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ORIGINS OF SOCKEYE SALMON (*Oncorhynchus nerka* Walbaum) IN THE TAKU-SNETTISHAM DRIFT GILLNET FISHERY OF 1984 BASED ON SCALE PATTERN ANALYSIS

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May 1986

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Don W. Collinsworth
Commissioner

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ABSTRACT

Mixed stocks of sockeye salmon (*Oncorhynchus nerka* Walbaum) harvested in the 1984 District 111 gillnet fishery were allocated, using linear discriminant function analysis of scale patterns and age composition data, to two groups, one composed of stocks originating in the Taku River drainage and another of stocks originating in drainages that empty into Port Snettisham. Approximately 75% (58,653 fish) of the harvest of 77,329 sockeye salmon were bound for the Taku River. The total return of the Taku River run was estimated to be 192,067 fish, of which 85,895 fish (45%) were harvested in the District 111 and Canadian in-river fisheries. The total return of the Port Snettisham run was estimated to be 35,247 fish, of which 18,676 fish (53%) were harvested in the District 111 fishery.

KEY WORDS: Sockeye salmon, *Oncorhynchus nerka*, stock separation, linear discriminant function analysis, catch allocation.

INTRODUCTION

The District 111 drift gillnet fishery operates near Juneau in Southeastern Alaska (Figure 1). Fishing time in this district is regulated based on sockeye salmon abundance from mid-June through mid-August, after which time regulations are based on abundance of coho and fall chum salmon. The average annual commercial gillnet harvest of sockeye salmon in the district during the period 1962 to 1983 was 53,829 fish; yearly harvests ranged from 17,735 to 123,081 fish. Sockeye salmon in this district originate from drainages that empty into Taku Inlet and Port Snettisham (Figure 2). Most Taku River fish are bound for spawning sites in western British Columbia, Canada, while Port Snettisham sockeye are thought to spawn almost exclusively in Southeastern Alaska in the Speel Lake and Crescent Lake drainages. A second commercial gillnet fishery operates in the Canadian portion of the lower Taku River and has harvested an average of 13,460 sockeye salmon each year since its inception in 1979.

The principal purpose of this report is to document methodology and results obtained from an ongoing scale pattern analysis study of the origin of sockeye salmon harvested in Alaska's District 111 gillnet fishery. I use the catch allocation by drainage, together with escapement data, to reconstruct total run strength by age. The data provide basic statistics for use in regulating Alaska's and Canada's fisheries on these stocks in accordance with conservation and allocation goals outlined in the Pacific Salmon Treaty of 1985.

METHODS

Catch and Escapement Statistics

Catch statistics for the District 111 fishery were compiled by the Division of Commercial Fisheries, ADF&G, and originated from individual fish tickets tabulated as of 23 May 1985. Harvest statistics for the Canadian in-river fishery were provided by the Canadian Department of Fisheries and Oceans. Weirs at the outlets of Crescent and Speel Lakes enabled monitoring of escapement to the major Port Snettisham systems. Mark-recapture methods were used to estimate the escapement to the Taku River drainage (Clark et al. 1986).

Age Composition

Age was determined by visual examination of scale impressions under moderate (40X) magnification. Scales were collected from the left side of the fish approximately two rows above the lateral line and on a diagonal row downward from the posterior insertion of the dorsal fin (INPFC 1963). Scales were mounted on gummed cards and impressions were made in cellulose acetate (Clutter and Whitesel 1956). Ages were recorded in European notation[1]. Sex determina-

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[1] European formula: Numerals preceding the decimal refer to the number of freshwater annuli, numerals following the decimal are the number of marine annuli. Total age is the sum of these two numbers plus one.

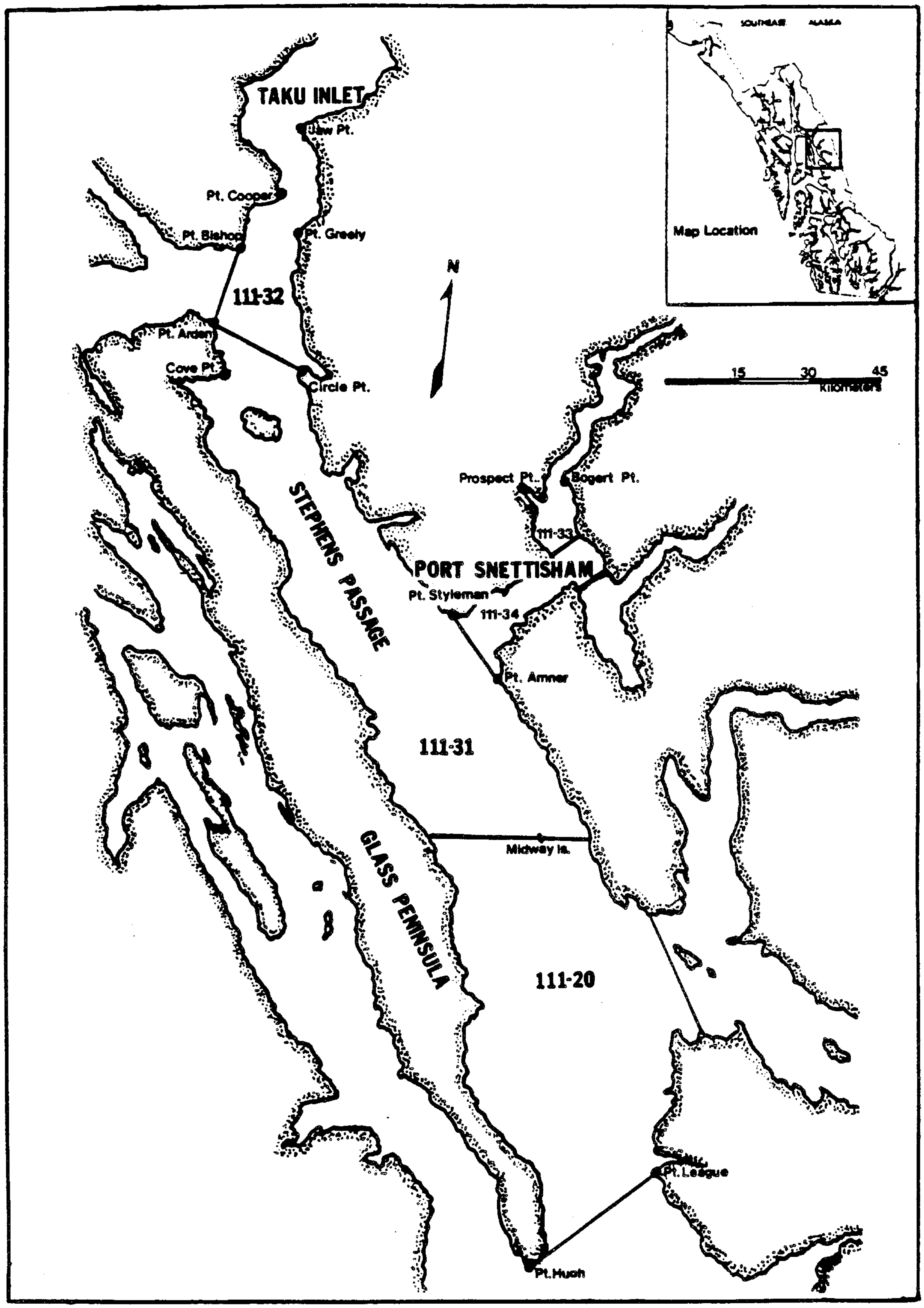

Figure 1. District 111 gillnet fishing area.

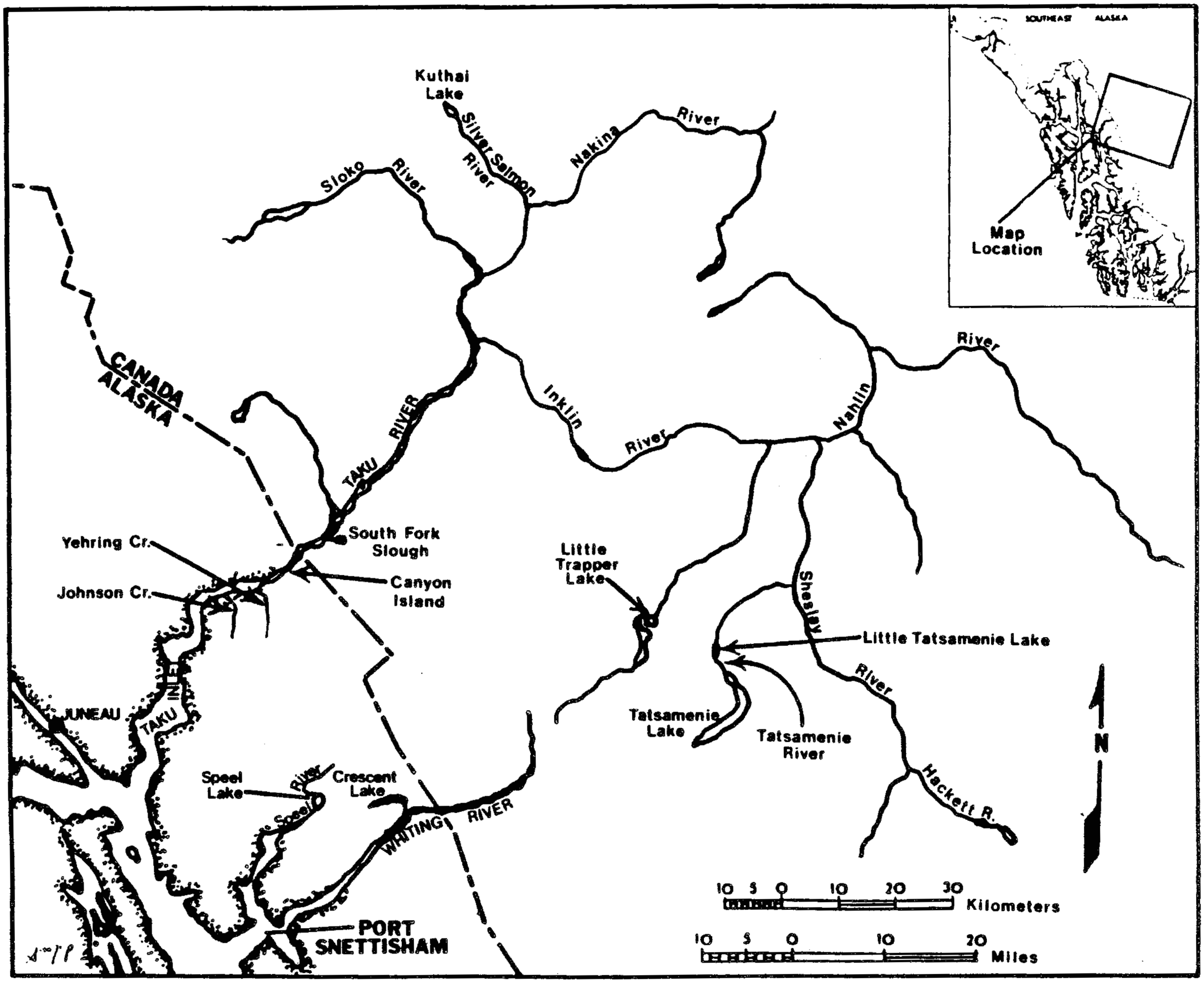

Figure 2. Taku, Speel, and Whiting River drainages.

tion was made by examination of external morphological features or gonads. Detailed age, sex, and size data of catches and escapements are presented in McGregor and McPherson (1986).

Run Identification

Estimates of the contributions of Taku River and Port Snettisham sockeye salmon to the District 111 commercial harvest were made using a combination of linear discriminant function (LDF) analysis (Fisher 1936; Dixon and Brown 1979) of scale patterns and age composition data.

Scale images were magnified to 100 power and projected onto a digitizing tablet using equipment similar to that described by Ryan and Christie (1976). Measurements were taken along a standardized axis approximately perpendicular to the sculptured field in each of four scale zones (Figure 3), and recorded with a microcomputer-controlled digitizing system. I measured the distance between each circuli within each zone and counted the number of circuli. The zones measured were: (1) the scale focus to the last circulus of the first freshwater annulus, (2) the last circulus of the first freshwater annulus to the last circulus of the second freshwater annulus (age 2.3 only), (3) the last circulus of the last freshwater annulus to the last circulus of freshwater growth (plus growth), and (4) the last circulus of freshwater growth to the last circulus of the first ocean annulus. A set of 108 scale variables were calculated from basic incremental distances and circuli counts (Appendix Table 1).

Linear discriminant functions were built using scale pattern data from samples of known origin. Scales used to represent the Taku River run were selected randomly from throughout the entire return and in approximate proportion to their abundance by age class through time in the Canyon Island catches. Scales from each of Crescent and Speel Lakes were chosen in proportion to the relative contribution of each age class to the total Snettisham escapement of that age class. Previous studies demonstrated the inability of scale pattern analysis to adequately separate Port Snettisham stocks from one another (McGregor et al. 1983).

Separate models were developed for age classes 1.2, 1.3, and 2.3. I attempted to use 200 scales per run but fewer scales were available for fish aged 1.2 and 2.3. Models were not constructed for fish aged 0.3 and 2.2, despite their contribution to the District 111 catch (12.3% and 4.6%, respectively), because of a lack of scales from these age classes in the Crescent and Speel Lake escapements.

Stepwise linear discriminant function analysis was used to develop the age class specific classification models. A leaving-one-out procedure was used to estimate the accuracy of each model (Lachenbruch 1967).

Scale samples from the commercial catch were classified using the models and estimated contributions were adjusted for misclassification errors (Cook and Lord 1978). The variances of the adjusted estimates were computed using procedures of Pella and Robertson (1979).

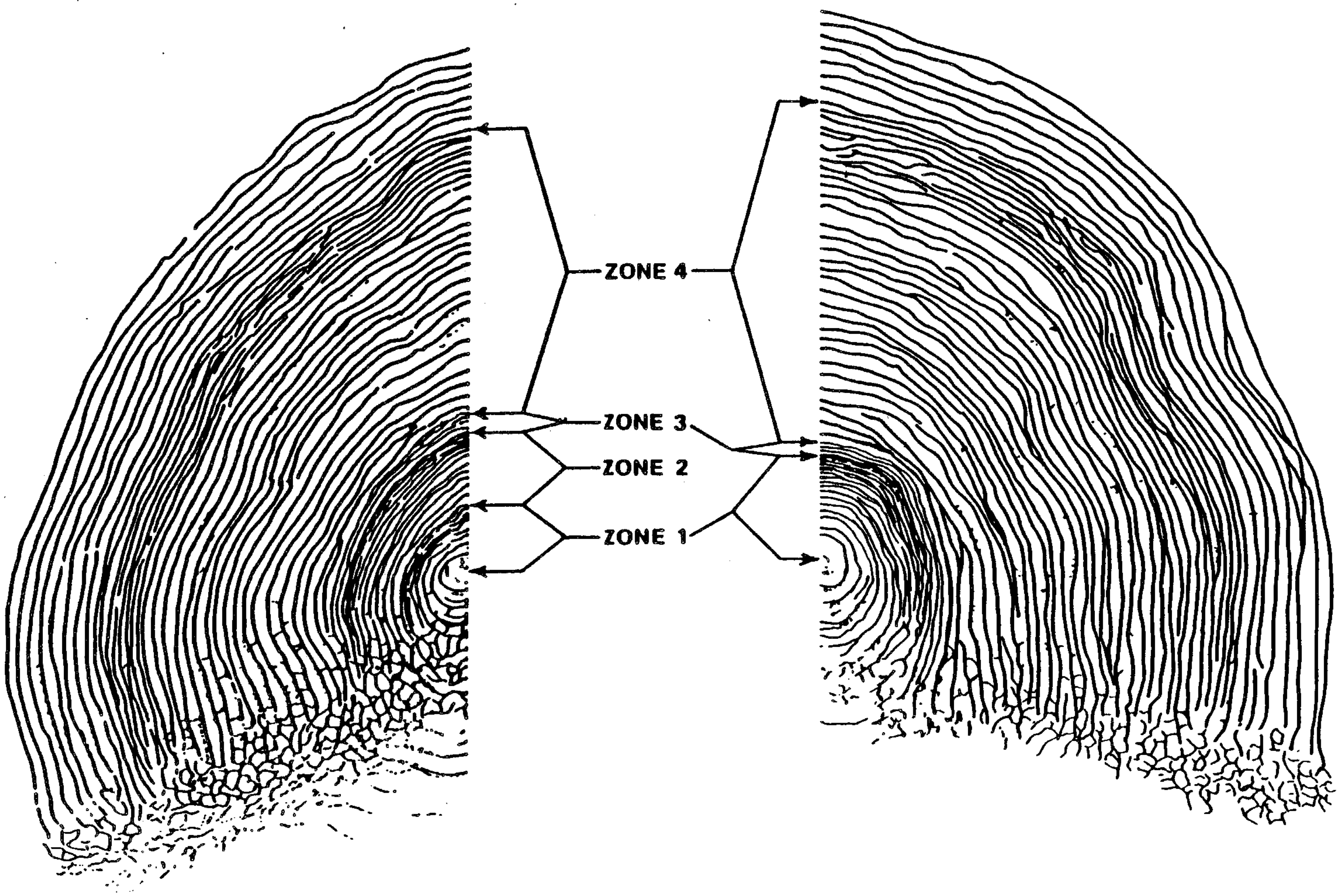

Figure 3. Typical scales for freshwater age 2. and 1. sockeye salmon showing the zones used to measure scale patterns.

A criterion of approximately 100 scales per age class from fish of unknown run composition in the commercial catch were used to denote strata. Because of the limited availability of scales from some age classes in the catch, samples were pooled over fishing periods. Contribution rates were estimated for age 1.3 fish for each of the first eight fishing periods, with the remaining fishing periods pooled into one strata. Two contribution rates were estimated throughout the season for age 1.2 and 2.3 fish. Fish from all 'other' age classes represented 17.5% of the catch. The catch of each of the 'other' age classes were allocated to the Taku and Snettisham runs using the following formula:

$$C_{ij} = T_j * \frac{S_{ij}}{\sum_{1}^{N} S_{ij}}$$

where: C_{ij} = estimated catch of fish aged j returning to run i.

T_j = estimated total catch of fish aged j during the strata.

S_{ij} = estimated number of aged j fish in the escapement of run i.

N = number of runs.

RESULTS

Numbers of Fish

A total of 77,329 sockeye salmon were harvested in the District 111 gillnet fishery in 1984. Fishing began the third week of June and continued through the first week of October, although no sockeye salmon were taken after the third week of September (Table 1). Specific time and area regulatory measures are summarized in Table 1. Almost 77% (59,325 fish) of the catch was taken in Taku Inlet (111-32), while 20% (15,544 fish) was taken in Stephens Passage (111-31 and 111-20). Catches in Port Snettisham (111-33 and 111-34) accounted for only 3% (2,460 fish) of the harvest. Port Snettisham was closed to fishing from 19 July through 18 August to increase sockeye salmon escapements to Crescent and Speel Lakes and to protect Snettisham Hatchery chum salmon brood stock (ADF&G 1985). Catches of between 9,000 and 13,000 fish were made for six consecutive weeks from 24 June through 4 August.

The in-river Canadian fishery harvested a record 27,242 sockeye salmon (Table 2). The maximum number of fishermen in any fishing period was 14. Catches of over 5,000 fish a week were made between 8 and 21 July.

An estimated 106,172 sockeye salmon escaped to spawning grounds in the Taku River drainage (Clark et al. 1986). The escapement to Port Snettisham systems was only 55% (16,571 fish) of that observed in 1983. A total of 9,764 sockeye salmon were counted through the Speel Lake weir, and 6,807 returned through the Crescent Lake weir (McGregor and McPherson 1986). The mean dates of return to Speel and Crescent Lake were 16 August and 8 August, respectively.

Table 1. District 111 fishery openings, effort, and harvest of sockeye salmon by week and subdistrict, 1984.

Statistical Week	Dates	Hours	Subdistrict 20		31		32		33		34		Total Catch
			Boats	Catch	Boats	Catch	Boats	Catch	Boats	Catch	Boats	Catch	
25 [1]	6/17-23	72	- closed	-	5	362	50	2,590					2,952
26 [1]	6/24-30	72	- closed	-	5	510	61	8,963					9,473
27 [2]	7/1-7	72	- closed	-	10	887	76	11,394			1	40	12,321
28 [2,3]	7/8-14	66	- closed	-	18	2,430	62	6,888	4	189	12	797	10,304
29 [2,4]	7/15-21	66			22	2,939	50	6,605	6	381	8	986	10,911
30 [5]	7/22-28	72			23	2,932	54	9,027	- closed	-	- closed	-	11,959
31 [5,6]	7/29-8/4	96	1	140	30	3,030	41	6,261	- closed	-	- closed	-	9,431
32 [5,6]	8/5-11	96	- closed	-	35	1,148	52	3,702	- closed	-	- closed	-	4,850
33 [5]	8/12-18	72	6	157	25	752	46	1,746	- closed	-	- closed	-	2,655
34 [2]	8/19-25	72	- closed	-	15	121	56	1,200			4	7	1,328
35 [2]	8/26-9/1	72	- closed	-	16	131	68	561			16	46	738
36 [2]	9/2-8	48	- closed	-	6	3	70	302			8	11	316
37 [2]	9/9-15	48	- closed	-	1	2	50	81			5	1	84
38 [7]	9/16-22	72	- closed	-	2	0	22	5	8	2			7
Total				297		15,247		59,325		572		1,888	77,329

1 Taku Inlet closed north of the latitude of Jaw Point.
2 Speel Arm closed north of a line from Prospect Point to Bogert Point.
3 Only waters north of a latitude of Point Arden were open for the final 18 hours of fishing.
4 Only waters north of a line from Cove Point to Circle Point were open for the final 18 hours of fishing.
5 Port Snettisham closed inside of a line from Point Styleman to Point Amner.
6 Only waters south of the latitude of Grand Island light were open for the final 24 hours of fishing.
7 Only waters of Speel Arm north of the latitude of Sharp Point were open for the final 24 hours of fishing.

Table 2. Canadian commercial gillnet harvest of sockeye salmon from the Taku River, 1984.

Statistical Week	Dates	Days Fished	Boats	Catch
25	6/17-23	2	5	491
26	6/24-30	2	7	900
27	7/1-7	3	12	1,968
28	7/8-14	3	12	5,458
29	7/15-21	3	12	5,608
30	7/22-28	2	12	3,801
31	7/29-8/4	2	11	2,014
32	8/5-11	2	14	2,665
33	8/12-18	2	12	2,404
34	8/19-25	2	10	1,269
35	8/26-9/1	2	8	59
36	9/2-8	2	6	507
37	9/9-15	1	4	66
38	9/16-22	2	3	32
Total		30	128	27,242

Age Composition

Weekly age composition estimates for the District 111 harvest are summarized in Table 3. Five-year-old fish were most common in the catch throughout the season. Age 1.3 fish were most common (73.0%), followed by age 0.3 (12.3%), age 2.3 (5.1%), age 2.2 (4.6%), and age 1.2 (4.4%). Other age classes comprised the remaining 0.6% of the catch. The proportion of age 1.3 fish decreased throughout the season while the incidence of 0.+ and 2.+ freshwater fish increased during the year. These seasonal trends were similar to trends in the age composition of the 1983 harvest.

Age composition estimates for the Canadian in-river harvest (Table 4) show that age 1.3 fish predominated (65.4%), followed by age 0.3 (15.5%), age 1.2 (6.8%), age 2.2 (6.3%), and age 2.3 (4.8%). The proportion of age 1.3 fish in the catch decreased through the season. Age 0.3 fish increased from 7.6% of the catch in the first sample period to 22.3% in the final sample period. A similar increase was noted during the season for age 2.2 fish, which represented only 0.7% of the catch in the initial period but increased to 13.2% of the harvest in the final period. Seasonal trends in the age compositions of both the Canadian in-river and District 111 catches were remarkably similar in 1983 and 1984 (see McGregor 1985). The sex compositions of both the District 111 and Canadian in-river harvests indicated slightly more females were caught than males.

Significant differences in age composition were apparent within the escapements to Port Snettisham systems (Table 5). Five-year-old sockeye salmon predominated in both Speel (55.9%) and Crescent (82.0%) Lakes. Four-year-old fish were far more common in Speel Lake (43.1%) than in Crescent Lake (13.9%); the reverse was true in 1983. Fish with one freshwater annulus comprised the vast majority (94.3%) of the combined Port Snettisham escapement. Age 1.3 sockeye salmon predominated (65.7%), followed by age 1.2 (28.4%), and small proportions of seven other age classes. The escapement was comprised of similar proportions of males (47.7%) and females (52.3%).

The age compositions of the Taku River and Port Snettisham escapements differed primarily in the incidence of zero freshwater age[1] sockeye salmon. Such age classes were much more common in the Taku River (13.5%) than in the Port Snettisham systems (2.7%; Table 5). Age 1.3 fish (54.3%) and age 1.2 fish (16.9%) represented the majority of the Taku River escapement, as was the case for Port Snettisham. The escapement was comprised of slightly fewer males (43.9%) than females (56.1%).

Spawning stocks within the Taku River drainage exhibited an extreme diversity in age composition, particularly between river and slough spawners and lake spawners (Table 6). Zero freshwater check fish comprised 35% of all ageable scales taken from river and slough spawners, but were absent from fish that spawned in lake systems. Fish with two freshwater annuli were scarce in both

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[1] Zero freshwater age sockeye salmon are fish that did not spend a winter in freshwater after emergence.

Table 3. Percent age composition of the District 111 gillnet catch of sockeye salmon by sample period, 1984.

			Brood Year and Age Class										
			1981		1980		1979			1978		1977	
Statistical Week	Dates	Sample Size	0.2	1.1	0.3	1.2	0.4	1.3	2.2	1.4	2.3	2.4	3.3
25	6/17-23	648			6.9	7.9	0.2	80.3	0.2	0.0+	4.2		
26	6/24-30	659			8.6	4.2		83.7	0.3		3.2		
27	7/1-7	1,126	0.2		8.9	3.6		83.5	0.5	0.4	2.8	0.1	
28	7/8-14	572	0.5		14.5	5.1		76.0	1.0	0.9	1.6	0.2	0.2
29	7/15-21	617			15.4	6.3		73.6	1.9	0.2	2.6		
30	7/22-28	410	0.2		15.4	2.7		66.6	5.9		9.0	0.2	
31	7/29-8/4	472	0.2		15.5	3.8		63.6	9.3	0.1	7.4		
32	8/5-11	534		0.2	7.7	6.1		60.7	15.5	0.4	9.2		0.2
33-38	8/12-9/22	496	0.2		10.3	3.4		59.5	15.9	0.4	10.1		0.2
Total		5,534	0.2	0.0+	12.3	4.4	0.0+	73.0	4.6	0.3	5.1	0.1	0.0+

Table 4. Percent age composition of the Canadian commercial gillnet catch of sockeye salmon on the Taku River by sample period, 1984.

Statistical Week	Dates	Sample Size	Brood Year and Age Class							
			1981	1980		1979			1978	
			0.2	0.3	1.2	0.4	1.3	2.2	1.4	2.3
25-28	6/17-7/14	556		7.6	9.3		79.3	0.7		3.1
29-31	7/15-8/4	479	1.5	17.5	6.9		62.4	6.5	0.2	5.0
32-38	8/5-9/22	516	1.9	22.3	3.3	0.2	52.7	13.2		6.4
Total		1,551	1.1	15.5	6.8	0.0+	65.4	6.3	0.1	4.8

Table 5. Percent age composition of escapements to the Port Snettisham and Taku River drainages, 1984.

			Brood Year and Age Class											
			1982	1981		1980			1979			1978		1977
Drainage	System	Sample Size	0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	1.4	2.3	2.4
Taku	Total Drainage [1]	1,583	0.3	2.3	2.3	10.7	16.9	0.2	0.2	54.3	10.3	0.2	2.3	
Snettisham	Speel Lake	765				1.7	41.4			54.9	1.0		1.0	
	Crescent Lake	1,140		0.1	0.1	4.0	9.9			81.1	0.9	0.4	3.3	0.2
	Total Drainage [2]	1,905		0.0+	0.0+	2.7	28.4			65.7	1.0	0.2	2.0	0.0+

[1] Age composition is derived from the estimated numbers of fish by age class in the escapement by Canyon Island minus the estimated numbers by age class removed in the upstream Canadian fishery.

[2] Age composition is weighted by relative abundances of the two escapements.

Table 6. Percent age composition of escapement collections from river and slough system spawners versus lake system spawners within the Taku River drainage, 1984.

System	Sample Size	Brood Year and Age Class							
		1981		1980		1979		1978	
		0.2	1.1	0.3	1.2	1.3	2.2	1.4	2.3
River and Slough System Spawners									
mainstem river sloughs	150	2.7		44.6	4.0	48.7			
Yehring Creek	102	2.9	9.8	10.8	23.5	51.0	2.0		
Nakina River	13		7.7	7.7	7.7	76.9			
Tatsamenie River	124	19.4		21.0	41.9	16.1	0.8		0.8
total (river and sloughs)	389	8.0	2.8	27.0	21.3	39.8	0.8		0.3
Lake System Spawners									
Tatsamenie Lake	59		1.7		8.5	72.8	10.2		6.8
Kuthai Lake	242				50.8	47.5			1.7
Little Trapper Lake	1,323				5.1	91.3	2.5	0.2	0.9
total (lakes)	1,624		0.0+		12.1	84.1	2.4	0.1	1.3

groups, but were more common among lake system spawners (3.7%) than river and slough spawners (1.1%). Fish that had one freshwater annulus were most common in all collections, however.

Model Performance

Summary statistics for basic measurements of scale growth for the 1.2, 1.3, and 2.3 age classes are presented in Table 7. Scale growth trends were similar for all three age classes. Taku River fish typically exhibit greater freshwater growth and less growth in their first marine year than do Port Snettisham sockeye salmon. The variability in scale patterns within the Taku River run was greater than for the returns to Port Snettisham. Summary statistics of scale measurements from the 1984 escapement samples were very similar to measurements from escapement samples taken in 1983 (McGregor 1985).

Mean classification accuracies (Table 8) for the age 1.3 and 2.3 models were 93.7% and 93.0%, respectively. Lower accuracy (81.5%) was obtained with the age 1.2 model. These high accuracies are indicative of the fact that differences in scale growth patterns between the Taku River and Port Snettisham sockeye salmon runs are much greater than differences within each group.

Catch Apportionment and Run Reconstruction

Age class specific run composition estimates were generated for each time period strata (Table 9). Run composition estimates varied throughout the season for all three age classes, but generally revealed much higher contribution rates of Taku River fish than of Port Snettisham fish.

Approximately three-quarters (75.8%) of the 1984 harvest of sockeye salmon in District 111 was allocated to the Taku River (Table 10). The weekly catches for each run are shown in Figure 4. Taku River fish comprised the majority of the catch in each fishing period. The catch of Taku River fish peaked during the week of 1-7 July (statistical week 27), when an estimated 10,389 fish destined for this drainage were harvested. A smaller peak (8,514 fish) of Taku River catches occurred three weeks later (22-28 July). Catches of Snettisham fish peaked during the week of 15-21 July (statistical week 29), when an estimated 4,495 fish destined for these systems were taken.

The percent contribution of the Taku River run decreased in catches from the initial fishing period in mid-June through the fifth period in mid-July (Figure 5). Concurrently, trends in CPUE indicate that Taku River fish were available in moderate to high relative abundance during the early season fishing periods. A second peak in the CPUE of the Taku River run occurred during the period 22-28 July (statistical week 30). The CPUE of the Taku River run progressively declined during the last three fishing periods and reached a minimum value during the last period. Taku stocks comprised a greater fraction of catches during the last four fishing periods of the season than they did during mid-July. The contribution of the Port Snettisham run was highest in mid-season. A plot of the CPUE of the Port Snettisham run resembled a normal distribution with a mean in mid-July.

The total estimated return (Table 11) of the Port Snettisham run was 35,247 fish, of which an estimated 18,676 fish (53.0%) were harvested in the District

Table 7. Group means ($\bar{x}$) and standard error (s.e.) of basic scale variables by age class (scale with measurements in 0.01's of inches at 100X).

Age	Variable Number	Description[1]	Taku $\bar{x}$	Taku s.e.	Snettisham $\bar{x}$	Snettisham s.e.
1.2	1	Number circuli first FW zone	11.7	0.2	8.0	0.1
	2	Width first FW zone	119.7	2.4	81.5	1.5
	61	Number circuli FW plus growth zone	1.7	0.1	2.1	0.1
	62	Width FW plus growth zone	15.3	0.8	18.4	0.7
	70	Number circuli first marine zone	28.1	0.3	29.2	0.2
	71	Width first marine zone	388.7	3.8	414.2	3.2
1.3	1	Number circuli first FW zone	12.1	0.2	7.1	0.1
	2	Width first FW zone	129.4	2.4	74.6	1.0
	61	Number circuli FW plus growth zone	2.1	0.1	2.4	0.1
	62	Width FW plus growth zone	20.7	0.8	23.1	0.8
	70	Number circuli first marine zone	29.1	0.2	31.2	0.2
	71	Width first marine zone	396.2	3.2	435.9	3.2
2.3	1	Number circuli first FW zone	7.5	0.2	5.4	0.1
	2	Width first FW zone	86.8	2.3	59.1	1.4
	31	Number circuli second FW zone	12.0	0.4	6.5	0.2
	32	Width second FW zone	111.9	3.9	51.5	1.5
	61	Number circuli FW plus growth zone	1.2	0.1	1.3	0.1
	62	Width FW plus growth zone	13.7	0.9	12.3	0.8
	70	Number circuli first marine zone	26.2	0.5	28.7	0.4
	71	Width first marine zone	346.4	7.1	415.3	6.0

[1] FW = freshwater.

Table 8. Classification accuracies for the linear discriminant models used to classify fish aged 1.2, 1.3, and 2.3 in 1984.

<u>Age 1.2</u>
Variables used (14,65)

Actual Group of Origin	Sample Size	Classified Group of Origin: Taku	Classified Group of Origin: Snettisham
Taku	143	74.1	25.9
Snettisham	163	11.0	89.0

Mean Percentage Correctly Classified = 81.5

<u>Age 1.3</u>
Variables used (17,26,7,83,30,1,2)

Actual Group of Origin	Sample Size	Classified Group of Origin: Taku	Classified Group of Origin: Snettisham
Taku	200	93.5	6.5
Snettisham	198	6.1	93.9

Mean Percentage Correctly Classified = 93.7

<u>Age 2.3</u>
Variables used (66)

Actual Group of Origin	Sample Size	Classified Group of Origin: Taku	Classified Group of Origin: Snettisham
Taku	50	86.0	14.0
Snettisham	42	0.0	100.0

Mean Percentage Correctly Classified = 93.0

Table 9. Age class specific run composition estimates and 90% confidence intervals calculated from scale pattern analysis of age 1.2, 1.3, and 2.3 sockeye salmon in the District 111 commercial gillnet fishery by period, 1984.

Age Class	Dates	Statistical Week	Sample Size	Taku	Snettisham
1.2	6/17-7/7	25-27	98	.893±.150	.107±.150
	7/8-9/22	28-38	100	.444±.139	.556±.139
1.3	6/17-6/23	25	100	.994±.058	.006±.058
	6/24-6/30	26	99	.970±.063	.030±.063
	7/1-7/7	27	100	.834±.081	.166±.081
	7/8-7/14	28	100	.605±.096	.395±.096
	7/15-7/21	29	99	.508±.097	.492±.097
	7/22-7/28	30	100	.651±.094	.349±.094
	7/29-8/4	31	100	.617±.095	.383±.095
	8/5-8/11	32	99	.751±.089	.249±.089
	8/12-9/22	33-38	100	.582±.096	.418±.096
2.3	6/17-7/28	25-30	100	.641±.117	.359±.117
	7/29-9/22	31-38	100	1.012±.130	-.012±.130

Table 10. Estimated contribution of sockeye salmon (in numbers of fish) originating from the Taku River and Port Snettisham drainages to the District 111 gillnet fishery, 1984.

			Catch By Age Class					90% C.I.		
Dates	Statistical Week	Group	1.2	1.3	2.3	Other	Total	Lower	Upper	Percent
6/17-23	25	Taku	207	2359	79	217	2862	2621	3102	97.0
		Snettisham	25	14	44	7	90	-150	330	3.0
		Total	232	2373	123	224	2952			
6/24-30	26	Taku	359	7683	194	822	9058	8211	9905	95.6
		Snettisham	43	238	108	26	415	-432	1262	4.4
		Total	402	7921	302	848	9473			
7/1-7	27	Taku	391	8578	224	1196	10389	9004	11774	84.3
		Snettisham	47	1707	126	52	1932	547	3317	15.7
		Total	438	10285	350	1248	12321			
7/8-14	28	Taku	232	4858	104	1707	6901	5648	8154	67.0
		Snettisham	290	2978	58	77	3403	2150	4656	33.0
		Total	522	7836	162	1784	10304			
7/15-21	29	Taku	306	4079	181	1850	6416	5116	7716	58.8
		Snettisham	384	3950	101	60	4495	3195	5795	41.2
		Total	690	8029	282	1910	10911			
7/22-28	30	Taku	143	5184	692	2495	8514	7236	9792	71.2
		Snettisham	178	2779	387	101	3445	2167	4723	28.8
		Total	321	7963	1079	2596	11959			
7/29-8/4	31	Taku	160	3698	700	2312	6870	5893	7847	72.8
		Snettisham	200	2296	0	65	2561	1584	3538	27.2
		Total	360	5994	700	2377	9431			
8/5-11	32	Taku	133	2210	445	1134	3922	3460	4384	80.9
		Snettisham	167	733	0	28	928	466	1390	19.1
		Total	300	2943	445	1162	4850			
8/12-9/22	33-38	Taku	78	1775	517	1351	3721	3211	4231	72.6
		Snettisham	98	1275	0	34	1407	897	1917	27.4
		Total	176	3050	517	1385	5128			
Total		Taku	2009	40424	3136	13084	58653	55568	61738	75.8
		Snettisham	1432	15970	824	450	18676	15591	21761	24.2
		Total	3441	56394	3960	13534	77329			

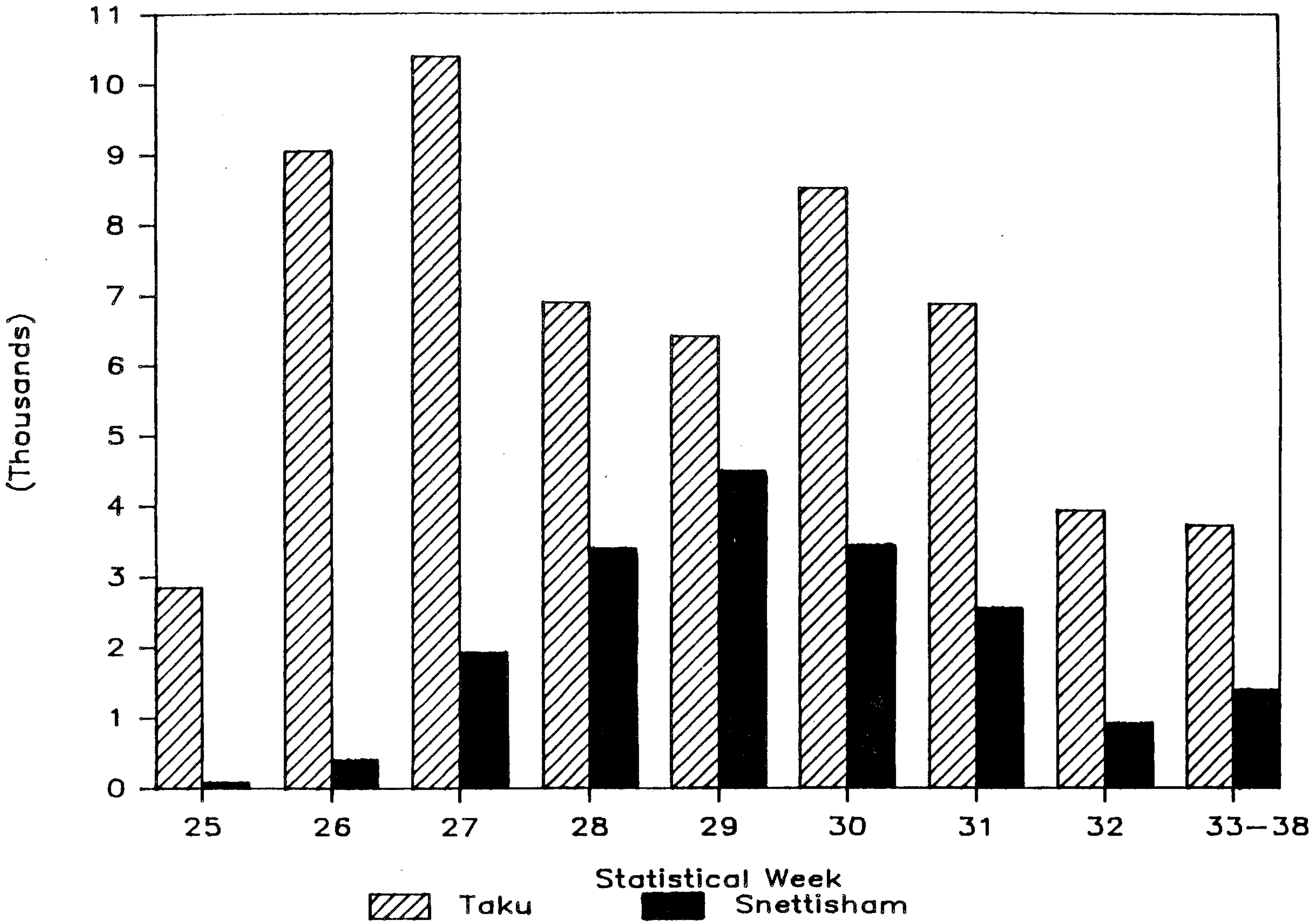

Figure 4. Harvest in numbers of fish by run in the District 111 gillnet fishery, 1984.

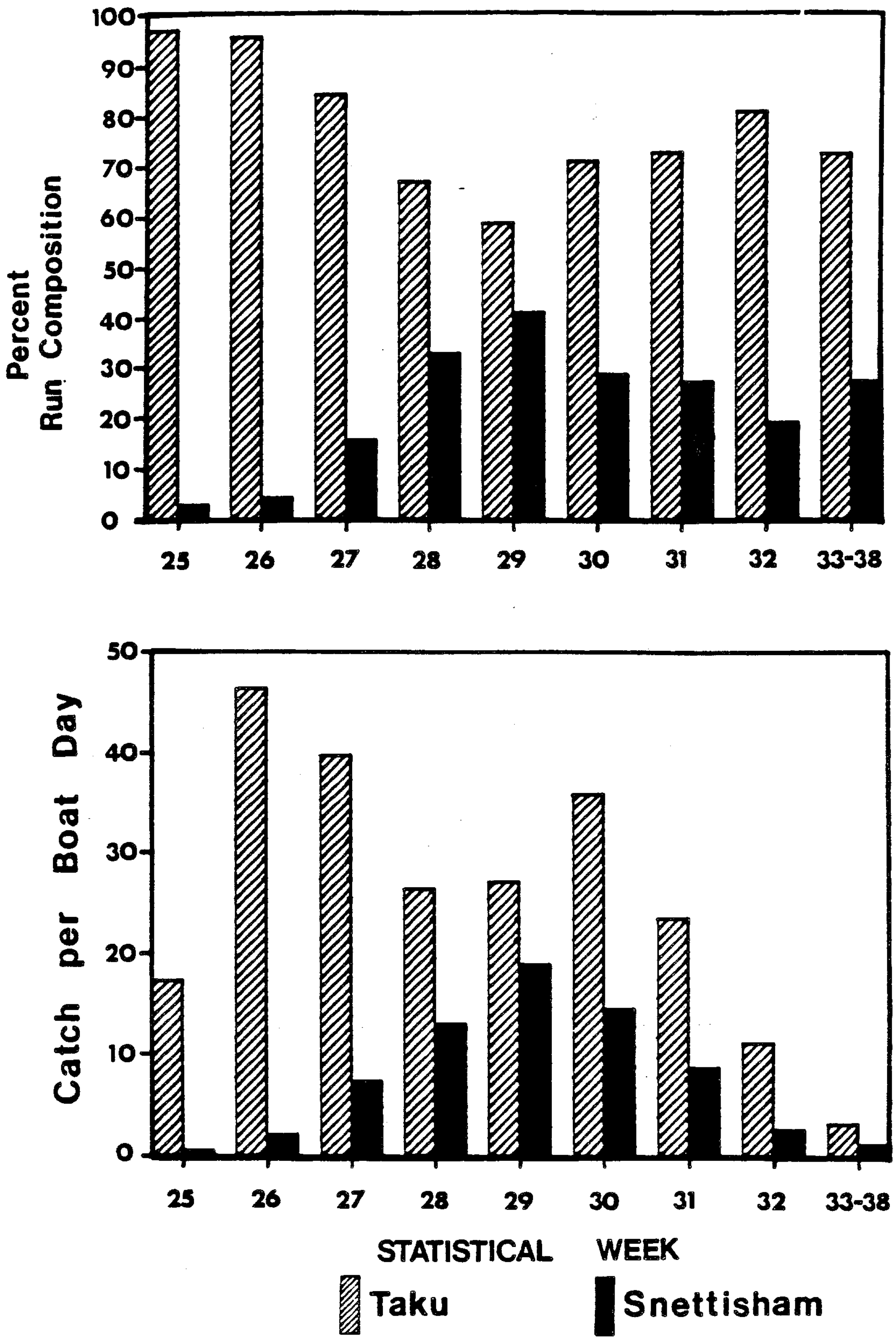

Figure 5. Percent run composition and CPUE by run in the District 111 gill-net fishery, 1984.

Table 11. Run reconstruction statistics for the 1984 Taku River and Port Snettisham sockeye salmon returns.

	Brood Year and Age Class													
	1982	1981		1980			1979			1978		1977		
System	0.1	0.2	1.1	0.3	1.2	2.1	0.4	1.3	2.2	1.4	2.3	2.4	3.3	Total
Taku River														
Harvest														
District 111		135	9	9184	2009		5	40424	3509	206	3136		36	58653
In-River		303	0	4230	1840		14	17815	1726	24	1290			27242
Total		438	9	13414	3849		19	58239	5235	230	4426		36	85895
Escapement	277	2474	2470	11351	17994	174	161	57627	10990	221	2433			106172
Total Return	277	2912	2479	24765	21643	174	180	115866	16225	451	6859		36	192067
Snettisham														
Harvest				305	1432			15970	65	21	824	58	1	18676
Escapement		6	6	443	4707			10881	164	25	327	12		16571
Total Return		6	6	748	6139			26851	229	46	1151	70	1	35247

111 gillnet fishery. Exploitation rates varied dramatically by age class, and were much higher for fish of older ocean age (and larger body size). Exploitation rates of age 1.2, 1.3, and 2.3 fish were 23.3%, 59.5%, and 71.6%, respectively. The total estimated return of the Taku River run was 192,067 fish, of which an estimated 58,653 (30.5%) were harvested in the District 111 gillnet fishery. The in-river Canadian fishery harvested 20.4% (27,242) of the 133,414 fish that were estimated to have passed Canyon Island. The District 111 and in-river fisheries combined harvested an estimated 44.7% of the Taku River return; 17.6% of age 1.2, 50.3% of age 1.3, and 64.5% of age 2.2 returns.

DISCUSSION

Results of scale pattern analysis of District 111 gillnet catches in 1983 and 1984 have revealed some salient trends in the run composition of harvests in this fishery. The timing of the Taku River run of sockeye salmon is more protracted than the Port Snettisham run; the Taku run begins earlier (a significant portion of the run may in fact pass through the fishing district prior to the start of the fishing season) and continues longer than the Port Snettisham run. During June and early July determination of harvestable surplus can be based principally on the strength of the Taku River run. Since Port Snettisham stocks are most available from mid- to late July, this time window is available to regulate the fishery in response to run strength of Speel and Crescent Lake stocks. The closure of Port Snettisham to fishing from mid-July to mid-August (implemented by ADF&G in recent years) appears well timed to allow increased passage of fish into Speel and Crescent Lakes. During August an important fraction of the Taku run is still available in the fishery and regulations ought to focus once again on this run. Other opportunities to selectively harvest or protect these runs may exist. Future sampling programs should be stratified by location within the fishery to identify principal interception areas for each run.

Exploitation rate estimates for the Port Snettisham run varied dramatically between 1983 (20.6%) and 1984 (53.0%). Several factors, including age composition of the returns and fishing effort patterns, could be responsible for this difference. Fishing effort was much greater in 1984 than in 1983. The number of hours open for fishing in 1984 was 71% higher and more boats fished during every week of the sockeye salmon season than in 1983. The estimated age composition of the 1983 return of Port Snettisham fish differed significantly from the 1984 return. In 1983 4-year-old (predominantly 2-ocean) fish comprised 42% of the return, but in 1984 they represented only 20% of the return. Because of their smaller size, 2-ocean fish are exploited at lower rates than 3-ocean fish in gillnet fisheries.

Differences in scale patterns between Taku and Snettisham fish were similar in 1983 and 1984. This consistency in scale patterns suggests that historical models (based on previous years' data) may be used for in-season estimation of interception rates of Taku and Snettisham runs. Biologists from the Canadian Department of Fisheries and Oceans have recently found that the prevalence of a particular brain parasite, *Myxobolus neurobius*, varies between fish of Taku and Snettisham origin (Transboundary Technical Committee 1986). Incorporation of brain parasite incidence with scale pattern data may allow us to improve the accuracy and precision of stock composition estimates in future years.

Numerous spawning populations of sockeye salmon have been identified within the Taku River drainage. Radio tagging and mark recapture studies (Transboundary Technical Committee 1986; Clark et al 1986) indicate that differences in run timing exist among stocks. We found that age composition varied through time in the lower river fishery (McGregor et al 1984; McGregor and McPherson 1986). In addition, fish aged 1.3 from two stocks studied (Kuthai and Little Trapper Lakes) have distinct scale patterns (McGregor 1983). Optimization of Taku River sockeye salmon production requires that catches and escapements be appropriately distributed among component stocks. To estimate production from each stock (or group of stocks) and regulate the fisheries to achieve appropriate harvest distribution requires that we estimate the contribution by stock through time. Research incorporating appropriate data sets, including scale pattern measurements, brain parasite incidence, and run timing, is needed to determine the degree of resolution obtainable among stocks within the Taku River drainage.

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APPENDICES

Appendix Table 1. Scale pattern variables considered for possible inclusion in linear discriminant function analysis classification models for sockeye salmon aged 1.2, 1.3, and 2.3.

Variable No.	Description
	First Freshwater (FW) Annular Zone
1	Number of circuli in the zone
2	Distance across the zone
3	Distance: scale focus (CO) to the second circulus in zone (C2)
4	Distance: CO to C4
5	Distance: CO to C6
6	Distance: CO to C8
7	Distance: C2 to C4
8	Distance: C2 to C6
9	Distance: C2 to C8
10	Distance: C4 to C6
11	Distance: C4 to C8
12	Distance: fourth from the last circulus of zone to end of zone
13	Distance: second from the last circulus of zone to end of zone
14	Distance: C2 to end of zone
15	Distance: C4 to end of zone
16	Relative Distance: (Variable #3)/(Variable #2)
17	Relative Distance: (Variable #4)/(Variable #2)
18	Relative Distance: (Variable #5)/(Variable #2)
19	Relative Distance: (Variable #6)/(Variable #2)
20	Relative Distance: (Variable #7)/(Variable #2)
21	Relative Distance: (Variable #8)/(Variable #2)
22	Relative Distance: (Variable #9)/(Variable #2)
23	Relative Distance: (Variable #10)/(Variable #2)
24	Relative Distance: (Variable #11)/(Variable #2)
25	Relative Distance: (Variable #12)/(Variable #2)
26	Relative Distance: (Variable #13)/(Variable #2)
27	Average distance between circuli: (Variable #1/Variable #2)
28	Number of circuli in the first 3/4 of the zone
29	Maximum distance between two adjacent circuli in the zone
30	Relative Distance: (Variable #29)/(Variable #2)
	Second Freshwater Annular Zone
31	Number of circuli in the zone
32	Distance across the zone
33	Distance: last circulus of first FW zone (CO) to second circulus of this zone (C2)
34	Distance: CO to C4
35	Distance: CO to C6
36	Distance: CO to C8
37	Distance: C2 to C4
38	Distance: C2 to C6
39	Distance: C2 to C8
40	Distance: C4 to C6
41	Distance: C4 to C8
42	Distance: fourth from last circulus of zone to end of zone
43	Distance: second from last circulus of zone to end of zone
44	Distance: C2 to end of zone
45	Distance: C4 to end of zone
46	Relative Distance: (Variable #33)/(Variable #32)
47	Relative Distance: (Variable #34)/(Variable #32)

-Continued-

Appendix Table 1. Scale pattern variables considered for possible inclusion in linear discriminant function analysis classification models for sockeye salmon aged 1.2, 1.3, and 2.3 (continued).

Variable No.	Description
48	Relative Distance: (Variable #35)/(Variable #32)
49	Relative Distance: (Variable #36)/(Variable #32)
50	Relative Distance: (Variable #37)/(Variable #32)
51	Relative Distance: (Variable #38)/(Variable #32)
52	Relative Distance: (Variable #39)/(Variable #32)
53	Relative Distance: (Variable #40)/(Variable #32)
54	Relative Distance: (Variable #41)/(Variable #32)
55	Relative Distance: (Variable #42)/(Variable #32)
56	Relative Distance: (Variable #43)/(Variable #32)
57	Average distance between circuli: (Variable #31/(Variable #32)
58	Number of circuli in the first 3/4 of the zone
59	Maximum Distance between two adjacent circuli in the zone
60	Relative Distance: (Variable #59/(Variable #32)
	<u>Freshwater Plus Growth (PG)</u>
61	Number of circuli in the zone
62	Distance across the zone
	<u>Combined Freshwater Zones</u>
63	Total number of circuli in the first two zones (Variable #1 + #31)
64	Total distance across the first two zones (Variable #2 + #32)
65	Total number of circuli of freshwater growth (Variable #1 + #31 + #61)
66	Total distance across the freshwater growth zone (Variable #2 + #32 + #62)
67	Relative Distance: (Variable #2)/(Variable #66)
68	Relative Distance: (Variable #62)/(Variable #66)
69	Relative Distance: (Variable #32)/(Variable #66)
	<u>First Marine Annular Zone</u>
70	Number of circuli in the zone
71	Distance across the zone
72	Distance: end of FW (EFW) to the third circulus in zone (C3)
73	Distance: EFW to C6
74	Distance: EFW to C9
75	Distance: EFW to C12
76	Distance: EFW to C15
77	Distance: C3 to C6
78	Distance: C3 to C9
79	Distance: C3 to C12
80	Distance: C3 to C15
81	Distance: C6 to C9
82	Distance: C6 to C12
83	Distance: C6 to C15
84	Distance: C9 to C15
85	Distance: sixth from the last circulus of zone to end of zone
86	Distance: third from the last circulus of zone to end of zone
87	Distance: C3 to end of zone
88	Distance: C9 to end of zone
89	Distance: C15 to end of zone
90	Relative Distance: (Variable #72)/(Variable #71)

-Continued-

Appendix Table 1. Scale pattern variables considered for possible inclusion in linear discriminant function analysis classification models for sockeye salmon aged 1.2, 1.3, and 2.3 (continued).

Variable No.	Description
91	Relative Distance: (Variable #73)/(Variable #71)
92	Relative Distance: (Variable #74)/(Variable #71)
93	Relative Distance: (Variable #75)/(Variable #71)
94	Relative Distance: (Variable #76)/(Variable #71)
95	Relative Distance: (Variable #77)/(Variable #71)
96	Relative Distance: (Variable #78)/(Variable #71)
97	Relative Distance: (Variable #79)/(Variable #71)
98	Relative Distance: (Variable #80)/(Variable #71)
99	Relative Distance: (Variable #81)/(Variable #71)
100	Relative Distance: (Variable #82)/(Variable #71)
101	Relative Distance: (Variable #83)/(Variable #71)
102	Relative Distance: (Variable #84)/(Variable #71)
103	Relative Distance: (Variable #85)/(Variable #71)
104	Relative Distance: (Variable #86)/(Variable #71)
105	Average distance between circuli: (Variable #71/Variable #70)
106	Number of circuli in the first 1/2 of the zone
107	Maximum distance between two adjacent circuli in the zone
108	Relative Distance: (Variable #107)/(Variable #71)