A PRELIMINARY BIOLOGICAL SURVEY

OF THE SKAGIT AND STILLAGUAMISH RIVERS

by

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This survey was carried out during the summer season of 1921 under the direction of John N. Cobb, Director of the School of Fisheries, University of Washington.

The survey must be considered as superficial. It would take very much more time than was spent to make anything like a thorough investigation of the waters covered.

THE SKAGIT AND ITS TRIBUTARIES

The skagit river rises in Beaver Lake, British Columbia, and flows in a southern direction through eastern Whatcom County into Skagit County, where it turns westward and traverses this county to empty by several branches into Skagit Bay, which is an arm of Puget Sound. The upper part of the river flows through a very mountainous country, while the lower reaches traverse a decidedly flat wide valley, which is not infrequently inundates. The river has a number of very important branches each of which will be considered in detail. The river and its tributaries drain the western slope of the Cascade Mountains in Whatcom and Skagit counties, and the nortnern two-thirds of Snohomish county. It is 125 miles long and drains an area of 3,100 square miles.

The main river will be considered in sections and then each of its important tributaries will be considered separately.

The first section is that part of the Skagit river between the

International Boundary and the mouth of Ruby Creek. This section flows through a comparatively narrow, well wooded valley which lies between lofty mountains. This part is about 20 miles long and has a fall of about 350 feet in the 20 miles. This stretch of the river was visited during the last week of June when the waters were high. About a mile above the mouth of Ruby Creek the river had a width of about 150 feet and an average depth of about two feet. The bottom was composed of very coarse gravel over which the water ran swiftly. The water was quite clear and had a temperature of 48°F. at noon, June 28.

Extensive log jams are reported as obstructing the river a short distance south of the International Boundary. The river bottom is practically free from vegetation, owing to the gravelly nature of the bed, the swiftness and coldness of the water.

Four creeks of importance empty into this section of the river. Flowing from the east are Lightning and Ruby creeks, while from the west flow Big and Little Beaver creeks.

This section of the river is without inhabitants and is rather inaccessible. The mouth of Ruby Creek is fourteen miles up the Skagit from the City of Seattle Camp where the railroad terminates. A fairly good trail follows the west side of the river to the mouth of Ruby Creek, where it crosses the Skagit and follows the eastern bank to the Canadian Boundary. A branch trail follows the west side for about four miles until near the mouth of the Big Beaver, where it turns to follow the southern bank of the latter stream. It crosses the Big Beaver after going up the south bank for about one mile, and then continues up the northern shore of the stream. These trails are used by pack horse trains for the transportation of the equipment of the City of Seattle engineers, who are making a survey of the power project.

No salmon have ever been seen in this part of the Skagit river, but it is well stocked with rainbow trout and Dolly Vardens. Game fishing is unusually good in this part of the river. Thirty-seven rainbow trout from this section of the river were examined. They varied in length between six and seventeen inches in length and all were in excellent condition. Five of the larger ones had a few copepods attached to the tissues in the vicinity of the gills, but there were not enough of them to do any appreciable harm to the fish. The stomachs of all were opened and the contents showed that they fed mostly on adult land insects; a few insect larvae were found, the most common of which were of the Caddis fly.

CITY OF SEATTLE PROJECT.

As this project, when completed, will make such a profound change in this part of the river, it is deemed advisable to note briefly these changes. The upper project when completed, will be the cause of the most marked modification. The intention at the present time is to construct a dam at a narrow gorge 1700 feet down the Skagit river from the mouth of Ruby Creek. This dam is to be 400 feet high and will back up the water for a short distance beyond the Canadian side. A lake expansion of the river will be formed which will be 20 miles long, one and one quarter miles in average width, and will have a depth varying from a few feet to 400 feet. It is evident that the fishing conditions will be greatly changed. Moreover, since the water is to be used for power production alone it is more than likely that this lake expansion will become a favorite summer resort to which many tourists will flock. Amongst them will be many game fishermen who should find excellent fishing if proper measures of conservation are taken by the state.

The section of the Skagit river between Ruby creek and the city of Seattle Camp, 14 miles in length, runs through the most rugged country drained by the river. The banks in many places are abrupt precipices. Through this region the Skagit boils and foams for the greater part of the distance. Several pictures will indicate the character of the country and the condition of the waters. While no single fall or rapid observed would form an insurmountable barrier to the upward migration of salmon, yet the continued series of low falls and rapids seem to have proved effective in stopping the run of salmon through this part of the river. Those living in this region who have given close attention to the movement of fish have never seen salmon more than one mile above the City of Seattle Camp.

The bottom and shores are rocky and covered in many places with immense boulders. The water is clear, cold and almost devoid of plankton life and the bottom has no vegetable growth worth mentioning.

Salmon have been seen about one mile above the City of Seattle Camp. Rainbow trout and Dolly Vardens are very abundant in this part of the river and afford excellent fishing. A few of the fish are parasitzed with copepods, but not enough to interfere to any extent with the well being of the fish.

Two streams of some importance flow into this part of the river. From the East enters Thunder creek, and from the west Stidadell creek.

Six miles up the trail from the City of Seattle Camp, hear the mouth of the Stidadell is the only dwelling in this stretch of the river. It is owned by Mr. G. G. Daivis, who furnishes accommodations for a few travelers. About one mile farther along the trail is a forest ranger's station, which is occasionally occupied.

The third section of the Skagit river extends from the City of Seattle Camp to Rockport, a distance of about 25 miles. This portion of the river flows through a decidedly mountainous district, but not nearly so rugged

as the section previously described. The stream in this section assumes the proportions of a large river, varying considerably in width, but averaging about 100 yards. The water is clear and cold. The bottom consists for the most part of coarse gravel, which makes an excellent spawning bed for salmon. In some parts the water is very rapid. There is no vegetation of any importance on the bottom, nor is there much plankton to be found in the water.

There are no obstruction in this part of the river that would impede the upward progress of migrating salmon.

A narrow strip of flat land exists along the right bank of the river. This strip is fairly well settled for 15 miles above Rockport. The left bank is abrupt and almost without settlement. The unsettled parts are thickly forested with fir, cedar and hemlock.

This stretch is reached by chinook, silver, hump and dog salmon migrating from Puget Sound. In the spring a considerable number steelhead trout reach this part of the river and ascend the tributaries to spawn. It is also well stocked with trout, the most important of which is the rainbow. Dolly Vardens are also very abundant. The river here or anywhere else where salmon run cannot be used for artificial propagation as the stream is far too large and swift to be racked.

This part of the river is paralleled by a railroad on its right bank from Rockport to the City of Seattle Camp. A rather poor wagon road extends up as far as Bacon Creek, the part up to Marblemount being better than the rest of it. At Marblemount, about nine miles from Rockport an automobile camping site is maintained, where tourists may camp comfortably. Two hotels at this place furnish comfortable accommodations for those desiring entertainment. A ferry is maintained here which transfers travelers to the trail ascending the Cascade River.

Several important streams enter the Skagit in this section. From the west side the tributaries of importance are Goodell, Bacon and Diobisud creeks, and from the east they are Cascade River and Illabot Creek.

The next section for consideration extends westward from Rockport to Lyman, a distance of about 25 miles. This district is still mountainous, but the valley of the Skagit widens out very much by the time it reaches Lyman. The width of the river has increased considerably owing to the large volume of water emptied into it by the Sauk River. The water from this stream is decidedly muddy, so that the water of the Skagit from the mouth of the Sauk onward is no longer clear. The water remains quite cold even during the warmest summer weather. The bottom of the river is composed of coarse gravel and, owing to the swiftness and low temperature of the water, is practically without bottom vegetation. The shore conditions are very varied, some places being forested to the water, while others are cleared and under cultivation.

A number of important streams enter this section of the river. Those entering from the north are: Jackman, Grandy and Alder Creeks and Baker River, while those entering from the south are Sauk River and Finny, Pressentin and Day Creeks. A railroad follows the north bank and wagon roads follow both banks of this section.

The remaining section runs westward for 8 or 10 miles and then almost south for 14 to 15 miles, where it enters by several branches into the Puget Sound. This part of its course is through a flat, well settled country. The river widens out, has a number of sloughs and becomes much slower. The bottom is muddy and soft. It receives no tributaries of much importance, the only one at all worth considering being the Nookachamps Creek.

BIG BEAVER CREEK.

Big Beaver Creek Was visited June 30. This stream, which is about 12 miles long, has its source in Beaver Pass (El. 3675 ft.) and discharges into the Skagit about 5 miles above the mouth of Ruby Creek. The mouth of the Beaver has an elevation of 1300 ft., so that there is a fall of 2475 feet in the 12 miles of its course. Within one mile and one quarter of its mouth it falls 300 feet. In this stretch there is a series of falls and rapids which completely obstruct the passage of fish (see pictures). Above this precipitous area the stream becomes smooth and deep and continues thus for about three miles. The depth in this stretch was, at the time of our visit, 10-12 feet and the width about 75. The bottom and the banks were muddy. Above this three mile stretch the stream became increasingly rapid as it approached the source. This upper area had a gravel and rock bottom.

The water was clear and had a temperature of 46°F. There is practically no vegitation on the bottom of the stream. The banks in most places are quite steep and covered with forest vegetation.

Several years ago some cutthroat trout were planted in the smooth waters one mile and one-half above the mouth. Five of these fish were obtained. They varied in length between 5.5 and 13.5 inches. They were unusually beautiful fish and in perfect condition. No parasites, external or internal, were found. The contents of their stomachs consisted almost entirely of land insects. The water, owing to its low temperature, was almost devoid of plankton forms of life.

A fairly good trail, following the west side of the Skagit ascended the south side of the Big Beaver creek for one mile and one-quarter, then crossed on a fairly substantial foot bridge to the north side, up which it went. A ranch house owned and continously occupied by J. H. McMillan is located on the south side of the creek about one mile above the bridge. Travelers may obtain lodgings at this house.

If the upper project on the Skagit is completed as at present planned the lake expansion will extend up this stream so as to cover the falls and be on a level with the slow flowing part of the stream.

RUBY CREEK.

Ruby Creek was visited June 28, 29, and July 1. The stream is about 20 miles in length and flows through an extremely rugged country. Some places its banks rise perpendicularly to a height of about 300 feet. The stream averaged 40 to 60 feet wide and 3 to 4 feet deep.

The temperature at noon, June 28, was 47°F. while the air was 78°F.

The water is very clear and flows over a bottom covered with gravel and boulders. Owing to the swiftness and low temperature the bottom is devoid of vegetation. The banks are densely forested with the common types of trees covering the mountains of this region.

About four miles above the mouth is a dam about 25 feet high which was formerly used to supply water for an hydraulic mining project near the mouth of the creek. The mining operations have not been carried on for some years and the flume has gone to pieces, so there is no reason why the dam should remain any longer as an obstruction in the stream. The stream is subject to sudden freshets which would be destructive to any devices that might be constructed for the taking of fish.

Ruby Creek is an excellent trout stream throughout the greater part of its length. The fish are not very large, but they are gamy. Twenty-six rainbow trout were caught. They varied in length between 6 and 10.75 inches and averaged 8.16. Examination of these fish showed that they were free from both internal and external parasites. Their stomachs were filled, mainly, with land insects. A few Caddis fly and other insect larvae were found. At the mouth of the creek where it empties into the Skagit River much larger fish were found. The majority of these were rainbow trout varying in length between 10 and 17 inches. Three of the largest of these trout had a few copepods on the

gills and the tissues in the neighborhood of the gills. Some Dolly Vardens are caught at the mouth of this creek which weigh up to 8 to 9 pounds.

A fairly good trail branching off of the one on the east side of the Skagit follows more or less closely the north bank of this creek. It is kept in such a state of repair that pack horses may be easily taken over it. This trail continues up State Creek, a tributary of the Ruby, and passes over to the east side of the Cascade range of mountains through State Creek Pass to the west fork of the Methow River.

A small ranch house stands about 100 yards from the mouth of Ruby Creek where fair accommodations may be obtained. This place is at present, occupied by Mr. H. B. Brown. Another house may be found about 12 miles up the creek from its mouth. This house is occupied by a Mr. John Mack, who offers accommodations to those who wish them.

THUNDER CREEK AND LAKE.

This creek and lake were visited July 3. The creek, which is about 17 miles long, flows in a northerly direction and empties into the Skagit River about 7 miles above the City of Seattle Camp. It rises in the glaciers of Boston and Logan peaks. A series of falls within one half mile of its mouth prevent the run of any fish from the Skagit into this creek, consequently it is reported to be without fish. Descriptions given by those who have followed the creek to its source indicate that it might become an excellent trout stream if the trout were planted above the falls. The water is clear and cold and the bottom is of gravel and boulders, as are nearly all of the mountain streams.

A fair trail crosses the Skagit by a suspension bridge about one quarter of a mile below the mouth of the creek. This trail follows the west side of the creek for about two miles, then crosses to the east side, which it follows to the source of the creek, then continues over the Cascade Mountains by Park Creek Pass to the Stehekin River by its Park Creek Branch.

Thunder Lake is about one and one-half miles from the mouth of Thunder Creek and nearly directly south of the mouth. It is connected with Thunder Creek by an insignificant stream about one mile in length. The lake nestles at the base of high snow clad mountains. It is about one-half mile in length and less than one-half as wide as it is long. The lake is comparatively shallow considering its location. The surface temperature taken at 10 A.M. was 64°F. while the air was but 60°F.

There was considerable vegetation in the shallower portions of the water, particularly at the northern and southern extermities where there were considerable areas of flat marshy ground that apparently were under water at other seasons of the year. The east and west shores of the lake were quite steep and were covered with heavy growths of timber, of which is considerable amount had fallen into the lake.

Trout, said to have been taken from Lake Chelan, had been planted in this lake some years ago. These fish had grown to be 16 to 18 inches long and were very gamy. From all appearances they had failed to reproduce successfully as no smaller fish were seen, or had the presence of any smaller ones been reported.

A fair trail, branching from the Thunder Creek trail, leads in to the lake.

STEDATTLE CREEK.

This creek was visited July 4. It is a rather small creek, being about 8 miles in length, and averaging about 30 feet in width, and probably 2 feet in depth. Its shore line is impossible to follow for more than one mile above the mouth, as it has cut its way through rocks, forming a canyon of considerable depth. The country through which it flows is very rugged.

The temperature of the water at 7 P.M. July 3, was 46°F. and the air 58°F. The following morning at 6 o'clock the temperature of the water was 44°F. and of the air 49°F.

The water is clear and swift. The bottom in the lower reaches is covered with coarse gravel, but as it is followed toward its source there is an ever increasing size in the boulders that obstruct the course of the water. The stream, owing to the precipitous nature of its banks, is subject to sudden freshets.

The bottom is devoid of vegetation, while the banks are thickly forested.

A short distance above the mouth a dam has been recently constructed for irrigation purposes, but provision has been made for fish to ascend the dam. About 1.5 miles above the mouth is a falls said to be 60 feet high, which completely obstructs the passage of fish.

The stream is fairly well stocked with rainbow trout below the falls. A few trout were planted above the falls last year. The stream is too small to be worthy of much consideration from the standpoint of game fish.

A trail leaves the main Skagit trail on the north side of the bridge crossing the Stedattle and follows the Stedattle for about one-half mile. A few hundred yards south of the mouth of the creek is the home of Mr. G. G. Davis, where travelers may be accommodated.

GOODELL CREEK

This creek was visited June 26 and again September 4, It is about 10 miles in length, has an average width of 25 feet for its lower reaches and has a depth of about 16 inches. The territory through which it flows is very rugged.

The water had a temperature of 47°F. at 10 A.M. Sept.4, and the air had a temperature of 52°F.

The bottom of the creek, in its lower reaches was of moderately coarse gravel, while in its upper reaches the bottom was strewn with boulders. The water was clear and flowed swiftly. The bottom was practically devoid of vegetation, while the shores were well forested. The volume of water was subject to sudden changes, owing to the steep mountains through which

the stream flowed. There were no obstructions worthy of consideration in the lower four or five miles of the stream.

The stream should be fairly good for game fish. Seven rainbow trout were obtained during the earlier visit. These were rather small, being 6 to 7 inches in length. They were free from external and internal parasites. Their stomachs were filled, principally, with Caddis fly larvae. All of these fish were sexually immature.

During the September visit we observed a few spring salmon spawning. There were probably less than one hundred in the lower two miles of the stream and the character of the stream was such that the fish would not seed the upper reaches as spawning grounds. A few humpback, silver and dog salmon visit the stream, but the numbers are insignificant compared with the numbers reported to visit this stream in earlier years. This is the farthest branch of the Skagit from its mouth in which salmon run, and as the depth of the stream, the character of its water and the bottom are very favorable to spawning one would expect to find a considerable number of salmon in this stream. The condition at present shows almost utter depletion so far as spring, silver, and humpback salmon are concerned.

Another unfortunate feature of the spring run was that the large majority of the fish were two and three year old males. In nearly every instance where it was possible to observe the spring salmon in groups of one dozen or more it was found that an occasional female of large size arrived on the spawning beds for every six or eight small males. This condition appears to be largely due to fishing with nets in the lower Skagit. The mesh of the fish nets were of such a size as to catch and hold the large fish while the smaller ones escaped. Unfortunately there are extreamely few females small enough to escape through the nets, while a considerable per cent of the males are small enough to pass through. Another reprehensible feature is that people living in the vicinity

of this stream destroy many of the fish. They are particularly anxious to catch the females in order to get their eggs for trout bait. They even kill the fish for the pure fun of killing. Few of the males at this time are fit for food, neverthe less the spearman landed every one he could get. Often leaving their dead bodies on the banks. This stream was surveyed but recently by the State Fish Commission with a view to building a hatchery there. It seems to us that the utter epletion of the fish makes such an enterprise not worth the undertaking. It might pay to rack the stream a short distance above the mouth and take the eggs to a central hatchery to which the eggs from a number of streams might be taken.

THORNTON CREEK.

This creek empties into the Skagit River from the west about one mile below the mouth of Goodell Creek. This creek was visited September 4. On this date it was about 15 feet wide and not more than 6 inches in average depth. The water was clear and cold and the bottom was covered with gravel. Less than one-half mile above the mouth is a falls of about 75 feet in height, which, of course, prevents the upward migration of fish. Spring, silver and humpback salmon run in this stream in small numbers.

BACON CREEK

This creek was visited September 7. It is 12 to 14 miles long and flows through a very rugged country. It has a southeastern direction and empties into the Skagit River about 9 miles below the City of Seattle Camp. The stream is 45 to 50 feet wide and has an average depth of less than 2 feet. The creek is quite variable in both width and depth. About six miles above the mouth of the creek it divides into two branches on each of which there are falls which completely obstruct the upward migration of fish. The temperature of the water was 51°F. and the air 58°F. at 3 P.M. September 7. The water was clear and swift.

For upwards of two miles from the mouth the bottom of the stream is

until the boulder size is reached. The bottom is devoid of vegetation and but little plankton life is found in the water. The banks are forested nearly all the way up. About 7 miles up-stream is located a shingle bolt camp which is constantly sending down bolts which do more or less harm to the spawning beds.

This creek is considered a very good game fish stream, and is an excellent stream for salmon spawning, but like other streams the salmon are a sad state of depletion. A few hundred humpback salmon were observed on the spawning beds and a small number of spring salmon were also seen. Silver salmon, dog salmon and steelhead are reported to run in fair numbers, but the over fishing of Puget Sound has so reduced the number of fish entering the stream that only drastic measures can prevent the anihilation of these fish. As in Goodell Creek, the so-called sportsmen were, with spears, trying to destroy the small remnant and were succeeding fairly well. They caught the females in particular for their eggs to be used as trout bait.

This stream would make about the best hatchery stream in the upper Skagit country. It could be reached during the summer and early fall months, but the stream is subject to sudden freshets during winter and spring, which would be apt to sweep away all but the most strongly constructed racks.

The mouth of Bacon Creek is the terminus of a rather poor automobile road. A ranch house at this place furnishes accommodations to the traveler. An automobile camp is also maintained at this point. A good trail follows the north side of the creek a distance of about 7 miles to the site of the shingle bolt camp.

DIOPSUD CREEK

This creek was visited September 2. It has its origin in high mountains with glaciers near their summits. The creek is about 9 miles long and flows in a southeastern direction to enter the Skagit two and one-half miles above Marblemount. The stream is variable in width and depth, but averages, for its

The temperature of the water at 10 A.M. was 47°F. and of the air 54°F. The water was decidedly muddy, so much so that the gravel at a depth of 10 inches could not be seen. The bottom for a mile above the mouth was covered with coarse gravel. Above this the bottom was covered with large boulders, increasing in size as the ascent was made.

One and one-half miles above the mouth of the creek falls 16 feet high formed, at the time observed, a complete barrier to the ascent of fish. Above these falls there was a series of falls, cascades and rapids which made the upper part of the stream very poor for game fish and impossible for salmon. The markings on the shore in the neighborhood of the lower falls indicated that the stream during freshets might rise 20 feet above its level as seen September 2. The bottom was without vegetation; the banks were fairly well cleared for the first mile above the mouth, but above this they were covered with the usual forest timber.

The stream was too small for the migration of many spring salmon but a fair number of silver, humpback and dog salmon ran up the stream, also a fair number of steelhead trout. That part of the stream which salmon could reach furnishes excellent spawning conditions, but here, as elsewhere, the spawning salmon were being destroyed in large numbers by the people living in the vicinity. A rather poor automobile road crosses the creek near its mouth and the City of Seattle railroad from Rockport crosses it as does other streams flowing into the Skagit River from the west. The car on this railroad will take on and let off passengers at every road crossing, so that all these streams may be conveniently reached by the sportsman.

CASCADE RIVER.

This river was visited September 3. It has its origin in a series of galciers at the summit of the Cascade Range and flows westward a distance of about 20 miles to enter the Skagit River at Marblemount. The lower reaches of the river average 50 to 60 feet in width and had an average depth of

60°F. The water was clear and quite rapid. The bottom of the lower two or three miles is covered with coarse gravel and boulders; above this the water is much swifter and is broken by large boulders. About seven miles above the mouth is a cascade but the water is not so swift that the salmon cannot migrate up the river. The valley through which the river runs is quite narrow and the banks become quite steep as the ascent toward the source is made. About 16 miles above the mouth the river branches into the north and south forks. Both of these forks are reported to be obstructed by falls that form impassable barriers to fish.

The bottom of the stream is free from vegetation. The banks are forested with the usual vegetation. There is scarcely any plankton life in the river.

The salmon and steelhead, excepting the sockeye, run up this river as far as the obstructions on the north and south forks (according to reports). Formerly these ran in very large numbers but now the numbers are comparatively small. Here again we found the salmon pursued by man with the same eager desire as in other streams but with scarcely the same results, as the river is so large that there is considerably difficulty experienced in spearing the fish.

This river has too large a flow of water to make it feasible to rack. A ferry crosses the Sakgit to the north bank of the Cascade River. From the landing a trail follows the north bank of the river to the forks, where it divides, one branch going a considerable distance up the south fork and the other following the north fork, crossing the summit by Cascade Pass and following the Stehekin River down to Lake Chelan.

There is a small clearing at the mouth of the Cascade River and another up about six miles. The latter is owned by a bachelor who is not equipped to accommodate travelers. No other dwellings, except small forest ranger stations, are found on this stream.

Several branches flow into the Cascade from the south side but all are obstructed by impassable falls within a short distance of their junctures

On the north side Marble Creek enters about 7 miles above the mouth of the Cascade. This creek has a gravel bottom for a short distance and is of such a character as to make good spawning beds for salmon. The Cascade River system is considered to have excellent trout fishing. The most important game fish is the rainbow trout.

ILLABOT CREEK.

Illabot Creek was visited September 8. This creek is about 12 miles long and rises in several lakes that are located at a considerable elevation in the mountains to the southeast of the juncture of this creek with the Skagit River. The mouth of the creek is about 5 miles above the town of Rockport. At the time visited the stream near the mouth was about 15 feet wide and about one foot deep. The temperature of the water was 52°F. at 4 P.M. of September 8, and the air at the same time was 62°F.

The water is clear and swift. The bottom for two miles from the mouth is covered with coarse gravel. Above this the water becomes swifter and the bottom gravel is replaced by boulders, many of which are of considerable size. There is no vegetation worthy of mention growing on the bottom. The banks, save just at the mouth, are heavily forested. The banks for the lower two miles of the creek's course are fairly flat; above the two miles they become very steep and rugged. The country is still very mountainous.

The stream is considered an excellent one for trout fishing and the lake by the same name is also good.

All species of salmon, except the sockeye, run in this stream. Steelhead run in small numbers. There were a few salmon in the stream at the time of our visit. Here it was particularly noted that among the spring salmon the small males numbered eight to ten for every female seen, which again shows the permicious results of permitting fishermen to use nets within the mouth of the river where salmon spawn. It is a question now whether it would pay to put in a hatchery on this creek, unless the run is

first built up by the planting of young salmon in the stream. While the stream is small, yet it is an excellent one for hatchery purposes.

Formerly the United States Bureau of Fisheries had an eyeing station near the mouth of this creek, but the racks were swept away by a freshet two years ago. Since then nothing has been done to restore the rack or care for the other equipment, consequently the plant is fast going to ruin. The United States Bureau was in the habit of shipping the eyed eggs to Birdsview to be hatched and cared for afterward. So far as we were able to ascertain none of the fry were returned to the stream. This, in itself, would tend to destroy the run of salmon in the stream.

The following table shows the results of the United States Bureau of Fisheries' work;

Eggs taken by the United States Bureau of Fisheries at Illabot Creek

Year	Chinook	Silver	Chum	Hump	Steelhead
1912-13	150,000	1,675,500	221,000		347,500
1913-14	106,500	372,500	254,000	784,000	187,755
1914-15	194,000	1,449,000	2,266,000		60,000
1915-16	50,000	44,000	3,793,000	2,504,000	272,000
1916-17	111,200	376,000	4,112,000		
1917-18	123,000	40,500	1,855,000	1,800,000	451,500
1918-19		2,000	684,000		
1919-20					

The creek is easily accessible. The railroad runs to Rockport. A ferry crosses the Skagit River at Rockport and a fair wagon road leads to a farm at the mouth of the creek. A trail follows along the creek to lake Illabot, a distance of 8 miles.

A very recent communication with Mr. Winn of the United States Bureau of Fisheries indicates that in the very near future it is the intention of the Bureau to resume hatchery operations on this creek.

Beginning August 14 a full week was spent in a study of this river and its tributaries. The upper river is divided into two forks known as the North and South Forks of the Sauk River.

The South Fork rises in a group of lofty glacier covered mountains in the southeastern part of Snohomish County. The extreme source is a glacier basin about three miles south of Monte Cristo, which lies about 14 miles from the southern boundary of the county and 12 miles from its eastern boundary. About one mile above Monte Cristo is a series of falls of considerable height. Between these falls and the mouth of this branch there are no insurmountable barriers to the progress of fish, but no salmon ascend to within six or eight miles of these falls. The stream does not become a really worth while fish stream until about one mile below Monte Cristo. At this place the stream is about 25 feet wide and averages less than one foot in depth.

The temperature of the water at 2 P.M. August 14 was 47°F. and the air 67°f. The water was clear and swift. The bottom of the stream from this place onward was covered with gravel of varying degrees of coarseness. A study of the banks indicated that at high water the stream would be 100 feet wide and 3 to 6 feet in depth. The banks were well forested, and although there were high mountains on either side, the land in the immediate vicinity of the stream is not steep. The whole bed of this stream would make excellent spawning beds for salmon. The smaller members of the species could easily ascend to within a mile of Monte Cristo, while the larger could ascend to within four or five miles of this place. It is reported that the concentrators at the mines around Monte Cristo discharged refuse into the stream which contained a considerable amount of arsenic compound in solution, which drove

the fish out of these waters. No refuse has been thrown into the stream since 1907, but reports show that no salmon have been seen in the upper waters of this fork since then. No information was obtainable as to the condition previous to the time that the concentrators began to pollute the stream. Apparently there is no reason why this part of the stream should not be stocked with salmon.

In the upper part of this fork the only fish found were Dolly Vardens. They were of fair size. This entire fork lies within a forest reserve and is closed to all fishing, so that we were dependent on our own efforts for obtaining information as to the present condition of the fish in this stream. Men who had fished in the stream before it was closed reported only Dolly Vardens from this part of the stream.

About two miles below Monte Cristo the Weeden Creek empties into the South Fork of the Sauk. The upper part of this stream is a series of rapids and falls. The lower part is less swift and has a gravelly bottom. Its size, where it empties into the South Fork of the Sauk is about one-half that of the Sauk. Mountain trout are reported from this stream. Two were obtained, which very closely resembled rainbow trout. Cutthroat and Dolly Vardens are reported from this stream. A railroad from Hartford strikes this stream at the forest ranger's station five miles below Monte Cristo. From the forest ranger's station an excellent trail follows the eastern side of the South Fork to its juncture with the North Fork. This portion of the South Fork is of great interest. It had an average width of about 50 feet and was quite variable in depth, averaging about 18 inches. Some parts of the bottom are covered with boulders by which the water flows very swiftly; in other places the bottom is covered with gravel over which the water flows more slowly. This portion of the stream would furnish excellent spawning beds for salmon. Silver, spring and dog salmon and steelhead trout run in the lower half of this part of the river. In this part of the river

the bottom is free from vegetation. The banks are well forested.

About two miles below Barlow Pass, where the river leaves the railroad there is a lake expansion of the river called Lake Monte Cristo. This lake has a superficial area of about 25 acres during the dry season and is probably nearly twice as large during periods of high water. The water is 15 to 20 feet in depth in the deeper places. The temperature of this water at 10 A.M. August 16 was 60°F. and that of the air 64°F. The water was clear and of a deep blue color. There was practically no difference between the temperature of the water in the lake and of the river before it entered the lake expansion. This lake expansion was the only place in the Skagit watershed outside Baker Lake that could be considered a fit place to try sockeye planting experiments. The conditions were very much like those existing at Baker Lake, except that the lake is much smaller than Baker Lake. It is also very convenient for such experiments. The young sockeye could be transported by train to Barlow Pass and there dumped into the river. As they migrated seaward they would pass through this lake so that when they returned to spawn they would come to this lake where they could remain until ripe, then for several miles above is the finest kind of spawning beds.

Several very fine rainbow trout were taken from this lake and the river just below it.

ELLIOTT CREEK.

Elliott Creek was visited August 16. It enters the Sauk River two miles below Barlow Pass, flowing from the east. It rises in Goat Lake, about 4 miles southeast of its mouth. The stream is very swift and has many falls and rapids. It makes a descent of 1450 feet in the four miles. The most rapid portion is that near the lake. Obstructions in the form of falls and rapids which would prevent the migration of salmon were found

within 300 to 400 yards above the mouth of the creek. It is, for its size, a good trout stream with many fair sized trout. The abundance of fish and the ease with which they were caught was without doubt due to the fact that the creek lies entirely within the forest reserve in which all fishing is prohibited by law.

The water was clear and cold. The bottom of the stream was devoid of vegetation. The banks were heavily forested with the common type of timbers. A good trail leads from the mouth of the creek to Goat Lake, following the north shore. It is not a salmon stream, although salmon run in the Sauk above the mouth of Elliott Creek. A number of young silver salmon were taken from a small pool a short distance above the mouth of Elliott Creek.

FALLS CREEK.

Falls Creek, a stream about 5 miles in length, enters the Sauk River from the west at a point about 3 miles below the mouth of North Fork of the Sauk. This stream is very rapid and has falls quite close to the mouth which completely obstruct the migration of salmon. We found it impracticable to visit this stream, as there was no way of crossing the Sauk nearer to this stream than 5 miles and no trail is found on the west side of the Sauk River at this place.

NORTH FORK OF THE SAUK RIVER.

The North Fork of the Sauk River rises in the mountains south of Glacier Peak. This river is fully as large as the South Fork and has a length of about 16 miles. It unites with the South Fork at Bedal, about seven miles from Barlow Pass. Near its mouth it is 75 feet in width and about 2 feet in depth. The water is clear and runs swiftly over a gravelly bottom.

One and one-half miles above the mouth of this stream a falls of feet high completely obstructs the upward migration of fish. The bottom was devoid of vegetation, but the banks are covered with dense forest vegetation. A good trail leads along the north shore nearly up to the head waters. Above the falls there is excellent trout fishing. Silver, spring and dog salmon as well as steelhead trout run in this river to the foot of the falls. The bottom, up to the falls, affords excellent spawning beds. Formerly a large number of salmon frequented the Sauk and its tributaries in this region, but at the present time the numbers are pitifully reduced.

There is a ranch at the juncture of the two forks of the Sauk River, owned by a Mr. Bedal, where travelers may find accommodations. He has pack animals that may be hired for very reasonable terms. This ranch is connected by telephone with Darrington and the ranger station near Barlow Pass. He has lived there for many years and was able to give us valuable information.

WHITECHUCK RIVER.

Whitechuck River was visited August 18. This stream flows in a westerly direction. It rises by several branches issuing from Glacier Peak and empties into the Sauk River 7 miles below Bedal or 8 miles above Darrington. The river from source to mouth is upward of 20 miles long, flows through a very narrow valley between lofty mountains. A number of unimportant branches contribute water to it. Near its mouth it is about 75 feet wide and averages about three feet deep. It is far too swift to be waded.

The temperature of the water at noon was 50°F. and the air was 64°F. The temperature of the water of the Sauk just before it united with the Whitechuck was 52°F. The water was loaded with silt which gave it a somewhat

milky color. The Sauk up to this point was clear, beautiful water. From the Whitechuck on it is muddy. The bottom of the stream is covered with boulders and is utterly devoid of vegetation. The banks are covered with forest vegetation. About one mile above the mouth is a shingle bolt camp, up to which a trail leads on the south side. We were informed that salmon formerly ran in considerable numbers in this stream, but at the present time but few are seen. However, it would seem to us that no very careful observations have been made as to the actual conditions of the fish. The water is so clouded with silt that very little could be seen by a casual observer. The water is practically without plankton life. Because of the silt the trout fishing is not very good. This stream would be of very little use for hatchery operations.

CLEAR CREEK.

Clear Creek was visited August 19. This stream empties into the Sauk River three miles above Darrington. It flows in a nearly north direction and joins the Sauk on the west side. Near its mouth it is about 75 feet wide and has a depth of two to three feet; as the stream ascends it narrows and becomes much swifter, and within one-half mile of the mouth it passes through a deep narrow canyon. The lower half mile of the bottom is covered with moderate sized gravel. Above this the bed is covered with immense boulders and coarse gravel.

The bottom is without vegetation, but the banks are covered with forest. Three miles above the mouth falls 45 to 50 feet in length completely obstruct the upward progress of fish. It is doubtful if salmon ever go more than a mile above the mouth.

There is some good trout fishing reported from this stream. Formerly there were good runs of salmon in this stream but now they are so depleted

that the stream can hardly be considered a salmon stream at all. In former years the United States Bureau of Fisheries had a fish rack on this stream and a hatchery a short distance down the Sauk River from the mouth of the creek, but the racks have been swept away and the hatchery is falling into decay. The following table shows the number of eggs of the different salmon taken by the United States Bureau of Fisheries at this station for the years 1913-1918.

Year	Chinook	Silver	Chum	Hump	Steelhead
1913-14	21,000	1,127,000	990,000	915,000	
1914-15		2,315,400	2,578,500		
1915-16	73,000	664,000	482,500	6,728,000	
1916-17		879,000	295,000		
1917-18	111,000	83,000	78,000	1,090,500	152,000
1918-19		20,000	633,000		

The temperature of the water below the falls was taken and found to be 54°F. at noon of August 19. The temperature of the air at the same hour was 64°F.

The stream is quite easily reached by wagon road from Darrington.

A forest ranger station is maintained at the mouth of this creek. The only way to restore the salmon to this stream would be by planting fry for several years in succession at some distance above the mouth of the creek.

At the mouth of this creek an automobile camp is maintained for the accommodation of the traveling public.

SUIATTLE RIVER.

The Suiattle River was visited August 22. It rises in the glaciers of Glacier Peak and several ice crowned mountains north of Glacier Peak. It flows in a westerly direction and empties into the Skagit about 7 miles north of Darrington after a course of about 40 miles.

This river, near its mouth, is about 175 feet in width and two to three feet deep. The water is very muddy, so much so that it was impossible to see objects more than two or three inches below the surface. The material suspended in the water is so fine as to remain dispersed through the water even after standing 12 hours. The temperature of the water 6 miles above the mouth was 49°F. at noon and the air at the same time was 60°F.

The bottom in the lower reaches is covered with coarse gravel and small boulders; farther up the stream the boulders increase in number and size. There is no vegetation on the bottom of the river, but the stones were covered with a muddy deposit from the water. The banks are well wooded. For 20 miles from the mouth the river flows through a valley of some width. Above this the mountains rise somewhat abruptly from the water's edge. The whole course of the river is in a country far from the settled parts. It lies, as indeed does nearly all the upper Skagit and its tributaries, in a region that has but little of the marks of men left on it as yet. A small settlement is found on Sauk Prairie that lies just south of the mouth of the Suiattle. This prairie is reached by a rather poor wagon road from Darrington. A ferry operated by the county transfers travelers with their automobiles across the Sauk River and a wagon road runs for about a mile over this prairie.

The river is so far out of the way of traffic that but little information could be obtained concerning the fish in the stream. It is reported that

salmon run up this stream. They are not usually seen in the lower reaches of the river because of the large amount of suspended matter in the water, but in some of the branches emptying into the Suiattle in which the water is clear salmon have been seen.

A good trail leads along the southern bank to a shingle bolt camp about 6 miles above the mouth. Another trail kept partially open by forest rangers runs along the north bank to the head waters of the stream, where it forks and passes over the summit of the Cascade Mountains by the Suiattle and Buck Passes to the Chelan Country.

The lower part of the stream is not considered as much good for game fishing, but many of the tributaries are reported to afford the best fishing in that part of the state.

We were not able to personally visit the branches of this river but the forest ranger at Sauk was able to furnish us with important information concerning these tributaries. The following information concerning the tributaries of the Suiattle was thus obtained:

BIG CREEK.

This creek rises in Crater Lake at an elevation of nearly 5000 feet. After flowing about 7 miles, in which distance it falls 4250 feet, it empties into the Suiattle River from the north at a point about 7 miles above the juncture at the Sauk and Suiattle Rivers. This creek is about 30 feet wide near the mouth and has a depth of about 2 feet. Three fourths of a mile above the mouth there is a fall of 12 to 15 feet which effectually prevents the migration of fish above this point. The water is clear and cold, and the bottom is covered with coarse gravel and boulders. The water is quite rapid. No vegetation is found on the bottom of this creek. The banks are covered with forest trees.

Excellent trout fishing is reported from this creek. Tyee, silver salmon and steelhead trout run in this creek as far as the falls. Not very

much of the creek below the falls furnishes good spawning beds. There is no trail worthy of mention following up this stream.

TENAS CREEK.

This creek parallels Big Creek and is not more than one to two miles from it. It rises in Boulder Lake at an elevation of 4500 feet; after a short course of less than seven miles in which it falls 3700 feet, it empties into the Suiattle about one mile above Big Creek.

The water is ladened with sediment so that it makes a poor stream for fishing. The bottom is more gravelly than Big Creek. Salmon have been seen in this stream.

BUCK CREEK.

Buck Creek flows in a southwesterly direction into the Suiattle, its mouth being about 8 miles above that of Big Creek. It is about 40 feet in width near the mouth and has a depth of nearly 3 feet. The water is clear and cold. The bottom is covered with boulders and coarse gravel. About one and one-half miles above the mouth there are cascades 12-15 feet high. A fair fisherman's trail goes up the creek for a short distance.

Trout fishing is reported excellent during August and September. Trout and Dolly Vardens are very plentiful. Spring salmon and steelheads are reported to be fairly abundant during the spawning season. It is believed that the salmon and stellhead do not ascend the stream beyond the cascades.

DOWNEY CREEK.

This creek's course nearly parallels that of Buck Creek. Its mouth is about 6 miles farther up the Suiattle than Buck Creek. Near the mouth the creek is about 25 feet wide and two feet deep. The water is clear and of glacial origin. The bottom is covered with gravel and boulders. About one-half mile above its mouth the valley narrows until the banks are exceedingly steep. Excellent trout fishing is found in this stream but the

season is late. The salmon situation is very similar to that found in Buck Creek.

SULPHUR CREEK.

Sulphur Creek empties into the Suiattle above the mouth of Downey Creek. The water is clear and cold. The stream is about 20 feet wide and 2 deep. The bottom is covered with boulders amongst which the water flows very swiftly. About one and one-half miles above the mouth the banks become very abrupt. On the east side of the stream a short distance above the mouth are found hot sulphur springs which may be of considerable value. This stream is not nearly so good a salmon stream as Buck Creek.

CANYON CREEK.

This creek enters the Suiattle from the east. Its mouth is about 5 miles above that of Sulphur Creek. Near the mouth the creek has a width of about 15 feet and a depth of about 1 foot. There are deep holes in the stream. The bottom is covered in part with large boulders; in other places it flows swiftly over smooth rock. Trout fishing is good near the mouth of the stream. No salmon have been observed in this creek.

NORTH FORK.

This branch rises near Suiattle Pass. Near its mouth it has a width of about 15 feet and a depth of one foot. The bottom near the mouth is covered with gravel, the water flowing fairly slowly over it. Farther up stream the gravel gives place to boulders and the water increases very materially in swiftness. Spring salmon and steelheads are reported to run in this stream.

SOUTH FORK.

This branch rises in the glaciers on the north side of Glacier Peak. The waters are cold and swift and the bottom is similar in character to that of the North Fork.

MILK CREEK.

This tributary joins the Suiattle on the south about two miles above that of Sulphur Creek. The bottom is covered with boulders and the water is very rough and of a milky color. This creek is reported to be of no importance as a salmon or trout stream.

LIME CREEK.

This branch enters the Suiattle from the south three miles above Buck Creek. The water is clear and cold. Many cascades render the water very swift. Excellent trout fishing is reported from this stream. No salmon seem to go up the stream much above the mouth. A fisherman's trail follows the stream for a short distance.

Numerous other streams feed the Suiattle but they are mostly mountain torrents and of no importance from the standpoint of the salmon.

JACKMAN CREEK.

This creek was visited July 28. The stream has a length of about 7 miles, and flows in a southwestern direction, entering the Skagit River two miles above the town of Concrete. Near its mouth it is about 20 feet wide and has an average depth of less than one foot. The lower reaches of the creek are through a comparatively flat country, cleared near the mouth and well wooded farther up. The upper reaches of the stream are through a mountainous country. For one and one-half miles above the mouth the bottom is covered with gravel, making an excellent spawning bed for salmon. Above the first mile and one-half the bottom becomes covered with boulders and about two miles above the mouth the valley of the creek narrows to a canyon filled with immense boulders through which the water tumbles in cascades which are impassable to migrating salmon. At noon of the day visited the water had a temperature of 54.5°F. while the air had a temperature of 62°F. The water was very clear and free from plankton life.

There was practically no vegetation on the bottom of ...

A few salmon run in this stream at the present time. Formerly the United States Bureau of Fisheries had a rack on the stream and took a considerable number of eggs, but in recent years the catch has dwindled to such small proportions that it no longer pays to maintain a rack to catch the few fish that frequent the stream.

The fish that seek the stream are spring, silver, humpback and dog salmon and also a few steelheads. So far as game fish are concerned the trout are small and pretty well depleted by constant fishing.

BAKER LAKE.

Investigations of Baker Lake were made July 8 to 12. This lake is situated about 6 miles east and a little south of the foot of Mount Baker and about 18 miles north of the town of Concrete on the Skagit River. The lake is emptied by Baker River which enters the Skagit River at Concrete. The lake is about one and one-half miles long and one mile. Its longer diameter lies east and west. Its principal water supply is from Baker River flowing into the lake from the northeast and Noisy Creek flowing in from the southeast. A small creek flows in from the south, called Silver Creek, on which is situated the United States Fish Hatchery. The surface of the lake has an elevation of 670 feet.

The following temperatures were taken:

July	8,	7	P.M.	water	50°F.
				air	52°F.
"	9	5	A.M.	water	48°F.
				air	42°F.
"	9	8	P.M.	water	50°F.
				air	58°F.
"	10	10	A.M.	water	49°F.
				air	60°F.

The water at the hatchery at 10 A.M. July 10 was 46°F. The water was clear

The bottom, save in some places along the shore, was quite hard and without vegetation. The lake is practically surrounded by a densely timbered shore. The land at the east and west ends of the lake is low, flat and marshy for a considerable distance and is subject to inundations at periods of high water. The extreme distance between high and low water is about 18 feet. The north and south shores rise abruptly and continue as the sides of mountains.

The periods of high water come irregularly throughout the year, but less often in summer than in remaining parts of the year. The high water periods are due in summer to heavy and continued rains, and due in the winter to warm rains and chinook winds. The lake not infrequently freezes over during the winter, the ice being usually composed of frozen water soaked snow.

Temperatures were taken at every ten feet from the surface to the bottom during the forenoon of July 9. The following table gives these temperatures.

Depth	Temperatures	
	Degrees C.	Degrees F.
Surface	10	50
10	8.75	47.75
20	8.6	47.48
30	8.2	46.85
40	8.1	46.58
50	8.0	46.4
60	7.8	46.04
70	7.5	45.5
80	7.3	45.14
90	7.2	44.96
100	7.1	44.78
110	7.0	44.6
115	7.0	44.6

A series of soundings was taken to determine the depth and general surface of the bottom of the lake. The following diagram of the lake will indicate the results of these soundings.

These soundings indicate a bottom of uniform slope without any abrupt changes in it and that the border dips suddenly to deep water. At the mouths of the streams emptying into the lake the deposits of gravel have filled up a considerable area of the bottom to within a very short distance of the surface, so that water weeds growing in these areas reach the surface of the water. The west end of the lake is shallow for more than 100 yards from shore. This area has a rather soft bottom in places and is grown up with water weeds of various kinds.

The lake is well stocked with trout called lake trout by the fishermen. Several of these are in the collection in the College of Fisheries. There are large numbers of Dolly Vardens in the lake and as food is very plentiful many of them grow to a large size. It is not at all unusual to catch individuals weighing 5 to 8 pounds. These fish prove to be a decided detriment to the propagation of other fish in the lake, as they live almost entirely on the young of other species.

Three species of salmon, the sockeye, the spring and the silver, frequent this lake. All of these fish are taken by the United States Bureau of Fisheries for artificial propagation.

The following table, covering the take for recent years will give an idea of the importance of the lake as a fish cultural station.

TABLE

SALMON EGGS TAKEN AT BAKER LAKE.

Date	Chinook Eggs	Silver Eggs	Sockeye Eggs
1912-13	12,000	3,505,000	8,585,000
1913-14	37,200	1,526,000	1,719,000
1914-15		3,427,000	8,215,000
1915-16	101,200	335,000	3,111,000
1916-17		1,850,000	5,445,000
1917-18	9,000	2,025,000	5,250,000
1918-19	100,000	3,750,000	6,900,000
1919-20		2,600,000	11,150,000

The report for 1920-21 is not yet available, but the number of sockeye taken during the runs was about 7,100. The previous year had 7,800 in its

run. Estimating from these figures the number of sockeye eggs will be about 10,150,000.

CURVE FOR SOCKEYE FOR 1913-1921.

This curve shows an exceedingly irregular run of sockeye in Baker Lake. It also indicates that large runs are not in four-year cycles as on the Fraser River - 1913 and 1915 being large runs and again 1920 and 1921. It also indicates that so far as the Baker River is concerned the sockeye run is better now than at any time since 1913, the year of the big run on the Fraser River.

The runs of Chinook and Silver salmon have been variable, but there appears to be little change in the size of the run during the last 8 years.

During the seasons 1915-16 and 1918-19 trials were made to determine whether it was worth while undertaking the propagation of steelheads. During the first of these seasons only 46,000 steelhead eggs were taken, and during the second season but 68,000 steelhead eggs were taken. For this small number it was deemed not worth the expense involved.

The methods of the United States Bureau seem worth reporting at this time.

A very complete plant is located at the mouth of Silver Creek. On the diagram of Baker Lake is indicated the relative positions of the various buildings. The trap is constructed at the outlet of Baker Lake into Baker River, in such a way that all fish ascending the river to enter the lake must pass into the trap. From the trap they are taken into floating traps to a slough at the opposite end of the lake where they are retained until ripe. The sockeye when taken showed very little of the characteristics that mark the fish at spawning. The scales had not as yet become imbedded in the skin. There was no indication of the

red so characteristic of the male when mature. However, it is true that, as a rule, the male could be distinguished from the female by the slight hook that was beginning to develop on the end of the upper jaw. Observations were made on more than 1000 fish taken during the second week of July. Several of the fish were opened, and in every case a number of slender round worms were found in the coelomic cavit. For the most part they were gathered in the vicinity of the liver and stomach, but a few were found scattered throughout the cavity. They were nearly all free in the coelomic cavity, a few were encysted beneath the peritoneal lining of the viscera. No worms were found infecting the flesh of the fish. Although these fish had traveled up 18 miles of very swift, comparatively shallow water which rushed amongst boulders for almost the entire distance none of them showed any signs of being bruised or damaged in the least.

The slough in which these fish are retained until ripe is indicated at the east end of the diagram of the lake. The water at the time of observation was not more than 4 feet deep in the slough, but was very cold, having a temperature of 46°F. at 9 A.M. July 10. The air at the same time was 64°F. The water at the surface of the lake the same day, but one hour later was 49°F. An area of this slough is penned off by a stockade fence 18 feet high and so constructed that the fish could not escape even if the water rose to a record height. An arrangement has been made, whereby, if necessary, water from Noisy Creek may be turned into the slough. It is necessary to retain these fish in this slough for about three months by which time they become ripe and are ready for spawning.

The young sockeye have at least two persistent and voracious enemies, the Dolly Varden and the sawbill ducks. The former are by far the more numerous and destructive of the two. An examination of the stomachs of a

number of Dolly Varden showed that each fish was guilty of destroying a considerable number of sockeye each day.

July 12, at 6:30 A.M. five of the sawbills were shot, and already they had devoured 39 young salmon, varying in length from one and one-half to three inches. It is probable that each duck would destroy almost 100 fish daily. Further observation may be made on the Dolly Vardens preserved and deposited with the College of Fisheries on the Campus.

The methods of spawning and taking care of the eggs and young are standard, therefore, need no further mention.

Up to date no attempt is made at this place to use rearing ponds to take care of the fish after they are too large to feed in the hatchery troughs. I believe that the introduction of some retaining system, where the young could be held until considerably larger, would enable many of them to escape from their persistent enemies. At least, a much less number of them would serve to satisfy the appetite of these enemies.

UPPER BAKER RIVER.

This river rises by three main branches descending from the glaciers on Mount Shuksan. Its length is about 12 miles and near its mouth it is about 45 feet wide and has an average depth of not more than one foot. The temperature about 100 yards above the mouth was 46°F. at 12:00 o'clock, July 9. The air at the same time was 66°F. The bottom of the stream was covered with gravel over which the water flowed so swiftly that it was impossible to pole a boat against the current. The bottom was without vegetation of any kind and on account of the swiftness and coldness of the water there was almost no plankton. Practically all the tow net gathered was sand.

This river flows, in its lower reaches, through a comparatively flat country covered with forest vegetation. This stream, so far as seen, would

make an excellent spawning bed for salmon. The Dolly Vardens from Lake Baker spawn here. It is also a fairly good trout stream, but is exceedingly difficult to follow as the waters are too swift and deep for wading, and the banks are covered too thickly with vegetation to make it at all easy to follow the shore. Because the marshes furnish such good breeding places for mosquitoes they are numerous enough to be exceedingly annoying.

NOISY CREEK.

This is a short turbulent stream, flowing northwest into Baker Lake. It is not more than five miles in length and has a lake expansion called Green Lake. Noisy Creek near its mouth, has an average width of about 15 feet and is less than one foot in average depth. Its bottom is a succession of huge boulders without vegetation of any kind. There are numerous rather deep holes in which trout lie, so that for a short distance there is good trout fishing, but above this it is a tumbling, brawling stream of no practical use from the standpoint of either game or commercial fish. No trail leads up this stream.

SILVER CREEK.

This creek flows north into Baker Lake. It is a short, swift flowing mountain torrent of importance only because it furnishes the water supply to the United States fish hatchery located at its mouth. The water is always quite cold. At 10 A.M., July 10, it was 46°F. while the air at the same time was 60°F.

BAKER RIVER.

Baker River rises in Baker Lake, flows southward and joins the Skagit River after a course of about 18 miles. Where it leaves Baker Lake it is

quite clear but becomes muddy after Swift Creek empties into it, which is about one and one-half miles below its exit from Baker Lake. The river falls 440 feet between Baker Lake and its mouth. The bottom in places is gravelly and furnishes excellent spawning beds. In other places it is covered with large boulders amongst which the water rushes swiftly. There are no falls or obstructions in the river.

The temperature of the water of Baker River near its mouth was 52°F. July 28 at 12 M., while the Skagit just above the mouth of the Baker was 56°F. The air at the same time was 68 F. On August 28 at 3 P.M. temperature readings were taken as follows:

Baker River near its mouth, 58°F.

Skagit River just above the mouth of the Baker River 58°F.

The air at the same time 74°F.

All the species of the salmon run in this river, but only the sockeye and the silver salmon run in sufficient numbers as far as Baker Lake to make their taking for hatchery purposes worth while. The country through which the river runs is well wooded and is without clearing except near its mouth. A ranger station is located on the east side of the river about nine miles above the mouth. But one stream of any size flows into the Baker River from the east side. This stream is called Thunder Creek. Less than a mile above its mouth its banks become precipitous walls of rock through which the creek tumbles in falls and cascades of such a nature as to make it impossible for fish to migrate up the creek beyond these obstructions. The water of this creek is clear and cold.

On the west side the Baker River receives a number of tributaries. The first one to join the Baker after it leaves the lake of the same name is Swift Creek. This creek rises in the uplands between Mount Baker and Mount Shuksan. Its length is 8 to 10 miles, and it had a width of 30 feet

and an average depth of one foot at the time of our visit. In its lower reaches it has a flat gravelly bottom and is liable to change its course from season to season. About three miles up it passes through a rugged canyon in which are obstructions that prevent the passage of fish. Several creeks ranging in length from 5 to 8 miles carry water from the glaciers of Mount Baker into the Baker River. Their names are Park Creek, Boulder Creek, Sandy Creek, Sulphur Creek and Bear Creek. Near their mouths they are gravelly streams but the upper parts of their streams are brawling torrents.

Bear Creek furnishes power for the cement works at Concrete. A little more than a mile above its mouth the river is obstructed by a series of falls and rapids between 200 and 300 feet high. A dam is constructed at the top of this series of falls which furnishes a head of water for the power house situated at the foot of the falls. This dam in no wise interferes with the upward movement of fish. The creek, near its mouth, was, at the time visited, September 10, about 10 feet wide and less than one foot deep. Spring and Humpback salmon were seen in this stream but not in any considerable numbers.

FINNEY CREEK.

Finney Creek was visited the first time July 20. It rises in a mountainous region, flows northeast for about 10 miles then turns and flows northwest for nearly the same distance. It empties into the Skagit River about one and one-half miles above Birdsview. For the lower 10 miles it had an average width of 20 feet and a depth of less than one foot. It could be waded easily at almost any place.

The temperature July 20 at 9:15 A.M. was 44°F. and the air at the same time was 58°F. The water was very clear. The bottom for the lower

7 miles was covered with gravel which made an excellent spawning bed. Above this the creek passed through a canyon. The bed of the stream through this canyon consisted of boulders in some places and in others of solid rock. Above the canyon was another stretch of gravelly bottom for three or four miles and than a canyon again was met. In this canyon was a falls which would completely obstruct the passage of fish.

A ferry crosses the Skagit River less than one-quarter of a mile below the mouth of Finney Creek. A wagon road follows up the creek on the south side for a couple of miles, then crosses at a ford and continues up the north side of the creek for about three miles to a ranch. From this ranch a poor trail continues up the stream for about two miles and then is lost in the woods. Crossing the Skagit at Sauk is another ferry and from there a wagon road follows the Sauk to Darrington. About one quarter of one mile from the ferry a branch road leaves the main road to follow down the Skagit River. About one-half mile down the road an excellent trail branches off, leading to Finney Creek. This trail, as it nears the creek, branches, one branch going up the creek and crossing the divide to Deer Creek, the other branch going down Finney Creek to a shingle bolt camp on the creek.

This creek in no part of it had vegetation on the bottom; the banks for the most part were covered with forest vegetation.

An unusual number of Caddis fly larvae were found on the gravel of this creek. They lived in open places and were quite conspicuous. Examination of the stomachs of trout taken in this creek showed that they did not feed to any extent on these larvae. The trout will devour these larvae greedily when their protective covering is removed, so it seems that this covering makes them undesirable as food in the larval condition.

A beaver dam obstructs the stream about 6 miles above its mouth. This

obstruction would stop the migration of salmon were it not for the fact that the men working in the shingle bolt camp keep a narrow way cut through the dam for their shingle bolts to pass.

There is a dam above this beaver dam constructed by the shingle bolt men to control water for the floating of their bolts down stream. The water under ordinary conditions is not deep enough to float the bolts so this dam furnishes a head of water which when released is sufficient to carry the bolts to the Skagit River. Reports indicate that this dam obstructs the passage of fish.

This stream has a large number of rainbow trout. A number were seen that were not less than 18 inches in length. A considerable number of these fish were caught. They were in excellent condition and free from all external parasites.

All species of salmon except the Sockeye run in this stream. They apparently do not run down the lower canyon as no young salmon were observed in the waters above this canyon, while large numbers of salmon fry were seen between the canyon and the mouth of this creek. Steelhead also frequent this stream in the spring of the year for spawning purposes. The only salmon observed running were Humpbacks, and not more than a couple of dozen of them were seen. These observations on the salmon were made in September when a second trip was made to this creek.

The United States Bureau formerly had a fish rack across this creek a short distance above its mouth. This rack has been torn out twice by the shingle bolts that are driven down the stream by floods let loose from the dam constructed for the purpose of supplying enough water to successfully make a bolt run. Something might be done here to prevent a recurrence of this damage to the fish culture interests. It is the purpose of the United States Bureau of Fisheries to rerack this stream next year.

The eggs taken by the United States Bureau of Fisheries from this creek were taken to their hatchery at Birdsview. A large number of fry have been returned to this stream. Our observations showed that the stream was well stocked with young Silver salmon at least.

PRESSENTIN CREEK.

This creek after a course of about 4 miles in a northern direction, empties into the Skagit River less than one-half mile below the mouth of Finney Creek. The creek was visited July 21. The creek at this time did not average more than 12-14 feet in width and could be easily forded in most places.

The water had a temperature of 52°F. at 10 A.M. and the air at the same time was 58°F. The water was quite clear, and flowed quite swiftly. The bottom, for the mile nearest to the mouth, was gravelly and of such a nature as to make an excellent spawning bed. That it was visited by spawning salmon was evident from the large number of young fry seen in the stream. Those observed were almost entirely young silver salmon. About a mile above the mouth the stream is crowded between abrupt walls. The bottom here is covered with huge boulders and in one place there is a fall high enough to obstruct the upward progress of fish. For its size the stream is considered a good trout stream, Rainbow trout being the principal game fish caught. There was no vegetation of any kind seen on the bottom of the stream. The banks all the way are covered with dense forest vegetation.

The most important animal life seen in this stream, besides the fish, were Caddis fly larvae of which there were very great numbers. The stream is too small to be considered of very great value from the standpoint of hatchery operations. It might pay to put in racks and take the eggs to the

Birdsview hatchery. From the number of young Silver salmon seen in the stream it seems certainly worth while to protect the stream and keep it stocked with salmon.

GRANDY CREEK.

This creek flows in a southwesterly direction and empties into the Skagit River at Birdsview. Near the mouth of this creek is located the hatchery of the U. S. Bureau of Fisheries. A week was spent in the vicinity of this creek. From this place as headquarters the streams of the neighborhood were visited. This creek rises in Lake Grandy and receives two or three branches before it reaches the Skagit, which is not more than 5 or 6 miles from the lake. This stream is quite small, averaging not more than 15 feet at the time visited. Its depth averaged 6 - 8 inches. The water is clear and quite cold except in the warmest part of the summer. The United States Bureau of Fisheries has made a very careful tabulation of temperatures for every day in the year.

The bottom of the stream is gravelly and well suited for spawning beds for salmon, particularly the smaller species. There is little or no vegetation on the bottom of the stream. The banks are wooded practically from the mouth to the source of the stream.

The number of salmon running in this stream may be estimated from the number of eggs taken by the U. S. Bureau of Fisheries. The rack is so arranged that practically all salmon and steelheads are taken. The following table gives the number of eggs taken for each species for a period of years extending from 1912 - 1920.

Year	Chinook	Silver	Chum	Hump	Steelheads
1912-13	243,000	5,000,000		2,000	2,679,000
1913-14	233,000	4,697,000	136,000	2,756,000	829,000
1914-15	122,000	9,437,000			1,800,000
1915-16	149,000	1,238,000		1,550,600	3,212,000
1916-17	25,000	2,734,700		38,000	290,000
1917-18	425,800	522,000	63,000	738,800	3,043,000
1918-19	36,000	944,000		86,000	226,400
1919-20	54,000	2,198,000		74,000	255,000

A few thousand sockeye eggs were taken during these years.

In addition to those taken in Grandy Creek a large number of eggs were taken care of that were taken from other streams. The most of the fry hatched in the hatchery were planted in Grandy Creek and nearby streams.

A very good system of rearing ponds has been constructed at this hatchery in which a considerable number of the young fish are fed for several months before they are turned free.

GRANDY LAKE.

This lake was visited July 7. It may be reached by wagon road from Concrete. This road leads to a sawmill about 6 miles from Concrete. From the sawmill the lake is reached by a fairly good trail which extends for a mile between the mill and the lake.

The lake is about three-fourths of a mile long and about 500 yards wide. The depth is not more than 12 to 14 feet at the most. The temperature of the water at the surface was 64°F. and the air was the same. At 12 feet the water was 62°F. The water is of a brownish color

due to the presence of an unusual amount of plankton. The bottom is exceedingly soft and covered with rank vegetation that comes nearly to the surface of the water, even in the deepest part of the lake. Along the shores the water is covered with water lily leaves. Reeds and other common water vegetation were very abundant. The lake is surrounded by woods.

The water was teaming with plankton and insect larvae, while over the surface myriads of insects flitted about; the most numerous were dragon and damsel flies.

The lake is well stocked with trout, which furnish excellent fishing during the earlier part of the season. During the warm weather they are said to be rather heavily parasitized with copepods. As the majority of fishermen consider these fish, when parasitized, unfir for food, it would be a wise provision to make a closed season for game fish during the months of summer. The lake can be of little value from the standpoint of commercial fisheries.

DAY CREEK.

This stream was visited July 23. It rises in Day Lake, flows in a northwesterly direction and after a course of about 8 miles, empties into the Skagit opposite the town of Lyman. The stream is quite variable in width, but averages about 25 feet and has an average depth of less than one foot.

The temperature of the water at 2 P.M. was 64°F. and the air at the same time was 74°F.

The bottom for the lower three or four miles is covered with gravel over which the clear water flows fairly swiftly. Above this stretch the character of the bottom changes, the gravel being replaced by boulders.

Here the swiftness of the water increased. The bottom throughout the length of the stream is devoid of vegetation. The banks are partially cleared for about 3 miles, but in the immediate vicinity of the water they are grown up with willows, alders and similar vegetation. Above the lower three miles the banks are much more rugged and are heavily timbered with fir and cedar. Falls are reported in a canyon above five miles above the mouth of the creek. Opinions differed as to whether they would obstruct the passage of salmon or not. Whether they would or not is not a matter of much significance as the only spawning beds worth consideration lie within three or miles of the stream's mouth and there is nothing to obstruct the passage of fish to these beds.

In this stream were found endless numbers of Caddis fly larvae, of which there were several species. Quite a large number of tadpoles were found in the quieter waters of the stream. A very large number of silver salmon and a few spring salmon fry were observed in the lower three miles of the creek. Steelheads were also abundant. This creek is a good stream for game fishing, the most important species being rainbow trout.

The United States Bureau of Fisheries had a rack near the mouth of this stream from 1913 to 1918. It was swept away during the year 1918. For these years a fair number of eggs were taken of all the species of salmon but the Sockeye. Some steelhead eggs were also taken.

The following table gives the take of eggs for each species year by year:

Year	Chinook	Silver	Chum	Hump	Steelhead
1913-14	23,000	1,303,000		3,250,000	194,000
1914-15	92,000	2,281,000	56,000		263,000
1915-16	88,000	605,000		2,896,000	286,000
1916-17	14,400	313,000			
1917-18	44,000	26,000	24,000	1,224,000	82,000

The U. S. Bureau of Fisheries expects to replace the racks in this stream next year.

The lower reaches of this stream are easily accessible. A ferry crosses the Skagit River at Lyman and a wagon road leads to the creek at a point nearly one mile above its mouth. On the west side a rather poor wagon road leads to a ranch a couple of miles above the mouth of the creek. On the east side a trail follows the valley of the creek up to Day Lake and thence over to Deer Creek.

A general survey of the work of the United States Bureau of Fisheries shows that practically all the good streams flowing into the Skagit River that are readily accessible are being fished by them for the taking of eggs. For the last two or three years they have been hampered for money to replace racks torn out by freshets, so that for the season of 1921 the only places where fish are being taken are Grandy Creek and Baker Lake. The intention of the U. S. Bureau, as recently reported through its officers in Seattle, is to reconstruct the eyeing station at Illabot Creek and put in racks on Finney Creek and Day Creek.

Their takes of eggs in general since 1912 indicate that the streams fished by them do not yield a very large supply of fish, and that there is a gradual decrease in the numbers. It appears that at present there is a possibility of doing much to restore the river to something of its former productiveness, but strenuous measures must be enforced to protect the fish entering this river.

DAY LAKE.

Day Lake was visited July 27 and 28. It is situated in the heart of a rather low range of mountains about 8 miles straight south of Hamilton. It has 4 or 5 small streams of water flowing into it. These streams are

but mountain torrents and of no value from the standpoint of fish. Day Creek flows out from the north end. The entrance to the creek is difficult to discover, as it is choked with logs and grown over with willows and other swamp shrubs. The elevation of the lake is 1616 feet, while the mouth of Day Creek is less than 100 feet elevation, so that the fall in Day Creek is over 1500 feet. The greater portion of the fall is in the upper half of the creek. The lake is somewhat more than one and one-half miles in length and about one-fourth of a mile in width. The land at the ends of the lake is flat and marshy. The southwest shore is quite steep, while the northeast is more gently sloping. The entire shore line is covered with valuable forest timber, principally fir and cedar.

A decidedly peculiar condition of this lake is that scattered throughout it are many broken stumps of trees protruding above the surface of the water and many more may be seen whose tops do not come quite to the surface. It appears as if the lake has been formed but recently by the sinking of this area beneath the level of the outlet. It might be that the trees had slid in from the mountain side, but there is little evidence of this having taken place in recent years as the mountain sides are covered with trees of large size, and the shore on either side of the lake does not show signs of any disturbance of this nature. Nearly every report was to the same effect, that the lake was very deep. Soundings were taken in a number of places where it seemed likely that water of a considerable depth would be found, but the greatest depth discovered was 45 feet. The average depth was very much less, being probably not more than 30 feet.

The following table gives the temperature of the water at various depths:

Depth	Temperature Degrees C.	Temperature Degrees F.
Surface	18	64.2
10 Ft.	17.8	64.04
20 "	10.3	50.54
30 "	9.3	48.74
35 "	9.3	48.74
45 "	8.1	46.58

The difference between morning and evening temperature was noted for the days the lake was visited.

July 27, 4 P.M., water 68°F.

" 27, 4 P.M., air 68°F.

July 28, 6 A.M., water 62°F.

" 28, 6 A.M., air 52°F.

The bottom of the lake consisted of soft mud. Along the shores in the shallow water there was a large amount of vegetation most common of which was pond lilies and reeds. The water was teeming with plankton life. The lake is of no value to the commercial fisheries, but is abundantly stocked with trout (rainbow). Examination was made of 15 and 18 were preserved and shipped to the College of Fisheries. Of those examined the largest was 10 inches and the shortest 6.25 inches. The average length was 8.97 inches, or practically 9 inches. The fish were rather slender, as if they were suffering somewhat from under nutrition. The stomachs of all were almost empty. There was an entire absence of internal parasites but externally they were more or less heavily infected with copepod parasites. These parasites were located on the inner side of the opercula, the gills and at the bases of the fins. There was in no case very many on

the gills, so that there was no serious interference with the respiratory functions of the fish. It is reported that fishermen going to the lake catch large numbers of the parasitized fish, and seeing the copepods on them, throw them away, deeming the fish unfit for food. In reality these copepods do very little harm to the fish when found in no greater numbers than on the fish observed and do not render the fish unfit to be eaten. Our party ate a number of them and found them very good.

The state forest rangers maintain a trail to this lake. It is on the east side of the creek and lies at a considerable distance from Day Creek, and for a good part of the way it follows an elevation of more than 1000 feet above the level of the creek. There is a fine camping site where the trail comes down to the north end of the lake. There is a cabin at the south end of the lake and another on the southwest side a short distance from the northern end of the lake.

ALDER CREEK.

This creek was visited July 29. The two branches of this creek rise in the foothills lying between the south fork of the Nooksack River and the Skagit north of the town of Hamilton. The stream is not more than 7 miles long. It empties into the Skagit River a short distance above Lyman. For the lower three miles of its course it flows through a flat country and has a slow current. The upper part of the stream is much swifter and carries away the water from the low mountains north of Hamilton. The creek at the time visited was not more than 6 to 8 feet in width and about six inches in average depth. The water is clear and fairly warm. The bottom for the lower two miles of the stream is gravelly. The country along the banks for this distance is cleared and largely under cultivation. The immediate banks are overgrown with alders, hence the name of the creek.

Just back of Hamilton there is a mill with a mill-dam to form a mill pond for the logs. This dam is about 4 feet high and forms an obstruction to the migration of fish. At high water the fish can go over it but not at low. The salmon congregate below the dam and large numbers of them are destroyed by fishermen who desire the eggs for bait. The habit of killing salmon to get the eggs for bait is very common on all the streams flowing into the Skagit River. The bottom is without vegetation, except the slime adhering to the gravel in slow flowing areas.

The United States Bureau of Fisheries, for a number of years has been planting salmon in this creek. Silver salmon fry have been planted in much larger numbers than other salmon fry. At the time visited a large number of young silver salmon were found in this creek.

This stream is different from all the other streams in the character of the life found in it. All the streams visited previous to this one were quite barren of life other than fishes and Caddis fly larvae. Alder Creek had in it leeches, stickleback, white fish suckers, cyclostomas and other forms of life.

The creek is frequented by all the forms of salmon but the sockeye.

There is a considerable amount of debris from the mill that more or less obstructs the creek for some distance below the dam.

NOOKACHAMPS CREEK.

This stream was visited August 8. It is a rather small stream flowing north and emptying into the Skagit about one mile above Burlington. It has two main branches, the west branch rising in Big Lake, and the east branch rising by several tributaries in the Cultus Mountains. The lower one and one-half miles of this stream is subject to back flow from the Skagit River. When this happens the stream inundates the flat swampy

country through which it flows. This part of the stream has a soft muddy bottom and is inhabited by practically all forms of fish life that lives in the Skagit River. Above the swampy area the bottom of the stream is gravelly. The branches of the East Fork become quite precipitous as the mountains are neared. The West Fork is comparatively slow flowing all the way from Big Lake to the Skagit. Just above their juncture both branches had an average width of about 7 feet, with an average depth of less than 6 inches. The water at 10 A.M. on the day visited had a temperature of 74°F. while the air at the same time was 72°F. There is but little vegetation on the bottom of the stream. The country along both banks is largely under cultivation. The banks in the immediate vicinity of the water are covered with alder and willow growths.

Chubs, suckers, rainbow trout, silver trout, cutthroats, bass and perch are reported from this stream. Young silver salmon were found all along the west fork up to the dam at the outlet of Big Lake. Dog salmon also run in this stream. The east fork is as well supplied with fish as the west fork. The stream is not considered of much importance from the standpoint of game fish.

Since the bottom makes good spawning beds and the creek is visited by silver and dog salmon it should be considered valuable to the commercial fisheries.

The dam at the foot of Big Lake obstructs the passage of fish from the creek to the lake. There is a fish ladder, but it is so arranged that it is of very little practical use. However, this seems of little consequence, as the lake is not good for spawning salmon, nor is any stream flowing into the lake.

There is a series of lakes drained by this creek. These lakes are McMurray, Big Lake and Clear Lake. There is another small lake called

Beaver just north of Clear Lake, but it seems to be without outlet unless at very high water it overflows into Clear Lake.

MC MURRAY LAKE.

This lake was visited August 4. It is located near the town of McMurray on the Northern Pacific Railway. It has an elevation of 200 feet. The lake is about one and one-half miles long and about 500 yards wide. On the west shore is the town of McMurray; near the north end is a large saw mill. The greatest depth of the lake is 50 feet, the average depth being about 30 feet. The following table gives the temperatures of the water at every 10 feet between the surface and the bottom. The temperatures were taken at 8 A.M.

	Depth	Temp. °C.	Temp. °F.
Air		17.6	63.68
Water	Surface	20.2	68.36
	10 Ft.	20.3	68.54
	20 "	10.5	50.9
	30 "	7.8	46.04
	40 "	7.2	44.96
	50 "	6.9	44.42

The bottom of the lake throughout is of very soft mud. In the shallow water along the shore much water vegetation is found, such as pond lilies, water grasses and reeds. Along the shore was abundance of vegetation, as rank grass, willows, alders and fir. The east shore of the lake is steep, the west shore rather flat, while the north and south ends are marshy. The lake at high water pours its overflow into Big Lake by a stream that follows the Northern Pacific Railroad. This stream in summer is practically

choked with vegetation and has scarcely any water in it. The lake has floating on its surface a large number of logs, most of which are boom logs. There is a considerable amount of sunken timber in the lake.

The lake is of no value so far as commercial fishes are concerned, but is considered an excellent place for game fish. The following fish are reported from this lake. Catfish, bass, trout, suckers, chub, perch, squaw and whitefish. The lake should be very good for bass. There is an abundance of plankton in this lake.

BIG LAKE.

This lake was visited August 4. This lake lies in the same valley as McMurray Lake and is separated from the latter by about three miles of rather swampy valley. It is about three miles long and one-half mile wide. The Northern Pacific Railroad runs along its eastern shore. The lake is quite shallow, not being much over 20 feet at any place.

The following table gives the temperature of the water at 10 foot intervals between the surface and the bottom:

Depth	Temp. °C.	Temp. °F.
Surface	22.2	71.96
10 Ft.	21.1	69.98
20 "	19.3	66.74

The elevation of the surface of the lake is 85 feet. A dam at the north end of the lake retains the water at a height of 8 feet above what it would be at its normal level. The bottom is very soft and has no vegetation except at the margin of the lake. There is considerable fallen timber in the lake along the shore.

The land on the east side of the lake is extensively cleared and under cultivation. Montborne, a small town, is located on the east shore midway between the ends of the lake. Just north of this town is a summer resort where a number of boats for fishing and pleasure are maintained for rent. At the south end of the lake is a large sawmill with a number of other buildings around it. The west shore of the lake is aprupt and has not been cleared. A good automobile road runs the length of the east side of the lake and about half way up the west side. No streams of any importance flow into the lake. The conditions of temperature and presence of organic matter in the lake induce the development of vast number of plankton.

The lake is not of any use so far as commercial fishes are concerned. The water is too warm and the bottom too soft and muddy. For game fish that do well in warm water the lake is excellent. It is well stocked with cutthroat, rainbow, catfish, bass, perch, carp, chub and suckers. Cutthroat and rainbow trout are of good size, measuring from 12 to 16 inches. The bass are of good size, ranging from 12 inches up to 2 feet.

CLEAR LAKE (Elevation 50 ft.).

This lake was visited August 5. It is located about 2 miles directly south of Sedro Woolley. It is practically a land-locked lake, so can be of no value to the commercial fisheries. It is about 1 mile long from north to south and one-half mile from east to west. The lake at its deepest place is about 40 feet. It is shallow around the margins. The shallow water is grown thickly with common water plants, as water lilies, reeds and grasses. The following table gives the temperature at each successive 10 feet from the surface to the bottom:

Depth	Temp. °C.	Temp. °F.
Surface	21.9	71.42
10 Ft.	19.2	66.56
20 "	21.1	53.78
30 "	9.6	49.28
40 "	9.3	48.74

The water was of a brownish shade and quite dirty. Much debris from the large sawmill and logging operations found its way into the water. The lake cannot be considered much more than a logging pond to the mill.

The shore line for a good part of the circumference is soft and boggy. The high temperature of the water and the amount of organic matter in it would lead one to expect large quantities of plankton, but such is not the case. The plankton was quite small in quantity when compared with that of the lakes just previously described.

It is reported that fishing is not nearly so good now as formerly. The fish reported from this lake are bass, perch, catfish and suckers. The condition of the water would make the lake scarcely fit for trout.

BEAVER LAKE.

This lake was visited August 5. It lies one-half mile south of Clear Lake. It is less than one-third mile in diameter and is quite shallow, the greatest depth being about 10 feet. Its entire shore line is swampy and grown up with water-loving plants. The temperature at the surface was 21.8°C. or 71.24°F. and at the bottom, 10 feet down, the temperature was 18°C. or 64.4°F. The water was exceedingly dirty and full of plankton forms. It is reported to be a fairly good lake for fishing. The following fish are reported as being fairly abundant in the lake: Catfish, bass, suckers, trout (probably silver) perch, and chubs.

THE MOUTHS OF THE SKAGIT RIVER.

A short distance below the town of Mount Vernon the Skagit River begins to break up into forks and sluggish sloughs which are much influenced by the tides of the Puget Sound. These forks and sloughs are deep and have soft mud bottoms and clay banks. The country is very flat and practically all under cultivation. The tides affect the forks and river up to Mount Vernon.

The most important thing to consider in this part of the river is the effect that fishing with gill nets has upon the possible output of fry in the river. The gill netters float their nets down the river stretched as nearly as possible to command the full width of the stream. The nets are of large mesh, at least when fishing for spring salmon. These nets catch the large springs and permit the small ones to get through. Now it happens that the females are all large, and all the small ones escaping are two and three year-old males. The fishermen even boast that their large meshed nets permit the smaller fish to escape to the spawning beds, but they fail to appreciate the fact that all males on the spawning beds are not likely to produce a very rich harvest of fish for the future. Our observations in the upper branches of the Skagit during the spawning season of the spring salmon indicated that there were eight to ten males to every female found on the spawning beds.

The take of eggs by the United States Bureau of Fisheries shows how small was the run of spring salmon even in the very best year since 1912. The banner year was 1918. Now if 4000 eggs represents each female spring salmon taken the following is the number of females taken at each place fished by the U. S. Bureau:

Baker Lake	9,000	eggs	—	2 females
Birdsview	425,000	eggs	—	100 females
Day Creek	44,000	eggs	—	11 females
Illabot	123,000	eggs	—	31 females
Darrington	111,000	eggs	—	28 females
Total				178 females.

Only 178 female spring salmon taken in four of the better branches of the Skagit during the best of the last nine years. For the year 1919-20 not one spring salmon is reported from these streams.

The report of buyers shows for this year (1921) that in the North Fork alone during

May	9	gillnetters caught	4,703	chinook
June	14	"	5,164	"
July	98	"	11,785	"
Total			21,742	"

This shows the taking of 21,742 spring salmon from one arm of the Skagit River only. There is no doubt that many more were taken. A very low estimate would be 30,000 spring salmon, of which 15,000 would be females. Had these been permitted to go to the spawning beds they would represent a planting of at least 60,000,000 more eggs in the Skagit and its branches.

Under the present depleted conditions of fish on the spawning beds it seems absolutely necessary that all fishing within the mouth of the Skagit River should be prohibited.

In the survey of this river from its mouth to its source, the most important move for the rehabilitation of the fisheries seems to us to be the protection of all salmon and steelheads entering the river.

STILLAGUAMISH RIVER.

This river flows westward, draining the northern half of Snohomish County between the Sauk River to Puget Sound. It consists of two branches of about equal size, the North and South Forks. They form a juncture just north of the town of Arlington. The North Fork rises within three miles of the juncture of the Sauk with the Skagit and follows a course parallel to the Sauk, but flows in the opposite direction for about 12 miles, where it turns westward. A comparatively narrow ridge of mountains separates the two streams. The part of this river above its juncture with Squire Creek was visited August 21 at a time when the water was very low. About one mile above the mouth of Squire Creek the Stillaguamish River was not more than 25 feet in width and had an average depth of less than one foot. A quarter of a mile farther up stream the width was upward of 75 feet, but the water was very shallow. A mile still farther up the stream issued from a canyon in which the water was narrowed down to not more than 10 feet. Here the bottom was covered with huge boulders and coarse gravel. After issuing from the canyon the bottom became gravelly and of such character as to make excellent spawning beds for salmon. The water from the place where it crossed the Skagit and Snohomish boundary to within a short distance of its mouth was moderately swift, but in most places fine for spawning. The temperature of the water at the time this part of the river was visited was 56°F. The stream, so far as game fish are concerned, is pretty well fished out, save for small fish of which a considerable number were seen. The principal game fish is rainbow trout.

A considerable number of silver salmon fry were observed and these were seen as far up as we went, but probably could not be found much farther than the inter-county line as the water above this line became rougher and the bottom became less useful for spawning.

Nowhere in the upper stream was any vegetation found on the bottom. Except in the upper reaches of the river the country along the course is fairly well cleared and much of it is under cultivation. Above the mouth of Squire Creek it runs through a wooded country. The immediate banks are largely grown up with alders and willows.

Reports state that formerly vast numbers of silver and humpback salmon crowded the stream, but now the numbers are very few. The stream above Squire Creek could be easily racked, but it is a question whether enough fish visit this part of the river to make hatchery undertakings worth while.

SQUIRE CREEK.

This creek was visited August 20. It is a stream about seven miles long, rising in snow-capped mountains 5 or 6 miles south of Darrington. This creek, for the three or four miles above its mouth, varies in width between 20 and 40 feet. There are numerous holes in the stream where the water is several feet in depth, but for the most part the water averages less than one foot in depth. The water was quite clear and fairly cold, having a temperature of 52°F. The bottom is covered with moderately sized gravel. The character of the stream for four miles above its mouth indicates that it would be an excellent spawning stream for salmon, but like all the other tributaries of the Stillaguamish, the number of salmon visiting the stream is very small.

The bottom is without vegetation and but little life of any kind except small salmon and trout was to be found.

A considerable number of silver salmon fry were seen as well as trout fry. There is some clearing along this creek. Practically all the timber between the mountains and the mouth of this creek having been cut, and the most of the land being comparatively useless for farming, the country presents a dreary aspect. The stream could be easily reached near the mouth,

but would scarcely pay unless the stream was previously stocked and the fish protected so that they might return to the parent stream.

BOULDER CREEK.

Boulder Creek was visited August 23. This creek rises in the same mountains as Squire Creek. It flows for the greater part of its length in a northwesterly direction and empties into the Stillaguamish about five miles below the mouth of Squire Creek. It is a little larger than Squire Creek, having an average width of 25 feet for its lower half.

The temperature of the water at 12 noon of the day the stream was visited was 53°F. and the air at the same time 66°F.

The bottom of the lower part of the Creek was covered with gravel without any vegetation being present. The stream is not at the present time of much interest from the standpoint of game fish, being pretty well fished out. A considerable number of young silver salmon were observed. It is reported that this stream is visited by spring, humpback, dog and silver salmon and also steelhead trouts, but the run has become so depleted that but few of these species are left to visit the stream. Much of the land is logged off and sudden freshets are frequent. Shingle bolts are driven down this stream but no obstructions exist that would interfere with the migration of salmon.

Caddis fly larvae were especially numerous in the water of this stream.

DEER CREEK.

Deer Creek was visited August 24. This creek drains a mountainous area in Skagit County lying east and south of Day Creek. There are two main branches, the North and South Forks. These forks are in an almost inaccessible region. A trail following the upper part of Finney Creek from

Sauk crosses over the divide to the North Fork, which it follows nearly to its source. A rather poor trail leads from Day Lake to Deer Creek, a distance of less than three miles. There is also a trail from Lake Cavanaugh to Deer Creek. The distance separating this lake from the creek is about one and one-half miles.

Both branches of this creek flow through heavily timbered mountains. The same character of country continues to within about three miles of the mouth of the creek. There is reported to be excellent trout fishing in the more inaccessible parts of this stream. The stream is rough, with numerous deep holes. The bottom is covered with large boulders almost down to the mouth. The stream issues from a steep walled canyon about one and one-half miles from the mouth of the creek.

Low falls, swift waters and the general character of the bottom would prevent this creek from being of very great value as a spawning stream for salmon.

The water is clear and moderately cold. At 2 P.M. of the day the stream was visited the temperature of the water was 56°F. and the air at the same time was 58°F.

Caddis fly larvae were fairly numerous in this stream.

Not many salmon fry were to be seen, those seen being silvers. All the salmon, except sockeye are reported to visit this stream, but at the present time but few of any species are observed. A few steelheads run in this creek.

GRANT CREEK.

Grant Creek was visited August 25. This is a very small stream but of interest because the Snohomish County game farm and trout hatchery is located on it. It is about four miles long, flows south and empties into the Stillaguamish River about seven miles above Arlington. Below the

hatchery it is about six feet wide and averages six inches in depth. The water is quite cold, having at the time visited a temperature of 52°F. The bottom is covered with gravel, which makes a good spawning bed for salmonoid fishes. Quite a number of silver salmon fry were seen in this creek. The country through which it flows is cleared between the hatchery and the mouth, while above the hatchery the country becomes hilly and covered with woods.

HARVEY CREEK.

Harvey Creek was visited August 25. This creek flows nearly due south and empties into the Stillaguamish about one and one-half miles below Arlington. It is about seven miles long and has an average width of six to seven feet for the lower two miles. Its average depth was about 6 inches, but in places there were holes two feet or more in depth. The temperature of the water at 2 P.M. August 25 was 56°F. and the air at the same time at a temperature of 70°F. For one-half mile nearest the mouth the bottom was of soft mud, the banks were flat and immediately along the stream overgrown with alders and willows. There was also much rank grass vegetation along the banks and in the edges of the water. The country along the banks for the lower mile of the stream is under cultivation.

After ascending the stream for one-half mile the bottom becomes gravelly, the gravel being at first covered with slime and mud, in which were growing many low vegetable organisms. A little farther up stream the water flowed more swiftly, consequently the gravel bottom was much cleaner and free from vegetable growth. In this part the stones were thickly covered with very small Caddis fly larvae, which were adhering closely to the stones, and among them were a number of small stone fly larvae. The upper part of the creek runs through a country covered with forest vegetation.

A considerable number of young silver salmon were seen in this stream, also many young rainbow trout or steelheads. A few humpback salmon and a larger number of dog salmon run in this creek, but the number running this year are insignificant compared with the number running in former years.

There is a jam of rubbish in the creek a short distance below the wagon bridge which it might be well to remove.

PILCHUCK CREEK.

The upper part of this creek was visited August 3 and the lower part August 26. This creek rises in Lake Cavanaugh, at an elevation of 1016 feet. It flows in a southwesterly direction, and after a course of about 17 miles empties into the Stillaguamish about one and one-half miles above Silvana, a town on the Great Northern Railroad. The creek begins at the northwestern end of a slough which extends about one-quarter mile northwestward from the lake. During the dry season there is almost no water flowing out of the lake into the creek. About 300 yards from the end of the slough there is a dam across the creek. This dam was constructed to control water for the driving of shingle bolts. The dam has been there for 11 years. It is now no longer in use and ought to be removed as it obstructs completely the migration of fish into the lake.

A large logging camp is located on the creek four and one-half miles below its source. A logging road runs into this camp from near Milltown on the Skagit. A wagon road follows the creek from the logging camp to the lake. This road was formerly in fair condition but is no longer used as a wagon road and is degenerating into a forest trail.

Before the creek reaches the logging camp a couple of branches unite with it. These add a considerable volume of water to the creek, so that when it reaches the logging camp it is about 8 feet wide and has an average depth of less than one foot.

The temperature of the water at this camp at 4 P.M. August 3, was 60.5°F. and the air at the same time was 68°F. The water is clear and pure in the upper part of the stream. The bottom is covered with coarse gravel and boulders. For the most part the stream makes a good spawning bed for salmonoid fishes.

A large saw mill is located on this creek where it crosses the Northern Pacific Railroad. This place, called Pilchuck, is between four and five miles above the mouth of the creek. A dam is constructed on the creek to form a mill pond for the logs. This dam at the present time completely obstructs the migration of fish. Much of the stream between this dam and the logging camp referred to above would make excellent spawning beds for salmon if they could reach it.

The temperature of the water below the dam at Pilchuck was 62°F. The bottom below the dam is covered with gravel but because the water is comparatively warm and slow flowing there is considerable vegetation of a low order growing on the stones. Nearer the mouth there is a series of log jams that obstruct the creek. The creek near the mouth flows through rather low flat land and takes on the nature of a slough, having a soft, muddy bottom and grown up along its edges with coarse grass vegetation, willows and alders.

Formerly vast numbers of silver, dog and humpback salmon spawned in this stream, but now very few run in it. This stream which was formerly an excellent stream for salmon propagation has degenerated until it is of very little importance from the standpoint of the fisheries.

LAKE CAVANAUGH.

This lake was visited August 3. It lies 10 miles east of McMurray and is rather inaccessible. A wagon road runs to a Finnish settlement six miles west of the lake. From this settlement an excellent trail leads to the lake.

A logging railroad runs from near Milltown on the Skagit to a large logging camp which lies about four miles from the lake, and through which the trail just mentioned passes. Formerly a number of settlers lived on the border of this lake, but the last one left a number of years ago. The only habitation nearer the lake than the logging camp is a forest ranger's cabin. This cabin lies at the foot of the slough from which flows the Pilchuck River, the outlet of the lake.

The lake is beautifully situated in the midst of rather low mountains. It is about three and one-half miles long and three quarters wide. Four small islands lie in the western part of the lake.

Soundings were made in various parts of the lake to find as near as possible its extreme depth. The greatest depth found was 70 feet and the average was about 45 feet. The following table gives the temperatures at every 10 feet below the surface.

Depth	Temp. °C.	Temp. °F.
Surface	20.28	68.36
10 Ft.	20.45	68.81
20 "	17.50	63.50
30 "	12.50	54.50
40 "	8.95	48.21
50 "	8.50	47.30
60 "	8.00	46.40
70 "	7.60	45.68

The shore to the water's edge is overgrown with rank forest vegetation. In the shallow water along the shore there is some vegetation, but not to any extent except in the slough through which the lake empties. This slough

is about one-quarter mile in length, averages about 60 feet in width and has an average depth of about two feet. Both shores for about 100 feet are very boggy and grown up with swamp vegetation. The bottom of the lake is soft mud in places and gravel in other places. The game fish reported from this lake are bass and trout, both of which attain a considerable size. Squaw fish were very abundant, particularly in the slough. No salmon found their way into the lake. A careful tow showed that the lake was rather barren of plankton life. Crawfish were said to be numerous in the slough. None were observed by us.

STILLAGUAMISH BETWEEN THE MOUTH OF THE PILCHUCK AND THE PUGET SOUND.

This part of the river flows through a flat country which is subject to inundations by the river during unusual freshets. The river here becomes more sluggish and breaks up into a number of forks which are like sloughs in character and are subject to tidal influence for a considerable distance above their mouths. There is a good deal of fishing for salmon carried on off the mouths of these forks of the rivers. Notices have been posted by the State Fish Commissioner at the mouths of these forks that salmon fishing is forbidden within the river.

SOUTH FORK OF THE STILLAGUAMISH RIVER.

This fork rises within one-half mile of the South Fork of the Sauk River in Barlow Pass. This fork, between its source, and Granite Falls, a distance of about thirty miles, receives no tributaries of importance and is of no importance from the standpoint of commercial fisheries. A series of falls at Granite Falls interferes with the upward migration of fish. A railroad parallels this part of the river from the source to Granite Falls. This part of the river flows through a rugged, mountainous country. The scenery along the river is of unusual beauty.

The river bottom is covered with coarse gravel and is a splendid stream for trout fishing, but seemed to be sadly overfished. A trip was made from Granite Falls to the source Saturday and Sunday, August 13 and 14. On Sunday there was scarcely a 500 yard stretch of the river that was not being whipped by fishermen. Above Granite Falls the country has very few inhabitants and practically no agriculture is carried on.

At Big Four a very large summer hotel is maintained, which furnishes excellent entertainment for hundreds of tourists.

Below the falls at Granite the Stillaguamish river is 70 to 75 feet wide and averaged about one foot in depth at the time visited. The bottom is covered with coarse gravel and boulders and furnishes excellent spawning beds all the way to Arlington, a distance of 12 miles. The water is swift, clear, and cold. No vegetation grows on the bottom of the river. The valley between Granite Falls and Arlington, where the North and South Forks unite, is fairly well settled.

CANYON CREEK.

This creek was visited August 13, and again August 27. This creek enters the South Fork of the Stillaguamish less than one-half mile below Granite Falls. The lower mile of this stream flows through a rather wide valley; above this it passes through a narrow canyon whose walls rise abruptly for more than 100 feet. A short distance above the mouth of this creek the state maintains a fish trap which is so constructed that all salmon and steelheads are caught. A small hatchery for the care of the eggs taken here and in two other creeks, is located on the South Fork of the Stillaguamish near the mouth of Canyon Creek. The other creeks racked to take fish eggs for this hatchery are Jim Creek, flowing into the South Fork of the Stillaguamish about three miles above Arlington, and the Pilchuck

River, a branch of the Snohomish River, which flows past Granite Falls at a distance of less than one mile. The records of the hatchery at Granite Falls showed the following take of fish for Canyon Creek and Jim Creek for the years 1916 to 1921.

Year	Trap	No. Chinooks	No. Silvers	No. Humpbacks	No. Steelheads
1916	Canyon				245
1917	Canyon		174		146
1917	Jim Creek	6	79	52	
1918	Canyon		49		59
1918	Jim Creek		30		
1919	Canyon		30		36
1919	Jim Creek		54		173
1920	Canyon		21		19
1920	Jim Creek		153		21
1921	Canyon				33
1921	Jim Creek				49

A few humpbacks, silvers and chinooks were in the traps at the time these creeks were visited.

Formerly these streams teemed with fish; now, as the above record shows, they are almost depleted.

Above the Canyon on Canyon Creek there are falls which would obstruct the migration of fish at low water, but at high water the fish can easily ascend the falls to the upper waters of the creek.

This creek, below the fish rack, is about 40 feet wide and about one foot in average depth. The bottom is covered with gravel without vegetation. This part of the stream makes excellent spawning beds.

JIM CREEK.

This creek was visited August 27. It flows westward and empties into the South Fork of the Stillaguamish two and one-half miles above its juncture with the North Fork. Only the lower two and one-half miles are of any importance from the standpoint of the fisheries interests. Two and one-half miles above the mouth is a dam 65 feet high which furnishes electric power for the town of Arlington. This dam completely obstructs the passage of fish.

The State Department of Fisheries has a rack and trap about 200 yards above the mouth of this creek, which takes all fish ascending the creek. The creek below the rack was about 25 feet wide and averaged 8 to 10 inches in depth at the time visited.

The temperature of the water was 59°F. The bottom of the stream was covered with gravel and was devoid of vegetation. The entire stream below the dam would make good natural spawning beds for salmon. At the time visited there were nearly 100 silver, humpback and chinook salmon in the trap.

SUMMARY

This summary contains in brief form the facts of interest related to the condition of the salmon on the spawning beds of the Skagit and Stillaguamish Rivers.

1. Sockeye salmon run, only, in the Baker River and Lake. No other tributary of these rivers presents a satisfactory spawning place for this species except, possibly, the South Fork of the Sauk and its expansion, Lake Monte Cristo. The Sockeye interests of Baker Lake and River are perfectly conserved by the United States Bureau of Fisheries.

Lake Monte Cristo is much smaller than Baker Lake but might be made very valuable as an adjunct to the Baker Lake project. Lake Monte Cristo is located about two miles north of Barlow Pass where the South Fork of the Sauk leaves the railroad. An excellent trail leads from the railroad down the Sauk to the lake. This lake covers an area of about 25 acres at the driest period of the year, and about twice as much during the wet season. Its depth is, at most, about 20 feet. The water is clear and very cold, being 50°F. at the warmest time of the year, which is only 4 degrees warmer than the Baker Lake Slough where the United States Bureau retains the Sockeye for nearly three months while their eggs mature. This lake is many times larger than the Baker Lake Slough and could be used to retain many thousands of Sockeye during the ripening season. The lake is fed by an abundant supply of glacial water. The Sauk for several miles above this lake is an ideal Sockeye spawning stream equal in every respect to the upper Baker River. This lake and river furnish

one of the finest situations for an experimental effort to increase the Sockeye output of the Skagit River. The whole district is removed from human enterprises that might be detrimental to the experiment and the territory is in a reservation in which all fishing is prohibited. There are no obstructions to prevent Sockeye running from the Puget Sound up the Skagit and its tributary, the Sauk, to Monte Cristo Lake.

2. The other species of salmon, i.e. Spring, Silver, Humpback and Dog, run in almost all the tributaries of the Skagit except those above the City of Seattle Camp at Newhalem. Reports and observations show that the conditions are extremely critical. Many of the streams were visited during the spawning period, and so few fish were found that it is but fair to report that the races are fast becoming extinct. Not one stream had more than a few scattered fish and these were being hunted down to furnish bait for trout fishing. The United States Bureau has had traps on six of the most important tributaries of the Skagit for a number of years and their reports show sadly diminishing returns. The following figures will give some idea of the depletion in hatchery returns during the two most recent periods of four years each. The figures are for the Illabot Creek, Baker River, Day Creek and Grandy Creek.

	1912-15 Inclusive	1916-19 Inclusive
Chum eggs	14,130,000	11,669,000
Humpback eggs	9,460,000	3,087,000
Silver "	36,904,000	14,780,000
Spring "	1,602,000	897,000
	62,096,000	30,463,000

The decrease in the last four years is more than half of the number taken in the four previous years.

3. Fishing in the Skagit River has a most serious effect on the number of fish reaching the spawning beds. This year the buyers report showed the following take on the North Fork alone for May, 9 gillnetters caught 4,703 Springs

June, 14	"	5,164	"
July, 98	"	11,785	"
	Total	21,652	

A very low estimate of the total number taken in the Skagit this year (1921) would be 30,000 Spring salmon, of which about 15,000 would be females. Had these been permitted to go to the spawning beds they would have seeded these beds with at least 60,000,000 more Spring salmon eggs than are there now.

The methods of the Skagit fishermen are ruinous to the run of Spring salmon, at least. They float their nets down stream stretched as nearly as possible to command the full width of the stream. Their nets being of large mesh take almost all the large salmon and permit the small ones to escape. Of this they make their boast. Unfortunately all the small salmon are males and all the females are large, consequently nearly all Spring salmon reaching the spawning beds are males; and males alone are not likely to produce a very rich harvest of fish for the future.

Again and again we observed on the spawning beds 8 to 10 males for every female Spring salmon. The males were almost all two and three year fish, therefore, quite small, while the occasional female seen was quite large.

As we see the situation all fishing in the Skagit for salmon should be absolutely prohibited.

4. There are several streams where hatcheries might be built, and fish racks maintained during the summer season, but all the streams in the upper country are subject to devastating freshets which would destroy all but the most strongly constructed racks. The streams are mostly mountain torrents except the last few miles of their courses before they enter the main river. At the present time, the runs of salmon are so small that there is not a single stream that could be successfully rached, that has enough salmon running in it to make the building of a hatchery worth while.

Between Rockport and Newhalem (City of Seattle Camp), are three streams flowing into the Skagit from the West called Goodell Creek, Bacon Creek and Diobsud Creek. By racking these three streams enough salmon might be obtained to run a small hatchery. Goodell Creek would be the best of the three on which to maintain a hatchery.

Between Marblemount and the mouth of the Skagit the U. S. Bureau utilizes all the streams of any importance, having racked the Illabot, Jackmann, Finney, Grandy and Day Creeks. The Cascade is too large and swift to be racked except possibly near its headwaters. The Suiattel is very large and muddy. It is possible that near its head-waters hatchery operations might be carried on but the region is very inaccessible. Clear Creek near Darrington is occupied by the U. S. Bureau.

The hatchery on the Stillaguamish collecting fish from three racks, one on Jim Creek, one on Canyon Creek and one on the Pilchuck River, does not take enough fish to make the

hatchery pay. For the last six years the average annual take has been one Spring salmon, eight Humpback salmon, 98 Silver salmon and 130 Steelheads, according to figures furnished at the hatchery by the superintendent.

5. The obstructions on Pilchuck Creek, Alder Creek and Finney Creek ought to receive consideration.

6. All the branches of the Skagit and Stillaguamish Rivers afford excellent opportunities for the development of the game fishes. But the opening up of roads and the use of the automobile are resulting in an ever increasing number of people frequenting these streams, so that except in the most inaccessible places the game fishes are suffering severely. It would be advisable to shorten by a considerable degree the game fishing season.

Report on a Biological Survey of the Nooksak River during the Summer of 1921.

By Martin Norgore
and
A. W. Anderson.

With the exception of about 17 miles of the South Fork, the Nooksak and its tributaries are confined within the boundaries of Whatcom County. It is divided into three main forks. The North Fork drains the north side of Mt. Baker and Mt. Shuksan. The Middle Fork has its origin in the western region of Mt. Baker and northern slope of the Twin Sisters Range. While the South Fork drains the eastern and western slopes of the Sisters and the southwestern part of Mt. Baker. The North and Middle Forks are of glacial origin and are thus extremely turbid during the summer months. But the South Fork is clear during the summer, due to its source being snow and spring.

The Nooksak proper, which is the result of the confluence of the three forks, represents, of course, an average of the three forks. Since two of these are turbid, it is also turbid. The temperature was higher than any of the forks and higher at the mouth than at the junction. This difference is due to the familiar fact that the further the water has traveled from its source, the longer it has been exposed to heat.

The ease with which different parts of this water system may be reached varies greatly. Thus on the North Fork

one may go as far as Nooksak Falls by automobile, while on the Middle Fork one may go as far as Heisler's Ranch by automobile and then pack in either on one's own back or by means of pack horses which are available. The trail is kept in good condition by the U.S. Forest Service, which has a station called Deming Ranger Station, between Warm and Thunder Creeks. The Rangers also open yearly the trail across the Sisters Divide to Elbow Lake and down the South Fork as far as the U.S. Forest Reserve line, which crosses the river about 2 miles below Wanlick Creek. From this point down to Cavanaugh Creek there is to be found here and there the rudiments of a trail, called the New York trail. It would be impossible to take a pack horse on this so-called trail in its present state. Therefore, those who want some good fishing on the upper reaches of the South Fork go up the Middle Fork and cross by Elbow Lake. They almost invariably return by the same route.

In addition to the instructions given by Director John H. Cobb, "Standard Methods for the Examination of Lakes and Streams", published by the Massachusetts Department of Conservation, was followed, as far as it was found practicable. The method outlined to determine the volume of water in any stream is only approximate, but for biological purposes it is sufficiently accurate when one considers that the volume of any stream varies greatly with the different seasons.

Although as much data as possible was collected

pertaining to the life in general of the streams and lakes, it must be understood that the primary object of the survey was to make observations bearing on the conditions of this water system for the production of the commercial species of salmon and trout. There are, to be sure, a number of attractive problems confronting the worker on such a survey, but the field is so vast that these had to be subordinated. Of course, in the larger sense there is nothing one could do which would not bear on the subject, but if an exhaustive study were to be made, one would be able to cover very little territory.

In the light of what has been stated to be the object of the survey, it follows that little was done beyond the limits of migration of the Pacific salmon. But when waterfalls, temporary or permanent, were encountered, investigation was made beyond this point to determine if it would be profitable to do anything in the way of assisting the salmon to get over the barriers.

It would be quite impossible in the allotted time to identify every species found in the plankton samples. To do this, specialists in the various fields would have to be consulted. Therefore the classes of animals or plants that predominated have been listed in what appeared to be the quantitative order. For the present purpose the quantity of plankton is the most important, as it, together with the bottom and marginal vegetation, indicates in a measure the suitability of a body of water for fish life. In the case of young salmon, and trout, this relation is

not so obvious, as these fishes live almost exclusively on insect life. Sometimes they are purely terrestrial. But usually the insects that salmonoid fishes feed on pass part of their life cycle in water. And during their aquatic period, they feed on plankton or marginal or bottom vegetation. In this relation diatoms seem to be very important, as these plants were found where the plankton sample was practically sterile. Interesting as the subject is, we cannot discuss here the specific forms and their amazing adaptations to widely different habitats - from the stagnant pool to the rapid stream. Nor is it necessary to point out the familiar fact that plant life is the source of all food in as well as out of water. Suffice it is to say that the quantity of plankton and attached vegetation indicates the food supply of a body of water for fish life.

By many it is believed that salmonoid fishes feed almost exclusively on insects hovering above the surface. This is not true, however. Rutter (1902) has found that one-half of the food of the young spring salmon studied consisted of pupae and nymphs, 1/3 of larvae, and only 1/6 of winged forms. His observations were made on the Sacramento River.

The practical necessity for more detailed knowledge of the feeding habits of fishes, and especially of the Pacific salmon, such as the sockeye, king, and silver, which feed for varying periods in fresh water, need not be emphasized.

In fishery legislation regarding the taking of salmon by gill nets the size of the mesh is usually specified. The theory is presumably that the smaller fish will not be caught and will migrate upstream to spawn. No doubt in practice this has been somewhat successful. It is better to permit the smaller fish to reach the spawning grounds than to catch both the large and small. But if we are to apply the facts established in animal breeding to this practice, it must be questioned. For by continuing to kill off the larger fish before they have had a chance to spawn, the average size of the species entering any stream is gradually reduced.

That the size to which any fish will grow does not depend entirely on the food supply has been definitely established. In fact, if a number of fry of the same species, hatched at the same time, are kept under identical conditions, where each individual has access to all the food it wants, one will find that in the course of a year the largest will be several times as heavy as the smallest. And animal breeders have demonstrated that by breeding the largest or the smallest members of the offspring, the size may gradually be increased or decreased, respectively. It is evident, then, that the size to which an individual will grow depends on the hereditary characteristics of the individual. To be sure, growth also depends on the factors conditioning life, such as food, oxygen, light, etc. For the growth of any individual, regardless of its hereditary qualities, may be stunted by unfavorable conditions of life.

If fishing with nets at the mouth of a stream prevents to an appreciable degree the larger fish from spawning, is

an important question. To judge by the observations of Supt. Kline of the Middle Fork hatchery, the effect of gill net fishing at the mouth of the Nooksak is appreciable. Mr. Kline says that the silvers caught in the traps during the open season are both fewer in number and uniformly smaller than after the season closes. That fewer silvers are taken while fishing is permitted at the mouth is by no means due to the gill nets alone, as other forms of apparatus are used, such as traps and purse seines. But if there is noticeable difference in the average size before and after closed season that difference must be due to a degree to the use of gill nets, as the other methods of catching fish take both large and small. We recognize the possibility of the earlier run being made up of uniformly smaller individuals. But according to Mr. Kline the difference is quite marked at the close of the season. Whether the same effects have been noticed at the North Fork hatchery, we were unable to ascertain. But if Mr. Kline's observations should be corroborated it would be more in harmony with scientific facts to devise means whereby the smaller would be caught, and the larger fish allowed to go upstream and spawn.

In order to prevent a misconception in connection with the above discussion, we wish to state that this is not a discourse on the relative merits or demerits of apparatus employed for the taking of salmon. But it must be conceded that all of them are responsible in a measure for the steadily diminishing supply of salmon. How that responsibility is to be divided, we do not propose to discuss.

According to the information which we obtained, the last run of humpback salmon on the Nooksak was in 1912. Previous to that year a great number of this species migrated up this stream to spawn. Racehorse, a tributary to the North Fork, was their favorite spawning ground. Since then a few enter the river, but not in such numbers as to constitute a run.

The observations of the spawning habits of any species of fish were limited, as but one species, the spring salmon, was on the spawning grounds at the time of the survey. But on August 20th a number of this species was observed spawning in the riffles of the North Fork at Kendall. The river was turbid, the temperature 49° F. The fish were not greatly disturbed by our approach. One female was taken by hand and removed from the water. About 100 eggs remained. The female was still in fairly good condition physically.

The data presented concerning the species of fish which enter a given stream was obtained from residents. This information was supplemented as far as possible by study of the fish found. But as the fry of certain species, as the dog salmon, go to sea shortly after being hatched, this could not always be done.

The data is presented in abbreviated form as much as possible. If a stream does <u>not</u> dry up, no mention is made of that fact. In order to avoid repetition of scientific names, the following glossary is prepared. This includes fishes mentioned in the report on other streams and lakes.

Chum or dog -.....	Onchorhynchus	kita (Walbaum)
Humpback	"	gorbuscha (Walbaum)
Silver and coho.....	"	kisutch (Walbaum)
Sockeye and landlocked sockeye and silver trout....	"	nerka (Walbaum)

Spring and chinook.....	Onchorhynchus tschawytscha (Walbaum)
Eastern brook trout.....	Salvelinus fontinalis (Mitchill)
Dolly vardon.....	" malma (Walbaum)
Mackinaw trout.....	Cristivomer namaycush (Walbaum)
Cutthroat.....	Salmo mykiss (Walbaum)
Steelheads.....	Salmo gairdneri (Richardson)
Whitefish.....	Coregonus williamsoni (Girard)
Sucker.....	Catostomus macrocheilus (Girard)
Chub.....	Mylocheilus caurius (Richardson)
Shiner.....	Leuciscus balteatus (Richardson)
Crappie.....	Pomoxis sparoides (Lacepede)
Pike.....	Lucius lucius (Linneous)
Large mouthod black bass.....	Micropterus salmoides (Lacepede).
Small " " "	" dolomieu (")
Perch	Perca flavescens (Mitchill)
Cottid.....	Cottus asper (Richardson)
Stickleback.....	Casterosteus williamsoni (Girard)
Starry flounder	Platichthys stellatus (Pallas)

Conclusions.

From the data presented it will be found that the Nooksak River is at present primarily a silver and dog salmon stream. A small run of springs enter this river and spawn in the North and South Forks. Very few, if any, enter the Middle Fork. As in other rivers, dog salmon fry migrate seawards shortly after hatching, while the silvers and springs remain for varying periods, from a few weeks to one year, in fresh water before going to sea. Many of the spring yearlings are caught by anglers, who call them "rainbow trout". This is not done to deceive, but through lack of knowledge.

The almost complete annihilation of the humpback on the Nooksak points to what might be expected in the case of other species such as the silver and the dog, unless drastic action is taken to prevent mining and introduce farming of our fisheries.

The Nooksak is not a sockeye stream, nor will it be, since no lake on this system is suitable for propagation of this species.

There is a small run of steelheads in the spring. Most of them spawn in Racehorse Creek. Many of the young steelheads are caught by anglers before returning to sea.

Although there are many obstructions on the upper reaches of the Nooksak, we do not recommend expenditure of money for the purpose of assisting salmon to get over them. In most cases the stream becomes steep with a second fall a few yards above.

But on the South Fork this is not the case. The

12 ft. falls, about 12 miles below Elbow Lake, formed by an immense slide, prevent salmon from reaching several miles of excellent spawning grounds on the upper reaches of the South Fork. Yet it would be a costly proposition to blast the boulders forming this falls, or to build a ladder. As will be seen elsewhere, tools and materials would have to be packed on horseback up the Middle Fork, across the Sisters Divide and down the South Fork, where a trail would have to be broken for 5 to 6 miles. But this is not a place that can be "fixed" once for all times. There are annual or perhaps semi-annual slides which would push other boulders into the river bed, thus necessitating yearly expenditures to keep the place open for salmon. And we doubt that the results obtained would justify the investment.

The State operates at present two hatcheries on the Nooksak. One is on Kendall Creek on the North Fork, and the other on Canyon Creek, on the Middle Fork. In the case of both hatcheries natural bottom ponds could be built at low cost, especially at Kendall. Until recently the State also operated a hatchery on the South Fork near Acme, but due to lack of breeders and unfavorable physical conditions, this has been abandoned.

We do not recommend erection of more hatcheries for the present.

But we do believe that a more judicious system of planting might well be tried. Instead of liberating the fry at or near the hatchery, it would be more in accordance with the facts established by Dr. Gilbert relative to the parent stream theory to

plant the fry in the tributaries. Also from the standpoint of food and shelter, we should expect better results if the fry were apportioned among the several streams. This refers especially to the species that feed in fresh water.

We believe that the data collected might be used most advantageously as a guide in planting fry.

Work was begun on the upper reaches of the North Fork. But as a 110 ft. falls is found at Excelsior, 7 miles beyond Glacier, very few observations were made beyond this point. Every tributary of any size below the Falls was investigated. The data follows:

1. Wells or Walls Creek. June 25th. Nearest P.O. - Glacier. Accessible by trail only. Temp. of water 41°F. Air 56°F. Extremely turbid, having its origin in three glaciers, the Shales, the Mazama, and the No Name. It joins the North Fork of the Nooksak just below Nooksak Falls. From the very beginning it is steep and no fish enter or can enter this stream. Bottom gravelly with stones and immense rocks. Plankton Sample - sterile. No bottom vegetation, but moss was found on the stones and partly submerged logs.

2. Dead Horse Creek: June 26th. Nearest P.O. - Glacier. Volume-about 28 cu.ft. per sec. Temp. of water-43.5°F. Air -60°F. Clear, its source being snow and spring. Enters North Fork about two miles below Nooksak Falls. The entire stream is quite steep, but salmon may go up one mile. Steelheads and silvers said to spawn in this stream. No fish life was observed or taken. The Plankton sample contained very little life, mainly vegetable debris. There was no bottom vegetation, but the stones and logs along the margins were partly covered with moss. Bottom gravelly with rocks and boulders.

North Fork of the Nooksak from Nooksak Falls to Glacier:

June 27th. Temp. of water - 44.5°F. Air - 56°F. Turbid. Average velocity as determined by the U.S. Geol. Survey - 8 ft. per second. Plankton sample - sterile. Insect life scant. No marginal or bottom

vegetation. A 12" dolly varden [illegible]

Silver fingerlings and advanced fry of the same species found in backwaters about 1½ miles below falls. The same species was found in two small creeks further down.

Thompson Creek: June 28th. Nearest P.O. - Glacier. Accessible by trail only. Volume - about 24 Cu. ft. per second. Moderately rapid. Temp. of water - 47°F. Air - 62°F. Clear, its source being snow and spring. Empties into Glacier Creek. Fish may go up 2 miles when a series of falls are encountered. Silver fingerlings, advanced fry and a six inch cutthroat were taken. Insect life moderately abundant. Plankton sample - some diatoms, but mostly vegetable debris. No bottom vegetation, but moss found on stones and logs.

Glacier Creek - June 29th - 30th. Nearest P.O. -Glacier. Accessible by road and R.R. Temp. of water - 42°F. Air - 56°F. Extremely turbid, having its origin in Roosevelt Glacier. Clears in October. Plankton sterile. Insect life scant. No bottom or marginal vegetation. Fish may go up more than 4 miles, and dolly vardens are reported caught in September at that distance from the mouth. No fish life was observed in the backwaters of this stream. The species that are said to enter Glacier Creek are the silver, the steelhead, the cutthroat, and the dolly varden. In the light of the fact that young silvers and cutthroat were taken in Thompson Creek - a tributary to the Glacier - it seems reasonable to believe that the above named species enter this stream.

Glacier. Accessible by road and R.R. Volume - 15 cu. in. per sec. Temp. of water - 45°F. Air - 61°F. Sand and gravel bottom. Clear, source being spring. Plankton sample - diatoms and algae, but mostly vegetable debris. Bottom vegetation - diatoms on rocks - some attached algae. Marginal vegetation - moss on stones and logs. Silvers, steelheads, and cutthroats said to spawn in this stream. Advanced fry of silver was taken in the lower part.

Cornell Creek: July 2nd. Nearest P.O. - Glacier. Accessible by road and R.R. Volume - about 14 cu. ft. per sec. Temp. of water - 44½°F. Air - 62°F. Dries up during the month of August, when many silver fry are said to perish. Sand and gravel bottom. Current rapid. Bottom and marginal vegetation - moss, and some diatoms. Fish may go up one mile, when falls are encountered. The following species are said to enter this stream: Steelheads, chum, silvers, cutthroat, and dolly vardon. Only silver fry were taken or observed.

Canyon Creek: July 2nd and 3rd. Nearest P.O. - Glacier. Accessible by road and R.R. at mouth. Upper part by not even trail. Volume approximately 200 cu. ft. per sec. Rapid. Fish may go 1½ miles up. Temp. of water - 43.5°F. Air - 62°F. Almost clear, its source being snow and spring. Bottom - gravelly below. Boulder and bedrock above. Insect life quite plentiful. Plankton sample meagre in life, mostly vegetable debris. Bottom vegetation - diatoms on stones. Some moss. Marginal vegetation - moss, or none. Springs, chums, silvers, dolly varden, and cutthroats reported to

North Fork from Glacier to Kendall: July 5th. Turbid. No marginal or bottom vegetation. No fry observed in backwater. Temp. - 44.5°F. Plankton sample sterile.

Boulder Creek: Nearest P.O. - Maple Falls. Accessible by road and R.R. Temp. - 48°F. Air - 64°F. Volume - about 18 cu. ft. per second. Rapid. Fish may go 1 mile up. Bottom - gravel and rock. Above, boulders. Water clear, source spring. Vegetation, diatoms on stones. Also moss. Plankton sample - diatoms and algae. Insect life fairly abundant. Springs, silvers, chums, steelheads, dolly varden, and cutthroat said to enter this stream. Cutthroat taken.

Maple Creek: July 7th. Nearest P.O. - Maple Falls. Accessible by road and R.R. Temp. of water - 62°F. Air - 65°F. Volume - about 14 cu. ft. per sec. Sluggish. Clear, source Silver Lake. Two falls, about 12 and 15 ft. respectively, ¾ mile up. Dries up during the month of August. Vegetation, attached algae and diatoms. Marginal grass and sedges. Insect life very plentiful. Plankton sample - diatoms mostly. Fish life: one six inch lamprey eel observed. Some yearlings of spring taken. But mos abundant fish life was the silver fry and fingerlings or larger.

Silver Lake: July 8th. Nearest P.O. - Maple Falls. Area about ¼ square miles. Length - 1 5/16 miles. Average depth - 16-18 ft. Max. 25 ft. Inlets - small streams from the surrounding hills. All but two were dry at the time of our visit.

1.5 -2 months. Temp. deepest part - 66° F. surface, 63.5° F. bottom. Air 70° F. Bottom mud. Some gravelly shores. Marginal vegetation - very abundant - cattail, sedges, rushes. Submerged. Myriophyllum, ceratophyllum ranunculus, narrow, medium and broad leafed potamogetons. Plankton - plentiful. Cladocera copepoda, vorticella and anabaena predominated. Fish life - cutthroat, suckers, stickleback, cottids. For production of commercial species this lake is valueless.

Maple Creek from Silver Lake to Falls previously described: July 9th. This part about 3 miles. Sluggish. About 2½ miles down a mill pond, 12 ft. high. a ladder provided. Fish - same as in Silver Lake.

Kendall Creek: July 10th. Nearest P.O. - Kendall. Accessible by road and R.R. Clear, sluggish. Source- spring. Volume app. 45 cu. ft. per sec. Temp. 49° F. Air 64° F. Bottom - mud, sand and gravel. Vegetation - Marginal, waterlilies and grasses. Submerged - ranunculus. myriophyllum. No falls or dams for 2 miles or more. Cultivated lands on both sides. Natural food abundant, copepoda cladocera and protozoa predominating. Fish life - cottid, silver fingerlings. State Hatchery at mouth. Of recent years the N.F. of the Nooksak has cut into the bank so that at present a pond which has been constructed between the building and the North Fork cannot be used. In the opinion of the authors, this hatchery should be located further up on Kendall

connection with this hatchery. Silvers and dogs are the species propagated. A few thousand steelhead eggs are also taken in Racehorse Creek, a stream opposite Kendall.

Racehorse Creek: July 11. Nearest P.O. - Kendall. Accessible by road. Volume - app. 70 cu. ft. per sec. Clear, source - spring and snow. Temp. 48° F. Air 66° F. Gravel bottom. Vegetation: Moss, both marginal and submerged. Plankton - not very abundant. Current not very rapid below falls. About 2 miles up a 20 ft. fall. Above this a series of falls, the stream running through a steep canyon. Above which it becomes a good trout stream. Adjacent land wild. Fish life - chums, silvers, steelheads, springs and humpbacks. Yearlings of chinook salmon caught by anglers. Silver fingerlings predominated.

Kenney Creek: July 12th. Nearest P.O. - Deming. [illegible] Volume - [illegible] cu. ft. per sec. Clear. Source - snow and spring. Temp 52° F. Air 66° F. Moderately rapid. Dries up during summer. Gravel bottom. Vegetation: diatoms on rocks, grass along margin, adjacent land wild. Natural food quite abundant. Silver fingerlings quite abundant. The State has a trap at the mouth of this creek. The eggs are taken to Kulshan Hatchery.

Bell Creek: July 13th. Nearest P.O. - Deming. Accessible by road. Empties into North Fork on north side, opposite Kenney Creek. Volume - 6 cu. ft. per second. Temp. -58°F.

Attached algae and diatoms. Falls about one mile up. 10 ft. Natural food abundant. Insect life plentiful. Plankton sample - diatoms, but mostly vegetable debris. Fish life - chums, silvers, and steelheads, as well as cutthroats. Silver adv./fry taken. Trap at mouth. Eggs taken to Kulshan Hatchery.

North Fork from Maple Falls to Kulshan:

Turbid. Temp. 45½° F. Plankton sample sterile. No marginal or bottom vegetation. No fish life observed or taken.

The Middle Fork.

Observations on the Middle Fork were made from the lower to the upper reaches, instead of from the upper to the lower, as was the case on the North Fork.

Canyon Creek: July 15th. Nearest P.O. - Deming. Accessible by road and R.R. Volume 60 cu. ft. per sec. Source- Canyon Lake. Temp. 56° F. Air 64° F. Sand and gravel bottom. Vegetation diatoms on rocks. Moss on logs and stones. Plankton - vegetable debris and some diatoms. Current rapid. Falls called Two Step Falls about 1½ mile up. First of these 20 ft., second 12 ft. Insect life scant. Fish life scant. Two 6" steelheads taken. Steelheads, cutthroat and Dolly Varden said to inhabit this stream. The State operates a hatchery on this creek. Ponds could be built for rearing the young. On account of the water being very cold it takes 100-120 days.for hatching.

Canyon Lake: July 16th. Nearest Pl O. - Deming. Accessible by trail only. Area -1/8 square mile. Depth - 26 ft. maximum. Average 18 ft. Inlets from surrounding hills. One larger than all the rest. Temp. 60° F. Freezes over during the winter. Bottom - logs, brush, mud. A great number of logs or fallen trees found in this lake. A number of these are partly above water. From a geologic standpoint this lake must be very young. Insect life fairly abundant. Plankton sample did not contain many forms - copepods predominating. Cutthroat is the only species found. No salmon or any other kind of fish could ever get

... the character of Canyon Creek.

Porter Creek: July 17th. Nearest P.O. - Deming. Accessible by road. Volume - almost dried up. Temp. 50° F. Air 60° F. Gravel bottom. Diatoms on rocks. Clear. Insect life plentiful, especially larvae and nymphs. Silvers said to run up during the winter. Fingerlings of silver fry observed in great quantities in pools.

Bear Creek: July 17th. Nearest P.O. - Deming. Volume: approx. 7 cu. ft. per sec. Clear- rapid. Source - thought to be underground outlet of Mosquito Lake. Temp. 46° F. Mud and sand bottom. Vegetation plentiful. Mostly water celery. Also attached algae. Natural food abundant. Silvers said to spawn during the winter. Silver fingerlings taken.

Mosquito Lake: July 17th. Nearest P.O. - Deming. Depth 15 ft. Area, 300 square yards. Average 7 ft. Source - creeks from surrounding hills. All dried up at the time of our visit. Outlet said to be underground. Temp. 76° F. Air 72° F. Freezes over during winter. Bottom mud. Vegetation.- water lilies in great abundance. More than half of this lake is a marsh. Natural food plentiful. Fish life: stickleback taken. Cutthroat said to inhabit this lake, but none were taken. Of no account for commercial species of salmon or trout.

Middle Fork of Nooksak through Box Canyon: July 18th. Temp. 50° F. Turbid, but less so than the North Fork. No fry or fingerlings of pacific salmon were observed or taken above the mouth of Bear Creek.

deep canyon called the box canyon. The information regarding the character of this canyon was highly conflicting. Some said there were falls ranging from 10 - 60 ft. high, while others maintained that there were no falls. In order to settle this controversy a thorough examination of this canyon was made, and it was found that there are no falls higher than 3 ft. To be sure, the river is rapid, but there is nothing to prevent a salmon or trout from going up. And indeed, steelheads do go up. That none of the species of the genus Oncorhynchus go up may be attributed to the fact that silvers and chums are the only species of this genus that enter the Middle Fork, and these never go very far up in any stream.

Heisler Creek: July 18. Nearest P.O. - Deming. Accessible by road. Of inconsequence from salmon standpoint, as it has a 20 ft. falls at the mouth. Very small.

Falls Creek: July 19th. Nearest P.O. - Deming. Accessible by trail only. Temp. 48° F. Small. Very steep. No fish could enter this stream.

Clearwater Creek: July 19th. Nearest P.O. - Deming. Accessible by trail. Volume approx. 200 cu. ft. per second. Clear - rapid. Source - snow and spring. Temp. 46° F. Air 56° F. Sand and gravel bottom with large boulders in the bed. Vegetation: moss, diatoms on stones. Plankton samples: very little life, mostly vegetable debris. Insect life rather plentiful. Fish life: cutthroats and Dolly Varden both taken. Steelheads said to go up. There are no higher than 6 ft. falls for 3 miles up. A very picturesque stream, good sport fishing.

Warm Creek: July 20. Nearest P.O. - Deming. Accessible by trail. Volume about 70 cu. ft. per second. Clear - rapid. Source - snow and spring. Temp. 42° F. Bottom sand and gravel with boulders. Vegetation mostly moss on stones and logs. Plankton sample: vegetable debris. Insect life not plentiful. At the mouth Dolly Varden/try [illegible] adv. [illegible] inch in length. Cutthroats 6 inches taken about ¼ mile up. About ¾ mile up there are a series of falls 15-20 ft. high.

Sister Creek: July 21st. Nearest P.O. - Deming. Accessible by trail. Cross river on foot log. Volume: 75 cu. ft. per second. Moderately rapid. Clear. No falls for 1½ mile up, when the stream becomes very steep. Source: snow on the Twin Sisters. Temp. 52° F. Bottom sand and gravel with a clay admixture, which makes the bottom very hard. Vegetation: diatoms on stones in great abundance. Moss on logs and stones. No other vegetation observed. Plankton sample, vegetable debris mostly. Few insects. Fish life: cutthroats and dolly varden.

Green Creek: July 22. Nearest P.O. - Deming. Accessible by trail. Volume - about 100 cu. ft. per second. Greenish in color - fine silt in water. Source - snow and spring. Temp. 44° F. Air 60° F. About ½ mile up, falls 10 ft. high. Above this more falls. Bottom sand and gravel. Vegetation; diatoms on stones. Plankton sample: silt. Natural food scant. No fish life observed. No record of anyone ever catching fish in this stream.

July 23rd. Nearest P.O. - Deming.

Accessible by trail. Volume: 65 cu. ft. per second. Turbid, slightly so, steel color. Source: snow and spring. Temp: 48° F. Air: 50° F. Bottom sand and gravel, with boulders. Vegetation: stones and logs covered with moss. Plankton sample: practically sterile. Little natural food. No fish. Fall of 8 ft. about 100 yards above the mouth. Lower part extremely rough.

Ward Creek: July 23. Nearest P.O. - Deming. Volume: 8 cu. ft. per sec. Clear - moderately rapid. Dolly varden adv. fry taken. Also a cutthroat. Natural food fairly abundant.

Upper Part of Middle Fork: July 24. Very rapid, but no falls. Extremely turbid, coming from Deming Glacier. Temp. 38° F. No vegetation.

Ridley Creek: July 24. Nearest P.O. - Deming. Accessible by trail. Volume: 44 cu. ft. per sec. Clear, rapid. Source - snow or spring. Vegetation: moss. Natural food scant. No fish life observed. No report of fish ever being taken in this stream.

The South Fork.

Having completed our observations on the Middle Fork, we crossed the Sisters Divide and worked down the South Fork.

Elbow Lake. July 25th. Nearest P.O. - Deming. Accessible by trail only. This lake is bent like an elbow, hence the name. Size - about 1/32 sq. mile. Temp., surface - 51° F., air - 48° F. Snow on south side. Steelheads planted in 1914 according to information obtained from the county game warden. Inlets - small creeks from the surrounding hills. Outlet - South Fork. Is steep and inaccessible by any species of fish. Temp. 44° F. Clear. The outlet from Elbow Lake is augmented by streams from the Sisters range. About 2.5 miles down, Dolly Varden caught. Water clear. Attached vegetation - moss and diatoms.

Bell Creek. July 25th. Nearest P.O. - Deming. Accessible by trail. Temp. 44° F. Air 55° F. Volume - 20 cu. ft. per sec. Clear. Source - snow and spring about Mazama Park. Spawning beds good, the bottom being gravelly. Vegetation scant. Moss on logs. About 1 mile up this creek becomes steep with many falls. Fish life - cutthroat and Dolly Vardon taken.

Wanlick Creek. July 26. Nearest P.O. - Deming. Accessible by trail only. Volume - 35 cu. ft. per sec. Bottom gravelly, good spawning grounds. About ½ mile up this creek divides and becomes steep. Clear, source - spring. Food not very abundant. Few insect larvae observed. Cutthroat and Dolly Varden taken.

South Fork from Bell Creek down - Temp. 45° F. Clear. Gravelly bottom. Very good spawning grounds. Not very swift. Food not very abundant. In addition to the tributaries described there are smaller ones coming in from both sides, but these are often very steep, or very small. About 12 miles from Elbow Lake, by Rivera, 12 ft. falls was found. It was formed by large boulders brought down by an immense slide of the bank on the north. From what we could see, any attempt to build a ladder or to blast the boulders forming the falls would be quite futile, for there is a slide every year which would push other boulders into the river bed and thus necessitate yearly expenditures to keep this part of the river open for salmon. That salmon do want to go up, there seems to be no question about. Anglers from Lyman informed us that during September and October of each year the pool below the falls is fairly swarming with salmon. What species, we were unable to determine with certainty, but these fish are very likely springs and silvers. About 8 miles below the falls advanced silver fry were taken, showing that silvers actually go that far and possibly further to spawn. To be sure, they might have been present further up and escaped our observations.

Haward or Sister Creek. July 27th. Nearest P. O. - Lyman. Accessible by what was once a trail but is no more. Temp. 52° F. Clear. Volume - 30 cu. ft. per sec. Another rough creek with boulders and intermittant pools. Bottom - gravel and sand. About ½ mile up 6 ft. falls. Insect life rather scant.

Vegetation - diatoms on stones. Cutthroat and Dolly Varden taken. No doubt, a good trout stream.

Cavanaugh Creek. July 29th. Nearest P.O. - Acme. Temp. 52° F. Clear. Accessible by road. Volume - 25 cu. ft. per sec. Divides and becomes quite shallow a short distance above mouth. There are good spawning beds when the water is higher. Insect life scant. Bottom vegetation scant. Plankton sample - vegetable debris. Silver fry taken.

Skookum Creek. July 30th. Accessible by road and logging R.R. Volume - approx. 100 cu. ft. per sec. Clear. Temp. 55° F. Air 54° F. About 1 mile up 10 ft. falls. ½ miles up another falls 12 ft. Temp. 50° F. Insect life fairly abundant. Bottom - sand and gravel. Vegetation: bottom - diatoms on stones, moss; marginal - moss. Plankton sample - cladocera, algae diatoms. Fish life - whitefish, chinook fingerlings, silver fingerlings and yearlings, young steelheads. Bellingham intends to take its water from this stream.

Hutchison Creek. July 31st. Accessible by road. Volume about 40 cu. ft. per sec. Temp. 40° F. (morning). Bottom - gravelly, lower portion well shaded by trees. Vegetation - diatoms and moss on rocks. About ½ mile up 6 ft. falls encountered. In the pool below a mature female spring salmon observed. The following species were taken: whitefish, cutthroat, silver fingerling and yearlings, and one sucker.

The lower portion of the South Fork has a few tributaries besides those recorded above, but these were small and

regarded unconsequential. A word might be added regarding the South Fork itself. Following heavy rains during the winter months the river rises and causes complete inundation of vast areas on both sides. Every year Acme is flooded. A short distance above Acme the State built and maintained a hatchery for some years. But it has been abandoned, as the supply of breeders became inadequate.

Nooksak River from Deming down to Bellingham Bay - This part of the River was covered in a rowboat. The streams that empty into the Nooksak below Deming are on the whole small. Most of the land on both sides is cultivated. The temperature varied from 54° F. at Deming to 61° F. at Marietta near the mouth. Of fish life the following were taken: fingerling silvers and springs, whitefish, freshwater cottid sucker shiners, Dolly Varden, 6 inch steelheads. The streams that empty into this part of the Nooksak are few. A more detailed description of these and some lakes that also drain into this river follows:

Weiser Lake - Aug. 8th. Temp. 74° F. About ¾ mile long and 250 yards wide. Shallow - 15 ft. maximum depth. Outlet through a ditch which was nearly dry at the time of our visit. Cutthroat and catfish caught. Marginal vegetation: cattail, sedges, grasses, etc. Plankton sample: very rich, especially in the following forms: rotifera, copepoda cladacera, anabaena. Of no value for commercial species.

Fish Trap Creek - Aug. 9th. Small, sluggish, clear. Temp. 59° F. Silver fingerling taken. Silvers and chums said to go up and spawn in this creek. The name comes from

the fact that Indians had traps on this Creek.

Keefe Lake: Aug. 10th. Temp. 70° F. Shallow. Of importance for commercial species.

Bertrand Creek: Aug. 10th. Temp. 67° F. Fairly clear. Muddy bottom. Sluggish. King and silver fingerling taken. Plankton sample mostly vegetable debris.

Barretts Lake and Tenmile Creek: Aug. 11th. This lake is really a widening of Tenmile Creek. Temp. 72° F. Duck weed in great abundance. Other vegetation typical of shallow mud-bottomed lakes. Silver fingerling taken at mouth of Tenmile.

According to the U.S. Geological Survey map, one would think that the Nooksak divides about 2 miles below Ferndale into the Lummi River, emptying into Lummi Bay, and the Nooksak, emptying into Bellingham Bay. This is not so any longer. To be sure, the river divides about ½ mile above Marietta, but both branches empty into Bellingham Bay. At the mouth stake nets are used for fishing.

About ½ mile southeast of Marietta, yearlings of springs, silvers and steelheads were taken by seine.