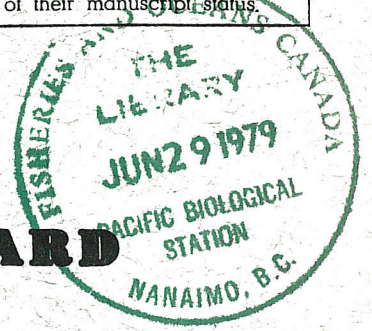




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FISHERIES RESEARCH BOARD OF CANADA

MANUSCRIPT REPORT SERIES (BIOLOGICAL)

No. 865 *C2*

TITLE

SKEENA SALMON MANAGEMENT COMMITTEE,
ANNUAL REPORT, 1964

AUTHORSHIP

J. G. McDonald

Establishment

Biological Station, Nanaimo, B. C.

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Terms of Reference

The Skeena Salmon Management Committee was established by the Minister of Fisheries in 1954 to investigate the condition of Skeena River salmon stocks, to improve management of the runs, and to increase the yield, if possible. To achieve its objectives the Committee uses both the administrative, fish culture, and research staffs of the Department of Fisheries. Present members of the Committee are Mr. W. R. Hourston, Director, Pacific Area, Department of Fisheries, and Dr. P. A. Larkin, Director of the Biological Station of the Fisheries Research Board of Canada at Nanaimo.

Upon establishing the Committee, the Minister of Fisheries appointed an Advisory Board representing the various sections of the industry concerned with the Skeena River salmon fishery. The Committee meets with its Advisory Board several times each year to discuss investigations and the basis for regulation of the fishery.

Record of Meetings

The Committee met at Vancouver on December 10, 1963, to consider evidence bearing on the likely size of the 1964 Skeena sockeye and pink runs and to discuss and formulate appropriate regulation of the fishery.

On the basis of the size of the parent spawnings of 1959 and 1960, and on the most probable division of the progeny into 4- and 5-year-olds, it was anticipated that the 1964 sockeye run would amount to 879,000 4₂ and 5₂ sockeye. An average return of other age groups (mainly 5₃'s and 6₃'s) would provide an additional 65,000 for a total run of 944,000. The large return of jacks (3₂'s) from the parent spawning of 1960 suggested that the return of 4's could be better than anticipated. However, because of the small escapement in 1960, even at best, an exceptionally large number of 4's could not be expected.

The 1964 pink run would return from a spawning of about 1,000,000 fish. In recent even-numbered years the return ranged from 0.5 to 6.5 times the number of parents and had averaged 3.1 times. An average return would therefore result in a run of about 3,000,000 pinks.

In formulating regulations for 1964, the Committee noted that the most likely return of 944,000 sockeye was only the equivalent of the estimated optimum escapement and on this basis alone would not provide any surplus for a commercial fishery. The pink run on the other hand would probably exceed escapement requirements, particularly if there was an average or better return to the Lakelse River which had a major part of the total escapement in the 1962 brood year.

In view of past difficulty in forecasting the sizes of the Skeena runs, and hence the possibility that the 1964 sockeye run might exceed expectations,

the Committee proposed a limited fishery of 1 day per week during the period when sockeye predominate in the fishery, and fishing for two days per week during the height of the pink run. It was anticipated that such regulation would result in a catch of approximately 33% of the expected 944,000 sockeye and 40% of the expected 3,100,000 pinks.

Details of the proposed regulations were as follows:

Proposed Regulations - 1964

- (a) That the upriver commercial fishing boundary be maintained at the Mowitch-Veitch Point line.
- (b) That prior to 6:00 p.m., Sunday, June 28, 1964, only gillnets having mesh not less than 8" linen, or 8½" nylon, stretched measure, be permitted and that prior to this date, a 72-hour weekly closed period from 6:00 p.m. Thursday, until 6:00 p.m. Sunday, be maintained.
- (c) That fishing for salmon with gillnets of any mesh size be permitted after 6:00 p.m. Sunday, June 28, 1964, until the end of the fishing season as follows:
 - (i) From June 28 to July 26 - 144-hour weekly closed time 6:00 p.m. Monday to 6:00 p.m. Sunday;
 - (ii) From July 26 to August 23 - 120-hour weekly closed time 6:00 p.m. Tuesday to 6:00 p.m. Sunday;
 - (iii) From August 23 to the end of the fishing season - 72-hour weekly closed time 6:00 p.m. Thursday to 6:00 p.m. Sunday.
- (d) The Committee also proposes to make recommendations as follows for adjacent fishing areas in order to extend similar protective measures for Skeena-bound sockeye and pink salmon whilst passing through those areas:

Area 3, Nass River - Sub Areas 3X and 3Y only

- (i) Same weekly closed times as in (c) above from July 5, 1964 to August 16, 1964.

Salmon Purse Seine Area No. 5 - Beaver Passage and Ogden Channel only

- (i) Same weekly closed times as in (c) above from July 26, 1964 to August 16, 1964.

(e) Provisos:

- (i) That the weekly closed times outlined above shall be extended in the event that for any week or series of weeks during the progress of the fishing season the

proposed weekly closures, in the opinion of the Committee, are deemed insufficient to provide adequate escapement of salmon for reproduction purposes.

- (ii) That extra fishing time would be granted if, in the opinion of the Committee in the light of development of sockeye and pink runs at the time, such might safely be permitted consistent with attaining adequate escapements for reproduction.

A release describing the above proposed regulations was provided the Committee's Advisory Board and the industry generally on December 31, 1963. This was followed by meetings of the Committee with its Advisory Board at Prince Rupert, B. C., on February 4 and 5, 1964. At the meetings, the prospects for the 1964 runs and the basis for the proposed regulations were reviewed. The views of Advisory Board members and other individuals and organizations associated with the fishery were received.

The Committee carefully considered all views and alternate proposals which bore on regulation of the 1964 runs and concluded as follows:

- (a) In view of representations received regarding the economic needs of both fishermen and plant operators, the Committee will recommend that during the period of June 28, 1964 to July 26, 1964 an additional 14 hours of fishing time weekly over that originally proposed be provided. Further, in the event that the sockeye run is larger than expected, the Committee is prepared to recommend regulatory changes which will provide an approximately equal division of the additional fish for catch and escapement purposes until escapement requirements are met. However, in the event that the runs are smaller than anticipated, further restriction of fishing may be necessary.
- (b) In regard to net fishing for spring and coho salmon, additional fishing time or the movement of fishing boundaries does not appear warranted. In the event sockeye fishing is not allowed in any one week, consideration will be given to permitting a spring salmon fishery with nets having mesh not less than 8 inches extension measure for linen nets and $8\frac{1}{2}$ inches extension measure for synthetic fibre nets during daylight hours in the river.
- (c) A review of the troll fishery for sockeye and pink salmon in the Skeena area in recent years has shown that as yet the catch of these species by trolling gear has remained a very small proportion of the total (less than 0.3% in the case of sockeye and less than 2.0% in the case of pinks). It is the Committee's view, however, that should the catch of these species by trolling increase sharply in 1964, or in future years, restriction of trolling within the net fishing area will be initiated.

In view of the foregoing the Committee recommended to the Department of Fisheries the following regulations for the 1964 Skeena salmon fishery:

- (a) That the upriver commercial fishing boundary be maintained at the Mowitch-Veitch Point line.
- (b) That prior to 6:00 p.m., Sunday, June 28, 1964, only gillnets having mesh not less than 8 inches extension measure for linen nets or $8\frac{1}{2}$ inches extension measure for synthetic fibre nets be permitted and that prior to this date a 96-hour weekly closed period from 6:00 p.m., Wednesday until 6:00 p.m., Sunday be maintained.
- (c) That fishing for salmon with gillnets of any mesh size be permitted after 6:00 p.m., Sunday, June 28, 1964, until the end of the fishing season as follows:
 - (i) From June 28 to July 26 - 130-hour weekly closed time 8:00 a.m. Tuesday to 6:00 p.m. Sunday;
 - (ii) From July 26 to August 23 - 120-hour weekly closed time 6:00 p.m. Tuesday to 6:00 p.m. Sunday;
 - (iii) From August 23 to the end of the fishing season - 72-hour weekly closed time 6:00 p.m. Thursday to 6:00 p.m. Sunday.
- (d) The Committee also proposes to make recommendations as follows for adjacent fishing areas in order to extend similar protective measures for Skeena-bound sockeye and pink salmon whilst passing through those areas:

Area 3, Nass River - Sub Areas 3X and 3Y only

- (i) Same weekly closed times as in (c) above from July 5, 1964 to August 16, 1964.

Salmon Purse Seine Area No. 5 - Beaver Passage and Ogden Channel only

- (i) Same weekly closed times as in (c) above from July 26, 1964 to August 16, 1964.

(e) Provisos:

- (i) That the weekly closed times outlined above shall be extended in the event that for any week or series of weeks during the progress of the fishing season the proposed weekly closures, in the opinion of the Committee, are deemed insufficient to provide adequate escapement of salmon for reproduction purposes.
- (ii) That extra fishing time would be granted if, in the opinion of the Committee in the light of development of sockeye and pink runs at the time, such might safely be permitted consistent with attaining adequate escapements for reproduction.

At the end of the 1964 fishing season the Committee met at Vancouver on December 7, to examine the 1964 Skeena runs and the effect of the regulations on the catch and escapement. Pertinent information is given in the following section of this report together with a brief review of research and development projects under the direction of the Committee.

The 1964 Skeena River Salmon Fishery

It was expected that the sockeye run would be very moderate in size (940,000) while the pink run would be better than average (3,000,000). In view of escapement requirements, it was recommended by the Skeena Salmon Management Committee that fishing for sockeye and pinks begin on June 28, and that weekly fishing periods be limited to $1\frac{1}{2}$ days during July when sockeye predominate in the fishery, and 2 days in August when pinks are most abundant.

The sockeye run actually amounted to 1,650,000 fish. This greater-than-expected number was due to a very high proportion of the progeny of the 1959 spawning returning as 5-year-olds. The pink run of 2,600,000 approached expectations. Figure 1 shows, for the Skeena Gillnet Area, the number of days fishing recommended by the Committee prior to the season, the actual number of days fishing allowed, the size of the weekly sockeye and pink stocks broken down into catch and escapement and estimates of the weekly rates of exploitation.

The sockeye fishery was atypical because of the way in which the run developed and because "outside" boats were unable to catch sockeye with their usual efficiency. Consequently, a reliable index of the abundance of sockeye in the fishing area was lacking and regulation depended almost entirely upon information provided by commercial catches in the river and test-fishing catches above the river fishing boundary.

With the greater-than-expected sockeye run, extensions to weekly fishing times were provided. At the peak of the run, fishing periods were extended to 4, 5, and 6 days per week. In addition, the river fishing boundary was moved upstream at a time when excessive escapement was indicated by test-fishing catches.

The season's sockeye catch amounted to 765,000 pieces (see Fig. 2 for comparison with past years) or 46% of the total run of 1,650,000. It is noteworthy that this rate of exploitation would normally result from fishing periods of 2 or 3 days per week.

The escapement was estimated to be 885,000. A near optimum number of spawners (828,000) was observed at Babine Lake. However, escapements to other sockeye producing areas were generally small.

The 1964 pink run was characterized by a small return of those stocks which contribute to the fishery in July and a large return of the Lakelse River stock which is most abundant during August. Because of the long weekly fishing

DAYS FISHING RECOMMENDED (PRE-SEASON)										
0	0	1½	1½	1½	1½	2	2	2	2	4
DAYS FISHED										
		1½	2½	1½	4	5	6	3	3	3
ESTIMATED RATES OF EXPLOITATION (%)										
PINK				76	82	64	61	21	39	35
SOCKEYE		42	61	32	46	56	54	22	71	28

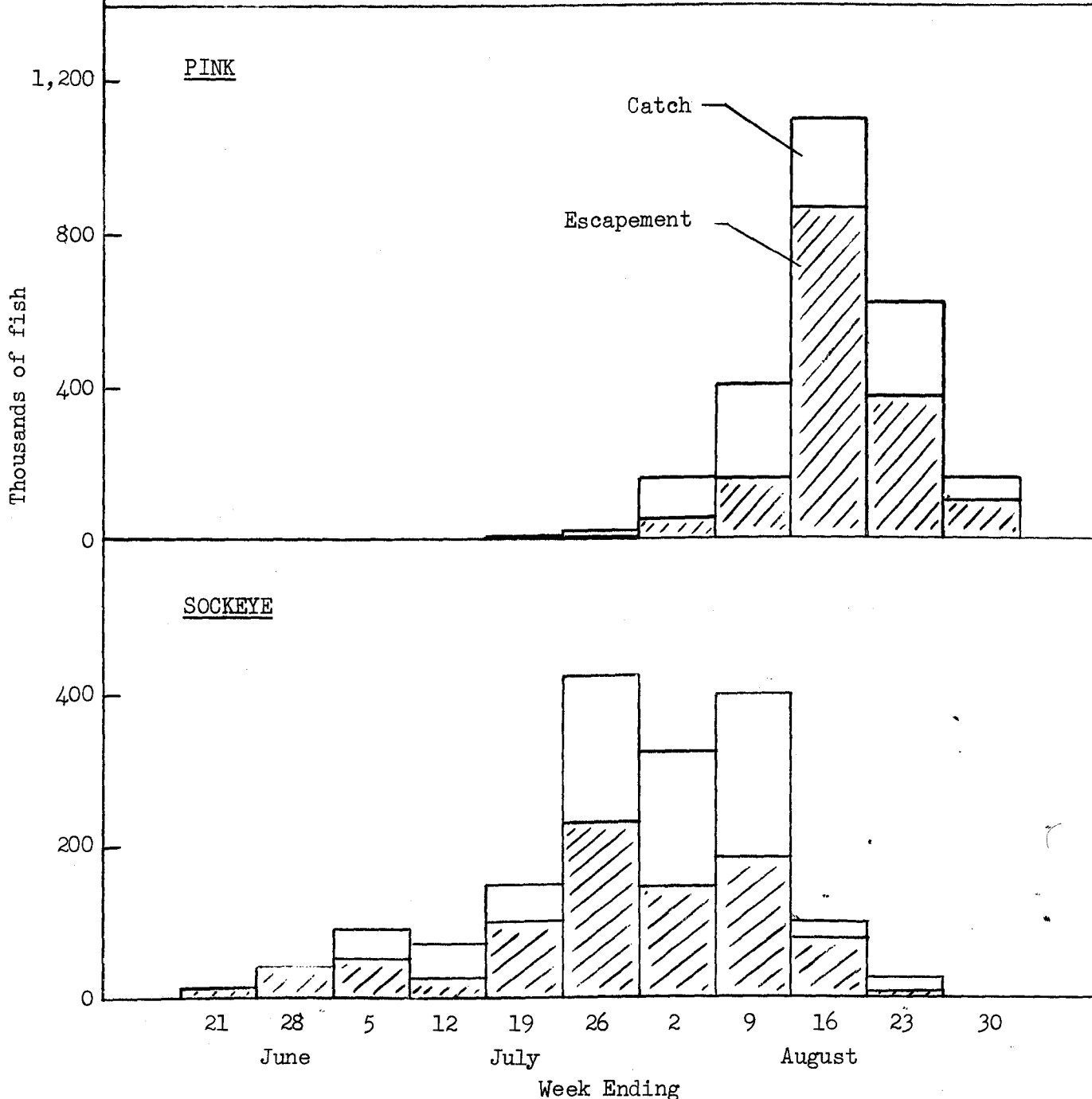


Fig. 1. Catch, escapement and total stock by weeks of Skeena River sockeye and pinks, 1964, together with the number of fishing days provided and resulting rates of exploitation.

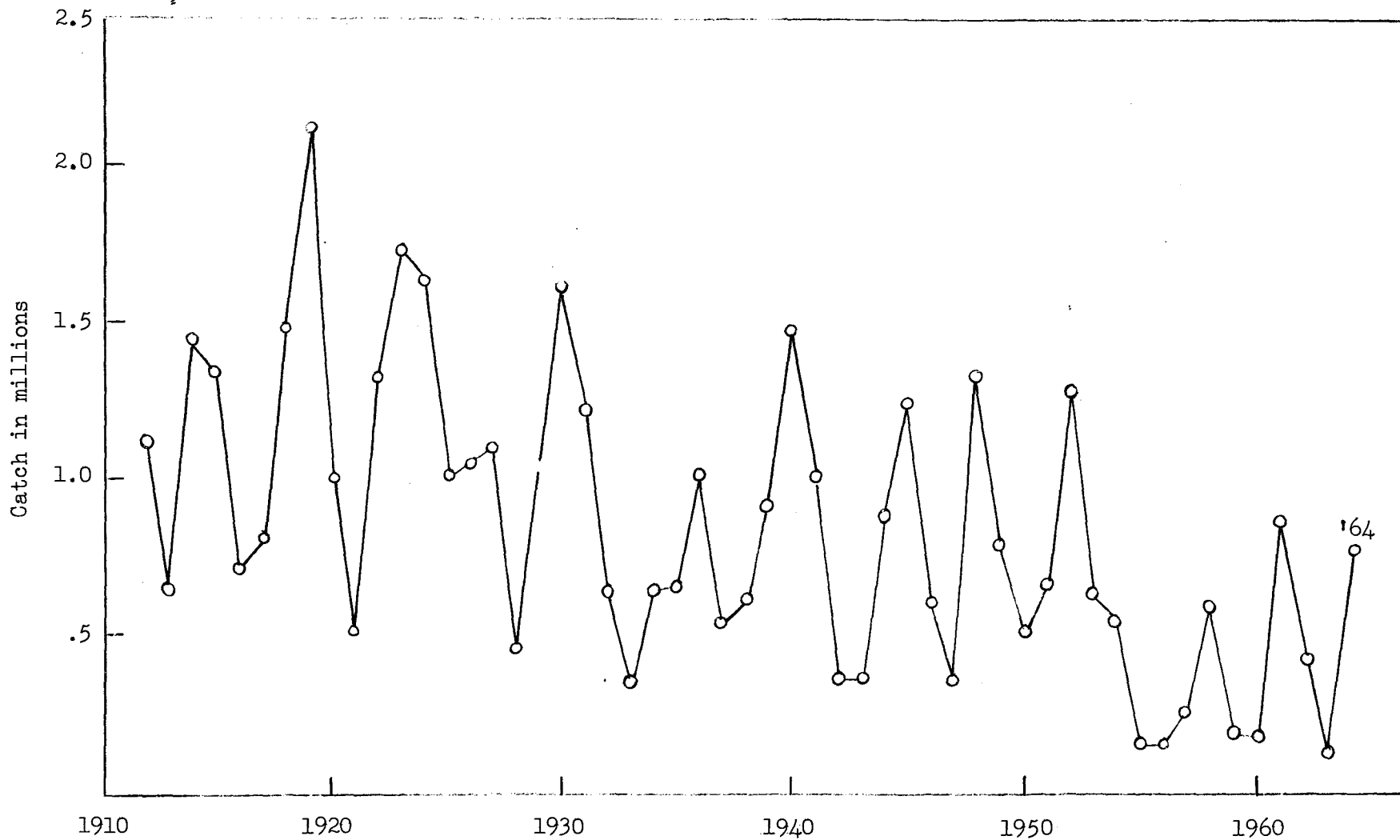


Fig. 2. Annual catch of sockeye in the Skeena Gillnet Area (from British Columbia Catch Statistics of the Department of Fisheries, 1950-1964, and from pack and sampling data, 1912-1949).

periods required to crop the sockeye run, the early pink stocks were heavily fished (weekly exploitation rates were as high as 82%) and escapements were generally much reduced from those in the brood year.

By August 9, it was clear that the sockeye run was terminating and that much needed protection to the pink run could be provided. During the week ending August 16, fishing was limited to two days. However, at the close of this week's fishing (Tuesday evening) test-fishing catches indicated that by the weekend, escapement to the Lakelse River could be excessive. Consequently the unusual action of opening the fishery on a Saturday rather than a Sunday was taken. Although this action and subsequent fishing times provided appeared to result in the desired number of spawners to the Lakelse River, spawning ground estimates revealed that the escapement was about twice as large as was indicated by test-fishing catches.

The total commercial pink catch in the Skeena area was 940,000 pieces or 36% of the total run of 2,600,000. The 1964 catch is compared to catches in past years in Fig. 3. Of the estimated total escapement of 1,609,000, 1,321,000 or 82% was estimated to spawn in the Lakelse River. The Lakelse River run was the largest single contributor to the fishery - probably contributing about 2,000,000 to the total Skeena run of 2,600,000 pinks.

The total catch of springs in Area 4 was 47,493 - the best since 1952 and better than the 1951 to 1963 average annual catch of 38,096. The gillnet catch of 18,497 was the largest since 1960 (Fig. 4), while the troll catch of 28,972 was the largest since 1952. The escapement as indicated by test fishing catches was about average. The good catch plus the average escapement reveals a better than average run in 1964.

The Skeena gillnet and troll catch of coho amounted to 177,519. This is the largest catch since 1954 (Fig. 4) and better than the 1951 to 1963 average of 119,711. The gillnet catch of 81,804 pieces was the best since 1955, while the troll catch of 95,468 was the best since 1952. Test fishing catches indicated that upriver escapement was about average for recent years.

The catch of chums amounted to 37,637. This is the best catch since 1958 (Fig. 4) but below the 1951 to 1963 average of 44,099. The chum escapement as indicated by test fishing catches was below the average for recent years.

The annual catches of sockeye and pink salmon since 1912 and 1909 respectively are shown in Figures 2 and 3. The annual gillnet catches of spring, coho, and chum for the period 1950 to 1964, are shown in Figure 4.

Investigations and Fish Cultural Projects

The Committee's staff continued to provide information needed for the seasonal and long-term management of Skeena salmon stocks. This involved such projects as the collection and analysis of commercial catch-effort data, test gillnet fishing, estimation of escapement size and distribution, and sampling for age and size composition of the runs.

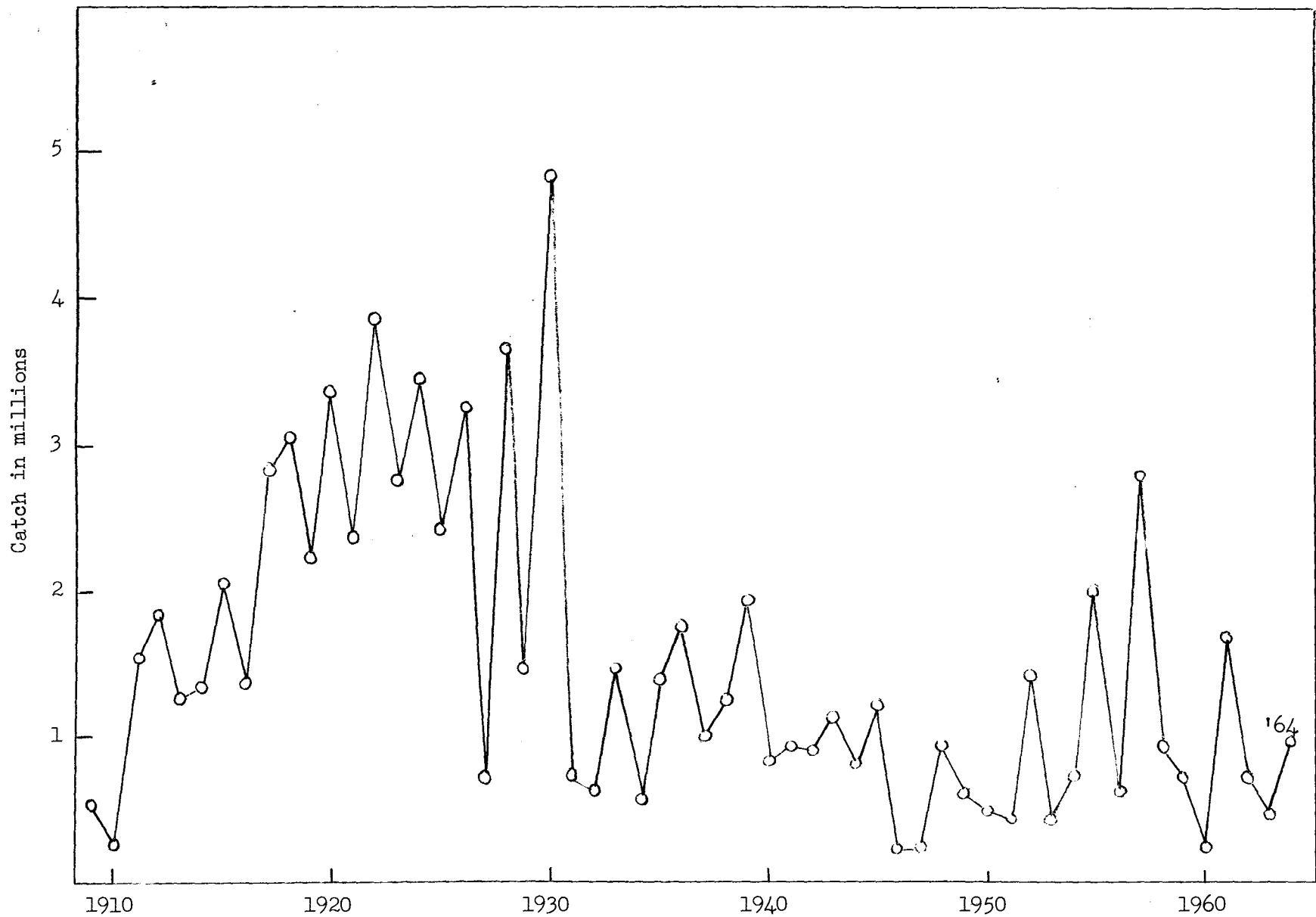


Fig. 3. Estimated annual catch of Skeena River pink salmon (1909-1949), using pack figures and available information of annual average fish per case; 1951-1961, from British Columbia catch statistics of the Department of Fisheries). In years 1955-1963 the estimated catches of Skeena fish caught in adjoining statistical areas 3 and 5 are included.

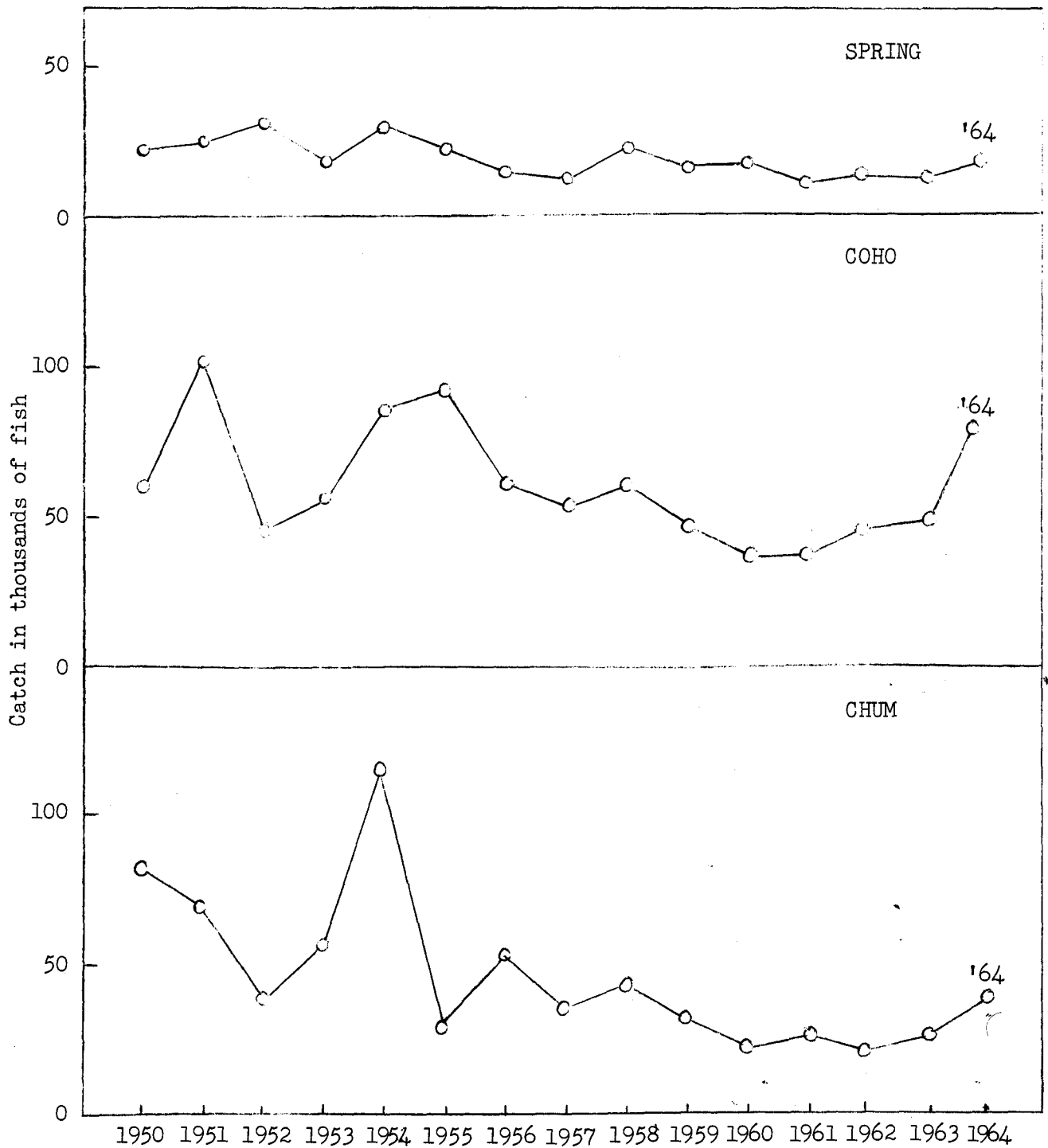


Fig. 4. Annual gillnet catches of spring, coho and chum salmon in the Skeena Gillnet Area (from British Columbia Catch Statistics of the Department of Fisheries).

Studies related to sockeye production at Babine Lake continued with the objective of determining how this important production area may be best utilized. The Committee's biological and engineering staffs continued to examine the feasibility of developing Babine Lake's potential as a sockeye producer by means of fish cultural facilities - particularly by means of artificial spawning channels.

1. The 1964 Babine escapement

The Babine Lake system is the largest sockeye producing area in the Skeena system and has supported approximately 90% of the total Skeena escapement of that species in recent years. In addition, good runs of all other species except chums have occurred in most years.

A count and the collection of certain vital statistics of the Babine escapements have been attempted each year since 1946 by the operation of the Babine counting fence. Counts are complete for all years except 1946 when the fence washed out, and 1964 when unusually high water prevented fence operation until September 1.

In 1964 the sockeye escapement was calculated by applying to the sum of counts on the individual spawning grounds an expression for the long-term relationship between the counts and the actual fence total. This expression ($x = 0.758y + 6.67$ where x is the Babine fence count) is for large 4-year-old and older sockeye only and yields an estimate of 827,500 for 1964. The consistent nature of the relationship in past years suggests that a high degree of accuracy will result from an estimate obtained in this way provided that stream counts are accurate. The discrepancy between fence counts and the sum of stream counts is believed to reflect the magnitude of lake spawning populations. No absolute count of jacks was possible in 1964 but observations on the streams showed the return to be small.

Distribution of sockeye spawners within the Babine system generally followed the pattern of past years, although an exceptionally large escapement to Fifteen Mile Creek was observed.

The Babine pink salmon escapement was estimated from a tag and recovery program and totalled 23,400 (95% confidence limits 21,600 and 25,300). Estimates of 3,500 jacks, 2,200 large springs, and 8,400 cohos were obtained by expanding the September 1 to 15 counts through the fence in accordance with the proportion of runs which passed through during that calendar period historically. No chums were observed to pass the Babine fence this year.

Fish of all salmon species appeared to be in good condition and little if any delay appeared to have accompanied the excessively high water in the Babine canyon.

2. Skeena pink salmon escapement and resultant production

Estimates of the 1964 pink escapements are given in Table I together with estimates for past years. The total number of spawners this year compared

favorably with totals observed in the past. However, the 1964 escapement was characterized by small numbers of spawners to most streams which contribute fish to the early one-half of the Skeena run and by an exceptionally large escapement to the Lakelse River. The escapement to the Kispiox River was exceptionally small due to a poor total return from the brood year spawning together with a very intensive fishery on this stock in 1964. The Kispiox stock, once a major contributor of pinks in the odd-year cycle, is now reduced to a minor stock in both cycles.

Table I. Estimated escapements of Skeena pink salmon, 1955 to 1964.

Place	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964
	(thousands)									
Kispiox River	540	75	360	66	650	45	280	50	32	8
Kitwanga River	125	35	160	158	250	27	100	65	170	50
Lakelse River	175	75	140	262	185	122	325	635	505	1,321
Babine River	5	3	27	10	77	7	75	40	93	24
Bear River	6	nil	15	nil	20	nil	5	nil	15	nil
Skeena River	10	5	50	50	150	10	450	37	40	200
Others	119	10	113	10	54	5	100	8	45	8
Coastal Rivers	78	75	105	116	95	45	99	165	128	no data
Total	1,058	278	970	672	1,478	261	1,434	1,000	1,028	1,611+
Total upstream of test fishing	987	202	868	558	1,383	215	1,335	835	900	1,611

The 1964 escapement of 1,321,000 spawners on the Lakelse River is the largest ever recorded. A gross estimate of the total size of the Lakelse run (escapement plus commercial catch) is 2,200,000. This represents a near average rate of return from the brood year spawning of 635,000 and a near average marine survival from fry to adult (Table II).

3. The Babine smolt output

Babine sockeye smolt runs have been estimated annually since 1951 by means of a mark and recovery program. Beginning in 1962 an electronic smolt counter has been under development in the hope that ultimately it will (1) improve the accuracy of smolt estimates, (2) reduce the cost of the operation, and (3) replace much of the tedious work associated with smolt marking procedures.

Details of the mark and recovery program have been presented in this report series, and statistics for the 1951-1963 runs were summarized in 1963.

Table II. Partial Lakelse River pink salmon production in brood years 1959-1964.

Brood year	Escapement ×10 ³	Estimated egg deposition ×10 ³	Fry production		Adult return			Marine survival (%)	Ratio of return from parent year escapement
			Output ×10 ³	Egg to fry survival (%)	Escapement ×10 ³	Exploitation rate (estimated)	Total return ×10 ³		
1959	185	217,027	29,900	13.8	325	55%	722	2.41	3.90
1960	122	103,502	20,400	19.7	635	25%	847	4.15	6.94
1961	325	454,662	38,800	8.5	505	35%	777	2.00	2.39
1962	635	806,196	90,500	11.2	1,321	40%	2,202	2.43	3.47
1963	505	615,090	4-year average					2.75	4.18
1964	1,321	1,029,600							

The 1964 run was characterized by unusual phenomena in both the run and the environment. The ice cover did not leave the north arm of Babine Lake until May 17. This was followed by unusually high water and extreme turbidity which hampered operations after June 1.

The smolt run was slow in starting and there was no clear separation, as in most years, into early fish from the North Arm-Nilkitkwa region, and late fish from the main lake basins. Size distribution and other features of fish in daily samples suggested that passing smolts were at most times mixed as to place of origin. The run was estimated from a standard mark and recovery program to total 50 million smolts, the second largest on record. (The largest estimate, 57 million in 1960, may have been considerably overestimated as discussed in the 1963 report.) The 1964 fish averaged 4.9 grams in weight. This compares with an average weight of 5.1 grams over the last 7 years and suggests that average growth did not suffer inordinately despite the large body of fish in the lake during the growing period.

Survival estimates for Babine smolts have been reviewed annually in the hope that a useful relationship would emerge between numbers of smolts migrating and adults in return. These estimates are brought up to date in Table III.

The electronic counters were operated during the greater part of the smolt migration period. Toward the end of the season the extraordinarily high, muddy water caused the counter accuracy to drop off. It is now clear that counter efficiency will decline as turbidity increases beyond some rather high but at present poorly defined level. Further tests will be needed in both field and laboratory to improve our understanding in this regard.

Greater standardization in sensitivity from one counter unit to the next is also required. This will probably necessitate the use of electronic components with less variable performance than those currently in use. However, electronic smolt counting does not appear to pose any insurmountable problems and operation under normal conditions at Babine should now proceed in a straightforward manner.

Table III. Partial survival estimates for Babine smolts from brood years 1956-64.

Brood year	Fence count	Egg potential	Smolts produced	Return of ^a 4 ₂ and 5 ₂	% survival		
					Egg-Smolt	Smolt-Adult	Egg-Adult
		← in millions →					
1956	.355	523	22.8	.541	4.37	2.37	.103
1957	.433	653	33.9	2.179	5.18	6.43	.334
1958	.812	1,547	57.1	.551	3.70	0.96	.036
1959	.783	1,554	20.8	1.688 ^b	1.34	8.11	.109
1960	.263	403	17.1	.426 ^c	4.24	..	..
1961	.941	1,512	14.3	..	0.94	..	..
1962	.548	1,070	50.0	..	4.67	..	..
1963	.588	940	..	..	..	..	..
1964	.828	1,424 ^d	..	..	..	..	..

^aincludes small numbers destined for areas other than Babine.

^c4-year-olds only

^bpreliminary

^dusing \bar{x} egg content 1949-1963

4. Age composition of Skeena sockeye stocks

Forecasting the size of sockeye runs has been greatly hampered thus far by our inability to accurately predict age at return and to understand the factors which govern it. Both genetics and the environment are believed to play a part and are being studied on the Skeena.

Annual census of age of spawning fish in separate Skeena stocks was taken in 1964 for the third consecutive year. Within the Babine lake basins 17 sub-stocks, each spawning in separate streams, are receiving attention. One sub-stock at Four-Mile Creek is being intensively studied to learn whether random mating occurs among spawning populations of mixed sizes and ages.

Since 1962, sockeye spawners in the north end of the Babine system (Upper and Lower Babine Rivers, Nine-Mile Creek, and Morrison drainage) have been mainly 5-year-olds while in streams adjacent to the main lake basin, and particularly in the Fulton River and Fifteen Mile Creek, larger proportions of 4-year-old spawners have been observed. This suggests that there is considerable independence in the age of return of fish from separate spawning stocks. Further observations will provide for a comparison of the age composition of the parents with the age composition of the returning progeny and perhaps indicate the factors which are operative.

In 1964 more than 2,000 fish spawned in Four-Mile Creek. Most of these were tagged as they entered the stream. Small fish (4-year-olds) received one type of tag, large fish (5-year-olds) received a second type and fish of intermediate size (mixed 4's and 5's) received a third type of tag. A complete age analysis was made from otoliths obtained from dead fish and the relative accuracy of the age-length assessments was established later. When the fish were distributed through the stream they were visited daily to establish the age composition of spawning pairs. For the purpose, a spawning pair was defined as one which remained over the same small area, judged to be a true redd, on two or more successive days.

During the spawning period, 629 spawning pairs were observed. The ages of the fish comprising these spawning pairs is shown in Table IV, along with the expected distributions of ages as determined from age analysis of the entire escapement and calculated on the assumption of random encounters between the sexes. The table shows the ages of mating pairs to be very like the expected composition except that the 4-year-old males appeared to spawn with 5-year-old females only one-third as often as expected. The discrepancy in this cross was in keeping with observations on spawning behaviour in the stream. Small males were often driven away by larger fish of both sexes, and presumably would experience great difficulty in competing for mates in the larger size group. The implications of non-random mating will have to be considered as part of the study of factors influencing age at return.

Table IV. Observed and expected values for spawning pair data, Four-Mile Creek, 1964.

Mating combination	Observed		Expected	
	Number	%	Number	%
4♂ x 4♀	6	1.13	5	.885
4♂ x 5♀	12	2.27	47	8.915
5♂ x 5♀	467	88.28	434	82.055
5♂ x 4♀	44	8.32	43	8.145
Total	529	100.00	529	100.000

5. Movements of sockeye fry in the Upper Babine River and to adjacent lake nursery areas

During the spring and summer of 1964 a detailed comparison was made of the upstream and downstream movements of sockeye fry in the Upper Babine River. The river is situated between two lakes. Downstream migrants enter Nilkitkwa Lake to the north and upstream migrants enter the north arm of Babine Lake. The following is a summary of the more important observations bearing on their movements and migration into the lake rearing areas.

(1) Downstream movement began earlier and reached a peak at least ten days prior to the peak of upstream migration.

(2) Neither the diel nor seasonal patterns of upstream and downstream movement can be consistently correlated with changes in water temperature or water level.

(3) As the season progressed, the pattern of nocturnal downstream migration became more peaked. At the same time the peak of movement tended to come earlier and earlier. This is the reverse of the seasonal pattern usually described for downstream fry migrations.

(4) The diel pattern of upstream movement was bimodal early in the season with a peak of movement shortly after dawn and a second larger peak during the late afternoon. Later, the timing of upstream movements of fry became more erratic. The daily pattern of upstream movements did not appear to be related to water temperatures.

(5) Upstream migrants in the Upper Babine River were larger than downstream migrants throughout most of the season. Field observations indicate that upstream migrants feed actively during their stay in the river.

(6) Schools of fry entering the North Arm of Babine from the Upper Babine River were observed moving close inshore for many miles uplake. The length-frequency distributions of fry taken in beach seines indicate a progressive increase in the size of fry associated with increasing distance from the Upper River. By the end of July observations revealed that most young sockeye had moved offshore.

6. A comparison of the sympatric kokanee and sockeye populations of Babine Lake

A comparative study of the biology of anadromous sockeye salmon and the kokanee, a freshwater form of the same species, was initiated during 1964. The objective of this study is to assess whether kokanee compete for lake nursery areas or spawning grounds with anadromous sockeye. Fences were established on Four-Mile and Sockeye Creeks, two streams supporting both kokanee and sockeye spawning runs, and estimates of kokanee abundance were made for streams throughout the Babine Lake area. Samples of both kokanee and sockeye were collected in several streams to be used in a comparison of meristic variation. Both scales and otoliths were collected for aging and the identification of racial differences which might exist between kokanee and anadromous sockeye. The results have thus far been subjected to only preliminary analysis but the following are apparent:

- (1) In the streams where they coexist, there is considerable overlap between kokanee and sockeye in both the time of spawning and the distribution of spawners on the grounds. Nevertheless, spawning between the two forms was not observed.
- (2) Male kokanee spawners are more abundant than females - over 58% of the run into Four-Mile Creek, for instance. This contrasts with the long-term ratio of approximately 54.8 females to 45.2 males (excluding jacks) for sockeye salmon entering Babine Lake at the Lower Babine fence.
- (3) Almost 95% of kokanee sampled on the spawning grounds were in their fourth year.
- (4) The number of kokanee spawners appear subject to severe annual fluctuations. Only 27,000 fish were counted in spawning streams in 1964 compared with an estimated million-plus spawning in 1963.
- (5) Kokanee have fewer vertebrae, lateral line scales and, possibly, total gill rakers than anadromous sockeye spawning in the same streams.
- (6) Kokanee seem to have fewer circuli in the first scale annulus than smolts of the same year class.

7. Protection to salmon spawning and rearing areas

During the course of the year a number of proposed and developing industrial projects in the Skeena drainage were examined by the Department of Fisheries Fish Culture Branch to determine what effect each project might have on salmon production and to ensure that sufficient safeguards are employed. These projects included (1) a proposed pulp mill at Houston, B. C., and an addition to the Celgar plant at Port Edward, B. C.; (2) the Granisle copper mine development at Babine Lake; (3) proposed dredging of the Skeena River near Shames, B. C., and numerous proposals by the forest industry regarding log-driving, logging, and gravel removal.

