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UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH and WILDLIFE SERVICE
WASHINGTON

May 12, 1941

Mr. John C. Page, Commissioner,

Bureau of Reclamation.

My dear Mr. Page:

Transmitted herewith is a report entitled "Time of Appearance of the Runs of Salmon and Steelhead Trout Native to the Wenatchee, Entiat, Methow, and Okanogan Rivers", by J. A. Craig and A. J. Suomela. This report has been prepared specifically at the request of Mr. F. A. Banks of the Bureau of Reclamation to answer as conclusively as data permit the question raised by Mr. B. M. Brennan, Director of the Washington State Department of Fisheries, regarding the existence of summer and fall spawning stocks of salmon under primitive conditions in the Wenatchee River and other tributaries of the Columbia River where fish from these late runs are now being transferred in connection with the Grand Coulee salmon salvage program.

This question was raised by Mr. Brennan during a meeting held in his office with representatives of the Bureau of Reclamation and the Fish and Wildlife Service, at which time an attempt was made to place responsibility for stream improvement and adjustment of water flow to assure successful migration and spawning in these streams during the extremely low water which is expected during the coming summer.

This report is not for publication in itspresent form because of the inclusion of confidential material related to the controversy which has arisen. It should be regarded as an administrative report to aid the agencies concerned in developing a proper program.

A carbon copy of the report is also enclosed for Mr. Banks, who desires to have the information in the very near future.

Very truly yours,

/s/ CHAS. E. JACKSON

Acting Director.

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

Not for publication

Time of Appearance of the Runs of Salmon and Steelhead Trout Native to the Wenatchee, Entiat, Methow, and Okanogan Rivers

J. A. Craig, Associate Aquatic Biologist

A. J. Suomela, Associate Aquatic Biologist

May 2, 1941

INTRODUCTION

A conference was held on March 6, 1941, in the office of Mr. B.M. Brennan, Director, Department of Fisheries, State of Washington, for the purpose of discussing means of securing proper passage for fish in the streams directly affected by the Grand Coulee fish salvage program. These streams are the Wenatchee, Entiat, Methow, and Okanogan Rivers. Representatives of the U. S. Bureau of Reclamation, U. S. Fish and Wildlife Service, Washington State Game Commission, and Washington State Fisheries Department were present.

In planning for the protection of the salmon runs interfered with by Grand Coulee Dam, it was decided that it was not possible to have the runs continue on beyond that structure because of the difficulties of getting both adult and downstream migrants over it without injury. The plan decided upon, and now in operation, provides for the trapping of the entire run of migrating fish at Rock Island Dam in the Columbia River. From Rock Island, the fish are transported in specially built tank trucks to a hatchery at Leavenworth, Washington. At that location the adult fish are held in ponds in the Icicle River until mature. The spawn is then taken and the eggs hatched and the fry reared at the central Leavenworth Hatchery and branch hatcheries on the Entiat and Methow Rivers. The location of these streams is shown in Fig. 1. The young fish resulting from these operations will be planted in the Wenatchee, Entiat, Methow, and Okanogan River systems. All these streams enter the Columbia River below Grand Coulee Dam, and it is believed that, because of the homing habit of the salmon, the adults returning from these plants will ascend the rivers in which they were reared and liberated. In that way the runs that formerly went past Grand Coulee Dam will be transferred to the tributaries on the Columbia below that structure. After one generation of fish have been so handled and tests have been made to determine the exactness of the homing of the salmon, it is expected that trapping operations at Rock Island can be discontinued, and the runs allowed to enter the streams to which they have been transferred.

This program has been under way since the season of 1939, so it is a matter of but a few years until the runs of salmon must migrate up the rivers in which they were planted. Therefore provisions must be made so that all of the streams present free passage to the fish and a minimum hazard to up and down stream migration. The irrigation ditches on these rivers have been screened to protect downstream migrants through the action of the Department of Fisheries, State of Washington, in securing W.P.A. funds and labor for their screening projects. Also, proper fish ladders have been erected at practically all of the dams. However, there remain several places where so much water is diverted for power and irrigation purposes that sections of the streams may not carry enough water during the summer to give the migrating salmon an unobstructed path up stream. This condition does not prevail on the Okanogan or Entiat Rivers at present. There are some locations on the Methow where danger of such obstruction is possible, and one section of the Wenatchee River which may possibly be an obstruction at extremely low water, and another on that same stream which is an acute case and must be remedied before adult salmon migrants can go through during the late summer and early fall. This latter situation is caused by the diversion of water at the Dryden Power Dam, where 1500 second feet of water is diverted for the combined purpose of power and irrigation. About $1\frac{1}{2}$ miles below this diversion a good part of this water is returned to the Wenatchee River. Therefore, the section in which there is danger of insufficient water to supply fish passage lies between the Dryden Dam and the power house and is about $1\frac{1}{2}$ miles in length. This diversion was the particular case taken up at the conference of March 6, since it is the most important acute case of diminished stream flow interfering with salmon migration in any of the streams related to the Grand Coulee fish salvage program.

Mr. F. A. Banks, of the U. S. Bureau of Reclamation, stated that his office was not inclined to assume responsibility for any stream improvement work such as would be necessary. His argument was that such conditions exist contrary to state laws or because of lack of enforcement of such laws. He also pointed out that the Board of Consultants which approved the Grand Coulee fish salvage program had specifically stated that all such improvements should be financed and carried out by the State of Washington. He further stated that his department had no choice but to adhere to the recommendations of this Board. Mr. B. M. Brennan, Director, Department of Fisheries, State of Washington, replied that his department was willing to assume responsibility for providing proper conditions for populations of fish which were native to the stream. However, he maintained that under the Grand Coulee salvage program strange races of salmon were being introduced to the Wenatchee River and other streams. He maintained that the original runs of salmon native to the Washington streams were parts of the early Columbia River run which entered the tributary streams before these low water conditions prevailed. Therefore he believed that any expense necessary to provide additional stream flows in July, August, or September, was not the responsibility of his department, since the reasons for such expenditures were caused directly by the introduction of late run fish into the streams.

Mr. Banks replied that he would refer this matter to the Board of Consultants and would act upon their advice. The question of responsibility for the maintenance of proper stream conditions for salmon returning, in cases where low water interferes with late summer or fall migration, as a result of the Grand Coulee salvage activities, appears to depend upon the time of run of the original salmon populations of the area in which they have been planted, namely the Wenatchee, Entiat, Methow and Okanogan River systems.

It is not the purpose of this report to enter into this question of responsibility on one side or the other, but rather to present the facts that are available regarding the time of original runs, and to draw unbiased conclusions from them. Since the Dryden diversion on the Wenatchee River is at present the chief source of contention, the greater part of this report will be devoted to a study of conditions on the Wenatchee River.

DRYDEN POWER AND IRRIGATION DIVERSION

Since the diversion at the Dryden Dam, which takes out 1300 second feet of water, returning part of that flow 1½ miles down stream through the power house, was the chief point of controversy, it appears advisable to examine the conditions actually existing at that place.

At present when the river flow reaches 1300 second feet or less, the entire river is diverted into the diversion canal with the exception of the small amount of water seeping through the dam and going down the two fishways. This minimum flow through the section depleted of water has been estimated at between 40 and 50 second feet. This is not sufficient to provide proper passage for salmon. Conditions could be much improved by confining this water to a small channel. However, it is believed that with present channel conditions a flow of 200 second feet, or slightly more, would be sufficient for the fish. Therefore, if the Dryden canal diverts 1300 second feet there should be approximately 1500 second feet in the river to provide an excess of 200 which we estimate to be satisfactory.

WENATCHEE RIVER at PESHASTIN, WASHINGTON

Number of days in each month, on which

flow was less than 1500 second feet

Table 1.

Year	April	May	June	July	August	Sept.	October
1929	23	-	-	5	31	30	31
1930	-	-	-	6	31	30	31
1931	-	-	-	15	31	30	31
1932	-	-	-	-	22	30	29
1933	2	--	-	-	5	27	5
1934	-	-	-	-	27	30	24
1935	-	-	-	-	16	30	31
1936	11	-	-	7	31	30	31
1937	9	-	-	-	30	30	28
1938	3	-	-	1	31	30	(1)

(1) No records available

Table 1 shows the number of days during April, May, June, July, August, September, and October of the years 1929-1938 inclusive, when the flow of the Wenatchee River measured at the Peshastin was less than 1500 second feet. This gauging station is the nearest available to the Dryden diversion and is above that point. Peshastin Creek enters between the gauging station and the diversion and may at times contribute significantly to the river flow below the station. However, since most of the flow is taken from Peshastin Creek during dry seasons for irrigation, it is thought that it will not contribute enough during the critical periods to alter the situation. Table 1 then gives an estimate of the number of days during each month over a 10-year period when lack of water in the Wenatchee River at the Dryden diversion would make conditions unfavorable for salmon to migrate past that location. Examination of this table shows that such conditions prevail rather rarely in April, occasionally during July and almost continuously during August, September, and October. Therefore, it is evident that while the early chinook run arriving at Rock Island in April, May and June will ordinarily find no hindrances at Dryden, the later run of fish is quite apt to find not enough water to successfully pass that point. The first half of the blueback run would probably not be adversely affected, but that portion of the fish arriving at Rock Island during the latter part of July and later, would have some difficulty in passing this diversion during years of unusually low run-off. The statement of the Department of Fisheries, State of Washington, that the early run fish are not subject to hindrances of low water conditions, appears to be well founded.

It now remains to inquire into whether or not all of the original salmon populations of the Wenatchee, Methow, Entiat, and Okanogan Rivers were of this early variety. Unfortunately most of the original salmon populations of these streams have been so seriously depleted by unscreened diversions, dams with improper ladders, and other bad conditions that it is very difficult to secure any first hand information regarding their time of appearance in these tributary streams.

We have found three main sources of information relating to this problem, they are: records of hatchery operations of the Washington State Fisheries Department; statements of residents who have been on these streams for many years and who are interested in fish, and who had been interviewed by our staff; and observations on the streams made by the staff of the Columbia River investigations before the runs were intercepted at Rock Island.

TIME OF SALMON RUNS AT ROCK ISLAND DAM

Since the time of migration of the fish in the tributary streams where salmon resulting from propagation of the Rock Island runs are to be planted, is the chief point of controversy, it seems advisable to briefly consider the dates of arrival of the various runs of salmon at Rock Island where they are now intercepted.

Figure 2 presents a graph showing the number of migratory, salmonoid fishes trapped at Rock Island during each seven-day period of the season of 1940. This particular year was selected because it is fairly representative of the runs occurring since the third fish ladder was constructed at Rock Island Dam in 1936. It will be noted that the chinook salmon (Oncorhynchus tschawytscha) first appeared on April 20 and steadily increased in number until the middle of May; the catch then fell off steadily until after June 20 when another small mode appeared. The catch then declined until about the middle of July, after which it increased and large catches were made through most of August, with another smaller peak during September. The first part of the run which arrives at Rock Island during April, May and June is that which is commonly called the early or spring run, while July, August and September arrivals are commonly called the late or summer run fish. The contention of the Department of Fisheries, State of Washington, is that the original populations of salmon inhabiting the streams under consideration were all part of the early, or May and June, migrations, and that they should not be held responsible for salmon arriving at Rock Island in July, August and September, and planted in the streams of Washington because of the Grand Coulee fish salvage program. There appears little doubt but that there is a racial difference between the May and June run and those coming to Rock Island at a later date. The fish taken in the latter part of June and first part of July are probably a mixture of the two racial components. There are, also, no doubt, many distinct races or populations of salmon mixed together in each of these two large divisions. These smaller components cannot be distinguished when they arrive at Rock Island.

In this same figure, the time of arrival of the bluebacks (Oncorhynchus nerka) is shown. It is evident that their time of run is quite concentrated, with a few fish in the latter part of June and during August, but the great majority of this species arrives in July, with a sharp peak in about the middle of that month. The steelheads (Salmo gairdnerii gairdnerii) are split into two groups. Many of these fish come to Rock Island in March, April and May, very few are present during June and July, and another run appears in August, September and October. In several other years few steelheads have come to Rock Island in August, the main body of the late run being in September and even late in October.

Note that usually redfish arrive later — often peaking in Aug.

TIME OF SPAWNING OF SPRING AND LATE RUN CHINOOKS

During the first two years of the Grand Coulee fish salvage program, 1939-1940, the hatchery facilities were not completed, therefore it was necessary to haul all of the adult fish during 1939 and a portion of the run of 1940 from Rock Island Dam and liberate them in the tributary streams and to depend upon natural spawning rather than artificial propagation for the transfer of these runs. Weirs were placed in these streams below the location where the fish were liberated so that they could not descend into the Columbia River, and from intensive observations made of their spawning activities, mortality, and upon the young fish resulting from these spawnings, it appears evident that this natural spawning was extremely successful.

This was [illegible] original idea. Why then the hatcheries? To rear fish to larger size & thus increase the run

When this program of hauling adult fish was first started it was recognized that the early April, May and June fish were of different racial stock than those coming later in the season. Therefore it was decided to confine that part of the run in one particular area in order to avoid mixing the racial stocks any more than was necessary. These early fish were placed in Nason Creek and spawned with good success. The later run of chinook were placed in the upper Wenatchee River and the Entiat River. During the course of the observations made on these fish, it was possible to discover the exact times when the two groups spawned. The difference in spawning time of the two groups was quite pronounced. This is shown by the following facts.

Observations made on the early spring fish liberated in Nason Creek during 1940 showed that spawning started on about August 5, with the peak of spawning activities occurring during the last ten days of August and the first week of September. After September 14 all spawning was practically completed. This can be seen from the following: 254 live chinooks were observed in Nason Creek between August 31 and September 7. From September 8 to 14 some were still in evidence. During the week September 15 to 21, the entire creek was carefully covered by men on foot and only 1 live chinook was found. A like survey made between September 22 and 28 also revealed only 1 live chinook. Spawning was considered as completed at that time and no further observations were made. This clearly indicates that the spawning of the early spring fish is almost entirely completed by September 15. The fish placed in Nason Creek were hauled during the period of time from April 22 to June 8, 1940 inclusive. A total of 3165 of these early run salmon were liberated in Nason Creek during that time.

In 1939, a part of the late run chinooks were placed in the upper Wenatchee River between Wenatchee Lake and Tumwater Canyon. These fish were taken at Rock Island Dam between July 18 and October 20. A total of 3584 late run chinooks were hauled and liberated in this stream section during that period. Our observers reported that during the week of September 11 to 17 inclusive, no chinooks had yet been observed digging or making redds, although many appeared well advanced towards spawning. On September 25 the first spawned-out chinooks were found in this area. Their spawning activities continued until about November 18, at which time no spawning salmon could be observed but 3 freshly dead chinooks were found. It was considered at that time that the spawning had been completed and observations were discontinued.

} Sept 25

} Nov. 18

The results of these observations indicate that the spawning time of the early run of chinooks, those arriving at Rock Island in April, May and early June, extends from about August 5 to approximately September 15, with the peak of their spawning activities occurring during the latter part of August and the first part of September. On the other hand, the later run fish, those appearing at Rock Island from the middle of July until the run is over in October, begin their activities on about September 20 and continue spawning until approximately November 20. Sept 20 – Nov. 15 The greatest concentration of spawning of this latter group occurred during the period from October 20 to 30. This information indicates that there is a distinct difference in spawning time of the chinook salmon of the early run and those of the late summer run. Apparently the individuals of the early run have completed their spawning activities by about September 18, while those of the later run do not start until about September 20. The peak of the spawning of the two groups is distinctly separated by a period of over a month. 2 full months Aug 25 – Oct 25 This segregation of spawning time can be used in determining what groups of fish were observed in the Wenatchee River during earlier years and these facts will be applied to the results of information which will be recorded later in this report.

TIME OF ORIGINAL SALMON RUNS OF THE WENATCHEE RIVER

INFORMATION OBTAINED FROM LOCAL RESIDENTS

Messrs. Les Hart, Bill Smith, and John Brender were interviewed in Leavenworth regarding the original runs of salmon and steelheads in the upper Wenatchee River. All of these men contributed to the conversation and their composite ideas appeared to be as follows:

Before construction of the Leavenworth mill dam in 1904 or 1905, the fall run of salmon was much larger than the spring run. This fall run was composed of both silvers and chinooks; a good fall run of steelheads also occurred at about the same time. They believe that these fish came about September 1. This fall run continued until about 1914-1915, after which it rapidly declined. Before the Leavenworth dam was built, the Indians' fishing grounds were near the mouth of Tumwater Canyon and on Nason Creek. After the construction of this dam they fished below that structure.

Mr. Burroughs, Superintendent of the Dryden Power Station for the Puget Sound Power & Light Co., was also interviewed. He stated that in the early days the fall run of salmon reaching the power dam was often much larger than the spring run. This fall run arrived in August and September and was composed of at least two kinds of salmon, big black fish which he assumes were chinook, and smaller fish which were more numerous, probably silvers and bluebacks. He remembers that one of the larger fish reached from his shoulder to the ground. That was quite evidently a chinook. He said that few fish were in evidence in July and late June, the spring run of chinooks and steelheads going up with the spring high water, which usually occurred in late May or early June. It should be noted that his statements correspond fairly well with Messrs. Hart, Smith and Brender, and that all agree that chinook salmon, as well as steelheads and bluebacks, appeared in the upper Wenatchee River in August and September, as well as in May and June.

OBSERVATIONS MADE ON CHINOOK SALMON RUNS OF THE WENATCHEE RIVER BEFORE ROCK ISLAND TRAPPING

During the course of the regular stream survey program of the Columbia River investigation and other activities, which made observations on that stream necessary, some data were gathered concerning the original chinook runs into that stream.

During summer and early fall of the years 1935 and 1936, a counting weir was placed in the fish ladder of the Tumwater power dam, situated in Tumwater Canyon on the main Wenatchee River. The primary purpose of this weir was to make an accurate count of the bluebacks ascending the Wenatchee River to Wenatchee Lake, therefore the weir was not placed in operation until July of these years. However, all chinooks passing through the weir were counted. In 1935, 9 chinooks passed through the ladder. The first of these arrived on August 14 and the last one on September 10. In 1936, the count was 5 chinooks, with the first recorded on August 8 and the last on September 2. These fish were, of course, some of the original stock of the Wenatchee River since at that time the Grand Coulee salvage program had not yet been undertaken. On the days mentioned above, these fish were actively migrating up stream and had not yet begun any of their spawning operations. It seems improbable that any of the fish passing Rock Island at the time of the early run, April, May, or June, would have ascended the Wenatchee River as far as Tumwater dam so slowly that their arrival would have been as late as August 8 or 14. Therefore, it appears probable that these few individuals were part of the summer run rather than the early or spring group. It should be pointed out that no count was made of the fish passing Tumwater Dam during May and June, and it may be that the early run of chinooks used the ladder at that time although we have no record of such fish.

On September 27, 1935, one of our regular stream survey parties surveyed Icicle Creek, a large tributary of the Wenatchee River entering that stream at the town of Leavenworth. The main hatchery for the Grand Coulee project is located on this stream. During the course of the survey of the lower portion of the Icicle River, made on the date referred to above, 21 chinook salmon were observed. Two were dead and nineteen alive. Some were engaged in spawning activities and others were seen quietly resting in pools. These fish were of the original Wenatchee River stock and apparently were just beginning their spawning activities on September 27. When one refers to the spawning time of the early and late runs already discussed in this paper, it becomes evident that they appear to fall into a classification of the late run fish rather than that of the early run since the early run chinooks had completed their spawning activities by September 27, while the late run chinooks were just well started by September 25. This observation indicated that the group of fish observed probably belong to the late run variety.

Another observation was made on October 19, 1934, when Messrs. A. J. Suomela and J. A. Craig found 4 chinooks on a riffle just below the power house in Tumwater Canyon. This small group of fish would certainly fall into the late run stock since all of the early run fish in Nason Creek completed their spawning considerably before October 19.

OBSERVATIONS MADE ON BLUEBACK SALMON ON THE WENATCHEE RIVER BEFORE ROCK ISLAND TRAPPING

A run of blueback salmon ascended the Wenatchee River to Wenatchee Lake before any of the Grand Coulee salvage work was undertaken. These fish were observed on their spawning grounds in the Little Wenatchee River above Wenatchee Lake in 1934 by Messrs. Suomela and Craig. During 1935 and 1936 counts of these fish were made in the ladder of the Tumwater power dam. The total count in 1935 was 889 bluebacks and in 1936 there were 29 bluebacks. The first blueback passed through the ladder on August 8 in 1935 and the last on September 20. In 1936 the first fish was recorded on July 2 and the last on September 2. It can be seen by referring to Figure 2 that the main portion of the bluebacks arrive at Rock Island during July. This natural run of the Wenatchee River may have taken a considerable length of time to ascend the short section of the Columbia from Rock Island dam to the mouth of the Wenatchee and then the Wenatchee to Tumwater dam, or perhaps that particular race is one which constitutes some of the later part of the run as it arrives at Rock Island. In any event it seems evident that the original blueback population of the Wenatchee River passes through that stream from the latter part of July to the first part of September. Inspection of Table 2 will indicate that there are often dangerously low water conditions prevailing at the Dryden diversion during that time.

EGGS TAKEN AND FRY PLANTED

Table 2. WENATCHEE HATCHERIES

Year	Eggs Taken: Chinook	Eggs Taken: Silver	Eggs Taken: Steelhead	Fry Planted: Chinook	Fry Planted: Silver	Fry Planted: Species not Stated	Fry Planted: Steelhead	Fry Planted: Chum	Hatchery Location
1899						7,810,000			Tumwater
1900						6,025,000			"
1901						(1)			"
1902						7,934,560			"
1903				600,000	3,836,000				"
1904									closed
1910		(2)30,000							"
1913									Leavenworth
1914		38,500		1,037,800					"
1915	105,000		20,000				(3)7,950		"
1916				1,464,100					"
1917				1,383,590					"
1921								484,955	"
1922									closed
1927				593,000					New Leavenworth
1928				1,702,600					"
1929				1,632,880					"
1930				1,445,275					"
1931									closed
1932									Chiwaukum

(1) No report available
(2) Taken at Leavenworth Dam
(3) Eggs planted

EGGS RECEIVED AND EGGS AND FRY SHIPPED

Table 3. WENATCHEE HATCHERIES

Year	EGGS RECEIVED				EGGS AND FRY SHIPPED			
	Chinook	Steelhead	Chum	From	Chinook Eggs	Silver Eggs	Steelhead Fry	To
1900								(1) Spokane Hatchery
1910						(2) 30,000		Kalama Hatchery
1914	(3) 2,076,400			Oregon	902,500	27,800		
1915	(4) 1,350,000			"				
"		213,818						
1916	1,872,000			Chinook Hatchery				
"		250,000					(5) 113,875	
1917	1,500,000							
1918		150,000		Methow Hatchery			138,820	
1919		500,000					494,400	
1920			500,000					
1926	600,000							
1927	1,750,000			Little White R.				
1928	1,650,000							
1929	1,500,000							
1932	(6) 2,000,000							

(1) 300,000 eggs shipped - species not given
(2) Hatchery closed - eggs taken experimentally at Leavenworth Dam
(3) 1,076,400 from Willamette Hatchery
(4) 1,350,000 from Willamette and McKenzie R. Hatcheries
(5) Many steelhead fry planted in Wenatchee R. tributaries
(6) Total loss - eggs frozen at Chiwaukum Hatchery

SALMON HATCHERIES ON THE WENATCHEE RIVER

The records of artificial propagation carried on in the Wenatchee River system offer information that has considerable bearing on the question under discussion. These data are presented in Tables 2 and 3.[1/] The 9th annual report of the State Fish Commissioner of Washington stated that:

"On the Wenatchee River we are satisfied that an extensive hatchery can be located from which a large amount of the May and June run of the Royal Chinook salmon and also of the summer run of Columbia River steelheads may be produced. We advise that a hatchery be at once located in this stream in order that it may be ready for operation by the time the early run of this salmon begin to spawn in the Wenatchee River."

This hatchery was built in 1899 on the Wenatchee River, near the Chiwaukum railroad station just above Tumwater Canyon. Eggs were at once taken and fry liberated as can be seen by referring to Table 2. Unfortunately, the species of salmon spawned is not mentioned in these records. This hatchery was closed in 1904. The reasons given were: extreme cold weather, heavy snow, isolated location and consequent expense of operating, freshets, and the fact that it was too far up the river to secure the best variety of fish. A quotation from the 14th and 15th annual reports of the State Fish Commissioner of Washington is as follows:

"If it had been below the Tumwater Canyon, the early chinook could have been secured, as it is it takes only an inferior run of silversides."

1/ The data presented in Tables 2, 3, 4 and 5, were obtained from the following sources:
1899-1934: Annual Reports of the Washington State Fish Commissioner, State Supervisor of Fisheries, State Department of Fisheries and Game-Division of Fisheries and State Department of Fisheries. Annual reports numbered serially from the tenth to the forty-fifth. Supplementary information was also found in the reports of the Oregon Fish Commission.

After the closure of this hatchery there were no activities connected with artificial propagation on the Wenatchee River until 1913 when a new hatchery was constructed at the town of Leavenworth, which is located below Tumwater Canyon. This new location was selected because it was thought that better weather and transportation conditions would exist and that large numbers of the early spring chinooks could be taken. Reference to Table 2 shows that the results were disappointing as far as the take of chinook eggs was concerned. Very few eggs of this or any other species were secured at any time by this hatchery until it was abandoned in 1931. Attempts were made to utilize this hatchery by means of shipping in chinook eggs from other places. Table 3 contains as complete a record of these shipments as can be secured at this time; unfortunately, in many cases there is no record as to the stream from which the eggs were originally taken before shipment to Leavenworth. However, in 1914, 1,076,400 eggs were shipped from Oregon. Be checking the Oregon state records it is found that such a shipment to Washington is recorded from the Willamette Hatchery, located on the upper Willamette River. This hatchery takes early run spring fish entirely so this shipment was apparently of that variety.

1,350,000 eggs were received at Leavenworth in 1915, from the McKenzie and Willamette hatcheries of Oregon. Again these were eggs from an early spring run. Other shipments of chinook eggs to the Wenatchee were made up to 1932. One of these was from the U. S. Bureau of Fisheries hatchery at Little White Salmon and the others were from Washington State Hatcheries. Most, or probably all, of these eggs were from fall run parents.

The records of the hatchery operations at both above Tumwater Canyon and Leavenworth indicate that it was not found possible at either location to secure either early run chinook or any other variety of that species in significant numbers. Also, numerous shipments were made to the Leavenworth station from streams on the lower Columbia and from outside the state. Some of these eggs were undoubtedly taken from the early run chinooks of the Willamette River system. However, other shipments, such as those made from Little White Salmon River by the U. S. Bureau of Fisheries, and probably some of those made by other Washington hatcheries on the lower Columbia, could have supplied only extremely late fall running chinooks. Therefore, it appears evident that the Washington State fisheries authorities have from time to time made attempts to introduce exotic populations of salmon to the Wenatchee River, many of which were of a late appearing variety, and that they carried on this program for many years before the Grand Coulee fish salvage activities made necessary the transfer of strange runs of fish to that river.

ORIGINAL SALMON RUNS OF THE METHOW RIVER

SALMON HATCHERY ACTIVITIES ON THE METHOW RIVI

The first salmon hatchery was built on the Methow Rive It was located at the junction of the Twisp and Methow Rive station was operated until 1914. It and all other hatcheri stream were built and operated by the State of Washington. fish it produced were silver salmon (Oncorhynchus kisutch), few chinook eggs being taken. The data showing the results hatchery operations on the Methow River are presented in Tab

In 1915 a new hatchery was built at Pateros on the main Methow River. This change was made in order to obtain better operating conditions and with the idea that large quantities of early spring chinook eggs could be secured at this new location. Table 4 indicates that the silver salmon continued to be taken and that large numbers of steelheads were also spawned; however, chinooks were never obtained in any quantity. Table 5 shows that some eggs were transferred to Methow from other locations. Even chum salmon eggs were shipped there in 1916 and 1917. However, it is not thought probable that any of the fish from plants of that species returned to the Methow. In many cases there is no indication as to where the transferred chinook eggs were taken, but some were obtained from the U. S. Bureau of Fisheries hatcheries on the lower Columbia and probably some of the Washington hatcheries from that section also contributed late run stock to the Methow River. It is very questionable whether any of these fish were able to return to the Methow River, since the distance they would have to migrate is much greater than that to which the original stock was accustomed. However, these records do indicate that the Washington State fisheries authorities made attempts to introduce strange runs of salmon to the Methow as well as to the Wenatchee.

One of the parties of the Columbia River investigation surveyed the Methow River system during the late summer of 1935. During the course of these investigations 23 chinook salmon were observed in the main Methow River from just above the mouth to the confluence of Lost River. These fish were observed from August 13 to 24 inclusive, and all were either dead or carrying on spawning activities.

EGGS TAKEN AND FRY PLANTED

METHOW HATCHERIES

Table 4.

Year	Eggs Taken: Chinook	Eggs Taken: Silver	Eggs Taken: Steelhead	Fry Planted: Chinook	Fry Planted: Silver	Fry Planted: Species not Stated	Fry Planted: Steelhead	Fry Planted: Chum	Hatchery Location
1900						152,500			Twisp
1901						(1) -			"
1902						2,969,350			"
1903				100,000	2,200,800				"
1904		35,000							"
1905		500,000							"
1906		1,500,000							"
1907		708,950							"
1908	10,000	1,120,000							"
1909	7,500	2,337,000							"
1910	30,500	997,000							"
1911	68,000	320,000							"
1912	5,000	2,015,000							"
1913		924,000							"
1914		1,427,000			148,559				"
1915					1,095,000				Twisp
"		18,000	(2) 2,051,000				(2) 1,543,800		Pateros
1916	2,000	1,498,000	3,037,500	1,342	252,150		1,662,280	1,318,800	"
1917		1,517,000	2,962,000	3,156,211	998,374		897,510	887,400	"
1918		130,500	1,841,000		1,269,130		691,250		"
1919		3,000	3,760,000		116,100				"
1920		328,000	2,399,000		2,700		945,500	938,450	"
1921			638,000		301,700				"
1922									Closed
1926				400,000					Pateros
1927				593,000					"
1928				230,000					"
1929				760,800					"
1930				99,450					"
1931				(3) 500,000					"

(1) 1901 No report available
(2) Methow Eyeing Station
(3) Planted in lakes

Sub tot. 11,883,950

3961

Subtotal 3,492,500

EGGS RECEIVED AND EGGS AND FRY SHIPPED

METHOW HATCHERIES

Table 5.

Year	EGGS RECEIVED			STEELHEAD EGGS AND FRY SHIPPED		
	Chinook	Chum	From	Eggs	Fry	To
1916		2,760,000		830,000	315,000	
1917	1,500,000			600,000	1,050,000	
1918				125,000		Pend Oreille Co.
				150,000		Leavenworth Hatchery
					575,000	
1919				540,200		Stevens Co.
				500,000		Spokane Co.
				52,000		Dumpka Lake
1920		1,000,000		500,000		
				200,000		Chelan Co.
				200,000		Stevens Co.
				50,000		Connecticut
				50,000		Dumpka Lake
						(1)Okanogan Co.
1921						
1926	400,000					
1928	700,000		Quilcene Hatchery			
1929	500,000					
1931	500,000		Little White Hatchery			

(1) 82,000 shipped - not listed as eggs or fry

In the Chewack River 63 chinooks were observed on the spawning beds between August 11 and 16. From August 17 to 25, 44 chinooks were counted in the Twisp River. These fish were either spawning or already spent. Both the Chewack and Twisp Rivers are upper tributaries of the Methow. These observations indicate that the chinook salmon observed were part of the early spring run which passes the Rock Island Dam. This appears to be definitely so because their time of spawning was well within the range of that of the early run fish and earlier than any of the late summer run have been observed to spawn.

General statements have been heard that some late summer chinooks entered the lower part of the Methow River and spawned there, however no direct evidence is available to support those statements. It appears that the Methow River originally supported runs of silver salmon in the river in September and October which have been exterminated, and steelhead which probably came in both early in the spring and during the fall, and a population of the early spring run chinooks. There is no definite evidence that later run chinooks have inhabited this river, although because of the fact that we had no observations made at the time during which these fish would spawn, it is not impossible that some of these fish have been present in that stream.

ORIGINAL SALMON RUNS OF THE ENTIAT RIVER

Unfortunately the salmon runs of the Entiat River have been practically exterminated for many years because of dams built on that stream, which were provided with either inadequate fish ladders or no fish ladders at all. There is, therefore, very little information available as to the time of appearance of those fish. Information was obtained from a man who had resided at Entiat, Washington since 1895. According to his statement, there was an excellent run of chinook salmon in the Entiat River during May and June in the early years. In 1898 a dam was built at a sawmill at a point about 1 mile above the mouth of the river. While a crude fishway was built on this dam, only a few salmon ascended the river. Shortly thereafter another dam, with no fish ladder, was constructed, and the salmon were completely cut off from the spawning areas. Statements have also been heard to the effect that silver salmon ascended the Entiat before the building of those obstructions. No information was obtained to indicate the presence of any late run chinooks. Chinooks entering the Entiat in May and June would certainly fall into the category of early or spring run populations.

ORIGINAL SALMON RUNS OF THE OKANOGAN RIVER

While there is no need of stream improvement to make the Okanogan River suitable for the upstream passage of salmon, it appears advisable at this time to record the information that is available concerning the time of appearance of the original salmon runs through that stream. This is considered to be proper because the Okanogan River is one of the streams into which salmon are being introduced because of the Grand Coulee fish salvage program.

The Indians residing near the Okanogan River made a practice of catching the salmon by means of weirs built across the stream so that all fish were stopped in their upstream migrations. These weirs were operated each year until 1931. Some of these were located about 4 miles above the mouth of the river in the vicinity of the town of Monse, Washington. Residents along the Okanogan River have stated that chinook salmon had been observed spawning in that stream during the early part of October. This was, of course, before the runs were intercepted at Rock Island. If these statements are to be relied upon it would place those fish definitely in the summer or late run classification.

In 1934, 1935, and 1936 counts of blueback entering Osoyoos Lake were made by the Fish and Wildlife Service (then the Bureau of Fisheries), and in 1937 the counts were continued by the Department of Fisheries, State of Washington, with funds secured from the U. S. Bureau of Reclamation. The fish were counted through a weir which was constructed at a mill dam located just outside the town of Oroville, Washington, a short distance below the outlet of Osoyoos Lake. The counters on this weir observed a few chinook salmon which spawned in the Okanogan River below the weir during the last week in September. This agrees fairly well with the statements obtained from the residents and makes it appear probable that those fish belonged in the late run category.

The Similkameen River enters the Okanogan River at the town of Oroville. There is a short portion of this stream, about 6 miles in length, extending from its confluence with the Okanogan River to an impassable power dam, in which chinook salmon spawned when the runs were permitted to pass Rock Island Dam. These fish were observed each week by the men counting bluebacks at Oroville during 1934, 1935, and 1936. In 1934, 40 chinooks were observed in that area; 20 were seen in 1935; and in 1936 the run was considerably larger, 50 being counted in one pool. These salmon made their appearance in the Similkameen in August, the 9th to the 17th being the earliest dates of occurrence. The bulk of these fish arrived during September and most of the spawning activities began during the latter part of that month. In 1934, the first spawning commenced about September 21st and in 1936 the first pre-spawning activities were noted on September 27th. These observations indicate that this portion of the original populations going up the Okanogan River belong to the summer or late part of the Rock Island run.

The first complete counts of the blueback run in the Okanogan River were secured in 1935, when 264 fish passed the Oroville weir. The operations in 1934 were not successful in securing a count because the weir could not be installed sufficiently early to intercept the run. In 1936, 895 individuals of this species were counted and a total of 2162 bluebacks was recorded in 1937. In each year the first of these fish arrived during the latter part of July and the greater part of the run passed through the weir and into the lake by September 1st. This indicates that the original runs of bluebacks on the Okanogan River passed up that stream during the latter half of July and the entire month of August in significant numbers.

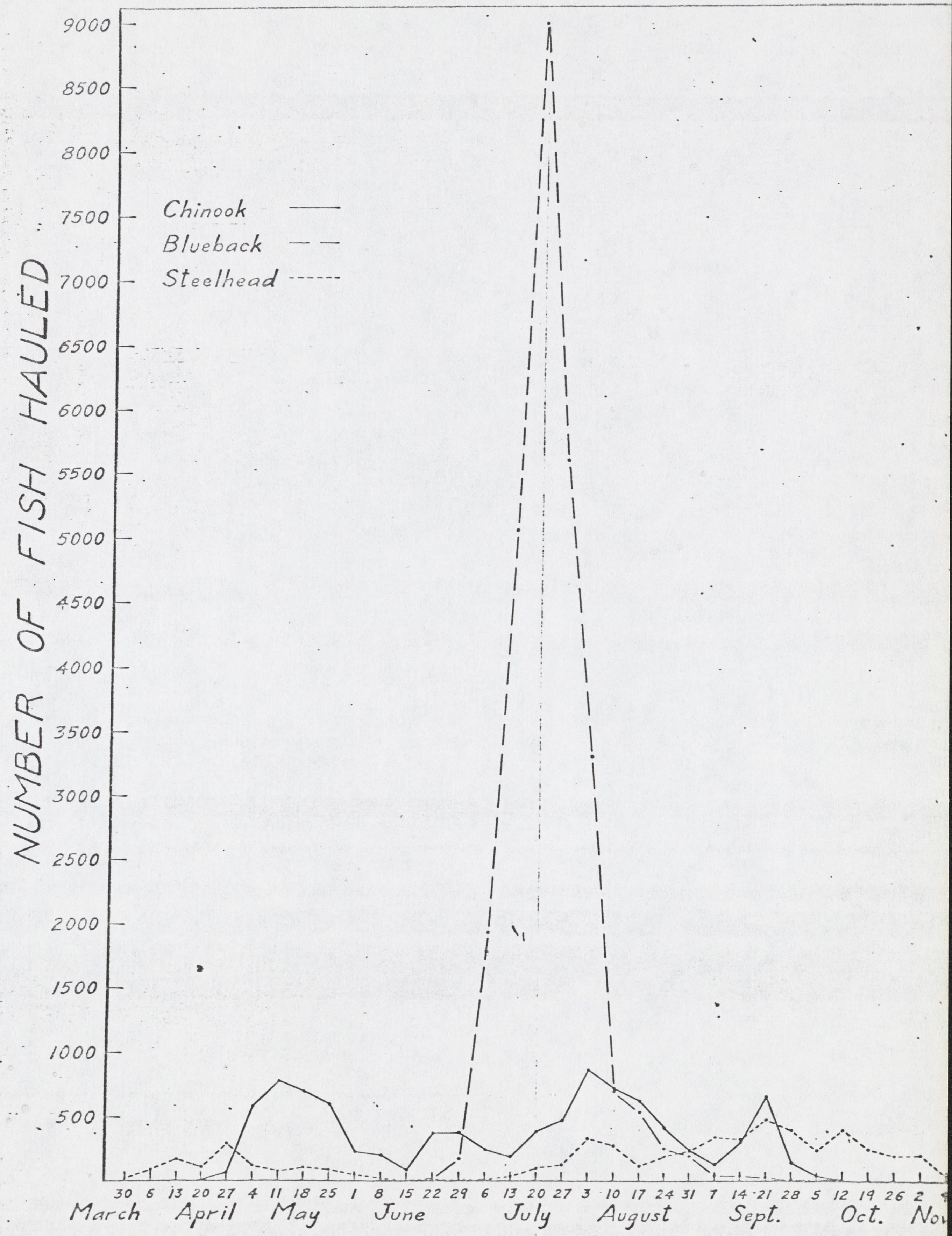
SUMMARY AND CONCLUSIONS

1. Evidence now available indicates that in its original state the Wenatchee supported runs of chinook salmon which would arrive at Rock Island dam during the last half of July and the month of August, thus forming part of the summer or late run. The original run of blueback salmon was present in the river during the latter half of July, all of August and the first part of September. Steelhead apparently migrated upstream in that river in September and October. It is probable that there was also an early spring run of both chinook and steelheads. A run of silver salmon, now extinct, ascended the river during September and October and perhaps later. Efforts were made by the Department of Fisheries, State of Washington, to transplant chinook salmon from other streams to the Wenatchee River. This procedure was carried on over a period of about 17 or 18 years. Some of these transplanted fish were from early spring run stock and others from late fall run parents.

2. Attempts were also made to establish runs of both fall and spring run chinooks in the Methow River. No success was had there in attempting to secure chinook salmon eggs for artificial propagation. Silver salmon and steelhead trout entering the river in September and later were at one time common in the stream. Spawning chinooks have been observed in the main stem of the Methow and in upper tributaries which were definitely of the early spring run variety. No definite evidence of late run chinooks entering the stream is available.

3. Spring run chinooks and fall run silver salmon were apparently abundant in the Entiat River before the runs were destroyed by dams which were not provided with adequate fishways.

4. The Okanogan River and its tributary, the Similkameen, contained runs of chinook salmon which appear to have belonged to the summer or late run group. The bluebacks ascending that stream were present there during July and August.



NUMBER OF FISH HAULED
9000
8500
8000
7500
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
Chinook
Blueback
Steelhead
30 6 13 20 27 4 11 18 25 1 8 15 22 29 6 13 20 27 3 10 17 24 31 7 14 21 28 5 12 19 26 2
March
April
May
June
July
August
Sept.
Oct.

State of Washington

C
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P
Y

THE DEPARTMENT OF GAME
515 Smith Tower
Seattle

April 1, 1942

Mr. V. W. Russell
Resident Engineer
Bureau of Reclamation
Ephrata, Wash.

Dear Sir:

Your letter of March 30, relative to salmon run in the Okanogan River is at hand. Will say that I have been more or less familiar with fish runs in waters of that district for the last twenty odd years and that the information obtained by you from Mr. Michel, the sheriff at Okanogan, is fairly accurate to the best of my knowledge. Will say that the various salmon runs in the Okanogan River were never large in my experience and with the exception of small tributary streams did not spawn to any great extent in the State of Washington but proceeded on into both the Okanogan and Similkameen water shed in Canada. To the best of my recollection these runs started to decline before the construction of Rock Island Dam, probably due to the fact that the spawning tributaries were facing an ever increasing drain for irrigation purposes as the area was developed agriculturally. The construction of the Washington Water Power Dam above the town of Oroville and certain pollution of the river by the Smelter British Columbia, not there before the early 1920's, no doubt had a contributary effect to the depletion of the fish runs.

While there was a run in the early spring, which was of steelhead, this run was small in comparison to the runs of fish which came into the upper Okanogan from August 1, through the fall. Blueback in considerable number were found in the Okanogan River proper during the month of August. These fish all went up the Okanogan River through Lake Osoyoss and eventually into those streams above that body of water and did not utilize any small tributary within the state of Washington. This run was followed by a run of extremely large Chinook salmon which for the most part turned into the Similkameen below Oroville.

The Methow River was much more important from the standpoint of salmon runs. Up until comparatively recent years, runs of steelhead and Chinook have been found in that river. As in the Okanogan the run declined gradually as there was heavier utilization of the streams for power and irrigation. Both the North Fork of the Methow to the falls some 32 miles above Winthrop, mentioned by Mr. Mitchel, and the Twisp River were heavily utilized as spawning tributaries.

The above recollections are as I remember them from an intimate knowledge of the streams named and from my work as a Game Warden in that county during the period mentioned, but are not to be considered as scientifically correct data.

Hoping that this information will be of assistance to you, I am

Yours very truly,

THE DEPARTMENT OF GAME

/s/ M. M. Fruit
Supervisor of Plantings

File 2
JRM
FJS
CBC

July 14, 1941

6-305 19-1

From Supervising Engineer

To Resident Engineer, Wenatchee

Subject: Rehabilitation of tributaries - Migratory fish control - Columbia Basin Project.

1. The Fish & Wildlife Service has indicated its willingness, under date of July 9, to allow us to obtain affidavits from several men who were at or near Leavenworth 25 to 40 years ago, and who can testify that a summer and fall run of salmon existed in the Wenatchee River before becoming exterminated by neglect on the part of the state to maintain a river negotiable for upstream and downstream migrants. The names of these men are as follows:

Les Hart	Leavenworth
Bill Smith	"
John Brender	"

Their composite testimony as taken from the Wildlife report reads as follows: "Before construction of the Leavenworth mill-dam in 1904 or 1905 the fall run of salmon was much larger than the spring run. This fall run was composed of both silvers and chinooks; a good fall run of steelhead also occurred at about the same time. They believe these fish came about September 1. This fall run continued until about 1914-15, after which it rapidly declined. Before the Leavenworth dam was built the Indians' fishing grounds were near the mouth of Tumwater Canyon and on Mason Creek. After the construction of this dam they fished below that structure."

2. It is suggested that affidavits be prepared embodying the pertinent statements contained in the above quotation and that these gentlemen be contacted for signatures thereto. It would be

well to ascertain if there are any incidents which support the belief of these men that the run in question occurred about September 1. This date is very important and any evidence to support its definite fixation will be advantageous. Possibly these three men can give you the names of other early settlers who might corroborate their statements and possibly add to the available information.

3. While similar data for the other tributaries, particularly the Okanogan and Methow Rivers, are not quite as important as the Wenatchee River record, whatever evidence along these lines is readily obtainable should be secured as soon as practicable.

- - -

F. A. Banks

CBC:hb

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

~~COULEE DAM, WASHINGTON~~
Ephrata, Washington
April 23, 1942

6-30-20-1

From Resident Engineer

To Supervising Engineer

Subject: Affidavits to salmon run in the Wenatchee, Methow and Okanogan Rivers.

1. There is enclosed herewith signed affidavits by the following parties:

Mrs. Henry L. Staples	Geo. R. Schmitten
Henry L. Staples	Mike Mahoney
Guy A. Gilmour	George Whistler
John Johnson	Ed J. Bown
Arthur S. Michel	Fay Larkin
R. J. Smith	William Wentworth
Geo. Siverly	J. B. Adams
Chas. Burbank	J. A. Adams

2. I am enclosing also copy of letter received from Mr. M. M. Fruit, Supervisor of Plantings, of the State Department of Game. This letter, while not being very definite, is interesting and may be of some assistance, since it follows closely the same line as the attached certificates.

- - - - -

V.W. Russell
V. W. Russell

Encl. 17

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

R. J. Smith, being first duly sworn, on oath, deposes and says:

"I, R. J. SMITH, do hereby certify that in the years previous to the building of the Lumber Company dam at Leavenworth, which was built in 1904 and 1905, the Silver, Chinook, and Steelhead Salmon all came up the Wenatchee River in large numbers, so many that the stream bed would be covered with them. This run began in September and continued on until late fall. There was a small run in the spring but it was not considered important. Very few salmon were found in the Icicle Creek. Nason Creek was an especially attractive spawning ground, and nearly all the smaller creeks had runs of Silvers and Steelhead. While some of the salmon were able to get over the Leavenworth Dam and also over the Dryden Dam, the Salmon run began to decrease after these structures were in operation."

R. J. Smith

Subscribed and sworn to before me, this 22 day of April, 1942.

C B Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Geo Siverly, being first duly sworn,

on oath, deposes and says:

"I, GEO. SIVERLY, do hereby certify that Steelheads and big Chinook Salmon, and some Silver Salmon used to come up the Wenatchee River in large quantities. In 1899 there were large numbers of Salmon. The gravel bar at the lower end of Lake Wenatchee just below the site of the present fish weir was a favorite spawning bed and the road crossed the river at this point. The salmon were so think they would scare the horses when people were crossing the ford during the spawning season. The run decreased steadily after the building of the power dams at Dryden and Tumwater Canyons."

Geo. Siverly

Subscribed and sworn to before me this 22 day of April, 1942.

C B Frank
Notary Public in and for
the State of Washington,
Residing at Coulee Dam
therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Chas Burbank, being first duly sworn,

on oath, deposes and says:

"I, CHAS. BURBANK, do hereby certify that in the years previous to the building of the Lumber Company Dam at Leavenworth, which was built in 1904 and 1905, the salmon came up the Wenatchee River in very large numbers. Silvers, Chinook, and Steelhead all came up about the same time, the run beginning in the latter part of August and ending in the late fall. This was the time the Indians caught their fish for drying."

Chas Burbank

Subscribed and sworn to before me this 22 day of April, 1942.

C B Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(SEAL)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

I Geo. R Schmitten, being first duly sworn, on oath, deposes and says:

"I, GEO. SCHMITTEN, do hereby certify that in the years previous to the building of the Lumber Company dam at Leavenworth in 1904 and 1905 and the power dams at Dryden and Tumwater Canyon in 1908, the Chinook, Steelhead and some Silvers came up the Wenatchee River, beginning in the latter part of August and continuing through September and on into October until the run was completed. It was during this run that the Indians came and caught and dried their salmon for winter consumption."

Geo R. Schmitten

Subscribed and sworn to before me this 2nd day of April, 1942.

C. B. [illegible]
Notary Public in and for the State of Washington, Residing at [illegible] therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Fay Larkin, being first duly sworn,

on oath, deposes and says:

"I, FAY LARKIN, do hereby certify that in the years previous to the building of the power dams in the Wenatchee River that salmon came up the River in large quantities; Silvers, Chinook, and Steelheads all came up about the same time the run beginning the last of August and continuing into late fall."

Fay Larkin

Subscribed and sworn to before me this 22 day of April, 1942.

C B Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

J. B. Adams, being first duly sworn,

on oath deposes and says:

"I, J. B. ADAMS, do hereby certify that in the years previous to the building of the Lumber Company Dam at Leavenworth, which was built in 1904 and 1905, the salmon came up the Wenatchee River in very large numbers. Silvers, Chinooks, and Steelhead all came up about the same time, beginning about the first of September and continuing on into November before they were all gone. All the creeks had their runs of Silvers and Steelheads. Nason Creek was especially attractive to Silvers and Steelhead. Very few salmon, however, were found in the Icicle Creek. As soon as the Leavenworth Dam was built, the salmon runs began to weaken and by the time the Dryden Dam was put into operation in 1908 the runs were practically at an end. The spring run was not considered of any importance and the Indians never came up in the spring but about September 1 they came in large numbers and caught and dried all the salmon they needed for the winter supply."

J. B. Adams

Subscribed and sworn to before me this 22 day of April, 1942.

C. B. Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

J. A. Adams, being first duly sworn,

on oath, deposes and says:

"I, J. A. ADAMS, do hereby certify that in the years previous to the building of the Lumber Company Dam at Leavenworth, which was built in 1904 and 1905, the salmon came up the Wenatchee River in very large numbers. Silvers, Chinooks, and Steelhead all came up about the same time, beginning about the first of September and continuing on into November before they were all gone. All the creeks had their runs of Silvers and Steelheads. Nason Creek was especially attractive to Silvers and Steelhead. Very few salmon, however, were found in the Icicle Creek. As soon as the Leavenworth Dam was built, the salmon runs began to weaken and by the time the Dryden Dam was put into operation in 1908 the runs were practically at an end. The spring run was not considered of any importance and the Indians never came up in the spring but about September 1st they came in large numbers and caught and dried all the salmon they needed for the winter supply."

J. A. Adams

Subscribed and sworn to before me, this 22 day of April, 1942.

C B Funk
Notary Public in and for the State of Washington,
Residing at Coulee Dam Wn therein.

(S E A L)

AFFIDAVIT ON MIGRATORY FISH

IN THE OKANOGAN RIVER

State of Washington)
)SS
County of Douglas)

C. C. Beery, being first duly sworn, on oath deposes and says:

Some thirty years ago about 1910-11, there were heavy runs of large "King" Salmon in the Okanogan near Oroville, and many Indians camped near the rapids below Lake Osoyoos during the last of August and early September to capture salmon. They speared a great many and fished at night with flashlights.

I recall catching a 50# "King" on August 26 about thirty years ago. The largest one I ever caught in that vicinity weighed 55#, but there were large quantities caught weighing 35# or 40#.

I recall borrowing an Indian's spearing rig at one time and fastening the cord attached to the spear around my waist, as was the Indian custom, and spearing a big "King", who rushed off with such power that I was pulled backward into the river and nearly drowned.

On Salmon Creek great numbers of "King" Salmon crowded this small stream and I have seen big fellows five miles above its mouth in pools too shallow to cover the fish and wondered how they managed to work their way so far up stream over the many ledges and falls.

The "King" run on the Okanogan was followed by a run of "Dog" or Chum Salmon--a white meated variety--not considered very desirable.

C C Beery

Subscribed and sworn to before me this 11th

day of ~~April~~ May, 1942

C. B. Funk
Notary Public in and for the
State of Washington, residing
at Coulee Dam

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Mrs Henry L Staples, being first duly sworn,

on oath, deposes and says:

"I, MRS. HENRY L. STAPLES, do hereby certify that the spring run of salmon at Oroville was a small variety but do not know the name. The fall run was mostly the big Chinook; a few Silvers and Steelheads. These fish came up in August and September and some in October. The Indians camped at the forks of the rivers and caught and cured their fish during August and September. They used the regular Indian willow traps across the Okanogan River and caught all the salmon they needed. I found at one time a few Chinook Salmon in the sloughs at the lower end of Palmer Lake, but do not believe any number ever went beyond the falls of the Similkameen River. Salmon spawned in the bed of both rivers."

Witness: C B Funk - Coulee Dam, Wn
V. W. Russell - Ephrata, Wn

her
) [mark]
mark

Subscribed and sworn to before me this 21 day of

April, 1942.

C. B. Funk
Notary Public in and for the
State of Washington, Residing
at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Henry L Staples, being first duly sworn,

on oath, deposes and says:

"I, HENRY L. STAPLES, do hereby certify that the spring run of salmon at Oroville was a small variety but do not know the name. The fall run was mostly the big Chinook; A few Silvers and Steelheads. These fish came up in August and September and some in October. The Indians camped at the forks of the rivers and caught and cured their fish during August and September. They used the regular Indian willow traps across the Okanogan River and caught all the salmon they needed. I found at one time a few Chinook Salmon in the Sloughs at the lower end of Palmer Lake, but do not believe any number ever went beyond the falls of the Similkameen River. Salmon spawned in the bed of both rivers."

Henry H. L. Staples.

Subscribed and sworn to before me this 21st day of

April, 1942.

C B Funk
Notary Public in and for the
State of Washington, Residing
at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Guy A Gilmour, being first duly sworn, on oath, deposes and says:

"I, Guy A. Gilmour, do hereby certify that large numbers of Chinook Salmon came up the Okanogan and Similkameen Rivers in August and September; some Steelhead and a few Silvers also came up. Since 1936 very few Chinook have come up, after the Chinook stopped coming a smaller variety came up for a few years, these were believed to be Blueback. As far as I know these salmon did not go above the falls of the Similkameen where the power dam is now located. The bed of the Similkameen River was used by the salmon for spawning beds."

Guy A Gilmour

Subscribed and sworn to before me this 21st day of April, 1942.

C. B. Fink
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Mike Mahoney, being first duly sworn, on oath, deposes and says:

"I, MIKE MAHONEY, do hereby certify that big Chinook Salmon came up the Okanogan River in August and September; some Silvers and Steelhead came with this run. There was a spring run of a smaller variety, species unknown. The beds of both the Similkameen and the Okanogan Rivers were excellent spawning beds. The salmon did not go above the falls of the Similkameen."

Mike Mahoney

Subscribed and sworn to before me this 21 day of April, 1942.

C B Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(S E A L)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

George Whistler, being first duly sworn,

on oath, deposes and says:

"I, GEORGE WHISTLER, do hereby certify that in August and September the salmon came up the Okanogan River in large quantities mostly Chinook. There was a spring run of salmon of unknown name, but of very high quantity. In 1887 and 1888, I know salmon went up to Conconully during the high water. Salmon did not go above the falls of the Similkameen.

George Whistler

Subscribed and sworn to before me this 21 day of

April, 1942.

C. B. Funk
Notary Public in and for the
State of Washington, Residing
at Coulee Dam therein.

(SEAL)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Ed J Bown, being first duly sworn, on oath, deposes and says:

"I, ED J. BOWN, do hereby certify that before the dam was put in Salmon Creek just above the town of Okanogan, the Salmon came up to Conconully in considerable numbers in the latter part of May and June and I am sure these Salmon were the small Chinook."

Ed J. Bown

Subscribed and sworn to before me this 21st day of April, 1942.

C B Frank
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(SEAL)

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

William Wentworth, being first duly sworn, on oath deposes and says:

"I, WILLIAM WENTWORTH, do hereby certify that before the dam was built across the Salmon Creek above the town of Okanogan that I used to catch Salmon at Conconully in latter part of May and June which was during the high water period."

William Wentworth

Subscribed and sworn to before me, this 22 day of April, 1942.

C. B. Faust
Notary Public in and for the
State of Washington, Residing at
Coulee Dam therein.

(S E A L)

Affidavits - former Salmon Run. 6156

I. Wenatchee River:

1. R.J. Smith, Leavenworth	Prior to 1904-5, a big run in Sept. & Oct. of Chinook Silver & Steelhead - Nason Cr. had a big run.
2. Geo. Siverly	In 1899 particularly there was a big run of Big Chinook and Steelhead - some Silvers: many speared on gravel bar at lower End of Lake Wenatchee.
3. Chas. Burbank	Prior to 1904-5 Silvers, Steelhead & Chinook all came up to L. in large quantities beg. latter part Aug. & thru Sept. & Oct.
4. Geo. R. Schmitten	Same as No. 3.
5. Fay Larkin	" " " "
J.B. Adams.	" " " " plus. Indians never bothered with the spring run but during September & Oct. came in large numbers & caught all they needed for winter supp.
J. A. Adams	Same as No. 6

II. OKANOGAN RIVER

C.C. Beery	Heavy runs of King Salmon near Oroville in late Aug. & Sept. Indians camped there & speared by flashlight. followed by a "Chinook run"
Mrs Henry L. Staples	Fall run was mostly Big Chinook; few Silvers & Steelhead. Salmon spawned in Similkameen & once saw a few Chinook at foot Palmer L., but not many could surmount the falls. Indians trapped in Okanogan with willow traps.
10. Mr. " " "	Ditto No. 9.
1. Guy A. Gilmour	About same as No. 9.
2. Mike Mahoney	" " " " " [in 1887-8.
3. Geo. Whistler	" " " " plus salmon reached Conconully
4. Ed. J. Bown	Salmon came to Conconully in May & June in early years
5. William Wentworth	" " " " " "

III. Methow River

	[and at Falls on the W. Fork 32 mi. above W.
6. John Johnson	Many salmon @ old hatchery site 2 1/2 miles above mouth
7	ditto

AFFIDAVIT AS TO SALMON RUN

STATE OF WASHINGTON)
: ss.
COUNTY OF CHELAN)

Arthur S. Michel being first duly sworn, on oath, deposes and says:

"I, ARTHUR S. MICHEL, Sheriff of Okanogan County, do hereby certify that I have been familiar with the salmon runs in the Okanogan River since 1909, and that Silvers and Chinook came up the Okanogan River in large numbers, mostly Chinook. These runs began to diminish with the building of the Rock Island Dam. The spring run were a smaller fish and probably were Steelhead. The salmon did spawn to some extent in the lower twenty miles of the Okanogan River. The Methow River was an important salmon stream and I have seen the salmon thick below the old dam at the old hatchery site about 2½ miles up the Methow River from Pateros and I have seen the salmon at the falls 32 miles up the North Fork of the Methow River above Winthrop."

Arthur S. Michel

Subscribed and sworn to before me this 21 day of April, 1942.

C. B. Funk
Notary Public in and for the State of Washington, Residing at Coulee Dam therein.

(SEAL)

C
O
P
Y

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH and WILDLIFE SERVICE
WASHINGTON

May 12, 1941

Mr. John C. Page, Commissioner,

Bureau of Reclamation.

My dear Mr. Page:

Transmitted herewith is a report entitled "Time of Appearance of the Runs of Salmon and Steelhead Trout Native to the Wenatchee, Entiat, Methow, and Okanogan Rivers", by J. A. Craig and A. J. Suomela. This report has been prepared specifically at the request of Mr. F. A. Banks of the Bureau of Reclamation to answer as conclusively as data permit the question raised by Mr. B. M. Brennan, Director of the Washington State Department of Fisheries, regarding the existence of summer and fall spawning stocks of salmon under primitive conditions in the Wenatchee River and other tributaries of the Columbia River where fish from these late runs are now being transferred in connection with the Grand Coulee salmon salvage program.

This question was raised by Mr. Brennan during a meeting held in his office with representatives of the Bureau of Reclamation and the Fish and Wildlife Service, at which time an attempt was made to place responsibility for stream improvement and adjustment of water flow to assure successful migration and spawning in these streams during the extremely low water which is expected during the coming summer.

This report is not for publication in itspresent form because of the inclusion of confidential material related to the controversy which has arisen. It should be regarded as an administrative report to aid the agencies concerned in developing a proper program.

A carbon copy of the report is also enclosed for Mr. Banks, who desires to have the information in the very near future.

Very truly yours,

/s/ CHAS. E. JACKSON

Acting Director.

Bullshit article relating somewhat to your methodology paper

SHOULD WE AGREE THAT SOME STANDARDIZED MINIMUM SET OF STREAM HABITAT COMPONENTS SHOULD BE MEASURED BY EVERYONE, REGARDLESS OF THE HABITAT EVALUATION METHODS UTILIZED?

by

James W. Mullan

U.S. Fish and Wildlife Service
Leavenworth, Washington

Abstract: The answer to the panel question is apparently no, at least for the time being, but there would appear to be many areas of common agreement concerning such measurements.

INTRODUCTION

Throughout the history of limnology and fisheries there has been much concern with lake and stream classification. Most categories that have been proposed do not apply on a worldwide basis, in contrast to geologic, soil and vegetation classifications, and are vitiated by regional factors (Cole 1977, Pennak 1977, Bailey 1982).

Lake classifications have been based on at least: geologic origin, edaphic factors, geographic and hydrologic features, trophic status, water chemistry, annual circulation patterns, the morphoedaphic index, and complex taxonomic schemes involving chemical, geographic, morphologic and biotic elements (Cole 1977). Cole (op cit) suggest that classification of lakes should be founded on assay at the regional level, but with comparative reference to relevant categories elsewhere; a truism equally applicable to streams considering geomorphics (i.e., Platts 1979, Harding 1981, Parsons et al. 1981).

Although lake classification systems leave much to be desired, Pennak (1977) notes that we nevertheless find common agreement on certain principles which have been generally adopted and refined during the past 50 years (i.e., the oligotrophic-mesotrophic-eutrophic series), whereas lotic classification systems are highly unsatisfactory. In contrast to the physical-chemical-biological unity and the persistent and pervasive identity of a lake ecosystem, most streams consist of a longitudinal series of different alternating but intergrading communities and habitats (op cit.).

The end result of this dilemma is that we have great difficulty in integrating lotic ecosystems with terrestrial ecosystems in land and water use planning (Platts 1980, Lotspeich and Platts 1981, Bailey 1982). It may be assumed that some standardized minimum set of habitat components measured by everyone, regardless of the habitat evaluation methods utilized, is the first step in resolving the problem.

Western AFS
Jackson Hole
1983

CONCEPTS

Pennak (1977) recognized seven distinctive lotic habitats that are remarkably similar from one part of the country to another: spring brooks, tundra brooks, mountain trout streams, sandy streams and rivers of the Great Plains, medium to large silted rivers, sewage pollution stretches, and irrigation ditches. The majority of the many other kinds of lotic habitats he grouped together as indistinctive and recommended that such waters be characterized by means of a larger cluster of physical and chemical measurements: width, flow, current speed, substrate, summer temperatures, winter temperatures, turbidity, total dissolved organic matter, total dissolved inorganic matter, water hardness, dissolved oxygen, rooted aquatics, and streamside vegetation. Earlier Pennak (1971) had demonstrated that any two lotic stretches of habitat that were similar with reference to these features would have parallel groups of genera and species in their biotic communities, even though the relative densities may differ greatly in the two localities.

During the last decade, the instream flow field has been in a constant state of evolution and there has been a bewildering proliferation of methodologies (Orsborn and Dean 1976, Orsborn and Allman 1976, Stalnaker and Arnette 1976, Wesche and Rechard 1980, Armantrout 1981) addressing stream habitat evaluation. In large part this effort has been directed towards Pennak's mountain trout stream category, or variations, using his recommended physical attributes that lend themselves to quantitative measurement and mathematical treatment. Where criteria are available (i.e., migration and spawning flows for salmonids) good relationships between potential instream resource quality and flow level can be developed. The point of flow recommendation and establishment is where the analysis fails to provide the type of information needed. One or two flow levels, or even a range of flow levels, without some sort of a production function is of limited value for evaluating alternative management options (Orsborn and Deane 1976) or biological consequences (Wesche and Rechard 1980).

Attempting to understand stream phenomena by detailed study of smaller and smaller components and then synthesizing the parts into a functional whole involves large-scale complexity at each hierarchial level. Fairly obviously we currently are in the midst of such process in melding the many known qualitative relationships between biological and physical requirements of fish and interactions between factors that make up the stream environment in quantitative terms. It is also evident that the environmental movement of recent years has generated a strong demand for various indexes to habitat quality at the ecosystem level of organization using indicator species or factors. Dynamic functional modelling and "red flag" assaying are approaches that have traditionally complemented each other in science (Ryder et al. 1974). Accordingly, much of the disarray signified by the proliferation in methodologies, employing a disparity of parameters, may be more illusory then real.

Overwhelming complexity can be countered with overriding simplicity (Odum 1977) and I conceptualize four clusters of deterministic components in a salmonid stream: (1) size, (2) structure, (3) temperature-chemical climate, and (4) community inhabitants, based on the dependent variables discussed by Hynes (1972) White (1973, 1977), and Wesche and Rechard (1980). In addition, I have attempted to build on the lentic experience where the principle involved in an interaction between variables would seem to equally apply to lotic habitat.

Stream size: Stream length, width, depth, area and flow are all surrogates for the size of the world fish can live in. Presumably, the more water vailable and the larger the fishes' world, the greater the abundance, all other factors being equal. But, other factors do not remain equal as the size of the fishes' world increases or decreases (Wesche and Rechard 1980); still it is axiomatic that some threshold amount of water is required. This may amount to one cfs in a small brook or 500 cfs in a large river. There is no upper extinction level to the size of the lotic world a fish can inhabit, but there may be an optimum range by species, beyond which production declines (Mullan 1960, Binns 1979). Regardless of the variables involved, it would seem that we have already agreed that size of the stream should be measured because this attribute is a common denominator of all methodologies. There also is common agreement that assessment should include maximum flows regulating channel morphology, as well as survival of eggs, juvenile fishes and benthos in record floods, and minimum flows, either in summer or winter, affecting the plant and animal community (Binns 1982, Hall and Knight 1981).

Habitat structure: Habitat structure relates to that portion of the stream channel and water volume that fish or bottom fauna can effectively use. Salmonids are strongly territorial in behavior and primarily occupy a limited area referred to as microhabitat, territory, or home area during some or all of their stream life. Permanence of station is determined by availability of food and cover and the aggression of other salmonids or interacting species. Cover may consist of water depth, surface turbulence, substrate, undercut banks, aquatic and terrestrial vegetation--in fact, almost anything that allows salmonids to avoid impact of the elements (i.e., current, sun, ice, etc.) or predators (Chapman 1966, Chapman and Bjornn 1969, Allen 1969, Binns 1982).

Efficiency of occupancy, particularly as it applies to food gathering and energy expenditure, depends on the spatial demensions of the channel in relation to where food and cover come together as edge creating micorhabitat (Clemens 1958, McFadden 1969). Salmonids generally are fish of low mobility and complex needs requiring diversity of microhabitat (i.e., resting, feeding, spawning) in acheiving optimum population density (Allen 1951, 1969a). "Edge" diversity provided by shoreline in relation to water area decreases with increases in stream width and undoubtedly relates to any optimum range in size of habitat. Such a relationship could be analogous to the fact that small lakes generally are more productive then large (and deeper) lakes due to small (and shallower) lakes having a large proportion of the substrate in the productive littoral zone (Ryder et al. 1974).

Despite the recognized importance of cover, measurement of cover per se has not received the attention warranted in current methodologies although there have been notable exceptions (i.e., Banks et al. 1974, Binns and Eiserman 1979, Wesche 1973, Fraley and Graham 1981). One of the reasons for this is that physical dimensions of a stream can be much more rigorously quantified then cover (Binns 1982). Also, physical attributes of substrate, depth, or both are measures of cover, if for no other reason then the fact that water velocities are lowest at the substrate interface (Gosse and Helm 1981). However, the gravel, rubble, rock, boulder substrate of most salmonid streams does constitute cover, depending on the size of the fish. For example, it was recently demonstrated that the reduction in sand bedload in a Michigan stream greatly enhanced the survival of small trout, apparently as a result of uncovering gravel, cobble, sticks, and other obstacles which provided more microhabitat for small fish (Alexander and Hansen 1982).

Temperature-chemical climate: For practical purposes, basic requirements of all salmonids may be considered to be similar. All species are cold water fish requiring cool, generally less than 70°F degrees, well oxygenated water (≥5ppm). Unpolluted salmonid streams are remarkably similar in that dissolved oxygen is almost always adequate (near 100 percent saturation) due to gradient, but differ from each other most often in temperature regime. Differences range from spring creeks with constant year-round temperatures at the preferred 45-55°F to streams with fluctuations from freezing (32°F) to beyond the upper lethal temperature (77°F) for short periods, with a vast disparity in intergrades. While no one can fault temperature as a primary ecological regulator in streams, the value of one or a few random readings as an indicator of temperature conditions prevailing during the life history of the organisms comprising the community can be questioned. Inasmuch as it is extremes of temperature that limit certain groups of organisms, particularly salmonids, I don't think anyone will disagree that temperature measurements should encompass at least one annual cycle and preferably a longer period of climatic variability (Binns 1982).

Readily-measured keys to understanding chemical nutrient supply of streams are yet to be perfected, although long sought by biologists, with fair success in ponded waters (Ryder 1965, Jenkins 1967, Ryder et al. 1974, Dillon and Rigler 1974, 1975, McConnell et al. 1977, Carlson 1977, Jenkins 1982). It would seem of more then passing interest that all of the more viable trophic indexes developed for lakes can be related to total dissolved solids (TDS). Ryder et al. (1974) points out that TDS (or any of its correlates such as conductivity, which is easily and accurately measured) represents an average edaphic condition for any watershed, as chemically it proportions the effects of various soil and geological conditions as reflected by both allochthonous and autochthonous dissolved minerals. Further, TDS may well be proportionate to one or more of its vital or limiting component parts such as carbon, phosphorus or nitrogen (Ryder et al. op cit.).

If we are also to benefit from the lentic experience, we should note that consistency of stream typology is a goal, and that it is not likely that acid-mine waste streams, marl streams, hot spring effluents and other atypical situations will fit simple indicators or categories, at least at the regional level. Most salmonid streams are not highly mineralized depending upon distance from source, time of year, volume of flow and local geochemistry. Furthermore, the more highly mineralized streams, other factors not being limiting, have been found to support the highest benthos and fish populations, and it is the relative differentiation of this narrow range of values on the bottom of the trophic scale that is of most pragmatic concern.

Community inhabitants: If only one species of fish existed in a stream, it would occupy a relatively wide range of microhabitats, an expression of the potential niche. With coexistence of two or more species, available and suitable microhabitats are partitioned between the species, an expression of the realized niche. The contraction of the potential niche into the realized niche is an adaptive evolutionary strategy to avoid direct competition between species. It forces a change from generalist to specialist in regard to habitat selection and feeding preferences (Behnke in press, Bisson et al 1981).

An important outcome of niche theory is that the sum of two or more realized niches is greater than the sum of one potential niche, although realization of the latter provides more biomass of an individual species (Behnke is press). For example, it has been demonstrated that numbers and biomass of either rainbow or brown trout were consistently depressed ponds where other fishes were removed, but containing abundant young-of-the-year planktivorous alewives introduced as forage (McCaig 1980).

Severity of interaction between species would seem to be largely a matter of how well a habitat favors a species, because each species is genetically programmed to perform within certain limits of heat and cold, water content of salts and gasses, habitat structure as well as being influenced by competition for food and space and the effects of predators (White 1977). Li and Schreck (1982) observed that mathematical approaches to measure habitat quality tend to ignore competition for food and space. Current emphasis in modelling of habitat quality for fishes is through the application of species habitat criteria (i.e., depth-velocity-substrate criteria for a given life history stage of a species) as typified in suitability curves. Li and Schreck (op cit) found that a new and different suitability curve had to be drawn to describe the relationship between cutthroat trout abundance and any particular variable when competitors were present. When biological competition was included as an assumption of the model, predictive errors dropped substantially. Without the correction, overestimates of cutthroat trout density were generated, which is not unexpected in light of the foregoing discussion.

Using bottom fauna as an index to habitat quality is also fraught with similar variability. A low value of benthos may not in itself indicate a low productivity, but a high productivity due to efficient predation by the fish population.

A faunal complex or indicator species can provide important insight between abiotic and biotic interrelationships, regardless of the problems in interpretation. This is because species have evolved specialized adaptive features in behavior and physiology so as to maximize efficiency of energy conversion and utilization of environmental resources (Behnke in press). With critical or total changes in habitat (i.e., drastic pollution of lakes and streams), we have little trouble in understanding the reasons for the changes in species that inevitably occur. Less obvious is the meaning to be drawn from changes in species, abiotic impacts, or both when the habitat retains its essential structure and function (Hall and Knight 1981).

Miller and Brannon (1981) recently conceptualized the evolution of the intricate web of interactive life history patterns that constitute the Pacific salmonid ecosytems, and, in turn, made possible the remarkably fine-tune fit between biological attributes of the populations. According to these theorists, the lower reaches of the high gradient, infertile North Pacific streams with then frequent floods would have been highly unpredictable and relatively inhospitable habitats for resident salmonids, whereas spring and fall freshets provide a relatively predictable vehicle for emergence and outmigration of young and spawning migration of adult anadromous salmonids. While these authors' augments for such a differentiation primarily focuses on temporal and spatial temperature regime as effecting fry emergence for the genus <u>Oncorhynchus</u>, one can only wonder about a commensurate intergrader of food and cover, especially in decerning between possible trade-offs in resident vs. anadromous salmonid management.

Newly hatched salmonids can only tolerate nearly-still water. As the young fish grow, they are associated with velocities and depths in proportion to body size, shifting to faster, deeper waters and larger territories as they become larger. It is not unreasonable to speculate that in the high gradient, infertile streams of the Pacific Northwest that the energy expenditure used to capture food organisms in successive early life phases, increasingly leaves little energy available for growth, thus favoring anadromous salmonid species that primarily escape from such limitations by rearing in the food rich ocean. Sedell and Luchessa (1981) infer a similar parrel for the dominance of cover in ameliorating the effects of excessive velocities. Using the historical record, these authors demonstrate the strong correlation between the decline of wild anadromous fish stocks and channelization and the cleanup of streams that has accompanied settlement. Side channels and sloughs and accumulations of large woody debris (i.e., fallen trees) once were characteristic of streams in coastal rain forests and provided an abundance and diversity of rearing habitat for small anadromous salmonids.

WHAT CAN WE AGREE ON?

Of the four general classes of components listed, the question arises as to which are the most important? The answer to the question is an unequivocal, "they all are" with each habitat constituent or surrogate directly influencing the type and quantity of salmonid population that is able to exist under a given set of conditions (Wesche and Rechard 1980). An important point not to be overlooked, however, is how one factor may outweigh another, depending on the mix and interaction of factors, and the essentiality of identifying the factor primarily limiting the resource.

Binns (1979) points out how in reality, any investigation of the limiting factors acting on a salmonid stream is controlled more by man's ability to measure than by theoretical considerations as to the true dominant limiting factors. Single-criterion measurements obviously are out, accordingly, there is much to be said for zeroing in on few carefully selected components that monitor the performance of the whole, either by stream types or problem perturbations (i.e., Oswood and Barber 1982, Helm et al. 1981, Graham et al. 1981), while at the same time not overlooking the obvious. For example, it is clear that habitat requirements for migration, spawning and incubation of anadromous salmonids all too frequently have been judged most critical, perhaps because spawners or redds can be counted, gravel enumerated and egg to fry survival estimated comparatively easily, with little or no consideration given to constraints on rearing habitat (Sedell and Luchessa 1981, Behnke in press). Nature has only one measure of success---survival---and very rarely, if ever, is ultimate survival determined by some ultimate largess of egg deposition and hatching.

Lastly, I think we can all agree with Platts (1980, 1981) that lotic habitat classification and evaluation is not going to get simpler, but more complex, although perhaps more manageable, and that garbage in is still going to equal garbage out.

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UNITED STATES GOVERNMENT

memorandum

DATE: 9/20/85

REPLY TO ATTN OF: Project Leader, Leavenworth FAO

SUBJECT: Leavenworth Hatchery Complex spring chinook salmon escapement, 1985, and related information.

TO: John Miller, Area 1 Supervisor
RO, Portland

Leavenworth NFH: About 8,000 spring chinook salmon returned to the Leavenworth Hatchery in 1985:

	3,295	used in propagation
	3,340	given to Yakima Indians (mid-June to early July)
	1,000	harvested in Icicle Cr. sport harvest (appendix 1)
	365	remaining in Icicle Cr. (appendix 2)
Total	8,000	

Jacks made up 3%, 4-yr. olds 65%, and 5-yr. olds (or older) 32% of the escapement (based on the length frequency distribution of 2,251 fish measured at time of spawning). Typically, females (55%) outnumbered males (45%). The year 1985 essentially completed returns for the 1980 brood year (1.88 million smolts released in 1982) for a total hatchery escapement of 0.28% (vs. 0.08% and 0.16% for brood years 1979 and 1978). The return of 5,220 4-yr olds in 1985, from the 1981 brood year release represents a hatchery survival of 0.27%, which bodes well for having ample fish return in 1986 for both broodstock and a sport fisheries.

Entiat NFH: A total of 793 spring chinook were used in propagation; however, this is by no means the total hatchery escapement. Entiat NFH is located on the Entiat River six miles above the confluence with the Columbia River and the hatchery holding pond was filled to capacity and closed to subsequent returning brood stock in early June. The Entiat River is not racked.

Inter-dam counts indicated a total wild and hatchery escapement of spring chinook to the Entiat River in 1985 of 3,671 fish. Leavenworth Hatchery spring chinook constituted 45% of the total inter-dam escapement to the Wenatchee River, and Winthrop Hatchery escapement constituted 23% of the spring chinook passing Wells Dam. Accordingly, one may peg the total hatchery escapement to the Entiat River as between 844 (23%) and 1,652 (45%) spring chinook. Based on an actual in-hand count of 793 spring chinook recovered early in the run, the actual hatchery component of the total escapement to the Entiat River perhaps had the magnitude of that of the Wenatchee River (45%) rather then that of the Methow River (23%).

Age composition of Entiat Hatchery spring chinook varied some what from those recorded at Leavenworth Hatchery: 81% consisted of 4-yr olds and 19% 5-yr olds; there were no jacks (based on the length frequency distribution of 469 fish measured at time of spawning). The sex ratio was also slightly different: 41% males, 59% females. However, these differences could merely be artifacts resulting from selective measurement of only a portion of the run. Jacks are excluded in the trapping and antibiotic treatment that occurs in the fish ladder before the fish are released into the holding pond.

Assuming that 1980 brood year survival was similar between Entiat and Leavenworth hatcheries (0.13% for 5-yr olds resulting from 658,098 smolts released in 1982 and 0.27% for 4-yr olds resulting from 623,373 smolts released in 1983), minus the additional turbine mortality (13%) of outmigrating smolts associated with Rocky Reach Dam, Entiat Hatchery escapement could have amounted to 2,200 spring chinook or 60% of the total Entiat River escapement.

A blatant, illegal sport fisheries occurred on the Entiat River during May and June 1985. In no way was this sport fisheries surreptitious; the crowds and campers were as obvious as those of the Icicle Creek spring chinook sport fisheries. Best guess, using the 12.5% harvest rate for Icicle Creek, is that the illegal harvest amounted to 459 fish. Rumors (e.g., individuals catching 100 to 200 fish) suggest that such a harvest may be low.

Winthrop NFH: About 1,200 spring chinook voluntarily returned to Winthrop Hatchery in 1985. Age composition (based on the length frequency distribution of 777 fish measured at time of spawning), sex ratio, and sizes were similar to Leavenworth Hatchery:

	Leavenworth	Entiat	Winthrop
Age composition			
Jacks	3%	0	2%
4-yr. olds	65%	81%	66%
5+yr. olds	32%	19%	32%
Sex ratio			
Females	55%	59%	62%
Males	45%	41%	38%

Average (upper number) and range (in italics) of fork length (cm) and corresponding age.

Hatchery	3 F	3 M	4 F	4 M	5 F	5 M
Leavenworth	-	55	75	82	89	100
		(42-64)	(63-83)	(67-91)	(84-100)	(92-111)
Entiat	-		75	79	86	97
			(67-81)	(68-90)	(83-96)	(92-106)
Winthrop	53	47	75	84	87	99
	(53)*	(38-58)	(63-83)	(69-88)	(84-102)	(89-109)

* Only two fish

The 791 4-yr old spring chinook that returned to Winthrop Hatchery in 1985 from the 1981 brood year release of 966,300 smolts represented a return of 0.08%. The 383 5-yr old spring chinook that returned from the 1980 brood year release of 1,207,000 smolts represented a return of 0.03%. While these are dismally low returns it should be noted that smolts from Winthrop Hatchery must pass nine dams enroute to the sea.

Turbine mortality per dam is about 13%[1] or a total mortality of 71% of smolts released. Theoretically, then, excluding turbine mortality, the 791 4-yr. old spring chinook in the Winthrop Hatchery escapement represented a

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[1] McKenzie, et al. 1983. 1982 systems mortality study. Battelle Pac. Northwest Labs for Chelan Co. PUD. McKenzie, et al 1984. 1983 systems mortality study. Battelle Pac. Northwest Labs for Chelan Co. PUD.

survival of 0.28% and the 385 5-yr olds a survival of 0.10%. If we treat the 1985 Leavenworth Hatchery escapements (5,220 4-yr olds and 2,528 5-yr olds) in a similar fashion, but allow for turbine mortality at only seven dams, it becomes obvious that survival (0.71% for 4-yr olds and 0.35% for 5-yr olds) is appreciably different between Leavenworth and Winthrop hatcheries.

Wrap-up: The 26,758 spring chinook counted over Rock Island Dam in 1985 represented an all time record since counting began in 1935. The next best years were in 1977 (19,382) and 1978 (20,406). The Leavenworth Complex hatcheries contributed about 11,000 fish (Entiat hatchery contribution estimated at 1,800) to the record run of 1985 or 41%. The Rock Island Dam count of wild spring chinook was a near record (15,758) in 1985 and only exceeded in 1978 (19,481). Synchronization of relative survival rate for both hatchery and wild spring chinook in the mid-Columbia River has long been true indicating the incommon importance of ocean survival.

Assuming comparable mortality between wild and hatchery smolts at dams suggest that if 3.9M hatchery smolts resulted in a return of 11,000 adults in 1985, than the 15,758 wild adults that returned might have been represented by 5.6 million smolts. However, it is likely that wild smolts produce 4-5 times as many returning adults as hatchery smolts, due to delaying the rigors of natural mortality on hatchery fish until released, but such adjustment still leaves 1.4 to 1.8 million naturally produced smolts.

Project Leader

James W Mullan

Appendix 1

Notes: 1985 Icicle Creek Creel Census FAO Leavenworth

The Northwest Steelheaders (Wenatchee and Icicle Creek Chapters) constructed six portable creel census drop card reporting stations (e.g., sign "Report your salmon catch here", holder for creel cards, etc.) and bore the costs ($150) of the creel cards. Cooperation was tremendous and my best guess is that the reported catch was better then 90% complete.

The writer fished the creek on four days. Reconciled observations with reported catches were close (plus or minus 1 or 2 fish). Other checks involving daily and two weekend days servicing the creel census stations, etc., suggest excellent compliance in reporting catches. However, there was some confusion about reporting fishing trips when no fish were taken, particularly early in the season. Negative reporting improved as the season progressed, and frequent and repeated contact was made with anglers explaining the need for this information. There were only one or two wise-guys playing cute games in filling out creel cards. These cards were easily identified and eliminated from consideration. The use of dummy cards on three occassions suggested that creel cards were not maliciously altered or stolen.

Within the foregoing bounds, a reasonable estimate of the sport catch of chinook salmon in Icicle Creek during 1985 would be about 1,000 fish; 910 were reported and I know of about 20 other fish by shore anglers who did not use the drop card stations due to inconvenience, but instead kept journals. Considering that the average catch rate of 10.3 hours per chinook is biased, due to under reporting of negative trips, particularly by shore anglers, best guess is that the true catch rate was about 11.2 hours per fish (90 unreported fish at 20 hours/ fish resulting in 1,800 additional hours of effort based on statistics from other years). This suggests that there was about 2,343 angler trips total for the season (9,403 hrs reported + 1,800 hrs not reported equalling 11,203 hrs divided by an average angler day of 4.8 hrs.).

First runoff of the season commenced two days (May 16) before the season began and water levels of Icicle Creek stayed up remarkably well through to the end of the season (June 30). The peak in the Icicle Creek run of chinook salmon appeared to occur in the first two weeks in June after flows in the Wenatchee River subsided from about 13,000-14,000 cfs down to about 8,000 cfs.

Other fish caught in the fisheries included a handful of suckers (largescale), whitefish, and spawned-out steelhead trout, aside for one "bright" 10 pound steelhead taken June 25.

The larger 5-yr old spring chinook dominated the catch during the early portion of the season. Jacks, which the sport fishery is selective for, did not show until mid season.

Icicle Creek Sport Harvest of Spring Chinook Salmon, 1985.

Date	Number anglers	Number hours fished	No. Salmon Caught Total	Jacks	Catch/ hour	Remarks
5/18	51	244	8	0	30.5	water high, turbid
5/19	28	145	7	0	20.7	8" higher, turbid
5/20	40	147	11	0	13.4	down a little, turbid
5/21	49	262	19	0	13.8	2,500 cfs (?)
5/22	54	229	13	0	17.6	high, turbid
5/23	30	161	10	0	16.1	higher, turbid
5/24	55	192	7	0	26.0	down 1½'
5/25	45	297	16	0	18.6	500 at hatchery
5/26	30	163	17	1	9.6	
5/27	51	243	11	0	22.1	
5/28	35	144	25	0	5.8	bank full, clear
5/29	47	161	9	0	17.9	590 at hatchery
5/30	45	210	15	0	14.0	Wen. R. 13,000 to 8,000 cfs
5/31	45	227	31	0	7.3	bankfull, clear
6/1	43	218	28	1	7.8	
6/2	58	229	47	4	4.9	1,170 at hatchery
6/3	61	235	78	8	3.0	bankfull, clear
6/4	67	258	58	1	4.4	1,467 at hatchery
6/5	53	237	41	5	5.8	
6/6	47	232	17	3	13.6	1,633 at hatchery
6/7	59	268	3	1	89.3	rained, creek 1½'+
6/8	83	540	31	2	17.4	bankfull, clearing
6/9	69	306	37	1	306.0	
6/10	81	377	34	3	11.1	Wen. R. high, turbid
6/11	49	213	33	3	6.4	
6/12	85	354	70	8	5.1	2,142 hatchery
6/13	73	444	35	3	12.7	total 3,350
6/14	84	521	37	1	14.1	bankfull, clear
6/15	57	376	24	3	15.7	" "
6/16	59	283	15	1	18.9	down 1½'
6/17	12	41	8	2	5.1	1st hot day
6/18	39	188	12	0	15.7	
6/19	43	107	23	0	4.6	
6/20	42	193	25	0	7.7	
6/21	31	149	14	0	10.6	
6/22	28	112	16	0	7.0	
6/23	15	73	4	0	18.2	
6/24	22	120	3	0	40.0	low & clear
6/25	29	154	1	0	154.0	lower & clearer
6/26	14	98	6	0	16.3	
6/27	21	81	4	1	20.2	
6/28	14	42	1	0	42.0	
6/29	12	65	3	0	21.6	
6/30	12	64	3	2	21.3	
Total or average	1,967	9,403	910	54 (6%)	10.3	

Appendix 2

Spring chinook remaining in Icicle Creek

Washington Department of Fisheries personnel expressed dismay over the large number of dead, unspawned spring chinook in the annual spawning ground count of Icicle Creek, 8/30/85. John Easterbrooks reported only 17 redds and 43 live chinook (including two jacks), but 136 dead chinook (16 males, 49 females, and 71 unidentified as to sex) from the hatchery downstream to the confluence with the Wenatchee River, a distance of 2.8 miles. Of the 49 females examined, 40 were unspawned.

On 9/6/85 I surveyed the 0.9 mile upstream area once used as holding ponds for the Leavenworth Hatchery and referred to as the Icicle Creek Bypass. Ten redds and 13 live fish were counted. Only one dead fish was found, an unspawned female, but at this time the chinook kill had pretty well run its course and the carcasses consumed by scavengers.

Fish kills as occurred in 1985 have been common from time to time in Icicle Creek dating back to the inception of the Leavenworth Hatchery in 1940. (Fish, F.F. 1944. The retention of adult salmon with particular reference to the Grand Coulee Fish - Salvage Program. USFWS, Spec. Sci. Rept. 27, 29 p.).

Holding ponds at Leavenworth Hatchery (for retaining adult fish between the time of their arrival in May-June and the onset of sexual maturity in August-September) were originally formed in the 0.9 mile section of Icicle Creek bypassed by a diversion canal. Construction of four dams created three separate creek-holding areas. Catastrophic losses of spawners occurred in drought years when water temperatures of Icicle Creek rose into the high 60's F^{o} or low 70's F^{o} and conditions were made favorable for the development of columnaris disease (<u>Flexibacter columnaris</u>). For example, in the 1977 drought 3,000 to 4,000 adult chinook (the entire brood stock) died in early August with little warning. In 1979, an adequate cold water spawning holding facility became operational using well water, and the problem was resolved for the hatchery, but not Icicle Creek.

Climatically, 1985 was an unusual year. The spring was late and colder then normal and flows in Icicle Creek remained substantial through June. By July the snow pack was gone, air temperatures of 90-100^{o}F prevailed, there was no precipitation (only one shower occurred between early June and early September), strong winds were incessant and evaporation was as high as 0.7 inches per day, and flows in Icicle Creek dropped to 50-60 cfs, with water temperatures commonly in the mid to high 60's F in the vacinity of the hatchery, if not considerably higher downstream. In early August night time air temperatures dropped noticeably, and along with augumentation of Icicle Creek flows on August 15 with 37 cfs from cold water released from Snow Lakes, located seven miles upstream from Leavenworth Hatchery at elevation 4,990 feet, conditions for survival improved. Apparently, however, it was about this time that columnaris began to exert its toll.

On July 12 the rack that had excluded passage of adult spring chinook into the Icicle Creek Bypass was removed to allow upstream passage. By the next day chinook were common throughout the entire 0.9 mile length. Many began to die by the end of the week and by the following week a pronounced stinch of rotten fish prevaded the area. On August 22, dead, unspawned chinook were common both in the bypass and downstream in Icicle Creek, as well as live fish. At this time there were six black bears in the vicinity of the hatchery feeding on salmon carcasses and it is assumed that they were highly effective in scavenging carcasses. On August 26 I watched two male and one female chinook spawning in a large, open riffle of the bypass; on September 9 I noted the completed redd but little trace of the carcasses of the spawners except for bear tracks.

Within the foregoing framework I have estimated 365 (about double the spawning ground count) chinook remaining in Icicle Creek that originated as hatchery fish. This estimate is believed conservative. While there is no doubt that some portion of the chinook spawning in Icicle Creek are wild fish, their numbers would not materially alter the estimate of hatchery fish.

Bryant and Parkhurst (Bryant, F.G. and Z.E. Parkhurst. 1950. Survey of the Columbia River and it's tributaries -- Part IV. USFWS, Spec. Sci. Rept. 37) in their stream surveys of the Columbia River Basin described the lower 2 miles of Icicle Creek as having the best spawning and rearing area for salmon. Although their survey was carried out before construction of Leavenworth Hatchery (September 27 - October 7, 1935), these writers provide no evidence that Icicle Creek was a major producer of wild salmon. In fact they provide no record of spring chinook spawning in Icicle Creek although a small number (21) of summer chinook were observed spawning near the mouth in 1935. Local residents stated that the run of chinook in 1935 was the first that had ever spawned in Icicle Creek (Craig and Suomela 1936). Testimony of eight old-time Wenatchee River area residents collected by Craig and Suomela (1941. Time of appearance of the runs of salmon and steelhead trout native to the Wenatchee, Entiat, Methow and Okanogan rivers. Unpub. MS, USFWS) is emphatic that while most of the other tributaries of the Wenatchee River supported an abundance of salmon at the turn of the century, very few salmon were found in Icicle Creek. These observations are an enigma for spring chinook until one considers the recurring restraint imposed by columnaris disease, a limiting factor regulated by climatic variability. James W. Wood (1979. "Diseases of Pacific salmon, their prevention and treatment") of the Washington Department of Fisheries has extensively documented the pre-spawning losses among adult chinook and sockeye salmon from columnaris disease induced by water temperatures that are too warm for these species. Augmentation of Icicle Creek flows with 50 cfs of cold water from the Snow Lakes proved of no avail in avoiding the catastrophic mortality of brood stock in the 1977 drought. From the foregoing it can only be deduced that spring chinook runs to Icicle Creek are largely of hatchery origin due to marginal habitat for returning adults.

I can't remember if I sent copies before

Analysis of Fish Populations in the Wenatchee River, Washington

A Report to:

James W. Mullan
U. S. Fish and Wildlife Service
Fisheries Assistance Office
Leavenworth, Washington 98826

By:

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30 September 1985

This report presents results of a survey of fish populations in the mainstem Wenatchee River conducted 26-29 August 1985. The study was designed to evaluate fish populations, especially juvenile chinook salmon and rainbow/steelhead trout, in large pool, run, and glide habitat that is difficult or impossible to sample by conventional methods such as electroshocking. Fish were counted at stations along nearly 60 km of river by a team of observers equipped with wet suits and snorkels. In order to enable estimation of biomass present, fish were concurrently collected from the Wenatchee River by the U. S. Fish and Wildlife Service, aided by personnel of the Chelan, Douglas, Grant Public Utilities Districts and Washington Department of Game, using chemical application.

Substantial assistance in the snorkeling survey was provided by personnel of the Chelan County Public Utilities District, coordinated by Steve Hays.

METHODS

Snorkeling Methods

Twelve stations from Wenatchee River Mile (RM) 1.1 to 38.5 at surface elevations from 187 to 518 m were studied by snorkeling. (Table 1). Stations thus ranged from the river mouth, where water level was influenced by the Rocky Reach dam and fluctuated frequently, to above Tumwater Canyon. Stations were selected to represent typical pool, run[1] and glide[2] habitat throughout that portion of the river.

[1] A run is "an area of swiftly-flowing water, without surface agitation or waves, which approximates uniform flow and in which the slope of the water surface is roughly parallel to the overall gradient of the stream reach."

[2] A glide is a "slow-moving, relatively shallow type of run" (Helm 1985)

Table 1. Wenatchee River sampling stations, August 1985.

River Mile	Elevation, m.	Description	Sampling Type	Stream gradient,%
1.1	187	under Highway 10 bridge in city of Wenatchee	snorkel and chemical	0.24
4.4	200	braided area along highway	snorkel and chemical	0.16
5.2 & 5.3	202 & 204		chemical	0.41
6.7	212	Highway overlook (asphalt stockpile), irrigation diversion at lower end	snorkel	0.34
10.0	230	between Cashmere bridges, adjacent to raft access parking lot	snorkel	0.22
12.5	239	at state fishing access	snorkel	0.56
14.7	259	below bridge above Mtn. View Drive-In Theater	snorkel	1.04
15.6	274	below defunct Dryden Hydroplant	chemical	0.62
16.5	283	between two bridges at Dryden - off Alice Rd.	snorkel	0.33
18.4	293	braided section below Peshastin	chemical	0.44
21.2	313	large pool immediately above lumber mill	snorkel	0.36
24.5	332	below island, at Leavenworth river access	snorkel	0.25

Table 1. Continued

River Mile	Elevation, m.	Description	Sampling Type	Stream gradient,%
26.5	340	braid just above Icicle Cr. road bridge, beginning of Tumwater Canyon	chemical	1.47
28.7	392	site of defunct Great Northern powerhouse	snorkel	1.17
33.8	488	braided area immediately below Swiftwater picnic area	chemical	1.86
34.0	494	along Hwy. 2 above Swiftwater picnic area	snorkel	0.33
38.5	518	on River Rd. above Tumwater Canyon	snorkel	

Wenatchee River discharge was approximately 14.2 m /sec (500 cfs) below Dryden and 19.8-22.7 m /sec (700-800 cfs) upstream above major irrigation diversions, and decreased about 0.7 m /sec (25 cfs) daily during the four-day study period. Water temperatures ranged between 15.5 and 19.0 C during the period. Stream gradient averaged 0.55% for the overall study area and ranged from 0.16% near the mouth to 1.86% (Table 1).

Procedures described by Schill and Griffith (1984) were followed, with a team of 7-8 observers floating downstream through each study section. Observers maintained a prescribed spacing from one another while floating by holding onto connected lengths of 3 cm diameter PVC pipe. Spacing was determined by underwater visibility, which was measured as the maximum distance at which an object the size of the smallest fish to be counted could be clearly recognized underwater at the time and place of sampling. Weather was clear with bright sunlight throughout the period. Water clarity ranged from 1.3 m to greater than 4 m, and observer spacing varied between 1.2 and 2.7 m (Table 2). Observers could easily see to the river bottom in all portions of each station except at RM 6.7 where a small pocket was too deep to be counted from the surface. Skin-diving into this pocket provided a satisfactory estimate of the few suckers that were present.

Each member of the team counted only those fish that passed underneath in a lane between themselves and the observer to their left. The flexible nature of the PVC pipe enabled the observers on each end of the counting line to position themselves about 1 m ahead of the others. This facilitated the counting of any fish which tended to move laterally along the counting line.

Table 2. Physical characteristics of Wenatchee River stations sampled by snorkeling, August 1985.

River Mile	Water Clarity, m	Diver Spacing, m	Length, m	Area, m^2	Maximum Depth, m	Predominate Substrate	Character
1.1	2.0	1.5	85	911	1.8	cobble-sand	"pool" - water backed up by downstream dam
4.4	1.3	1.2	156	6,786	1.8	cobble-bedrock	run-glide
6.7	2.0	1.5	210	6,867	3.9	cobble-boulder	pool
10.0	2.2	1.2	75	2,374	2.1	cobble-gravel	pool-glide
12.5	2.4	1.5	123	3,210	1.3	cobble-gravel	riffle-glide
14.7	2.4	1.5	108	3,974	1.1	cobble-boulder-bedrock	run
16.5	2.4	1.8	172	7,052	1.7	cobble-sand	glide
21.2	4+	2.7	221	10,337	4+	cobble-sand	pool-glide
24.5	4+	1.8	160	5,384	2.0	gravel-cobble	glide
28.7	4+	2.7	80	3,040	2.7	cobble-boulder	pool-glide
34.0	4+	2.7	138	4,968	3.9	cobble-gravel	pool-glide
38.5	4+	2.7	324	10,397	1.8	gravel-bedrock	riffle-glide

Sets of replicate counts were made within 30 minutes of each other at two stations. Replicate counts were similar (within 15%) for all species except suckers and chinook salmon, for which second counts were significantly lower.

Each station except RM 1.1 encompassed from 2,000 to 11,000 m^2 of stream surface (Table 2). The main channel habitat was counted first at each station, followed by counts along each bank. At RM 1.1, the water surface was rising rapidly during the count, and therefore bank counts were not conducted.

All species we observed while snorkeling except dace, sculpin and stickleback were counted. Species present were:

chinook salmon, *Oncorhynchus tshawytscha* [a]
rainbow/steelhead trout, *Salmo gairdneri*
cutthroat trout, *Salmo clarki*
bull trout, *Salvelinus confluentus*
mountain whitefish, *Prosopium williamsoni*
largescale sucker, *Catostomus marcrocheilus*
bridgelip sucker, *Catostomus columbianus*
speckled dace, *Rhinichthys osculus*
longnose dace, *Rhinichthys cataractae*
redside shiners, *Richardsonius balteatus*
chiselmouth, *Acrocheilus alutaceus*
northern squawfish, *Ptychocheilus oregonensis*
threespine stickeback, *Gasterosteus aculeatus*
sculpin, *Cottus* sp.

[a] Electrophoretic data for the chinook samples collected suggest a mixture of spring- and summer-run fish below Leavenworth with only spring chinook occurring upstream (Appendix 1).

Large beds of mussels (*Margaritana margaritifera*) were observed in some upper river stations, especially at RM 28.7.

Separate counts were made for age 0 chinook and older juvenile chinook. For juvenile rainbow/steelhead trout, three size groups (<100mm, 100-200mm, > 200mm) were counted separately. Adult salmon and steelhead were not counted. Juvenile mountain whitefish were differentiated from adults by the presence of parr marks on the former. At three stations (RM 10.0, 21.2, and 28.7) there were too many size/species combinations present for observers to tally in a single pass. At these stations one pass was made to count salmonids and a second to count the remaining species.

Chemical Application

Eight stations were sampled by chemical application to obtain fish biomass data. All were riffles and associated small pools on side-channels passing 10% or less of the Wenatchee River discharge (Table 3). Bedrock-boulder habitat predominated.

RESULTS AND DISCUSSION

Snorkel Counts

Numbers of fish counted are given in Table 4. Chinook and rainbow/steelhead were by far the predominant species in the upper three stations. Sucker numbers were highest in the middle portion of the river (RM 12.5-21.2), with most, if not all, of the suckers observed being adult largescale suckers. Adult mountain whitefish followed a similar trend, although

Table 3. Physical characteristics of Wenatchee River stations sampled by chemical application, August 1985.

River mile	Length, m	Area, m^2	Flow, cfs	Average[a] Velocity, fps	Percent[a] cover	Predominate substrate	Character
1.1	69	751	11	0.3	5	boulder-sand	riffle-pool
4.4	55	425	20	1.0	2	boulder	riffle-pool-riffle
5.2	199	3,561	49	0.7	15	bedrock-sand	riffle-pool
5.3	137	1,291	49	1.5	50+	boulder	chute-run
15.6	180	2,030	23	0.6	50+	bedrock-boulder	riffle-pool
18.4	73	1,218	51	0.9	50+	boulder	riffle-pool
26.5	115	1,436	21	0.5	50+	bedrock-boulder	riffle-pool
33.8	127	1,779	30	0.6	50+	bedrock-boulder	pool-riffle
total		12,501					

[a]Methodology of Binns (1982)

Table 4. Numbers of fish counted in Wenatchee River snorkel stations, August 1985.

River Mile	Area (m^2)	Chinook 0+	Chinook I+	Rainbow/Steelhead <100 mm	Rainbow/Steelhead 100-200 mm	Rainbow/Steelhead 200mm+	Whitefish juv.	Whitefish adult	Bull trout	Sucker	Squaw-fish
1.1	911	1	0	0	0	0	24	10	0	122	2
4.4	6,786	9	8	0	2	2	9	36	0	113	0
6.7	6,867	52	7	2	32	20	17	24	0	81	7
10.0	2,374	111	12	86	13	3	79	57	0	142	4
12.5	3,210	38	0	41	36	14	131	103	0	487	0
14.7	3,974	5	0	27	3	1	53	81	0	TNC[a]	4
16.5	7,052	17	2	71	18	7	32	184	0	284	8
21.2	10,337	83	1	91	41	4	312	327	0	282	0
24.5	5,384	102	0	101	80	49	19	167	0	148	0
28.7	3,040	112	2	153	104	9	34	7	1	0	0
34.0	4,968	72	0	10	23	1	8	71	0	2	0
38.5	10,397	147	0	91	3	3	57	82	0	39	18
Total	65,300	749	32	673	355	113	775	1,149	1	2,200+	43

[a]Too numerous to count - more than 500

juveniles were found more consistently throughout the river. A single bull trout was the only other salmonid observed. Northern squawfish were found in several study sections in low numbers.

Counts made at the river mouth (RM 1.1) were made under less than ideal conditions when the water surface elevation was changing, and as such are less representative of actual population size than are counts at the other stations.

Chinook Salmon

In addition to age 0 chinook, a few larger (130-150 mm) chinook were observed in several study sections. These fish appeared to be hold-over I+ individuals.

Age 0 chinook appeared to show several trends in spatial distritution. In upriver stations, glides and riffles (RM 24.5 and above), fish tended to be scattered individually throughout medium depth-medium velocity water. In deep pools such as those at RM 6.7 and 21.2, and to a lesser extent at 28.7, nearly all of the chinook were found in a single cluster of several dozen individuals found near the surface in deep water at the head of the pool, usually at the edge of a backeddy. The pool at RM 34.0 was an exception, with no cluster of fish present. Downriver from RM 21.2, there appeared to be a considerable amount of suitable habitat that was not occupied by age 0 chinook.

The reaction of age 0 chinook to snorklers differed in each type of spatial distribution. Fish distritubed individually over gravel or cobble substrate displayed little reaction, often moving a short distance and then returning to their station almost immediately. If heavy boulder cover was present, however, these fish would move into hiding at the approach of the diver. Replicate counts in this habitat produced considerably smaller counts on the second pass. Clusters of chinook showed virtually no reaction to the observers, and follow-up counts there were similar to the initial passes. Overall, counts of juvenile chinook are believed to be good indicators of actual abundance, especially in pool environments, although counts in other habitat should be viewed as slight to moderate underestimates.

Rainbow/steelhead Trout

Fish counted in the size group $<$100 mm were age 0 rainbow/steelhead. The 100-200 mm group was probably a composite of age I pre-smolts and resident rainbow, and the $>$200 mm group were probably all resident rainbow.

Intermediate- and large-sized fish were present in areas of moderate to high water velocity close to instream cover. Their distribution did not generally overlap with that of juvenile chinook, except at the heads of pools. The largest rainbow (400-450 mm) were consistently in areas where accessibility by anglers was poorest.

Age 0 rainbow/steelhead were consistently found along the river margin in shallow, low-velocity water. They were distributed individually and were not found in clusters. Overall, 92% of all age 0 rainbow/steelhead were counted by observers during bank counts and 8% were found in the main channel.

Rainbow/steelhead of all sizes did not display strong avoidance reactions to underwater observers, and in some cases would actually swim toward the observer. Because of the shallow habitat and close association with the substrate of the age 0 fish, however, we assumed that our counts were underestimates of actual numbers. For intermediate- and large-sized fish, counts should closely reflect numbers present.

Mountain whitefish

Juvenile whitefish were observed as aggregations of fish about 100-140 mm in length. Adults were often in loose clusters and typically were 250-350 mm long. Whitefish, especially adults, were visibly "nervous" in the presence of observers, but often remained motionless on the bottom of deep pools as observers passed overhead. Counts should very closely reflect actual abundance.

Suckers

Largescale suckers were found in large numbers in deep pools and, somewhat surprisingly, in higher-velocity runs and riffles. Fish were virtually all large adults (300-400 mm) and were typically in clusters of up to several hundred individuals. They exibited the strongest response to observers of any fish species in the Wenatchee system, becoming very agitated and attempting to form fright huddles. Because of their abundance and behavior, some counts may be underestimates, and it was impossible to obtain a satisfactory count at the RM 14.7 station.

Other species

A single bull trout, about 300 mm long, was noted at RM 28.7.

Northern squawfish were occasionally noted, usually as solitary individuals 250-300 mm in length. They were sometimes found in a cluster of suckers. From above, the squawfish closely resembled suckers and mountain whitefish in size, shape and color, and therefore we may have slightly underestimated their numbers.

Chemical Application in Riffles

A total of 14 species was collected in the eight sampling stations (Table 5). The lengths of age 0 chinook averaged from 70 to 78 mm, with the larger fish found in the middle stations. Lengths of age 0 rainbow/steelhead showed more variability with location, ranging from 48 mm at the upper station to approximately 73 mm in the middle stations.

Densities of Chinook and Rainbow/Steelhead

Densities (fish/100 m^2) were calculated separately for juvenile chinook and rainbow/steelhead in both pool-run-glide habitat and in riffle habitat (Table 6). For chinook, densities averaged 1.2 fish/100 m^2 in the former habitat and 3.5 in the latter.

For rainbow/steelhead, densities in riffle habitat were also several times that seen in the pool-run-glide habitat for fish <100 mm and for those 100-200 mm. Those stations that had higher densities of chinook also tended to hold higher densities of age 0 rainbow/steelhead.

Because age 0 rainbow/steelhead in the pool-run-glide habitat appeared to utilize near-bank areas almost exclusively, a separate density estimate was calculated for that habitat, assuming a width of 4 m along each bank (Table 6). Densities averaged 4 fish/100 m^2, still considerably less than those in the riffle habitat.

Table 5. Numbers, average total lengths in mm. (in parentheses), and average weights of fish collected by chemical application, Wenatchee River, August 1985.

River Mile	Chinook 0+	Rainbow/steelhead <100 mm	100-200mm	200mm+	Mountain whitefish (juvenile)	Sucker[a]	Speckled dace	Longnose dace	Sculpin	Other
1.1	7 (70.0)	9 (69.0)	0	0	0	19	12	0	6	4 redside shiners 4 chiselmouth 4 squawfish 500+ stickleback
4.4	39 (76.8)	22 (70.0)	6	0	37	0	22	235	20	1 squawfish
5.2	58 (71.6)	20 (72.6)	7	1	30	3	TNC[b]	42	24	2 redside shiners 6 squawfish 1 stickleback
5.3	62 (78.4)	22 (67.9)	13	0	6	59	TNC	116	71	7 chiselmouth 2 stickleback
15.6	36 (76.3)	169 (72.4)	66	2	7	1	TNC	465	270	1 redside shiner
18.4	52 (76.5)	183 (65.3)	42	1	4	1	29	31	59	none
26.5	81 (77.9)	161 (51.2)	86	1	2	0	26	211	101	1 cutthroat trout
33.8	103 (72.9)	285 (48.0)	248	2	17	2	2	213	383	2 bull trout
Average weight, g	5.8	3.2	18.9	136.4	21.0	687.0	1.2	9.3	7.7	

[a]All largescale except those at station RM 33.8 which were bridgelip.
[b]Too numerous to count

Table 6. Densities (fish/100 m^2) of juvenile chinook salmon and rainbow/steelhead in pools and riffle stations, Wenatchee River, August 1985.

Pool, RM	Riffle, RM	Bank habitat (m^2)	Chinook age 0 & 1	Steelhead < 100 mm entire site	Steelhead < 100 mm bank only	Steelhead 100-200 mm
1.1		0	0.1	0	0	0
	1.1	-	0.9	1.2	-	0
4.4		1,248	0.3	0	0	0.03
	4.4	-	9.2	5.2	-	1.4
	5.2	-	1.6	0.6	-	0.2
	5.3	-	4.8	1.7	-	1.0
6.7		1,680	0.9	0.03	0	0.5
10.0		600	5.2	3.6	12.3	0.6
12.5		984	1.2	1.3	4.2	1.1
14.7		864	0.1	0.7	3.1	0.1
	15.6	-	1.8	8.3	-	3.3
16.5		1,376	0.3	1.0	5.2	0.3
	18.4	-	4.3	15.0	-	3.5
21.2		1,768	0.8	0.9	4.1	0.4
24.5		2,625[a]	1.9	1.9	3.6	1.5
	26.5	-	5.6	11.2	-	6.0
28.7		640	3.8	5.0	22.2	3.4
	33.8	-	5.8	16.0	-	13.9
34.0		1,104	1.5	0.2	0.6	0.5
38.5		2,595	1.4	0.9	3.4	0.03
Weighted average:		pool	1.2	1.0	4.0	0.5
		riffle	3.5	7.0	-	3.7

[a]includes 1,345 m^2 of shallow backeddy habitat

This trend in density is similar to that found by Johnson (1985) for age 1 and older juvenile steelhead in several western Washington mainstem rivers. As stream gradient increased, steelhead density increased from 1.05 fish/100 m^2 at 0-0.25% gradient to 4.10 fish at 0.50-1.0%. As expected, there was a greater proportion of riffles and runs in the high gradient area than in the low gradient areas (81% vs. 37%). Densities of 100-200 mm rainbow/steelhead found in the Wenatchee system (0.5 fish/100 m^2 in pools, 3.7 in riffles) were similar but somewhat less than those found by Johnson.

Biomass Estimates

Observed biomass in terms of grams of fish tissue per square meter of river surface was calculated for all chemical application stations (Table 7). The average was 6.60 g/m^2 for those riffle stations, with a range of 1.05 to 32.23 g/m^2. The high value was composed largely of sucker biomass. Juvenile chinook and rainbow/steelhead made up 3.1 and 15.2% of the overall total biomass, respectively.

Average weights of the juvenile chinook, juvenile rainbow/steelhead, juvenile mountain whitefish, and suckers collected by chemical application (Table 5) were used to estimate biomass present in the pool, run, and glide sections that were snorkeled. Estimates of average weight for adult whitefish, squawfish, and bull trout were taken from length-weight relationships in Carlander (1969) for the average lengths of fish observed. Since sculpin were noted at all snorkel stations but were not counted, the average biomass value obtained from the chemical stations was utilized. Similar procedures were applied for speckled dace, which were observed at all snorkel stations except RM 38.5, and for threespine stickleback, which were observed only at RM 1.1.

Table 7. Biomasses (g/m 2) of fish at sites sampled by chemical application in the Wenatchee River, August 1985.

River Mile	Area m^2	Chinook salmon	Rainbow/ steelhead	Other trout	Mountain whitefish	Longnose dace	Sculpin	Sucker	Other species	Total
1.1	751	0.04	0.05				0.06	4.46[e]	0.47[cfghi]	5.08
4.4	425	0.52	0.81		0.97	2.31	0.49		tr[ci]	5.10
5.2	3,561	0.08	0.18		0.11	0.09	0.10	0.39[e]	0.10[cfgi]	1.05
5.3	1,291		0.33		0.20	1.01	0.69	29.27[e]	0.10[cgh]	32.23
15.6	2,030	0.11	1.52		0.03	2.92	0.80	0.34[e]	0.33[cf]	6.05
18.4	1,218	0.27	1.70		0.24	0.30	0.35	0.75[e]	tr[c]	3.61
26.5	1,436	0.34	1.30	0.03[d]	0.09	1.14	0.91		0.02[c]	3.83
33.8	1,779	0.29	2.10	0.02[a]	0.36	0.96	1.29	0.07[b]	tr[c]	5.09
Weighted average	12,501	0.20	1.01	tr	0.17	0.97	0.57	3.55	0.12	6.60
Percent of total		3.1	15.2	tr	2.6	14.8	8.7	53.7	1.8	
Number/ m^2		0.035	0.11	tr	0.01	0.11	0.07	0.01	0.19	

[a] bull trout
[b] bridgelip
[c] speckled dace
[d] cutthroat
[e] largescale
[f] redside shiner
[g] threespine stickleback
[h] chiselmouth
[i] northern squawfish

Biomass estimates for the the pool, run, and glide study sections ranged from 3.0 to 116.4 g/m^2 (Table 8). Sucker biomass accounted for the bulk of the total at the mid-river locations. Disregarding suckers, values were relatively consistent, ranging from 2 to 5 g/m^2 for the lower three and the upper three sections and 8 to 12 g/m^2 for the six mid-river sections. Juvenile chinook and rainbow/steelhead trout combined made up less than 2 g/m^2. The rainbow/steelhead biomass at three stations (RM 6.7, 12.5, and 24.5) was composed largely of fish larger than 200 mm (82, 70, and 79% of totals, respectively).

Table 8. Estimated biomasses (g/m^2) of fish at Wenatchee River snorkel stations, August 1985. Average weights were those obtained by chemical application (Table 5), except squawfish and adult whitefish which were taken from Carlander (1969) for average lengths of fish observed.

River Mile	Chinook Salmon	Rainbow/ Steelhead	Mountain Whitefish	Sucker	Squaw-fish	Sculpin[a]	Speckled dace	Other	Total
1.1	tr[b]	0	3.9	92.0	1.0	0.6	0.1	0.3[c]	97.9
4.4	tr	tr	1.6	11.4	0	0.6	0.1		13.7
6.7	0.1	0.5	1.1	8.1	0.5	0.6	0.1		11.0
10.0	0.4	0.4	7.9	41.1	0.8	0.6	0.1		51.3
12.5	0.1	0.9	10.5	104.2	0	0.6	0.1		116.4
14.7	tr	0.1	6.4	86.4+[d]	0.5	0.6	0.1		94.1
16.5	tr	0.2	7.9	27.7	0.5	0.6	0.1		37.0
21.2	0.0	0.2	10.1	18.7	0	0.6	0.1		29.7
24.5	0.1	1.6	9.4	18.9	0	0.6	0.1		30.7
28.7	0.2	1.2	0.9	0	0	0.6	0.1	0.1[e]	3.0
34.0	0.1	0.1	4.3	0.3	0	0.6	0.1		5.5
38.5	0.1	0.1	2.5	2.6	0.8	0.6	0		6.7
Weighted average	0.08	0.37	5.29	23.15	0.30	0.6	0.1	tr[b]	29.8

[a] avg. for all chemical stations
[b] tr= < 0.05g
[c] threespine stickleback
[d] assuming 500+
[e] bull trout

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Appendix 1

Oregon Cooperative
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October 15, 1985

Jim Mullan
Fisheries Assistance Office
Route 1, Box 123-A
Leavenworth, WA 98826

Dear Jim:

I have enclosed the electrophoretic data for the chinook samples that you collected from the Wenatchee River. I also included the isozyme gene frequencies for 8 upper Columbia River stocks collected in 1984 for comparison. For the analysis, we must assume that the isozyme gene frequencies are similar between year classes although results of our data indicate that statistically significant differences can occur between year classes. However, the differences between year classes are small relative to the differences between spring and summer chinook for the three enzyme systems that we examined.

Both spring and summer chinook are present in the lower Wenatchee River. The isozyme gene frequencies of the samples from river miles 4.4, 15.6, and 18.4 are intermediate between the 1984 summer chinook and 1984 spring chinook. The isozyme gene frequencies of the samples at river mile 26.5 and 33.8 are similar to those of the 1984 spring chinook. None of the common allele frequencies for the lower three stations are as low as the 1984 common allele frequencies for summer chinook that were collected in June. This suggests that spring chinook which have higher frequencies of the common alleles are present in these samples.

It is possible that there are behavioral differences between genotypes that could cause a gradient in gene frequencies with river mile; however, I don't believe that is happening in this case since the results are similar in three different enzyme systems.

On another note, I talked to Ken Currens about those resident rainbow that you collected, and he indicated that he is swamped with work on our contract and also for his thesis, so he doesn't have the time to run the analyses at present. I also need to know if you want the carcasses of either the chinook or steelhead juveniles from the Wenatchee River. Please let me know if you want them or have any questions.

Sincerely,

Randy Hjort

Randy Hjort

RH:ah

enc

Table 1. Electrophoretic analysis of juvenile chinook salmon in the Wenatchee River system, 1984-85.

River Mile	Sample Size	Enzyme system: ACO 100	ACO 86	ACO 116	ACO missing	PMI 100	PMI 109	PMI missing	SOD -100	SOD -260	SOD missing
1985 samples											
1.1	5	-	-	-	5	1.00	.00	2	.00	1.00	
4.4	35	.92	.08		4	.76	.24	8	.60	.40	
15.6	39	.89	.11	-	27	.80	.20	22	.71	.29	
18.4	40	.94	.05	.01	0	.78	.22	11	.61	.39	
26.5	40	.96	.01	.03	6	.90	.10	14	.84	.16	
33.8	31	1.00	.00	-	14	.83	.17	7	.76	.24	
1984 samples											
Wenatchee summers		.81	.19			.66	.34		-	-	
Methow summers		.82	.18			-	-		.49	.51	
Okanogan summers		.78	.22			.74	.26		-	-	
Wells Dam summers		.88	.12			.71	.29		.58	.12	
Wenatchee springs		.99	.01			.90	.10		.82	.18	
Methow springs		.99	.01			.97	.03		.77	.23	
Entiat springs		.98	.02			.90	.10		.84	.24	
Leavenworth Hatchery		.99	.01			.90	.10		.84	.16	

Growth and Survival of Salmon and Steelhead in a Controlled Section of Icicle Creek

Information Report
FRI/FAO-86-14

February 1986

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and

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Introduction

In February 1983, 1.3 million spring chinook salmon, *Oncorhynchus tshawytscha*, from Leavenworth National Fish Hatchery (LNFH) were planted in a controlled section of Icicle Creek. In July 1983, a sample of these fish included what appeared to be an exceptionally high number of precocious males. Gametogenesis may have been stimulated in these fish because they had been fed a hatchery diet and had experienced rapid growth before they were released from the hatchery.

In 1984, adult chinook salmon were permitted to enter the section and spawn, a situation that made it possible for us to attempt to compare the incidence of precocity in juveniles spawned natural and in juveniles from the same brood that had been reared under hatchery conditions for several months. This situation also provided the opportunity to assess the survival of hatchery fish that were planted prior to the time that they would be expected to emigrate to the ocean as smolts. We describe observations made concerning the growth and survival of the fish spawned and stocked in the section in 1983 and 1985 and discuss the potential of the controlled section of Icicle Creek as a site for experimental work to evaluate planting procedures.

Study Site

Icicle Creek originates as a steep-gradient, high-velocity, degrading stream in the north central Cascade Mountains of Washington. Mean, minimum, and maximum annual flows measured at river mile (RM) 5.8 (USGS) are 628, 55, and 11,600 cubic feet per second (cfs). Several diversions occur between the gauging station and RM 3.8, downstream from which the gradient of Icicle Creek is low and the channel is depositional and meandering.

Diversions are for irrigation, for municipal supply for the town of Leavenworth, and for LNFH.

In 1939, areas for holding adult salmon and steelhead between the time of their return to LNFH and the onset of sexual maturation were developed in a 0.9 mile meander of Icicle Creek bypassed by a diversion canal. Four concrete dams, regulated by flashboards, provided three separate holding areas. A fifth dam at the downstream end of the diversion canal provided the head needed to regulate flow in the controlled section of Icicle Creek. In 1979, use of the controlled section for holding brood fish was discontinued.

Morphometry of the controlled section has changed over the years as the channel adjusted to reduced flows of less than 200 cfs and sedimentation, mostly coarse sand, increased. Gradient of the section is low (1129 to 1113 feet elevation). Its water surface area has been reduced by 40 to 50% to 5.1 surface acres. Vegetation on aggraded islands and along the shoreline is in the early stages of succession. Reaches below the semi-defunct dams still include the typical alternating riffles and pools, with cobble-rubble and sand predominating as substrate.

Both anadromous and resident fish occur in Icicle Creek. The LNFH, located at RM 2.8, releases 2.5 million spring chinook salmon and 100,000 steelhead (Salmo gairdneri) smolts annually. Both steelhead and chinook salmon spawn naturally in the reach downstream from the hatchery, but the hatchery diversion canal dam is a barrier to upstream migrants. The furthermost upstream dam in the controlled section also is a barrier to upstream migrants, as is the lowermost dam when racked, except at extreme high water.

Resident fishes found in Icicle Creek include rainbow trout (*Salmo gairdneri*), cutthroat trout (*Salmo clarki*), brook trout (*Salvelinus fontinalis*), bull trout (*Salvelinus confluentus*), mountain whitefish (*Prosopium williamsoni*), sculpins (*Cottus* spp.), dace (*Rhinichthys cataractae* and *R. osculus*), and suckers (*Catostomous macrocheilus* and *C. columbianus*). Rainbow trout are generally stocked as "catchables" in upstream areas of Icicle Creek beginning about three miles above the hatchery. No fishing is allowed in the controlled section.

Methods

Juvenile spring chinook salmon from LNFH only became available in May 1985 when they approximated 3.5 g in weight. On May 9, 1985, we pressure-sprayed 38,600 fish with fluorescent dye (Phinney and Mathews 1969). As the spraying proceeded we removed small lots of fish to hold at the hatchery. All fish not retained were put into the controlled section below the furthermost upstream dam. Fourteen days later, a sample of the marked fish retained in the hatchery was examined under an ultraviolet lamp in a darkened room and 105 of 143 fish (73%) had a visible mark.

A preliminary sample of fish from the controlled section was obtained by electrofishing a 100-m reach on May 23. Discrete hydraulic units (i.e., riffle-pool) of the controlled section of Icicle Creek were sampled from July through October.

After August, when the lengths of the larger young-of-the-year (y-o-y) steelhead began to overlap with the smaller, older trout, representative samples of otoliths were used to distinguish fish from separate age groups. Because rainbow trout were present in Icicle Creek, it is possible that some of the juvenile fish that we examined were offspring of resident rainbow trout rather than of steelhead. We assumed, however, that all y-o-y rainbow trout were steelhead.

Results

We removed 34 chinook salmon from the controlled section on May 23, 1985. Because of their large size (length ranged from 60 to 72 mm) relative to fish from natural spawning, we assumed that four of these fish were from the hatchery--three had particles of dye embedded in their skin. The remaining 30 fish in the sample ranged in length from 33 to 52 mm, and included some recent emergents that still had a visible yolk-sac. Accordingly, chinook salmon from the hatchery could be identified by fluorescent mark, large size, or both.

Despite sampling more that 1000 juvenile chinook salmon and 33% of the area in the controlled section from May to October (Table 1), only 17 fish were captured that were large enough to be considered hatchery fish and only nine of these were marked. In addition, no marked fish were captured after July 17. We concluded that most of the hatchery fish emigrated from the section within two weeks after they were planted.

A different result was obtained in 1983. The total number of fish in the controlled section of Icicle Creek in July 1983 was estimated by multiplying the average density (0.18 fish/m^2) in six reaches of the section (estimated in snorkel surveys) by the total area (20,639 m^2) of the section. We estimated that a total of 3715 fish or 0.29% of the fish that had been stocked in February were still present in the controlled section in July 1983. This estimate is based on the assumption that all of the fish present in the controlled section were accounted for in the snorkel surveys.

The difference in behavior of salmon planted in the section in 1983 and 1985 appears to have been related to the time and size that they were released. The average weight of the fish stocked in 1983 was less than a gram, whereas fish stocked in 1985 averaged 3.5 g.

Adult steelhead that were permitted entry to the controlled section in fall and winter 1984-85 were observed spawning from early March to late May 1985. Length frequencies of fry showed that their offspring emerged from the gravel from late June to early August.

There was little overlap in the sizes of y-o-y steelhead versus chinook salmon through August, but their length distributions began to overlap in September. The apparent convergence in the size of y-o-y for both species (Figure 1) cannot be explained with the data obtained. In either species there seems to be a tendency for larger fish to leave the section. If this tendency persists throughout the summer, the growth summarized in Figure 1 underestimates the growth that actually occurred. Very few salmonids remained in the reaches sampled on October 30, and of those that did remain, the average size was small compared to the size of the fish that left. Maximum biomasses occurred in late summer and then declined for both species (Table 1).

Discussion

Our results showed that planting hatchery fish that have been reared on the feeding and temperature regimes at the hatchery through May of their first year may not stay at the planting location for more than a brief period of time. Consequently, the experimental design proved to be

Table 1. Numerical density (n/m^2) and biomass (g/m^2; in parentheses) of fish in the controlled section of Icicle Creek in 1985. Values are means when more than one sample was taken.

Date	Area (m^2)	Chinook 0+	Steelhead 0+	Steelhead 1+	Bull trout	Sculpin	Dace	Sucker
7-10	847[1]	0.155	0.035	0.013	0	0.054	0.004	0
		(0.2)	(+)	(0.1)	(0)	(0.3)	(+)	(0)
8-12	1500[1]	0.253	0.313	0.032	0.003	0.077	0.037	0.002
		(0.8)	(0.3)	(1.0)	(0.2)	(0.2)	(0.2)	(+)
9-17	1639	0.084	0.081	0.004	0	0.044	0.022	0
		(0.4)	(0.2)	(0.1)	(0)	(0.1)	(+)	(0)
10-7	1473	0.155	0.075	0.020	0	0.074	0.030	0.005
		(0.9)	(0.3)	(0.4)	(0)	(0.4)	(+)	(+)
10-30	1330[2]	0.003	0.047	0	0	0.068	0.019	0
		(+)	(0.1)	(0)	(0)	(0.3)	(+)	(0)

[1]Two samples
[2]Three samples

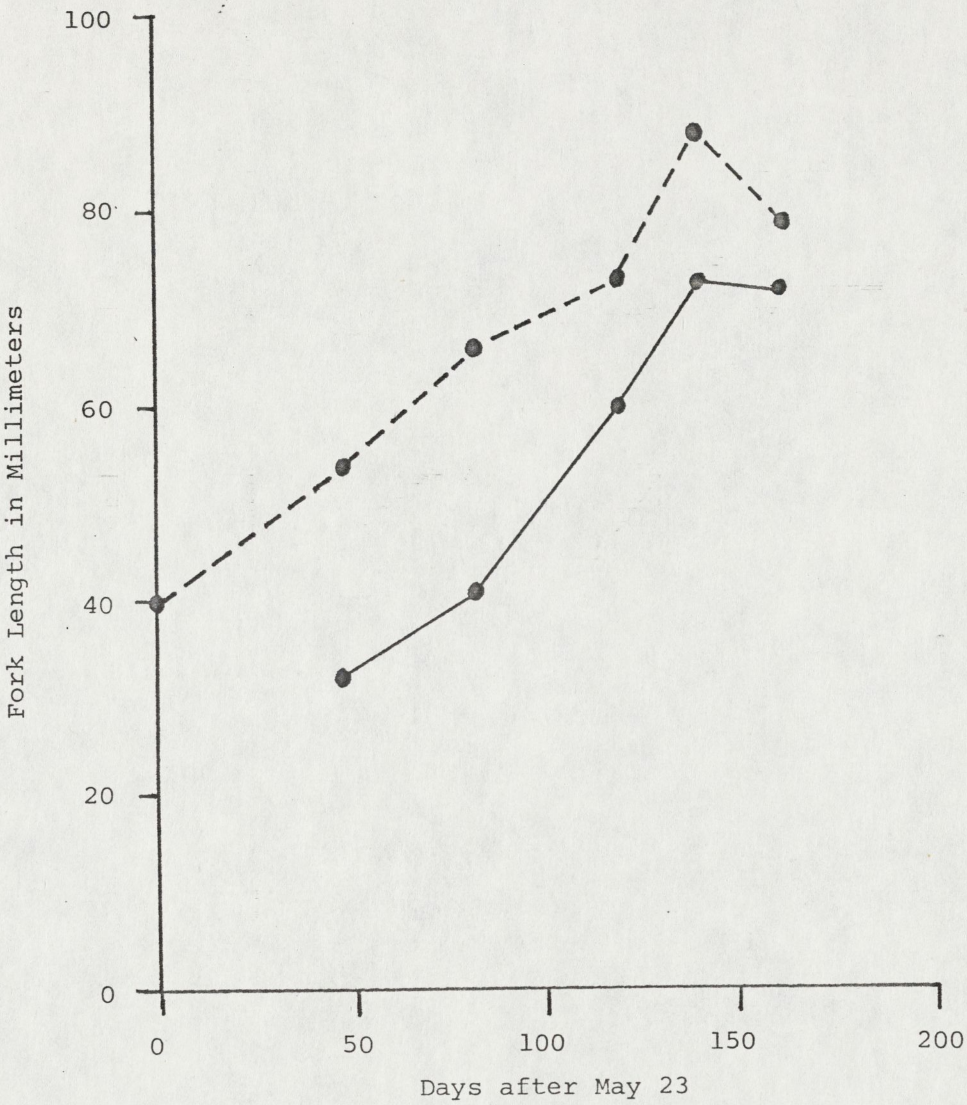

Figure 1. Mean length of young-of-the-year chinook salmon and steelhead in the controlled section of Icicle Creek from May 23 to October 30, 1985. Dashed line is chinook salmon; solid line is steelhead.

faulty for the purpose of comparing precocity in fish that began their lives under hatchery conditions with that in naturally produced fish.

Whether the chinook salmon from LNFH that we planted in the controlled section of Icicle Creek in 1985 found suitable habitat somewhere downstream from the section is not known. We do know, however, that they did not supplement the population of naturally spawned fish in the controlled section. Because of the differences in behavior of chinook salmon planted in 1983 and in 1985, we now believe that spring chinook as large as 3.5 g in early May of their first year will emigrate from streams as small and as cold (maximum temperature in 1985 was 64°F) as Icicle Creek. Attempts to supplement natural populations of anadromous salmonids with fry, fingerlings, or presmolts is a management tool that is being used with increasing frequency in hopes that more fish can be produced from natural rearing areas. Our results indicate that the size and time that these fish are released may be crucial in determining the success of these efforts.

One of our objectives was to assess the suitability of the controlled section of Icicle Creek as an experimental release site for testing the outcome of alternative planting strategies. There has been some concern that the modifications of the section in 1939 and the changes that have occurred since have rendered the section unsuitable for production of juvenile salmonids.

In February 1983, 1.3 million chinook salmon fry were planted in the controlled section of Icicle Creek. We are probably safe in assuming that the 0.9 mile section was "seeded to capacity" for chinook salmon. In fact, we probably can assume that density-dependent mortality was great among these fry during the first weeks after they were planted. Density effects may also have depressed their growth rate, but their biomass in late July

1983 probably was approaching the limiting capacity of the section for supporting chinook salmon tissue under the conditions present in that year. The biomass (product of the mean weight of fish sampled during late July 1983 and the number of fish present) for y-o-y chinook salmon was 1.23 g/m^2. In 1985, both y-o-y chinook salmon and steelhead were present in the section, and on August 12 their combined biomass was 1.11 g/m^2. We do not know how many steelhead spawned in the section, but we did observe six chinook salmon redds in the section in September 1984. Although we cannot be sure that 1.11 g/m^2 represents "full seeding" of the habitat, it does appear that one could expect late summer biomasses for y-o-y salmonids to be between 1.0 and 1.5 g/m^2 if as many as six female chinook salmon, and perhaps an equivalent number of female steelhead, successfully spawn in the controlled section.

Subyearling salmonids continued to grow in Icicle Creek during the summer and during early fall as water temperature declined. This growth pattern may be characteristic of fish in mid-Columbia River tributaries as a similar trend was found for chinook salmon and steelhead in the Methow River in 1985 (unpublished data of J. Mullan). As in Icicle Creek, the growth rate of y-o-y steelhead appeared to exceed that of y-o-y chinook salmon during late summer and during early fall as water temperature declined.

The controlled section of Icicle Creek provides suitable habitat for both y-o-y steelhead and chinook salmon. Our data show, however, that chinook salmon fry must be stocked early in the spring before they approach 3.5 g in body weight if they are to remain in the section. Similar data are not available for steelhead, but samples that were taken in October showed that very few chinook salmon remained in the section as fall approached. We have to conclude that the section did not provide the type of habitat that these fish preferred as they attained body lengths in excess of 70 mm and as stream temperature declined in the fall. A similar but less pronounced tendency also was evident for steelhead.

Acknowledgements

Jim Spotts of the Washington Department of Game kindly aged a portion of the otoliths obtained from fish in Icicle Creek. Reg Reisenbichler of the USFWS National Fishery Research Center in Seattle provided assistance in all phases of the work. Ralph Malsam, Manager, Leavenworth National Fish Hatchery, provided fish and technical support.

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UNITED STATES GOVERNMENT

memorandum

National Fisheries Research Center – Seattle
Bldg. #204, Naval Station
Seattle, WA 98115-5007

DATE: February 26, 1986

REPLY TO ATTN OF: Project Leader, Leavenworth Fisheries Assistance Office

SUBJECT: The controlled section of Icicle Creek

TO: ARD-HFR; Region 1

It is suggested periodically that the natural discharge of Icicle Creek be restored in the controlled section and that the diversion canal be abandoned. While such rehabilitation is possible, it would be expensive (cost of the alteration was $300,000 in 1939) and inimical to hatchery operations.

The large tailrace pool of the diversion canal dam currently functions as a temporal refuge for newly released chinook salmon and steelhead smolts and for adults returning to spawn. With abandonment of the diversion canal, the tailrace pool would fill in and disappear over time because flows in the controlled section rejoin the main channel in the tail of the pool and do not have the scouring effect of flow going over the 22-foot diversion dam. Furthermore, with re-diversion the major flow would then be on the right bank and not on the left bank where the fishway to the currently used holding ponds is located.

Catastrophic losses of adult salmon in Icicle Creek have been common in drought years when water temperatures rose into the high 60's F or higher and made conditions favorable for the development of columnaris disease (Flexibacter columnaris). The meandering, wide channel below the hatchery has been carved by discharges as high as 11,600 cfs, and discharges as low as 55 cfs do not afford much protection from rapid heating of the shallow, spread-out flow during hot, dry summers. Accordingly, the diversion canal dam tailrace pool, which receives cold well-water discharge from the holding ponds via the fishway, is important for survival of both fish that are spawned at the hatchery, many of which hold there well into August before ascending the fishway, and those that spawn in Icicle Creek.

On the other hand, the controlled section of Icicle Creek provides a semi-natural stream with year-round flow of good-quality water. These physical circumstances provide low-cost potentials for better understanding of salmonid production in mid-Columbia River tributaries:

1. Evaluation of any number of scenarios involving outplanting of excess hatchery fish, as exemplified in the enclosed report, is possible. Considering the current interest in restoring coho salmon (O. kisutch) to historical habitat of the mid-Columbia River, study of the interaction of coho salmon with existing species, especially steelhead, warrants high priority. A fry-trapping capability at the downstream end of the controlled section to monitor success of emergence of wild fish and emigration of hatchery and wild fish is needed.

2. Comparative information on precocity, disease, and timing of smolt out-migration for salmonid stocks in the controlled section versus those raised at Leavenworth Hatchery could have profound implications for integration of wild and artificial propagation.

3. Habitat manipulation and evaluation are both readily possible and desirable in maintaining the controlled section of Icicle Creek. Although the section is depositional while most mid-Columbia River streams are erosional in character, the contrast could be revealing as to habitat "quality" in erosional streams. The presence of sand sediment in mid-Columbia River tributaries is deceiving in that it does not produce the turbidity commonly associated with severe stream sedimentation. The trout population declined to less than half its normal abundance in Hunt Creek, Michigan, following an experimental introduction of sand sediment (Alexander and Hansen 1983). Conversely, the trout population increased 40% in Popular Creek, Michigan, when the sand bedload was reduced using a sediment basin (Hansen et al. 1983; Alexander and Hansen 1983). These authors concluded that fry production was reduced because of loss of microhabitat caused by sand embeddedness of the substrate or vice versa. The implications of sand deposition filling, plugging, and burying most of the rough substrate of the controlled section and the need for a sediment basin just below the uppermost diversionary dam in correcting the situation should be obvious.

James W Mullan

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United States Department of the Interior

FISH AND WILDLIFE SERVICE

Dear Bob,

I ran my thoughts about a catch-and-release Chinook fishery by Red Pettach last night. He agreed that catch-and-release was a last option, but better than no open season at all. However, he made a good point that in any catch-and-release proposal, that the fish be tagged so as to get a handle on mortality. Currently, of course, we perpetuate our ignorance through bureaucratic obstinacy, and I thought his point worth forwarding.

Incidently, he is off to $3\frac{1}{2}$ weeks in Russia for TV. It is to be a demonstration of fly-tying, quality rods and other tackle, which apparently the Russians are keen on obtaining. After his recent trip to New Zealand, he is getting to be part of the jet set.

Jim

June 30
Monday

Dear Bob,

Many thanks for your most recent packet of information. I have been "racing" with the moon to complete the Chinook review and synthesis. Friday at closing I had it pretty well blocked out, but found myself exhausted that evening. I was scheduled to drive to Reno, with others, today for an area, not a region meeting, returning Thursday, the day before the 4th. My exhaustion turned into a bad head cold and I said to hell with listening to the usual bullshit of training, EEO, etc., for two days and wasting four.

Because of the complexities involved in obtaining opportunity for a sport fisheries of chinook salmon here in the mid-Columbia, I have given catch-and-release, males only, etc., a lot of thought. I was fairly naive when I started a few years back about catch-and-release, but after observing and participating in, with Red Pittock, the open seasons that we have had, I'm dubious of catch-and-release. The fish size runs mostly for 8 to 30 pounders, and the protocol of conventional angling just doesn't apply. These fish return in May and early June and appear little worse for over a 500 mile migration (one of the paradoxes is that in August they are garbage, something I have not gotten use to). In any event, their landing requires stiff tackle, 8-12 lb test mono and a huge net, with 15 to 20 minutes of "playing", which seems to exhaust their huge energy reserves. They are not easily subdued and it isn't a question of getting them alongside the boat (most are caught from drift boats) and flicking the hook out. The major baits are sand shrimp, herring, and salmon eggs on a single hook with yarn. Rarely are they deeply hooked, and frequently are fowled hooked in the head, suggesting a frenzy slash at the baits. Nevertheless, the hooks, if the fish are landed, are deeply imbedded, but this would be no problem in a no kill situation if the line was merely severed. However, it is totally against human nature to put in the effort required to land one of these fish and then let them go. As in all fisheries, a select minority catch the bulk of the fish, but they put a lot of time in to catch a fish, scoring heavily occassionally, but frequently going 7-10 days without catching a single fish. Pittach put in about 33 days this year, 3:30 AM to dark that night, what ever it took, to catch 27 of the monsters, ~~this year~~, and he is perhaps the best avid chinook fan that I know, although there is a strong tendency for the avid anglers sorta to average out similarly.

We don't have many jacks in our runs, nor do they in Idaho. Jacks definitely run later then most adults, and I'm firmly convinced that they are more vulnerable to sport harvest, which is something that can be used in developing a harvest strategem where you have jacks. Early in the season here (mid-May to about June 1,) it is generally difficult or impossible to distinguish males from females, so this tidbit isn't of much help in developing a selective fisheries.

My basic feeling is that if we have two fish and one can be harvested in a sport fisheries, I'm all for it. An angling population with a vested interest is the only real deterrent to poaching, etc. Accordingly, I'd shoot for providing some kind of fishing opportunity in almost any ~~sit~~ situation, even if it were only a 1-3 day openner, but I would rank catch-and-release at the bottom of the fishing options.

I found your "Critique of Instream Flow Methodologies" excellent. I have been and continue to be involved with IFIM. The concerns you raise and address relative to IFIM and other methodologies have been mine for a long time. However, you nail them down in a fashion I could never do. I'm going to make some copies of your paper for distribution and I'd like the correct reference if this isn't asking too much; no hurry.

My runny nose requires attention, so I'll sign off.

Best wishes,

Jim

James W. Mullan, Project Leader
U. S. Fish and Wildlife Service
Fisheries Assistance Office
Leavenworth National Fish Hatchery
Route 1, Box ~~123A~~ 549
Leavenworth, WA 98826

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Bob,
The most terrible house-of-cards I have ever seen; plain shit. They don't even have the physical dimensions of the habitat — not even correct stream lengths — let alone biological "measurement". I wrote and got copies of 7 years — quantitative and qualitative ... and he says it all. Thanks for the reference. See densities table. Don Chapman and others are just as frustrated as I am.
Jim Mullan

COLUMBIA BASIN SYSTEM PLANNING

DATA STANDARDIZATION REPORT

Developed by

System Planning Group

and

Monitoring and Evaluation Group

September 1987

DATA STANDARDIZATION REPORT

9/18/87

Page

I. Introduction

System planning is a focused effort to double salmon and steelhead runs into the Columbia River Basin through the integration and implementation of 31 subbasin plans, consistent with a range of principles and objectives in the System Work Plan. To help facilitate the system planning process, the Northwest Power Planning Council (NPPC) is developing a system planning model to explore alternative strategies for improving fish runs. The model will be used as a tool to better understand how such elements as production, passage and harvest interact. The model will also be an important tool in a long-term monitoring and evaluation program being developed through the Monitoring and Evaluation Group to complement the Systems Planning effort.

For the model to be most useful, specific kinds of information are required from each subbasin. The main purpose of the Data Standardization Report (DSR) is to clearly identify to the subbasin planners and planning teams which specific information is required and in what form it should be provided in the Preliminary Information Report (PIR) for each subbasin. The PIR will be prepared by the subbasin planners working with the technical committee. The DSR describes the specific information which the Monitoring and Evaluation Group (MEG) and System Planning Group (SPG) have identified as necessary for early model runs. These simulations will be used to evaluate the potential of existing mitigation measures to achieve the goal. The MEG will use the preliminary data for model calibration as a check to ensure that the common data reporting requirements will provide the necessary outputs. In addition, preliminary model runs will be used to decide the level of detail necessary for describing enhancement strategies for model simulations. Because of the importance of the PIR in supplying information for the system modelling, the SPG and MEG have set a January 1, 1988 due date for the report.

The DSR also serves additional purposes. First, it contains a description of the system planning model and how it functions. This should help the subbasin planners and planning teams better understand the importance of specific information reporting requirements. Second, the DSR briefly describes relevant data bases which will be useful for system planning (i.e., NPPC and U.S. vs. Oregon data bases). Third, the DSR provides a description of a standard techniques for estimating habitat carrying capacity. This technique must be used in each subbasin but does not preclude the use of other techniques to estimate smolt capacity. Finally, the DSR provides a list of definitions for critical parameters for system planning.

II. Use of the System Planning Model in System Planning

A. Introduction.

The System Planning Model (SPM) is a computer simulation of the salmon and steelhead life cycle in the Columbia River Basin. It permits simulation of hypotheses concerning tributary production, mainstem passage, and ocean survival and harvest. The model is designed to function on a standard IBM-type personal computer.

The SPM will be used extensively in system planning as a structure for technical discussions and to integrate the subbasin plans to a common set of harvest, passage and survival rates. The model will also be used as an analytical tool to estimate the contribution of the subbasin plans to the goal of doubling runs. This section will provide a description of the model and discuss the function and use of the model in subbasin and system planning.

B. Description of the model.

The System Planning Model was originally constructed during a series of basinwide workshops conducted by the Council. The model became a summary of the technical discussions of the workshop. Since these workshops, the model has undergone considerable development, mainly to make it easier to use; the actual logic of the model is retained from the original versions. The model is presently written in IBM-compiled BASIC; however, it is now being rewritten in TURBO PASCAL. This rewrite will include modifications to improve the ease of input/output functions.

1. General Features. The SPM steps through the the salmonid life cycle in three discrete modules involving tributary production, mainstem passage, and adult survival and return. The time step of the model is one year. Simulations can be made up to 50 years (100 years in the new version).

The SPM is a steady-state model that will equilibrate eventually at a level resulting from balancing the productivity of the stock with the mortality forces of passage, harvest, and natural factors. The model will arrive at its equilibrium for a given set of production and survival factors, although it is possible to intervene and change input data during the course of the simulation.

2. Tributary Production Module. Production of fish in the tributaries includes the period from egg deposition to outmigrant smolts entering the mainstem Columbia River.[1]
The model begins with an age structured adult spawning population in the tributary. Sex ratio and fecundity by age class are input to produce an initial egg deposition.

---

1 Although the model conceptually assumes that production occurs in the tributaries, mainstem spawning areas could be treated adequately as a "subbasin" by the model.

The number of smolts produced in the model from a given number of eggs is the result of a density dependent survival rate. Calculation of this rate assumes a Beverton-Holt type relationship between the number of fry present and the resulting fry-smolt survival rate. Parameters for this function are the maximum fry-smolt survival rate (therefore, the survival rate at near zero fry density), and the maximum smolt carrying capacity which acts as an asymptote. The model thus assumes that smolt rearing area in the subbasins is a limiting factor. It is also possible to use spawning area (egg capacity) as a limiting factor, although this is not assumed to be density dependent.

3. Mainstem Passage Module. The mainstem passage module uses logic similar to that in other fish passage models but with the time step of one year. Fish exiting the tributary production module are looped an appropriate number of times through a generalized model of fish passage at a mainstem hydroelectric project (dam and reservoir).

Reservoir survival is modeled as a function of flow and reservoir length.[2] This makes the assumption that mortality is a function of smolt residence time in the reservoir. The mortality rate per mile is assumed to be constant at flows above a specified level, and increases at flows less than this level.

At the dam, fish are routed through as many as three passage routes (spillway, turbines, or bypass) at project-specific survival rates. Spill can be provided at each project at a constant rate for the scenario. Fish transported from the collector projects are subject to a specified survival rate.

4. Adult Survival and Harvest. After crossing Bonneville Dam, transported and nontransported migrants are added together and subjected to a survival rate up to the age of first recruitment into the fishery.

Once recruited into the fishery, the model applies both a natural survival rate and an age-specific harvest rate. Ocean harvest rates are applied as one age-specific rate, and no further analysis of harvest by ocean area occurs. Fish are also matured and returned to the river as escapement. The maturation schedule is based on the age structure of the original adult spawners.

Fish escaping to the river of various ages are added together and subjected to estuary harvest (commercial zones 1-5) and harvest in each of the mainstem pools (zone 6 and beyond, if desired). Mortality is also assessed at each of the mainstem dams. This mortality is a constant rate for the simulation (specific to each dam).

Fish escaping to the tributary can be subjected to a terminal harvest rate which can be specific to production type (hatchery vs. wild). The resulting spawning escapement is used to start the cycle over again.

5. Additional Features. Three production types are available in the present model. Fish can be produced either as wild spawners or from a hatchery. Hatchery fish can be

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2 It is possible to remove the effect of reservoir length (as might be indicated by recent predator research) by specifying the length of each reservoir as equal to the average reservoir length.

released from the hatchery or treated as fry plants to the wild. Returning adults to the hatchery are selected at random from the general tributary returns (wild and hatchery) or taken selectively from the hatchery returns.

It is possible to specify an effect of crossing wild and hatchery fish in the wild. Production from hatchery X wild or hatchery X hatchery are discounted a specified amount relative to a wild X wild. Interspecies competition in the wild can also be specified. This uses the form that the production of species 1 is discounted a specified amount if species 2 is present.

Variation can be introduced into the model in a number of places for the purpose of providing a realistic variance to the results. Wild production can have random variation attached to the egg-fry survival or the fry-smolt survival rates. Hatchery production can be subject to random hatchery failures. This discounts hatchery production by an amount that is generally close to 1.0 but which occasionally, at a rate that can be controlled, is appreciably less. Finally, the reservoir survival rate can vary annually based on a file containing annual flows at a reference dam (presently The Dalles). All of these sources of variation can be turned off, if desired.

Data is input to the model in three files. BASFILES contain subbasin specific data such as initial adult escapement, age structure, juvenile survival rates, and fecundity. GENFILES contain information considered generic to the subbasins. This includes all mainstem passage parameters and all harvest except that in the tributary. FLOFILES contain average mainstem flow for use in calculating the annual reservoir survival rate.

Results can presently be output graphically to the screen or as a printed report. It is also possible to dump all output data to a disk file for access by other software. In the new version of the model, the on-screen graphics are being eliminated and the ability to output printed results is being enhanced.

A number of output variables are available from the model. These include number of smolts produced, harvest, and escapement. The model can also be used to compute the productivity of a scenario in the form of the Maximum Sustained Yield (MSY) and the equilibrium run size.

C. Use of the model in system planning.

The goal of system planning is to create subbasin plans that are consistent with a common set of passage, survival, and harvest rates, and achieve the Council's goal of doubling consistent with the program system policies. The System Planning Model will be used by the Monitoring and Evaluation Group (MEG) to perform an *a priori* test of the calculated productivity of the subbasin scenarios against the survival rates.

The intent of the analysis is not to make numeric predictions of effects because of the many uncertainties in input values and future events. Rather, the goal is to provide a consistent analytical tool and numerical index that can be used to compare alternative scenarios and help ensure that subbasin plans are consistent with conditions and policies operating outside the subbasins.

The results of the analysis will contain considerable uncertainty but will represent our best estimate of the outcome. Therefore, subbasin plans will be hypotheses concerning the effect of a certain production scenario at a given position in the river, harvest rates, and natural mortality rates. Testing of these hypotheses will be an important part of the System Monitoring and Evaluation Program being prepared by MEG. The intent of the monitoring and evaluation of the subbasin hypotheses is to decrease the level of uncertainty regarding factors limiting salmon and steelhead production in the basin and also to determine the success of the action in accomplishing what was planned.

Subbasin scenarios will be compared using primarily two outputs from the the model. These are the Maximum Sustained Yield (MSY) and the total production. The MSY will be calculated in adult equivalents. This is the total amount of production surplus to the replacement population size that would occur at equilibrium in the absence of any harvest. This statistic is independent of any assumed harvest rate and pattern. The MSY provides an index of the relative robustness of the population to harvest or environmental fluctuations. The total production is the statistic for assessing the progress toward the goal of doubling. It is defined as the return to the mouth of the Columbia River plus any prior harvest. Calculation of this will use assumed harvest rates and patterns consistent with the U.S./Canada treaty.

The System Planning Work Plan calls for the model to be used by MEG in at least two points in the process. The first is termed the System Productivity Report. This will use the information requested in the Data Standardization Report to analyze the "constraints on production imposed by passage, harvest, and natural sources of mortality...." (System Planning Work Plan). This analysis will have three objectives:

1) To provide subbasin planners with analytical guidance regarding how external factors affect production in their subbasins.

2) To identify data uncertainties that critically affect the productivity of the subbasins. These will be flagged for particular attention at a policy and research level.

3) To identify critical policy issues that emerge from a technical basis. These will be identified and passed on for consideration by the System Planning Group.

This report will be provided to the System Planning Group by March 31, 1988.

The second product from the model analysis is termed the System Integration Report. This report will be prepared separately for the subbasins above and below Bonneville Dam. In these analyses, the model will be used as the primary analytical tool for integrating the subbasin plans into a coherent system plan. As discussed above, this will involve simulations of the subbasin plans using a common set of harvest, passage, and natural survival rates. The goal will be not only to insure the external consistency of the subbasin plans, but also to assess the progress toward the goal of doubling that can be expected from the system plan.

Throughout the subbasin planning process, the model will be available as a tool to compare alternative scenarios. Subbasin planners are encouraged to use the model to test the effectiveness of actions to increase production.

III. System Planning Data Needs

The main functions of this report are to provide subbasin planners with an overview of the data requirements and the processes that will be used to evaluate production potential and production options at the system level.

The bulk of the data needed for system planning is described in Attachment 1A, "Draft Subbasin Planning Format," of the project statement of work. Section IV, "Fisheries Resources," is of particular concern for producing the preliminary information reports above and below Bonneville Dam. The emphasis in these reports is to gather together, in a consistent format, those data presently found in the gray literature or in regional files which are needed to provide a more complete, consistent and comparable description of the fish stocks we are attempting to manage. Previous attempts at constructing such a data set have been only partially successful because of limited manpower, limited time or the multitude of programs and jurisdictions which have important pieces of information. While these data are classified here as relating to model data or "other" data, this is an artificial division and considerable overlap exists between these categories. This distinction is ignored when describing data formats and standards, below.

Obviously, there will be many instances where explicit values for requested data elements have not been measured. In these cases, subbasin planners should not attempt to fill out the tables with information from other basins or choose a value based on their own experience. Rather, subbasin planners should provide explanatory descriptions of what is known in cases where actual data are unavailable. This statement could, for instance, include data ranges which appear consistent with observed results or values from nearby or similar stocks (for example, as referenced in Milner, et al., Riggs, and Schreck, et al.).

The SPG would like to receive as complete a set of information as possible for the years 1977-1981 and 1982-1986 because these are the periods used to calibrate other parts of the model. Information from earlier periods should be reported only if information for the preferred period does not exist or is minimal.

Remember that the listed data are needed for each stock in every subbasin. If raw data are requested and should be adjusted or transformed to properly represent a particular stock, describe this procedure and give several examples.

Questions regarding data collection and reporting will inevitably arise during development of the preliminary information reports. Such questions should be referred to Chip McConnaha (503-222-5161) or Phil Roger (503-238-0667) if answers are needed quickly. Otherwise raise these questions, or describe how they were resolved, in the text of the preliminary information report.

Certain data elements are particularly critical for model calibration and validation and we ask that they be provided by December, 1987 in advance of the full preliminary information report. These critical data elements are described below under the sections entitled 'Stock Characteristics', 'Stock Abundance' and 'Natural Juvenile Production'.

A. Data Needs of the Model

The data elements described below are those stock-specific items needed to build the basin input files, rather than a complete listing of all input data required. It was these elements which proved most difficult to obtain in the initial modelling effort and which limited the initial analysis.

1. Stock Characteristics

These elements are contained in Tables 1a and 1b, below. Basically we need age specific numbers on sex ratios, size, and fecundity. It is most useful if this information can be provided for individual fish over a series of years, since we can then consider the amount of annual variation, brood year effects, similarities and differences between stocks, and better compare model performance to actual observations. We also need to know details about the sampling methods (e.g., were jacks included or excluded) and measurements used (fork lengths of spawning fish cannot be compared to ocean size limits but hypural lengths can, for instance).

The objective here is to get as much stock-specific information as possible so extrapolations from other stocks, which obscure regional differences, will be minimized. Maximum consideration cannot be given to stock-specific needs unless we have stock-specific data.

2. Stock Abundance

The number of subbasin returns for the two most recent brood cycles should be reported, if available (Table 2). State the methods used to collect or calculate these numbers. The stock characteristic data, above, will be applied to stock abundance data to develop population profiles for model input.

3. Subbasin Harvest

List annual sport and tribal harvest separately for the last ten years, if available (Table 2). These numbers should also be included in the reported subbasin returns so that spawning escapement would be the difference between annual stock abundance and annual subbasin harvest. Describe methods and assumptions used to estimate or record harvest (e.g., punch card, interviews, voluntary reports, etc.).

4. Hatchery Profiles

Recent hatchery programs should be described both in writing and by using Table 3. Review the attached program descriptions from the U.S. v. Oregon discussions (Attachment 1) for completeness and accuracy. Expand these written descriptions to include details of brood stock selection, time of spawning, degree of straying of hatchery fish, timing of outplanting and smolt releases, and a description of plans for future modifications to the program.

When reporting the number of hatchery returns, be sure to describe the methods used to determine return (e.g., all fish trapped and counted, only fish entering the hatchery are counted, Peterson estimate from marked/ unmarked ratios, etc.) and whether the hatchery ladder or weir was not used during part of the run. In cases where intermixing of hatchery and naturally-produced spawners occurs (e.g., Priest Rapids, Entiat, Methow), we will assume only one stock exists which has both hatchery and natural components of production.

5. Natural Juvenile Production

Survival estimates from egg-to-fry and fry-to-smolt stages are needed. For those subbasins where specific data are available, this information should be reported as the estimated number of fry and smolt resulting from a particular number of spawners (Table 4). Report estimates for each year rather than average values, and include copies of the raw data and reports from which survival was calculated. Egg-to-smolt survival rates should be reported in cases where survival to fry stage was not estimated.

6. Coded-Wire-Tag (CWT) Releases

List at least releases of coded-wire-tagged fish which are representative of production. Generally this will only be available for hatchery programs but look for tag lots on naturally-produced fish also. Releases of some experimental groups may also be closely representative of normal production and these should also be listed.

B. Other Data Needs

1. Genetic Information

Identify any electrophoretic studies conducted on each stock. Include copies of any reports available at the subbasin or regional level. If reports are not readily available, indicate the principle investigators of the study and where reports might be obtained.

Describe in the hatchery profile (see above) the strategy for brood stock selection. Include such information as the ratio of males to females used, whether brood stock is taken from throughout the run or only from a portion, whether jacks are used or excluded, and whether naturally-produced fish are regularly incorporated into the brood stock.

Review the attached outplanting report (Attachment 2) for accuracy and update the information for recent years. For each area where plants have been made, indicate whether outplanting occurs rarely, frequently but at irregular intervals, or almost every year. Also indicate the number of fish outplanted and known or anticipated survival rates. If survival rates are known, provide a copy of the study report(s) or indicate where they may be obtained.

Report any other information which may be related to genetic characterization of each stock and which is not reported previously (e.g., morphology, timing of return, spawning, emergence, etc.).

2. Species Interactions

Describe any known or anticipated species interactions between life stages of outplanted fish and existing anadromous or resident fish. Consider both present and anticipated levels of outplants. Also describe areas where the potential for negative species interactions is so great that outplanting should not occur. Provide copies of, or cite sources for, studies which have been conducted on species interactions.

3. Stock Similarities

Review the attached material identifying similar stocks and acceptable or preferred stock transfer guidelines (Attachment 3) and indicate whether changes should be considered. In the absence of stock-specific data, extrapolations will be made in model input based on this or a subsequent list of closely similar stocks.

4. Habitat Information

We anticipate developing maps and other information called for in section II of the subbasin planning format at a later date. These can be corrected and submitted as part of the draft subbasin plans. Do not spend time now searching out this information.

Computerized data from the Council's river reach data base, along with appropriate programs, will be provided for each subbasin technical group. We ask that you review and correct this information for anadromous fish usage (spawning, rearing, passage, etc.), habitat quality and stream widths and document the sources of your updates.

5. Other Relevant Studies

Provide copies of, or cite sources for, other studies or information which you feel might be useful for modelling production of each stock.

C. Formats, Standards and Documentation Requirements

It is understood that much of the data requested in Tables 1a through 4 may not be available. We ask the subbasin planners to fill in as many of the items as possible and not get overly concerned about the number of blank spaces.

Formats for many of the elements discussed above are presented in Tables 1a through 4. Coding conventions for these tables follow that proposed for the new CWT data base maintained by the Pacific Marine Fisheries Commission (PMFC) since this represents a degree of consensus among fishery agencies coastwide. Information needs not lending themselves to these coding conventions should be reported in prose form or other tabular form, as appropriate. An explanation of data elements used in the tables follows.

SPECIES - self-explanatory, except that steelhead, rainbow, sockeye, and kokanee are treated as separate species.

RACE - normally spring, summer, fall, or winter. Coho may be designated as North or South depending on their predominant ocean distribution.

STOCK - normally the subbasin or hatchery of origin and, in these cases, need not be specified, IF it is the same as location sampled. In some cases two stocks may be sampled from the same location and date, and then it is mandatory to specify stock in this field.

DATE SAMPLED - in the form YYMMDD with punctuation being allowed (e.g., 87-3-12 or 87/10/6).

LOCATION - the location at which the sampling was done. Normally reported as the name of a hatchery or subbasin.

LENGTH UNITS - inches, millimeters or centimeters.

LENGTH TYPE - The type of measurement made is usually one of the following:

Code	Meaning
FL	tip of snout to fork of tail (fork length)
TL	tip of snout to tip of tail (total length)
ME-HP	mid-eye to hypural plate
SL	tip of snout to hypural plate (standard leng)

WEIGHT UNITS - kilograms, grams, pounds, or ounces.

WEIGHT TYPE - usually round weight but may also be dressed head-on or dressed-head-off.

AGE METHOD - method used to determine age. It is usually either scales or LF (length-frequency). If length-frequency method was used, indicate under "comments" the source of the break points used to separate ages (e.g., "these measurements," "Garfunkle, 1917", etc.).

BROOD YEAR - the year in which the majority of spawning occurs. For salmon, this is the same as the run year but for steelhead, this is one year later than the run year.

FISH # - begin at "1" and number consecutively for each line used.

SEX - M = male, F = female

AGE - F = freshwater age, usually 0, 1, or 2
O = ocean age, usually 1, 2, or 3, often this can be reasonably estimated from length/frequency data without knowledge of the freshwater age.
T = total age, usually 2, 3, 4, 5, or 6

EGGS - fecundity likely will come from hatchery data. It is preferable to report data by individual fish but an average by age is acceptable if estimates were made from combined samples. Specify under comments the method used to estimate fecundity (e.g., direct count, weight, volumetric, etc.) and the number of females used if an average value is reported.

ADULT RETURNS - specify the method of estimating catches (e.g., punch cards, interview, voluntary report, etc.) and escapement (e.g., weir count, redd expansion, mark-recapture, etc.). Be sure to cite sources for the expansion methodology and data or provide a description if this has not been done previously.

PRODUCTION - for hatchery programs describe the method of estimating juvenile releases ("book" estimates, weight expansions, etc.) and adult returns (complete weir counts, voluntary returns, etc.). For wild sampling, briefly describe the methods used (weir, trap, mark-recapture, etc.) and provide copies of the source documents.

DATA SOURCES - Data sources must be listed for all data on each sample sheet. Reports and publications should be cited using common scientific format. Other data should be referenced by the individual (and file, if appropriate) having physical possession of the information. Provide xerox copies of previously unreported data (field data).

Table 1a. Stock sex, size, age composition for system planning.

Species ______________________ Date Sampled ______________

Race ______________________ Location Sampled ______________

Stock ______________________

Length: Units___ Type___ Weight: Units___ Type___ Age Method___

				AGE			
Fish #	Sex	Length	Wt	F	O	T	Comments

Data Sources:

Table 1b. Stock size--fecundity information for system planning.

Species ______________________ Date Sampled ______________

Race ______________________ Location Sampled ______________

Stock ______________________

Length: Units___Type___ Weight: Units___ Type___ Age Method_______

Fish #	Length	Wt	Ocean Age	# Eggs	Comments

Data Sources:

Table 2. Stock abundance and harvest information for system planning.

Species ____________________ Location ____________________

Race ____________________ Sample Methods: Sport ______

Tribal ______

Stock ____________________ Escapement __

	Sport Catch		Tribal Catch		Escapement		Total Return	
Year	Jacks	Adults	Jacks	Adults	Jacks	Adults	Jacks	Adults
1977								
1978								
1979								
1980								
1981								
1982								
1983								
1984								
1985								
1986								

Data Sources:

Table 3. Hatchery production profile for system planning.

Species ____________________ Hatchery ____________________

Race ____________________ Method of Estimating

Juveniles ____________________

Adults ____________________

	Releases			Returns		
Year	Fry	Fingerling	Smolt	Jacks	Adults	Comments
1977						
1978						
1979						
1980						
1981						
1982						
1983						
1984						
1985						
1986						

Data Sources:

Table 4. Natural production profile for system planning.

Species ____________________ Location ______________________

Race ____________________

Stock ____________________

Brood					Survival (%)		
Year	Escap	# Eggs	# Fry	# Smolt	Egg-Fry	Fry-Smolt	Egg-Smolt

Data Sources:

IV. Data Available for System Planning

A. NPPC Data Base

1. Introduction.

The Northwest Power Planning Council's Fish and Wildlife data base, under development since 1985, is a result of the Hydro Assessment Study conducted by the Council and Bonneville. The study had two major components: the anadromous study which pertained strictly to streams containing anadromous stocks in the region, and the Northwest Rivers Study which examined resident fish, wildlife, natural features, cultural features, and recreational features of all streams in the region.

The data base will provide the baseline species use and habitat information needed by the subbasin planners and will provide a consistent regional structure for the input of additional information that will result from the system planning process. The data base will also be used by the Monitoring and Evaluation Group to aid them in tracking the Council's progress toward the goal of doubling the run size.

2. Description of the data base.

The data base contains information on over 30,000 individual stream reaches representing nearly 130,000 miles of streams. The data are organized into a regional stream coding system developed by the Environmental Protection Agency. This is a data base of surface water segments in the United States, indexed in such a way that data contained in it, or data linked to it, may be retrieved either geographically or hydrologically. For each reach, the file includes approximately 50 attributes including a surface water name, a unique reach number, the reach length, reach-to-reach linkages, reach latitudes and longitudes, and state and county codes. The system is linked to the STORET data base of water quality information. A major update of the system is currently underway and will result in a system representing all streams that now appear on 1:24,000 scale USGS maps. In addition, new attributes such as mean monthly flow, peak flow, slope, drainage area, mean hardness, and mean monthly temperature will be available for each reach. Mean annual and monthly precipitation, mean elevation, and soils types will be available for each cataloging unit (a hydrologic sub-division of the system).

Information in the data base is divided into two major groups: anadromous and nonanadromous. Anadromous information includes species presence/absence for spring, summer, and fall chinook, coho, summer, and winter steelhead, chum, and sockeye. Estimated low flow stream widths are also available for all anadromous reaches as is an estimated smolt productivity value and smolt density factor. Stream blockages are encoded, and those targeted by the Council's Fish and Wildlife Program for mitigation are flagged. Historical escapement information in the form of adult and redd counts is available with records dating back to 1933. Hatchery release information has been compiled for the four major state agencies (ODFW, WDF, WDW, and, IDFG) from 1980 through 1986 and includes hatchery locations and release sites encoded by EPA reach number, as well as dates, numbers, pounds, species, and broodstock for all releases. Federal and tribal hatchery information has not yet been entered.

Nonanadromous information in the data base was generated primarily by the Pacific Northwest Rivers Study. This study, conducted by BPA, includes data on five major categories, including resident fish, wildlife, natural features, recreational features, and cultural features. Value classifications for each of these categories were made for all the stream reaches in the four state region. Although these data were originally encoded using a different stream coding system for each state, they are now available by EPA reach number due to a cross-reference system that was developed by the Council. Also included in the nonanadromous category of data is the Army Corps hydro-site data base. This is a data base of all active hydro-sites in the region containing many attributes pertinent to the operation of the project, as well as the FERC status of the project, if it has not yet been licensed. The EPA reach on which the hydro-sites lie have been encoded.

The data base, with the underlying EPA reach structure, provides a flexible, yet consistent means for storing and accessing data throughout the region. Data searches can be made by state, county, lat/long coordinates, stream order, stream name, or hydrologic boundary (or any combination of these). Once a stream or stream reach is chosen, one can instantly view the anadromous species present in the reach, the predominant resident fish and wildlife species present, information on water quality, and the status of any active FERC site on the reach.

The data base currently resides on the Council's MICROVAX computer system, but the data is easily transferred to micro computer data base packages, such as DBASE III or RBASE 5000. Software development is currently underway to provide a menu driven data access and update system to be used by the subbasin planners on micro computers using the data base manager ZIM. Runtime versions of this software will be provided to the system planners.

3. Use of the data base in system planning.

The data base will be used in the system planning process to provide baseline information on present conditions to the subbasin technical groups. These groups will be asked to review, update and refine this information and return it to the systems planners.

A major part of this task will include the refinement of the Council's presence/absence data. These data were used by the Council in a productivity analysis of the Basin using a habitat-based, smolt-density model for estimating smolt production. The smolt estimates generated by this method were quite high in most cases. This was partly due to the smolt densities chosen but primarily attributable to the fact that the data base does not delineate spawning and rearing areas from migration corridors.

The system planners have developed a method similar to that of the Council's to estimate the smolt production of the subbasins for use as input in the Systems Planning Model. Data requirements for this method include smolt densities and usable spawning and rearing areas. It will be the responsibility of the subbasin technical work groups to take the presence/absence information in the Council's data base and break it down into three major categories: 1) areas used for spawning and rearing, 2) areas used for rearing only, and 3) areas not used for either spawning or rearing. Stream width estimates will also be subject to review and update. Species use is further discussed in section V. of this report.

A computerized, menu-driven system will be provided for each subbasin technical work group for the input of the new data elements as well as for the correction of existing data. The data will be structured by river reach, and the system will require input at this level. A hard copy summary of this data will be provided as an addendum to this report by the end of September.

Other types of data also will be made available for review and update, including the location and nature of stream blockages, subjective estimates of habitat condition, and land use. The technical work groups will be asked to verify or enhance this information.

When this process is complete, the System Planners will have a consistent method for estimating smolt production throughout the Basin, as well as information on the current distribution of anadromous species, the amount of usable spawning and rearing area in the Basin, the habitat quality of these areas, and a means for estimating the potential habitat available through the removal of existing barriers.

B. United States vs. Oregon Data Base

The U.S. vs. Oregon data base includes subbasin specific production information for adults and smolts for steelhead and spring chinook for most subbasins above Bonneville Dam. Where this information is available, it will be included in appropriate sections of subbasin plans. Besides subbasin specific information, U.S. vs. Oregon also established two standards (i.e., fish/redd, eggs/redd) and two sets of survival rates (i.e., egg-smolt, smolt-adult), all of which deal with production. A discussion of each of these follows:

1. Fish/redd

A value of 2.40 fish/redd was used in calculations of spring chinook production and supplementation for all streams, based on spring chinook/redd data in the Yakima (1982-84 broods) (unpublished data, Washington Department of Fisheries) and the Lemhi River (1965-74 broods) (Bjornn 1978). The eight year (1977-84 brood) average spring chinook/redd in the Warm Springs (Deschutes River) was 3.0. It was thought that the Warm Springs fish/redd was too high which may be due to incomplete redd surveys (redd surveys for the Yakima and Lemhi rivers were complete) or high prespawning mortality of females. Mortality of spring chinook from Bacterial Kidney Disease (BKD) and inoculation to control BKD has been a serious problem in the Warm Springs River during recent years. The BKD problem in the Warm Springs should be temporary and fish/redd should be the same as other basins.

For steelhead, a value of 1.67 fish/redd was used in calculations of production and supplementation needs. The only available data on steelhead/redd is from Snow Creek, a Western Washington winter steelhead stream. During three years of study (1976/77-1978/79), each female dug an average 1.2 redds (WDG 1979). This equals to 1.67 fish/redd assuming a 50/50 female/male sex ratio.

2. Eggs/redd

Eggs/redd was established as the fecundity of females in each stream. Unless there was subbasin specific information standards were established as 4,000 for spring chinook and 5,000 for steelhead.

3. Egg-to-smolt survival

The egg-to-smolt survivals for spring chinook are based in part on a regression of egg-to-smolt survival of spring chinook in the Deschutes, John Day, and Yakima rivers on adult seeding level. The regression is shown in Figure 1 and Table 5. Seeding levels were calculated by dividing egg deposition for each brood by the potential maximum egg deposition (determined from maximum inriver catch and escapement) on record for each river. Egg-to-smolt survivals include production from fall (subyearling) and spring (yearling) migrants, but excludes production from spring (subyearling) migrants.

Fairly good data sets were available to determine potential maximum egg deposition in the John Day, Yakima and Lemhi rivers. For these rivers, escapement data were available since 1959, 1957, and 1954, respectively. Catch and escapement data for the Deschutes River were available only since 1975. However, the potential egg deposition for 1976 (4,360,000) should be near the maximum for the system as evidenced by the low observed survivals (down to 2.3%0 at egg depositions ranging from 351,000-3,198,000 for 1975-82 broods (Table 5).

The regression of egg-to-smolt survival on seeding level was highly significant ($r=0.766$, $p<0.01$) (Figure 1). The natural log (ln) of seeding level produced the best fit (correlation) of the data. Regression values were used for 10% (11.91), 255 (7.72), and 50% (4.56) adult escapement levels (Figure 1). Due to limited data, egg-to-smolt survivals were estimated at 3.50% for 75% adult escapement and 3.00 for 100% adult escapement. No survival data was available for hatchery produced fish spawning in the wild. Egg-to-smolt survival of hatchery fish at each seeding level was assumed to be 75% of the survival of naturally produced fish (Table 6).

Limited data were available for two Columbia River tributaries for determining egg-to-smolt and seeing level relationships for steelhead. For 1963-73 brood summer steelhead in the Lemhi River, egg-to-smolt survivals ranged from 0.6-1.5% (Bjornn 1978). Survivals were determined from placement of eggs in an incubation channel and from stocking fry into Big Springs Creek and the Lemhi River. Unfortunately, it is not known how these survivals relate to seeding levels. We estimated that the egg-to-smolt survival of steelhead at full seeding was estimated to be 0.75% (Table 7). To determine survival at other seeding levels, spring chinook egg-to-smolt/seeding level relationship was used (Table 6).

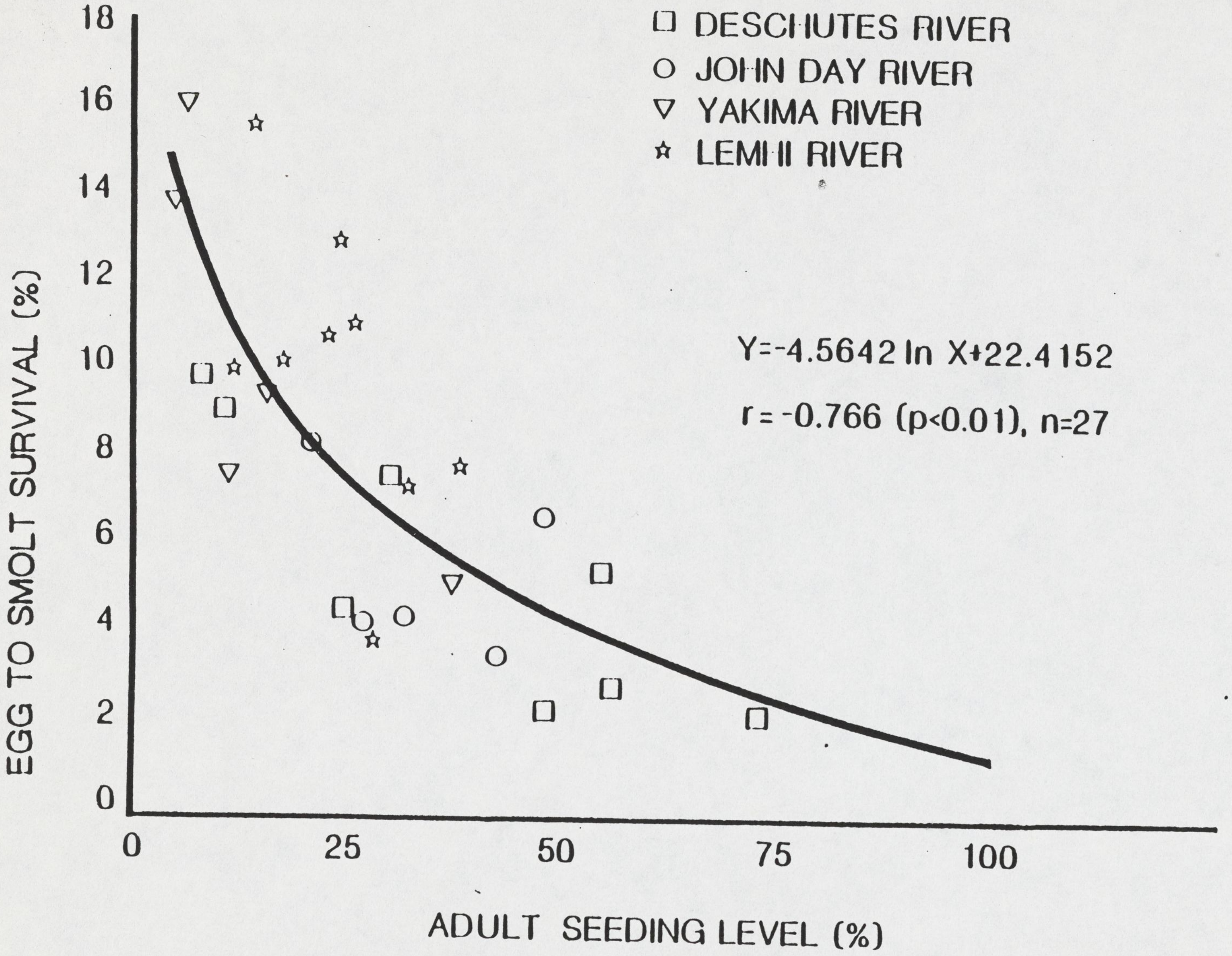

FIGURE 1. REGRESSION OF EGG-TO-SMOLT SURVIVAL RATE ON SEEDING LEVEL OF SPRING CHINOOK FROM FOUR SUB-BASINS OFZTHE COLUMBIA RIVER.

Table 5. Data for regression of egg-to-smolt survival on seeding level of spring chinook in the Deschutes, John Day, Yakima, and Lemhi rivers.

Deschutes River

Brood Year	No. Eggs (thousands)[a]	% Seeding[b]	Egg-to-Smolt Survival[a]
1975	2,424	55.6	2.8
1976	3,198	73.3	2.3
1977	2,097	48.1	2.4
1978	2,388	54.8	5.5
1979	1,077	24.7	4.7
1980	351	8.1	10.0
1981	471	10.8	9.1
1982	1,299	29.8	7.7

John Day River

Brood Year	No. Eggs (thousands)[c]	% Seeding[d]	Egg-to-Smolt Survival[c]
1978	2,510	46.5	6.7
1979	2,310	42.8	3.6
1980	1,090	20.2	8.6
1981	1,440	26.7	4.4
1982	1,750	32.4	4.5

Yakima River

Brood Year	No. Eggs (thousands)[e]	% Seeding[f]	Egg-to-Smolt Survival[g]
1957	8,670	37.5	5.4
1958	3,260	15.4	9.8
1959	2,568	10.6	7.6
1960	1,240	5.9	14.3
1961	1,505	6.5	16.4

Lemhi River

Brood Year	No. Eggs (thousands)[h]	% Seeding[i]	Egg-to-Smolt Survival[h]
1965	1,794	18.1	10.3
1966	2,738	27.6	4.0
1967	3,169	31.9	7.5
1968	3,774	38.0	7.9
1969	1,219	12.3	10.6
1970	2,258	22.7	10.9
1971	1,417	14.3	15.9
1972	2,530	25.5	11.2

1973	2,375	23.9	13.1

[a]Jonasson and Lindsay (1983)

[b]Percent of maximum (1976=4,360,000 eggs from 4,360 adults assuming 3.0 fish/redd and 3,000 eggs/redd)

[c]Knox et al. 1984.

[d]Percent of maximum (1970=5,395,000 eggs from 3,237 adults assuming 2.4 fish/redd and 4,000 eggs/redd.

[e]Washington Department of Fish (unpublished).

[f]Percent of maximum (1957=23,108,348 eggs from 12,665 adults assuming 2.4 fish/redd and 4,379 eggs/redd).

[g]Major and Mighell (1969).

[h]Bjornn (1978).

[i]Percent of maximum (1961=9,937,167 eggs from 5,450 adults assuming 2.4 fish/redd and 4,376 eggs/redd).

Table 6. Survival rates for spring chinook.

A. Egg-to-smolt survival:

Percent of Maximum Adult Escapement	Smolt Seeding Level (%)	Egg-to-smolt survival (%) Natural	Hatchery
100	100	3.00	2.25
75	88	3.50	2.63
50	76	4.56	3.42
25	64	7.72	5.79
10	40	11.91	8.93

B. Smolt-to-adult survival:

No. Dams	Natural (%)	Hatchery (%)
1	3.50	1.75
2	2.30	1.15
3	1.50	0.75
4	1.00	0.50
5	0.83	0.41
6	0.67	0.33
7	0.50	0.25
8	0.40	0.20

Table 7. Survival rates for steelhead.

A. Egg-to-smolt survival:

Percent of Maximum Adult Escapement	Smolt Seeding Level (%)	Egg-to-smolt survival (%)	
		Natural	Hatchery
100	100	0.75	0.60
75	88	0.90	0.70
50	77	1.20	0.90
25	61	2.00	1.50
10	40	3.00	2.25

B. Smolt-to-adult survival:

No. Dams	Natural (%)	Hatchery (%)
1	7.1	4.8
2	6.0	4.0
3	4.0	2.7
4	3.2	2.2
5	-[a]	-[a]
6	-[a]	-[a]
7	-[a]	-[a]
8	1.5	1.0

[a]Not established.

4. Smolt-to-adult survival

Established smolt-to-adult survivals for spring chinook are listed in Table 2B. Actual survival data was used to estimate survival rates of naturally produced fish over two dams (from Deschutes River, Jonsson and Lindsay 1983) and hatchery produced fish over eight dams (from Rapid River, unpublished data, Idaho Department of Fish and Game). Both the Deschutes and Rapid River survival estimates include contribution to inriver fisheries. All other survivals of naturally and hatchery produced fish at each of the dams were estimated. Other survival data for other Columbia River tributaries exist, but it is felt that the Deschutes and Rapid River data are the only reliable data. In developing survival schedules, it was assumed that survival of hatchery produced fish would be 50% that of naturally produced fish.

Established smolt-to-adult survival for steelhead are listed in Table 3B. Actual survival data was used to estimate survival of hatchery produced steelhead over two dams (from Round Butte Hatchery unpublished data, Oregon Department of Fish and Wildlife). All other survivals of naturally and hatchery produced steelhead at each of the other dams were estimated. A 1.0% survival for hatchery produced fish over eight dams were used which is approximately the average survival for steelhead released from Snake River Hatcheries in Idaho (unpublished data, Idaho Department of Fish and Game). Survival schedules were developed assuming that survival of hatchery produced fish would be 67% that of naturally produced fish.

Use

The use of U.S. vs. Oregon production information in the system planning process will be two-fold. First, subbasin specific production information will be included in the subbasin plans. Secondly, both sets of survival rates generated under U.S. vs. Oregon (i.e., egg-smolt, smolt-adult) will be used to evaluate performance of the system planning model. It is likely that these rates will be revised to reflect new and better information as the system planning process proceeds. It is the responsibility of the MEG to see that these rates, as well as other critical model parameters, are updated to reflect the best available information. The fish per redd and eggs per redd standards which U.S. vs. Oregon established have utility at both the system and subbasin level, but are not presently used as model input (See also section III A.- Data Needs of the Model, above).

V. Habitat Capacity Estimates - Juvenile Production

A. Standardized Technique

Subbasin planners are charged with developing estimates of the current capacities (assuming full seeding) for natural fish production of salmon and steelhead in 31 subbasins of the Columbia River Basin. The MEG will be available as needed to assist in calculating these estimates.

One of the key parameters necessary for evaluating production potential in the subbasins is carrying capacity. A variety of methods has been used to estimate carrying capacity for specific drainages and runs in the Columbia Basin. In some drainages no estimates are available, and there may be very little information to derive an estimate. Based upon a review of available techniques and information, the SPG and MEG developed the following set of "standard" techniques for estimating carrying capacity for application in the planning process. In some subbasins carrying capacity estimates based upon more detailed specific information may be available. Subbasin planners are not precluded from providing estimates, in addition to the results of applying the standardized approach, as long as the alternative methods are fully documented for review at the system level.

The SPG used several criteria in selecting a standard method for estimating current production capacity levels. The selected method had to be simple to use and applicable to all subbasins. It had to require no additional data collection beyond currently existing information (available for <u>all</u> subbasins), and it had to allow incorporation of subbasin-specific information where it is available.

The standard method selected was a habitat-based, smolt-density approach. Requisite data for this method are smolt density estimates (number of smolts per unit of usable habitat area) and estimates of the availability of usable smolt rearing habitat.

Generic estimates of smolt density for species, races and key stocks of salmon and steelhead to be used as standard estimates were selected by the SPG following a review of available information. These are presented in Table 8. The estimates selected for each species, race and stock and for each production area type fall within the range of estimates present in the literature reviewed. A list of references reviewed in selecting these estimates is presented in Attachment 4. Adjustment of density estimates for application to specific production area types (described below) was based upon a subjective, negotiated assessment by the SPG. Generally speaking, density estimates from the higher end of the ranges presented in the literature were selected for production area types classified as spawning and rearing areas and higher quality habitat areas. Estimates from the lower end of the ranges presented in the literature were selected for production area types classified as rearing-only areas and lower quality habitat areas.

The standard smolt density estimates should be used for calculating subbasin production capacities. If subbasin planners can document the existence of more accurate density estimates specific to a given subbasin, these also should be used for calculating production capacities and the resulting estimates compared with those from the standard density estimates.

One standard smolt density estimate for each species, race or stock was identified for application to all production areas identified for coho salmon and sockeye salmon (Table 8). Two standard smolt density estimates were identified for application to all production areas containing mid-Columbia fall chinook salmon, Snake River fall chinook salmon, and mid-Columbia summer chinook salmon. However, a series of standard smolt density estimates was developed for application to each of eight specific types of production areas for steelhead trout, spring chinook salmon and Snake River summer chinook salmon. Two specific types of production areas were identified as 1) areas where both spawning and rearing occur, and 2) areas where only rearing occurs in the subbasin. Each of these types of production areas is divided into four additional categories (excellent, good, fair or poor) based upon an assessment of habitat quality. Each group of subbasin planners should describe the criteria it has selected for classifying production areas into each of these four categories.

Very little information on the maximum juvenile densities of summer or fall chinook is available. The standard approach developed for these races is based on the assumption that age ´0´ juvenile rearing area is a limiting factor. The standard density estimates for application to fall and Mid-Columbia summer chinook are taken from Everest and Chapman (1972) and Marshall , et al. (1980). The estimates are expressed in terms of age ´0´ smolts in late summer. As with spring chinook and steelhead, the density factors are intended to be applied to specific estimates of the amount of available rearing habitat in a given system or reach. The production potential of certain reaches, for example, the north fork Lewis River and the Hanford Reach of the Columbia mainstem, may be significantly higher (Don McIssac, personal communication). Specific production estimates, including documentation, for those areas should be provided in the appropriate subbasin plan.

Current capacity or current production capacity is defined as the present capacity for a given habitat, area, stream reach, or subbasin area for the natural production of anadromous salmon and steelhead smolts, assuming full seeding and no enhancement of existing passage barriers or habitat conditions. Estimates of current production capacity generated for each species, race or stock within each subbasin are intended to serve as an index of the subbasin´s general production capability comparable to production indices generated for other subbasins. While every effort should be made to estimate current production capacity as accurately as possible, these production estimates are not necessarily intended to be accurate estimates of what is actually being produced within each subbasin at present.

Further, the production estimates are not intended to be used to estimate the potential benefits from passage or habitat enhancement efforts within a subbasin. For example, it is unlikely that enhancement of a degraded production area would result in improved production up to the level of an excellent quality production areas. Rather, enhancement more likely would result in some unknown proportion of this maximum increase. Potential increases in production resulting from enhanced passage into areas currently blocked to spawning and rearing also is not addressed in the estimates of current production capacity to be developed by subbasin planners. These adjustments will be addressed during subbasin planning analysis of enhancement potential.

However, planners should consider carefully the habitat quality rating which they choose to assign to a given reach, as this rating will determine the appropriate standard smolt density estimates to use in estimating current production capacities for steelhead, spring chinook salmon, and Snake River summer chinook salmon within the reach. While a subbasin may appear to be more productive and perhaps more important in terms of its potential impacts on overall systemwide planning under present conditions if the majority of its habitat is considered to be of high quality, clearly the potential for enhancement of production within such a subbasin through passage and habitat improvement efforts would be limited. What is needed is an assessment of the current natural production capacity which is as accurate and unbiased as possible for each species, race or stock within each subbasin.

The major task regarding estimation of current production capacities for subbasin planners is to determine as accurately as possible the types and amounts of usable rearing area in each subbasin and to enter this information onto the computerized system that will be provided. Subbasin planners should make use of documentation whenever possible in defining production area types, but it will be necessary to rely upon subjective evaluations from knowledgeable experts in many areas for designating production area types within a subbasin. As an example, production areas classified as being rearing only areas may actually have low levels of spawning activity which result in questionable levels of fry or parr production. Likewise, degraded areas are those where production presently occurs but the productivity could be increased (to a known or unknown but presumably significantly higher level) through some type of passage or habitat enhancement activity.

One aspect of the standard method which was emphasized in its design was an attempt to reduce overestimates of production which result when entire stream lengths or major portions of streams are used in combination with smolt density estimates for generating production estimates rather than giving adequate consideration to areas actually used for production within these large reaches. Habitat which is not classified as usable production area may be occupied by salmonids for brief periods of time but would not be considered to be habitat where either spawning or rearing takes place. Some areas, for example, such as lower subbasin mainstem areas, may serve only as migration routes and do not directly contribute to smolt production.

Within each production area (regardless of type), subbasin planners must estimate the amount (in square meters) of usable area which exists. Usable area is defined as sections or portions of streams or stream reaches where one would expect (as a result of documentation where possible or otherwise based upon a subjective evaluation) to find fall or mid-Columbia summer chinook salmon rearing during low flow summer periods or where you would expect to find other species, races and stocks of anadromous salmon or steelhead rearing during overwinter periods. For purposes of the standard method estimation approach, these usable areas are considered to be smolt-producing areas to which the standard smolt density estimates are truly applicable.

At first, the proportion of the total length of a given stream reach estimated to contain usable production area should be determined,[3] the reach should be classified as either a spawning and rearing area or a rearing only area[3] and the quality of the usable habitat within the reach should be classified.[3] Then the computer program provided to subbasin planners can be used to perform the calculations necessary to arrive at totals for usable area of production area type and habitat quality category. These areas then will be

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3 Necessary only for steelhead, spring chinook salmon, and Snake River summer chinook salmon production areas.

multiplied by the appropriate standard smolt density estimates and the results summed to give total subbasin production capacity estimates for each species, race or stock.

The computer program also will allow calculation of alternative production capacity estimates using alternative smolt density estimates entered into the program by the subbasin planners.

The resulting natural production capacity information (production capacity estimates and usable area estimates) for each subbasin then will be incorporated into the Preliminary Information Report developed by the subbasin planners and presented to the SPG for review.

B. Other Estimates

Subbasin planners may have information specific to the subbasin for which they are developing a plan which they feel provides more accurate information about the current production capacity for a given species, race or stock than the above described standard method can provide. In this case the subbasin planners should provide to the SPG estimates of production capacity based upon the alternative method in addition to the estimate based upon the standard method. A complete description of and rationale for using the alternative method must be provided.

Table 8. Standard smolt density estimates adopted by the System Planning Group.

Species, Race or Stock	Areas of Spawning and Rearing Habitat Quality: Excellent	Good	Fair	Poor	Areas of Rearing Only Habitat Quality: Excellent	Good	Fair	Poor
		(fish/m²)			(fish/m²)			
Summer or winter steelhead	0.10	0.07	0.05	0.03	0.04	0.03	0.02	0.01
Spring chinook and Snake River summer chinook	0.90	0.64	0.37	0.10	0.40	0.27	0.15	0.03
Mid-Columbia summer chinook[4]		1.80	0.66					
Snake River and mid-Columbia fall chinook[1]		1.80	0.66					
Coho	0.40							
Wenatchee sockeye	0.12							
Osoyoos sockeye	0.11							

This translates to 90/100 m²
In about 150 snorkel and cyanide biomass-density samples (representing more than 100 surface acres of area), I have found spring chinook yearly ranging from 0 to 150/100m², but the average perhaps is no more than 10/100m², and we do not have underseeding

Wenatchee

Table 8. Standard smolt density estimates adopted by the System Planning Group.

Species, Race or Stock	Areas of Spawning and Rearing Habitat Quality				Areas of Rearing Only Habitat Quality			
	Excellent	Good	Fair	Poor	Excellent	Good	Fair	Poor
	(fish/m^2)				(fish/m^2)			
Summer or winter steelhead	0.10	0.07	0.05	0.03	0.04	0.03	0.02	0.01
Spring chinook and Snake River summer chinook	0.90	0.64	0.37	0.10	0.40	0.27	0.15	0.03
Mid-Columbia summer chinook[4]		1.80	0.66					
Snake River and mid-Columbia fall chinook[1]		1.80	0.66					
Coho	0.40							
Wenatchee sockeye	0.12							
Osoyoos sockeye	0.11							

This translates to 90/100 m² In about 150 snorkel and cyanide biomass-density samples (representing more than 100 surface acres of area), I have found spring chinook y-o-y ranging from 0 to 150/100m², but the average perhaps is no more than 10/100², and we do not have underseeding

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