached a peak about August 11 and declined rapidly during the next week. United States pinks apparently reached peak abundance at or just before the last date for which tagging data were available (August 19) while

¹² Vernon, Hourston and Holland, 1964, FIGURE 23.

¹³ See section on times of passage through the major fishing areas. Data given in Vernon, Hourston and Holland, 1964, APPENDIX S.

TABLE 22. Weekly percentage composition of the run in the Canadian Juan de Fuca Strait fishing area during the early part of the 1961 season as indicated by recoveries of tags applied in that fishing area. Tag recoveries from each of the three major stock groups are given in parentheses.

TAGGED IN WEEK ENDING		RECOVERED FROM			ALL
		Canada Non-Fraser	Fraser River	United States	
July	30	66.21 (194)	2.73 (8)	31.06 (91)	100.0 (293)
August	6	68.98 (269)	12.05 (47)	18.97 (74)	100.0 (390)
	13	44.07 (145)	29.48 (97)	26.45 (87)	100.0 (329)
	20	7.82 (47)	53.41 (321)	38.77 (233)	100.0 (601)

TABLE 23. Relative "weekly" abundance by stock group for periods during which the run in the Canadian Juan de Fuca Strait fishing area was tagged in 1961. Percentage composition (from TABLE 22) is given in parentheses.

DATE ^a	CANADA NON-FRASER	FRASER RIVER	UNITED STATES	ALL
July 29	103.3 (66.21)	4.3 (2.73)	48.4 (31.06)	156 (100.00)
August 5	186.3 (68.98)	32.5 (12.05)	51.2 (18.97)	270 (100.00)
12	268.8 (44.07)	179.8 (29.48)	161.4 (26.45)	610 (100.00)
18	48.5 (7.82)	331.1 (53.41)	240.4 (38.77)	620 (100.00)

^a Midpoint of tagging period for which percentage composition by stock group was calculated.

Fraser fish probably reached peak abundance after that date. These curves were then extrapolated to the beginning and end of the season according to the timing of these stock groups in 1959 (FIGURE 7)¹⁴ so that the sum of the abundance of the three stock groups during these periods approximated the total relative abundance in this fishing area as indicated by the original estimates of relative abundance (FIGURE 9).

¹⁴ Relative abundance in FIGURE 7 is for the week ending on the date shown on the horizontal axis while that in FIGURE 9 is for the 7 day period centered on the date shown. Consequently dates in FIGURE 9 correspond with dates three days later in FIGURE 7.

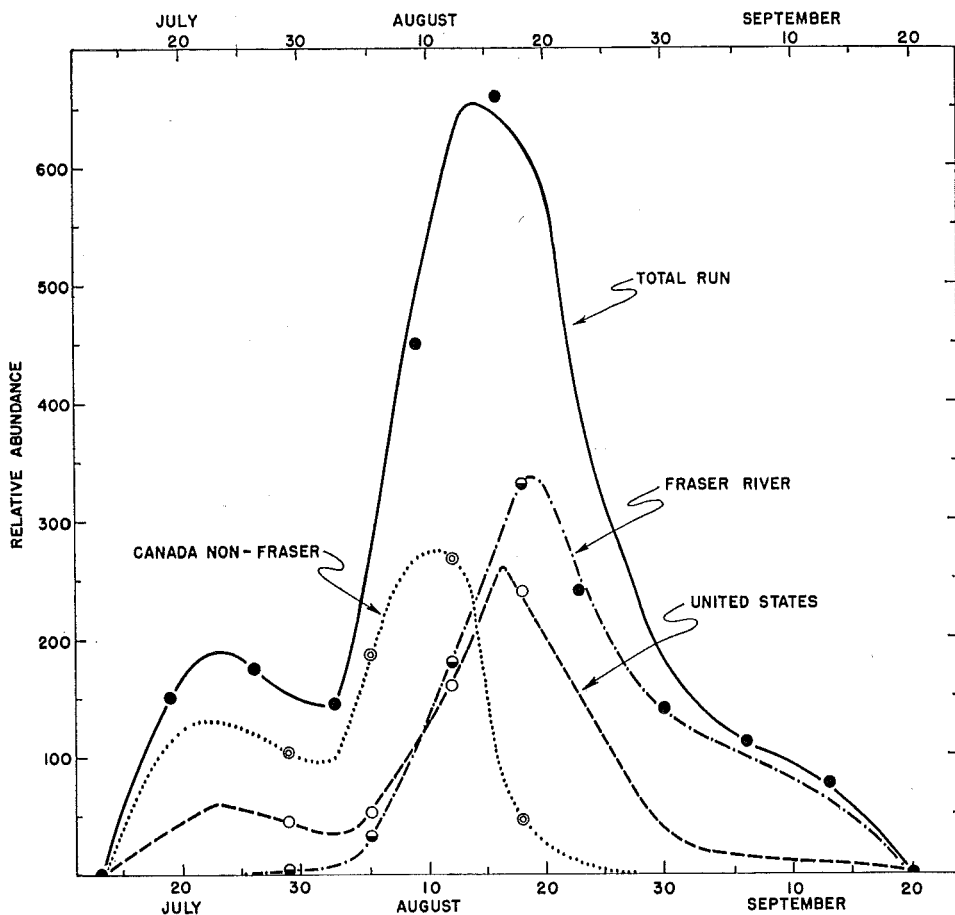


FIGURE 10. Estimated weekly relative abundance in Juan de Fuca Strait of the pink salmon runs to Canada Non-Fraser, Fraser River and United States streams in 1961. The curve for the total run represents the sum of the abundance of the three component stock groups. The original estimates of weekly relative abundance (FIGURE 9) are indicated by solid circles on mid-week dates.

The original curve of weekly relative abundance for the total run could now be revised by summing the weekly relative abundance of the three stock groups (as indicated by the interpolated curves) on the original mid-week dates (FIGURE 10). Comparison of this revised curve with the points from the original curve (also shown in FIGURE 10) shows that the revised value was about 10 per cent higher than the original in the week preceding the peak, slightly lower in the peak week, nearly double the original in the week following the peak and slightly higher than the original value in the next week. These differences resemble the differences in 1959 between the curve for the calculated abundance (equivalent to revised estimates of relative abundance in 1961) and the curve for relative abundance (calculated in the same way as the original estimates in 1961) as shown in FIGURE 9. The estimates of weekly relative abundance of the three stock groups derived above were therefore considered to represent the weekly relative abundance of the run in the Canadian Juan de Fuca Strait fishing area.

Catches of Southern Approach¹⁵ Canada Non-Fraser, Fraser River and United States pinks in the Canadian Juan de Fuca Strait fishing area may now be estimated (TABLE 24, rows 3) by apportioning the weekly catches (TABLE 25) to stock group according to their weekly relative abundance (TABLE 24, rows 1).

In 1959, 522,931 (64 per cent) of the 814,077 United States pinks *escaping* the Juan de Fuca Strait fishing area were estimated to have gone through the Canadian part of the fishing area. Assuming a similar migration pattern in 1961, 751,975 (64 per cent) of the 1,174,961¹⁶ United States pinks considered to have escaped from the Juan de Fuca Strait fishing areas would have gone through the Canadian part of the fishing area and the remainder (422,986) would have passed through the United States part of the fishing area.

The total seasonal abundance of United States fish in the Canadian Juan de Fuca Strait fishing area in 1961 was 868,700 pinks (a catch of 116,725 plus an escapement of 751,975 - TABLE 24). The total seasonal abundance of Canada Non-Fraser and Fraser River pinks in the Canadian Juan de Fuca Strait fishing area was estimated from their relative abundance in comparison with the United States pinks whose actual abundance has already been estimated (TABLE 24). Thus

$$A_{\text{CNF}} = R_{\text{CNF}} \cdot \frac{A_{\text{US}}}{R_{\text{US}}} \text{ and } A_{\text{FR}} = R_{\text{FR}} \cdot \frac{A_{\text{US}}}{R_{\text{US}}}$$

where A_{CNF} , A_{FR} and A_{US} are the actual abundance of Canada Non-Fraser,

Fraser River and United States pinks respectively;

and R_{CNF} , R_{FR} and R_{US} are the relative abundance of Canada Non-Fraser,

Fraser River and United States pinks respectively.

The total seasonal abundance thus estimated for each of the stock groups (TABLE 24, rows 2, final column) was then allocated to weeks in proportion to the weekly relative abundance (rows 1) of that stock group. Weekly escapements (rows 4) were obtained by subtracting weekly catches (rows 3) from the weekly total abundance (rows 2).

Abundance of Canada Non-Fraser, Fraser River and United States Pinks in the United States Juan de Fuca Fishing Area

The relatively small commercial catch in this area in 1961 (12,264 fish) plus the virtual absence of a commercial fishery after late August (APPENDIX A) precluded an analysis for this area similar to that for the Canadian fishing area. However, comparison of the recoveries of tags applied in both fishing areas between the weeks ending July 30 and August 20 in 1961¹⁷ indicated that United States pinks were relatively twice as abundant in the United States fishing area as in

¹⁵ The run in the Canadian Juan de Fuca Strait area contained a few Northern Approach fish all of which were considered to be destined for United States streams. The estimated seasonal catch of these fish (TABLE 12) was distributed to weeks according to the relative weekly abundance of United States fish in the fishing area and deducted from the total weekly catches to give weekly catches of Southern Approach fish.

¹⁶ Spawners plus local catches in the United States terminal area (1,117,945—TABLE 11) plus West Beach catch (87,294—TABLE 1) minus the contribution of Northern Approach fish to the run in these areas (30,278—TABLE 12).

¹⁷ Vernon, Hourston and Holland, 1964, APPENDIX S.

TABLE 24. Estimated weekly abundance (catch plus escapement) of Canada Non-Fraser, Fraser River and United States pinks in the Southern Approach run in Canadian Juan de Fuca Strait fishing area in 1961.

	WEEK ENDING										ALL WEEKS (Season Total)
	To July 22	July 29	Aug. 5	Aug. 12	Aug. 19	Aug. 26	Sept. 2	Sept. 9	Sept. 16	Sept. 23 on	
1. Relative Abundance ^a	112	120	100	270	95	10	CANADA NON-FRASER STOCKS				707
2. Total Abundance	137,811	147,654	123,045	332,222	116,893	12,305	—	—	—	—	869,930
3. Catch	17,130	47,106	17,101	23,196	19,945	1,206	—	—	—	—	125,684
4. Escapement	120,681	100,548	105,944	309,026	96,948	11,099	—	—	—	—	744,246
				FRASER RIVER STOCKS							
1. Relative Abundance ^a	—	1	8	110	285	250	140	100	69	3	966
2. Total Abundance	—	1,230	9,844	135,350	350,680	307,614	172,263	123,045	84,901	3,691	1,188,618
3. Catch	—	392	1,369	9,450	59,836	30,139	1,871	5,214	1,448	1,249	110,968
4. Escapement	—	838	8,475	125,900	290,844	277,475	170,392	117,831	83,453	2,442	1,077,650
				UNITED STATES STOCKS							
1. Relative Abundance ^a	40	54	35	110	260	150	35	12	10	—	706
2. Total Abundance	49,218	66,444	43,066	135,350	319,918	184,568	43,066	14,765	12,305	—	868,700
3. Catch	6,118	21,198	5,985	9,450	54,587	18,083	468	626	210	—	116,725
4. Escapement	43,100	45,246	37,081	125,900	265,331	166,485	42,598	14,139	12,095	—	751,975
				ALL STOCKS							
1. Relative Abundance ^a	152	175	143	490	640	410	175	112	79	3	2,379
2. Total Abundance	187,029	215,328	175,955	602,922	787,491	504,487	215,329	137,810	97,206	3,691	2,927,248
3. Catch	23,248	68,696	24,455	42,096	134,368	49,428	2,339	5,840	1,658	1,249	353,377
4. Escapement	163,781	146,632	151,500	560,826	653,123	455,059	212,990	131,970	95,548	2,442	2,573,871

^a From mid-week points on curves in FIGURE 10 (July 19, July 26, August 2, etc.).

the Canadian fishing area. Tag recoveries were too few and the period of tagging too short to provide reliable estimates of this factor on a weekly basis. Moreover the numbers of recoveries from the Canada Non-Fraser and from Fraser River streams after the first week of tagging were too few to permit adequate comparisons of the relative abundance of these two groups. However, since their migration routes would be expected to coincide through Juan de Fuca Strait, it was assumed that the proportions of these two stock groups would be the same on either side of the international boundary. On this basis the weekly relative abundance of the run in the United States Juan de Fuca fishing area was estimated by doubling the relative abundance of United States fish in the Canadian fishing area for that week and reducing the relative abundance of Canada Non-Fraser and Fraser River stocks proportionately (TABLE 26, rows 1). The weekly catches by stock group (rows 3) were then calculated from the relative weekly abundance of the three stock groups (rows 1) and the weekly total abundance (rows 2) and escapements (rows 4) estimated as for the Canadian fishing area.

Contributions of Southern Approach Pinks from the Three Stock Groups to Catches in Inshore Fishing Areas

After leaving the Juan de Fuca Strait fishing areas, Southern Approach pinks destined for United States streams were fished again in the *West Beach* area, where the run was considered to have been made up entirely of United States fish. Following this, they entered the United States terminal area.

Southern Approach pinks destined for Canada Non-Fraser and Fraser River streams were fished subsequently at San Juan Islands, Point Roberts and Fraser Gulf before entering their terminal areas. In these fishing areas, the estimated catch of Northern Approach fish destined for United States streams (TABLE 12) was distributed to the various fishing weeks according to the relative weekly abundance of United States fish in Juan de Fuca Strait one week earlier¹⁸ and deducted from the total weekly catches to give the weekly catch of Canadian fish (TABLE 25).

At *San Juan Islands*, the catch of Canadian fish was assumed to have been composed entirely of Southern Approach fish as in 1959. The relative weekly abundance of Canada Non-Fraser and Fraser pinks was assumed to be the same as that in the Juan de Fuca Strait area one week earlier¹⁹ and the weekly catch divided between the two groups on this basis (TABLE 27).

The weekly catch of Canadian pinks at *Point Roberts* was apportioned between Canada Non-Fraser and Fraser River fish on the same basis²⁰ (TABLE 27). As in 1959, all Canada Non-Fraser pinks taken in this area were considered to be Southern Approach fish. In 1959, of the 715,345 Fraser River pinks estimated to have been caught at Point Roberts, 47,838 (6.7 per cent) were considered to

¹⁸ Assumes that the arrival time of United States fish at the West Beach-Admiralty Inlet area was the same for the Northern and Southern Approach runs in those areas and that the migration rates for these two runs were similar to those observed in 1959.

¹⁹ The median travel time between the Canadian Juan de Fuca Strait fishing area and San Juan Islands was estimated at four days in 1959.

²⁰ The median travel time between the Canadian Juan de Fuca Strait and Point Roberts fishing areas was estimated at six days in 1959. Also the median travel time between San Juan Islands and Point Roberts was estimated at two days in 1959. The 1961 fisheries in these areas were conducted mainly on a two-day-week basis. Consequently the portion of the run fished at Point Roberts would have passed through the San Juan Islands area while the fishery was closed and its composition by stock would resemble that of the run leaving Juan de Fuca Strait.

TABLE 26. Estimated weekly abundance (catch plus escapement) of Canada Non-Fraser, Fraser River and United States pinks in the United States Juan de Fuca Straits fishing area in 1961.

	WEEK ENDING								ALL WEEKS (Season Total)		
	To July 22	July 29	Aug. 5	Aug. 12	Aug. 19	Aug. 26	Sept. 2	Sept. 9	Sept. 16	Sept. 23 on	
1. Relative Abundance 2. Total Abundance 3. Catch 4. Escapement	72	66	68	192	30	4	CANADA NON-FRASER STOCKS				432
	22,284	20,427	21,046	59,423	9,285	1,238	—				133,703
	1,166	1,949	1,911	1,167	148	38	—				6,379
	21,118	18,478	19,135	58,256	9,137	1,200	—				127,324
1. Relative Abundance 2. Total Abundance 3. Catch 4. Escapement	—	1	5	78	90	106	FRASER RIVER STOCKS				535
	—	309	1,547	24,141	27,855	32,807	—				165,581
	—	15	154	473	444	994	—				4,121
	—	294	1,393	23,668	27,411	31,813	—				161,460
1. Relative Abundance 2. Total Abundance 3. Catch 4. Escapement	80	108	70	220	520	300	UNITED STATES STOCKS				1,412
	24,760	33,426	21,665	68,090	160,938	92,849	—				437,011
	1,294	3,165	1,983	1,336	2,563	2,813	—				14,025
	23,466	30,261	19,682	66,754	158,375	90,036	—				422,986
1. Relative Abundance 2. Total Abundance 3. Catch 4. Escapement	152	175	143	490	640	410	ALL STOCKS				2,379
	47,044	54,162	44,258	151,654	198,078	126,894	—				736,295
	2,460	5,129	4,048	2,976	3,155	3,845	—				24,525
	44,584	49,033	40,210	148,678	194,923	123,049	—				711,770

TABLE 27. Estimated weekly catches of Canada Non-Fraser and Fraser River pinks at San Juan Islands and Point Roberts in 1961.

	WEEK ENDING								ALL WEEKS
	To July 29	Aug. 5	Aug. 12	Aug. 19	Aug. 26	Sept. 2	Sept. 9	Sept. 16	Sept. 23 on
Canada Non-Fraser Fraser River Total	100.0	99.1	92.7	71.1	25.0	3.8	0.0	0.0	0.0
	0.0	.9	7.3	28.9	75.0	96.2	100.0	100.0	100.0
	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
CATCH AT SAN JUAN ISLANDS									
Canada Non-Fraser	59,698	52,121	34,572	18,559	12,425	13	—	—	—
Fraser River	—	473	2,722	7,544	37,273	338	595	219	5,053
Total	59,698	52,594	37,294	26,103	49,698	351	595	219	5,053
CATCH AT POINT ROBERTS									
Canada Non-Fraser	19,433	22,522	21,137	12,059	7,706	—	—	—	—
Fraser River	—	205	1,665	4,901	23,117	—	—	—	3,586
Total	19,433	22,727	22,802	16,960	30,823	—	—	—	3,586

^a In escapement from the Juan de Fuca Strait fishing areas in the previous week (from TABLES 24 and 26).

have been Northern Approach fish. In the absence of information on differences between 1959 and 1961 in the proportion of the Northern Approach run to the Fraser which passed through the Point Roberts area and, at this stage of the analysis, on the proportions of Northern and Southern Approach pinks in the Fraser River terminal area, the proportion of Northern Approach fish in the catch of Fraser pinks at Point Roberts was considered to be the same in 1961 as in 1959. Thus 2,243 (6.7 per cent) of the estimated catch of 33,474 Fraser pinks at Point Roberts in 1961 were considered to have been Northern Approach fish and the remaining 31,231 Southern Approach fish.

In the *Fraser Gulf* fishing area, there was almost complete temporal separation of Canadian Non-Fraser and Fraser River stocks in 1959. All Canadian fish taken up to the week ending August 22 were considered to have been destined for Canada Non-Fraser streams. From the following week (ending August 29) to the end of the season, the catch was estimated to have been made up almost exclusively of Fraser fish. Since the timing of the migration of these two stock groups in 1961 appeared to be similar to that in 1959, it was considered that the 1961 catch (commercial plus sport) of Canadian fish in this area up to the week ending August 26 (18,555 pinks - TABLE 25) consisted of Canada Non-Fraser fish while the catch for the remainder of the season (24,887 pinks) was composed of Fraser fish. As in 1959, all Canada Non-Fraser fish in this area were considered to have approached from the south while the Fraser fish were considered to have been made up of Northern and Southern Approach pinks in proportion to their relative abundance in the terminal area. These latter fish were therefore included in the Fraser River terminal population for the purposes of this analysis.

The escapements of Southern Approach fish to the Canada Non-Fraser, Fraser River and United States terminal areas may now be estimated by subtracting from the estimated abundance of these three stock groups in Juan de Fuca Strait the catches for each stock group in the fishing areas through which they passed on their migration to their terminal areas (TABLE 28).

ABUNDANCE OF NORTHERN AND SOUTHERN APPROACH FISH IN THE CATCHES AND SPAWNING ESCAPEMENTS

Abundance in the Terminal Areas

In the preceding two sections, for each of the five stock groups, estimates were made of the numbers of fish which entered Queen Charlotte Strait on the Northern Approach and Juan de Fuca Strait on the Southern Approach and which were taken in the more inshore fisheries en route to their respective terminal areas. From these data, preliminary estimates were made of the numbers of Northern and Southern Approach fish escaping to Kingcome Inlet, Queen Charlotte Strait, Strait of Georgia, Fraser River and United States streams (TABLES 14 and 28). Terminal populations in the Kingcome Inlet and Queen Charlotte Strait areas were considered to have consisted entirely of Northern Approach fish as they did in 1959. Since it could be assumed that almost all United States pinks would have migrated via the south, estimates of the Northern and Southern Approach components for this stock group were made on the basis of their relative abundance in 1959 (APPENDIX E). Consequently the estimates of Southern and/or Northern fish reaching these three terminal areas account exactly for the "known" (estimated number of spawners and local catch) populations in these areas and may be considered final (TABLE 29).

TABLE 28. Escapements to terminal areas of Canada Non-Fraser, Fraser River and United States pink salmon in the Southern Approach run in 1961.

	CANADA NON-FRASER	FRASER RIVER	UNITED STATES	ALL STOCKS
RUN ENTERING JUAN DE FUCA STRAIT ^a	1,003,633	1,354,199	1,305,711	3,663,543
CATCH				
Canadian Juan de Fuca ^b	125,684	110,968	116,725	353,377
United States Juan de Fuca ^c	6,379	4,121	14,025	24,525
West Beach	—	—	86,193	86,193
San Juan Islands ^d	177,388	54,217	—	231,605
Point Roberts ^d	82,857	31,231	—	114,088
Fraser Gulf ^e	18,555 ^e	— ^f	—	18,555
TOTAL	410,863	200,537	216,943	828,343
ESCAPEMENT TO TERMINAL AREA	592,770	1,153,662	1,088,768	2,835,200

^a Total abundance for the season in the Canadian and United States Juan de Fuca Strait fishing areas (TABLES 24 and 26 respectively).

^b From TABLE 24.

^c From TABLE 26.

^d From TABLE 27.

^e Catch to August 26—from TABLE 25.

^f Included in terminal population.

TABLE 29. Estimation of proportions and abundance of Northern and Southern Approach pinks in terminal populations in 1961. Percentages of Northern and Southern Approach fish in each population are estimated from the proportions of Northern and Southern Approach fish in the preliminary estimates.

TERMINAL POPULATION	PRELIMINARY ESTIMATES OF ABUNDANCE			"ACTUAL" ABUNDANCE (Table 11)	PER CENT DIFFERENCE ^e
	Northern	Southern	Total		
Kingcome Inlet	60,493 (100.0%)	— (0.0%)	60,493 (100.0%)	60,493 —	— —
Queen Charlotte Strait	578,473 (100.0%)	— (0.0%)	578,473 (100.0%)	578,473 —	— —
Strait of Georgia	820,440 ^a (58.1%)	592,770 ^d (41.9%)	1,413,210 (100.0%)	1,070,680 —	+31.1 —
Fraser River	288,769 ^b (20.0%)	1,153,662 ^d (80.0%)	1,442,431 (100.0%)	1,233,701 —	+16.9 —
United States	29,177 ^c (2.6%)	1,088,768 ^d (97.4%)	1,117,945 (100.0%)	1,117,945 —	— —

^a From TABLE 14.

^b Estimated escapement from Johnstone Strait (292,070—TABLE 14) minus catches at Texada Island and Point Roberts (1,058 and 2,243 respectively—TABLE 31).

^c From TABLE 11 (spawners and local catches).

^d From TABLE 28.

^e (Column 3 — Column 4) / Column 4.

The number of Northern and Southern Approach fish in the Fraser River and Strait of Georgia terminal areas were estimated independently in more seaward areas on each approach. Consequently, these preliminary estimates required adjustment so that their sums equalled the totals "known" to have reached the terminal areas. Preliminary estimates of the numbers of fish reaching the Strait of Georgia and the Fraser River terminal areas via the Northern Approach (TABLE 29, Column 1) and via the Southern Approach (Column 2) when summed (Column 3) exceeded the actual abundance in these areas (Column 4) by 31 per cent in Georgia Strait and 17 per cent in the Fraser River (Column 5). Considering the approximations involved in the calculations, the lack of close agreement between the two sets of figures is not surprising. On the basis of the available evidence, it was considered that the escapements to these two terminal areas were over-estimated on both approaches to approximately the same extent²¹ (APPENDIX F). These estimates were therefore considered to be reasonable indices of the relative abundance of the two runs, and the percentage of each terminal population which approached from the north and from the south was calculated from these preliminary estimates (TABLE 29). As in 1959, the Northern and Southern Approach runs were considered to have contributed to the local catch and to the spawning escapement in proportion to their relative abundance and the local catches and spawners were each apportioned between the two runs on this basis (TABLE 30).

Abundance in Catches and Spawning Escapements

The abundance of Northern and Southern Approach pinks caught in the various fishing areas between Johnstone and Juan de Fuca Straits inclusive are colligated in TABLE 31, Columns 2-9 and numbers of spawners in Column 15. To complete the census by stock group it remains to determine the contributions of these runs and stock groups to the fisheries outside this area. These include the Canadian troll fishery in Queen Charlotte Strait and the Canadian and United

TABLE 30. Contributions of Northern and Southern Approach pinks to the local catches and spawners in the five terminal areas in 1961. Proportions of Northern and Southern Approach fish calculated in TABLE 29 are applied to local catches and spawners given in TABLE 11.

	LOCAL CATCH			SPAWNERS		
	Northern	Southern	Total	Northern	Southern	Total
Kingcome Inlet	18,693	—	18,693	41,800	—	41,800
Queen Charlotte Strait	306,273	—	306,273	272,200	—	272,200
Strait of Georgia	81,735	58,945	140,680	540,330	389,670	930,000
Fraser River	30,198	116,561	146,759 ^a	217,600	870,400	1,088,000
United States	8,169	301,776	309,945	21,008	786,992	808,000
TOTALS	445,214	477,136	922,350	1,094,026	2,045,794	3,140,000

^a Includes 145,701 fish taken in local catches which were apportioned to the Northern and Southern Approach runs plus 1,058 Northern Approach fish taken at Texada Island.

²¹ The escapements of Fraser River and Strait of Georgia fish approaching from the south appear to have been over-estimated to a slightly greater extent than for fish from these two stock groups approaching from the north. However, this difference was not considered large enough to inflict a detectable bias on the subsequent analysis (APPENDIX F).

TABLE 31. Catches and escapements by stock group, fishery and approach in the Study Area in 1961.

STOCK GROUP		CATCH																	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)		(9)	(10)		(11)		(12)	(13)	(14)	(15)	(16)	(17)
Queen Charlotte Strait	Johnstone Strait	Local Fisheries	Fraser Gulf	Point Roberts	West Beach	San Juan Islands	U.S.A.	Canada	Juan de Fuca St.	U.S.A.	Canada	Convention	Non-Convention	U.S.A.	Canada	All Fisheries	SPAWNERS	TOTAL	PER CENT REMOVAL
Canada Non-Fraser																			
2,041	—	18,693	—	—	—	—	—	—	—	—	—	—	—	—	—	20,734	41,800	62,534	33.16
24,407	145,523	306,273	—	—	—	—	—	—	—	—	—	—	—	—	—	476,203	272,200	748,403	63.63
43,617	671,269	81,735	—	—	—	—	—	—	—	—	—	—	—	—	—	796,621	540,330	1,336,951	59.58
70,065	816,792	406,701	—	—	—	—	—	—	—	—	—	—	—	—	—	1,293,558	854,330	2,147,888	60.22
20,231	349,842	25,221	4,977	2,243	—	—	—	—	—	—	—	—	—	—	—	402,514	217,600	620,114	64.91
Fraser	2,506	36,490	190	983	1,101	2,114	5,966	—	5,966	—	—	—	—	—	—	57,519	21,008	78,527	73.25
United States	92,802	440,091 ^a	5,167	3,226	1,101	2,114	5,966	—	5,966	—	—	—	—	—	—	1,733,591	1,092,938	2,846,529	61.60
TOTAL NORTHERN APPROACH	3.26	42.27	0.18	0.11	0.04	0.07	0.21	—	0.21	—	—	—	—	—	—	61.60	38.40	100.00	—
Per Cent Removal																			
SOUTHERN APPROACH																			
Straits of Georgia	—	58,945	18,555	82,857	—	177,388	6,379	125,684	16,385	13,890	2,779	22,023	524,885	389,670	914,555	57.39			
Fraser	—	96,651	19,910	31,231	—	54,217	4,121	110,968	22,615	19,171	3,836	30,396	393,116	870,400	1,263,516	43.36			
United States	—	301,776	—	—	86,193	—	14,025	116,725	24,893	21,100	4,222	33,456	602,390	736,992	1,389,392	31.11			
TOTAL SOUTHERN APPROACH	—	457,372	38,465	114,088	86,193	231,605	24,525	353,377	63,893	54,161	10,837	85,875	1,520,391	2,047,062	3,567,453	42.62			
Per Cent Removal	—	12.82	1.08	3.20	2.42	6.49	0.69	9.90	1.79	1.52	0.30	2.41	42.62	57.38	100.00	—			
BOTH APPROACHES																			
Canada Non-Fraser	2,041	18,693	—	—	—	—	—	—	—	—	—	—	—	—	—	20,734	41,800	62,534	33.16
Kingcome Inlet	24,407	306,273	—	—	—	—	—	—	—	—	—	—	—	—	—	476,203	272,200	748,403	63.63
Queen Charlotte Strait	43,617	671,269	18,555	82,857	—	177,388	6,379	125,684	16,385	13,890	2,779	22,023	1,321,506	930,000	2,251,506	58.69			
Straits of Georgia	70,065	816,792	18,555	82,857	—	177,388	6,379	125,684	16,385	13,890	2,779	22,023	1,818,443	1,244,000	3,062,443	59.38			
Total	20,231	349,842	24,887	33,474	—	54,217	4,121	110,968	22,615	19,171	3,836	30,396	795,630	1,088,000	1,883,630	42.24			
Fraser	2,506	36,490	190	983	87,294	2,114	14,025	122,691	24,893	21,100	4,222	33,456	659,909	808,000	1,467,909	44.96			
United States	92,802	440,091 ^a	43,632	117,314	87,294	233,719	24,525	353,343	63,893	54,161	10,837	85,875	3,273,982	3,140,000	6,413,982	51.04			
TOTAL BOTH APPROACHES	1.45	18.76	0.68	1.83	1.36	3.64	0.38	5.60	1.00	0.84	0.17	1.34	51.04	48.96	100.00	—			
Per Cent Removal																			

^a Includes 1,058 Northern Approach Fraser fish estimated to have been taken at Texada Island.

States troll fisheries inside and outside Convention waters off the west coast of Vancouver Island. Catches in these areas were taken almost exclusively by trollers operating more or less continuously throughout the season (APPENDIX A). Consequently, all of these fisheries may be considered to have removed fish from the various stock groups according to their relative abundance for the season as a whole. Moreover, all pinks taken by the West Coast Troll fisheries may be considered as Southern Approach fish (as in 1959), while all fish taken by the Queen Charlotte Strait troll fishery may be considered as Northern Approach fish.²² Thus, the catch in the Queen Charlotte Strait troll fishing area was assigned to stock group (TABLE 31, Column 1) on the basis of the relative abundance of the stock groups in the run leaving the area (catches in subsequent fisheries from each stock group plus their spawning escapements). Similarly, the catches in the four West Coast Troll fishing areas were assigned to the three stock groups (TABLE 31, Columns 10-13) according to their relative abundance in the run entering Juan de Fuca Strait.

A census of the 1961 run by stock group, including the numbers caught in the various fishing areas and the numbers of spawners, has now been completed for both the Northern and Southern Approach runs (TABLE 31). Although some of the estimates of the abundance of stock groups were made on rather tenuous grounds, 63 per cent of the run was enumerated in the terminal areas where the destination, and thus stock group, was known. Moreover, an additional 8 per cent of the run consisted of pinks caught in areas (e.g. West Beach, Salmon Bank, Point Roberts, Fraser Gulf) where the contribution of each stock group could be deduced with reasonable confidence on the basis of its timing in 1959. Thus the estimates of abundance by stock group would appear to be reasonably reliable.

Estimates of the proportions of the run migrating via Northern and Southern Approach routes must be considered somewhat less accurate. Pink salmon spawning north of the Strait of Georgia and those spawning in United States streams may be considered to have consisted almost exclusively of Northern and Southern Approach fish respectively. However, fish spawning in Strait of Georgia and Fraser River streams, where the two runs were mixed, made up nearly two-thirds of the total run. Calculations of the abundance of Northern and Southern Approach fish in these two terminal areas were based on limited data and involved somewhat tenuous procedures.

Description of the 1961 Pink Salmon Run to the Study Area

ABUNDANCE AND MIGRATION ROUTES OF NORTHERN AND SOUTHERN APPROACH RUNS

The general pattern of the migration of the 1961 pink salmon runs to the Study Area (FIGURE 11) was considered, on the basis of a limited tagging program in Juan de Fuca Strait and of the timing of catches in the major fishing areas, to be the same as that observed in 1959.

²² In 1959, 21 per cent of the Queen Charlotte Strait troll catch was considered to have been Southern Approach fish. However, this estimate was based on the tagging for one weekend only. In the more general 1961 analysis, all of the relatively small catch in this area (less than 3 per cent of the total catch) was assigned to the Northern Approach. Some support for this procedure is given by the 52 recoveries of pink salmon tagged off the west coast of Vancouver Island in 1961 by the Fisheries Research Board as part of a study of high seas salmon distribution. These recoveries indicated that Cape Scott was the best division point between Northern and Southern Approach pinks in that year (Neave, personal communication).

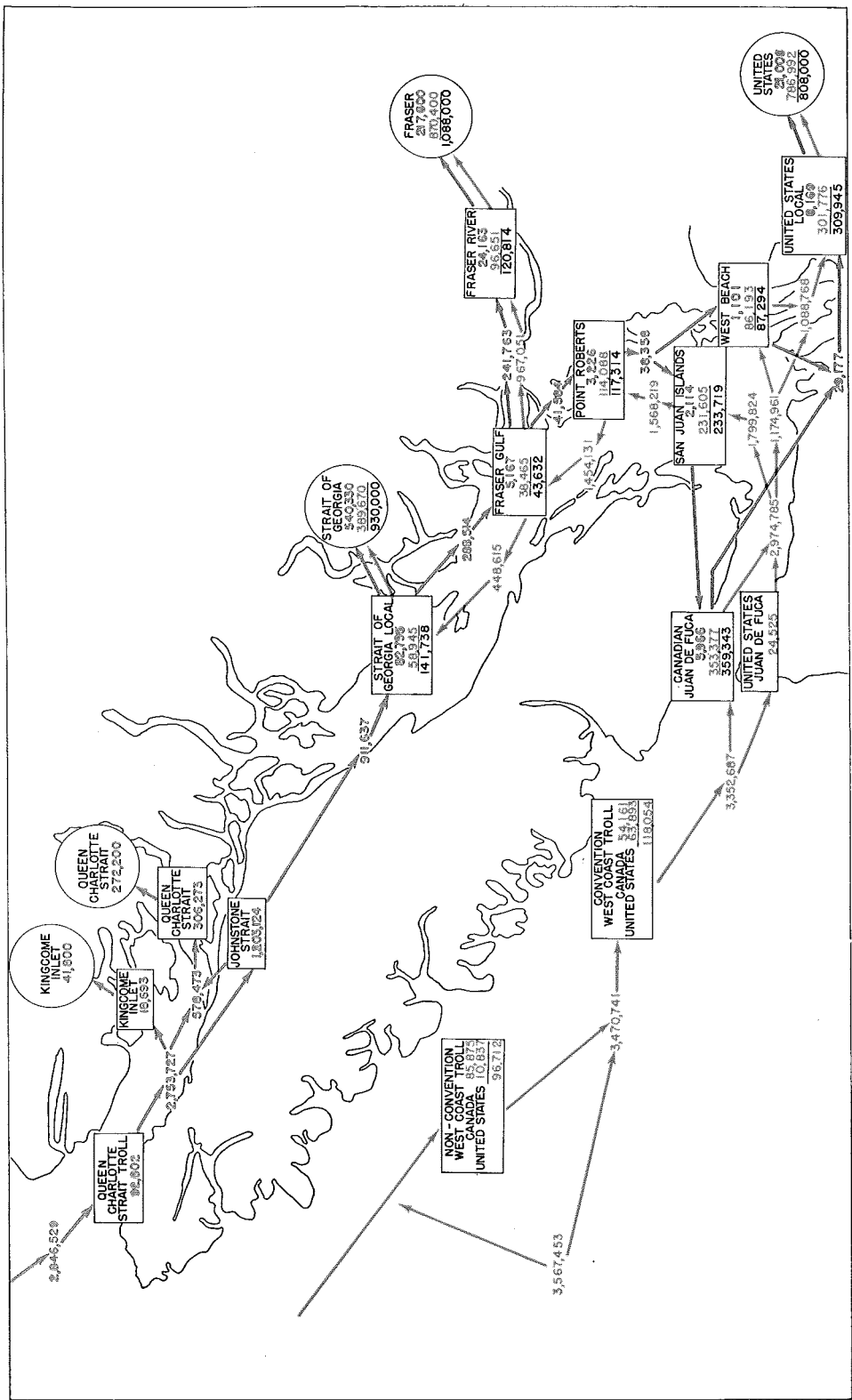


FIGURE 11. Migration routes of Northern and Southern Approach runs in the Study Area in 1961, showing, for each run, catches in the various fishing areas (rectangles), spawning escapements by stock (circles) and the total numbers of fish entering and leaving fishing areas along the migration routes.

Of the 6,414,000 pinks entering the Study Area, 2,847,000 (44 per cent) were estimated to have approached from the north. These Northern Approach fish first encountered a troll fishery in Queen Charlotte Strait which removed 93,000 (3 per cent of the Northern Approach run). On passing through this fishing area, 60,000 Kingcome Inlet fish and some of the Queen Charlotte Strait fish left the main migration route and proceeded to their spawning grounds, being reduced in numbers by local fisheries en route. The main run then entered Johnstone Strait, where a major net fishery removed 1,203,000 (42 per cent of the run) and the remainder of the Queen Charlotte Strait fish left the main body of pinks and proceeded to their spawning grounds. The remaining 912,000 pinks (32 per cent of the run) entered the Strait of Georgia²³ where the majority (623,000 or 22 per cent of the run) migrated towards spawning grounds in that area. En route, local fisheries (including the small Strait of Georgia fisheries) removed a further 83,000 fish, leaving 540,000 (19 per cent of the run) to spawn in Strait of Georgia streams. The remaining 289,000 pinks (10 per cent of the run) escaping from Johnstone Strait continued onward to the southern end of the Strait of Georgia. Here, fisheries in the Fraser Gulf and River removed 29,000 pinks and 218,000 (8 per cent of the run) proceeded upriver and spawned in the Fraser system. Of the 42,000 pinks (1 per cent of the run) that continued on south of the Fraser, 13,000 were taken in fisheries in the Convention area and 8,000 in local fisheries in United States waters south of the Convention area, leaving 21,000 to spawn in streams in the State of Washington.

Of the 3,567,000 pinks entering from the south, 96,000 were removed by trollers before the run entered Convention waters leaving 3,469,000 to enter the Convention area. Inside the Convention area trollers removed 118,000 leaving 3,353,000 to enter Juan de Fuca Strait where Canadian fishermen took 353,000 pinks (10 per cent of the Southern Approach run) and United States fishermen took 25,000 pinks. Of the 2,975,000 pinks (83 per cent of the run) reaching the eastern end of the Strait, 1,175,000 fish (33 per cent of the run) proceeded to United States waters south of the Convention area. En route, some of these fish passed through a fishery at West Beach which removed 86,000 pinks (3 per cent of the run). United States local fisheries removed a further 302,000 (8 per cent of the run) leaving 787,000 pinks (22 per cent of the run) to spawn in streams in the State of Washington. The remaining 1,800,000 pinks (50 per cent of the Southern Approach run) reaching the eastern end of Juan de Fuca Strait turned northward through the San Juan Islands, Point Roberts and Fraser Gulf areas where net fisheries removed 231,000 (6 per cent of the run), 114,000 (3 per cent of the run) and 38,000 (1 per cent of the run) respectively. From the Fraser Gulf area 967,000 fish (27 per cent of the run) entered the Fraser River, where the local fishery took 97,000, leaving 870,000 (24 per cent of the run) to spawn in Fraser River streams. The remaining 449,000 fish (13 per cent of the run) migrated northward into the Strait of Georgia. Here local fisheries removed 59,000, leaving 390,000 (11 per cent of the run) to spawn in streams in this area.

ABUNDANCE AND EXPLOITATION OF MAJOR STOCK GROUPS

Fraser River fish, which dominated the 1959 run (accounting for nearly two-thirds of the fish entering the Study Area), were considerably less abundant in 1961, making up less than one-third of the total run (TABLE 31). The largest

²³ Pinks spawning in streams tributary to Johnstone Strait are included in the Strait of Georgia stock group in this analysis.

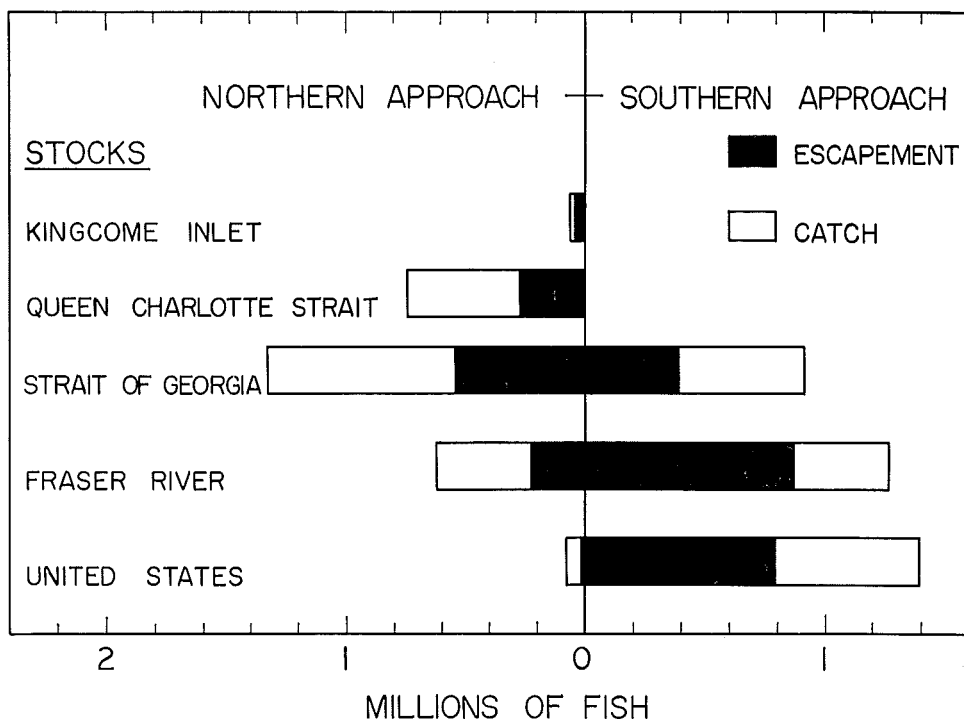


FIGURE 12. Abundance (catch plus spawners) of pink salmon stocks in 1961. Northern and Southern components are shown for each stock.

stock group in 1961 was the Strait of Georgia stocks, whose 2,251,000 fish made up slightly more than one-third of the total run (FIGURE 12). The Fraser and United States stock groups were somewhat less abundant (1,884,000 and 1,468,000 fish respectively). The Queen Charlotte Strait and Kingcome Inlet stocks contributed 748,000 and 63,000 fish respectively to the run.

Fishing was heaviest on the Queen Charlotte Strait stocks; fishermen removed 64 per cent of these stocks, mainly in a heavy local fishery (TABLE 31). The Strait of Georgia stocks contributed 59 per cent of their numbers to the fisheries and United States stocks contributed 45 per cent. Mainly as a result of protective measures during the fishing season, only 42 per cent of the Fraser-bound fish were caught in 1961 (as opposed to 83 per cent in 1959). As in 1959, the rate of removal for the Kingcome Inlet stock was relatively low (33 per cent).

The Northern Approach segments of all stock groups were fished more heavily than their counterparts approaching from the south (TABLE 31), reflecting the effects of more severe fishing restrictions in Convention waters to protect the Fraser stocks. As a result, the Northern Approach run, although comprising only 44 per cent of the combined run, provided 54 per cent of the total catch.

Review of the 1961 Run in Terms of Catches in the Canadian, United States and Convention Areas

In the following section, the 1961 run of pink salmon to the Study Area is discussed and compared with the 1959 run in terms of the catches taken by Canadian and United States fishermen inside and outside the Convention area from the runs to the Canadian area (Canada Non-Fraser streams), the United States area (United States streams) and the Convention area (Fraser River system).

Of the 6,414,000 pink salmon that entered the Study Area in 1961, it was estimated that 2,847,000 (44 per cent) approached from the north via Queen Charlotte Strait and 3,567,000 approached from the south via Juan de Fuca Strait (FIGURE 13). North of Convention waters, Canadian fishermen removed 1,704,000 pinks (60 per cent) from the Northern Approach run and a further 854,000 pinks (30 per cent of this run) migrated to spawning grounds in streams north of the mouth of the Fraser. Only 289,000 (10 per cent) of the fish entering Queen

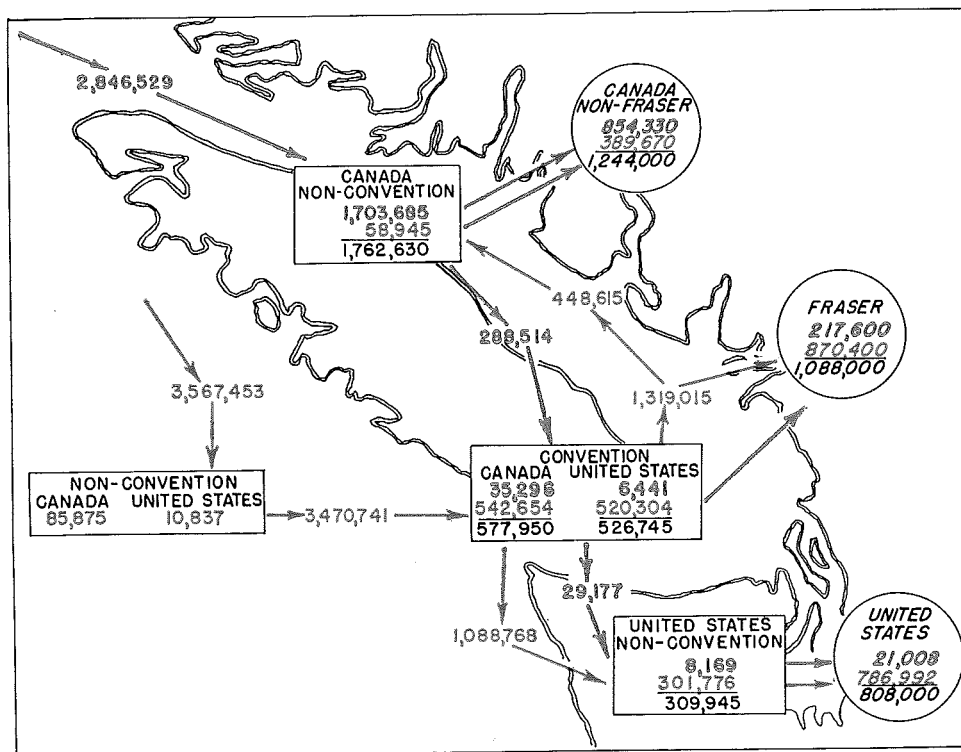


FIGURE 13. Migration routes of Northern and Southern Approach runs in the Study Area in 1961 showing, for each run, the catches by Canadian and United States fishermen outside and inside the Convention area (rectangles), spawning escapements by Study Area (circles) and the total numbers of fish entering and leaving fishing areas along the migration route. (Northern Approach fish destined for Burrard Inlet and Howe Sound are considered not to have entered Convention waters.)

TABLE 32. Numbers and percentages of pink salmon destined for Canada Non-Fraser, Fraser River and United States areas which were caught by Canadian and United States fishermen inside and outside the Convention Area, and the percentage of the total fish destined for these areas which were caught (rates of removal) in 1961.

	AREA OF DESTINATION			ALL
	Canada Non-Fraser	Fraser	United States	
NUMBERS OF FISH				
Catch				
Canada—Non-Convention	1,374,526	401,527	72,452	1,848,505 ^a
—Convention	158,129	275,840	143,981	577,950 ^a
United States—Convention	283,009	114,427	129,309	526,745
—Non-Convention	2,779	3,836	314,167	320,782
Total Catch	1,818,443	795,630	659,909	3,273,982
Spawners	1,244,000	1,088,000	808,000	3,140,000
Total Abundance	3,062,443	1,883,630	1,467,909	6,413,982
PERCENTAGE DESTINED FOR EACH AREA				
Catch				
Canada—Non-Convention	74.4	21.7	3.9	100.0
—Convention	27.4	47.7	24.9	100.0
United States—Convention	53.7	21.7	24.6	100.0
—Non-Convention	0.9	1.2	97.9	100.0
Total Catch	55.5	24.3	20.2	100.0
Spawners	39.6	34.7	25.7	100.0
Total Abundance	47.7	29.4	22.9	100.0
PERCENTAGE IN CATCHES AND SPAWNING ESCAPEMENTS				
Catch				
Canada—Non-Convention	44.9	21.3	5.0	28.8
—Convention	5.2	14.6	9.8	9.0
United States—Convention	9.2	6.1	8.8	8.2
—Non-Convention	0.1	0.2	21.4	5.0
Total Catch	59.4	42.2	45.0	51.0
Spawners	40.6	57.8	55.0	49.0
Total Abundance	100.0	100.0	100.0	100.0

^a The 6,825 pinks caught in Burrard Inlet are included in the Canada Non-Convention catch in this analysis although Burrard Inlet is located in Convention waters (See TABLE 1 and Footnote 24).

Charlotte Strait entered the Convention area²⁴. Of these 289,000 pinks, 42,000 were caught in Convention waters, 218,000 (8 per cent of the Northern Approach run) spawned in the Fraser River system and 29,000 migrated southward out of the Convention area. South of Convention waters, 8,000 of these pinks were caught by United States fishermen and 21,000 spawned in streams in the State of Washington.

Of the 3,567,000 pinks entering along the Southern Approach, Canadian and United States trollers removed 96,000 (3 per cent of this run) before the run

entered Convention waters. The remaining 3,471,000 entered the Convention area via Juan de Fuca Strait. In Convention waters, Canadian and United States fishermen shared (approximately equally) a catch of 1,063,000 (30 per cent of this run). Of the remaining 2,408,000 fish, 1,089,000 (30 per cent of the run) entered United States waters south of the Convention area where 302,000 (8 per cent of this run) were taken in local fisheries, leaving 787,000 (22 per cent of this run) to spawn in streams in the State of Washington. Of the remaining 1,319,000 pinks (37 per cent of the run) escaping from the Convention area fisheries, 870,000 (24 per cent of the run) spawned in the Fraser River system and 449,000 (13 per cent of the run) proceeded northward beyond the Convention area. In the Strait of Georgia, local fisheries removed 59,000 of these fish, leaving 390,000 pinks (11 per cent of the run) to spawn in Strait of Georgia streams.

The Canadian catch outside the Convention area in 1961 came mainly from Canada Non-Fraser fish (74 per cent—TABLE 32) whereas in 1959 it was evenly divided between Canada Non-Fraser and Fraser fish (48 per cent each). Fraser fish formed a plurality in the Canadian catch in the Convention area in 1961 (48 per cent vs. 27 and 25 per cent for Canada Non-Fraser and United States fish respectively). However, over half (54 per cent) of the catch by United States fishermen in the Convention area came from Canada Non-Fraser stocks, with United States stocks contributing slightly more (24 per cent) than Fraser stocks (22 per cent). In 1959, Fraser stocks made up the bulk of the Convention area catches by both Canada and the United States (84 and 87 per cent respectively). The major difference between the two years was the Convention area catch (1,105,000 in 1961 vs. 4,809,000 in 1959). The Canada Non-Convention catch was down 27 per cent from the 1959 level while the United States Non-Convention catch was up 49 per cent. There were 49 per cent more spawners in United States streams in 1961 than in 1959 and 21 per cent more in Canadian streams other than the Fraser, while the Fraser spawning population was approximately the same in both years (up 1 per cent in 1961).

Summary and Comparison of the Basic Characteristics of the 1961 and 1959 Runs

1. The migration routes (FIGURE 11) and times of passage (FIGURES 6, 7 and 10) of the various stock groups of pink salmon through major fishing areas in the Study Area appear to have been similar to those for the 1959 run²⁵. Pink salmon entering the Study Area from the north migrated through Queen Charlotte and Johnstone Strait to spawning streams in that area and to streams in the Strait of Georgia, the Fraser River and, to a much lesser extent, Puget Sound area. Pink salmon entering from the south migrated through Juan de Fuca Strait to

²⁴ Pink salmon migrating to streams in Howe Sound and Burrard Inlet pass through the northern fringe of the Convention area en route to their spawning grounds. Small numbers of these fish were caught in Convention waters (Burrard Inlet and Fraser Gulf). However, for the purposes of this analysis it is assumed that Burrard Inlet and Howe Sound fish, other than those included in Convention area catches, did not enter Convention waters.

²⁵ Data on the 1959 run are from Vernon, Hourston and Holland, 1964. Corresponding figures and tables to those referenced herein are as follows:

1961	1959
FIGURE 13	FIGURE 27, p. 135
TABLE 33	TABLE 78, p. 136
TABLE 32	TABLE 79, p. 138

TABLE 33. Numbers and percentages of pink salmon migrating by the Northern and Southern Approaches which were destined for Canada Non-Fraser, the Fraser River and United States areas in 1961 and the percentages of the total runs to these areas which migrated by each approach.

	AREA OF DESTINATION			ALL
	Canada Non-Fraser	Fraser	United States	
	NUMBERS DESTINED FOR EACH AREA			
Northern Approach	2,147,888	620,114	78,527	2,846,529
Southern Approach	914,555	1,263,516	1,389,382	3,567,453
Both	3,062,443	1,883,630	1,467,909	6,413,982
	PERCENTAGE DESTINED FOR EACH AREA			
Northern Approach	75.46	21.78	2.76	100.00
Southern Approach	25.63	35.42	38.95	100.00
Both	47.75	29.37	22.88	100.00
	PERCENTAGE MIGRATING BY EACH APPROACH			
Northern Approach	70.14	32.92	5.35	44.38
Southern Approach	29.86	67.08	94.65	55.62
Both	100.00	100.00	100.00	100.00

spawning streams in Puget Sound, the Fraser River and the Strait of Georgia areas. Canada Non-Fraser fish were the first to appear, followed by United States and then Fraser fish.

2. The 1961 run totalled 6,414,000 pinks (TABLE 33), 38 per cent less than the 1959 run²⁵ (10,265,000 pinks). The Northern Approach run in 1961 (2,847,000) was 25 per cent less than in 1959 (3,776,000) and the Southern Approach run (3,567,000) was 45 per cent less than in 1959 (6,488,000). Thus a smaller proportion of the run migrated via the Southern Approach in 1961 (56 per cent) than in 1959 (63 per cent).

3. Of the 6,414,000 pink salmon entering the Study Area in 1961, 3,062,000 (48 per cent) were destined for Canadian streams other than the Fraser, 1,884,000 (29 per cent) were destined for the Fraser and 1,468,000 (23 per cent) were destined for United States streams (Table 33). Of the 10,265,000 pink salmon entering the Study Area in 1959, 2,534,000 (25 per cent) were destined for Canadian streams other than the Fraser, 6,549,000 (63 per cent) were destined for the Fraser and 1,272,000 (12 per cent) were destined for United States streams²⁵. Thus the 1961 runs to Canada Non-Fraser and United States streams were 21 and 15 per cent higher respectively than in 1959 while the 1961 run to the Fraser was 71 per cent lower than in 1959. As a result, Fraser fish, which dominated the 1959 run (63 per cent of the run) made up a much smaller proportion of the 1961 run (29 per cent) whereas Canada Non-Fraser fish, which accounted for only 25 per cent of the 1959 run, were the largest stock group in 1961 (48 per cent of the run).

4. Of the 2,847,000 pinks migrating via the Northern Approach in 1961, 2,148,000 (75 per cent) were destined for Canadian streams other than the Fraser, 620,000 (22 per cent) were destined for the Fraser and 79,000 (3 per cent) were destined for United States streams (TABLE 33). Of the 3,776,000 pinks migrating via the Northern Approach in 1959, 1,989,000 (53 per cent) were destined for Canadian streams other than the Fraser, 1,698,000 (45 per cent) were destined for the Fraser and 89,000 (2 per cent) were destined for United States streams²⁵. Thus, the abundance of Canada Non-Fraser and United States fish in the Northern Approach run in 1961 was similar to that in 1959 (8 per cent higher and 11 per cent lower respectively), whereas the big difference between the two years was the much smaller run of Fraser fish in 1961 (63 per cent lower than in 1959). This resulted in raising the proportion of Canada Non-Fraser fish in the Northern Approach run from a bare majority in 1959 to three-quarters of the run in 1961.

5. Of the 3,567,000 pinks migrating via the Southern Approach in 1961, 915,000 (26 per cent) were destined for Canadian streams other than the Fraser, 1,263,000 (35 per cent) were destined for the Fraser and 1,389,000 (39 per cent) were destined for United States streams (TABLE 33). Of the 6,488,000 pinks migrating via the Southern Approach in 1959, 544,000 (8 per cent) were destined for Canadian streams other than the Fraser, 4,762,000 (74 per cent) were destined for the Fraser and 1,182,000 (18 per cent) were destined for United States streams²⁵. Thus while the abundance of United States fish was only slightly (15 per cent) greater in 1961 than in 1959, their relative abundance in 1961 (39 per cent) was over twice as great as in 1959 (18 per cent) and United States fish formed the largest stock group in the Southern Approach run in 1961. The abundance of Canada Non-Fraser fish in this run in 1961 (915,000) was nearly twice that in 1959 (544,000) and their relative abundance in 1961 (26 per cent) was three times as great as in 1959 (8 per cent). As on the Northern Approach, the Fraser stocks showed the greatest difference between the two years. The abundance of Fraser fish in 1961 (1,263,000), when they made up 35 per cent of this run, was only one-quarter of that in 1959 (4,672,000), when they accounted for 74 per cent of the Southern Approach run.

6. Although the majority (67 per cent) of the Fraser fish approached from the south in 1961 (TABLE 33), the proportion was appreciably less than in 1959 (74 per cent)²⁵. In contrast, the proportion of Canada Non-Fraser fish approaching from the south was higher in 1961 (30 per cent) than in 1959 (21 per cent). The proportion of United States fish approaching from the south was about the same as in 1959 (95 per cent in 1961 vs. 93 per cent in 1959).

7. The number of spawners in 1961 (3,140,000—TABLE 32) was up 19 per cent from that in 1959²⁵ (2,642,000). The number of spawners in the United States Study Area in 1961 (808,000) was one and one-half times that in 1959 (540,700): the number of spawners in the Canadian Study Area in 1961 (1,244,000) one and one-fifth times that in 1959 (1,024,700): the number of spawners in the Convention area (1,088,000) virtually identical to that in 1959 (1,077,000). The total number of spawners in the combined Study Area in 1961 (3,140,000) was about one-fifth greater than that in 1959 (2,642,400). The proportion of Canada Non-Fraser fish in the total spawning escapement (40 per cent) was almost identical to that in 1959 (39 per cent) while that of the Fraser fish (35 per cent) was down 6 per cent from 1959 and that of the United States fish (26 per cent) up 5 per cent (TABLE 32).

8. Of the 3,274,000 pink salmon caught in the Study Area in 1961, 1,848,000 (56 per cent) were taken by Canadian fishermen outside the Convention area, 1,105,000 (34 per cent) were taken in the Convention area (approximately half by Canadian fishermen and half by United States fishermen) and 321,000 (10 per cent) by United States fishermen outside the Convention area (TABLE 32). Of the catch of 7,622,000 pinks in 1959, 2,591,000 (34 per cent) were taken by Canadian fishermen outside the Convention area, 4,809,000 (63 per cent) were taken in the Convention area and 222,000 (3 per cent) was taken by United States fishermen outside the Convention area²⁵. Thus the total catch in 1961 was 57 per cent lower than in 1959 while the catches in the Canada Non-Convention and the Convention areas were down 29 and 77 per cent respectively from those in 1959. Only the United States catch outside the Convention area was greater (by 45 per cent) in 1961 than in 1959, reflecting the fact that a larger proportion of the fish destined for United States streams reached the terminal fishing areas in 1961 than in 1959. In 1961, Canadian fisheries outside the Convention area took 29 per cent of the total run (vs. 25 per cent in 1959), fisheries in the Convention area took 17 per cent of the total run (vs. 47 per cent in 1959) and United States fisheries outside the Convention area took 5 per cent of the total run (vs. 2 per cent in 1959).

9. Of the 3,274,000 pinks caught in 1961, 1,818,000 (56 per cent) were estimated to have been destined for Canadian streams other than the Fraser, 796,000 (24 per cent) were estimated to have been destined for the Fraser and 660,000 (20 per cent) were estimated to have been destined for United States streams (TABLE 32). Of the 7,622,000 pinks caught in 1959, 1,509,000 (20 per cent) were estimated to have been destined for Canadian streams other than the Fraser, 5,382,000 (71 per cent) were estimated to have been destined for the Fraser and 731,000 (9 per cent) were estimated to have been destined for United States streams²⁵. The catches of Fraser River and United States fish in 1961 were 90 and 10 per cent lower, respectively, than in 1959 while the catch of Canada Non-Fraser fish was 20 per cent higher than in 1959. Thus the big difference in catches by stock group in the two years was the tremendous reduction in the catch of Fraser fish in 1961 from the 1959 level. Whereas Fraser fish dominated the 1959 catches, they contributed less than half as many fish to the 1961 catches as did Canada Non-Fraser fish and only slightly more than did United States fish.

10. As would be expected from their contributions to the catches and spawning escapements, the Canada Non-Fraser fish were most heavily exploited by the fishermen and Fraser fish least heavily exploited (TABLE 32). The rate of removal (percentage of the total numbers entering the Study Area which were caught) for Canada Non-Fraser fish (59 per cent) remained at the 1959 level²⁵ (60 per cent) while that for Fraser fish (42 per cent) was half the 1959 level (83 per cent)²⁶ and that for the United States stocks (45 per cent) was down somewhat from the 1959 level (58 per cent). The rate of removal for the total run in 1961 (51 per cent) was only about two-thirds that in 1959 (74 per cent).

²⁶ Because of the low abundance of Fraser fish in 1961, fishing in the Convention area was severely restricted during the passage of the run to the Fraser.

ANNUAL VARIABILITY IN PINK SALMON RUNS TO THE STUDY AREA

As indicated in the general introduction, the purpose of this study was to determine the extent to which the detailed description by Vernon, Hourston and Holland (1964) of the 1959 pink salmon run to the Fraser River and adjacent areas has applied to other cycle years. The extent to which such an assessment is possible depends on the completeness and reliability of information on the migration routes, times of passage, composition, exploitation rates and abundance of the runs under consideration in other years.

In the preceding sections, the major characteristics of the 1961 runs to Canada Non-Fraser, Fraser River and United States streams were described and compared with similar information from the more intensive study conducted on the 1959 run. Quantitative data on the composition, exploitation and abundance of the run in these two years are summarized in TABLE 34. A similar but more gross analysis of the 1963 run in the Convention area (International Pacific Salmon Fisheries Commission, 1964), combined with information on catches and spawners north of the Convention area, TABLE 35 and APPENDIX G respectively, provided quantitative information on some of the more important characteristics of the run as a whole in that year (TABLE 34). Thus the information required for quantitative assessments of the extent of variability in some of the basic numerical characteristics of the run is available for these three cycle years.

Information on *migration routes and times of passage through the major fishing areas* for the cycle years prior to 1959 is limited to rather incomplete tagging data for a few years and the pattern of peak catches in some fishing areas. These data are not adequate to fully describe the migration routes and times of passage for individual years, but may be compared with the 1959 data for comparability with the detailed description of migration routes and times of passage in that year.

Information on the *composition* of the total run to the Study Area (relative abundance of its Northern and Southern Approach components and of the runs to Canada Non-Fraser, Fraser River and United States streams) in the cycle years prior to 1959 may be derived from catch data. Subject to changes in rates of removal, variations from year to year in the Johnstone Strait catch (which accounted for 53 and 42 per cent of the Northern Approach run in 1959 and 1961 respectively) can be used as indices of variations in the abundance of the *Northern Approach* run. Similarly, annual catches in the Convention area and Puget Sound (which amounted to 70 and 31 per cent of the *Southern Approach* run in 1959 and 1961 respectively) can be used as indices of variation in abundance of the Southern Approach run²⁷. The proportions of the total run migrating via the Northern and Southern Approaches can also be estimated from these two sets of catch data. However, comparison between years of these proportions would be subject to additional errors to the extent that concomitant changes in exploitation rates were dissimilar on the two approaches. Even so, large differences in the proportions caught on either approach probably would be indicative of variations in the relative abundance of the runs on the two approaches.

²⁷ These catches would include a very small proportion of Northern Approach fish (5 and 4 per cent of these catches in 1959 and 1961 respectively) which may be considered negligible.

TABLE 34. Catch, spawners, run (each in thousands of fish) and rate of removal for Canada Non-Fraser, Fraser River and United States pink salmon migrating via the Northern and Southern Approaches in 1959, 1961 and 1963. Data for the Convention and United States areas in 1963 are from the Annual Report of the International Pacific Salmon Fisheries Commission for that year; data for the Canadian area in 1963 are from TABLE 35 and APPENDIX G. Data for 1961 are summarized from TABLE 31 of this report and data for 1959 are summarized from Vernon, Hourston and Holland, 1964, TABLES 64, 65, 68, 69 and 70.

	1959				1961				1963			
	Catch	Spawners	Run	Rate of removal	Catch	Spawners	Run	Rate of removal	Catch	Spawners	Run	Rate of removal
NORTHERN APPROACH												
Canada Non-Fraser	1,194	795	1,989	60.0	1,293	854	2,147	60.2	1,547 ^a	1,128	2,675	57.8
Fraser River	1,355	343	1,698	79.8	403	218	621	64.9	742 ^b	—	—	—
United States	75	14	89	84.2	58	21	79	73.3	0 ^c	0 ^c	0 ^c	—
TOTAL	2,624	1,152	3,776	69.5	1,754	1,093	2,847	61.6	—	—	—	—
SOUTHERN APPROACH												
Canada Non-Fraser	315	229	544	57.8	525	390	915	57.4	662 ^a	638 ^a	1,300	50.9 ^a
Fraser River	4,027	734	4,761	84.6	393	870	1,263	31.1	2,567 ^d	1,953 ^d	4,520 ^d	56.8 ^d
United States	656	527	1,183	55.5	602	787	1,389	43.4	7,106 ^c	3,224 ^c	10,330 ^c	68.8
TOTAL	4,998	1,490	6,488	77.0	1,520	2,047	3,567	42.6	—	—	—	—
BOTH APPROACHES												
Canada Non-Fraser	1,509	1,024	2,533	59.6	1,818	1,244	3,062	59.4	2,209	1,766	3,975	55.6
Fraser River	5,382	1,077	6,459	83.3	796	1,088	1,884	42.2	3,309	1,953	5,262	62.9
United States	731	541	1,272	57.5	660	808	1,468	45.0	7,106 ^c	3,224	10,330 ^c	68.8 ^c
TOTAL	7,622	2,642	10,264	74.3	3,274	3,140	6,414	51.0	12,624 ^e	6,943	19,567	64.5

^a Assumes catch of Southern Approach fish north of Convention waters was negligible.

^b Johnstone Strait catch only.

^c Assumes Northern Approach run of United States fish was negligible.

^d Total run entering the Convention area (Northern and Southern Approach).

^e Catch in Convention waters (8,600) plus Canada Non-Convention catch (2,289) plus United States Non-Convention catch (1,735). Excludes West Coast Troll (Canada 237, United States 228).

TABLE 35. Catches of pink salmon in the Queen Charlotte and Johnstone Strait area^a to August 26 and in the Strait of Georgia area^b throughout the season and catches in the Queen Charlotte and Johnstone Strait area after August 26 for the cycle years 1951 to 1963. The former are considered to represent the catch of Northern Approach Canada Non-Fraser fish and the latter the Non-Convention catch of Northern Approach Fraser fish for these years.

	YEAR						ALL YEARS
	1951	1953	1955	1957	1959	1961	1963
	CATCHES						
CANADA NON-FRASER							
Queen Charlotte and Johnstone Straits ^a to August 26	1,196,990	2,645,390	1,712,940	2,917,798	1,260,198	1,369,904	1,207,840
Strait of Georgia ^b	191,333	258,706	139,080	71,468	177,709	128,845	339,317
SUB-TOTAL	1,388,323	2,904,096	1,852,020	2,989,266	1,437,907	1,498,749	1,547,157
FRASER RIVER							
Queen Charlotte and Johnstone Straits ^a after August 26	865,975	2,227,619	1,330,831	1,437,465	1,026,828	261,986	741,534
TOTAL	2,254,298	5,131,715	3,182,851	4,426,731	2,464,735	1,760,735	2,288,691
	PER CENT IN CATCHES NORTH OF THE CONVENTION AREA						
CANADA NON-FRASER	61.6	56.6	58.2	67.5	58.3	85.1	67.6
FRASER RIVER	38.4	43.4	41.8	32.5	41.7	14.9	32.4
	PER CENT IN JOHNSTONE STRAIT CATCH						
CANADA NON-FRASER	58.0	54.3	56.3	67.0	55.1	83.9	62.0
FRASER RIVER	42.0	45.7	43.7	33.0	44.9	16.1	38.0

^a Canadian Statistical Areas 12 and 13.
^b Canadian Statistical Areas 14, 15, 16 and 28.

Indices of the *relative abundance* of the runs to Canada Non-Fraser, Fraser River and United States streams from year to year may also be derived from catch data, (subject to the same source of error resulting from changes in rates of exploitation over the years). In the years for which catch data are available on a weekly basis (since 1951 for Canadian fisheries and since 1937 for United States fisheries - APPENDIX H), approximate divisions of the Johnstone Strait, San Juan Islands and Point Roberts catches into Canada Non-Fraser and Fraser fish are possible on the basis of the times of passage of these runs. (The contributions of United States fish to the catches in these areas are considered to have been negligible.) Indices of the relative abundance of United States and Canadian stocks on the Southern Approach may be obtained by comparing the catches at San Juan Islands, Point Roberts and the Fraser River (considered to be almost exclusively Canadian fish) with those at West Beach, Puget Sound and Bellingham Bay (considered to be almost exclusively United States fish).

Quantitative estimates of spawning populations throughout the Study Area are not available for years prior to 1959 (except for the Fraser River in 1957 - Ward, 1959). Consequently, quantitative estimates of the *rates of removal* for the run to the Study Area and its various components are limited to the past three cycle years (TABLE 34).

Since quantitative estimates of rates of removal are limited to the 1959, 1961 and 1963 cycle years, quantitative estimates of the *abundance* of the run and its various components are also limited to three years. Again, however, catch data may be used as indices of relative abundance from year to year, subject, as above, to the effects of changes in rates of removal over the years. Complete catch records by area are available for all cycle years since 1951 (APPENDIX H). Moreover, since the proportions of Northern and Southern Approach fish and of the runs to Canada Non-Fraser and Fraser River streams can be estimated for these years (see above) gross quantitative estimates can also be made for these components of the run in these years.

Seine catches in Johnstone Strait, representing the bulk of the catch of Northern Approach fish, and catches in Convention and United States waters, representing almost all of the catch of Southern Approach fish (plus relatively small numbers of Northern Approach fish) are available for cycle years since 1937. However, so little is known or can even be assumed concerning the year to year changes in the rates of removal in years prior to 1951 that detailed quantitative comparisons of these catches would have little meaning. Nevertheless, it may be assumed that rates of removal in the earlier years were lower than those for the largest runs in recent years. Catches during any of the earlier years which approached or exceeded the highest catch in recent years would serve to indicate that much larger runs occurred in the earlier years. Similarly, unless catches in some of these earlier years were much lower than any in recent years, none of the runs in these earlier years could have been less abundant than the smallest run experienced in recent years.

For the years prior to 1935, the available catch data are lumped by large geographic areas and/or species and provide no reasonable basis for assessment of the abundance of pink salmon runs to the Study Area.

Timing of the Runs to the Three Terminal Areas

NORTHERN APPROACH

Information on the times of passage of odd-year pink salmon runs through the main fishing areas on the Northern Approach prior to 1959 is available from the results of limited tagging programs conducted in Johnstone Strait in 1929 (Pritchard, 1932), 1943 (Pritchard and DeLacy, 1944), 1945 (DeLacy and Neave, 1948) and 1953 (Manzer, 1958). In all of these years except 1929 (when 470 tags were applied) the numbers of tags applied exceeded 3,000. The spawning grounds were not searched to any extent for tags and so recoveries were limited almost exclusively to the commercial fisheries. Tags which could be assigned to stock on the basis of date and/or area of recovery were examined for each of these programs.

The 1953 pink salmon run was tagged in the upper (Area 12) and lower (Area 13) portions of Johnstone Strait throughout the season using commercial catches as a source of fish. In all, 3,438 tags were applied between late July and early October (TABLE 36). Of the 1,251 tags recovered, 400 were identified as to stock (TABLE 36).

Weekly catch statistics for Areas 12 and 13 were available for 1953 (TABLE 37). Since the Johnstone Strait fishery usually accounted for the bulk of the catch from these two areas (83 per cent for Area 12 and 98 per cent for Area 13 in 1959) and since in 1953 the fishery was extensive and the weekly fishing time relatively constant throughout the season, the weekly catches were employed as indices of the relative abundance of the run from week to week. Thus, by weighting the numbers of tags applied each week to the catch for that week and applying the same weighting factors to the recoveries from that week's tagging, the recoveries from each stock were tabulated weekly in terms of a standard recovery unit (TABLE 38). This procedure permitted estimation of the percentage of that stock which passed through Johnstone Strait each week (TABLE 39).

In 1945, a total of 4,827 pink salmon was tagged in Johnstone Strait mainly during August (TABLE 40). No fish were tagged from late August to late September and only 135 tags were applied thereafter. Consequently, although there were large numbers of tags available for recovery (453 recoveries were identified as to stock—TABLE 40), all but 13 of these recoveries came from August taggings. Because of this time bias, the lack of adequate catch statistics on a weekly basis, and an apparent bias in the distribution of recovery effort among the stocks, the value of these data in the present analysis was limited to indications of the presence and approximate timing of the stocks in the Johnstone Strait fishery.

Tagging in Johnstone Strait during the 1943 fishing season covered the period from the last week in July to the third week in September. Although ample numbers of pinks were tagged each week throughout the season (TABLE 41), an adequate measure of weekly abundance in Johnstone Strait (i.e., weekly catch statistics) was again lacking. Thus the data from this tagging could be used in the present analysis only to indicate the presence and peak abundance of the various stocks in Johnstone Strait. Original recovery data for this program were not available but the presence and relative abundance of the stocks (TABLE 41) were indicated in the analysis presented by Pritchard and DeLacy (1944).

TABLE 36. Numbers of pink salmon tagged in Upper and Lower Johnstone Strait in 1953 and numbers of recoveries from each week's tagging which were identified to stock. Data for tags applied in Upper Johnstone Strait (Area 12) are shown on the top line for each stock and data for tags applied in Lower Johnstone Strait (Area 13) are shown on the next line. (From Manzer, 1958).

STOCK	TAGGED IN WEEK ENDING												ALL WEEKS
	July 25	Aug. 1	Aug. 8	Aug. 15	Aug. 22	Aug. 29	Sept. 5	Sept. 12	Sept. 19	Sept. 26	Oct. 3	Oct. 10	
	NUMBER TAGGED												
CANADA NON-FRASER	6	134	—	255	236	246	343	253	160	29	1	—	1,663
	34	86	279	83	300	299	300	152	151	37	50	4	1,775
	—	—	—	—	NUMBER RECOVERED								—
	—	—	—	—	1	—	—	—	—	—	—	—	1
	—	—	2	1	—	—	—	—	—	—	—	—	3
	—	3	—	—	2	3	1	—	—	—	—	—	9
	—	—	7	2	5	12	1	—	—	—	—	—	27
	—	—	—	—	1	—	—	—	—	—	—	—	1
	—	—	4	—	1	1	—	—	—	—	—	—	6
	—	2	—	4	5	2	2	—	1	—	—	—	16
TOTAL CANADA NON-FRASER	—	7	28	4	14	7	3	1	1	—	—	—	65
	—	8	—	2	0	2	—	—	—	—	—	—	12
	—	7	18	1	3	3	—	—	—	—	—	—	32
	—	—	—	1	1	—	—	—	—	—	—	—	2
	—	1	—	2	2	1	—	—	—	—	—	—	6
FRASER RIVER	—	13	—	7	10	7	3	—	1	—	—	—	41
	—	15	59	10	25	24	4	1	1	—	—	—	139
	—	—	—	2	8	15	16	7	1	—	—	—	49
	—	—	5	5	29	28	40	5	1	1	4	1	119
	—	—	—	2	6	3	11	3	—	—	—	—	25
UNITED STATES	—	—	4	3	7	3	10	—	—	—	—	—	27
	—	13	—	11	24	25	30	10	2	—	—	—	115
ALL AREAS	—	15	68	18	61	55	54	6	2	1	4	1	285

TABLE 37. Weekly catches of pink salmon in Area 12 (mainly Upper Johnstone Strait) and Area 13 (mainly Lower Johnstone Strait) for the weeks ending July 25 to October 10 in 1953.

WEEK ENDING	AREA 12	AREA 13	BOTH AREAS
July 25	14,406	4,829	19,235
Aug. 1	86,258	11,261	97,519
Aug. 8	227,295	75,374	302,669
Aug. 15	377,480	135,286	512,766
Aug. 22	822,843	314,008	1,136,851
Aug. 29	669,136	331,584	1,000,720
Sept. 5	683,220	295,196	978,416
Sept. 12	407,213	161,760	568,973
Sept. 19	161,531	54,359	215,890
Sept. 26	13,022	14,317	27,339
Oct. 3	1,878	3,518	5,396
Oct. 10	224	625	849
ALL WEEKS	3,464,506	1,402,117	4,866,623

Only 470 pinks were tagged in Johnstone Strait in 1929 and of these tags only 27 were recovered which could be identified as to stock (TABLE 42). These few recoveries were sufficient, however, to indicate the presence of several stocks in Johnstone Strait during four tagging periods in 1929.

The percentage of each stock of pink salmon which passed through the Johnstone Strait fishery each week in 1959 is available from the numbers of fish from each stock estimated to have been present in Johnstone Strait each week (Vernon, Hourston and Holland, 1964—TABLE 74). These percentages were compared with similar percentages for the 1953 run (estimated from less extensive data) and the periods when these stocks were present and most abundant in 1945, 1943 and 1929 (TABLE 43).

In general, the periods when *Canada Non-Fraser* stocks were present and most abundant in 1945, 1943 and 1929 coincide rather well with the times of passage of the stocks through Johnstone Strait in 1959. In 1953 about half of the Canada Non-Fraser stocks appear to have passed through Johnstone Strait about one week later than in 1959. However, in 1953 tagging was conducted during the fishing week whereas in 1959 tagging was conducted in the closed period prior to the beginning of the fishing week (i.e., about half a week earlier than in 1953). Thus the times of passage of the Canada Non-Fraser stocks through Johnstone Strait in 1959 appear to have been virtually the same as in 1953 and are quite compatible with the available data for 1945, 1943 and 1929.

Fish bound for *United States* streams were present in Johnstone Strait for virtually identical periods in 1959, 1953 (allowing for a half week difference in the time the tags were applied), 1945 and 1943. The periods of peak abundance varied from year to year but, since this "stock" is composed of several spawning stocks (grouped for convenience) which could vary in relative abundance, variation

TABLE 39. Percentage of each pink salmon stock present each week in the 1953 Johnstone Strait fishery. (Based on the distribution of tag recoveries weighted to abundance as indicated by catch).

STOCK	TAGGED IN WEEK ENDING										ALL WEEKS
	Aug. 1	Aug. 8	Aug. 15	Aug. 22	Aug. 29	Sept. 5	Sept. 12	Sept. 19	Sept. 26	Oct. 3	
CANADA NON-FRASER											
Mid Vancouver Island	—	14.8	44.5	40.7	—	—	—	—	—	—	—
Phillips Arm	2.6	5.6	9.8	25.2	51.2	5.6	—	—	—	—	—
Toba Inlet	—	23.5	—	53.0	23.5	—	—	—	—	—	—
Jervis Inlet	2.5	13.1	15.8	39.2	17.8	8.1	2.0	1.5	—	—	—
Howe Sound	18.6	28.9	18.6	12.7	21.2	—	—	—	—	—	—
Burrard Inlet	1.2	—	31.4	39.5	27.9	—	—	—	—	—	—
TOTAL CANADA NON-FRASER	4.3	12.4	16.4	32.7	27.5	5.1	0.9	0.7	—	—	—
FRASER RIVER	—	0.8	5.6	25.5	29.1	31.8	6.1	0.5	0.3	0.2	0.1
UNITED STATES	—	2.2	11.9	31.5	13.2	37.2	4.0	—	—	—	—

TABLE 40. Numbers of pink salmon tagged in Johnstone Strait in 1945 and numbers of recoveries from each week's tagging which were identified to stock. (From DeLacy and Neave, 1948.)

STOCK	TAGGED IN WEEK ENDING									ALL WEEKS
	July 28	Aug. 4	Aug. 11	Aug. 18	Aug. 25	Sept. 29	Oct. 6	Oct. 13	Oct. 20	
	NUMBER TAGGED									
	3	709	1,366	1,919	695	81	8	40	6	4,827
	NUMBER RECOVERED									
CANADA										
NON-FRASER										
Knight Inlet	—	4	—	4	3	—	—	—	—	11
Mid Vancouver Island	—	—	—	1	—	1	—	—	—	2
Toba Inlet	1	14	68	57	12	—	—	—	—	152
Jervis Inlet	—	—	—	2	—	—	—	—	—	2
Howe Sound	—	1	7	7	2	—	—	—	—	17
TOTAL CANADA										
NON-FRASER	—	19	75	71	17	1	—	—	—	184
FRASER RIVER	—	3	41	69	41	9	2	—	—	165
UNITED STATES	—	12	35	46	11	—	—	—	—	104
ALL AREAS	1	34	151	186	69	10	2	—	—	453

TABLE 41. Numbers of pink salmon tagged weekly in Johnstone Strait in 1943 and the stocks identified in the recoveries from each week's tagging.

0—Tags available but none recovered
x—Tag recoveries relatively few
xx—Tag recoveries relatively abundant
(From Pritchard and DeLacy, 1944).

STOCK	TAGGED IN WEEK ENDING								ALL WEEKS
	July 31	Aug. 7	Aug. 14	Aug. 21	Aug. 28	Sept. 4	Sept. 11	Sept. 18	
	NUMBER TAGGED								
	29	401	977	987	964	569	181	318	4,426
	NUMBER RECOVERED								
CANADA									
NON-FRASER									
Mid Vancouver Island	—	xx	xx	xx	x	x	x	0	—
Knight Inlet	—	x	x	x	0	0	0	0	—
Phillips Arm	—	xx	xx	x	x	x	x	x	—
Toba Inlet	—	xx	xx	x	x	x	0	0	—
Jervis Inlet	—	0	0	x	0	0	0	0	—
Howe Sound	—	xx	xx	x	x	x	0	0	—
Burrard Inlet	—	0	x	x	x	x	x	0	—
TOTAL CANADA									
NON-FRASER	—	xx	xx	xx	x	x	x	x	—
FRASER RIVER	—	x	x	xx	xx	xx	xx	xx	—
UNITED STATES	xx	xx	x	x	x	0	0	0	—

TABLE 42. Numbers of pink salmon tagged in Johnstone Strait in 4 periods during the 1929 fishery and numbers of recoveries from each period's tagging which were identified to stock. (From Pritchard, 1932.)

STOCK	PERIOD				ALL PERIODS
	August 5-9	August 12-16	August 28-29	September 5	
	95	NUMBER TAGGED			470
		193	151	31	
		NUMBER RECOVERED			
CANADA					
NON-FRASER					
Mid Vancouver Island	—	1	—	—	1
Phillips Arm	1	1	—	—	2
Toba Inlet	—	1	—	—	1
Jervis Inlet	—	1	—	—	1
Burrard Inlet	1	—	—	—	1
TOTAL CANADA					
NON-FRASER	2	4	—	—	6
FRASER RIVER	2	6	10	2	20
UNITED STATES	—	—	1	—	1
ALL AREAS	4	10	11	2	27

in the time of peak abundance might be expected. This situation should not seriously affect comparisons of the total run in Johnstone Strait between years as long as the abundance of fish destined for United States streams was low (as was the case in 1959).

Data on the time of passage of the *Fraser* fish in 1945 and 1929 are inadequate for comparison with 1959 because tagging in the two earlier years was not conducted during the period indicated as the peak by the 1959 data. Information on the time of passage of Fraser fish is available throughout the season for the 1943 run and corresponds rather well with the time of passage of Fraser fish in 1959. The 1953 run appears to have been about a week earlier than the 1959 and 1943 runs on the basis of tag recoveries. However, unlike the 1959 program, the 1953 program was dependent on the Fraser River gill net fishery for recoveries of Fraser tags. In 1953 the Fraser River fishery was open to fishing for only seven days during the period September 10 to October 18 and, for five of these fishing days, gear was restricted to large-mesh nets. Thus the apparent abrupt decline of Fraser fish in Johnstone Strait after the week ending September 5 may be attributed to a lack of recovery effort late in the season. Moreover the "levelling off" of the rate of increase in the week ending September 5 probably reflects the reduced fishing effort for tags when these fish entered the Fraser River fishery a week or so later. Thus the timing information on the 1953 Fraser pink salmon run through Johnstone Strait does not conflict with the timing estimated for the 1959 run.

It would therefore appear, from the somewhat limited information available, that the times of passage through Johnstone Strait of the various stocks of pink salmon in the odd years have remained more or less consistent from year to year.

TABLE 43. Relative weekly abundance of pink salmon stocks in Johnstone Strait in 1959, 1953, 1945, 1943 and 1929 as indicated by recoveries of tags applied in Johnstone Strait. Relative abundance is expressed as follows:

1959 and 1953—Percent of total stock present each week.
 1945, 1943 and 1929—Tags available but none recovered (o),
 tag recoveries relatively few (x),
 tag recoveries relatively abundant (xx).

STOCK	YEAR	1959 WEEK ENDING ^a											
		To July 25	Aug. 1	Aug. 8	Aug. 15	Aug. 22	Aug. 29	Sept. 5	Sept. 12	Sept. 19	Sept. 26	Oct. 3	Oct. 10
CANADA NON-FRASER													
Upper Vancouver Island	1959	23.5	13.8	33.6	23.0	6.1	0	0	0	—	—	—	—
Johnstone Strait	1959	18.8	9.9	16.1	48.0	6.3	0.9	0	0	—	—	—	—
Howe Sound	1959	—	7.4	37.2	47.9	5.6	1.9	0	0	—	—	—	—
	1953	—	18.6	28.9	18.6	12.7	21.2	0	0	0	—	—	—
	1945	—	x	xx	xx	x	—	—	—	—	0	—	—
	1943	—	—	xx	xx	x	x	x	0	0	—	—	—
Jervis Inlet	1959	6.6	7.5	10.6	47.8	18.0	8.0	1.5	0	—	—	—	—
	1953	—	2.5	13.1	15.8	39.2	17.8	8.1	2.0	1.5	—	—	—
	1945	—	0	0	x	0	—	—	—	—	0	—	—
	1943	—	—	0	0	x	0	0	0	0	—	—	—
	1929	—	—	0	x	—	0	0	—	—	—	—	—
Burrard Inlet	1959	—	4.4	17.5	45.4	29.5	3.2	0	0	—	—	—	—
	1953	—	1.2	0	31.4	39.5	27.9	0	0	0	—	—	—
	1943	—	—	0	x	x	x	x	x	0	—	—	—
	1929	—	—	x	0	—	0	0	—	—	—	—	—
Toba Inlet	1959	6.1	6.3	12.9	48.7	17.8	4.5	3.5	0.2	—	—	—	—
	1953	—	0	23.5	0	53.0	23.5	0	0	0	—	—	—
	1945	x	x	xx	xx	x	—	—	—	—	0	—	—
	1943	—	—	xx	xx	x	x	x	0	0	—	—	—
	1929	—	—	0	x	—	0	0	—	—	—	—	—
Mid Vancouver Island	1959	5.9	3.0	8.4	32.2	27.8	12.3	9.1	1.3	—	—	—	—
	1953	—	0	14.8	44.5	40.7	0	0	0	0	—	—	—
	1945	—	0	0	x	0	—	—	—	x	0	—	—
	1943	—	—	xx	xx	xx	x	x	x	0	—	—	—
	1929	—	—	0	x	—	0	0	—	—	—	—	—
Knight Inlet	1959	—	3.1	10.8	19.8	26.2	16.7	11.6	8.7	3.1	—	—	—
	1945	—	x	0	x	x	—	—	—	—	0	—	—
	1943	—	—	x	x	x	0	0	0	0	—	—	—
Phillips Arm	1959	—	1.2	4.5	22.1	25.0	28.8	13.2	4.9	0.3	—	—	—
	1953	—	2.6	5.6	9.8	25.2	51.2	5.6	0	0	—	—	—
	1943	—	—	xx	xx	x	x	x	x	x	—	—	—
	1929	—	—	x	x	—	0	0	—	—	—	—	—
TOTAL CANADA NON-FRASER	1959	4.3	5.4	13.1	37.5	20.2	11.1	5.2	2.5	0.7	—	—	—
	1953	—	4.3	12.4	16.4	32.7	27.5	5.1	0.9	0.7	—	—	—
	1945	x	x	x	xx	x	—	—	—	—	0	—	—
	1943	—	—	xx	xx	xx	x	x	x	x	—	—	—
	1929	—	—	x	x	—	0	0	—	—	—	—	—
FRASER RIVER	1959	—	0	0	3.1	11.3	24.0	23.7	28.2	7.6	1.6	0.4	0.1
	1953	—	0	0.8	5.6	25.5	29.1	31.8	6.1	0.5	0.3	0.2	0.1
	1945	—	x	xx	xx	xx	—	—	—	—	x	x	—
	1943	—	—	x	x	xx	xx	xx	xx	xx	—	—	—
	1929	—	—	x	xx	—	xx	x	—	—	—	—	—
UNITED STATES	1959	—	6.2	35.5	24.5	15.7	16.0	2.1	0	—	—	—	—
	1953	—	0	2.2	11.9	31.5	13.2	37.2	4.0	0	—	—	—
	1945	—	x	xx	xx	x	—	—	—	—	0	—	—
	1943	—	xx	xx	x	x	x	0	0	0	—	—	—
	1929	—	—	0	0	—	x	0	—	—	—	—	—

^a Comparable weeks for other years (e.g., week ending August 8 in 1959 is week ending August 8 in 1953, August 11 in 1945, August 7 in 1943 and period August 5-9 in 1929).

SOUTHERN APPROACH

Information on the times of passage of the pink salmon runs on the Southern Approach in years other than 1959 may be derived from limited tagging programs conducted in 1943 (Pritchard and DeLacy, 1944), in 1945 (DeLacy and Neave, 1947) and in 1957 (Milne, *et al.*, 1959). Some additional information can be derived from an examination of daily catch data from the San Juan Islands and West Beach fishing areas.

In 1957 a total of 1,941 pink salmon was tagged in Juan de Fuca Strait; of the 736 recoveries, 121 could be assigned to Canada Non-Fraser, Fraser River or United States stocks on the basis of the area of recovery. Because of the small number of recoveries and since only the Fraser River spawning populations were enumerated and searched for tags, the data were not adequate for estimating the proportions of the various stocks present in Juan de Fuca Strait. However, the recovery data could be used to indicate the timing of these groups of stocks in the Juan de Fuca Strait area. To remove bias due to the changing effectiveness of the tagging and recovery program, assigned recoveries from each period of tagging were weighted so that they totalled 100 tags (TABLE 44). Furthermore, since differences in the relative abundance of the stock groups were not adequately represented by these data, these differences were removed by expressing the adjusted recoveries assigned to each stock group as percentages of their season totals (TABLE 44). Similar procedures were followed for the recoveries from tagging at Sooke in 1945 and in the San Juan Islands-West Beach area in 1943 (TABLE 44).

Since the tagging in these programs was conducted in widely separated geographical areas, the tagging periods at Sooke and at San Juan Islands-West Beach were adjusted in accordance with the travel time from Juan de Fuca Strait (as estimated in 1959) so that data from all three programs would represent the times of passage of pink salmon in Juan de Fuca Strait. Thus, in plotting the data (FIGURE 14) 2 days were subtracted from all dates at Sooke and 4 days from all dates at San Juan Islands and West Beach.

Information on times of passage in these years is incomplete because in none of these programs was tagging conducted continuously throughout the season. In general the times of passage of the stock groups form a pattern similar to that of the 1959 run except that, in 1943 and 1945, pinks destined for United States streams appear to have been earlier than in 1957 (FIGURE 14) or 1959 (FIGURE 7). In all years the Canada Non-Fraser pinks were declining in numbers by the third week in August while Fraser fish were steadily increasing in abundance. Peak passage of Fraser fish was not clearly depicted by these data in any year. The time of passage of pinks destined for United States streams in 1957 was compatible with that in 1959. In 1945 and 1943 the tagging data suggest that United States pinks were about two weeks earlier than in 1959 but this is not corroborated by evidence from catch data (see below) and the apparent early passage of these stocks may have been due to a decline in tag recovery effort (fishing) in Puget Sound during the later part of the season.

Another source of information on the timing of the various stock groups is provided by trends in weekly catches in fishing areas through which they pass during their migration. In 1959 pinks destined for United States streams made up virtually the entire catch in the West Beach fishing area while Fraser River

TABLE 44. Recoveries from tagging in Juan de Fuca Strait in 1957, at Sooke in 1945 and in the San Juan Islands-West Beach area in 1943 assigned to Canada Non-Fraser, Fraser River and United States stocks. Recoveries are adjusted so that they total 100 for each tagging period and expressed as a percentage of the season total for each stock.

TAGGING PERIOD	RECOVERY AREA								ALL AREAS	
	Canada Non-Fraser			Fraser River			United States			
	Tags Recov.	Adjust. Recov.	% of Total	Tags Recov.	Adjust. Recov.	% of Total	Tags Recov.	Adjust. Recov.		% of Total
To July 13 Aug. 11-24 Aug. 25-Sept. 7 Sept. 8-28	JUAN DE FUCA STRAIT, 1957									
	2	11	47	1	6	4	15	83	39	100
	2	11	47	4	22	13	12	67	31	100
	1	2	6	21	41	25	29	57	27	100
	0	0	0	32	94	58	2	6	3	100
All periods	5	24	100	58	163	100	58	213	100	400
To Aug. 4 Aug. 5-11 Aug. 12-18 Aug. 19-25 Aug. 26-Sept. 1 Sept. 2-8 Sept. 9-15	Sooke, 1945									
	2	40	45	0	0	0	3	60	20	100
	1	5	6	1	5	2	20	90	31	100
	8	12	14	25	36	11	36	52	18	100
	6	8	9	42	57	18	26	35	12	100
	5	15	17	21	62	19	8	23	8	100
	1	8	9	10	76	24	2	16	5	100
	0	0	0	9	82	26	2	18	6	100
All periods	23	88	100	108	318	100	97	294	100	700
To Aug. 4 Aug. 15-21 Aug. 22-28 Aug. 29-Sept. 4	SAN JUAN ISLANDS-WEST BEACH, 1943									
	9	8	24	7	6	4	100	86	41	100
	16	16	53	15	15	9	70	69	33	100
	8	4	13	119	61	38	67	35	17	100
	3	2	7	133	77	49	37	21	9	100
All periods	36	30	100	274	159	100	274	211	100	400

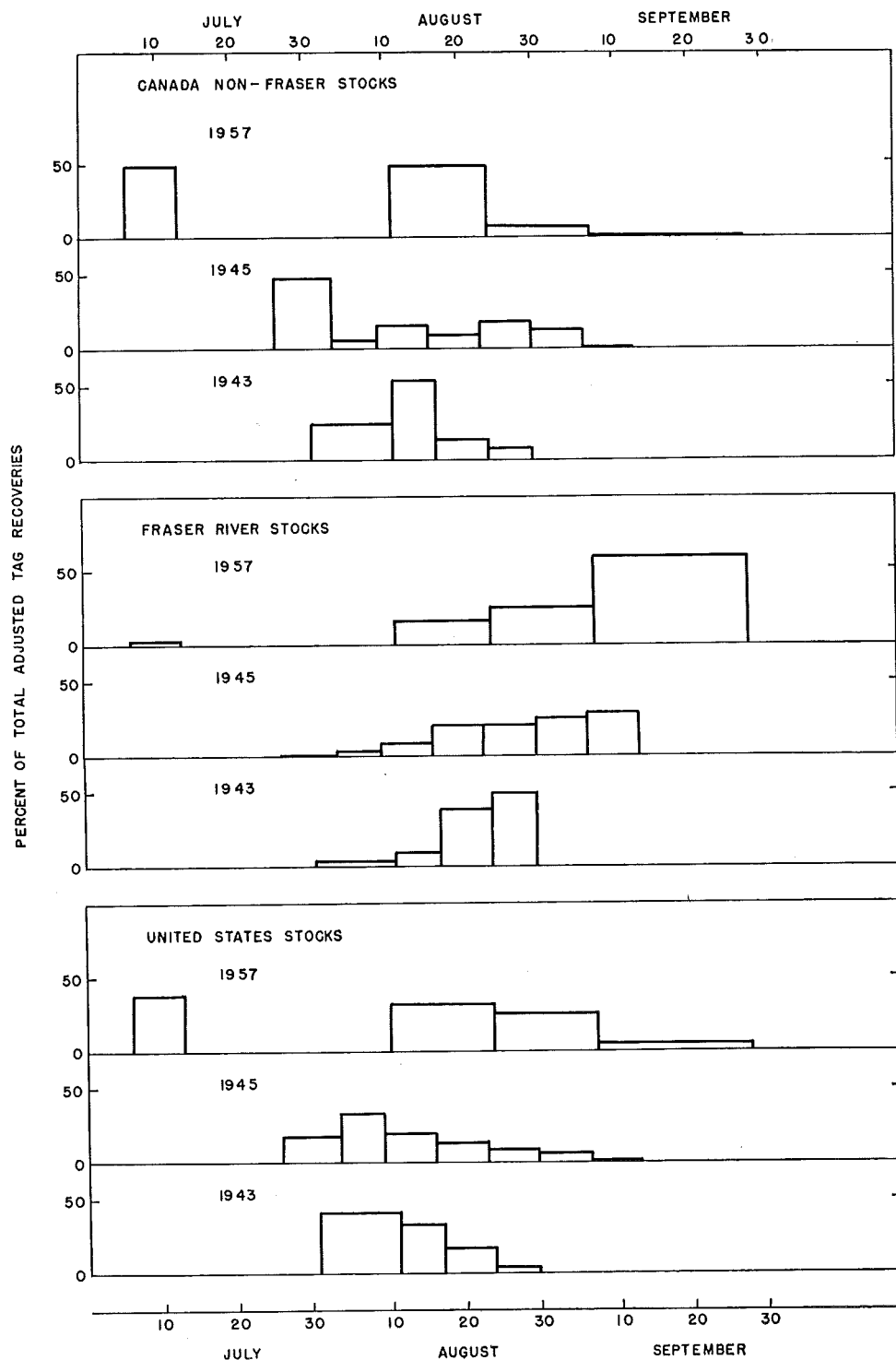


FIGURE 14. Times of passage through Juan de Fuca Strait of pink salmon destined for Canada Non-Fraser streams, the Fraser River and United States streams as indicated by tagging programs in Juan de Fuca Strait in 1957, at Sooke in 1945 and in the San Juan Islands-West Beach area in 1943. Periods for which tagging was carried out but no tags were recovered are indicated by a heavy base line.

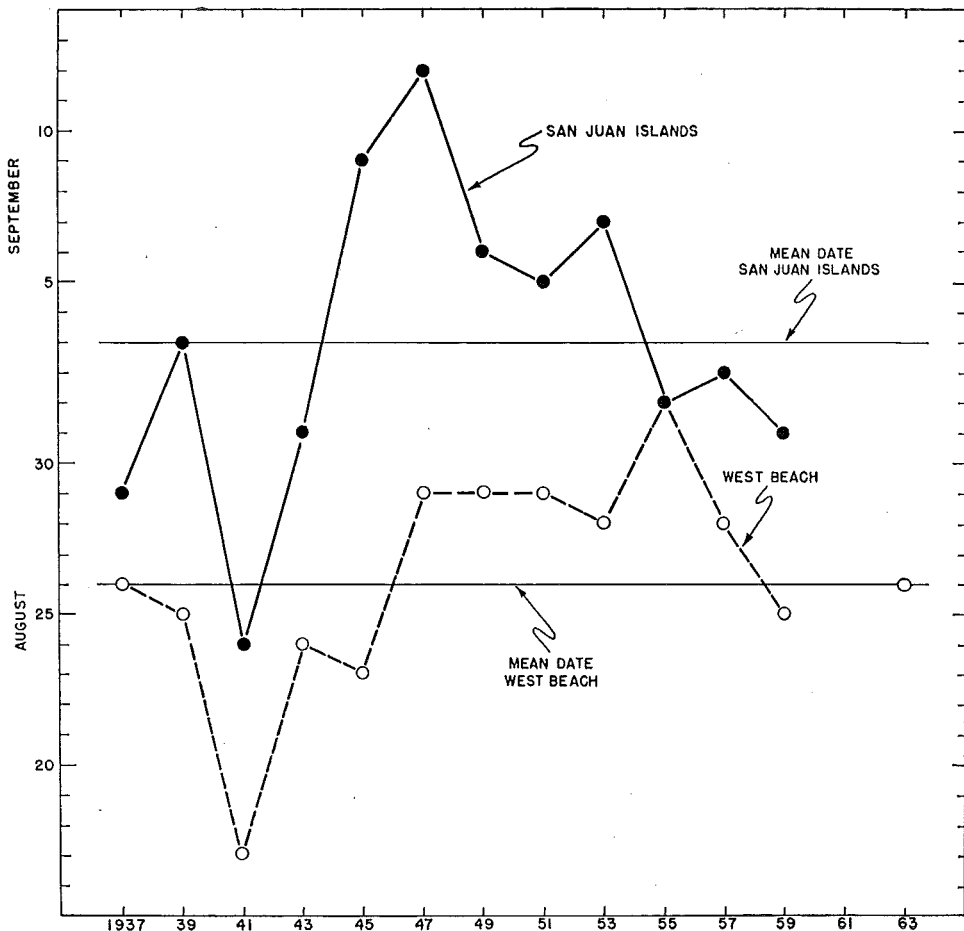


FIGURE 15. Dates by which 50 per cent of the seasons' pink catch had been taken at San Juan Islands (1937-1959) and West Beach (1937-1959, 1963). Reduced fishing time in the later portions of the seasons would have biased estimates of timing at San Juan Islands and West Beach in 1961 and at San Juan Islands in 1961 and 1963.

pinks formed the bulk of the catch at San Juan Islands. Similar differences between the composition of the run at West Beach and that at San Juan Islands were indicated by tagging data in 1943 (Pritchard and DeLacy, 1944). In each of the odd-numbered years between 1937 and 1959 reasonably consistent fisheries operated each week at San Juan Islands and West Beach throughout most of the pink salmon run. Weekly fishing periods were almost invariably the same in both areas. An intensive fishery also operated throughout the season at West Beach in 1963. Thus for these years the temporal pattern of daily catches provided an indication of the time of passage of United States pinks at West Beach and of Fraser fish at San Juan Islands. The most useful temporal measure of catches in these areas was considered to be the median catch date, i.e., the date on which the cumulative catch of pinks reached 50 per cent of the season total catch (FIGURE 15). Since 1937 the date of the median catch of the Fraser run at San Juan Islands has fluctuated over a range of 19 days between August 24 (in 1941) and September 12 (in 1947). In 1959 the timing of the Fraser run (August 31) was within three days of its average for the 1937-1959 period (September 3). Similarly, the

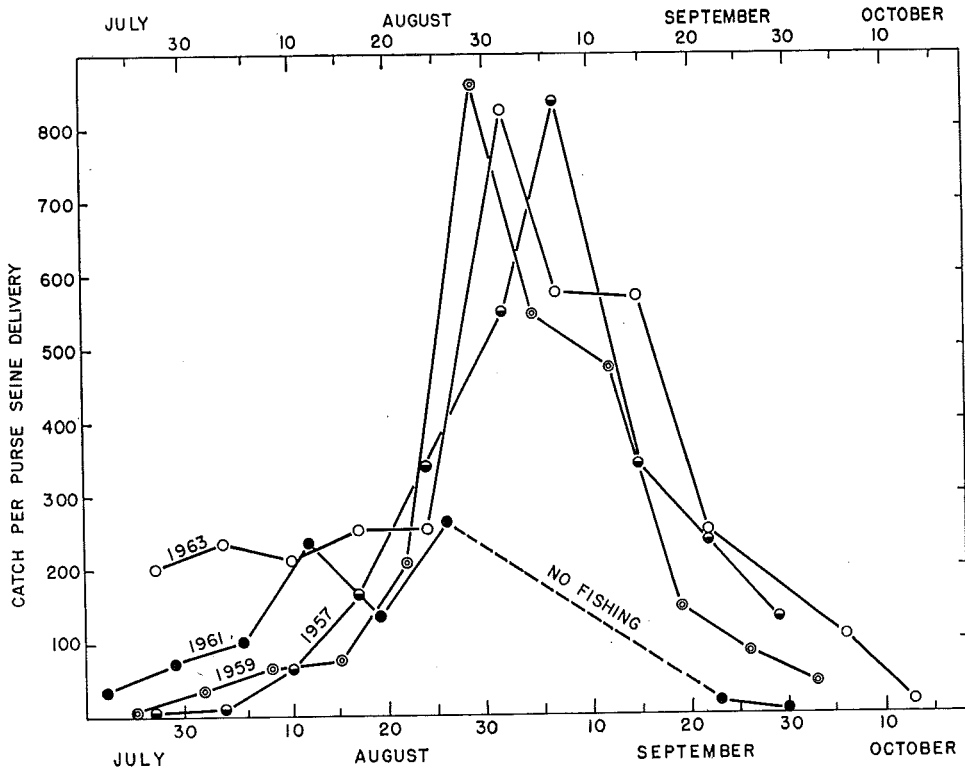


FIGURE 16. Weekly pink salmon catch per seine delivery in the combined San Juan Islands-Point Roberts fishing area during the odd-numbered years from 1957 to 1963.

date of median catch of the United States run at West Beach has fluctuated over a range of 15 days between August 17 (in 1941) and September 1 (in 1955). In 1959 the timing of the United States run (August 25) was within one day of the 1937-1963 mean (August 26).

On the average the United States run has been eight days earlier than the Fraser run in the San Juan Islands-West Beach area. Further, the United States run has been consistently earlier except in 1955 when the median catch date was the same in both areas. Rounsefell and Kelez (1938) also found that, during the years 1919 to 1933, peak United States trap catches at West Beach and in Puget Sound occurred about August 22 while those at San Juan Islands and Point Roberts occurred about September 1—a difference of 10 days. Their estimates were based on median catch weeks and probably were biased toward early dates by the tendency in those years for fishing effort to be concentrated during the early portion of the season.

Since 1937 there has been a tendency for large runs of Fraser fish to be late and small runs to be early, as indicated by a comparison by year of median catch dates at San Juan Islands (FIGURE 15) and indices of abundance of Fraser fish (TABLE 46). However, a similar comparison of median catch dates at West Beach (FIGURE 15) and indices of abundance of United States fish (TABLE 46) fails to indicate a similar tendency.

It is probable that much of the variation in timing of the runs has been due to changes in the relative abundance of early and late constituent stocks. For example, in 1961 and 1963 the unusually large catches early in the season in the San Juan Islands-Point Roberts area (FIGURE 16) may be attributed to the relatively high abundance in those years of the very early Howe Sound stock, which in 1959 reached peak abundance in this area during the week ending August 8. The escapement and local catch of this stock increased from 110,000 in 1959 to 409,000 in 1961 and 1,045,000 in 1963 with no comparable increase in the terminal abundance of other Canada Non-Fraser stocks which contribute to the Southern Approach run.

Migration Routes of the Runs to Canada Non-Fraser, Fraser River and United States Streams

For each of the seven tagging programs discussed in the previous section, recoveries were made in each of the three terminal areas indicating the presence of Canada Non-Fraser, Fraser River and United States fish on both approaches for all years for which tagging data were available. Moreover, catch data indicated that the time of peak abundance was progressively later in the more shoreward fishing areas along the migration routes described for the 1959 and 1961 runs. Thus the limited information available from earlier years on migration routes of individual stock groups was not at variance with the more detailed description of the 1959 run. It is therefore considered unlikely that the general pattern of migration described for the 1959 run has changed during the period that pink salmon in the Study Area have been subjected to an appreciable commercial fishery.

Composition of the Run

The composition of the pink salmon run to the Study Area may be considered in terms of its Northern and Southern Approach components, each made up of fish destined for Canada Non-Fraser, Fraser River and United States streams.

NORTHERN AND SOUTHERN APPROACH RUNS

Quantitative estimates of the Northern and Southern Approach runs have been made for the 1959 and 1961 runs (TABLE 34). In these two years the Southern Approach run made up 63 and 56 per cent respectively of the total run. In 1963, the number of Canada Non-Fraser fish in the Southern Approach run was estimated at 1,300,000 and the numbers of United States and Fraser fish entering the Convention area were estimated at 10,330,000 and 4,520,000 respectively (TABLE 34). If it is assumed that as in 1959, 97 per cent of the United States fish entering Convention waters approached from the south and 89 per cent of the 4.5 million Fraser fish entering Convention waters approached from the south²⁸, the abundance of the Southern Approach run in 1963 would have been 15,343,000 ($1,300,000 + .97 \times 10,330,000 + .89 \times 4,520,000$) or 77 per cent ($15,343,000 / 19,567,000$) of the total run in 1963.

²⁸ In 1959, of the 1,187,000 United States fish entering the Convention area 38,000 approached from the north and of the 5,193,000 Fraser fish entering the Convention area, 563,000 approached from the north (Vernon, Hourston and Holland, 1964, FIGURES 16, 17, 20 and 21).

TABLE 45. Pink salmon seine catches in Johnstone Strait and adjacent waters (Canadian Statistical Areas 12 and 13), 1935-1963, and pink salmon catches in the Convention area and Puget Sound^b areas (combined), 1937-1963.

YEAR	NORTHERN APPROACH		SOUTHERN APPROACH		BOTH APPROACHES
	Seine catches in Johnstone Strait and adjacent waters ^a	Per cent of total	Catches in the Convention area and Puget Sound ^b areas	Per cent of total	Total
1937	4,743,910	42.6	6,400,807	57.4	11,144,717
1939	2,566,608	32.0	5,461,046	68.0	8,027,654
1941	2,131,315	38.2	3,454,440	61.8	5,585,755
1943	2,155,642	60.8	1,390,455	39.2	3,546,097
1945	3,343,141	31.8	7,172,083	68.2	10,515,224
1947	3,937,743	23.4	12,873,249	76.6	16,810,992
1949	— ^c	—	10,781,032	—	—
1951	1,728,025	16.9	8,486,011	83.1	10,214,036
1953	4,273,413	29.6	10,142,145	70.4	14,415,558
1955	2,524,671	21.4	9,294,322	78.6	11,818,993
1957	3,692,952	39.0	5,778,697	61.0	9,471,649
1959	1,730,034	26.0	4,924,411	74.0	6,654,445
1961	1,211,326	48.0	1,311,185	52.0	2,522,511
1963	1,639,977	13.7	10,334,904	86.3	11,974,881
Mean	2,744,520 ^d	32.6	6,986,056	67.4	9,438,655 ^d

^a From Canada Department of Fisheries Annual Reports to 1947. From British Columbia catch statistics, Department of Fisheries, Pacific Area from 1951 on.

^b Puget Sound catches include those made in areas south of Convention waters and in the Bellingham Bay area.

^c Information on the numbers of fish caught in Johnstone Strait and adjacent waters is not available for 1949. However, the pack of canned pink salmon from the Vancouver Island area in 1949 (Province of British Columbia, Report of the Fisheries Department for the year 1949), indicates an above average catch for this area, probably of the order of that in 1947.

^d Mean 1937-1963 excluding 1949.

Thus the proportion of Southern Approach fish in the total run varied from 63 to 56 to 77 per cent from 1959 to 1961 to 1963 respectively. This variation is largely accounted for by variations in the proportions of Canada Non-Fraser, Fraser River and United States fish in the total run. When Canada Non-Fraser fish were relatively abundant (as in 1961) the proportion of Southern Approach fish was relatively low. When Fraser fish were relatively abundant (as in 1959) the proportion of Southern Approach fish was higher. In years in which United States fish were relatively abundant (as in 1963) the proportion of Southern Approach fish was higher still.

A rough indication of the extent to which the proportions of Northern and Southern Approach fish varied in earlier cycle years may be obtained by comparing the abundance of catches on the two approaches (TABLE 45). Seine catches in Johnstone Strait and adjacent waters were used as indices of abundance on the Northern Approach and catches in the Convention area and Puget Sound were used as indices of abundance on the Southern Approach.

On the basis of these indices, the proportion of Southern Approach fish in the total run in 1963 was the highest since 1937. Indices of abundance of Southern Approach fish were lowest in 1943 and 1961. The relatively small catch in 1943, although indicating a poor run in that year, probably also reflects a less efficient fishery than in recent years. Because of more severe fishing restrictions on the Southern Approach in 1961, the indices for that year would have under-estimated to some extent the proportion of Southern Approach fish in the run. In spite of this bias, the proportion of Southern Approach fish in the total run must have been at or near minimum levels in 1961. Thus, since 1937, the proportion of Southern Approach fish in the total run has probably not been much lower than in 1961 (56 per cent) or higher than in 1963 (77 per cent).

CANADA NON-FRASER, FRASER RIVER AND UNITED STATES STOCKS

The Northern Approach run to the Study Area in 1959 was made up almost exclusively (98 per cent) of fish bound for Canadian streams. Since the large run of United States fish in 1963 (53 per cent of the total run to the Study Area) failed to evidence itself in early season catches in the Fraser Gulf and Point Roberts area, it does not appear that appreciable numbers of United States fish approached from the north in that year either. In the absence of evidence for other years²⁹ it is assumed that the proportion of United States fish in the Northern Approach run was negligible in other years.

Indices of the proportions of Canada Non-Fraser and Fraser River fish in the Northern Approach run may be derived from catch data. Following the general procedures employed in the analysis of the 1961 run, it was considered that catches in Johnstone and Queen Charlotte Straits up to August 26 approximated the seasonal catch of Canada Non-Fraser fish in this area while catches after August 26 approximated the seasonal catch of Fraser River fish (TABLE 35). The proportions of Canada Non-Fraser fish in the 1959 and 1961 runs as indicated by these catch indices (55 and 84 per cent respectively) were slightly higher than those obtained from the detailed analyses of these runs (53 and 75 per cent respectively). Considering the gross nature of these indices, their agreement with the calculated proportions for these two years is quite close. Moreover, since the bias was in the same direction in both years, it would appear reasonable to compare indices for different years on a qualitative basis.

The proportion of *Canada Non-Fraser* fish in the Northern Approach run was much greater in 1961 than that calculated for any other year since 1951 (TABLE 35). On the other hand, the proportion was lower in 1959 than in any other year except in 1953, when it was virtually identical. Moreover, the proportion for each of the other four years was much closer to that for 1959 than to that for 1961. It would therefore appear that, since 1951, the proportion of Canada Non-Fraser fish in the Northern Approach run has not been less than in 1959 (53 per cent³⁰) or more than in 1961 (75 per cent) and that in at least five of these seven years, the proportion has been in the lower part of this range.

²⁹ Although the percentages of the recoveries from tags applied in Johnstone Strait in earlier years which were considered to have come from United States fish were appreciably higher than in 1959 (15, 23 and 4 per cent in 1953, 1945 and 1929 respectively.—TABLES 38, 40 and 42) this is considered to reflect the greater opportunity for recovery of tags from United States fish in subsequent fisheries than for Canadian fish.

³⁰ Proportions given for the years 1959-1963 are the actual proportions estimated from the direct census of the runs (TABLE 34) rather than those for catch indices.

Pinks destined for the Fraser River may be considered to have made up virtually all of the remainder of the Northern Approach run in all years. Thus the proportion of Fraser fish in this run appears to have varied between that in 1961 (22 per cent) and that in 1959 (45 per cent).

Indices of the relative abundance of Canada Non-Fraser, Fraser River and United States stocks on the *Southern Approach* may also be derived from catch data. Information on migration routes indicates that the run reaching the West Beach, Puget Sound and Bellingham Bay areas is composed virtually exclusively of United States fish. Since the contribution of Northern Approach fish to these stocks is exceedingly small (see above) the annual catches in these areas may be considered as indices of abundance of the run of Southern Approach United States fish leaving Juan de Fuca Strait. Similarly the Southern Approach run in the San Juan Islands, Point Roberts and Fraser River³¹ areas would be made up almost exclusively of Canadian fish. Although Northern Approach fish would contribute to the catches in these areas, the proportion of Southern Approach fish would still be sufficiently great (92 per cent³² in 1959) to justify the use of these catches as an index of abundance of the Southern Approach Canadian fish leaving Juan de Fuca Strait. Moreover, since Canada Non-Fraser fish made up the majority of the Southern Approach run in the San Juan Islands and Point Roberts areas up to about August 15,³³ catches prior to that date would serve as an index of abundance of the Southern Approach Canada Non-Fraser fish leaving Juan de Fuca Strait. On the same basis, catches in these two areas after August 15 plus the catch for the season in the Fraser River area would form an index of the abundance of Fraser fish leaving Juan de Fuca Strait. Comparisons of the percentage composition by stock group on the basis of these indices (TABLE 46) are subject to the further provision that they do not take into account any differences in the rate of exploitation on the three stock groups in Juan de Fuca Strait. Even so, these indices were considered adequate to demonstrate the extent to which the proportions of the three stock groups have varied from year to year in the Southern Approach run.

On the basis of these indices *Fraser* fish have made up the bulk of the Southern Approach run with the exception of the last two cycle years (TABLE 46). Since 1937 it would appear that the proportion of the run made up by Fraser fish exceeded that in 1959 in only one year (1947). The lack of a fishery before August 18 in 1947 would lead to a greater over-estimate of the proportion of Fraser fish in that year than in other years. Even so, the large catch taken mainly from Southern Approach Fraser fish (10.7 million) was over double the total abundance of Fraser fish in the Southern Approach run in 1959 (4.8 million). Although nothing is known of the relative abundance of Canada Non-Fraser fish in that year, United States fish were relatively less abundant in 1947 than in any other year since 1937. On this basis it would appear that Fraser fish made up a greater proportion of the Southern Approach run in 1947 than in 1959 (73 per cent).

³¹ Including Fraser Gulf.

³² Of the 2,652,000 pinks caught in the San Juan Islands, Point Roberts, Fraser Gulf and Fraser River fisheries in 1959, 2,428,000 were estimated to have been Southern Approach fish (Vernon, Hourston and Holland, 1964, FIGURE 12).

³³ The Southern Approach run passes through these areas about one week after passing through the Juan de Fuca Strait fishery, where Canada Non-Fraser fish made up the majority of the run up to August 8 in 1959 (FIGURE 7).

TABLE 46. Indices of abundance of Canada Non-Fraser, Fraser River and United States fish in the Southern Approach run and percentage composition of the run on the basis of these indices for the cycle years 1937-1963. (The index for Canada Non-Fraser fish does not include catch for this stock group off the Fraser River and consequently is under-estimated. The index for Fraser River fish includes catch of Canada Non-Fraser fish off the Fraser River and catch of Northern Approach fish on the Fraser River and Point Roberts areas and consequently is over-estimated.)

YEAR	ABUNDANCE INDICES				PER CENT COMPOSITION			
	Canada Non-Fraser ^a	Fraser River ^b	United States ^c	Total	Canada Non-Fraser	Fraser River	United States	Total
1937	332,041	4,325,278	825,098	5,482,417	6.1	78.9	15.0	100.0
1939	129,062	4,152,758	1,061,430	5,343,250	2.4	77.7	19.9	100.0
1941	198,089	2,248,103	438,891	2,885,083	6.9	77.9	15.2	100.0
1943	49,138	831,631	293,954	1,174,723	4.2	70.8	25.0	100.0
1945	182,131	5,682,253	924,722	6,789,106	2.7	83.7	13.6	100.0
1947	Closed to August 18	10,661,537	845,795	11,507,332	—	92.6	7.4	100.0
1949	436,212	5,724,984	1,757,837	7,919,033	5.5	72.3	22.2	100.0
1951	164,194	5,345,405	635,302	6,144,901	2.7	87.0	10.3	100.0
1953	170,991	4,785,353	1,444,484	6,400,828	2.7	74.7	22.6	100.0
1955	153,461	3,775,599	706,652	4,635,712	3.3	81.5	15.2	100.0
1957	143,342	3,201,885	467,550	3,812,777	3.7	84.0	12.3	100.0
1959	116,317	2,533,853	261,706	2,911,876	4.0	87.0	9.0	100.0
1961	243,499	236,968	344,807	825,274	29.5	28.7	41.8	100.0
1963	485,073	1,467,774	3,915,205	5,868,052	8.3	25.0	66.7	100.0

^a Catch at San Juan Islands and Point Roberts to August 15.

^b Catch at San Juan Islands and Point Roberts after August 15 plus Fraser River catch.

^c Catch at West Beach, Puget Sound and Bellingham Bay.

In 1961, the rate of removal for Fraser fish on the Southern Approach was much lower than that for other stocks (TABLE 31). Consequently, the index of abundance of Fraser fish for 1961 would under-estimate the proportion of Fraser fish in the Southern Approach run for that year (29 per cent vs. a direct estimate of 35 per cent—TABLE 32). A direct estimate of the proportion of Fraser fish in the Southern Approach run is not available for the 1963 run. However, Fraser fish made up 27 per cent of the run on both approaches (TABLE 34), and, following the pattern of the 1959 and 1961 runs, probably accounted for an appreciably larger proportion of the Southern Approach run. Thus the relative abundance of Fraser fish in the Southern Approach run in 1963 was not less than that in 1961.

Thus, since 1937, it would appear on the basis of these indices of abundance that Fraser fish made up between 35 per cent (in 1961) and more than 73 per cent (in 1947) of the Southern Approach run. Moreover, in all years except 1961 and 1963, Fraser fish appear to have made up over half the run.

According to the abundance indices, the proportion of *United States* fish in the Southern Approach run in 1959 was the lowest since 1937 with the exception of 1947. Since there was no value for the index of Canada Non-Fraser fish in 1947, the proportion of United States fish would be over-estimated in comparison with other years. Consequently, it would appear that United States fish made up

a smaller proportion of the Southern Approach run in 1947 than in 1959 (18 per cent). On the other hand, the proportion of United States fish in 1963 was much higher than any other year on record. In 1963, United States fish made up 53 per cent of the total run (TABLE 34) and since the Northern Approach run was practically exclusively Canadian fish, would have made up a much higher proportion of the Southern Approach run. Moreover, United States fish were estimated to have made up 64 per cent of the run entering Convention waters in 1963 (International Pacific Salmon Fisheries Commission, 1964). Since this run also includes some Northern Approach fish, the proportion of United States fish in the Southern Approach run must have been even greater than 64 per cent. On this basis, United States fish have made up between less than 18 per cent (in 1947) and more than 64 per cent (in 1963) of the Southern Approach run since 1937. However, in all other years they have been much less abundant than Fraser fish (i.e., well under 50 per cent of the run) but much more abundant than Canada Non-Fraser fish.

On the basis of catch indices, the proportion of *Canada Non-Fraser* fish in the Southern Approach run was much greater in 1961 than in any other year. Even allowing for the fact that the index for this year would be over-estimated because of the selective protection of Fraser fish provided by the 1961 fishing regulations, it is doubtful that Canada Non-Fraser fish made up a higher proportion of the Southern Approach run in any other year since 1937 than they did in 1961 (26 per cent). In 1963, the year in which Canada Non-Fraser fish apparently made up the next highest proportion of the Southern Approach run, this stock-group accounted for only 20 per cent of the total run and certainly would have made up a much smaller proportion of the Southern Approach run. Although the proportion of Canada Non-Fraser fish in the Southern Approach run was relatively small in 1959 (8 per cent) the proportions based on catch indices for four other years (1939, 1945, 1951 and 1953) were two-thirds or less that for 1959. On this basis it would appear that since 1937, the proportion of Canada Non-Fraser fish in the Southern Approach run has varied between less than 8 per cent (in several years) and 26 per cent (in 1961). Moreover, in most years, the proportion would appear to have been in the lower half of this range.

Information on the proportions of the *combined run* made up by Canada Non-Fraser, Fraser River and United States fish is more difficult to derive in that differences in the relative abundance of the run on the two approaches must be taken into account along with the proportions of the three stock groups on either approach. The proportion of *Canada Non-Fraser* fish was highest in both the Northern and Southern Approach runs in 1961 than in any other year since 1951 (TABLES 35 and 46). Thus the proportion of Canada Non-Fraser fish in the combined run would also have been highest in that year (48 per cent). In 1959 and 1963, Canada Non-Fraser fish made up 24 and 20 per cent respectively of the total run (TABLE 34). On the basis of catch indices, the proportion of Canada Non-Fraser fish was lower in both the Northern and Southern Approach runs in 1953 than in either 1959 or in 1963 (TABLES 35 and 46). It would therefore appear that the proportion of Canada Non-Fraser fish was even lower in 1953 than in 1963. Thus the proportion of Canada Non-Fraser fish in the combined run has varied between less than 20 per cent (in 1953) and about 48 per cent (in 1961).

Since the contribution of the Northern Approach run to the *United States* stocks was considered to be exceedingly small in all years for which data are available, the years in which the proportion of *United States* fish in the combined run was largest and smallest would be the same as those for the Southern Approach run. On this basis, the relative abundance of *United States* fish in the combined run has varied between about 12 per cent (in 1959) and 54 per cent (in 1963).

The proportion of *Fraser* fish in the combined run would appear, on the basis of catch indices for the Southern Approach, to have been at its lowest level since 1937 in 1961 and 1963 (29 and 27 per cent respectively). On the basis of catch indices for both approaches, *Fraser* fish formed a greater proportion of the combined run in 1959 than in any other year since 1951. According to catch indices the proportion of *Fraser* fish on the Southern Approach was higher in 1947 than in 1959, but this difference would probably be largely accounted for if data on the proportion of Canada Non-*Fraser* fish were available for that year³⁴. Thus the proportion of *Fraser* fish in the combined run has probably not greatly exceeded that in 1959 and may be considered to have varied between about 27 per cent (in 1963) and 63 per cent (in 1959) in recent years.

In summary, the 1959 run on both approaches was composed of a higher proportion of *Fraser* fish than in almost any year since 1937. The proportion of *Fraser* fish in the combined runs was more than double that in some other years. *United States* fish made up a smaller proportion of the run (12 per cent) than in any other year and was less than one-quarter that in 1963. The proportion of Canada Non-*Fraser* fish in both the Northern and Southern Approach runs was smaller than in most years but not the smallest on record. As would be expected for a year in which the abundance of *Fraser* fish was relatively high, the proportion of Southern Approach fish in the run (63 per cent) appears to have been higher than in most years.

Rates of Removal

Information on rates of removal is limited to those years for which quantitative data on the numbers of spawners are available. This information has been derived for the 1959 and 1961 run and may be approximated for the combined run in 1963 (TABLE 47).

The rate of removal of Canada Non-*Fraser* fish has remained relatively consistent over the past three cycles. However, in 1959 and 1963 there were strikes early in the season (when the run would consist mainly of Canada Non-*Fraser* fish), and in 1961, fishing time was more restricted on the Southern Approach than in other years (FIGURES 8 and 17). The relatively low rate of removal of *Fraser* fish and, to a lesser extent, *United States* fish, in 1961 reflects the severe fishing restrictions later in the season on both approaches. The difference in rates of removal between 1959 and 1963 for *Fraser* fish (.83 and .63 respectively) also reflect differences in the fishing time permitted during the

³⁴ Indices for Canada Non-*Fraser* fish on the Southern Approach consisted of catches at San Juan Islands and Point Roberts to August 15. In 1947 these areas were closed to fishing during this early period.

TABLE 47. Rates of removal for Canada Non-Fraser, Fraser River and United States stocks on the Northern and Southern Approach, 1959-1963. (Data for 1959 are summarized from Vernon, Hourston and Holland, 1964, TABLES 68-70; data for 1961 summarized from TABLE 31; data for 1963 summarized from TABLE 34.)

	1959	1961	1963
NORTHERN APPROACH			
Canada Non Fraser	.60	.60	—
Fraser River	.80	.65	—
United States	.84	.73	—
TOTAL	.70	.62	—
SOUTHERN APPROACH			
Canada Non-Fraser	.58	.57	—
Fraser River	.85	.31	—
United States	.56	.43	—
TOTAL	.77	.43	—
BOTH APPROACHES			
Canada Non-Fraser	.60	.59	.56
Fraser River	.83	.42	.63
United States	.57	.45	.69
TOTAL	.74	.51	.65

periods when these stocks were present on the Southern Approach. Thus during these three years, rates of removal appear to have been directly related to the amount of fishing time permitted.

The number of days fishing permitted on both approaches declined more or less continuously over the period 1951 to 1961 (FIGURES 8 and 17). On this basis, the rates of removal in the years prior to 1959 would be expected to have decreased continuously since 1951. Several factors however, mitigate against such a conclusion:

1. The effectiveness of the fleet per boat day of fishing would be on the increase over the same period with the development of larger and faster boats, fishing experience and new fishing aids.
2. Increases in fishing effort on pink salmon on the part of trollers would increase the total catch regardless of restrictions on net fishermen.
3. During each fishing week, daily catches usually decline continuously and often sharply after the first day, as accumulations of fish are taken and the schools scattered. Thus a decrease in fishing time from, for example, six to three days would result in a decrease in catch very much less than the decrease in time of 50 per cent. Moreover, the longer closed period would provide more time for fish to accumulate and gather into large schools, resulting in a higher catch for the first days of fishing in the subsequent week.

For these reasons it is considered that rates of removal in years prior to 1959 would not have exceeded those in 1959 to any extent. On the other hand, since the fishing was well developed in 1951 and since the permitted fishing time decreased more or less continuously between 1951 and 1959 in both Juan de Fuca (FIGURE 8) and Johnstone Strait (FIGURE 17) it does not appear likely that the rates of removal in the years 1951 to 1957 were appreciably less than in 1959. Prior to 1951 however, it is considered likely that, moving backward through the years, the rate of removal was progressively lower. Moreover, it would be expected that wartime conditions and market conditions during the depression and post-war periods would have had some effect on the rates of removal during these years (Hoar, 1951). Without intensive studies of all these factors it would be presumptuous to attempt to assess quantitatively the changes in rates of removal during this period. No such broad studies have been attempted in conjunction with this analysis.

Abundance of the Run and its Various Components

Abundance may be estimated from any two of catch, spawners or rates of removal. Direct quantitative estimates of spawners and rates of removal for the pink salmon run to the Study Area are available only for the years 1959, 1961 and 1963 (TABLE 34). Direct estimates of the Northern and Southern Approach components of the run are limited to 1959 and 1961. However, estimates of the abundance of the Canada Non-Fraser, Fraser River and United States stocks entering the Convention area are available for 1963 (International Pacific Salmon Fisheries Commission, 1964), and approximations of the abundance of some of the components of the 1963 run may be derived from these and estimates for the total run (TABLE 34).

If it is assumed that in 1963 the catch of Southern Approach fish in the Strait of Georgia area was negligible (49,000 fish in 1959), the escapement of Southern Approach Canada Non-Fraser fish from the Convention area (638,000 pinks—TABLE 34) would all have spawned in Canada Non-Fraser streams. By dividing the Johnstone Strait catch into Canada Non-Fraser and Fraser River fish on the basis of timing as for the 1961 run (TABLE 35), the remaining information required to estimate the abundance of Northern and Southern Approach Canada Non-Fraser fish was obtained (TABLE 34).

In 1959, seven per cent of all the pinks destined for United States streams approached from the north. There was no evidence that this proportion differed significantly in 1963 (see above). Since the proportion of United States pinks taken outside the Convention area is small (6.6 per cent in 1959), the number estimated to have entered the Convention area in 1963 (10,330,000—TABLE 34) could be taken as an approximation of the total run to the Study Area in 1963. Assuming that seven per cent of these fish approached from the north, the abundance of United States fish in the 1963 runs on the Northern and Southern Approaches could be estimated.

The range in abundance of Canada Non-Fraser, Fraser River and United States stocks in the Northern and Southern Approach runs has now been determined for the period 1959 to 1963 (TABLE 48, Column 2). From these ranges in abundance it is apparent that in 1959 (Column 1) the abundance of Fraser fish

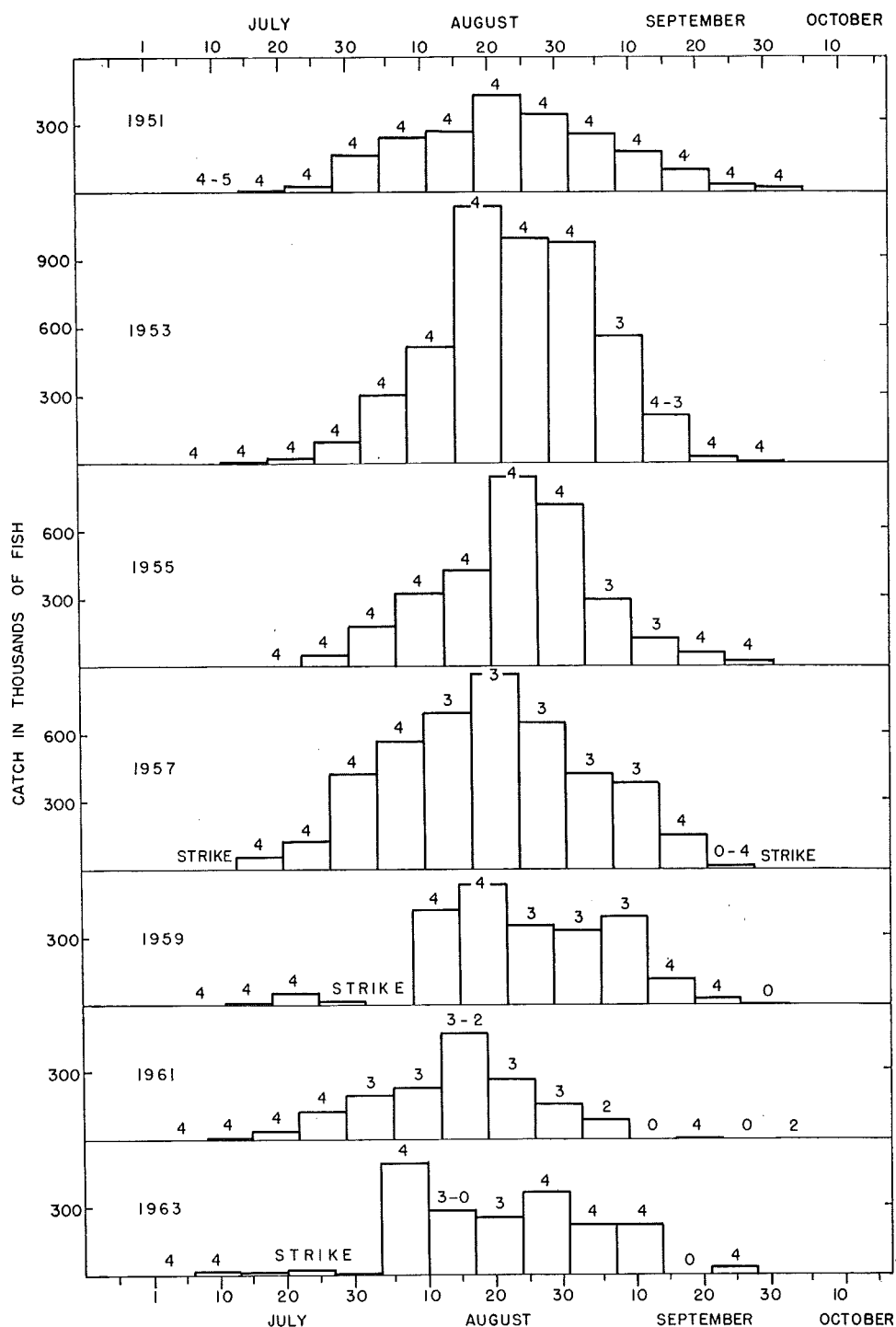


FIGURE 17. Weekly catches of pink salmon in the Johnstone Strait area during the odd-numbered years from 1951 to 1963. (Some local catches in mainland inlets are included.) The number of days fishing is shown for each week. In weeks for which the number of days fishing permitted varied for different areas within the Strait, the range in fishing time is given with that for the most important area shown first.

TABLE 48. Range of abundance of the odd-year Northern and Southern Approach runs to Canada Non-Fraser, Fraser River and United States streams. The year for which each estimate applies is given below in parentheses. Abundance estimates for the years 1959-1963 are based on direct field observation; those for other years are derived from catch data and are considered to be somewhat low, especially prior to 1951. (< = less than, > = greater than, >> = much greater than.)

	(1) 1959	(2) 1959-1963	(3) 1951-1963	(4) 1937-1963
MILLIONS OF FISH				
NORTHERN APPROACH				
Canada Non-Fraser	1.989	1.989-2.675 (1959) (1963)	2.0-4.1 (1959) (1957)	— —
Fraser River	1.698	.621-1.698 (1961) (1959)	0.6-3.7 (1961) (1953)	— —
United States	.089	.079-.7 (1961) (1963)	— —	— —
TOTAL	3.776	2.847-3.776 (1961) (1959)	2.8->9.3 (1961) (1953)	3->>10 (1961) (1937)
SOUTHERN APPROACH				
Canada Non-Fraser	.554	.554-1.300 (1959) (1963)	0.6-1.3 (1959) (1963)	0.6 ^c ->>2 ^d (1959) (1949)
Fraser River	4.761	1.263-4.761 (1961) (1959)	1.3-9.9 (1961) (1951)	1->>12 (1961) (1947)
United States	1.183	1.183-9.6 ^a (1959) (1963)	1.2-9.6 (1959) (1963)	1.2->9.6 (1959) (1963)
TOTAL	6.488	3.567-13.4 ^{a, b} (1961) (1963)	3.6-13.4 (1961) (1963)	4->>17 (1961) (1947)
BOTH APPROACHES				
Canada Non-Fraser	2.533	2.533-3.975 (1959) (1963)	2.5->4.8 (1959) (1953 & 1957)	— —
Fraser River	6.459	1.884-6.459 (1961) (1959)	1.9->12.6 (1961) (1953)	— —
United States	1.272	1.272-10.330 (1959) (1963)	1.3-10.3 (1959) (1963)	— —
TOTAL	10.262	6.414-19.567 (1961) (1963)	6.4->22.2 (1961) (1953)	6->>26 (1961) (1947)

^a Assumes 7 per cent of United States fish approached from the north in 1963.

^b Assumes one-third of Fraser fish reaching the terminal area approached from the north in 1963.

^c Calculated value for 1943 was 0.3. However, since this value is minimal (assumes the same rate of removal in 1943 as in 1959 and fishing effort in 1943 was undoubtedly curtailed by wartime conditions) the 1959 value was considered to better represent the minimum for this period.

^d Although the calculated value for 1963 (2.2) slightly exceeded that for 1949 (2.0), the rate of exploitation was considered to have been relatively high in 1963 and relatively low in 1949. On this basis the 1949 run would have been larger than the 1963 run.

was relatively high while that of Canada Non-Fraser and that of United States fish were relatively low. The abundance of the Northern Approach run was relatively high in 1959 while the abundance of the Southern Approach run and that of the combined run were at an intermediate level.

More approximate comparisons of abundance can be made for the years prior to 1959. In discussing the composition of the run, indices of abundance derived from catch data (TABLES 35 and 46) were used to indicate years of relatively high and low abundance of Canada Non-Fraser, Fraser River and United

States stocks in the Northern and Southern Approach run. By using the ratio of this index of abundance in 1959 to the actual abundance in that year to scale the indices for the other years, gross estimates of abundance were obtained for these years, i.e.

$$A_n = I_n \times \frac{A_{59}}{I_{59}}$$

where A_n , A_{59} are the actual abundance in years "n" and 1959 respectively and I_n , I_{59} are the indices of abundance in years "n" and 1959 respectively. This procedure assumes that the rates of removal in the years prior to 1959 were the same as in 1959³⁵. As indicated above, the rates of removal were probably lower in the earlier years, especially in the years prior to 1951. On this basis, estimates of abundance for the years 1957 to 1951 would be minimal, and abundance in the earlier years was probably much greater than indicated.

On the basis of these indices, since 1937, the Fraser River stocks, the Northern and Southern Approach runs and the total run were all at their lowest level of abundance in 1961, and the Canada Non-Fraser and United States stocks were at their lowest level of abundance in 1959 (TABLES 35, 45 and 46). Thus the minimum abundance of the various components of the run was estimated directly during 1959 and 1961 and these data may be considered reasonably reliable.

During the 1959-1963 period, the only component of the run to reach its maximum abundance was that of United States stocks in 1963 (TABLE 46). All other components of the run apparently reached much higher levels of abundance in years prior to 1959 when direct estimates of abundance were not available. For each of these components the largest index was converted into an estimate of abundance following the procedure outlined above.

The resulting estimates of abundance for the period 1951 to 1963 (TABLE 48, Column 3) indicate that for the Fraser River stocks on both approaches, the Canada Non-Fraser fish on the Northern Approach and the Northern Approach run, much higher levels of abundance were attained than in the period 1959 to 1961. Little or no difference was apparent in the other estimates involved.

Estimates of the range in abundance for the period 1937 to 1963 for the Northern Approach, Southern Approach and combined runs and for the three stock groups on the Southern Approach (TABLE 48, Column 4), all showed higher levels of maximum abundance than did those for the period 1951-1963 except for the United States stocks on the Southern Approach. Since abundance during these years would have been under-estimated (see above), perhaps grossly so in the earlier years, the maximum levels of abundance during this period would have been much higher than the calculated values, depending on the effectiveness of the fisheries involved. Rates of removal for the catches used as indices of abundance are given for 1959 in the last column of TABLE 47. Interpretation of the extent to which abundance has been under-estimated for earlier years would depend on estimating the extent to which the rates of removal in the earlier years were less than those in TABLE 47. Such interpretation is beyond the scope of this analysis.

³⁵ Because of the high rate of removal in 1959, especially for Fraser fish (83 per cent), abundance in other years as calculated by the above procedure would be only slightly over-estimated if the actual rate of removal was as high as 99 per cent.

Comparing the abundance of the various components of the 1959 run with the range of estimates available for other years (TABLE 48), the following conclusions may be drawn:

1. The abundance of *Canada Non-Fraser* fish on both the Northern and Southern Approach was the lowest on record. In some earlier and later years these stocks were at least twice as abundant as in 1959.
2. The abundance of *Fraser* fish was higher on both approaches than in the two subsequent cycle years but less than in almost all of the earlier years, when some runs appear to have been at least twice as abundant. The lowest level of abundance of Fraser fish occurred in 1961 when they were about one-third as abundant as in 1959.
3. The abundance of *United States* stocks in 1959 was the lowest on record. United States pinks were most abundant in 1963 when they were eight times as abundant as in 1959. In all but three or four of the 14 cycle years since 1937, United States fish appear to have been more than twice as abundant as in 1959.
4. The *Northern Approach* run in 1959 was larger than in the two subsequent years but was probably smaller than in any year prior to 1959. Some earlier runs appear to have been at least three times as abundant as that in 1959.
5. The *Southern Approach* run in 1959 was almost twice as abundant as that in 1961 (the lowest record) and about half as abundant as that in 1963 (one of the highest on record). In almost all of the other years, the Southern Approach run would appear to have been larger than in 1959.
6. Variations in abundance of the *total run* followed those of the Southern Approach run, which forms its major component.

Summary of Annual Variability

1. *Information* on migration routes and times of passage for years other than 1959 is limited to rather incomplete tagging data for a few years and to the timing of peak catches in some fishing areas. These data were not adequate to fully describe migration routes and times of passage for individual years but were compared with the 1959 data for comparability with the detailed description of the run in that year. More or less complete information on the composition of the run and the abundance and rates of removal of its various components was available from direct estimates of catches and spawning escapements in 1959, 1961 and 1963. All quantitative information for these years is based on these estimates. Comparisons of the composition of the run and the abundance of its various components over periods extending back prior to 1959, were carried out on the basis of catch data employed as indices of relative abundance for each year (including 1959, 1961 and 1963). Information on rates of removal for years prior to 1959 is limited to general changes in the character of the fisheries.

2. The basic *migration routes* of the runs of pink salmon to Canada Non-Fraser, Fraser River and United States streams have not changed in recent years, with some fish destined for each of these three areas migrating via the Northern Approach (through Queen Charlotte and Johnstone Straits) and some migrating via the Southern Approach (through Juan de Fuca Strait).
3. The *times of passage* through the major fishing areas for Canada Non-Fraser, Fraser River and United States stocks were similar on both approaches. Canada Non-Fraser fish were the first to appear in all years, reaching their peak abundance about mid-August. As this run declined, the abundance of the runs to United States and Fraser River streams increased rapidly with the United States run reaching peak abundance about one week before the peak of the Fraser run at the end of August. After the first week in September, the run on both approaches was made up almost exclusively of Fraser fish.
4. On the basis of indices of relative abundance derived from catch data, it would appear that, since 1937 most of the total run to the Study Area has approached from the south. According to these indices, the proportion of Southern Approach fish in the run has probably not been much lower than in 1961 (56 per cent) or higher than in 1963 (77 per cent). In years when Canada Non-Fraser fish were relatively abundant (as in 1961) the proportion of Southern Approach fish was relatively low; in years when Fraser fish were relatively abundant (as in 1959), the proportion of Southern Approach fish was higher; in years when United States fish were relatively abundant (as in 1963) the proportion of Southern Approach fish was higher still.
5. According to catch indices, Canada Non-Fraser fish have formed the largest component of the *Northern Approach run* in all years since 1951. This proportion appears to have ranged between 53 per cent (in 1959) and 75 per cent (in 1961). Fraser fish may be considered to have made up virtually all of the remainder of the Northern Approach run in all years.
6. On the same basis, Fraser fish have made up the bulk of the *Southern Approach run* since 1937 with the exception of the runs in 1961 and 1963. The proportion of Fraser fish in the Southern Approach run appears to have ranged between 35 per cent (in 1961) and more than 73 per cent (in 1947). In 1961 and 1963, United States fish formed the largest component of the Southern Approach run. The proportion of United States fish in the Southern Approach run appears to have varied between less than 18 per cent (in 1947) and 64 per cent (in 1963). The proportion of Canada Non-Fraser fish in the Southern Approach run was apparently much greater in 1961 (26 per cent of the run) than in any other year since 1937. In several years, Canada Non-Fraser fish appear to have been relatively less abundant than in 1959, when they made up 8 per cent of the run.
7. Combining the above information, Fraser fish appear to have formed the largest component of the *total run* in most years. The proportion of Fraser fish in the total run during the period 1951-1963 apparently did not

greatly exceed that in 1959 (63 per cent) or go below that in 1963 (27 per cent). The proportion of Canada Non-Fraser fish in the total run during this period was lowest (less than 20 per cent) in 1953 and highest (48 per cent) in 1961. Over the same period, the proportion of United States fish in the total run apparently varied between the 1959 level (12 per cent) and that in 1963 (54 per cent).

8. Direct information on *rates of removal* is limited to the 1959, 1961 and 1963 runs. During these three cycle years, the rate of removal for Canada Non-Fraser fish has remained remarkably constant on both approaches (.56 to .60). Rates of removal for United States fish on the Southern Approach and in the combined run varied to a greater extent (.43 to .69) while rates of removal for Fraser fish show the most extreme variation (.31 to .85). During this three year period variations in rates of removal for all three stock groups reflect directly the amount of fishing time permitted. On the basis of a cursory examination of factors affecting the effectiveness of the fisheries it was considered that rates of removal in the years prior to 1959 were less than in 1959. In the years prior to 1951 they were considered to have been appreciably less than in 1959.
9. On the basis of catch indices, the *abundance* of Canada Non-Fraser fish and of United States fish was considered to have been the lowest in recent years in 1959 (2.5 and 1.3 million fish respectively) while that of Fraser fish was lowest in 1961 (1.8 million fish). United States fish were apparently at their highest level of abundance in recent years in 1963 (10.3 million). On the other hand, the abundance of Canada Non-Fraser fish apparently exceeded its 1963 level (4.0 million) in several years prior to 1959 and the abundance of Fraser fish in 1953 appears to have been at least twice as great as in 1959 (6.5 million) and may have been even greater in 1947.
10. The *abundance of the total run* and of its Northern and Southern Approach components appears to have been at its lowest level since 1937 in 1961 (6.4, 3.6 and 2.8 million respectively). The abundance of the run and its Northern and Southern Approach components appears to have been greatest in the earlier years when it is considered to have appreciably exceeded 26, 10 and 17 million respectively. The maximum abundance estimate for the total run in the years for which firm data are available was 20 million (in 1963). The abundance of the Northern Approach run in 1963 probably did not exceed that in 1959 and therefore the maximum abundance of this run in the 1959-1963 period was considered to be 4 million (in 1959). The maximum estimate for the Southern Approach run (more than 13 million in 1963) was based on conservative assumptions concerning the proportions of Southern Approach fish in some areas and hence was definitely minimal. This accounts for the fact that the sum of the maximum Northern and Southern Approach runs (17 million) does not match the estimate of maximum abundance for the total run (20 million).
11. On the basis of the above information, the routes and timing of the migration in 1959 were similar to those for other years for which data were available. The 1959 run was less abundant than almost all of the

runs since 1937 but almost twice as abundant as the 1961 run (the smallest on record). The abundance of Canada Non-Fraser fish and of United States fish was the lowest on record while that of Fraser fish was well below average for this period. The proportion of Fraser fish in the total run was higher than in almost any other year since 1937 and more than double that in some other years. The proportion of United States fish in the run appears to have been the lowest in recent years while that of Canada Non-Fraser fish was well below average. Rates of removal were exceedingly high in 1959, especially for Fraser fish, and were probably greater than in any other year during this period.

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APPENDIX A

Pink Salmon Catches in the Study Area in 1961

Information on the catches of pink salmon was compiled for fishing areas within which the composition of the run would be reasonably homogeneous and different from that in adjacent areas. The fishing areas and the methods used in compiling catch data were virtually the same as those in 1959 and have been described in detail by Vernon, Hourston and Holland (1964). As in 1959 weekly catches from fisheries in Canadian waters north of the Convention area were compiled by the Canadian agencies (Tables A-1 to A-14), catches from fisheries in the Convention area were compiled by the Salmon Commission (Tables A-15 to A-22) and catches from fisheries in United States waters south of the Convention area were compiled by the Washington Department of Fisheries (Tables A-23 to A-28). Sport catches in Canadian waters (Table A-29) were compiled by the Canadian agencies and sport catches in United States waters (Table A-30) were compiled by the Washington Department of Fisheries. Procedures used in compiling these data will be discussed only where they differ from those employed for the 1959 run.

In the Canadian Study Area the only significant difference in procedure between the two years was that in 1961 assignments of catches to individual fisheries within Statistical areas (for which catch data are routinely provided by the Canadian Department of Fisheries) was based on daily estimates for these fisheries by the Department's field officers rather than from direct examination of sales records as in 1959. These field estimates were of catches by fishery by day by gear in round numbers and were used to determine, for each Statistical area, the percentage of the weekly catch by gear to be assigned to each component fishery. In turn, these percentages were applied to the exact weekly catches by gear compiled by the Department of Fisheries for each Statistical area. In practically all cases the totals of the field estimate for each Statistical area were very close to the exact catches later compiled from sales records.

Data on the fishing effort in the Canadian Study Area in 1961 were based on the field officers' daily estimates of the number of boats operating or, when these estimates were incomplete or unavailable, the number of landings reported by the Statistical Branch for that fishing area. These data included landings for all species of salmon and thus, particularly at the beginning and end of the season, many of these landings would have contained no pink salmon. However, these deficiencies in the data on the effort directed on pink salmon were not considered important since these data played a very minor part in subsequent analyses.

In 1959, the sport catch in the Howe Sound-Burrard Inlet area was recorded for the area as a unit. Since fishing effort in the two terminal areas appeared similar and the spawning escapements were similar in magnitude for these two stocks, equal portions of this catch were allocated to the Howe Sound and Burrard Inlet stocks. In 1961, however, the Howe Sound spawning escapement was over five times as abundant as that in Burrard Inlet and an equal division of sport catch between the two stocks could not be justified. Furthermore, the catch off the Indian River (Burrard Inlet stock) was recorded separately in 1961 (Table A-29). The 15,650 pinks taken by sportsmen in the remainder of the Howe Sound-Burrard Inlet area were therefore divided between the Howe Sound (13,150) and Burrard Inlet (2500) stocks according to the relative abundance of spawners in

these two stocks. The 4,325 pinks taken by sport fishermen off the Indian River were then added to the estimated catch of 2500 Burrard Inlet fish elsewhere in this area to give a total "terminal area" sport catch for Burrard Inlet of 6825 pinks.

In the Convention area the catches in Canadian Statistical Area 29 (in and adjacent to the Fraser River) were again separated into those made outside the mouth of the Fraser (Fraser Gulf) and those made inside the mouth (Fraser River). Since catches in this area were relatively small in 1961 a separation of daily catches in consultation with local buyers was not attempted. All troll-caught fish were known to have been taken outside the mouth. No gill net fishing was permitted outside the mouth for five weeks during the height of the run (Table A-16). Minor gill net catches in weeks before and after the extensive closed period were separated by using as a guide the percentage taken in each fishery in the corresponding weeks in 1959.

In the United States Study Area procedures did not differ significantly from those employed in 1959.

TABLE A-1. Weekly commercial catches of pink salmon and fishing effort by gear in the Canadian West Coast (troll) fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days ^a	Fish	Boat- days ^b	Fish	Boat- days ^b	Fish	Fish
May 13	—	—	—	—	56	2	2
20	—	—	—	—	210	2	2
27	—	—	—	—	80	3	3
June 3	—	—	—	—	279	11	11
Totals May	—	—	—	—	625	18	18
June 10	—	—	—	—	34	1	1
17	—	—	—	—	713	381	381
24	—	—	—	—	1,209	3,855	3,855
July 1	—	—	—	—	1,025	3,869	3,869
Totals June	—	—	—	—	2,981	8,106	8,106
July 8	—	—	—	—	1,775	9,043	9,043
15	—	—	—	—	1,361	2,633	2,633
22	—	—	—	—	1,370	6,020	6,020
29	—	—	—	—	1,220	6,122	6,122
Aug. 5	—	—	—	—	1,373	16,985	16,985
Totals July	—	—	—	—	7,099	40,803	40,803
Aug. 12	—	—	—	—	2,000	15,146	15,146
19	—	1	—	—	1,871	13,742	13,743
26	—	—	—	—	1,345	5,643	5,643
Sept. 2	—	—	—	—	701	1,887	1,887
Totals Aug.	—	1	—	—	5,917	36,418	36,419
Sept. 9	—	—	—	—	665	350	350
16	—	—	—	—	583	85	85
23	—	—	—	—	266	86	86
30	—	—	—	—	—	—	—
Totals Sept.	—	—	—	—	1,514	521	521
Oct. 7	—	1	—	—	—	—	1
14	—	4	—	—	—	—	4
21	—	—	45	3	—	—	3
Totals Oct.	—	5	45	3	—	—	8
SEASON TOTALS	—	7	45	3	18,136	85,866	85,875

^a Incidental to herring.

^b Total deliveries for all species of salmon.

TABLE A-2. Weekly commercial catches of pink salmon and fishing effort by gear in the Queen Charlotte Strait fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
June 10	—	—	—	—	262 ^a	1	1
17	—	—	—	—	126 ^a	2	2
24	—	—	—	—	384 ^a	62	62
July 1	—	—	—	—	578 ^a	281	281
Totals June	—	—	—	—	1,350 ^a	346	346
July 8	—	—	18 ^a	8	377 ^a	785	793
15	—	—	21	33	320	2,241	2,274
22	19	787	9	127	375	3,673	4,587
29	15	529	14	316	558	9,680	10,525
Aug. 5	2	128	27	286	434	13,264	13,678
Totals July	36	1,444	89	770	2,064	29,643	31,857
Aug. 12	—	—	19	799	517	25,927	26,726
19	—	—	15	402	420	14,527	14,929
26	—	—	—	—	565	13,712	13,712
Sept. 2	—	—	—	—	285	2,746	2,746
Totals Aug.	—	—	34	1,201	1,787	56,912	58,113
Sept. 9	—	—	—	—	317	1,391	1,391
16	—	—	—	—	243	181	181
23	—	—	—	—	16 ^a	14	14
Totals Sept.	—	—	—	—	576	1,586	1,586
SEASON TOTALS	36	1,444	123	1,971	5,777	88,487	91,902

^a Total deliveries for all species of salmon.

TABLE A-3. Weekly commercial catches of pink salmon and fishing effort by gear in the Malcolm Island fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
July 8	109 ^a	290	290 ^a	124	—	—	414
15	161	2,396	225	500	—	—	2,896
22	170	14,455	98	1,506	42	758	16,719
29	98	21,782	108	2,665	160	3,992	28,439
Aug. 5	163	55,457	357	6,069	855	14,141	75,667
Totals July	701	94,380	1,078	10,864	1,057	18,891	124,135
Aug. 12	106	43,990	285	10,250	505	14,145	68,385
19	136	85,313	148	5,913	925	52,920	144,146
26	209	68,392	305	8,759	360	9,276	86,427
Sept. 2	141	46,462	207	3,196	320	4,733	54,391
Totals Aug.	592	244,157	945	28,118	2,110	81,074	353,349
Sept. 9	56	8,772	75	1,372	230	1,751	11,895
16	—	—	—	—	125	396	396
23	323	2,510	1,132	700	11 ^a	9	3,219
30	—	—	—	—	—	—	—
Totals Sept.	379	11,282	1,207	2,072	366	2,156	15,510
Oct. 7	9 ^a	2	182 ^a	5	—	—	7
14	—	—	—	—	—	—	—
21	—	—	—	—	—	—	—
Totals Oct.	9 ^a	2	182 ^a	5	—	—	7
SEASON TOTALS	1,681	349,821	3,412	41,059	3,533	102,121	493,001

^a Total deliveries for all species of salmon.^b Probably includes small number of pinks caught in Upper Johnstone Strait.

TABLE A-4. Weekly commercial catches of pink salmon and fishing effort by gear in the Upper Johnstone Strait fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Fish
May 27	—	—	17 ^a	1	1
June 3	—	—	35 ^a	1	1
Totals May	—	—	52 ^a	2	2
June 10	—	—	176 ^a	5	5
17	—	—	241 ^a	25	25
July 1	86 ^a	22	465 ^a	45	67
Totals June	86 ^a	22	882 ^a	75	97
July 8	109 ^a	290	290 ^a	124	414
15	162	2,396	225	500	2,896
22	170	14,455	98	1,506	15,961
29	229	50,971	252	6,205	57,176
Aug. 5	163	55,457	358	6,069	61,526
Totals July	833	123,569	1,223	14,404	137,973
Aug. 12	105	43,990	285	10,250	54,240
19	167	104,271	182	7,233	111,504
26	171	55,998	250	7,175	63,173
Sept. 2	165	54,542	243	3,752	58,294
Totals Aug.	608	258,801	960	28,410	287,211
Sept. 9	169	26,314	225	4,117	30,431
16	—	—	—	—	—
23	108	837	378	233	1,070
30	—	—	—	—	—
Totals Sept.	277	27,151	603	4,350	31,501
Oct. 7	113 ^a	24	327 ^a	9	33
14	—	—	—	—	—
21	74 ^a	1	—	—	1
Totals Oct.	187 ^a	25	327 ^a	9	34
SEASON TOTALS	1,991	409,568	3,995	47,250	456,818

^a Total deliveries for all species of salmon.

TABLE A-5. Weekly commercial catches of pink salmon and fishing effort by gear in the Lower Johnstone Strait fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
June 17	—	—	—	—	562	6	6
24	—	—	13 ^a	2	780	3	5
July 1	9	9	23	9	637	5	23
Totals June	9	9	36	11	1,979	14	34
July 8	29	262	16	22	609	21	305
15	153	1,551	94	70	735	19	1,640
22	164	5,483	68	391	615	44	5,918
29	87	16,558	76	1,659	421	280	18,497
Aug. 5	50	19,546	90	2,039	442	186	21,771
Totals July	483	43,400	344	4,181	2,822	550	48,131
Aug. 12	65	20,020	173	3,210	387	770	24,000
19	96	36,672	107	2,474	390	374	39,520
26	157	41,524	172	4,888	348	441	46,853
Sept. 2	165	42,835	150	4,022	161	78	46,935
Totals Aug.	483	141,051	602	14,594	1,286	1,663	157,308
Sept. 9	135	39,014	135	4,157	163	447	43,618
16	—	—	—	—	186	42	42
23	213	2,398	298	631	162	21	3,050
30	—	—	—	—	—	—	—
Totals Sept.	348	41,412	433	4,788	511	510	46,710
Oct. 7	130 ^a	118	235 ^a	4	170	2	124
14	—	—	—	—	—	—	—
21	130 ^a	3	—	—	—	—	3
Totals Oct.	260 ^a	121	235 ^a	4	170	2	127
SEASON TOTALS	1,583	225,993	1,650	23,578	6,768	2,739	252,310

^a Total deliveries for all species of salmon.

TABLE A-6. Weekly commercial catches of pink salmon and fishing effort by gear in the Comox fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days ^b	Fish	Boat- days	Fish	Boat- days	Fish	Fish
June 17	—	—	7	1	589 ^a	15	16
24	—	—	—	—	925 ^a	16	16
July 1	—	8	—	—	770 ^a	55	63
Totals June	—	8	7	1	2,284 ^a	86	95
July 8	—	—	—	—	713 ^a	74	74
15	—	—	—	—	488 ^a	25	25
22	—	—	—	—	320 ^a	28	28
29	—	—	30	14	267 ^a	11	25
Aug. 5	—	—	—	—	306 ^a	10	10
Totals July	—	—	30	14	2,094 ^a	148	162
Aug. 12	—	—	—	—	350	194	194
19	—	—	—	—	480	152	152
26	—	—	—	—	325	200	200
Sept. 2	—	—	—	—	336	139	139
Totals Aug.	—	—	—	—	1,491	685	685
Sept. 9	6	6	1	3	233	9	18
16	—	—	—	—	350	3	3
23	6	1	102	54	—	—	55
30	—	—	—	—	1	1	1
Totals Sept.	12	7	103	57	584	13	77
Oct. 7	—	—	112	1	—	—	1
14	—	—	—	—	—	—	—
21	—	—	80	1	—	—	1
Totals Oct.	—	—	192	2	—	—	2
SEASON TOTALS	12	15	332	74	6,453	932	1,021

^a Total deliveries for all species of salmon.^b Incidental to herring.

TABLE A-7. Weekly commercial catches of pink salmon and fishing effort by gear in the Cortes Island fishing area during 1961.

WEEK ENDING	GILL-NET		TROLL		ALL GEAR
	Boat- days ^a	Fish	Boat- days	Fish	Fish
July 1	—	—	122 ^a	1	1
Totals June	—	—	122 ^a	1	1
July 8	—	—	129 ^a	1	1
15	—	—	119 ^a	3	3
22	—	—	109 ^a	1	1
29	—	—	51 ^a	5	5
Aug. 5	—	—	16 ^a	5	5
Totals July	—	—	424 ^a	15	15
Aug. 12	—	—	22	33	33
19	—	—	50	9	9
26	1	5	39	65	70
Sept. 2	8	106	36	40	146
Totals Aug.	9	111	147	147	258
Sept. 9	1	9	5	10	19
16	—	—	8	8	8
23	66	18	—	—	18
30	—	—	—	—	—
Totals Sept.	67	27	13	18	45
Oct. 7	37	3	—	—	3
Totals Oct.	37	3	—	—	3
SEASON TOTALS	113	141	706	181	322

^a Total deliveries for all species of salmon.

TABLE A-8. Weekly commercial catches of pink salmon and fishing effort by gear in the Texada Island fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
June 17	—	—	—	—	481 ^a	2	2
24	—	—	21 ^a	4	711 ^a	4	8
July 1	—	—	—	—	493 ^a	7	7
Totals June	—	—	21 ^a	4	1,685 ^a	13	17
July 8	—	—	—	—	—	—	—
15	—	—	26 ^a	15	439 ^a	5	20
22	—	—	9 ^a	6	394 ^a	27	33
29	—	—	18 ^a	155	290 ^a	124	279
Aug. 5	—	—	13	110	130	184	294
Totals July	—	—	66 ^a	286	1,253	340	626
Aug. 12	—	—	268	2,765	118	440	3,205
19	—	—	10	221	51	85	306
26	—	—	36	1,388	103	80	1,468
Sept. 2	2	194	58	2,260	33	119	2,573
Totals Aug.	2	194	372	6,634	305	724	7,552
Sept. 9	2	260	6	314	19	77	651
16	—	—	—	—	248 ^a	18	18
23	1	30	76	341	114 ^a	5	376
30	—	—	—	—	—	—	—
Totals Sept.	3	290	82	655	381	100	1,045
Oct. 7	—	—	193 ^a	10	—	—	10
14	—	—	—	—	—	—	—
21	—	—	204 ^a	2	—	—	2
28	—	—	—	—	—	—	—
Nov. 4	—	—	943 ^a	1	—	—	1
Totals Oct.	—	—	1,340 ^a	13	—	—	13
SEASON TOTALS	5	484	1,881	7,592	3,624	1,177	9,253

^a Total deliveries for all species of salmon.

TABLE A-9. Weekly commercial catches of pink salmon and fishing effort by gear in the Kingcome Inlet fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Fish
July 29	20	9,789	8	1,533	11,322
Aug. 5	—	—	57	4,454	4,454
Totals July	20	9,789	65	5,987	15,776
Aug. 12	—	—	36	2,745	2,745
19	—	—	15	172	172
Totals Aug.	—	—	51	2,917	2,917
SEASON TOTALS	20	9,789	116	8,904	18,693

TABLE A-10. Weekly commercial catches of pink salmon and fishing effort by gear in the Knight Inlet fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
July 8	36 ^a	98	32 ^a	13	—	—	111
15	25	806	25	55	—	—	861
22	30	1,795	32	498	—	—	2,293
29	30	5,115	72	1,448	—	—	6,563
Aug. 5	23	16,740	80	3,556	—	—	20,296
Totals July	144	24,554	241	5,570	—	—	30,124
Aug. 12	35	41,783	135	10,703	—	—	52,486
19	104	116,196	250	43,683	75	1,729	161,608
26	74	28,611	380	30,655	64	858	60,124
Sept. 2	—	—	—	—	48	1,238	1,238
Totals Aug.	213	186,590	765	85,041	187	3,825	275,456
Sept. 9	—	—	—	—	37	616	616
16	—	—	—	—	20	77	77
Totals Sept.	—	—	—	—	57	693	693
SEASON TOTALS	357	211,144	1,006	90,611	244	4,518	306,273

^a Total deliveries for all species of salmon.

TABLE A-11. Weekly commercial catches of pink salmon and fishing effort by gear in the Phillips Arm fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL ^b		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days ^a	Fish	Fish
Aug. 5	—	—	6	16	—	—	16
Totals July	—	—	6	16	—	—	16
Aug. 12	4	1,438	15	429	29	57	1,924
19	8	1,568	31	1,309	29	28	2,905
26	6	505	70	5,254	26	33	5,792
Sept. 2	1	14	121	895	12	64	973
Totals Aug.	19	3,525	237	7,887	96	182	11,594
Sept. 9	—	—	79	822	134	366	1,188
16	—	—	—	—	152	35	35
23	—	—	—	—	132	18	18
Totals Sept.	—	—	79	822	418	419	1,241
SEASON TOTAL	19	3,525	322	8,725	514	601	12,851

^a Total deliveries for all species of salmon.

TABLE A-12. Weekly commercial catches of pink salmon and fishing effort by gear in the Toba Inlet fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
July 29	—	—	12	3	—	—	3
Aug. 5	—	—	4	46	—	—	46
Totals July	—	—	16	49	—	—	49
Aug. 12	—	—	24	593	—	—	593
19	—	—	33	715	9	125	840
26	1	42	—	—	—	—	42
Totals Aug.	1	42	57	1,308	9	125	1,475
SEASON TOTALS	1	42	73	1,357	9	125	1,524

TABLE A-13. Weekly commercial catches of pink salmon and fishing effort by gear in the Jervis Inlet fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL		ALL GEAR
	Boat- days	Fish	Boat- days	Fish	Boat- days	Fish	Fish
Aug. 5	1	223	--	—	62	150	373
Totals July	1	223	—	--	62	150	373
Aug. 12	11	2,031	22	1,381	84	663	4,075
19	10	11,127	25	3,649	140	2,833	17,609
26	79	55,126	45	872	119	2,984	58,982
Sept. 2	51	13,695	—	—	182	749	14,444
Totals Aug.	151	81,979	92	5,902	525	7,229	95,110
Sept. 9	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—
23	16	375	1	3	—	—	378
Totals Sept.	16	375	1	3	—	—	378
SEASON TOTALS	168	82,577	93	5,905	587	7,379	95,861

TABLE A-14. Weekly commercial catches of pink salmon and fishing effort by gear in the Howe Sound fishing area during 1961.

WEEK ENDING	GILL-NET		TROLL		ALL GEAR
	Boat- days ^a	Fish	Boat- days ^a	Fish	Fish
Aug. 19	12	185	—	—	185
26	2	52	—	—	52
Sept. 2	—	—	1	9	9
Totals Aug.	14	237	1	9	246
SEASON TOTALS	14	237	1	9	246

^a Total deliveries for all species of salmon.

TABLE A-15. Weekly commercial catches of pink salmon and fishing effort by gear in the Canadian Juan de Fuca Strait fishing area^a during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL	ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish	Fish
June 24	—	—	79	33	—	33
July 1	—	—	—	—	—	—
Totals June	—	—	79	33	—	33
July 8	—	—	—	—	—	—
15	—	—	—	—	108	108
22	169	19,780	308	2,841	644	23,265
29	290	57,427	781	11,018	497	68,942
Aug. 5	195	19,698	623	3,163	1,280	24,141
Totals July	654	96,905	1,712	17,022	2,529	116,456
Aug. 12	169	37,026	580	3,778	1,702	42,506
19	153	132,178	256	2,392	1,394	135,964
26	152	43,306	258	4,830	2,380	50,516
Sept. 2	—	—	—	—	1,435	1,435
Totals Aug.	474	212,510	1,094	11,000	6,911	230,421
Sept. 9	29	2,943	331	2,590	208	5,741
16	4	480	313	1,025	188	1,693
23	87	486	907	549	4	1,039
30	83	26	1,080	115	4	145
Totals Sept.	203	3,935	2,631	4,279	404	8,618
Oct. 7	76	16	675	17	25	58
14	7	—	259	3	4	7
Totals Oct.	83	16	934	20	29	65
SEASON TOTALS	1,414	313,366	6,450	32,354	9,873	355,593

^a Includes catches at San Juan and Sooke.

TABLE A-16. Weekly commercial catches of pink salmon and fishing effort by gear in the Fraser Gulf fishing area^a during 1961.

WEEK ENDING	SEINE		GILL-NET		TROLL	ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish	Fish
July 8	—	—	800	2	1	3
15	—	—	2,052	43	17	60
22	—	—	1,204	93	18	111
29	—	—	1,037	385	45	430
Aug. 5	—	—	1,565	1,029	61	1,090
Totals July	—	—	6,658	1,552	142	1,694
Aug. 12	—	—	—	—	48	48
19	—	—	2,485	11,536	132	11,668
26	1	270	904	4,236	742	5,248
Sept. 2	—	—	—	—	8,747	8,747
Totals Aug.	1	270	3,389	15,772	9,669	25,711
Sept. 9	—	—	—	—	1,865	1,865
16	—	—	—	—	10,882	10,882
23	—	—	—	—	2,319	2,319
30	—	—	—	—	—	—
Totals Sept.	—	—	—	—	15,066	15,066
Oct. 7	—	—	80	1,026	9	1,035
14	—	—	—	—	27	27
21	—	—	—	—	27	27
28	—	—	—	—	—	—
Totals Oct.	—	—	80	1,026	63	1,089
SEASON TOTALS	1	270	10,127	18,350	24,940	43,560

^a Canadian Statistical Areas 17, 18 and 29A.

TABLE A-17. Weekly gill-net catches of pink salmon and fishing effort in the Fraser River fishing area during 1961.

WEEK ENDING	DELIVERIES	FISH
July 22	588	2
29	609	2
Aug. 5	659	28
Totals July	1,856	32
Aug. 12	—	—
19	731	406
26	686	1,531
Sept. 2	1,513	17,541
Totals Aug.	2,930	19,478
Sept. 9	—	9,543
16	—	9,200
23	—	7,677
30	—	10,910
Totals Sept.	—	37,330 ^a
Oct. 7	651	34,422
14	14	9
21	475	540
28	56	1
Nov. 4	24	2
Totals Oct.	1,220	34,974
SEASON TOTALS	6,006	91,814

^a Virtually all males taken incidentally while fishing for chinook salmon with large-mesh nets.

TABLE A-18. Weekly troll catches of pink salmon in the Canadian and United States Convention West Coast Troll fishing areas during 1961.

WEEK ENDING	CANADA	UNITED STATES
June 10	10	4
17	364	92
24	3,311	208
July 1	5,201	905
Totals June	8,886	1,209
July 8	6,818	2,709
15	4,691	3,448
22	5,787	6,201
29	5,432	5,048
Aug. 5	4,204	6,928
Totals July	26,932	24,334
Aug. 12	4,872	13,111
19	7,350	15,499
26	4,055	6,120
Sept. 2	1,751	2,224
Totals Aug.	18,028	36,954
Sept. 9	190	594
16	103	604
23	22	197
30	—	1
Totals Sept.	315	1,396
SEASON TOTALS	54,161	63,893

TABLE A-19. Weekly commercial catches of pink salmon and fishing effort by gear^a in the United States Juan de Fuca Strait fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 15	—	—	19	2	2
22	—	—	50	1,258	1,258
29	—	—	91	3,929	3,929
Aug. 5	1	12	84	2,436	2,448
Totals July	1	12	244	7,625	7,637
Aug. 12	1	2	27	613	615
19	2	49	85	1,506	1,555
26	3	471	102	1,974	2,445
Sept. 2	—	—	—	—	—
Totals Aug.	6	522	214	4,093	4,615
Sept. 9	—	—	—	—	—
16	—	—	—	—	—
23	—	—	27	10	10
30	—	—	30	2	2
Totals Sept.	—	—	57	12	12
SEASON TOTALS	7	534	515	11,730	12,264

^a Minor troll catches in this area were included in the United States Convention West Coast Troll fishing area (TABLE A-18).

TABLE A-20. Weekly commercial catches of pink salmon and fishing effort by gear in the San Juan Islands fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		REEF NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 1	113	2	—	—	—	—	2
Totals June	113	2	—	—	—	—	2
July 8	220	63	480	14	124	7	84
15	203	478	363	46	120	25	549
22	396	14,300	510	3,551	179	1,183	19,034
29	431	25,466	685	10,406	193	3,527	39,399
Aug. 5	402	33,332	747	14,790	191	4,184	52,306
Totals July	1,652	73,639	2,785	28,807	807	8,926	111,372
Aug. 12	130	30,792	178	1,082	64	4,797	36,671
19	147	21,489	153	1,181	73	2,362	25,032
26	155	37,366	185	2,219	137	9,991	49,576
Sept. 2	—	—	—	—	—	—	—
Totals Aug.	432	89,647	516	4,482	274	17,150	111,279
Sept. 9	—	—	—	—	—	—	—
16	—	—	—	—	1	43	43
23	220	3,573	102	99	103	1,104	4,776
30	76	184	69	16	62	61	261
Totals Sept.	296	3,757	171	115	166	1,208	5,080
Oct. 7	57	36	—	—	84	5	41
14	38	3	40	1	—	—	4
21	—	—	—	—	16	1	1
Totals Oct.	95	39	40	1	100	6	46
SEASON TOTALS	2,588	167,084	3,512	33,405	1,347	27,290	227,779

TABLE A-21. Weekly commercial catches of pink salmon and fishing effort by gear in the West Beach fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 8	43	11	123	3	14
15	20	95	126	10	105
22	24	750	193	418	1,168
29	35	5,954	197	1,921	7,875
Aug. 5	52	6,477	185	2,384	8,861
Totals July	174	13,287	824	4,736	18,023
Aug. 12	12	3,896	52	335	4,231
19	50	22,189	67	859	23,048
26	43	38,152	77	2,753	40,905
Sept. 2	—	—	—	—	—
Totals Aug.	105	64,237	196	3,947	68,184
Sept. 9	—	—	—	—	—
16	—	—	—	—	—
23	104	933	82	56	989
30	72	85	47	3	88
Totals Sept.	176	1,018	129	59	1,077
Oct. 7	48	8	—	—	8
14	—	—	—	—	—
21	—	—	—	—	—
28	8	1	—	—	1
Nov. 4	—	—	21	1	1
Totals Oct.	56	9	21	1	10
SEASON TOTALS	511	78,551	1,170	8,743	87,294

TABLE A-22. Weekly commercial catches of pink salmon and fishing effort by gear in the Point Roberts fishing area during 1961.

WEEK ENDING	SEINE		GILL-NET		REEF NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 8	274	31	355	4	—	—	35
15	205	204	324	32	—	—	236
22	251	4,720	520	1,198	24	40	5,958
29	306	10,086	580	3,114	30	83	13,283
Aug. 5	346	16,755	664	5,858	29	220	22,833
Totals July	1,382	31,796	2,443	10,206	83	343	42,345
Aug. 12	121	20,227	215	2,488	11	156	22,871
19	165	15,365	214	1,774	3	38	17,177
26	154	27,263	198	3,406	18	666	31,335
Sept. 2	—	—	—	—	—	—	—
Totals Aug.	440	62,855	627	7,668	32	860	71,383
Sept. 9	—	—	—	—	—	—	—
16	—	—	—	—	—	—	—
23	104	1,172	49	69	6	19	1,260
30	156	699	87	29	—	—	728
Totals Sept.	260	1,871	136	98	6	19	1,988
Oct. 7	106	1,517	34	74	—	—	1,591
14	37	3	50	—	—	—	3
21	90	3	—	—	1	1	4
Totals Oct.	233	1,523	84	74	1	1	1,598
SEASON TOTALS	2,315	98,045	3,290	18,046	122	1,223	117,314

TABLE A-23. Weekly commercial catches of pink salmon and fishing effort by gear in the Bellingham Bay-Nooksack River fishing area during 1961.

WEEK ENDING	PURSE SEINE		GILL-NET		INDIAN GILL NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Deliv- eries	Fish	
July 8	—	—	—	—	1	2	2
15	—	—	—	—	85	239	239
22	—	—	1	1	219	2,700	2,701
29	—	—	—	—	268	5,397	5,397
Aug. 5	—	—	3	29	315	6,585	6,614
Totals July	—	—	4	30	888	14,923	14,953
Aug. 12	3	490	27	76	367	13,456	14,022
19	22	3,002	22	54	471	15,235	18,291
26	1	2	6	6	340	4,639	4,647
Sept. 2	1	3	—	—	184	324	327
Totals Aug.	27	3,497	55	136	1,362	33,654	37,287
Sept. 9	1	3	1	1	115	156	160
16	1	1	10	11	33	36	49 ^a
23	1	6	6	7	19	26	39
30	—	—	3	3	12	78	81
Totals Sept.	3	10	20	22	179	296	329 ^a
Oct. 7	—	—	1	1	3	3	4
14	—	—	—	—	—	—	—
21	—	—	1	1	—	—	1
Totals Oct.	—	—	2	2	3	3	5
SEASON TOTALS	30	3,507	81	190	2,432	48,876	52,574 ^a

^a Includes one pink salmon taken by Indian trap.

TABLE A-24. Weekly commercial catches of pink salmon and fishing effort by gear in the Skagit Bay fishing area during 1961.

WEEK ENDING	GILL-NET		INDIAN SEINE		INDIAN TRAP		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 29	7	8	1	3	4	275	286
Aug. 5	54	103	12	240	6	376	719
Totals July	61	111	13	243	10	651	1,005
Aug. 12	202	822	34	1,653	8	1,488	3,963
19	230	6,053	65	5,788	6	3,245	15,086
26	262	18,487	62	6,451	8	11,763	36,701
Sept. 2	60	5,031	45	8,258	6	5,069	18,358
Totals Aug.	754	30,393	206	22,150	28	21,565	74,108
Sept. 9	305	15,049	67	3,696	12	7,544	26,289
16	169	1,314	33	366	4	337	2,017
23	82	210	15	52	3	265	527
30	19	55	5	8	4	26	89
Totals Sept.	575	16,628	120	4,122	23	8,172	28,922
Oct. 7	5	6	—	—	—	—	6
14	4	5	—	—	—	—	5
21	—	—	—	—	—	—	—
28	1	1	—	—	—	—	1
Totals Oct.	10	12	—	—	—	—	12
SEASON TOTALS	1,400	47,144	339	26,515	61	30,388	104,047

TABLE A-25. Weekly commercial catches of pink salmon and fishing effort by gear in the Port Susan-Port Gardner fishing area during 1961.

WEEK ENDING	GILL-NET		INDIAN SEINE		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish
July 22	—	—	11	24	24
29	—	—	26	318	318
Aug. 5	1	1	44	787	788
Totals July	1	1	81	1,129	1,130
Aug. 12	8	226	67	1,666	1,892
19	34	828	137	9,615	10,443
26	113	5,510	122	12,564	18,074
Sept. 2	7	259	77	7,529	7,788
Totals Aug.	162	6,823	403	31,374	38,197
Sept. 9	22	915	151	17,981	18,896
16	47	316	68	1,159	1,475
23	146	375	67	641	1,016
30	27	35	20	361	396
Totals Sept.	242	1,641	306	20,142	21,783
Oct. 7	3	3	1	1	6 ^a
14	2	2	—	—	2
Totals Oct.	5	5	1	1	8 ^a
SEASON TOTALS	410	8,470	791	52,646	61,118 ^a

^a Includes two pink salmon taken by purse seine.

TABLE A-26. Weekly commercial catch of pink salmon and fishing effort by Indian gill nets in the Puyallup-Nisqually fishing area during 1961.

WEEK ENDING	PUYALLUP RIVER		NISQUALLY RIVER		COMBINED
	Deliv- eries	Fish	Deliv- eries	Fish	Fish
Aug. 5	6	10	—	—	10
Totals July	6	10	—	—	10
Aug. 12	27	63	4	9	72
19	59	278	20	64	342
26	78	1,458	28	80	1,538
Sept. 2	159	4,945	74	502	5,447
Totals Aug.	323	6,744	126	655	7,399
Sept. 9	129	6,907	69	736	7,643
16	130	3,660	85	564	4,224
23	96	1,415	55	117	1,532
30	24	350	18	43	393
Totals Sept.	379	12,332	227	1,460	13,792
Oct. 7	7	9	11	15	24
14	1	2	1	1	3
Totals Oct.	8	11	12	16	27
SEASON TOTALS	716	19,097	365	2,131	21,228

TABLE A-27. Weekly commercial catches of pink salmon and fishing effort by gear in the Admiralty Inlet-Lower Puget Sound fishing area during 1961.

WEEK ENDING	PURSE SEINE		GILL-NET		ALL GEAR
	Deliv- eries	Fish	Deliv- eries	Fish	Fish
Aug. 12	—	—	2	14	14
19	14	5,859	3	104	5,963
26	19	10,889	5	317	11,206
Sept. 2	—	—	—	—	—
Totals Aug.	33	16,748	10	435	17,183
Sept. 9	—	—	—	—	—
16	—	—	56	166	166
23	—	—	31	62	62
30	—	—	5	6	6
Totals Sept.	—	—	92	234	234
Oct. 7	4	6	3	3	9
14	—	—	1	1	1
Totals Oct.	4	6	4	4	10
SEASON TOTALS	37	16,754	106	673	17,427

TABLE A-28. Weekly commercial catches of pink salmon in the United States Non-Convention Troll area during 1961.

WEEK ENDING	FISH	WEEK ENDING	FISH
Total June	238	Aug. 12	2,525
July 8	1,943	19	1,419
15	1,169	26	548
22	372	Sept. 2	59
29	826	Total Aug.	4,551
Aug. 5	990	Total Sept.	48
Total July	5,300	SEASON TOTAL	10,137

TABLE A-29. Weekly sport catches of pink salmon in Canadian waters during 1961.

Week Ending	Queen Charlotte Strait	Lower Johnstone Strait	Comox	Cortes ^a Island	Texada ^a Island	Jervis Inlet	Howe Sound ^a and Burrard Inlet	Indian River	Fraser Gulf	Juan de Fuca Strait	Total Fish
June 25	—	—	5	—	—	—	—	—	—	—	5
July 1	—	—	10	—	—	—	—	—	—	—	10
Totals June	—	—	15	—	—	—	—	—	—	—	15
July 9	—	10	10	—	—	—	35	—	—	30	85
16	—	20	10	—	2	—	150	—	—	60	242
23	—	30	10	—	3	—	315	—	—	90	448
30	55	75	10	1	30	—	550	—	24	210	955
Aug. 6	105	150	20	—	—	80	1,600	—	19	610	2,584
Totals July	160	285	60	1	35	80	2,650	—	43	1,000	4,314
Aug. 13	150	200	20	—	16	66	2,600	300	20	520	3,892
20	200	300	20	10	—	38	2,935	1,200	9	600	5,312
27	245	100	50	—	9	—	4,415	1,800	—	180	6,799
Sept. 3	100	20	60	—	4	1	2,650	1,000	—	1,200	5,035
Totals Aug.	695	620	150	10	29	105	12,600	4,300	29	2,500	21,038
Sept. 10	45	40	60	—	—	—	400	25	—	200	770
17	—	50	60	—	—	—	—	—	—	50	160
24	—	—	50	—	—	—	—	—	—	—	50
Oct. 1	—	—	30	—	—	—	—	—	—	—	30
Totals Sept.	45	90	200	—	—	—	400	25	—	250	1,010
SEASON TOTALS	900	995	425	11	64	185	15,650	4,325	72	3,750	26,377

* Preliminary estimates. Final estimates for the season were: Cortes Island 0, Texada Island 65, Howe Sound and Burrard Inlet 15,700.

TABLE A-30. Weekly sport catches of pink salmon in United States waters during 1961^a.

WEEK ENDING	SKAGIT BAY	PORT SUSAN- PORT GARDNER	ADMIRALTY INLET-PUGET SOUND	SAN JUAN ISLANDS	JUAN DE FUCA STRAIT	TOTAL FISH
July 8	—	—	—	—	50	50
15	10	—	100	200	350	660
22	25	50	200	250	800	1,325
29	51	75	300	300	1,200	1,926
Aug. 5	675	300	600	450	1,600	3,625
Totals July	761	425	1,200	1,200	4,000	7,586
Aug. 12	1,300	400	1,540	728	2,361	6,329
19	2,355	793	2,700	1,400	1,600	8,848
26	4,125	500	2,000	900	1,400	8,925
Sept. 2	9,967	300	842	800	1,200	13,109
Totals Aug.	17,747	1,993	7,082	3,828	6,561	37,211
Sept. 9	12,075	150	700	700	1,000	14,625
16	7,717	100	401	212	700	9,130
23	2,200	—	—	—	—	2,200
30	1,000	—	—	—	—	1,000
Totals Sept.	22,992	250	1,101	912	1,700	26,955
SEASON TOTALS	41,500 ^b	2,668	9,383	5,940	12,261	71,752

^a An additional 700 pinks were taken in the United States Non-Convention West Coast Troll area for which weekly data were not available.

^b All but 765 were taken inside the Skagit River mouth.

APPENDIX B

Pink Salmon Spawning Populations Enumerated by Visual Surveys in 1961

Streams supporting pink salmon spawning populations which were not enumerated by tagging and recovery programs in 1961 are listed, along with their general location and estimates of the numbers of spawners present in TABLES B-1 to B-3 for the Canadian, Convention and United States Study Areas respectively. Comparable data for 1959 are also given. The numbers of spawners in these streams were estimated from counts made during a series of visual surveys by foot and/or aircraft during the peak of the spawning period. While some of the very small populations were surveyed only once or twice during the season, all of the larger populations involved (and many of the smaller ones) were surveyed several times throughout the spawning period.

TABLE B-1. Estimates of pink salmon spawning populations not enumerated by stream tagging and recovery programs in the Canadian Study Area in 1959 and 1961. Estimates in parentheses were obtained from stream tagging and recovery data and are not included in totals. Local names of streams are indicated in parentheses following the proper name.

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT	
		1959	1961
<u>Kingcome Inlet</u>			
Embley Lagoon River	Mackenzie Sound	50	50
Kingcome River	Kingcome Inlet	5,000	3,500
Nahwitti River	Goletas Channel	7,500	1,550
Nimmo Bay Creek	Mackenzie Sound	50	—
Shushartie River	Goletas Channel	700	1,500
Songhees Creek	Goletas Channel	200	200
Wakeman River	Wakeman Sound	30,000	35,000
Approximate Total	(7 streams in 1959 6 streams in 1961)	43,500	41,800
<u>Upper Vancouver Island</u>			
Cluxewe River	Broughton Strait	3,000	3,500
Hyde Creek	Broughton Strait	800	400
Keogh River	Queen Charlotte Strait (E. of Hardy Bay)	(26,000)	15,000
Mills Creek	Broughton Strait	50	400
Nimpkish River	Broughton Strait	3,500	3,500
Quatse River	Hardy Bay	500	750
Tsulquate River	Hardy Bay	750	750
Approximate Total	(7 streams)	8,600	24,300

TABLE B-1 (Continued)

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT	
		1959	1961
<u>Johnstone Strait</u>			
Amor de Cosmos Creek (Bear River)	Johnstone Strait	50	—
Bouhey Bay Creek	Havannah Channel-Broken Island	100	—
Fulmore River	Port Neville	50	—
Hemming Bay Creek	East Thurlow Island, Nodales Channel	50	—
Kokish-Tsulton Rivers	Beaver Cove	1,500	1,500
Read Creek	Topaze Harbour, Sunderland Channel	200	200
Thurston Bay Creek	Thurston Bay, Nodales Channel	100	—
Wortley Creek	Forward Harbour, N. of Hardwicke Island	50	—
Tsitika River	Johnstone Strait	(1,000)	800
Approximate Total	(9 streams in 1959 3 streams in 1961)	2,100	2,500
<u>Mid Vancouver Island</u>			
Campbell River	Discovery Passage	50	75
Englishman River	Georgia Strait, E. of Parksville	50	25
Granite Bay Creek	Kanish Bay, Discovery Passage	50	—
Hyacinthe Bay Creek	Quadra Island, Sutil Channel	40	—
Kanish Bay River	Kanish Bay, Discovery Passage	50	—
Little Qualicum River	Georgia Strait, W. of Qualicum Beach	50	75
Millard Creek	Comox Harbour	50	—
Mohun Creek	Menzies Bay, Discovery Passage	50	—
Nile Creek	Qualicum Bay, Georgia Strait	50	—
Oyster River	N. of Comox, Georgia Strait	1,500	1,500
Puntledge River ^a	Comox Harbour	—	9,000
Quinsam River	Campbell River, Discovery Passage	(5,000)	3,500
Qualicum River (Big)	Georgia Strait, S. of Qualicum Bay	10	—
Tsable River	Baynes Sound	50	25
Village Bay Creek	Village Bay, Hoskyn Inlet	200	—
Approximate Total	(14 streams in 1959 7 streams in 1961)	2,200	14,200

^a Other than Tsolum River tributary. In 1959 a combined estimate was made for the Puntledge-Tsolum system involving the Tsolum River weir count, a tagging program below the weir and visual surveys of spawners in the lower Puntledge River.

TABLE B-1 (Continued)

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT	
		1959	1961
<u>Knight Inlet</u>			
Ahnuhati River	Knight Inlet	2,000	35,000
Ahta Valley Creek	Head, Bond Sound	100	200
Hoeya Sound Creek	Knight Inlet	1,500	400
Kakweiken River	Thompson Sound	(10,000)	30,000
Klinaklini River	Knight Inlet	2,000	3,500
Kwalate Point River	Knight Inlet	1,500	750
Lull Creek	Knight Inlet	200	50
Protection Point Creek	Knight Inlet	100	—
Sim (Wahshihlas) Creek	Wahshihlas Bay, Knight Inlet	1,500	1,500
Viner Sound River	Viner Sound	400	1,500
Waterfall River	Bond Sound	(1,700)	10,000
Approximate Total	(11 streams in 1959 10 streams in 1961)	9,300	82,900
<u>Phillips Arm</u>			
Apple River		(25,000)	10,000
Cumsack River	Mouth of Homathko River, Bute Inlet	200	—
Teaquahan (Eva) River	Head, Bute Inlet	400	1,500
Fanny Bay Creek	Phillips Arm	50	—
Grassy Creek	Loughborough Inlet, E. of Beaver Inlet	50	—
Gray Creek	Loughborough Inlet, E. of Sidney Bay	1,500	200
Heydon Creek	Heydon Bay, Loughborough Inlet	1,500	—
Homathko River	Head, Bute Inlet	5,000	—
Orford River	Orford Bay, Bute Inlet	2,000	15,000
Phillips River	Phillips Arm	(35,000)	30,000
Southgate River	Waddington Harbour, Bute Inlet	5,000	1,500
Stafford River	Loughborough Inlet	(1,500)	3,500
Approximate Total	(12 streams in 1959 7 streams in 1961)	15,700	61,700
<u>Toba Inlet</u>			
Brem River	Toba Inlet	(3,000)	3,500
Forbes Creek	Homfray Channel	30	30
Quatam River	Ramsay Arm	(4,000)	3,500
Sliammon River	Malaspina Straits	30	30
Theodosia River	Malaspina Inlet	40	40
Toba River	Toba Inlet	(40,000)	40,000
Approximate Total	(6 streams)	100	47,100

TABLE B-1 (Continued)

<u>Jervis Inlet</u>			
Brittain River	Princess Royal Reach	750	3,500
Deserted River	Princess Royal Reach	(15,000)	7,500
Gray (Shannon) Creek	Sechelt Inlet, S. of Salmon Inlet	100	200
Lang (Wolfsohn) Creek	Malaspina Strait	250	400
Sechelt (Siwash) Creek	Salmon Inlet, Sechelt Inlet	200	1,500
Thunder Bay Creek	W. side of Jervis Inlet near mouth	50	—
Tzoonie River	Narrows Inlet, Sechelt Inlet	200	7,500
Vancouver River	Prince of Wales Reach	750	3,500
Approximate Total	(8 streams in 1959 7 streams in 1961)	2,300	24,100
<u>Howe Sound</u>			
McNab Creek	Thornborough Channel	50	50
Squamish River ^a	Howe Sound	(44,000)	46,000
Stawamus Creek	Head, Howe Sound	50	50
Approximate Total	(3 streams)	100	46,100
<u>Burrard Inlet</u>			
Capilano River	First Narrows	50	50
Lynn Creek	W. of Seymour River	50	50
Seymour River	Second Narrows	7,500	500
Approximate Total	(3 streams)	7,600	600
GRAND TOTAL	(80 streams in 1959 59 streams in 1961)	91,500	345,300

^a Tributaries other than Cheakamus River.

TABLE B-2. Estimates of pink salmon spawning populations not enumerated by stream tagging and recovery programs in the Fraser River system in 1959 and 1961. Estimates in parentheses were obtained from stream tagging and recovery data and are not included in totals.

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT	
		1959	1961
<u>Early Fraser</u>			
Chehalis Creek	Harrison	6,729	(11,000)
Ruby Creek	Lower River	528	448
Jones Creek	Lower River	2,604	5,088 ^a
Coquihalla	Fraser Canyon	(16,000)	7,316
Lorenzetti Creek	Fraser Canyon	991	218
Silver Creek	Fraser Canyon	1,914	705
Hunter Creek	Fraser Canyon	234	140
American Creek	Fraser Canyon	790	147
Spuzzum Creek	Fraser Canyon	2,111	263
Nahatlatch River	Fraser Canyon	216	244

TABLE B-2 (Continued)

Anderson Creek	Fraser Canyon	567	166
Stein River	Fraser Canyon	62	83
Texas Creek	Fraser Canyon	195	—
Popkum Creek	Fraser Canyon	57	—
Flood Creek	Fraser Canyon	8	—
Yale Creek	Fraser Canyon	510	31
Emory Creek	Fraser Canyon	728	22
Stoyoma Creek	Fraser Canyon	42	—
Kawkawa Creek	Fraser Canyon	1,279	502
Portage Creek	Seton-Anderson	52	1,550
Bridge River	Seton-Anderson	1,201	1,895
Yalakom River	Seton-Anderson	13	—
Nicola River	Thompson	806	—
Bonaparte River	Thompson	3	—
Nicomen River	Thompson	73	—
Total	(25 streams in 1959 22 streams in 1961)	21,713	18,818
<u>Late Fraser</u>			
Stave River	Lower River	1,383	3,994
Whonock Creek	Lower River	57	278
Silverdale Creek	Lower River	68	88
Kanaka Creek	Lower River	18	23
Weaver Creek	Harrison	87	539
Sweltzer Creek	Vedder	751	—
Slesse Creek	Vedder	317	—
Middle Creek	Vedder	528	—
Total	(8 streams in 1959 5 streams in 1961)	3,209	4,922
GRAND TOTAL	(33 streams in 1959 17 streams in 1961)	24,922	23,740

^a Total count of all carcasses in artificial spawning channel.

TABLE B-3. Estimates of pink salmon spawning populations not enumerated by stream tagging and recovery programs in the United States Study Area in 1959 and 1961.

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT	
		1959	1961
<u>Bellingham Bay</u>			
Dakota Creek	Drayton Harbor	100	200
California Creek	Drayton Harbor	100	200
Terrell Creek	Birch Bay	100	100
Chuckanut Creek	Bellingham Bay	100	100
Oyster Creek	Samish Bay	50	50
Colony Creek	Samish Bay	50	50
Samish River	Samish Bay	200	200
Approximate Total	(7 streams)	700	900

TABLE B-3 (Continued)

<u>Lower Puget Sound</u>			
Nisqually River	Nisqually Reach	1,000	2,000
Minter Creek	Carr Inlet	500	600
Burley Creek	Carr Inlet	50	50
Sherwood Creek	Case Inlet	50	50
Coulter Creek	Case Inlet	200	200
Rocky Creek	Case Inlet	200	200
Approximate Total	(6 streams)	2,000	3,100
<u>Hood Canal</u>			
Finch Creek	Near Hoodspout	2,000	3,200
Hamma Hamma River	Near Eldon	500	800
Duckabush River	Near Brinnon	10,000	14,000
Mission Creek	Near Belfair	100	100
Skokomish River	Near Union	100	100
Jorsted Creek	Near Eldon	100	100
Big Quilcene River	Near Quilcene	100	100
Fulton Creek	Near Triton	100	100
Approximate Total	(8 streams)	13,000	18,500
<u>Olympic Peninsula</u>			
Elwha River	Angeles Point	10,000	8,000
Lyre River	Gettysburg	300	150
Hoko River	Sekiu	300	100
Pysht River	Pysht	300	150
Morse Creek	Port Angeles	100	100
Approximate Total	(5 streams)	11,000	8,500
GRAND TOTAL	(26 streams)	26,700	31,000

APPENDIX C

Recoveries of Enumeration Tags by Stream Section, by Week of Recovery and by Week of Tagging

The following tables list for all streams on which pink salmon spawners were enumerated by tagging and recovery programs in 1961 the percentage of carcasses bearing tags by stream section (TABLE C-1), the percentage of the carcasses bearing tags by week of recovery (TABLE C-2) and the percentage of the tags recovered from each period of tagging (TABLE C-3). On some streams the division into sections was not the same in 1961 as that in 1959.

TABLE C-1. Freshwater tagging and recovery programs in 1961. Percentage of male and female pink salmon carcasses bearing tags by stream section (numbers of carcasses listed in parentheses and tagging areas indicated by asterisks).

STREAM	SECTION OF RECOVERY PROCEEDING UPSTREAM											
	1		2		3		4		5		6	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Glendale Cove	0.4 *	0.5	0.6	0.4	0.4	0.5	0.5	0.5	0.3	0.5	0.5	0.5
Stream	(23)	(13)	(10)	(3)	(11)	(18)	(26)	(40)	(3)	(5)	(23)	(12)
Weir	1.3 *	0.6	1.7	1.5	1.0	0.7	0.9	0.7	1.3	0.7	1.1	0.8
	(68)	(18)	(28)	(10)	(31)	(26)	(63)	(50)	(12)	(8)	(47)	(22)
	4.6	4.3	7.2 *	11.8	4.1	5.5	3.6	4.2	4.2	4.1	3.3	3.9
	(243)	(121)	(119)	(80)	(123)	(206)	(201)	(307)	(39)	(43)	(147)	(69)
Skwawka	3.7 *	4.1	3.5	3.7	2.6	3.3	2.7	2.7	3.7	4.1	—	—
	(172)	(210)	(317)	(460)	(273)	(666)	(81)	(125)	(8)	(15)	—	—
Cheakamus	4.9	2.8	3.5	1.7	1.6	1.1	1.5	1.3	1.2 *	0.7	—	—
	(15)	(5)	(70)	(41)	(53)	(49)	(127)	(173)	(74)	(72)	—	—
Indian	3.2 *	5.8	1.0	4.5	2.2	1.8	2.6	2.1	3.2	2.3	—	—
	(115)	(181)	(6)	(23)	(47)	(61)	(31)	(34)	(26)	(18)	—	—
Harrison	2.8	2.6	3.1	1.9	3.3 *	1.9	3.3	1.9	3.5	2.3	3.4	1.8
	(20)	(23)	(73)	(50)	(114)	(106)	(303)	(264)	(303)	(323)	(16)	(49)
Thompson	2.9 *	0.9	1.6	1.3	1.4	1.7	1.2	1.7	0.9	0.8	—	—
	(6)	(1)	(9)	(7)	(4)	(8)	(11)	(19)	(6)	(13)	—	—
Vedder	3.4	0.7	5.4 *	1.9	3.1	1.6	1.7	1.1	1.0	1.0	1.2	1.1
	(13)	(2)	(54)	(25)	(59)	(40)	(25)	(20)	(23)	(28)	(13)	(15)
Seton	0.8	0.3	1.1	0.3	1.9	0.5	2.4 *	1.6	0.6	0.3	—	—
	(29)	(12)	(20)	(4)	(72)	(22)	(53)	(98)	(1)	(2)	—	—
Nooksack	0.6 *	0.2	0.2	0.2	0.4	0.3	—	—	—	—	—	—
	(2)	(1)	(7)	(9)	(18)	(28)	—	—	—	—	—	—
Skagit	0.6 *	0.9	0.6	0.7	0.6	0.7	0.7	0.9	—	—	—	—
	(21)	(26)	(30)	(37)	(39)	(44)	(31)	(46)	—	—	—	—
Stillaguamish	1.2 *	0.8	1.2	1.3	1.4	1.1	1.1	1.2	—	—	—	—
	(25)	(21)	(21)	(29)	(49)	(58)	(13)	(29)	—	—	—	—
Snohomish	7.3 *	3.0	2.0	2.4	2.6	2.2	4.2	2.3	—	—	—	—
	(26)	(14)	(18)	(24)	(8)	(9)	(128)	(87)	—	—	—	—
Puyallup	3.9 *	1.9	2.0	0.7	—	—	—	—	—	—	—	—
	(20)	(26)	(1)	(2)	—	—	—	—	—	—	—	—
Dosewallips	2.4 *	1.4	0.2	0.0	—	—	—	—	—	—	—	—
	(58)	(52)	(1)	(0)	—	—	—	—	—	—	—	—
Dungeness	4.3 *	3.6	2.5	2.4	1.7	0.7	—	—	—	—	—	—
	(194)	(242)	(42)	(30)	(88)	(48)	—	—	—	—	—	—

TABLE C-2. Freshwater tagging and recovery programs in 1961. Percentage of male and female pink salmon carcasses bearing tags by period of recovery (number of tags recovered listed in parentheses).

STREAM	PERIOD OF RECOVERY													
	1		2		3		4		5		6		7	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Glendale Cove	0.6 (3)	2.0 (8)	0.7 (16)	0.6 (10)	0.5 (17)	0.7 (18)	0.4 (45)	0.4 (66)	0.5 (29)	0.3 (22)	—	—	—	—
Stream	0.9 (5)	1.2 (5)	1.1 (26)	0.7 (12)	1.2 (40)	0.5 (12)	1.2 (148)	0.6 (103)	0.9 (59)	0.5 (35)	—	—	—	—
Weir	7.7 (39)	11.6 (47)	4.5 (103)	4.1 (72)	3.7 (119)	4.7 (118)	3.9 (475)	4.1 (659)	3.5 (221)	4.3 (276)	—	—	—	—
Skwawka	0.3 (1)	0.7 (2)	2.6 (72)	2.6 (90)	3.0 (156)	3.1 (243)	3.6 (144)	4.1 (250)	3.2 (300)	3.6 (594)	3.4 (166)	3.6 (278)	1.8 (12)	1.5 (19)
Cheakamus	4.1 (9)	1.9 (5)	1.9 (181)	1.2 (138)	1.4 (140)	1.1 (185)	1.6 (18)	0.9 (20)	—	—	—	—	—	—
Indian	2.0 (2)	8.1 (32)	2.5 (19)	6.0 (99)	2.6 (35)	3.3 (33)	2.3 (69)	2.3 (81)	3.1 (81)	2.5 (66)	3.8 (19)	1.8 (6)	—	—
Harrison	2.8 (57)	1.8 (36)	3.4 (334)	2.3 (242)	3.8 (312)	2.4 (348)	2.9 (115)	1.5 (154)	1.3 (11)	1.2 (35)	—	—	—	—
Thompson	0.8 (12)	0.2 (5)	1.9 (24)	1.9 (29)	1.9 (7)	1.6 (14)	3.0 (4)	1.6 (4)	—	—	—	—	—	—
Vedder	2.0 (53)	1.1 (19)	1.3 (83)	0.9 (70)	1.5 (115)	0.9 (103)	1.2 (58)	0.7 (55)	—	—	—	—	—	—
Seton	3.2 (33)	1.8 (16)	2.1 (55)	1.2 (43)	1.6 (18)	1.1 (43)	0.6 (18)	0.4 (17)	0.4 (8)	0.3 (10)	—	—	—	—
Nooksack	0.4 (1)	0.5 (1)	0.0 (10)	0.2 (2)	0.2 (6)	0.2 (5)	0.5 (16)	0.3 (22)	0.4 (4)	0.1 (3)	0.0 (0)	0.4 (5)	—	—
Skagit	0.6 (8)	0.5 (7)	0.7 (24)	0.9 (32)	0.6 (21)	1.2 (34)	0.6 (39)	0.6 (42)	0.4 (18)	0.6 (25)	0.7 (8)	0.4 (5)	—	—
Stillaguamish	1.8 (18)	1.4 (13)	1.2 (37)	1.2 (47)	0.9 (11)	0.9 (21)	1.4 (29)	1.3 (39)	1.3 (5)	0.7 (2)	1.1 (6)	0.9 (11)	—	—
Snohomish	2.7 (16)	4.1 (5)	2.7 (22)	2.1 (8)	2.1 (109)	2.3 (82)	3.6 (10)	2.8 (22)	5.7 (19)	1.5 (12)	—	—	—	—
Puyallup	4.7 (10)	3.1 (12)	1.3 (1)	2.2 (7)	3.6 (9)	1.0 (7)	—	—	—	—	—	—	—	—
Dosevallips	1.0 (2)	0.0 (0)	2.8 (27)	1.7 (1)	2.8 (12)	2.6 (12)	1.2 (10)	1.5 (29)	2.3 (7)	1.0 (10)	—	—	—	—
Dungeness	2.9 (14)	3.9 (10)	2.2 (55)	0.9 (19)	2.1 (48)	1.2 (31)	2.5 (74)	1.6 (71)	4.2 (63)	2.8 (90)	3.5 (50)	3.8 (73)	2.8 (8)	2.4 (14)

TABLE C-3. Freshwater tagging and recovery programs in 1961. Percentage of tags recovered from each period of tagging (numbers of tags recovered listed in parentheses and sexes listed separately).

STREAM	SUCCESSIVE TAGGING PERIODS													
	1		2		3		4		5		6		7	
	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.	M.	F.
Glendale Cove	25.7 (75)	21.1 (79)	22.6 (35)	19.4 (45)	—	—	—	—	—	—	—	—	—	—
Stream	—	—	27.9 (36)	19.0 (20)	—	—	27.0 (178)	23.0 (119)	—	—	—	—	—	—
Weir	—	—	31.0 (183)	24.1 (232)	25.2 (418)	26.6 (535)	31.0 (170)	26.9 (182)	21.5 (22)	32.3 (41)	28.0 (137)	29.8 (147)	24.4 (20)	25.8 (24)
Skwawka	32.3 (276)	34.6 (381)	36.3 (95)	36.9 (166)	26.6 (318)	34.7 (674)	16.5 (56)	20.5 (111)	20.8 (103)	24.7 (144)	—	—	—	—
Cheakamus	13.5 (5)	9.3 (4)	17.3 (22)	8.4 (13)	15.7 (34)	12.9 (30)	15.3 (147)	18.4 (140)	13.3 (75)	17.5 (71)	9.1 (47)	12.0 (62)	12.7 (19)	11.8 (29)
Indian	29.6 (18)	30.0 (12)	24.6 (31)	22.2 (29)	28.6 (136)	32.7 (191)	19.4 (34)	35.6 (72)	15.8 (6)	27.6 (13)	—	—	—	—
Harrison	34.8 (121)	16.6 (85)	34.8 (278)	34.6 (283)	30.2 (398)	33.4 (403)	—	—	—	—	—	—	—	—
Thompson	11.5 (6)	11.8 (4)	12.1 (11)	14.1 (13)	13.9 (17)	10.9 (22)	6.5 (6)	8.2 (13)	—	—	—	—	—	—
Vedder	31.3 (82)	26.0 (54)	25.8 (77)	27.1 (70)	22.7 (55)	21.2 (45)	23.8 (53)	23.5 (44)	20.7 (38)	27.8 (45)	—	—	—	—
Seton	49.2 (93)	56.3 (58)	41.5 (71)	56.5 (83)	—	—	—	—	—	—	—	—	—	—
Nooksack	0.0 (0)	9.3 (4)	14.3 (7)	24.1 (7)	22.2 (10)	17.1 (6)	23.3 (10)	32.3 (20)	—	—	—	—	—	—
Skagit	6.1 (3)	4.4 (3)	11.1 (14)	11.7 (24)	10.2 (28)	8.2 (39)	9.5 (41)	8.9 (51)	5.5 (4)	9.2 (10)	15.3 (17)	17.2 (17)	8.2 (14)	8.9 (9)
Stillaguamish	16.9 (31)	22.2 (47)	23.0 (28)	23.2 (43)	8.3 (2)	11.1 (3)	14.7 (36)	13.4 (38)	10.4 (10)	5.2 (5)	—	—	—	—
Snohomish	25.0 (12)	20.0 (10)	28.6 (114)	20.2 (89)	22.9 (32)	12.5 (15)	15.0 (21)	11.1 (20)	—	—	—	—	—	—
Puyallup	13.6 (8)	13.6 (8)	21.0 (13)	22.2 (20)	—	—	—	—	—	—	—	—	—	—
Dosewallips	43.6 (27)	30.3 (10)	20.4 (10)	25.0 (13)	21.0 (22)	36.7 (29)	—	—	—	—	—	—	—	—
Dungeness	39.3 (24)	29.3 (22)	50.0 (100)	33.5 (60)	36.9 (52)	39.3 (77)	35.7 (99)	35.5 (110)	37.7 (43)	36.2 (47)	—	—	—	—

APPENDIX D

Comparison of Fishing Effort in Johnstone Strait in 1961 with that for a "1961 Type" Fishery in 1959

In estimating the abundance of the various stock groups entering Johnstone Strait in 1961 it was assumed that a "1961 type" fishery in this area (a fishery operating for the same number of days at approximately the same periods during the run as in 1961) would have removed the same fraction of each stock group present in 1959 as it did in 1961. Involved in this assumption is the consideration that fishing effort per day of fishing was comparable in the two years or that any difference in fishing effort would not have resulted in a significant difference in the rate of removal by the fishery.

To examine this assumption, the average number of boats operating per day of fishing was calculated for each week of fishing during 1961 and for a 1961 type fishery operating in 1959 (TABLE D-1). For the purposes of this comparison, calculations were limited to those weeks in which catches were appreciable (weeks ending July 22 to September 9) and for which data were available for both years. The average number of seiners operating per day of fishing in 1961 was 117 for the period up to August 29 (when Canada Non-Fraser fish were considered to make up the bulk of the catch) and 172 for the period after August 29 (when Fraser fish were considered to have made up the bulk of the catch). Comparable estimates of the number of seiners operating per day in a 1961 type fishery operating in 1959 were 136 and 201 respectively.

On the basis of these data, it would appear that fishing effort was appreciably less in 1961 than for a "1961 type" fishery operating in 1959. It could therefore be concluded that, in the main analysis, the rates of removal in Johnstone Strait in 1961 were over-estimated and the abundance of the run under-estimated. However, this possibility of bias is mitigated by the fact that the data on boat days were gathered in different ways in the two years. The 1961 data were based on approximate counts of boats on the major fishing grounds and would tend to under-estimate the number of boat days. On the other hand, the 1959 data were compiled from sales slips giving the number of landings per day wherein any one boat may have landed fish more than once in a day and the catches by some boats fishing the mainland inlets may have been included in the Johnstone Strait catch. These factors would both result in an over-estimate of the number of boat days in 1959. Thus the difference in estimates of the number of boats fishing per day between the two years is exaggerated to some extent at least, in the data given in TABLE D-1.

Furthermore, if the rate of removal in 1961 had been over-estimated, the escapement from the Johnstone Strait fishing area would have been under-estimated. However, the estimate of the escapement from Johnstone Strait derived from rates of removal in the main analysis was larger than any reasonable estimate of the abundance of Northern Approach fish in the subsequent areas (APPENDIX F). Consequently, it does not appear likely that the 1961 fishery in Johnstone Strait was any less effective in exploiting the run on a day to day basis than was the 1959 fishery.

TABLE D-1. Calculation of boats per day from seiner days and days fishing each week for the fishery in the Johnstone Strait area in 1961 and for a "1961 type" fishery^a in 1959.

WEEK ENDING	1961			1959 ^b						Boats per Day
	Seiner ^c Days	Days ^d Fishing	Boats per Day	Seiner Days ^e		Days Fishing ^d				
				n — ½	n + ½	n — ½	n + ½	n		
July 22	504	4	126	240	371	306	4	4	4	77
29	414	4	104	371	— ^f	371	4	— ^f	4	93
Aug. 5	(376)	(4)	(125)	— ^f	— ^f	—	— ^f	— ^f	—	—
12	276	3	92	— ^f	749	749	— ^f	4	4	187
19	399	3-2 ^g	144	749	753	751	4	4	4	188
AVERAGE TO AUGUST 19			117							136
Aug. 26	537	3	179	753	660	707	4	3	3.5	202
Sept. 2	471	3	157	660	599	630	3	3	3	210
9	360	2	180	599	540	570	3	3	3	190
AVERAGE AFTER AUGUST 19			172							201

^a See text.

^b Columns n - 1/2 and n + 1/2 are for the 1959 weeks ending 3 days earlier and 4 days later than the 1961 week. Column n is the average of the two preceding columns and represents the 1961 week.

^c From TABLES A-3 to A-5.

^d From FIGURE 3.

^e From Vernon, Hourston and Holland, 1964, TABLES A-3 to A-5.

^f Strike in 1959.

^g Three days fishing at Malcolm Island and Upper Johnstone Strait, two days fishing in Lower Johnstone Strait.

APPENDIX E

Estimation of the Numbers of Pink Salmon which Escaped the Johnstone Strait Fishing Area and were Destined for United States Streams in 1961

Estimates of the abundance of Northern Approach pinks destined for United States streams which were caught in the various fishing areas south of the Strait of Georgia³⁶ were based on the assumption that the proportion of United States fish approaching from the north in 1961 was the same in these areas as in 1959. On this basis, the catch of Northern Approach pinks destined for United States streams in any of these fishing areas in 1961 is given by:

$$CN_{61} = \frac{CN_{59} \times CT_{61}}{CT_{59}} \quad (1)$$

where CN_{59} and CN_{61} = catch of Northern Approach pinks destined for United States streams in 1959 and 1961;

and CT_{59} and CT_{61} = total catch of United States pinks (from both approaches) in 1959 and 1961.

SPAWNERS AND LOCAL CATCHES

In 1959, Northern Approach pinks were estimated to have made up 2.6 per cent of the United States terminal population³⁷. Substituting this value for CN_{59}/CT_{59} in Equation 1, along with that for the numbers of spawners in 1961 (808,000—TABLE 11), the numbers of Northern Approach fish in the United States spawning escapement in 1961 was estimated at 21,008 ($808,000 \times 0.026$). Applying the same value for CN_{59}/CT_{59} to the 1961 local catch (309,945—TABLE 11), the number of Northern Approach pinks taken in the local catch of United States fish in 1961 was estimated at 8,169 ($309,945 \times 0.026$).

CANADIAN JUAN DE FUCA STRAIT

In 1959, 246,813 pinks³⁸ destined for United States streams were estimated to have been caught in the Canadian Juan de Fuca Strait fishing area, and of these 8,210 pinks³⁸ were estimated to have approached from the north. In 1961, a preliminary analysis, based on catches in the more inshore fishing areas and

³⁶ The catch of United States pinks in the Strait of Georgia area in 1959 was limited to 465 fish estimated to have been taken at Texada Island. The 1961 catch at Texada Island was only one-third that in 1959 (TABLE 2) and consequently the catch of United States fish in this area in 1961 was considered to be negligible.

³⁷ Vernon, Hourston and Holland, 1964, TABLE 21.

³⁸ Catches of United States pinks in the various fishing areas in 1959 are from Vernon, Hourston and Holland, 1964, APPENDIX X. Catches of Northern Approach fish in these areas are from FIGURE 12 in the above paper.

spawning escapements, indicated that 179,370 United States pinks³⁹ were taken in this area. Substituting these values for CT_{59} , CN_{59} and CT_{61} in Equation 1, the catch of Northern Approach pinks in the Canadian Juan de Fuca Strait fishing area in 1961 (CN_{61}) was estimated to be $(8,210/246,813 \times 179,370)$ or 5,966 pinks (TABLE E-1).

WEST BEACH

In 1959 the contribution of United States fish to the catches at West Beach was estimated to be 65,669 pinks³⁸ of which 828 were estimated to have approached from the north³⁸. In 1961, all the catch at West Beach (87,294 fish—TABLE 1) was assumed to have been contributed by United States stocks. Substituting these values for CT_{59} , CN_{59} and CT_{61} in Equation 1, the number of Northern Approach fish in the 1961 catch (CN_{61}) was estimated to be $(828/65,669 \times 87,294)$ or 1,101 pinks (TABLE E-1).

SAN JUAN ISLANDS

In 1961 the catch of pinks at West Beach (87,294 fish) was taken to be the total catch of United States pinks in the combined San Juan Islands-West Beach area (CT_{61}). In 1959 the catch of United States pinks in this combined area (CT_{59}) was estimated to be 87,618 (65,669 at West Beach and 21,949 at San Juan Islands³⁸). The catch at San Juan Islands of Northern Approach fish destined for United States streams in 1959 (CN_{59}) was estimated to be 2,122 pinks³⁸. Thus the catch at San Juan Islands of Northern Approach pinks destined for United States streams in 1961 (CN_{61}) was estimated from Equation 1 to be $(2,122 \times 87,294/87,618)$ or 2,114 pinks (TABLE E-1).

POINT ROBERTS AND FRASER GULF

Estimates of the numbers of Northern Approach pinks destined for United States streams which were caught in the Point Roberts and Fraser Gulf fishing areas were complicated by the fact that the numbers of United States fish in the 1961 catches in these two areas (CT_{61}) were not known at this stage of the analysis. However, the ratio of the United States⁴⁰ fish in the catches for the two years (CT_{61}/CT_{59}) would be approximated by the ratio of the total catches from all stocks adjusted for differences in exploitation and the proportion of United States fish. Thus:

$$\frac{CT_{61}}{CT_{59}} = \frac{CA_{61}}{CA_{59}} \times \frac{E_{61}}{E_{59}} \quad (2)$$

where CA_{59} and CA_{61} = the catch from all stock-groups in 1959 and 1961 respectively,

and E_{59} and E_{61} = the escapement from the fishing area of Northern Approach United States pinks in 1959 and 1961 respectively.

³⁹ A preliminary estimate of United States fish in this fishing area was required in estimating the number of Northern Approach pinks in the catch in this area. This latter estimate was required for the basic analysis (see text, page 26). In the final analysis the number of United States pinks in the Canadian Juan de Fuca Strait catch was estimated at 122,691. On this basis the catch of Northern Approach pinks in this area was over-estimated by 1885 fish.

⁴⁰ Considered to be all Northern Approach fish in both years.

The escapement of United States pinks from *Point Roberts* in 1961 is given by the catches in subsequent fishing areas on the migration route and the numbers of spawners reaching the streams. The total number of Northern Approach pinks reaching United States terminal areas in 1961 was 29,177 (spawners plus local catch—TABLE E-1). These fish would have approached from the north through the Point Roberts area. Northern Approach United States pinks caught in Juan de Fuca Strait, at West Beach and at San Juan Islands (totalling 9,181—TABLE E-1) would also have passed through the Point Roberts fishing area. Thus the escapement of Northern Approach fish from the Point Roberts area (E_{61}) totalled 38,358 ($29,177 + 9,181$) in 1961.

In 1959 the escapement from the Point Roberts area of United States pinks from the north (E_{59}) was estimated to be 30,631 fish³⁸ and the catch of United States pinks in this area (CN_{59}) was 5,177 fish³⁸. The total catch at Point Roberts in 1961 (CT_{61}) was 117,314 pinks (TABLE 1) compared with 773,894 (CT_{59}) in 1959 (TABLE 2). Substituting in Equation 2, the ratio CT_{61}/CT_{59} for this area was:

$$\frac{CT_{61}}{CT_{59}} = \frac{117,314}{773,894} \times \frac{38,358}{30,631} = 0.1898$$

The catch of United States pinks from the north at Point Roberts in 1961 (CN_{61}) was estimated from Equation 1 to be ($5,177 \times 0.1898$) or 983 pinks (TABLE E-1).

The catch in the *Fraser Gulf* fishing area of United States pinks approaching from the north in 1961 was estimated similarly. In 1959 it was estimated that 1,727 (CN_{59}) United States pinks were caught in this area³⁸ and 35,808 (E_{59}) proceeded southward³⁸. In 1961, it was estimated that 39,341 United States pinks (E_{61}) escaped from this area (TABLE E-1). The total catch in Fraser Gulf in 1959 (CT_{59}) was 435,727 (TABLE 2) and in 1961 this catch (CT_{61}) was 43,560 pinks (TABLE 1). Thus the catch of United States pinks in Fraser Gulf in 1961 was estimated to be ($1,727 \times 43,560/435,727 \times 39,341/35,808$) or 190 pinks (TABLE E-1).

TABLE E-1. Estimation of escapement from Johnstone Strait of pink salmon destined for United States streams in 1961.

Spawners in United States streams	21,008
Catch in local Bellingham Bay and Puget Sound Fisheries	8,169
Catch in Fraser Gulf	190
Catch at Point Roberts	983
Catch at San Juan Islands	2,114
Catch at West Beach	1,101
Catch in Canadian Juan de Fuca Strait	5,966
Total	39,531

APPENDIX F

Assessment of the Accuracy of the Estimates of the Proportions of Northern and Southern Approach Pinks in the Strait of Georgia and Fraser River Terminal Areas in 1961

The proportions of Northern and Southern Approach pinks in the Strait of Georgia and Fraser River terminal areas in 1961 were estimated by comparing the abundance of fish from these stock groups estimated to have escaped from the fisheries on either approach en route to these terminal areas. The numbers of Northern and Southern Approach pinks estimated by this procedure to have reached the Strait of Georgia terminal area was 31 per cent higher than a direct estimate of the terminal population (local catch plus estimated numbers of spawners). A similar estimate of the Fraser River fish was 17 per cent higher than the direct estimate of the terminal population (TABLE 29). These discrepancies were accounted for in subsequent analyses of the abundance of Northern and Southern Approach fish by assuming that the escapements from both approaches were over-estimated to the same degree. It is the purpose of this appendix to examine the validity of this assumption.

On the Northern Approach, estimates of the escapement from Johnstone Strait were based on weekly catches and estimated rates of removal. Since the latter were based on rates of removal in 1959, it is quite possible that the rates of removal in 1961 were under-estimated, and hence that the escapement from Johnstone Strait was over-estimated. In this event, similar errors would be expected in estimates of the abundance of Strait of Georgia and Fraser River pinks and the proportions of the two stock groups would be correctly indicated within the limits of accuracy of the data.

On the Southern Approach, estimates of the escapements of Strait of Georgia and Fraser River fish from Juan de Fuca Strait to the terminal areas were based on the relative abundance of these two stock groups and that for United States fish whose abundance in the escapement could be determined directly. Thus if the relative abundance of United States fish were under-estimated, the relative and actual abundance of the other two stock groups would be over-estimated. This situation is quite possible since the tagging data on which estimates of relative abundance were based required some extrapolation. Also, the proportion of the run through Juan de Fuca Strait which passed through the Canadian fishing area was based on the same limited tagging data. Under these circumstances, the relative abundance of Strait of Georgia and Fraser River fish in the escapement from Juan de Fuca Strait would not be affected by over-estimating the escapement of these two stock groups as a whole.

Thus the validity of the estimates of the proportions of Northern and Southern Approach fish in both the Strait of Georgia and Fraser River terminal areas would depend upon the extent to which the total escapement from each approach was over-estimated. To determine the extent of the possible error involved, the results of the analysis employing the proportions derived from the numbers of Northern and Southern Approach fish estimated to have escaped the fisheries on the two approaches (combined analysis) were compared with the results of analyses in which all of the error was attributed to estimates for one approach

only. In the first of these two alternatives, the escapement from the Northern Approach was assumed to have been estimated accurately and the remainder of the terminal populations were assumed to have come from the south (Northern Approach analysis). In the second, the escapement from the Southern Approach was assumed to have been estimated accurately and the remainder of the terminal populations were assumed to have come from the north (Southern Approach analysis).

In these three analyses⁴¹ the basic procedures were the same as those described in greater detail in the text. The percentage of Northern and Southern Approach fish in each of the two terminal areas was calculated from the estimated abundance of fish from each approach in each terminal area (TABLE F-1). The escapement and local catch were then allocated to the two approaches in proportion to these percentages (TABLE F-2, rows 1 and 2). Since the two stocks showed relatively little overlap in their timing on either approach (FIGURES 6 and 10), any changes in their relative total abundance would have little effect on the catch by stock group in the major net fisheries (estimated weekly). The catch for these fisheries (Other catch—row 3) was therefore considered to be the same in all three analyses. The catch in the outside troll fishing areas was divided between the stock groups (row 4) according to their relative seasonal abundance in the run leaving these areas. The total catch (row 5) was then added to the escapement (row 1) to give total abundance (row 6). The percentage of each stock group which entered by the Northern and Southern Approach (row 7) and the rate of removal for each stock group on either approach (row 8) were then calculated.

The rates of removal for the two stock groups on each approach as estimated for each of the three analyses were then compared with those for 1959. As a basis for this comparison, an index of the fishing effort (E) applied to each was calculated (TABLE F-3) as follows:

$$E = D_1F_1 + D_2F_2 + \dots + D_nF_n$$

where D_1, D_2, \dots, D_n are the numbers of days fishing permitted in that fishing area in weeks 1, 2, \dots, n

and F_1, F_2, \dots, F_n are the fractions of the total run of fish of that stock group entering that fishing area which were present in that fishing area in weeks 1, 2, \dots, n .

This index provides a common basis for comparison of rates of removal between years. Although the Southern Approach index applies to only one of three major fisheries on these two stocks, it is representative of the fishing effort in all three. Nevertheless, comparisons between Northern and Southern Approach groups must be treated with caution as differences in the rates of removal between the Northern and Southern Approach were not exactly proportionate to the differences in fishing indices for either stock group in 1959 (TABLE F-4, rows 1 and 2).

⁴¹ Data from the combined analyses are given in the text but are repeated herein for ready comparison with the other two analyses.

TABLE F-1. Numbers and percentages (in parentheses) of Northern and Southern Approach pinks in the Strait of Georgia and Fraser River terminal populations as estimated by their proportions in the estimated escapements from two areas (combined analysis), the total escapement and the estimated escapement from the north (Northern Approach Analysis) and the total escapement and the estimated escapement from the south (Southern Approach Analysis).

TERMINAL POPULATION	NORTHERN	SOUTHERN	TOTAL
COMBINED ANALYSIS			
Strait of Georgia	622,065 (58.1)	448,615 (41.9)	1,070,680 (100.0)
Fraser River	246,740 (20.0)	986,961 (80.0)	1,233,701 (100.0)
NORTHERN APPROACH ANALYSIS			
Strait of Georgia	820,440 (76.6)	250,240 (23.4)	1,070,680 (100.0)
Fraser River	288,769 (23.4)	944,932 (76.6)	1,233,701 (100.0)
SOUTHERN APPROACH ANALYSIS			
Strait of Georgia	477,910 (44.6)	592,770 (55.4)	1,070,680 (100.0)
Fraser River	80,039 (6.5)	1,153,662 (93.5)	1,233,701 (100.0)
1959 ANALYSIS			
Strait of Georgia	638,118 (69.2)	283,812 (30.8)	921,930 (100.0)
Fraser River	311,763 (31.7)	669,465 (68.3)	981,228 (100.0)

Fishing effort on Fraser River pinks on the Northern Approach was much less in 1961 than in 1959 (TABLE F-4, rows 1 and 3). Consequently, the rate of removal for these fish would be expected to be less than in 1959. The rate of removal for these fish, as estimated from the Southern Approach analysis (row 6), was greater in 1961 (84.3 per cent) than in 1959 (79.8 per cent) which is difficult to reconcile with the much lower fishing index in 1961 (1.9) than in 1959 (3.2). Similarly, the higher rate of removal of Strait of Georgia pinks on the Northern Approach in 1961 (65.2 per cent vs. 64.5 per cent in 1959), as estimated from the Southern Approach analysis, would not be expected in view of the slightly lower fishing index in that year (2.9 in 1961 vs. 3.2 in 1959). On the other hand, the Northern Approach analysis (row 5) gave a rate of removal of Strait of Georgia stocks on the Southern Approach in 1961 of 69.3 per cent which is much higher than the 1959 rate (57.8 per cent) although the fishing index for 1961 (2.3) was similar to that in 1959 (2.1).

To facilitate closer comparisons, the rates of removal for 1959 (R_{59}) were adjusted (R_A) to what they would have been had the fishing pressure been the same as in 1961:

$$R_A = R_{59} \times \frac{FI_{61}}{FI_{59}}$$

where FI_{59} and FI_{61} are the fishing indices for 1959 and 1961 respectively.

TABLE F-2. Abundance and rate of removal of Northern and Southern Approach pinks destined for Strait of Georgia and Fraser River streams in 1961 with the proportion of Northern and Southern Approach pinks in the terminal areas estimated from the combined analyses (proportions in the estimated escapements from both approaches), the Northern Approach analysis (escapement of Southern Approach fish given by total escapement minus estimated Northern Approach escapement) and the Southern Approach analysis (escapement of Northern Approach fish given by total escapement minus estimated Southern Approach escapement).

	STRAIT OF GEORGIA STOCKS			FRASER RIVER STOCKS		
	Northern	Southern	Total	Northern	Southern	Total ^b
COMBINED ANALYSIS						
(1) Spawners	540,330	389,670	930,000	217,600	870,400	1,088,000
(2) Local catch	81,735	58,945	140,680	29,140	116,561	145,701
(3) Other catch ^a	671,269	410,863	1,082,132	353,143	200,537	553,680
(4) Outside troll	43,617	55,077	98,694	20,231	76,018	96,249
(5) Total catch	796,621	524,885	1,321,506	402,514	393,116	795,630
(6) Abundance	1,336,951	914,555	2,251,506	620,114	1,263,516	1,883,630
(7) Per cent abundance	59.4	40.6	100.0	32.9	67.1	100.0
(8) Rate of removal	59.6	57.4	58.7	65.0	31.1	42.2
NORTHERN APPROACH ANALYSIS						
(1) Spawners	712,643	217,357	930,000	254,665	833,335	1,088,000
(2) Local catch	106,657	34,023	140,680	34,104	111,597	145,701
(3) Other catch ^a	671,269	410,863	1,082,132	353,143	200,537	553,680
(4) Outside troll	46,355	45,683	92,038	19,683	79,016	98,699
(5) Total catch	824,281	490,569	1,314,850	406,930	391,150	798,080
(6) Abundance	1,536,924	707,926	2,244,850	661,595	1,224,485	1,886,080
(7) Per cent abundance	68.5	31.5	100.0	35.1	64.9	100.0
(8) Rate of removal	53.6	69.3	58.6	61.5	31.9	42.3
SOUTHERN APPROACH ANALYSIS						
(1) Spawners	414,780	515,220	930,000	70,720	1,017,280	1,088,000
(2) Local catch	62,743	77,937	140,680	9,471	136,230	145,701
(3) Other catch ^a	671,269	410,863	1,082,132	353,143	200,537	553,680
(4) Outside troll	43,645	58,849	102,494	16,463	79,381	95,844
(5) Total catch	777,657	547,649	1,325,306	379,077	416,148	795,225
(6) Abundance	1,192,437	1,062,869	2,255,306	449,797	1,433,428	1,883,225
(7) Per cent abundance	52.9	47.1	100.0	23.9	76.1	100.0
(8) Rate of removal	65.2	51.5	58.8	84.3	29.0	42.2

^a Includes all catches other than Queen Charlotte Strait and West Coast Troll and local catches. The 1058 Northern Approach Fraser River fish estimated to have been taken at Texada Island are also included. (These fish are grouped with local catches in TABLE 31.)

^b Totals differ for the three analyses because of slight changes in the catches of United States fish.

Comparisons of these adjusted 1959 rates (TABLE F-4, row 9) with those of the combined (row 4) Northern Approach (row 5) and Southern Approach (row 6) analyses indicated that those for the combined analyses were more compatible with the 1959 rates for both stock groups on both approaches.

The results of the Northern Approach analysis resembled those of the 1959 analysis more closely than did those for the Southern Approach analysis. To examine this difference more closely, the rates of removal for the Northern and Southern Approach analyses were each averaged with those for the combined analysis (TABLE F-4). The averages of the rates of removal for the combined

TABLE F-3. Fishing indices (sum of the number of days fishing times the fraction of the run present each week) for the Strait of Georgia and Fraser River stocks in Johnstone and Juan de Fuca Straits in 1959 and 1961.

WEEK ENDING	JOHNSTONE STRAIT							FISHING DAYS (8)	JUAN DE FUCA STRAIT				
	STRAIT OF GEORGIA STOCKS			FRASER RIVER STOCKS					STRAIT OF GEORGIA STOCKS		FRASER RIVER STOCKS		
	Abundance (2)	Fraction of run (3)	Fishing index (4)	Abundance (5)	Fraction of run (6)	Fishing index (7)	Abundance (9)		Fraction of run (10)	Fishing index (11)	Abundance (12)	Fraction of run (13)	Fishing index (14)
To July 25	4	63,107	.044	.176	—	—	1959 ^a	15,785	.032	.096	—	—	—
Aug. 1	—	55,145	.039	—	—	—	—	74,926	.154	—	—	.001	—
Aug. 8	—	166,656	.116	—	—	—	—	106,692	.219	—	—	.011	—
Aug. 15	4	604,490	.422	1.688	17,310	.011	.044	175,593	.361	1.444	—	.056	.224
Aug. 22	4	310,039	.216	.864	103,133	.063	.252	90,582	.186	.372	1,143,914	.265	.530
Aug. 29	4	132,435	.092	.276	404,683	.249	.747	14,086	.029	.116	1,107,814	.256	1.024
Sept. 5	3	56,848	.040	.120	417,086	.257	.771	8,776	.018	.090	1,214,649	.281	1.405
Sept. 12	3	42,954	.030	.090	493,812	.304	.912	707	.001	.006	437,651	.101	.606
Sept. 19	4	905	.001	.004	145,563	.090	.360	—	—	—	104,372	.024	.120
Sept. 26 on	4	—	—	—	42,093	.026	.104	—	—	—	19,268	.005	.020
TOTAL		1,432,579	1.000	3.218	1,623,680	1.000	3.190	487,147	1.000	2.124	4,320,962	1.000	3.929
To July 22	4	39,820	.028	.112	—	—	1961 ^b	112	.158	.316	—	—	—
July 29	4	50,860	.036	.144	—	—	—	120	.170	.510	1	.001	.003
Aug. 5	3	110,900	.077	.231	—	—	—	100	.142	.426	8	.008	.024
Aug. 12	3	385,573	.269	.807	8,655	.005	.015	270	.382	.764	110	.114	.228
Aug. 19	3	457,264	.319	.957	60,221	.037	.111	95	.134	.268	285	.295	.590
Aug. 26	3	221,237	.155	.465	253,908	.156	.468	10	.014	.028	250	.259	.518
Sept. 2	2	94,641	.066	.132	410,885	.253	.506	—	—	—	140	.145	—
Sept. 9	—	49,901	.035	—	455,449	.281	.788	—	—	—	100	.104	.208
Sept. 16	4	21,930	.015	.060	319,688	.197	.071	—	—	—	69	.071	.142
Sept. 23 on	—	453	.000	—	114,874	.071	1.888	—	—	—	3	.003	—
TOTAL		1,432,579	1.000	2.908	1,623,680	1.000	—	707	1.000	2.311	977	1.000	1.713

^a Weekly abundance from Vernon, Hourston and Holland, 1964, TABLES 61, 74 and 77.

^b Weekly abundance in Johnstone Strait considered to be the mean of those for the 1959 weeks ending 4 days earlier and 3 days later. Weekly relative abundance in Juan de Fuca Strait from TABLE 24.

TABLE F-4. Fishing indices^a and rates of removal for Strait of Georgia and Fraser River pinks approaching from the north and from the south in 1961 and 1959.

	STRAIT OF GEORGIA		FRASER RIVER	
	Northern Approach	Southern Approach	Northern Approach	Southern Approach
1959				
(1) Fishing index	3.2	2.1	3.2	3.9
(2) Rate of removal	64.5	57.8	79.8	84.6
1961				
(3) Fishing index	2.9	2.3	1.9	1.7
Rate of removal				
(4) Combined analysis	59.6	57.4	65.0	31.1
(5) Northern Approach analysis	53.6	69.3	61.5	31.9
(6) Southern Approach analysis	65.2	51.5	84.3	29.0
(7) Average, combined and Northern	56.6	63.4	63.3	31.5
(8) Average, combined and Southern	62.4	54.5	74.7	30.0
(9) 1959 rates of removal adjusted to 1961 fishing index	58.4	63.3	47.4	36.9

^a Sum of estimates for each week of the number of days fishing times the fraction of that stock group which passed through the fishing area in that week. Northern Approach indices are for the Johnstone Strait fishery and Southern Approach indices are for the Canadian Juan de Fuca Strait fishery. (From TABLE F-3.)

and Northern analysis (TABLE F-4, row 7) corresponded even more closely with those for 1959 than did those for the combined analysis (row 4) especially when compared with the 1959 rates adjusted to the 1961 fishing index (row 9). Thus it would appear that estimates for the Southern Approach were in error to a greater degree than were those for the Northern Approach.

Since Fraser pinks were appreciably more abundant than Strait of Georgia pinks on the Southern Approach (TABLE F-2), a greater over-estimate of the run on that approach would result in larger errors in the estimated rates of removal for Fraser fish than for Strait of Georgia fish. The estimated rate of removal on the Southern Approach would be low while that on the Northern Approach would be high. This, indeed, appears to have been the case in the 1961 combined analysis (TABLE F-2, rows 4 and 9). However, even the Northern Approach analysis, which did not make use of estimates made on the Southern Approach, indicated a high rate of removal of Fraser fish on the Northern Approach (row 5), suggesting that other factors are also involved.

Assuming, for the moment, that the 1961 rates of removal should correspond closely with those for 1959 adjusted for differences in the fishing indices between the two years⁴², in what way and to what extent were the 1961 estimates of catch and escapement by stock group in error?

⁴² As indicated above, differences between stock groups in fishing indices in 1959 were not strictly proportional to differences in rates of removal. A reduction in the fishing index corresponded to a proportionately smaller reduction in rate of removal. Consequently, modifications of the data on this basis would tend to "over-correct" the error.

Re-assessment of the data on this basis was carried out in a "modified" analysis (TABLE F-5). The rates of removal for 1959, adjusted to the 1961 fishing index, (TABLE F-4, row 9) were entered in rows 4 and 8 of TABLE F-5. Most of the catch of Southern Approach fish from these two stock groups was taken in southern fisheries (TABLE 31) where they made up the bulk of the run (FIGURE 11). Fraser and Strait of Georgia fish could be fairly well distinguished in these areas on the basis of timing (FIGURE 10, TABLE 25). The estimates of catches of Strait of Georgia and Fraser fish from the Southern Approach run were therefore considered reasonably accurate and were entered in column 5, TABLE F-5 (rows 2 and 6 respectively).

The numbers of Strait of Georgia spawners and the abundance of this stock group in the Southern Approach run (rows 1 and 3 respectively) were then calculated from the "modified" rate of removal and catch. The resulting reduction in spawners from the estimate for the "combined" analysis (column 4, row 1) was 86,000 (column 6, row 1). To account for the known escapement of Strait of Georgia fish, a similar amount was then added to the Northern Approach spawners (column 3). From the "modified" estimate of the Northern Approach Strait of Georgia spawners (column 2, row 1) and the "modified" rate of removal for these fish (row 4) the "modified" catch and total abundance were estimated (rows 2 and 3 respectively). The "modified" catch was 82,000 greater (column 3, row 2) than the "combined" estimate and a similar amount (column 3, row 6) was subtracted from the estimated catch of Northern Approach Fraser fish (column 1, row 6) so that the total Northern Approach catch remained unchanged.

This shift of a relatively small number of the Northern Approach catch from Fraser River to Strait of Georgia stocks appears justified and even desirable in the light of the procedures employed in the original analysis. In the "combined" analysis, the Johnstone Strait catch, which made up the vast majority of the catch of Northern Approach fish (TABLE 31) was essentially divided between Strait of Georgia and Fraser fish on the basis of the timing of the two runs in 1959 (FIGURE 6). The relative abundance of Strait of Georgia fish with respect to Fraser fish on the Northern Approach run, was appreciably greater in 1961 than in 1959 (see above). This procedure would therefore be expected to underestimate slightly the catch of Strait of Georgia fish and correspondingly overestimate the catch of Fraser fish in the period when the runs overlap.

The abundance (TABLE F-5, column 2, row 7) and spawners (row 5) were then calculated for the Northern Approach Fraser River run from the catch (row 6) and the rate of removal (row 8). Since the "modified" estimate of Fraser River spawners from the Northern Approach run was 139,000 greater than the "combined" estimate, the "combined" estimate of the Southern Approach spawners (TABLE F-5, column 4, row 5) was reduced by a corresponding amount (column 5). The spawners and catch of Southern Approach Fraser River fish were then summed to give abundance and the "modified" rate of removal calculated (column 5, rows 5 to 8). This "modified" rate of removal (35.0 per cent) was relatively close to the adjusted value for the 1959 run (36.9—TABLE F-4).

Thus in the "modified" analysis, the total catch from the runs on both approaches and the numbers of spawners in both stock groups remained the same as in the "combined" analysis, while the rates of removal were virtually identical to those for the 1959 run adjusted to the 1961 fishing intensity. The composition

TABLE F-5. Calculation of modified estimates of spawners, catch and abundance (in thousands of fish) of Northern and Southern Approach Strait of Georgia and Fraser River pinks in 1961 based on the rates of removal for these groupings in the 1959 run.

	NORTHERN APPROACH			SOUTHERN APPROACH		
	(1) Combined analysis	(2) Modified analysis	(3) Difference (2) — (1)	(4) Combined analysis	(5) Modified analysis	(6) Difference (5) — (4)
STRAIT OF GEORGIA						
(1) Spawners	540	626	+86	390	304	-86
(2) Catch	797	879	+82	525	525	—
(3) Abundance	1,337	1,505	+168	915	829	-86
(4) Rate of removal	59.6%	58.4%	-1.2%	57.4%	63.3%	+5.9%
FRASER RIVER						
(5) Spawners	217	356	+139	870	731	-139
(6) Catch	403	321	-82	393	393	—
(7) Abundance	620	677	+57	1,263	1,124	-139
(8) Rate of removal	65.0%	47.4%	-17.6%	31.1%	35.0% ^a	+3.9%
BOTH						
(9) Spawners	757	982	+224	1,260	1,035	-225
(10) Catch	1,200	1,200	0	918	918	—
(11) Abundance	1,957	2,182	+224	2,178	1,953	-225
(12) Rate of removal	61.3%	55.0%	-6.3%	42.1%	47.0%	+4.9%

^a Actual estimate for the 1959 run (adjusted to the 1961 fishing index) was 36.9%.

TABLE F-6. Results of analysis modifying rates of removal in 1961 to correspond with 1959. Numbers and percentages of pink salmon migrating by the Northern and Southern Approaches which were destined for Canada Non-Fraser, Fraser River and United States streams in 1961 and the percentages of the total runs to these areas which migrated by each approach are given along with comparable data from the "combined" analysis^a (in parentheses).

	AREA OF DESTINATION			ALL
	Canada Non-Fraser	Fraser River	United States	
	NUMBERS DESTINED FOR EACH AREA (THOUSANDS)			
Northern Approach	2,316 (2,148)	677 (620)	79 (79)	3,072 (2,847)
Southern Approach	829 (915)	1,124 (1,263)	1,389 (1,389)	3,342 (3,567)
Both	3,145 (3,063)	1,801 (1,883)	1,468 (1,468)	6,414 (6,414)
	PERCENTAGE DESTINED FOR EACH AREA			
Northern Approach	75.4 (75.4)	22.0 (21.8)	2.6 (2.8)	100.0 (100.0)
Southern Approach	24.8 (25.7)	33.6 (35.4)	41.6 (38.9)	100.0 (100.0)
Both	49.0 (47.7)	28.1 (29.4)	22.9 (22.9)	100.0 (100.0)
	PERCENTAGE MIGRATING BY EACH APPROACH			
Northern Approach	73.6 (70.1)	37.6 (32.9)	5.3 (5.3)	47.9 (44.4)
Southern Approach	26.4 (29.9)	62.4 (67.1)	94.7 (94.7)	52.1 (55.6)
Both	100.0 (100.0)	100.0 (100.0)	100.0 (100.0)	100.0 (100.0)

^a From TABLE 32.

of the run according to the "modified" analysis is shown, along with that from the "combined" analysis in TABLE F-6. As would be expected from the analytical procedures, the abundance and proportions of Northern Approach fish was greater in the "modified" analysis than in the "combined" analysis. However, the differences between the two sets of results were small in all categories. The largest was a difference of five per cent in the proportions of Fraser fish approaching from the north and south. On this basis, the proportion of Fraser fish approaching from the north (37.6 per cent) was 14 per cent higher according to the "modified" analysis than for the "combined" analysis (32.9).

As indicated above, the "modified" analysis tended to "over-adjust" for reductions in fishing intensity and consequently the adjustments in the results of the "combined" analysis indicated by the "modified" analysis would be slightly high. In view of the small differences in the results of the two analyses, either set of results could be considered sufficiently representative of the 1961 run for comparison with those from the more detailed analysis of the 1959 run. Since

the "combined" analysis involved fewer assumptions and simpler procedures, these results were employed in subsequent comparisons with other years in the text. In interpreting these comparisons however, allowances had to be made for the probability that the Northern Approach components of the Strait of Georgia and especially the Fraser stocks had been slightly under-estimated and the Southern Approach components similarly over-estimated.

APPENDIX G

Pink Salmon Spawning Populations in the Canadian Study Area in 1963

The numbers of pink salmon that spawned in streams in the Canadian Study Area in 1963 were estimated by Department of Fisheries protection officers from visual surveys by foot and/or aircraft during the peak of the spawning period. The abundance of spawners in each stream was recorded according to the following abundance scale:

1 - 50 A	300 - 500 D	2,000 - 5,000 G	20,000 - 50,000 L
50 - 100 B	500 - 1,000 E	5,000 - 10,000 H	50,000 - 100,000 M
100 - 300 C	1,000 - 2,000 F	10,000 - 20,000 K	Over 100,000 N

Estimates in these categories were converted to quantitative form by using the mean of the abundance range indicated except in a few instances where quantitative estimates were given by the officers. The resulting estimates for individual streams (TABLE G-1) must be considered as gross approximations only. However, quantitative estimates were supplied for four of the six populations exceeding 100,000 fish and the other two populations were not considered to greatly exceed 100,000. Consequently, the total number of pinks estimated in this way to have spawned in the Canadian Study Area in 1963 is probably not subject to very much greater error than the estimates for 1959 and 1961. However, since visual surveys tend to under-estimate the numbers of fish present, the estimate of the number of spawners in the Canadian Study Area in 1963 given in TABLE G-1 must be considered minimal.

Estimates of the 1963 pink salmon spawning populations in the Convention and United States Study Areas are given in the Annual Report of the International Pacific Salmon Fisheries Commission for that year.

TABLE G-1. Estimates of pink salmon spawning populations in the Canadian Study Area in 1963.

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT
<u>Kingcome Inlet</u>		
Embley Lagoon River	Mackenzie Sound	—
Kingcome River	Kingcome Inlet	7,500
Nahwitti River	Goletas Channel	400
Nimmo Bay Creek	Mackenzie Sound	—
Shushartie River	Goletas Channel	—
Songhees Creek	Goletas Channel	75
Wakeman River	Wakeman Sound	35,000
Approximate Total		42,975
<u>Upper Vancouver Island</u>		
Cluxewe River	Broughton Strait	200
Hyde Creek	Broughton Strait	25
Keogh River	Queen Charlotte Strait (E. of Hardy Bay)	7,500
Mills Creek	Broughton Strait	75
Nimkish River	Broughton Strait	1,500
Quatse River	Hardy Bay	750
Tsulguate River	Hardy Bay	200
Approximate Total		10,250
<u>Johnstone Strait</u>		
Adam River	Johnstone Strait	130,000
Amor de Cosmos Creek (Bear River)	Johnstone Strait	—
Bouhey Bay Creek	Havannah Channel-Broken Island	—
Call Creek	E. of Cracroft Island	750
Fulmore River	Port Neville	—
Hemming Bay Creek	East Thurlow Island, Nodales Channel	—
Kokish-Tsulton Rivers	Beaver Cove	400
Pye (Little Bear) Creek	Johnstone Strait	200
Read Creek	Topaze Harbour, Sunderland Channel	200
Salmon River	Kelsey Bay	35,000
Thurston Bay Creek	Thurston Bay, Nodales Channel	—
Tsitika River	Johnstone Strait	3,500
Wortley Creek	Forward Harbour (N. of Hardwicke Island)	—
Approximate Total		170,050

TABLE G-1.—(Continued).

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT
<u>Mid Vancouver Island</u>		
Campbell River	Discovery Passage	200
Englishman River	Georgia Strait, E. of Parksville	25
Granite Bay Creek	Kanish Bay, Discovery Passage	—
Hyacinthe Bay Creek	Quadra Island, Sutil Channel	—
Kanish Bay River	Kanish Bay, Discovery Passage	—
Little Qualicum River	Georgia Strait, W. of Qualicum Beach	75
Millard Creek	Comox Harbour	25
Mohun Creek	Menzies Bay, Discovery Passage	—
Nile Creek	Qualicum Bay, Georgia Strait	—
Oyster River	N. of Comox, Georgia Strait	3,500
Puntledge River ^a	Comox Harbour	7,500
Quinsam River	Campbell River, Discovery Passage	3,500
Qualicum River (Big)	Georgia Strait, S. of Qualicum Bay	—
Tsable River	Baynes Sound	25
Tsolum River	Comox Harbour	7,500
Village Bay Creek	Village Bay, Hoskyn Inlet	—
Approximate Total		22,350
<u>Knight Inlet</u>		
Ahnuhati River	Knight Inlet	7,500
Ahta Valley Creek	Head, Bond Sound	1,500
Gilford (Fraser) Creek	S. side of Gilford Island	400
Glendale River	Knight Inlet	100,000+
Hoeya Sound Creek	Knight Inlet	400
Kakweiken River	Thompson Sound	35,000
Klinaklini River	Knight Inlet	3,500
Kwalate Point River	Knight Inlet	200
Lull Creek	Knight Inlet	—
Maple Cove Creek	S. side of Gilford Island	200
Protection Point Creek	Knight Inlet	—
Sim (Wahshihlas) Creek	Wahshihlas Bay, Knight Inlet	—
Viner Sound River	Viner Sound	200
Waterfall River	Bond Sound	7,000
Approximate Total		155,900
<u>Phillips Arm</u>		
Apple River	Loughborough Inlet, head	25,000
Cumsack River	Mouth of Homathko River, Bute Inlet	—
Teaquahan (Eva) River	Head, Bute Inlet	—
Fanny Bay Creek	Phillips Arm	—
Frazer Bay Creek	Loughborough Inlet	1,500
Grassy Creek	Loughborough Inlet, E. of Beaver Inlet	—
Gray Creek	Loughborough Inlet, E. of Sidney Bay	—
Heydon Creek	Heydon Bay, Loughborough Inlet	75
Homathko River	Head, Bute Inlet	—
Orford River	Orford Bay, Bute Inlet	35,000
Phillips River	Phillips Arm	55,000
Southgate River	Waddington Harbour, Bute Inlet	—
Stafford River	Loughborough Inlet	7,500
Approximate Total		124,075

TABLE G-1.—(Continued).

STOCK AND STREAM	LOCATION	ESTIMATED ESCAPEMENT
<u>Toba Inlet</u>		
Brem River	Toba Inlet	750
Forbes Creek	Honfray Channel	75
Klite River	Toba Inlet	7,500
Little Toba River	Toba River	35,000
Quatam River	Ramsay Arm	3,500
Sliammon River	Malaspina Straits	75
Theodosia River	Malaspina Inlet	75
Toba River	Toba Inlet	35,000
Approximate Total		81,975
<u>Jervis Inlet</u>		
Brittain River	Princess Royal Reach	75
Deserted River	Princess Royal Reach	15,000
Gray (Shannon) Creek	Sechelt Inlet, S. of Salmon Inlet	—
Lang (Wolfsohn) Creek	Malaspina Strait	750
Sechelt (Siwash) Creek	Salmon Inlet, Sechelt Inlet	200
Skwawka River	Head, Queens Reach	200,000
Thunder Bay Creek	W. side of Jervis Inlet near mouth	—
Tzoonie River	Narrows Inlet, Sechelt Inlet	3,500
Vancouver River	Prince of Wales Reach	750
Approximate Total		220,275
<u>Howe Sound</u>		
Ashlu Creek	Squamish River	7,500
Cheakamus River	Squamish River	555,000
Mamquam River	Squamish River	100,000+
McNab Creek	Thornborough Channel	25
Squamish River ^a	Howe Sound, Head	75,000
Stawamus Creek	Howe Sound, Head	75
Approximate Total		737,600
<u>Burrard Inlet</u>		
Capilano River	First Narrows	100
Indian River	N. Arm Burrard Inlet	200,000
Lynn Creek	W. of Seymour River	25
Seymour River	Second Narrows	400
Approximate Total		200,525
GRAND TOTAL		1,765,975

^a Other than Tsolum River tributary.

^b Tributaries other than Cheakamus River.

APPENDIX H

Major Pink Salmon Fisheries and Catch Data for Cycle Years Prior to 1959

On the Northern Approach, pink salmon have been fished extensively in Johnstone Strait at least since 1935, the earliest year for which separate catch data for Johnstone Strait are available. Catch data for Johnstone Strait for the period 1935 to 1949 are limited to seine catches. However, in the cycle years since 1951, seines have taken over 82 per cent of the pinks caught in this area, and seiners have probably accounted for the bulk of the pink salmon caught in this area in all the odd years since 1935. Although some restrictions in fishing methods, times and areas have been applied over the years, these are considered to have been more than balanced by increases in the amount and efficiency of the gear. Thus indices of abundance based on catch in this area would tend to underestimate (probably to a considerable degree) the abundance of the runs in the earlier years.

On the Southern Approach, pink salmon have been intensively fished at least since the years of the first World War (Rounsefell and Kelez, 1938), particularly by United States fishermen who took the great majority of the catch in years previous to 1951. Before 1935, when the use of traps was permitted, about a third of the catch in United States waters was taken by this gear; since the relatively effectiveness of the trap and seine fisheries is not known, data from these early years cannot be related readily to catches after 1935. Furthermore, since the fishery was apparently not as effective in the first year of operation without traps as it was in subsequent years, catch data from years prior to 1937 were not included in the present analyses.

In the Juan de Fuca Strait area, considerable changes have occurred since 1937 in the character of the fishery for pink salmon. Prior to the establishment of the present net fishing boundary at the entrance to the Strait in 1957, an extensive United States and a lesser Canadian seine fishery operated with variable effectiveness immediately outside the entrance on Swiftsure Bank. Subsequent to the imposition of the boundary, the United States Juan de Fuca fishery declined to almost negligible proportions. On the other hand, since 1947 a very sizable Canadian net fishery has operated in the Juan de Fuca Strait area. Unlike the United States fishery the effectiveness of the Canadian fishery was not appreciably altered by the imposition of the net fishing boundary in 1957. Because of these profound changes in the nature of the fishery, catches in the Juan de Fuca area would not, in themselves, provide reliable information on the size of the incoming runs.

The fisheries east of Juan de Fuca Strait (San Juan Islands, West Beach, Puget Sound, Point Roberts and Fraser) have been reasonably stable since 1937 in that the areas of operation and the major types of gear generally have remained the same. However, even in these fisheries considerable changes have occurred in the amount and efficiency of gear and in the degree of regulatory restrictions. Moreover, the catches in these areas would be affected by differences in the rates of removal in the more seaward Juan de Fuca Strait fisheries. To some extent the imposition of restrictions has tended to balance the increasing effectiveness of the fisheries, particularly for the most recent runs.

Catch statistics by week and by area for the British Columbia Fisheries have been published annually since 1951 by the Department of Fisheries, Canada. Annual seine catches in the Johnstone Strait area (Statistical areas 12 and 13) are available back to 1935 from the Annual Reports of the Department of Fisheries, Canada. Annual pack data for the Vancouver Island and Fraser River areas are available back to 1935 in the Annual Reports of the Province of British Columbia, Department of Fisheries. Statistics by day and by fishery for United States waters for the years since 1935 are on file in the offices of the Washington Department of Fisheries and of the International Pacific Salmon Fisheries Commission. Catch data by day and by fishery for the United States Convention area since 1935 and the Canadian Convention area since 1945 have been compiled by, and are on file in the offices of the International Pacific Salmon Fisheries Commission.