Olympia State Park Wa
[1953] report

Gervais
Gerstung
- S.C. values 3 of 5 samp. 1-3
- pop. est. dsts
to 1971

- beardslei - statement
- crescenti stock - good
- lathsecals domestic rainbow

- declivifrons - what there now?
- of [illegible]

- Vidan -

- Andrews - red band - ests
- willow ck. [illegible]
- may - native restoration

Bonneville abstract

1/23

Dear Bob,

We have two copies of the green report on Beardsley tent. Keep it if you have any idea that it ever may be of use. Copies would be of little value in that you wouldn't have the color photos. If on the other hand you can not anticipate any use, just return it. I thought it might be of interest, comparison of S. c. crescentus & S. g. beardslei. Perhaps you've seen it.

The black & white photo in Washington Wildlife of a sea run cutthroat — evidently typical — shocked me after some of the discussion I heard years ago on whether the cutthroat subspecies were real or not. Now I wonder why it wasn't more obvious to guys like Seigler — they had just never seen them.

I'm sure hearing a lot lately on the use of genetic strains of salmon and trout in achieving a given mgt. objective.

I talked to Paul Sebuhich this A.M. He was in town being interviewed about a job with W.D.F. He finishes his PhD up about May 1st.

This FWS never ceases to amaze me. April 1st we are to go to the AO except. In June

they got rid of "Kay" Heckman and now we have another one. Both Azvedo and myself are already on his shit list. I have resigned myself to another sign of creative rebellion, discouraging as it may be after my most recent bout with Hanson. Can you knock out three in a row? Personally I doubt whether I'll ever return or go the full course with this outfit.

Best wishes

Jim

May 24, 77 Ore. ST
50 ± comm - Suislaw R.
- Triangle L. has 2 pop. cutthroat - "normal"
late winter spawner + May spawner. - not known if
result of introductions (ex. Odell L. kokanees)

John Day R. drainage - ✱ 3329 : S. c. lewisi
Indian Crk. - Sept 14, 1953 Oregon ____ Co.
spots more 'west slope' ≈ prx 150mm. - faded -
41-43-43 rakers 8/12 13 basibranchials (Grant Co., Ezstol
217-217 - fine scale, John Day
217

L. Chelan

Ore. - Chelan Co.
✱ 3669 - Park Crk. (Stehekin watershed) [L. Chelan]
VU: 4:57 - 172, 200mm. - more but spots rounder -
spotting - but not on top of head or ventral
① - rakers 9+12 well developed (not coastal-like)
13 basibranch.
Scales missing 37-160
no accurate counts
② 9+11 : not so well developed (upper, short)
1 tooth

✱ - Gila trout - Chitty Crk. Dennis Scorcchnis (form.
U. Ariz. student) trib. Eagle Crk.

end 75 - Glenn Jenny form
- Smith Hucho fossils L. Idaho & Mus. Paleon. Univ. Mich

John Day Drainage – Canyon Crk. – hybrids
Grant Co. III : 8 ; 48 (At town John Day),
– fine spotted – west-slope-like. (largest spec.
w/ spots on top head – may be hybrid + no basi branch.

① . 7/13 – no teeth (but worked over & torn up) #1 165-183

upper rakers short – ill developed

② 8/12 – 8 teeth 37/–,? scales missing
③ 8/12 – 3 teeth ,?
④ 7/12 – no teeth 33/168
5 – . no teeth

[1953]

REPORT ON THE MANAGEMENT OF THE BEARDSLEY TROUT FISHERY

OF

LAKE CRESCENT, OLYMPIC NATIONAL PARK

U. S. Fish and Wildlife Service
Portland, Oregon
January, 1953

REPORT ON THE MANAGEMENT OF THE BEARDSLEY TROUT FISHERY

OF

LAKE CRESCENT, OLYMPIC NATIONAL PARK

Reviewed:

Lewis R. Garlick
Regional Supervisor

Approved:

Paul T. Quick
Acting Regional Director

Submitted by:

Zell E. Parkhurst
Fishery Management Biologist

and

Marvin A. Smith
Fishery Management Biologist

January 1953

ACKNOWLEDGMENTS

The authors are greatly indebted to Dr. Arthur D. Welander, Assistant Professor of Fisheries, School of Fisheries, University of Washington, and his graduate students in ichthyology for their careful taxonomic study of the fish specimens from Lake Crescent and the Quilcene Station.

The independent study by Dr. Robert R. Miller, Associate Curator of Fishes, University of Michigan, using the same specimens, also is greatly appreciated.

Superintendent Fred J. Overly, Chief Ranger Otto Brown, District Ranger William Merril, and other officials of the U.S. Park Service, Olympic National Park, have cooperated fully in our limited study of the Lake Crescent trout populations.

Helpful advice was given by Regional Supervisor Lewis R. Garlick, J. T. Barnaby and H. B. Holmes of the Regional staff of the U.S. Fish and Wildlife Service.

The history of the trout populations of Lake Crescent and early efforts in artificial propagation, stocking and management of the fishery have been adequately recounted in a progress report (unpublished) by L. R. Garlick in the year 1949, copy of which is attached.

This account begins with the start of Beardsley trout spawning operations at Lake Crescent by the Fish and Wildlife Service in 1949. In order to present a complete history of our efforts in the artificial propagation of this trout population, some data on egg collection for the year 1949 are taken from the report by L. R. Garlick.

In an attempt to clarify this complex fishery management problem the data for the years 1949 through 1952, contained in Tables 1 - 4, including lengths, weights, scale analyses, and size of the runs, have been critically examined.

Interpretation of the data derived from fish taken in the spawning trap is difficult and uncertain because the samples are too small, the trap is selective of the larger fish, and the samples, being composed only of sexually mature or maturing fish, are not representative of the entire lake population. However, the data now available must be analyzed so far as possible because if the Beardsley-type trout spawning population continues its present rapid downward trend there will be an insignificant number of fish available in the immediate future. Therefore our interpretation of the available data

is reviewed briefly, subject to the criticism of inadequacy, in order to give some background for the conclusions and recommendations contained in the proposed management plan.

Year 1949

During the egg collection period of March 15 - 21 there were 51,216 eggs taken from eighteen Beardsley trout at the newly rebuilt Lyre River trap at the outlet of Lake Crescent. The eggs weighed 144 per ounce. Only a portion of the fish that were trapped were artificially spawned. In the year 1949 the total run was estimated to be approximately 160 fish, with 50 fish handled in the trap and approximately 30 having escaped through the trap leads. The water temperature at the trap during the spawntaking period was 43.0°F. The average water temperature at the Quilcene Hatchery, where the eggs were incubated, was 44°F. during the same period. After having been spawned the fish were held until the next spawning day in order to allow them to recuperate before being weighed, measured, and released. Scale samples were taken from sixteen females.* The scales on the males were absorbed to such an extent that it was impossible to obtain a sample.

Losses in the hatchery were high among Beardsley-type trout of the 1949 brood, particularly in the eyed egg and fry stages. The eyed egg loss was 16,360 and the fry loss 11,364. Total mortality to the time of liberation was 32,206, or 62.9%. The surviving fish, amounting to 19,010, were liberated in Lake Crescent during the period

*Pp. 11-12, report by L. R. Garlick

of July 20 - 31, 1950. At the time of liberation these fish were 4-inch fingerlings weighing 87 fish per pound. All of the fish were reported to be extremely wild and excitable, difficult to rear, and slow growing.

Year 1950

The egg collection period for the Beardsley-type trout extended from April 11 - 17, inclusive. As in the previous year, it was decided to limit the spawntaking to approximately 50,000 eggs. There were 51,795 eggs taken, of which the first 45,459 were obtained from sixteen fish. On the last day of spawntaking only 6,336 eggs were obtained from five fish. The latter fish did not yield their eggs readily and were not fully spawned. The eggs weighed 144 per ounce and the average production was 2,466 eggs per fish.

The run showed evidence of depletion, thirty fish entering the trap, of which only four were males. However, there was some natural spawning before the trap was in operation and after it was opened. It was estimated that there were ten fish below the trap and that the run amounted to approximately 100 fish, including all that spawned naturally. Spawntaking operations were somewhat retarded by high water conditions, which prevented early closing of the trap leads, and by long continued low water temperatures in the lake, resulting in a late spawning season. During the egg collection period the water temperature was 43° - 44°F. at the trap and 45.5°F. at the hatchery. All of the fish spawned were later measured, weighed, and scale samples taken from the females. The scales on the male fish

were found to have been absorbed and eroded to such an extent that they were unusable for age determination. These data are included in Table 1.

TABLE 1

Beardsley-type Trout, Lyre River Trap, Season of 1950

Date Taken	Sex	Total Length In Inches	Weight In Pounds	Age In Years	Previous Spawning Checks
4-11-50	F	28	9	6	2
4-11-50	F	30	10	6	1
4-11-50	F	31	11½	6	2
4-11-50	F	26	7	5	1
4-11-50	F	31½	11½	6	1
4-11-50	F	28	9	6	1
4-11-50	F	28	8	6	2
4-11-50	F	31½	11½	6	1
4-13-50	F	26½	8½	5	1
4-13-50	F	30	12	5	1
4-13-50	F	29	11½	6	1
4-13-50	F	28½	10½	5	1
4-13-50	F	20	3½	4	0
4-13-50	F	31	12	5	1
4-13-50	F	31½	13	7	1
4-13-50	F	22½	4½	4	0
4-13-50	F	18	2	3	0
4-17-50	F	17	2¼	5	1
4-17-50	F	26 3/4	6½	6	2
4-17-50	F	20 3/4	2½	4	0
4-17-50	F	22	4½	4	0
4-17-50	F	21	3¼	4	0
4-17-50	F	18	2	4	0
	M	28	8½		
	M	27	7½		
	M	27½	7¼		
	M	18	2		

The eggs were treated regularly with malachite green for fungus control during the incubation period, and at first appeared to be in fine condition. However, losses during the eyed egg and fry stages again were

high, and remained abnormally high throughout the rearing period. The total mortality amounted to 30,870, or 59.6%. Of the surviving fish, 18,925 were planted in Lake Crescent on May 29, 1951. At the time of liberation the fish were three-inch fingerlings weighing 144 fish per pound. In addition, 2,000 of the larger fish, four-inch fingerlings, were retained at the Quilcene Hatchery for the possible formation of a future brood stock.

Year 1951

The Lyre River trap at the outlet of Lake Crescent was placed in operation on March 1, and Beardsley eggs were taken at intervals from March 21 - April 12. There were 58,762 eggs taken, weighing 144 per ounce, for an average production of 2,260 eggs per fish. There were 26 Beardsley-type females and 11 males used for artificial propagation. Of the fish trapped, six females escaped from the pen in which they were being held after having been spawned, and before they could be measured, weighed, and scale samples taken. This occurred because it was not deemed advisable to subject the fish to the additional handling required to obtain these data immediately after spawning, but to allow the fish a recuperative period. The data collected are shown in Table 2. Legible scales were not obtainable from the male fish because of absorption.

There was a further decline in magnitude of the spawning run, a close estimate being 51 fish, of which 37 were trapped and spawned, and seven were observed above and seven below the trap. During the egg collection period the water temperature ranged from 42° to 45°F. at the hatchery.

TABLE 2

Beardsley-type Trout, Lyre River Trap, Season of 1951

Date Taken	Sex	Total Length In Inches	Weight In Pounds	Age In Years	Previous Spawning Checks
3-21-51	F	31½	11½	6	2
3-21-51	F	29	8½	5	1
4- 9-51	F	21	2 3/4	4	0
4-12-51	F	25	6½	5	0
4-12-51	F	20½	3½	4	0
4- 9-51	F	22	5	4	1
4- 9-51*	F	22	5	4	0
3-21-51**	F	28½	7¼	6	1
	F	27	9	Regenerated Scales	
4-12-51	F	28	8½	5	1
4-12-51	F	22	4¼	5	1
4-12-51	F	18½	2¼	4	0
4- 9-51	F	26	7	5	1
4- 4-51	F	24	6	4	0
3-21-51	F	29	9¼	6	1
4-4-51***	F	26	8¼	6	0
4-12-51	F	24	6	5	1
4-12-51	F	24½	5¼	4	0
4- 9-51	F	20	3	4	0
4- 9-51	F	26	6 3/4	5	0
	M	25½	7		
	M	28	7½		
	M	25	5 3/4		
	M	26½	6 3/8		
	M	26	8½		
	M	16½	3 3/4		
	M	27	6		
	M	25	8½		
	M	25	6		
	M	26	5 3/4		
	M	24	6 5/8		

Photographs of selected scales from three Beardsley-type trout artificially spawned in 1951 are shown in Figures I, II, and III.

As in previous years, losses at the hatchery were high, particularly during the eyed-egg and fry stages. Moreover, the mortality

* Figure I
** Figure II
*** Figure III

also was high in the advanced fingerling stages, aggravated by a heavy infestation of Octomitus salmonis. The total loss to the time of liberation was 45,450, or 77.4%. Of the surviving fish, 9,812 were planted in Lake Crescent on April 17, 1952. At the time of liberation the fish were 3-inch fingerlings weighing 165 fish per pound. In addition, there were 3,500 of the same size fish retained at the hatchery for the possible formation of a future brood stock. It again was reported by the superintendent at Quilcene that the fish were difficult to rear and that development was slow.

FIGURE I

Scale taken from Beardsley-type trout.
Spawned April 9, 1951.
Four years old; no previous spawning checks.
Magnification - 14.5 X

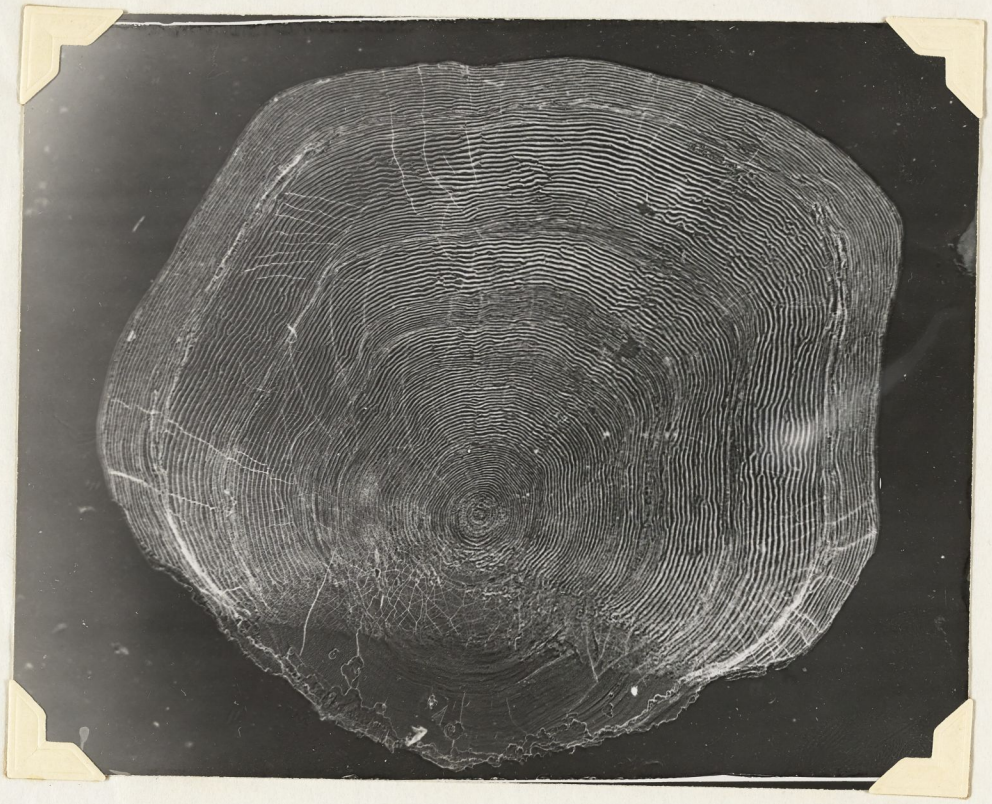


FIGURE II

Scale taken from Beardsley-type trout.
Spawned March 21, 1951.
Six years old; previous spawning check
at five years of age.
Magnification - 14.5 X

FIGURE III

Scale taken from Beardsley-type trout.
Spawned April 4, 1951.
Six years old; no distinct previous spawning check.
Magnification - 14.5 X

Year 1952

This year eggs were taken at the Lyre River trap at the outlet of Lake Crescent during the period from March 7 - April 8. There were 35,638 eggs taken for an average production of 2,970 eggs per fish. There were twelve female and six male Beardsley-type trout used for artificial propagation. Two of the males were killed on April 8, one being sent to Dr. George S. Myers at Stanford University and the other to Dr. Arthur Welander at the University of Washington.

The fish were weighed, measured, and scale samples taken from the females after spawning. The data collected are shown in Table 3.

During the egg collection period the water temperature ranged from 42° to 43°F. at the trap and from 43° to 45°F. at the hatchery.

TABLE 3

Beardsley-type Trout, Lyre River Trap, Season of 1952

Date Taken	Sex	Total Length In Inches	Weight In Pounds	Age In Years	Previous Spawning Checks
3- 7-52	F	28¼	8	6	1
3- 7-52	F	27½	7½	6	1
3-13-52	F	26½	7	6	1
3-13-52	F	29	10	6	1
3-25-52	F	26¼	6½	6	2
3-25-52	F	27¼	8	6	1
3-25-52	F	27½	6¼	6	3
3-25-52	F	23½	4¼	5	2
3-31-52	F	21	3½	5	1
3-31-52	F	22	3¼	4	0
3-31-52	F	20¼	2 3/4	4	0
4-8 -52	F	26½	7¼	6	2
	M	30	9 3/4		
	M	20½	3		
	M	26¼	6¼		
	M	28½	7½		

A considerable degree of variation in the age-length and age-weight relationships is apparent in the data included in Table 3 and also in the data for previous years. This may be caused by the number of previous spawnings and also by the extent of hybridization with cutthroat-type trout.

The total run in the year 1952 was closely estimated at 36 fish. A point of great concern is that the estimated number of fish in the spawning run has decreased each year. This is shown in Table 4.

TABLE 4

Runs of Beardsley-type Trout, Lyre River Trap

Year	Number Used for Artificial Propagation			Estimated Number In Total Run
	Male	Female	Total	
1949	13	18	31	160
1950	4	21	25	100
1951	11	26	37	51
1952	6	12	18	36

From the accounts of local residents and officials of the U. S. Park Service it was learned that a condition of gradual depletion has occurred for a number of years prior to the start of the trapping and artificial propagation program in 1949.

It was considered advisable to allow part of the run to spawn naturally, and no attempt was made to trap all of the fish. During the 1952 spawning season several holes were cut in the trap leads by beavers, thus allowing a number of fish to pass downstream below the trap. However, the natural spawning area of the Beardsley-type trout is located just below the trap, and the fish were observed spawning in this area.

In addition to the Beardsley-type trout there were a number of cutthroat-type trout taken in the trap that were presumed to be Salmo clarkii crescentis. These fish are smaller than the Beardsley-type and so different in appearance that it is impossible to become confused in recognizing the adult form. The marked differences in size and external appearance of the two types of fish are shown in the color photographs (Figures IV and V).

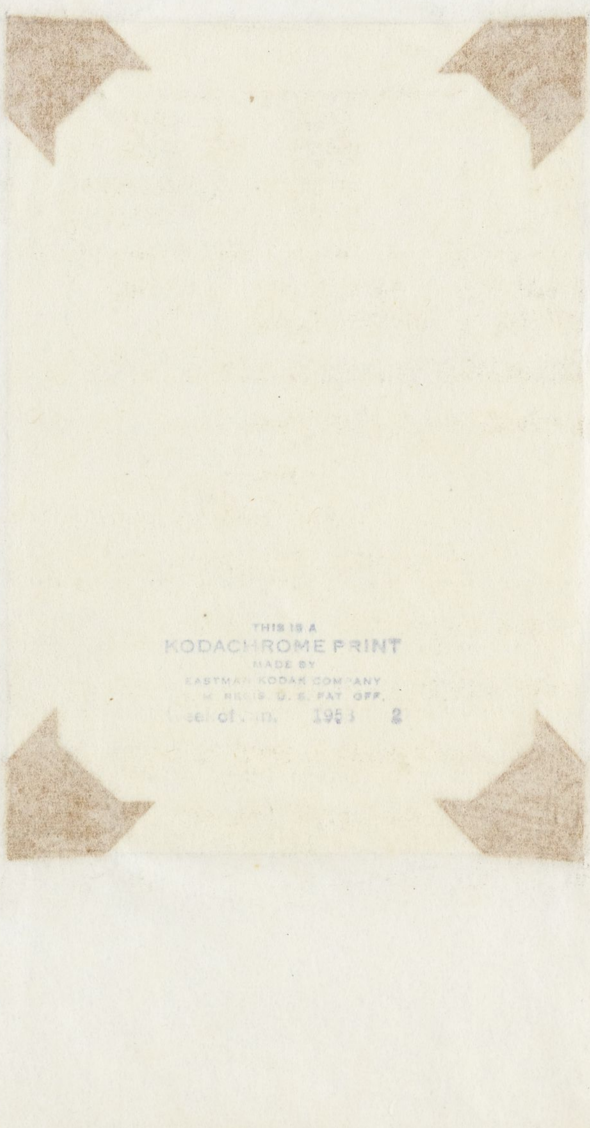
FIGURE IV

Upper - S.c. crescentis
Lower - S.g. beardsleei

FIGURE V

S.c. crescentis

Several male cutthroat-type fish were observed on the spawning ground below the trap attempting to spawn with the female Beardsley-type trout. Since the male crescentis or cutthroat-type fish seem to be more pugnacious than the male Beardsley-type, despite his smaller size, we do not doubt that in many instances he is successful in breeding with the latter fish. The question then arises as to what extent hybridization has occurred in nature, and whether the present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stocks of both the so-called Salmo gairdnerii beardsleei and Salmo clarkii crescentis conform with the paratypes. Our own superficial examinations lead us to believe that hybridization is general throughout the so-called Beardsley stock. Table 5 gives size and age data for several specimens of the cutthroat-type fish taken in 1952 from the trap and the Lake Crescent sport fishery.

TABLE 5

Cutthroat-type Trout, Lake Crescent and Lyre River Trap, Season of 1952

Date Taken	Place Taken	Sex	Total Length In Inches	Weight In Pounds	Age In Years	Previous Spawning Checks
April 1952	Lake Crescent	Unknown	20.0	2.8	5	2
April 20, 1952	Lake Crescent	Unknown	23.0	3.4	6	2
March 7, 1952	Lyre R. Trap	Male	22.5	3.5	6	2
March 13,1952	Lyre R. Trap	Male	19.5	2.4	4	1

In the period from March 7 - April 8, 1952, four cutthroat-type trout, locally called "Crescenti" trout, were taken from the trap, killed, preserved, and sent to Dr. A. D. Welander at the University of Washington for taxonomic study. One male and one ripe female cutthroat-type trout were released above the trap, and several more escaped through the pickets. None of the cutthroat-type trout were used for artificial propagation. The trap was constructed to hold the Beardsley-type trout, and the smaller cutthroat often are able to escape through the pickets. A study by Dr. Welander and his students on the taxonomy of the cutthroat-type specimens delivered to him is included in Tables 6 - 10 under specimen numbers 7927, 7928, 7929, and 7930. Dr. Welander's account verifies our identification of these fish as cutthroat-type,

and also points to various meristic characters indicating hybridization, clearly showing the difficulties encountered in classification. Ordinarily, when indigenous stocks of cutthroat and rainbow trout are found in the same waters they do not interbreed. However, the history of Lake Crescent shows the introduction of several different races of cutthroat, rainbow, and steelhead trout.* Even the Montana black-spotted trout (Salmo clarkii lewisi) has been planted in the lake. Any one or several of these introduced subspecies or races may have caused the present difficulties.

In the spring of 1952 it was observed by Mr. E. N. Hunter of the Quilcene Station staff that the 1950 brood Beardsley trout showed great variation in external appearance. There were only 1,587 of these fish remaining at the hatchery, and it was planned to hold them as a possible source of Beardsley brood stock. We examined and sorted these fish on a basis of external appearance and found 251 or 16.4% with typical cutthroat characteristics. The external cutthroat characters used were the heavy spotting, red slash on the dentary, and long maxillary. These cutthroat-type fish were then held separately from the remainder of the lot. In addition to these easily recognizable cutthroat-type fish there was a greater number of fish of questionable appearance exhibiting both cutthroat and rainbow characteristics. These were allowed to remain in the so-called Beardsley stock. There was also, of course, a large group that possessed all of the rainbow-type characters. Samples of all three groups were taken to Dr. A. D. Welander at the School of Fisheries, University of Washington, for a careful study of the

*Pp. 6-7, report by L. R. Garlick

taxonomic characters. As expected from our superficial examination, the samples indicated interbreeding between various subspecies of rainbow and cutthroat trout. This conclusion was further substantiated by an independent study of the same specimens by Dr. Robert R. Miller, Associate Curator of Fishes, University of Michigan. These fish are now labelled as collection numbers 7922, 7923, and 7924, and their taxonomy is outlined in Tables 6 - 10 which were kindly prepared by Dr. Welander, and together with a letter and summary explaining the technique employed and a summary of the results of his laboratory work are presented following page 18 of this report.

It should be pointed out that the parents of these fish were all the typical Beardsley-type trout now inhabiting Lake Crescent. However, some of the parent stock apparently included hybrids that could not be recognised from external characters.

A typical adult Beardsley-type fish, an excess male taken from the Lyre River spawning trap in March 1952 and labelled number 7926 in the University of Washington collection, is described by Dr. Welander as follows: "A long-headed and long-jawed form, but lacks the other cutthroat characteristics. It seems to fit best into the original descriptions of S.g. beardsleei by virtue of the head ratio and coarseness of scales."

The eggs from each female Beardsley-type trout were kept separate in the 1952 brood spawntaking operation with the hope that some information might be gained on the relative degree of fertility of the individual fish. The losses proved to be general throughout

the eggs from each of the twelve females. However, the question arises as to the breeding of the males that were used in the spawntaking. It is quite possible that males with some degree of hybridization in their ancestry may have been used, thus further reducing the chance of obtaining a pure strain of Beardsley trout for brood stock purposes.

A number of cutthroat-type fish are found on the Beardsley spawning grounds in the Lyre River at the outlet of Lake Crescent. These fish do not fit the description of S.c. crescentis, but exhibit varying degrees of hybridization with other cutthroat and rainbow subspecies. However, the principal cutthroat spawning area is in Barnes Creek, the principal tributary to the lake. No attempt has been made in recent years to trap fish in Barnes Creek. The dams that formerly obstructed the lower two miles of the stream now have been washed out or removed. It was considered that possibly this stream might provide a source of native cutthroat (S.c. crescentis), in which case the stock might be increased by artificial propagation. However, a recent sample taken by the use of an electric shocker in the stream indicates that this fish population also has been extensively hybridized.

COPY

UNIVERSITY OF WASHINGTON
School of Fisheries
Seattle 5, Washington

July 18,1952

Dear Mr. Parkhurst:

The following is a brief history of the systematics of the Crescent Lake complex summarized from our work on the trout of that lake. It includes the combined thoughts and data gathered by George Allen, Edgar Best, Francis Fukuhara, Robert Simon, Richard Takahashi, Warren Ward, George Warner (all my students) and myself. I am including the original data that we gathered from the specimens received from you, some specimens obtained from the fish collection, and the data from the literature.

The systematic history of the lake began in 1896 with Jordan and Evermann describing Salmo gairdneri beardsleei and Salmo gairdneri crescentis. In 1899 Meek described Salmo bathoecetor. Schultz (1936) collected fish in 1930 (about the time the first plants of other species and subspecies of trout were made in the lake) and referred S. g. crescentis to the cutthroat group S. clarkii crescentis. We believe we have one of the specimens he used in this analysis and it is definitely a cutthroat trout.

The specimens were analysed by various people and combined in the following data. Standard techniques were used throughout except in dorsal and anal fin ray counts. In these cases we tried to count all the rays, designating the simple soft rays with small roman numerals and the branched rays with arabic numerals. The last fin rays, if they converged at the base, were counted as one and one-half rays.

There are a number of possible discrepancies, in addition to the personal errors, in comparing this data with data from the literature. For example, in counting scales along the lateral line there are usually more scale rows in the length of the fish above or below the lateral line than in the lateral line itself. Often the method of counting is not described or is so vague as to be at least irritating.

Results from these small samples are, of course, inadequate. As a matter of fact, much if not all the problem hinges on the comparisons of these specimens from Crescent Lake today with the types and paratypes taken 53 or more years ago. The original descriptions are not adequate to differentiate these specimens. Furthermore, if the analysis hinges on the number of meristic characters some determination must be made of the differences, if any, of these counts in fish raised in the hatchery and fish raised naturally in the environs of Crescent Lake.

Sincerely,

A. D. Welander
Assistant Professor

ADW:jp
Enclosure

C O P Y

SUMMARY

Crescent Lake Complex

The first fish we received 7927 and which we called Salmo clarkii crescentis was obviously a cutthroat trout and different from the rest of the large fish collected later, being more finely scaled. It has both a red streak on the dentary and hyoid teeth. Its head ratio, .250, coincides exactly with the descriptions of S. c. clarkii or lewisi.

Fish number 7928 appears to be similar to the Puget Sound race of cutthroat trout as defined by Schultz (1936) as having fewer scales above and below the lateral line, i.e., 26-29 above and 27-28 below, and 120 to 135 scales in the lateral line.

Number 7926 is a long-headed and long-jawed form, but lacks the other cutthroat characteristics. It seems to fit best into the original descriptions of S. g. beardsleei by virtue of the head ratio and coarseness of scales.

Number 7930, similarly, falls within this possibility, but possesses hyoid teeth and the dentary character, and seems quite definitely to be a cutthroat type. There is a possibility of a cross between S. g. beardsleei and S. c. clarkii here.

Number 7929 is a short-headed trout with the low scale count of Puget Sound race of S. c. clarkii. Hyoid teeth are present in this specimen. The length of the head corresponds with that of S. g. kamloops.

Lots number 7922, 7923, and 7924, divided principally on the basis of color at the hatchery from the same brood stock, appear to indicate interbreeding of cutthroat and rainbow trout. The scale counts along the lateral line fall within the Puget Sound race of cutthroat trout, with No. 7923 having the highest count. The scales above and below the lateral line indicate a rainbow parent in most. The cutthroat mark in six of the specimens 7922 indicates a cutthroat characteristic but the hyoid teeth were not discernible except perhaps as small, blunt protuberances. This does not denote their absence, for, as Miller (1950) notes, hyoid teeth can often be determined only after extremely careful dissection, being easily scraped off in small specimens. Similarly, there was no evidence of hyoid teeth in the remainder of the lots. Scale counts and body proportions are inconclusive, but seem to indicate crosses between various subspecies of gairdneri and clarkii.

COPY

TABLE 6 - A DESCRIPTION OF THE GROUPS OF FISH AS EXAMINED IN FISHERIES 403 LABORATORY PROBLEM CONCERNING THE SALMONOID FISHES OF LAKE CRESCENT, WASHINGTON

U. of Washington Fisheries School Collection No.	Number of Specimens	Scientific name as listed for specimen by original collector	Available information as to locality and lineage of specimens
7920	12	Salmo gairdneri gairdneri(?)	Sample from fish at Quilcene Fish Hatchery, stock originally from Williams Lake, Idaho
7920	13	Salmo gairdneri gairdneri	Quilcene Hatchery stock that originated from Manchester, Iowa
7922	6	Salmo gairdneri beardsleei(?)	"Cutthroat type". Selected from progeny of fish from Crescent Lake
7923	6	" " " "	"Beardsley type". "
7924	6	" " " "	"true " " "
7926	1	" " " "	Taken from spawning rack in Lake Crescent
7927	1	Salmo gairdneri crescentis "	"
7928	1	" " "	"
7929	1	" " "	"
7930	1	" " "	"

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TABLE 7 - DATA AS OBTAINED BY STUDENTS IN FISHERIES 403 LABORATORY ON THE SPECIMENS OF RAINBOW AND CUTTHROAT TROUT UNDER CONSIDERATION

Catalogue number	Stand. lg. mm.	Head lg. mm.	Length upper jaw mm.	Scales in lat. line	Scale rows above l. l.	Scale rows below l. l.	No. dor. rays	No. anal rays	Hyoid teeth	Red dash on dentary
7920	68	18	8.5	129	29	26	i,10.5	i,10.5	0	--
	67	17	6.5	130	27	24	ii,9	i,11	0	--
	63	17	7.5	127	25	25	ii,9.5	ii,9	0	--
	68.5	16	7.5	124	27	24	ii,9	ii,9.5	0	--
	65	18	8.5	131	28	24	i,10	ii,9	0	--
	52	15	6.5	130	27	27	ii,9	i,10	0	--
	56	17.5	8	124	25	25	ii,9	i,9	0	--
	50	15	7	126	26	24	ii,9	ii,9.5	0	--
	70	18	8	121	24	26	*iii,9.5	*iii,10.5	0	--
	60	15	6	130	26	24	*iii,10.5	*iii,9.5	0	--
	57	12	4	131	21	23	*iii,10.5	*iii,10.5	0	--
	49	13.5	6	126	21	25	*iii,10.5	*iii,10.5	0	--
			av.	127.4	25.5	24.8	9.8	9.9		
7921	130	32	15	133	29	25	iii,10.5	iii,10.5	0	--
	142	32	16	128	27	27	iii,9.5	iii,10.5	0	--
	121	31	15	127	26	23	iii,9.5	iii,10.5	0	--
	129	29	14	125	27	26	iii,10.5	iii,9.5	0	--
	122	31	15	130	24	25	iii,11.5	iii,10.5	0	--
	135	32	15	132	24	25	iv.8.5	iv.8.5	0	--
	102	26	13	128	25	25	iii,10.5	iii,9.5	0	--
	95	25	12	128	24	24	iii,10.5	iii,10.5	0	--
	86	23	12	126	25	20	iii,9.5	iii,10.5	0	--
	111	29	14	137	25	28	iii,10.5	iii,8.5	0	--
	121	33	15	126	25	27	iii,8.5	vi,7.5	0	--
	119	27	13	134	23	20	iii,10.5	ii,10	0	--
	114	28	14	117	23	23	iii,10.5	iii,9.5	0	--
			av.	128.5	25.2	24.5	10.8	9.6		

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TABLE 7 - cont.

7922	181	45	25	119	21	23	ii,8.5	ii,8.5	0	#
	166	32	17	124	22	21	ii,9	ii,9	0	#
	194	47	26	128	22	22	iii,8	ii,9	0	#
	178	46	26	114	22	20	iii,8	ii,8.5	0	#
	152	31	16	118	21	22	iii,8	iii,9.5	0	#
	167	45	26	115	21	20	ii,9	iii,8.5	0	#
			av.	120.3	21.5	21.3	8.4	8.8		
7923	177	43	22	125	28	27	ii,9	ii,9.5	0	-
	164	39	21	121	28	27	ii,9	ii,9	0	-
	203	47	26	133	27	26	ii,8.5	i,10	0	-
	177	44	24	131	27	24	ii,9	ii,9	0	-
	161	38	20	126	26	27	i,10	i,10	0	-
	171	42.5	22.5	125	26	27	i,11	ii,9	0	-
			av.	126.2	27	26.3	9.4	9.4		
7924	188	42	21	127	25	(367)	*iii,9.5	*iii,9.5	3	-
	164	40	19	118	22	23	*iii,10.5	*iii,10.5	0	-
	174	41	20	123	22	22	*iii,10.5	*iii,10.5	0	-
	164	40	19	121	22	23	*iii,10.5	*iii,10.5	0	-
	179	40	18	124	24	21	*iii,10.5	*iii,10.5	0	-
	179	44	20	120	21	19	*iii,10.5	*iii,10.5	0	-
			av.	122.1	22.7	21.6	10.5	10.5		
7926	500	147	80	130	22	24	ii,9	i,10	0	-
7927	431	108	67	154	33	38	ii,9	i,9	6	#
7928	445	115	66	127	32	31	iii,9.5	ii,8.5	3 or 4	#
7929	427	102	58	124	32	35	*iii,9.5	ii,9.5	3	#
7930	495	137	68	124	Undeter.	Undeter.	iii,8.5	ii,9.5	2	#

*The first simple ray was only assumed to be present according to statement made by student making these counts.

(367) This count was omitted in calculating the average for group 7924 for scale rows below 1. 1.

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TABLE 8 - DATA OBTAINED FOR THE VARIOUS SPECIMENS AS DERIVED FROM THE MEASUREMENTS LISTED IN TABLE 7

Catalogue Number	Head Length / stand. lg.	Upper Jaw Lg. / Head lg.
7920	.265	.472
	.298	.500
	.321	.441
	.273	.469
	.277	.472
	.288	.433
	.313	.457
	.300	.467
	.257	.444
	.250	.400
	.211	.333
	.276	.444
X =	.277	.444
7921	.246	.469
	.225	.500
	.256	.484
	.225	.483
	.254	.484
	.237	.469
	.255	.500
	.263	.480
	.267	.523
	.261	.483
	.273	.455
	.227	.481
	.246	.500
	.249	.486

Catalogue No.	Head Length / stand. lg.	Upper Jaw Lg. / Head lg.
7922	.249	.556
	.193	.531
	.242	.553
	.258	.565
	.204	.516
	.241	.577
	.238	.563
7923	.243	.512
	.238	.538
	.232	.553
	.249	.545
	.236	.526
	.249	.529
	.241	.534
7924	.223	.500
	.244	.475
	.236	.488
	.244	.475
	.223	.450
	.246	.454
	.236	.474
7926	.294	.605
7927	.250	.620
7928	.239	.549
7929	.239	.549
7930	.277	.642

COPY

TABLE 9 - SUMMARY OF THE DATA PRESENTED IN TABLES 7 and 8

Cat. No.	Sample size	Scales in lat. line	Scale rows above l.l.	Scale rows below l.l.	Dorsal rays-br.	Anal rays-br.	Head lg. / St. lg	Up. Jaw Lg. / Head lg.	Hyoid Teeth	Red dash on dent.
7920	12	127.4 (121- 130)	25.5 (21 - 29)	24.8 (23- 27)	9.8 (9 - 10.5)	9.9 (9 - 11)	.277 (.211-.321)	.444 (.333-.500)	0	-
7921	13	128.5 (117 - 137)	25.2 (23 - 29)	24.5 (20 - 28)	10.8 (9.5-11.5)	9.6 (7½-10½)	.249 (.225-.273)	.486 (.455-.500)	0	-
7922	6	120.3 (114 - 126)	21.5 (21 - 22)	21.3 (20 - 23)	8.4 (8.5-9.0)	8.8 (8½-9.5)	.238 (.193-.258)	.563 (.516-.577)	0	#
7923	6	126.2 (121 - 131)	27.0 (26 - 28)	26.3 (24 - 27)	9.4 (8.5-11.0)	9.4 (9.0-10.0)	.241 (.232-.249)	.534 (.512-.563)	0	-
7924	6	122.1 (118 - 127)	22.7 (21 - 25)	21.6 (19 - 23)	10.3 (10.5-9.5)	10.3 (9.5-10.5)	.236 (.223-.246)	.474 (.454-.500)	0	-
7926	1	130	22	24	9	10	.294	.605	0	-
7927	1	154	35	38	9	9	.250	.620	6	#
7928	1	127	32	31	9.5	8.5	.256	.562	3 or 4	#
7929	1	124	32	35	9.5	9.5	.239	.549	3	#
7930	1	124	undeter.	undeter.	8.5	9.5	.277	.642	2	#

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TABLE 10 - COMPARISON OF DATA AS LISTED IN THE LITERATURE

Species	Scales in lat. line	Scales rows above l. l.	Scale rows below l. l.	Dorsal rays branches	Anal rays branched	Head Lg. / Stan. lg.	U. Jaw Lg. / Head lg.	Hyoid teeth	Red Dash on dent.
1. Salmo bathoeceter	150 - 152	?	?	10	11	.286-.264	.602	?	-
2. Salmo gaird. beardsleii	123-137	23-24	20-26	10-12	11-12	.262-.264	.566-.604	0	-
3. Salmo gaird. crescentis	161	32	34	10	11	.264	.604	0	?
4. Salmo clarkii jordani	146	?	?	10	11	.260	.563	?	#
5. S. clarkii clarkii	120 - 200	?	?	8-11	9(10)11	?	?	#	#
6. S. c. clarkii	120 - 180	less than 35	less than 35	9(10)11	9-11	?	.625-.444	#	#
7. S. c. lewisi	156 - 190	32-42	32-42	11	10-11	?	?	#	#
8. S. c. lewisi	156 - 190	32-42	32-42	9(10)11	9-11	?	.625-.444	#	#
9. S. g. gaird.	115 - 159	?	?	11-12	9(10-11)12	?	?	0	-
10. S. g. gaird.	125 - 135 (120-138)	23-30	20-26	10(11-12)13					
11. S. g. irideus	120 - 245	11	11	?	?	?	?	faint mark ?sometimes present	
12. S. gairdneri	115 - 165				8 - 13			0 occasionally developed	
13. S. clarkii	120 - 230				8 - 12			usually # present	

Source of Data: Clemens and Wilby (1949): 6, 9 - Jordan and Evermann (1896): 2,3,4
Meek (1889): 1 (as described in Jordan & Evermann 1896) - Schultz (1936): 6,8, 10
Simon (1946): 7, 11
Welander (1952): 12, 13

CONCLUSIONS

1. The spawning run of so-called Beardsley trout shows continued evidence of declining numbers. We do not believe that restrictions on the type of fishing gear, length of fishing season, or other more stringent regulations would materially increase the yield to the fisherman from this hybrid stock.

2. There is a high degree of hybridization with cutthroat-type fish in the present so-called Beardsley trout population. This hybridization is so general that we have little hope of obtaining a pure strain of Beardsley for a hatchery brood stock.

3. The existing mixed strain of Beardsley trout is extremely difficult to hatch and rear by artificial methods. Efforts at artificial propagation are discouraging because of unusually high losses in egg and fry stages and extremely slow growth of the fingerlings.

RECOMMENDATIONS

1. Discontinue the attempt to establish a Beardsley brood stock at the Quilcene Station, since these fish have been shown to comprise a hybrid stock.

2. Discontinue the trapping and egg collection of the Beardsley-type trout.

3. Establish a program of heavy spring liberations in Lake Crescent of yearling rainbow trout of a good domestic strain. Continue these plantings for several successive years, and maintain periodic checks on abundance and rate of growth. We suggest the exclusive use of a select brood stock at the Winthrop, Washington Station. These fish are an excellent pure rainbow strain developed by the Washington State Game Department, and thrive exceptionally well in Washington waters.

4. Augment stocking of rainbow trout by later planting of kokanee fry (O. nerka kennerlyi) in Lake Crescent for forage fish as conditions may require.

Report of Fishery Investigations

Lake Crescent

Olympic National Park

With Management Recommendations

July, 1949

Lewis R. Carlick
Fishery Management Biologist

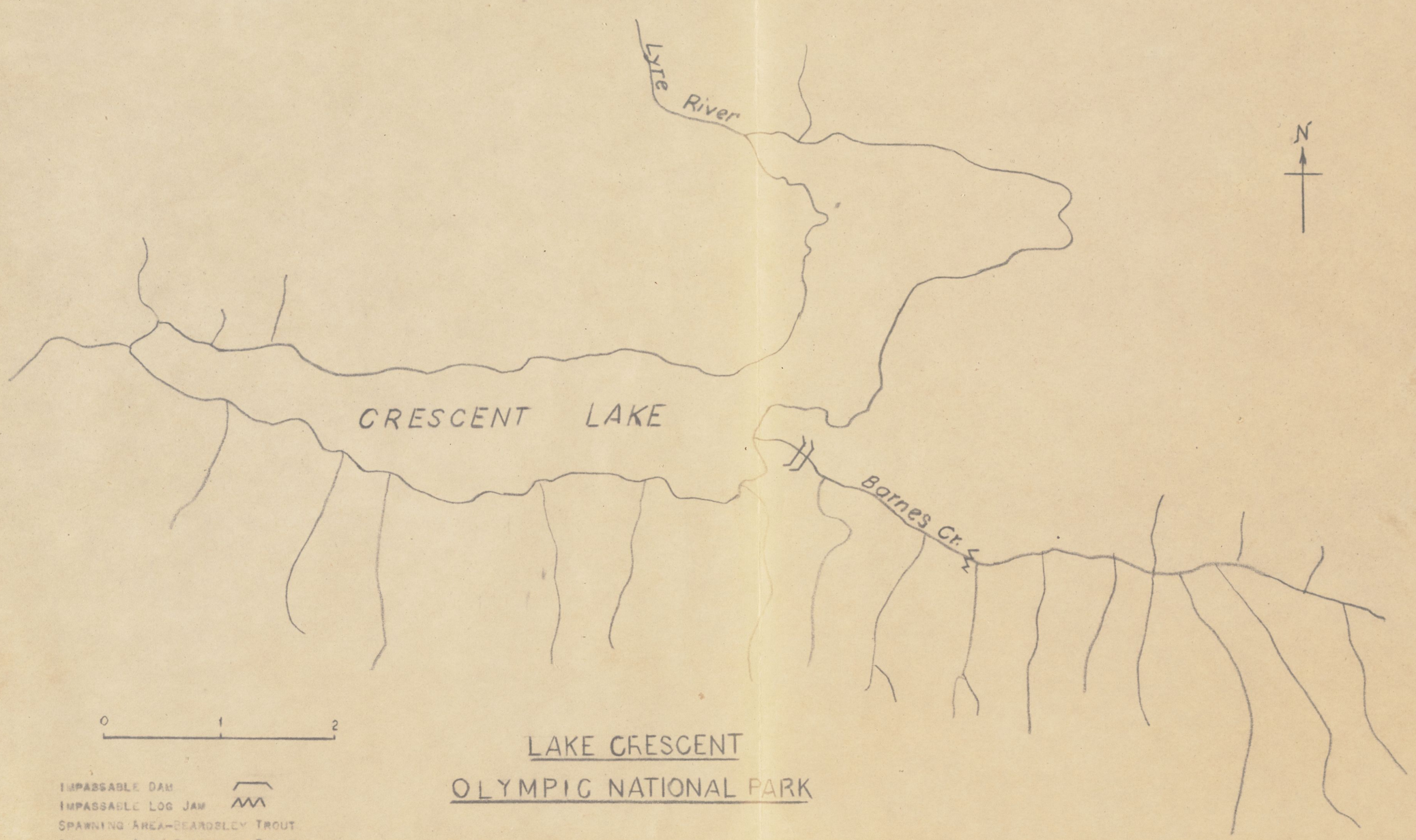
ENCLOSURE

Introduction

Lake Crescent in the Olympic National Park has presented a most difficult fishery management problem for many years. Under County, State, and now Federal control, various management plans have been put forth and followed for brief lengths of time. There appears to have been no consistent program except that in which the State of Washington Department of Game planted silver trout (Oncorhynchus nerka) as a forage fish for the large trout of the lake. There is sound basis for this program if the population of large trout is high. At the present low level, however, the natural production of silver trout is probably adequate.

The general chemical and physical features are well known, having been investigated by George Kemmerer, J. F. Bovard, and W. R. Boorman in 1911, 1912, and 1913 and also by Victor Scheffer in 1935. Biologists from the State Departments of Game and Fisheries have also worked on the lake from time to time.

The usual causes of depletion, including obstruction of spawning streams, over-fishing, and the gaffing of spawning fish, took their toll until by 1935 only a small remnant of the once fine fishing for the giant trout of Lake Crescent remained. The efforts to bring back this lost fishing have been meager and unproductive. The present investigations have been designed to determine what practical steps may be taken to prevent extermination of the fine stocks of native rainbow and cutthroat trout and to increase their numbers so as to provide a fair return to the sportsman's creel.



LAKE CRESCENT

OLYMPIC NATIONAL PARK

General Description and Game Fish Present

Lake Crescent in the Olympic National Park is located on the northern end of the Olympic Peninsula. The length at mid-channel is 9 miles and the average width is approximately 1 mile. The total surface area is 4,700 acres. The surrounding watershed of about 80 square miles is mountainous and heavily wooded. Shoal areas are scarce and confined to three bays comprising about 1 per cent of the total lake area. Bottoms drop off abruptly from the shore to a maximum depth of 574 feet. Aquatic plants are scarce and confined to the ends of small bays. Shore lines are for the most part rocky and wave-swept. The water is exceptionally clear, a Secchi disk being visible at 75 feet.

Numerous tributary streams enter the lake. However, only Barnes Creek has any considerable importance as a spawning stream, the others being small and precipitous. The Lyre River flows north from the lake a distance of about 5 miles to the Strait of Juan de Fuca. Log jams, cascades, and falls prevent sea run fish from entering the lake.

Lake Crescent is considered poor in fish foods. Both plankton and bottom forms suitable for trout are scarce. However, there is no evidence that this lack of food is a limiting factor in the production of game fish at the present low trout population level.

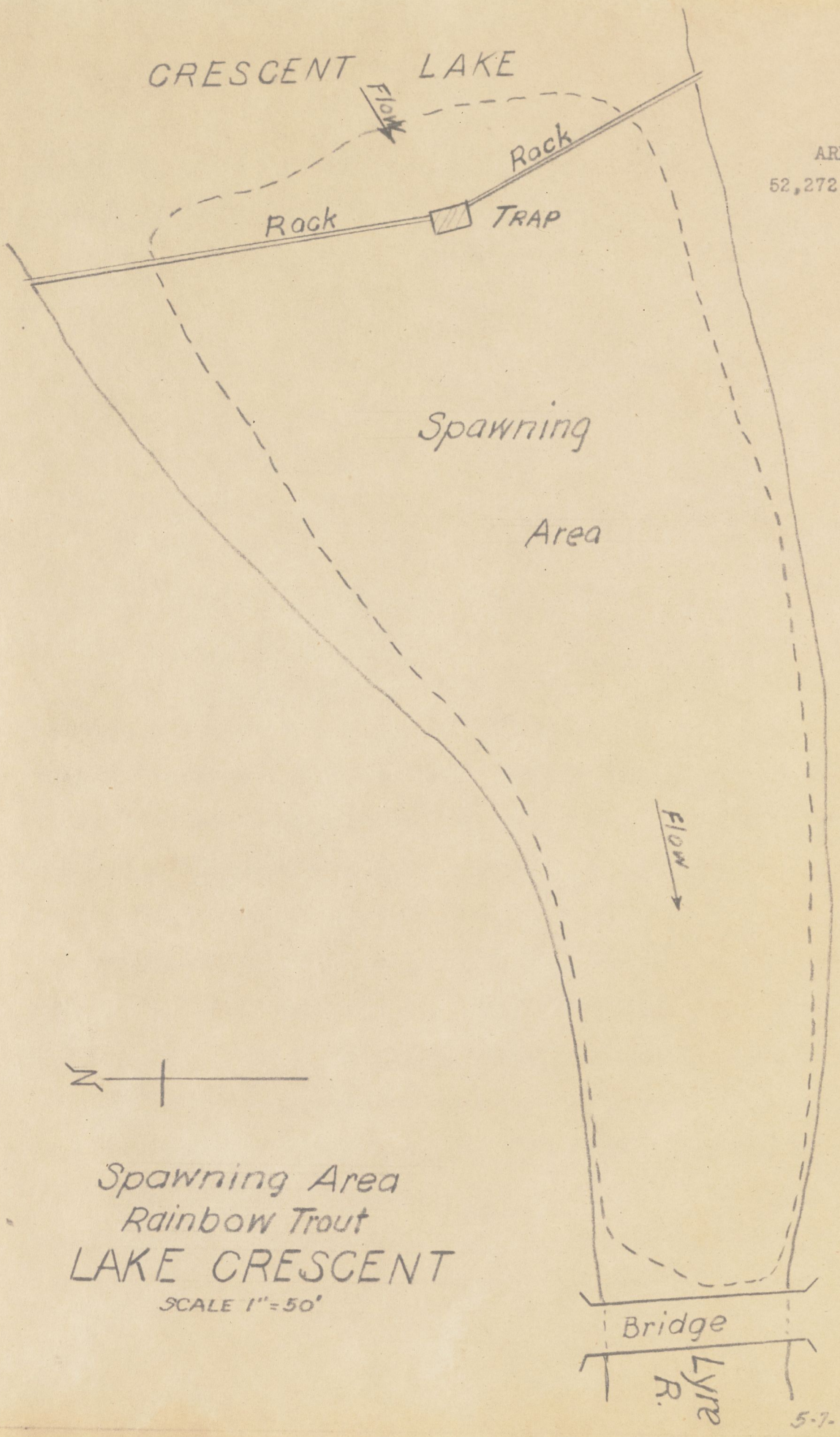
Trout found in Lake Crescent include the following:

1. Rainbow trout - known locally as "Beardsley". When caught by fisherman in the lake, they closely resemble a steelhead, being a bright silver with a steel-blue back. When spawning, the typical coloration of a spawning rainbow or steelhead is assumed. David

Starr Jordan in 1896 named the fish Salmo gairdneri beardsleei. Recent workers have indicated that the "Beardsley" trout cannot be definitely distinguished from the typical steelhead or rainbow trout.

2. Cutthroat trout - known locally as a "Crescenti". This trout when found in the lake is also a silvery color with a dark back and lacks the typical color of the cutthroat. When ascending Barnes Creek in the spawning season, however, the appearance is typical of the coastal cutthroat trout. David Starr Jordan described this trout as Salmo gairdneri Crescentis. Subsequent work has indicated that this trout is a cutthroat and cannot be distinguished from the typical cutthroat of the area.

3. Sockeye salmon - locally called silver trout - is present in considerable numbers and is a most important food item for the large rainbow trout. There is good reason to believe that this fish is native to the lake. Early fishermen reported the presence of a "small salmon" in Lake Crescent. Since the sockeye salmon is the only Pacific salmon known to complete its life cycle in fresh water, it appears that the small salmon referred to was the sockeye. For several years until the National Park assumed jurisdiction of the lake, the State of Washington Department of Game planted silver trout for forage fish. Silver trout spawn along the shore and are apparently maintaining themselves in some numbers in Lake Crescent.



AREA
52,272 Sq. Ft.

Spawning Area
Rainbow Trout
LAKE CRESCENT
SCALE 1" = 50'

5-7-49, 1-27-53

Bullhead (cottidae), whitefish, and a sucker are reported from the lake but the whitefish and sucker are reported as rare.

Spawning Areas

The spawning ground utilized by the rainbow trout is largely confined to a small area in the Lyre River at the outlet of the lake. Spawning rainbows have been reported seen in the lake near the mouths of several small streams and some are said to ascend Barnes Creek. A careful examination of several miles of lake shore at the time rainbows were spawning in the Lyre River failed to locate any evidence of spawning in the lake. Also observations at Barnes Creek at the same time failed to reveal spawning rainbow trout.

The spawning grounds in the Lyre River are confined to an area about 450 feet long at the outlet of the lake just before the river breaks over the lip and starts its precipitous run to salt water. It was noted that no amount of disturbance in this area would cause the trout to move out of this particular area or force them downstream. No spawning of these rainbow trout has been reported below the above described area.

The available spawning area was surveyed by the use of an aladade and plane table and through the use of a polar planimeter the area of the spawning ground was obtained. This area comprises approximately 52,272 square feet. The spawning area requirements of these trout is about 30 square feet per pair of spawning fish. On this basis then 1,749 pairs of fish could be accommodated. It is recognized that all of the area is not equally desirable for spawning fish and that with that many fish present some re-use with

resulting loss of some eggs would occur. At least it may be said that the present low numbers of spawning fish do not near utilize the available area.

Barnes Creek provides the principal spawning ground for cutthroat trout. This creek is a swiftly flowing stream with an estimated flow varying from 12 c.f.s. in mid-summer to 70 c.f.s. in January. The lower 2 miles provide good spawning conditions. Above 2 miles the stream becomes more precipitous and presents less desirable spawning conditions.

The use of Barnes Creek for spawning is now limited to approximately ½ miles from the mouth to a series of three water supply dams. The first dam encountered by spawning trout is about 8 feet high. A fish ladder is present but the design and construction is so poor as to cause this dam to be almost a complete block to spawning fish. A few hundred feet above are two other dams, neither equipped with fish ladders. The lower of these two dams is in bad repair and fish could get through without difficulty. However, the upper dam is a complete block to upstream migration.

Approximately 2 miles above the mouth of the stream a log jam about 12 feet high filled behind with gravel presents another barrier to migrating fish.

The presence of the dams and log jam is without a doubt one of the most important limiting factors in the production of cutthroat trout in Lake Crescent. It has been demonstrated many times that the natural production of trout is impossible without adequate spawning and rearing area. As was pointed out, Barnes Creek is the only spawning stream of importance tributary to Lake Crescent. Every effort must be made to remove all barriers to

migration if Lake Crescent is to produce to its maximum capacity. Another consideration which makes it vital that the barriers be removed is that the creek is subject to flooding with possible washing out of spawning beds while the eggs are in the gravel. It then becomes desirable to spread the spawning over the entire stream, thereby minimizing losses that may occur from local scouring.

Past Plantings in Lake Crescent

From the State of Washington Department of Game the following record of plantings in Lake Crescent was obtained.

Year	Species	Number	Size
1933	Cutthroat	26,000	-
1933	Rainbow	36,768	-
1934	Rainbow	140,229	1½ - 2
1935	Silver trout	200,000	1
1935	Crescenti	16,397	4½ - 6
1936	Crescenti	4,680	2½
1936	Montana black spot	15,022	2
1936	Silver trout	200,000	1
1936	Rainbow	10,000	2
1937	Rainbow	20,065	2
1937	Silver trout	125,000	1
1937	Rainbow	26,415	1½

Past Plantings (Continued)

Year	Species	Numbers	Size
1937	Steelhead	16,000	2½
1937	Steelhead	10,000	3½
1937	Steelhead	7,335	3½
1938	Silver trout	400,000	1
1938	Eastern brook	11,800	2
1939	Silver trout	355,239	1
1941	Crescenti	17,990	2½

From a study of the above table, it is evident that heavy plantings of rainbow and steelhead in the years of 1934 and 1937 may have resulted in a considerable contamination of the original rainbow stock. Whether or not this is the case will probably never be determined. Schultz and Hansen in 1935 stated that the Beardsley and Crescenti trout appear to be local varieties of rainbow and cutthroat, respectively, and cannot be definitely separated from the typical steelhead or rainbow and cutthroat trout. Subsequent plantings may have obliterated any distinguishing characters of the original stock overlooked by investigators prior to 1934. From the standpoint of fishery management, the taxonomy of the trout of Lake Crescent is relatively unimportant. The basic consideration is that we have local strains of cutthroat and rainbow trout which should be preserved and managed for maximum return to the fisherman.

The last planting of silver trout was in 1939. Since the life cycle of this fish is four years, the silver trout present are the result of natural propagation. The examination of stomach contents has shown that silver trout are a most important part of the diet of the large trout of the lake.

Trap and Spawn-taking Operations

Prior to 1941 the State of Washington Department of Game operated a hatchery on Lake Crescent at Barnes Creek. When jurisdiction of Lake Crescent was assumed by the Olympic National Park, the hatchery was closed. Low water temperatures also made it inadvisable to continue operations. Under State operation a trap on Barnes Creek was installed to take cutthroat trout eggs and a downstream trap in the Lyre River at the lake outlet was utilized for the taking of rainbow eggs. Nothing now remains of the Barnes Creek trap. The trap on the Lyre River was repaired and put in operation in March, 1949. On March 14 approximately 4,000 rainbow eggs were taken. On March 17 and again on March 21 eggs were taken. The total take was 51,215. In view of uncertainty as to how the eggs and resulting fish would handle in the hatchery, it was agreed that only this number of eggs would be taken and the trap was opened to allow the natural spawning of the balance of the run. The water temperature at the time of spawning was 45° F.

Character and Magnitude of the Spawning Run in the Lyre River

The trapping operation on the Lyre River provided an opportunity to gather limited data on the rainbow of Lake Crescent. In view of the small

number of fish in the spawning run, it was felt desirable to hold handling to a minimum to prevent losses. Therefore, only as much data were obtained as would not endanger the fish.

Total lengths and weights were obtained from 23 females and 13 males. Scales samples were taken from 16 females.

Table of Lengths and Weights, Rainbow Trout, Lyre River Trap

Sex	Length in Inches	Wt. in Pounds	Sex	Length in Inches	Wt. in Pounds	Sex	Length in Inches	Wt. in Pounds
F	17	1-3/4	F	29½	6½	M	22½	3-3/4
F	22-3/4	4-7/8	F	29½	11¼	M	24	5
F	23	5	F	29½	9¼	M	24½	6
F	24¼	5¼	F	29½	10½	M	25¼	5½
F	26-5/8	6¼	F	30	10-7/8	M	25¼	6
F	27	7-3/4	F	30	11-3/4	M	25½	6
F	27-3/4	7½	F	30	11-7/8	M	26½	6-3/4
F	28	8½	F	30-3/4	10¼	M	26½	6-3/4
F	28¼	9½	F	30-3/4	11¼	M	27	7¼
F	28½	9¼	F	31	11½	M	28¼	10
F	28½	10¼	F	31	12	M	28-3/4	8-3/4
F	29	10½	M	22¼	3¼	M	29	9-3/4

The speed necessary in taking the above weights and measurements as well as the crude equipment available makes it advisable to regard these data as

approximations. In order to avoid injuring the eggs by the violent struggles of the fish, it was necessary to weigh and measure the females after the eggs were taken. Compensation was then made for the weight of the eggs removed. It is felt that the weights are accurate within ½ pound and lengths within ½ inch.

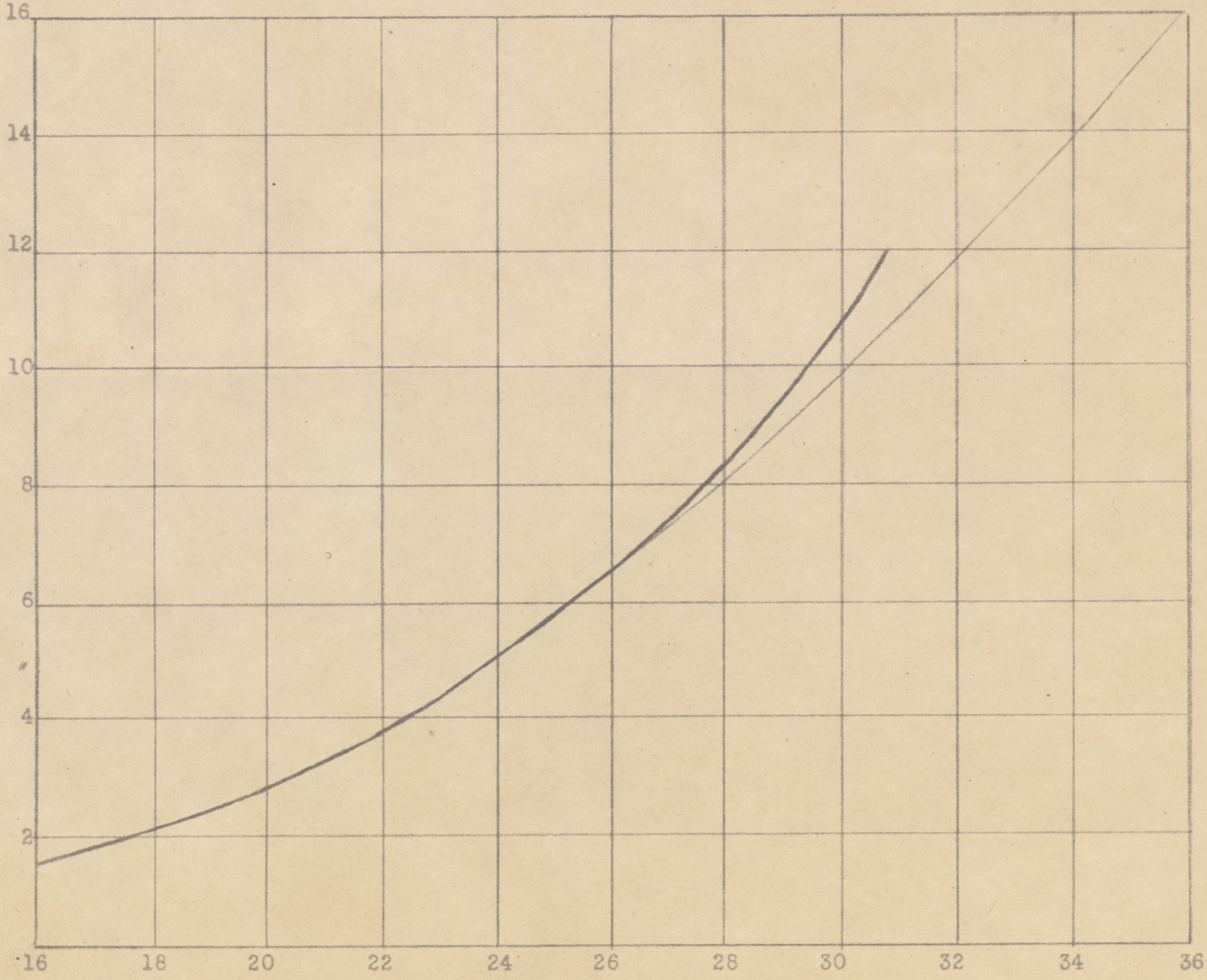
From the table of lengths and weights the following averages were obtained:

	Average Length in Inches	Average Weight in Pounds
Females	27.89	6.95
Males	25.77	6.52

In the spawning operations 18 females were spawned in obtaining the total of 51,216 eggs, making an average of 2,845 eggs per female. The sexes were represented in the trapping operations in about equal numbers.

The general appearance and size of these fish was very much like spawning steelhead. Studies on the coastal steelhead in the Green River in Washington State indicated that the average spawning steelhead was 27½ inches long, weighed 7½ pounds, and produced 5,000 eggs per female. The Lake Crescent rainbow averages 26.85 inches in length, 7.72 pounds in weight at spawning time, and produces 2,845 eggs per female.

From the accompanying graph, it can be seen that the Lake Crescent rainbow and the Green River steelhead are almost identical in length and weight until about 27 inches. Over this length, they weigh more than steelhead of comparable size.



Length and weight curves of Green River steelhead (light line) and Lake Crescent rainbow trout (heavy line).

Steelhead data from Meigs and Pautzke (1941).

From information available, it appears that the number of fish in the spawning run is decreasing each year. At the time the trap was placed in operation, a number of trout were already on the spawning beds below the trap. A few more evidently made their way around or under the netting of the trap leads. It was estimated that the total number below the trap was 30. This number, with 50 handled in the trap, makes 80 fish present. It is probable that half of the run was observed. This makes a total of 160 fish in the run. All accounts of the number of fish on the spawning beds in previous years indicate that a much heavier population of spawning fish formerly was present.

Scales were taken from 16 female rainbow trout in the Lyre River trap. The spawning condition of the males made it impossible to obtain scales without removing pieces of skin with resulting injury to the fish. This was deemed inadvisable due to the small number of fish in the spawning run. A sample of 16 scales is too small for a complete analysis, however it provides information on which to base future programs.

The information obtained from the interpretation of scales is summarized in the following tables.

Age of Fish in the Spawning Run

3 years old -- 2 fish
4 " " -- 2 "
5 " " -- 4 "
6 " " -- 8 "

Age at First Spawning

3 years old -- 2 fish

4 " " -- 5 "

5 " " -- 9 "

6 " " -- 0 "

Of the 16 fish, 9 had spawned once before and one had spawned twice before. Only 5 were spawning for the first time.

This information is an indication of depletion. Ten of the fish in the 1949 sample had entered the 1948 run and of these, 9 had spawned for the first time in 1948. In the sample of 16 from the 1949 run, only 6 were spawning for the first time. Of these 6, only one was 5 years old at first spawning whereas of the spawning run as a whole 9 out of 16 had spawned first as 5-year-olds. Five-year-olds which had been abundant in previous years were poorly represented in 1949 spawning, indicating a decline in that year class.

Calculations from scale measurements and total lengths were made to determine the length of the fish one year before first spawning. This information was needed in order to recommend bag limits designed to provide for a greater escapement of spawning fish.

It was determined that the average size of the trout at the time of the winter check one year before spawning the first time was 19.2 inches with a spread from 11.9 inches to 26.0 inches. Sixty-three per cent were 18 inches or over. Since some growth occurs between the time of formation of the winter check and the opening of the fishing season and many trout under 18 inches would grow to this size during the season before capture, it is felt that to set 18 inches as the size over which protection should be given would preserve

the maximum number of mature fish for spawning use. This bag limit restriction will be discussed later.

Recommendations

From information gathered to date, it is evident that drastic action must be taken to preserve the native trout of Lake Crescent and increase the return to the fisherman. Three management tools are indicated to accomplish this, namely: (1) control of catch to provide greater spawning escapement, (2) stream improvement to provide greater spawning area, and (3) a suitable hatchery program to eliminate natural mortality in young fish.

The immediate action to control catch should be aimed at preserving the supply of fish that will spawn the following spring so as to quickly increase the number of adults in the spawning run. It would be desirable to close the lake to fishing, however there are objectionable features of such an action. These may be summarized as follows:

1. The increased fishing pressure following the opening of a body of water closed to fishing may nullify entirely the gains made in the closed period. Due to local interest in Lake Crescent, this could be expected to occur.
2. A difficult problem in public relations would be created since the attraction of fishing plays an important part in the resort business on the lake and surrounding area. Further, the many owners of summer homes would certainly object to a complete closure of the lake to fishing.

An alternative to closing the lake to fishing is to restrict the bag limit drastically. The present bag and possession limit is 10 fish or 10 pounds of fish and one fish. Since the purpose of reducing the bag limit is to protect to a greater extent the fish which will spawn the following spring, a bag limit of 5 fish per day or 10 per week, only one of which may be over 18 inches in length, is recommended. Such a low bag limit as that proposed above would have the desirable effect of (1) discouraging "meat" fishermen who would probably fish other waters with more liberal limits and (2) overcome the objections listed above to closing the lake to fishing entirely.

Restricting the taking of trout over 18 inches in length would not interfere to any great extent with the cutthroat trout fishing. The bulk of the mature cutthroat observed in Barnes Creek were under 18 inches. To a limited extent the cutthroat would benefit, as would the rainbow, from this bag limit.

In order to make such a bag limit effective, strict law enforcement would be required. It is felt that the importance of preserving the trout of Lake Crescent would certainly warrant the attention to enforcement required to accomplish the objective of the proposed bag limit.

The removal of all dams on Barnes Creek should be effected immediately. The presence of these dams constitutes probably the greatest limitation to the production of cutthroat trout in Lake Crescent. Barnes Creek provides the only suitable spawning grounds of importance for cutthroat trout on the lake. The sight of large numbers of these trout battering themselves against the lower dam in an effort to reach suitable spawning grounds was a very discouraging one to the writer. The removal of the log jam is also of vital

importance. The amount of labor involved in removing enough of this barrier to permit the migration of trout is certainly justified. The complete removal of the log jam would not be necessary to allow a passage for fish.

Another stream improvement suggestion advanced by Park personnel warrants attention. A layer of fine silt has been deposited over the spawning ground of the rainbow trout at the lake outlet in the Lyre River. It was noted that most but not all of the spawning takes place where the silt is less deep. It was suggested that silt be removed prior to the spawning season by means of a stream from a portable fire pump in order to encourage the trout to spawn further in the lake to reduce the losses, if any, of newly emerged fry down the outlet. The deposition of silt during the period of incubation would not be sufficiently great as to smother the developing eggs and fry. What effect the removal of silt would have on the selection of spawning area by trout is not known. However, the cost of such an operation is so small that it is worthy of trial.

Since the first rainbow trout eggs from Lake Crescent were taken in March, 1949, it is too early to determine fully the possibilities in hatchery operations with this fish. Wild strains of rainbow trout vary widely in their adaptability to hatchery operations. Coastal steelhead will usually reach 6 inches in one year in rearing ponds, whereas certain strains of high-lake rainbow handled by the writer grew poorly to a size of 3 inches in one year.

If as is expected the fish from eggs taken at Lake Crescent grow to about 6 inches in the first year, a rearing program is recommended. Experimental evidence clearly indicates that the rearing of trout to larger sizes is desirable, particularly so in a situation such as Lake Crescent where shelter for

small fish is lacking and there are present large fish whose diet is largely smaller fish. It should be noted that the proposal to rear to 6 inches or over is <u>not</u> to provide fish for the fisherman on a "put and take" basis but as an emergency measure to preserve the native strain. As such, it is felt that this departure from National Park policy is justified.

Particular attention must be given to the proper planting of the trout. Experience has shown that it is very important to plant trout where it is desired that they return to spawn. In this case, they should be planted in the lake near the trap site but away from any considerable river current so as to minimize any tendency to drift with the current down the outlet. It has also been shown that in coastal waters there is a definite urge on the part of 6-inch or larger newly planted rainbow trout to migrate down streams and out of lakes during the months of April, May, and part of June whether or not there is free access to salt water. For this reason and also since food conditions are good after this period, plantings should be made in late June or thereafter.

In view of possible catastrophic losses in the hatchery from disease, water failure, etc., it is advisable that the maximum number of eggs taken not exceed one-half of the total available -- the balance to be deposited naturally.

The history of the management of runs of native trout in the West is replete with instances of complete depletion resulting from failure to return reared trout to the stream from which the eggs were taken. It is recommended, therefore, that with the exception of a small stream on the east end of the lake, no plantings be made in any location other than the vicinity of the

spawning grounds at the Lyre River until such time as the run in the Lyre River is built up to the point of maximum utilization of the spawning area. The stream excepted from this action is a small creek flowing through what is known as the Log Cabin Resort. It is recommended that not to exceed 2,000 fingerling be planted in this stream where there formerly was a run of rainbow trout.

Summary

1. Lake Crescent was studied during the trout spawning season and later to determine factors influencing trout production in the lake.
2. The spawning area of rainbow trout appears to be confined to an area of approximately 1.2 acres at the lake outlet in the Lyre River. This area is utilized to only a small fraction of capacity.
3. Reports from various sources confirmed by limited scale studies and 1949 observations indicate a decline in the numbers of spawning rainbow trout. The number of these fish in the spawning run is estimated at 160 fish.
4. Barnes Creek, the most important spawning area for cutthroat trout on Lake Crescent, is largely rendered useless by the presence of impassible dams about one-half mile above the lake and a log jam further upstream.
5. Management recommendations are made as follows:

(a) Restrict the take of trout which may be expected to spawn the next season.

(b) Remove obstructions to migration in Barnes Creek.

(c) If experience this season with rainbow trout from Lake Crescent eggs proves satisfactory, a fingerling hatchery program is recommended using proper planting techniques to build up the run of spawning fish in the Lyre River.

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