REARING OF CHINOOK SALMON IN TRIBUTARIES OF THE SOUTH FORK SALMON RIVER, IDAHO

William S. Platts
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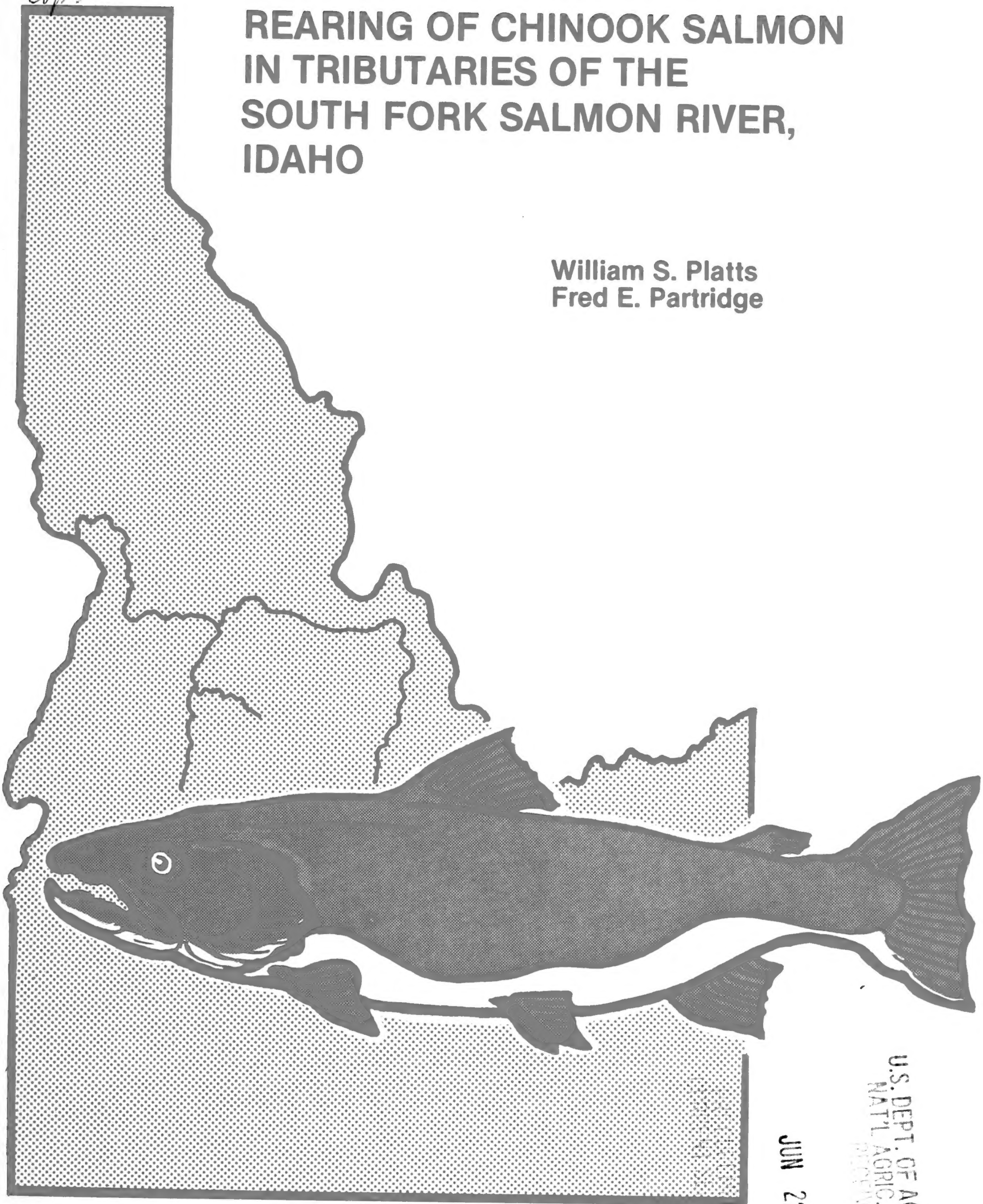

USDA Forest Service Research Paper INT-205
INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
FOREST SERVICE, U.S. DEPARTMENT OF AGRICULTURE

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USDA Forest Service
Research Paper INT-205
May 1978

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INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION
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RESEARCH SUMMARY

Fish populations in 23 tributaries of the South Fork Salmon River were sampled in 1971, 1972, and 1974. Juvenile chinook salmon were found in one secondary and 11 primary tributaries. The first 400 m reach of stream adjacent to the river was the most important area for rearing and supported 58 percent of the total tributary chinook salmon population. Only three tributaries had chinook salmon more than 1.6 km from the river. The tributary chinook salmon standing crop ranged from 0.01 to $0.38/m^2$ and averaged $0.06/m^2$ for all streams.

Chinook salmon were rearing with rainbow trout and sculpin over most of their tributary range and occasionally with brook trout, Dolly Varden, mountain whitefish, mountain suckers, and dace. Cutthroat trout and chinook salmon were not found together. Chinook salmon preferred the larger, lower gradient, grassy-banked streams having deep pools. Chinook salmon were found in the fluvial and depositional landtype associations but mainly in the alluvial and alluvial fan landtypes.

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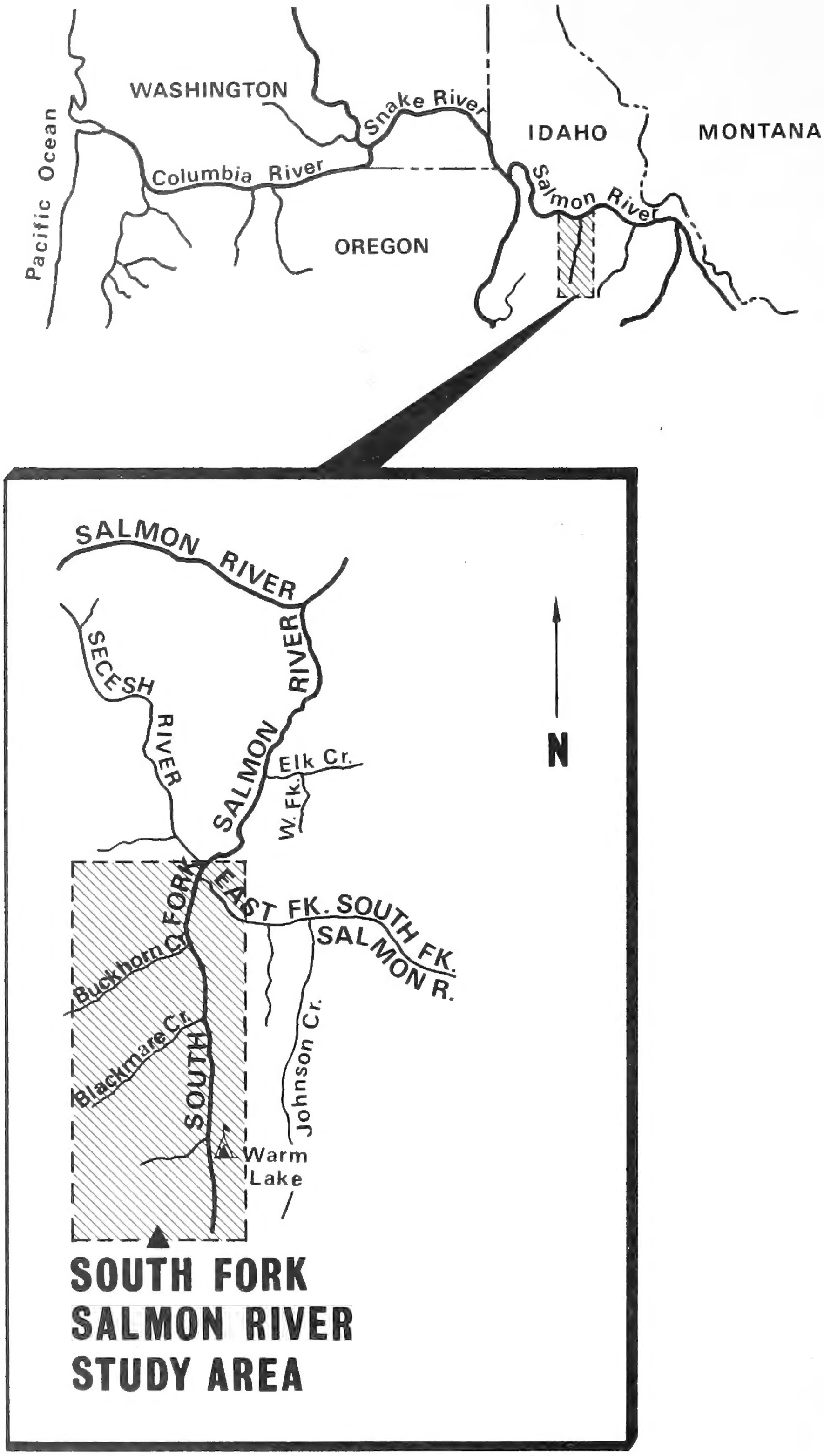

Figure 1.--A portion of the Columbia River drainage, showing the South Fork Salmon River and study area.

SALMON POPULATIONS IN THE SOUTH FORK DRAINAGE

Adult chinook salmon, *Oncorhynchus tshawytscha* (Walbaum),[1] and steelhead trout, *Salmo gairdneri* Richardson, returning from the ocean to the South Fork Salmon River (SFSR) have steadily declined in numbers since 1957. This decline resulted in sport fishing closures on both species. Summer chinook salmon are approaching the status of a "threatened species" in the Salmon River drainage. There is no evidence that their populations have stabilized or that the downward trend will not continue. Decline of salmon populations in the Salmon River Drainage has been caused mainly by impoundments in the lower Snake and Columbia Rivers. In the South Fork of the Salmon River, erosion triggered by past logging has probably contributed to the decline by silting and filling in sections of the streambed. If degraded habitat is to improve, land managers must be able to identify streams critical to summer chinook salmon survival.

Adult summer chinook salmon runs into the SFSR are monitored by the Idaho Fish and Game Department by conducting annual salmon redd counts. However, there is little knowledge of the status and needs of the juvenile stage of the summer chinook salmon's life cycle in the SFSR drainage. In the past it has been assumed that the rearing of salmon juveniles was almost entirely in the main SFSR. This report evaluates the use and importance of small tributaries for rearing summer chinook salmon.

SURVEY OF SOUTH FORK TRIBUTARIES

Study Sites and Methods

The SFSR is a major tributary of the Salmon River, draining a 1,270 mi^2 (3,290 km^2) watershed representative of much of the forested mountainous terrain found in central Idaho (fig. 1). The study area includes 397 mi^2 (1,028 km^2) of watershed along the upper 52 miles (84 km) of the river. The study area topography ranges in elevation from 9,000 feet (2,740 m) around the headwaters, to 3,700 feet (1,130 m) at the river's confluence with the East Fork-South Fork Salmon River. Most slopes are steeper than 40 percent and slopes more than 65 percent are common. Waters draining from the watershed are low in mineral content (averaging 60 mg/liter total dissolved solids) because of the dominant granitic bedrock in the watershed (Platts 1974).

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[1] Scientific names according to the American Fisheries Society (1970) list of common and scientific names of fishes.

The SFSR historically contained Idaho's largest salmon run, which is composed entirely of summer chinook salmon. This race has been reduced from more than 5,000 returning adults in the mid-1950's to about 700 returning adults in 1977. Almost all of the SFSR chinook salmon spawn in the river and a few spawn in the tributaries. Some juvenile chinook salmon hatched in the SFSR probably migrate into the tributaries to rear. Fish populations in the study tributaries are dominated by rainbow trout, *Salmo gairdneri* Richardson, followed by chinook salmon, Dolly Varden, *Salvelinus malma* (Walbaum), brook trout, *Salvelinus fontinalis* (Mitchell), sculpin, *Cottus* spp., cutthroat trout, *Salmo clarki* Richardson, mountain whitefish, *Prosopium williamsoni* (Girard), dace, *Rhinichthys* spp., and sucker, *Catostomus* spp.

The 23 tributaries, accounting for about 80 stream miles (130 stream km) were described for fish population structure by using an average of one 50-foot (15.2 m) study plot for every 465 yd (425 m) of stream. All streams were sampled randomly from mouth to headwaters until the stream became dry. Each study plot was selected with a table of random numbers, marked on aerial photographs (1-15,000), and then located on the ground. The plots were located 100 feet (30.5 m) upstream from the photographic location to avoid any bias resulting from the method of locating study plots.

Stream Environment

The aquatic survey used methods outlined by Herrington and Dunham (1967), with modifications (Platts 1974) to increase the validity in variable estimates and to quantify additional physical conditions. The methods satisfactorily quantified most of the variables, because water depths rarely exceeded 48 inches (122 cm) and water velocities were never excessive for wading. The clear water with low flows (July-November) offered excellent conditions for observational measurement.

A transect (channel cross section) was used to identify the stream reach where the aquatic structural analysis and fish population data would be taken. (A transect is an imaginary line running perpendicular to the centerline of the stream.) Each station included a cluster of five transects at 50-foot (15.2-m) intervals. The following measurements and conditions were recorded:

1. Stream, pool, and riffle widths.
2. Stream depths at equal intervals across the stream.
3. Ratings, locations, and features of pools.
4. Streambed material.
5. Cover, conditions, and types of streambanks.
6. Channel elevations and gradients.
7. Landtype association and landtypes.
8. Stream order.
9. Fish species and numbers.

A given transect crossing the stream channel was divided into 1-foot (0.3-m) intervals, and the dominant streambed material was classified as follows:

Particle Diameter	*Classification*
12 inches or over (304.8 mm or over)	Boulder
3 to 11.99 inches (76.1 to 304.7 mm)	Rubble
0.185 to 2.99 inches (4.7 to 76.0 mm)	Gravel
0.184 inch and less (less than 4.7 mm)	Fine sediment

Stream areas were stratified as either pool or riffle. The pools then were classified as to suitability as fish environment as follows:

Description	*Rating*
Maximum pool diameter exceeds average stream width. Pool is more than 3 feet (0.92 m) in depth, or more than 2 feet (0.6 m) deep with abundant fish cover.	5
Maximum pool diameter exceeds average stream width. Pool is less than 2 feet in depth, or if between 2 and 3 feet, lacks fish cover.	4
Maximum pool diameter is less than the average stream width. Pool is more than 2 feet in depth, with intermediate to abundant cover.	3
Maximum pool diameter is less than the average stream width. Pool is less than 2 feet in depth and has intermediate to abundant cover.	2
Maximum pool diameter is less than the average stream width. Pool is less than 2 feet in depth and is without cover.	1

Streambank type and condition were rated using the total streamside area between each transect, in accordance with the following tabulation. (Streamside type indicates habitat type where the transect met the bank.)

Vegetation		*Stability*		*Habitat Type*	
Forested	2.0	Excellent	2.0	Sod, root, log	2.0
Brush	1.5	Good	1.5	Brush, rubble	1.5
Grass	1.0	Fair	1.0	Grass, gravel	1.0
Exposed	0.5	Poor	0.5	Fines, road fill	0.5

Station and transect channel elevations were read with an altimeter; elevations were accurate to ±40 feet (12 m).

At each transect channel gradients were recorded with a clinometer, then averaged over each 200-foot (61-m) study section.

Stream width refers to surface water widths measured perpendicular to the flow. Station depths were averaged from four equidistant measurements.

Stream order was determined by methods originally developed by Horton (1945) and later modified by Strahler (1952, 1957); when two channel segments of order N join they then form a channel of order N+1.

Fish Collection Methods

The low concentration of total dissolved solids (60 mg/liter) in stream waters meant that more reliable fish population samples could be obtained with explosives than by using electrical fish collecting equipment. A total of 2.75 miles (4.42 km) of stream were sampled at 291 stations, using 4 miles (6.4 km) of explosive prima cord.

A 0.13- to 0.23-inch (0.33- to 0.58-cm) mesh net was stretched across the stream to block fish from moving out of the sampling area prior to the explosion. The net and the effectiveness of prima cord assured an unbiased collection of close to 100 percent of the fish population within each sample area. All collected fish were identified and total length measured.

Fish in lower Lodgepole and Curtis Creeks were also collected with a Smith-Root type V electrofisher in 1974. The stream was stratified into 26-foot (7.9-m) sample sections. A net was used to block the downstream end of each study plot so fish could not escape downstream. Each reach was electrofished upstream and then back downstream.

The upstream and downstream collections were kept separate and all fish identified and measured. The two separate population numbers were then regressed to gain an estimated total population using the two-catch method described by Seber and Le Cren (1967).

These two streams were continuously electrofished to determine how fish community structure changed as distance from the river and channel elevation increased. Curtis and Lodgepole Creeks were electrofished completely from their mouths 1,144 yd (1,046 m) and 1,733 yd (1,585 m) respectively upstream.

RESULTS OF TRIBUTARY SURVEY

Tributary Streams Used by Salmon

Summer chinook salmon, although considered primarily a river fish, utilize most of the tributaries in the upper 50 miles (80 km) of the SFSR for rearing and minor spawning. Of the seven secondary and 16 primary tributary streams sampled for fish, one secondary and 11 primary streams contained chinook salmon (table 1). (Primary tributaries empty directly into the SFSR, while secondary tributaries empty into a primary tributary).

Chinook salmon could occur in other streams, but manmade blocks keep them out. Our random sample design could have caused us to miss some reaches containing chinook salmon. Tailholt Creek contains rainbow trout but no chinook salmon because a dam blocks this stream. The first sampling station on Four-Mile Creek was 0.5 mile (0.8 km) above the mouth and even though no chinook salmon were found in or upstream from this area it is possible they could rear downstream from this point. Both Cougar and Six-Bit Creeks are relatively large tributaries and based on findings in adjacent tributaries were expected to rear chinook salmon. However, salmon were not found in any of the sample areas.

Stream Reaches Most Used by Salmon

Fifty-eight percent of the juvenile summer chinook salmon were rearing in stream reaches within 440 yd (400 m) of the river (table 2). In Tyndall, Trail, Dollar, Blackmare, and Fitsum Creeks, some of the larger streams in the study area, chinook salmon were found only in the first 440 yd (400 m) of stream. If stream size had been a dominant factor it would be expected that chinook salmon would rear further up these streams than they did.

Table 1.--*Fish species occurring in tributaries of the South Fork Salmon River*

Tributary	Chinook Salmon		Rainbow Trout	Cutthroat Trout	Dolly Varden	Brook Trout	Mountain Whitefish	Sculpin	Dace	Sucker
	<¼ Mi[1]	>¼ Mi[2]								
Bear	x	x	x		x	x		x		
Blackmare	x		x		x	x		x		
Buckhorn	x	x	x		x			x		x
West Fork			x	x						
North Fork			x	x	x					
South Fork					x					
Cabin	x	x	x		x	x	x	x	x	
Cougar			x		x	x		x		
Curtis	x	x	x		x	x	x	x		
Trail[3]	x		x	x	x	x		x		
Dollar	x		x			x		x		
Fitsum	x		x	x				x		x
Four-Mile				x						
South Fork				x	x					
Lick	x	x	x			x		x		
Cly[3]			x							
Duck Lake[3]				x						
Lodgepole	x	x	x		x	x		x		
Roaring	No fish found									
Six-Bit			x		x					
Tailholt			x							
Tyndall	x		x		x			x		
Upper SFSR	x	x	x		x		x	x		

[1]Ocurring ¼ mile or less above mouth of stream.
[2]Ocurring over ¼ mile above mouth of stream.
[3]Secondary tributaries.

Table 2.--*Stream reaches used by chinook salmon in relation to the river. Percent of total fish collected by stream is in parentheses*

	Reach distance from river (miles)											
	(0 - 0.25)		(0.25 - 0.5)		(0.5 - 0.75)		(0.75 - 1)		(1 - 2)		(2 - 3)	
	Salmon	*%*	*Salmon*	*%*	*Salmon*	*%*	*Salmon*	*%*	*Salmon*	*%*	*Salmon*	*%*
Bear	9	(90)	1	(10)								
Blackmare	39	(100)										
Buckhorn	0	(0)			3	(25)			6	(50)	3	(25)
Cabin	47	(54)	21	(24)	19	(22)						
Curtis (1971)	10	(6)	36	(24)	51	(34)	9	(6)	46	(30)		
(1974)[1]	101	(44)	55	(24)	72	(32)						
Dollar	2	(100)										
Fitsum	17	(100)										
Lick			0	(0)					12	(67)	6	(33)
Lodgepole (1971)	40	(98)	1	(2)								
(1974)[2]	209	(94)	12	(5)	1	(0.5)						
Trail	1	(100)										
Tyndall	22	(100)										
Total	497	(58)	126	(15)	146	(17)	9	(1)	64	(8)	9	(1)

[1]0.65 mi of stream sampled.

[2]1 mi of stream sampled.

Only three streams (Curtis, Buckhorn, and Lick Creeks) were found to have chinook salmon more than 1 mile (1.6 km) upstream from the mouth. These are all major tributaries, with stream widths averaging more than 18 feet (5.5 m) and individual stream length over 6.5 miles (10.4 km). Juvenile chinook salmon were not found in the main SFSR above the confluence of Vulcan Hot Springs Creek, 7 miles (11 km) from the SFSR headwaters.

Random sampling of Lodgepole Creek in 1971 found 98 percent of the chinook salmon in the first 0.25 mile (0.4 km) of stream adjacent to the river and only 2 percent in the second quarter mile of stream. In 1974 the electrofishing results were comparable, with 94 percent of the chinook salmon collected in the first quarter mile, 5 percent in the second quarter mile, and 1 percent in the third quarter mile of stream (fig. 2). However, in Curtis Creek in 1971 random sampling collected only 6 percent of the chinook salmon in the first quarter mile of stream as compared to 44 percent collected in 1974 by elctrofishing (fig. 3). Chinook salmon were found about 1.2 miles (2 km) above the mouth in Curtis Creek.

Salmon Standing Crops

Standing crops of juvenile chinook salmon in the tributary streams averaged from 0.001 salmon/ft^2 (0.011/m^2) in Dollar Creek to 0.036/ft^2 (0.383/m^2) in Lodgepole Creek (table 3). Six streams (Tyndall, Lodgepole, Curtis, Cabin, Blackmare, and Fitsum Creeks) had standing crops averaging higher than 0.019/ft^2 (0.202/m^2). The remainder of streams had chinook salmon standing crops less than 0.006/ft^2 (0.068/m^2), with an overall average of 0.005 salmon/ft^2 (0.055/m^2).

The extensive electrofishing of the lower reach of Lodgepole Creek in 1974 yielded a population estimate of only 0.006 chinook salmon/ft^2 (0.068/m^2). The higher standing crop in the 1971 random sampling could be due to the two lower stations being in highly populated reaches. The Curtis Creek standing crop estimate was 0.003/ft^2 (0.031/m^2). Sampling in Lodgepole Creek included the entire range of the juvenile chinook salmon rearing area in 1974 while the sampling in Curtis Creek only covered a part of their range.

Population estimates in September 1975 on Big Springs Creek, Idaho, found chinook salmon densities of 0.002/ft^2 (0.020/m^2)(Horner and Bjornn 1976). Horner and Bjornn also made visual (snorkeling) estimates of selected study sites on Bear Valley Creek in July 1975 and estimated less than 0.004 chinook salmon/ft^2 (0.04/m^2).

In Capehorn, Elk, and Marsh Creeks, tributaries of the Middle Fork Salmon River, chinook salmon densities averaged about 0.034/ft^2 (0.368/m^2) in August 1972 and 1973 (Bjornn and others 1974). The major portion of the chinook salmon were located in pool areas with depths over 0.5 foot (0.15 m). Edmundson (1967) visually (snorkeling) reported 0.020 chinook salmon ft^2 (0.220 per m^2)for a selected study site on Crooked Fork, a tributary of the Lochsa River.

The SFSR tributaries are considered marginal for rearing of summer chinook salmon and standing crop values were lower than in those areas considered prime salmon and steelhead rearing areas.

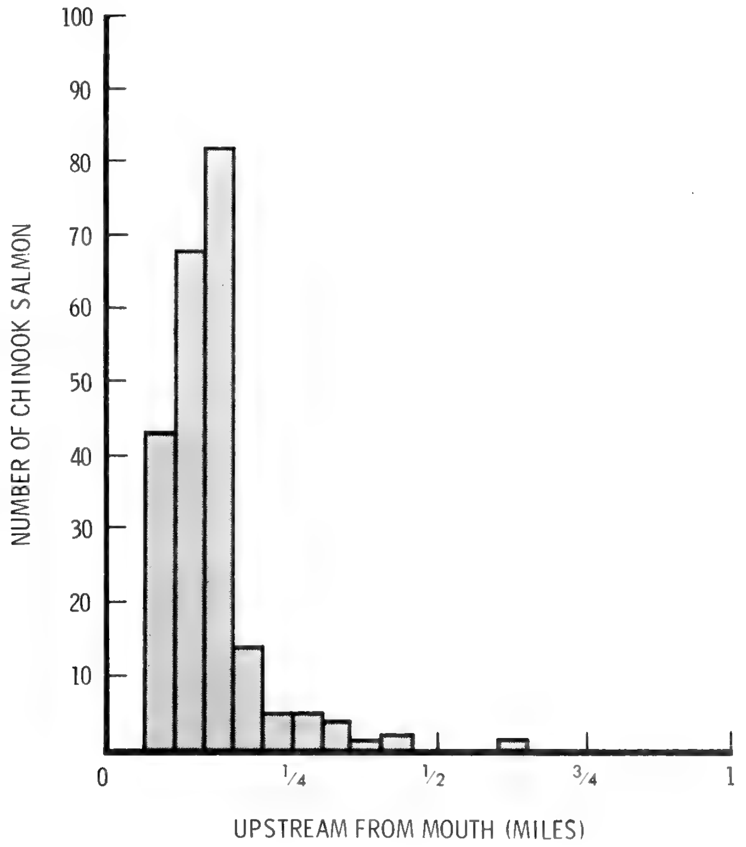

Figure 2.--Distribution of juvenile chinook salmon in the first mile of Lodgepole Creek, 1974.

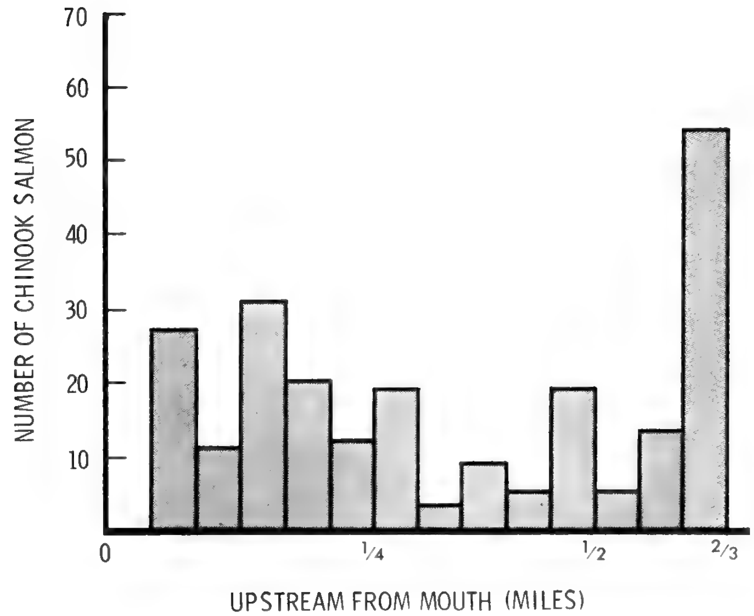

Figure 3.--Distribution of juvenile chinook salmon in the first two-thirds mile of Curtis Creek, 1974.

Table 3.--*The standing crop of the chinook salmon in tributaries of the South Fork Salmon River*

Stream	Stream area sampled	Number of salmon	Salmon per ft^2
	ft^2		
Dollar	1,900	2	0.001
Buckhorn	6,500	12	.002
Trail	500	1	.002
Lick	6,500	18	.003
Curtis[1]	85,800	[2]251 ± 19	.003
Bear	2,000	10	.005
Upper SFSR	1,500	9	.006
Lodgepole[1]	45,630	[2]288 ± 53	.006
Cabin	4,625	87	.019
Curtis	8,000	152	.019
Fitsum	750	17	.023
Tyndall	925	22	.024
Blackmare	1,350	39	.029
Lodgepole	1,150	41	.036

[1]Complete sampling of the lower reach only (1974), all other streams were randomly sampled (1971, 1972).
[2]Estimated populations, 95 percent confidence limit.

ECOLOGICAL RELATIONSHIPS

Salmon in the Community Structure

Rainbow trout, possibly composed mainly of juvenile steelhead trout, were found in all stream areas occupied by chinook salmon (table 4). Steelhead trout are using all tributary areas for spawning and rearing that chinook salmon are using plus upstream areas chinook salmon are not using. Rainbow trout were dominant over chinook salmon in the tributaries, making up 44 percent of the total population, while chinook salmon made up 32 percent.

Numbers of adult chinook salmon and steelhead trout migrating into the SFSR were low during the years of study compared to past years (Hoss and others 1975; U.S. Army Corps Engineers 1963-1976). Even if chinook salmon and steelhead trout numbers were as high as they were in the mid-1950's, the ratio between the two species would probably be similar. If adult runs into the SFSR of one species should start increasing over the other species, changes should show in the juvenile standing crop ratio.

Sculpin were found in all of the tributary streams and all but one of the tributary areas used by chinook salmon. Both species prefer low energy habitats with relatively low channel gradient. Brook trout and chinook salmon were found living together in three streams. Cutthroat trout, which were only found in upper stream reaches, were not

Table 4.--*Number of areas in which each fish species was found in combination with other fish species in the tributaries of the SFSR*

Species	Alone	Rainbow	Chinook salmon	Sculpin	Dolly Varden	Eastern brook	Cutthroat	Mountain whitefish	Dace	Sucker
Rainbow	12		12	10	5	5	4	3	1	2
Chinook salmon	0	12		11	2	3	0	2	1	1
Sculpin	1	10	11		2	3	0	2	1	1
Dolly Varden	13	5	2	2		3	2	0	0	0
Eastern brook	3	5	3	3	3		0	1	1	0
Cutthroat	4	4	0	0	2	0		0	0	0
Mountain whitefish	0	3	2	2	0	1	0		1	0
Dace	0	1	1	1	0	1	0	1		0
Sucker	0	2	1	1	0	0	0	0	0	

found with chinook salmon. Chinook salmon were found with Dolly Varden, mountain whitefish, and mountain suckers in only two streams, and with dace in Cabin Creek, the only stream containing dace. Finding chinook salmon in Cabin Creek was unexpected because it was believed that the Cabin Creek culverts were impassable to migrating adult salmon and steelhead trout.

The standing crop information demonstrates the controlling effect that anadromous fish can have on resident fish. If chinook salmon and steelhead trout populations disappeared from the SFSR, the lower reaches of the tributaries would undoubtedly be used more by resident trout species.

Salmon Densities Related to Aquatic Habitat Conditions

Juvenile chinook salmon preferred stream areas containing high quality pools, with 55 percent occurring in pools with excellent ratings (Platts 1974). Pool condition accounted for 8 percent of the chinook salmon's observed variation in population numbers. However, even though chinook salmon preferred high quality pools, 59 percent were found in stream areas where the percent of channel in pool was less than 20 percent. This can be explained by chinook salmon preferring lower tributary reaches that naturally had a low pool/riffle ratio. Seventy-one percent of the chinook salmon collected were in stream reaches with widths more than 30 feet (9.1 m).

As average channel gradients increased from 2 to 4 percent, mean chinook salmon numbers per stream length increased. As channel gradients increased above 4 percent, chinook salmon numbers declined and were not found in channels exceeding 10 percent gradient.

Chinook salmon in the study area reared in channels with elevations between 3,600 and 5,600 feet (1,100 and 1,710 m), with 52 percent occurring between 4,800 and 5,200 feet (1,460 and 1,580 m). These channel elevations corresponded to most of the tributary confluences with the SFSR.

Sixty-one percent of the chinook salmon collected were in channels dominated by grassy streambanks. The lowest densities found were in channels dominated by forested streambanks because chinook salmon reared mainly in the lower elevations where grassy streambanks dominate. The stability of the streambank and the composition of channel materials had no detectable influence on population means of chinook salmon. Chinook salmon were found in third, fourth, and fifth order streams, with their numbers increasing as the stream order increased. Fifth order streams contained 76 percent of the chinook salmon collected. Chinook salmon occurrence was influenced most by the proximity of the stream reach to the river.

Salmon Occurrences as Related to Geomorphic Type

Chinook salmon were found in six landtypes within two of the four landtype associations (fluvial and depositional) occurring in the study area. Fluvial lands are lands formed by the erosive force of running water. Depositional lands are formed by water and glacial soil deposits. No chinook salmon were collected in the cryic landtype association, nor in the flaciated landtype association almost barren of fish, with only rainbow trout being found in the glacial trough landtype.

Chinook salmon dominated the fish populations in the alluvial and alluvial fan landtypes, and their populations occurred mainly in these low channel gradient areas in close proximity to the river. Chinook salmon were also found in streams within the moraine, dissected mountain slope, terrace, and valley train landtypes.

SUMMARY

Juvenile summer chinook salmon made unexpected use of the tributary streams; they were found in 69 percent of the tributaries sampled. They were the second most numerous fish species, following the resident and anadromous forms of rainbow trout, which were usually found living with chinook salmon.

Sculpin were found with chinook salmon in all but two tributary areas; and brook trout, Dolly Varden, mountain whitefish, sucker, and dace were occasionally found in the same stream areas.

Chinook salmon preferred high quality pools found in the larger streams, with lower channel gradients and grassy streambanks. They were most numerous in channel elevations between 4,800 and 5,200 feet (1,460 and 1,580 m). Chinook salmon were found mostly in the alluvial and alluvial fan landtypes, with the closeness of the stream reach to the river as the most important variable determining whether chinook salmon occurred or not.

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☆ U.S. GOVERNMENT PRINTING OFFICE: 1978-0-777-095-85

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KEYWORDS: chinook salmon, salmon habitat, trout, fisheries, management.

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