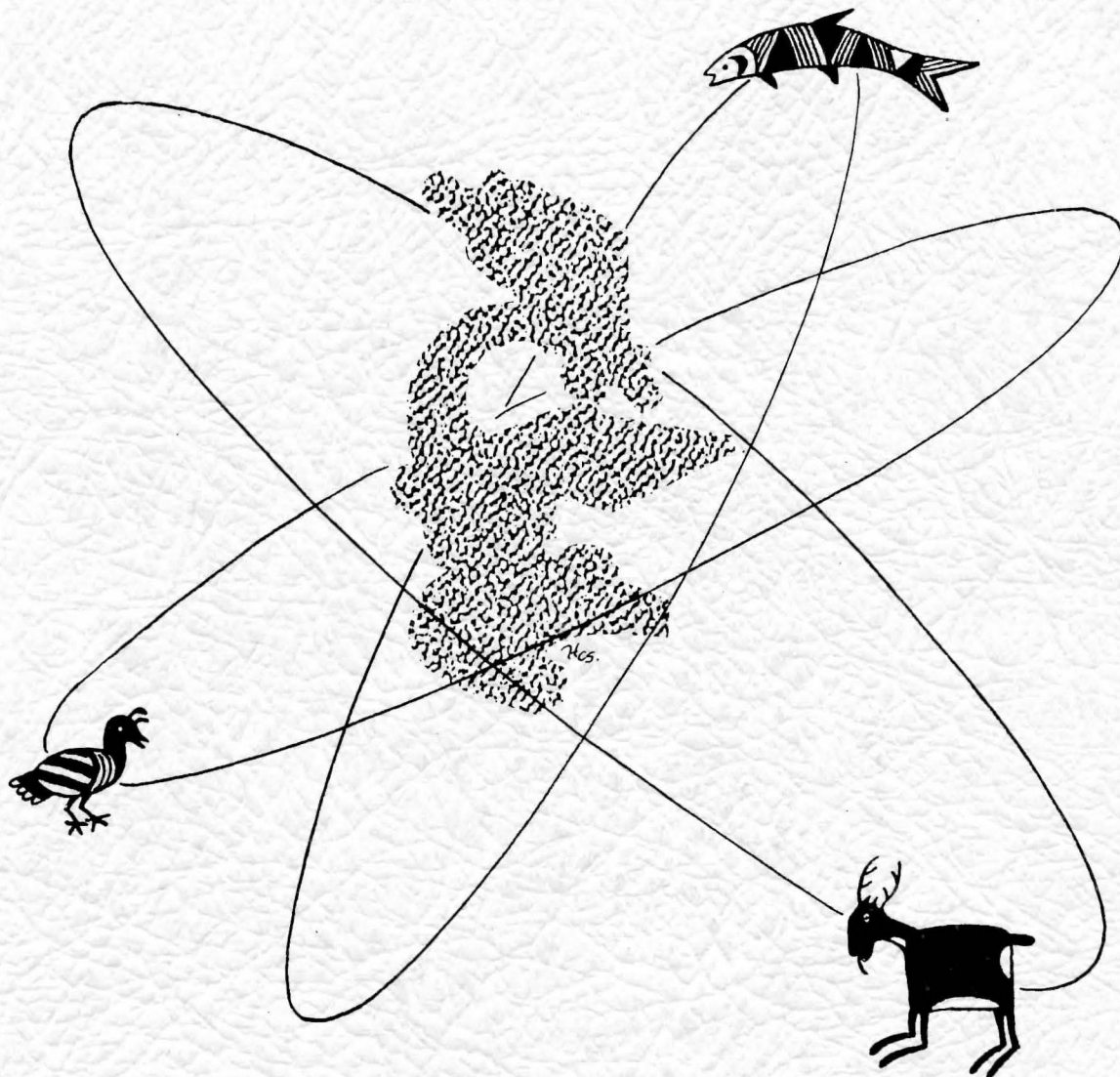


FISHERY RESEARCH REPORT NUMBER 1



RESEARCH DIVISION

Oregon State Game Commission

Federal Aid Project

F-71-R-1

Kokanee Research

A PRELIMINARY INVESTIGATION OF THE KOKANEE

IN

ODELL LAKE, OREGON

by

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Research Division

Oregon Game Commission

FEDERAL AID TO FISH RESTORATION

Progress Report

Kokanee ecology

F-71-R-1

Oregon State University

Corvallis, Oregon

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INTRODUCTION

Anglers have enjoyed large populations of kokanee in Odell Lake for about 15 years. Kokanee, the non-migratory sockeye salmon (Oncorhynchus nerka kennerlyi), are sought after because of their excellent eating qualities, the finesse required to take them, and the fact that they are often available when other species cannot be easily caught.

Very little is known of the ecological requirements for kokanee in Oregon. Perhaps the greatest problem is our inability to stabilize population fluctuations which seem to occur regardless of stocking densities, productivity of the habitat, or the catch. Knowledge of the distribution, abundance and growth patterns of kokanee correlated with possible causative forces would lead, hopefully, to a better utilization of the species in some Oregon lakes and reservoirs.

Preliminary studies initiated by Chapman and Fortune (1963) were centered on the summer distribution of kokanee fry in Odell and Elk lakes in central Oregon, with emphasis on the distribution of the food supply and the physical characteristics of the environment. Fortune (1964) established patterns in fry distribution in relation to several physical and biotic factors. This report brings together preliminary data which might be useful in establishing some early guidelines for the use of kokanee in similar Oregon waters.

Objectives

The principal objectives of the overall study^{1/} are (1) to determine the spatial distribution of kokanee in lakes and reservoirs (2) to examine the relative success of survival and growth for different kokanee strains and (3) to investigate the success of natural spawning.

Part of the study was designed to provide continuity with work initiated in 1962 by sampling the distribution of fry in relation to depth and light intensity, to determine the age and growth of kokanee by systematic gill net sampling, and to provide physical measurements which might be associated with the vertical or horizontal distribution of kokanee.

A first tangible objective was to systematically sample Odell Lake kokanee populations by gill net, midwater trawl, and creel inspection to determine the comparative survival, growth, and maturation of wild and marked, hatchery-reared kokanee of a known strain.

Methods and equipment

Gill nets used to sample kokanee populations in deep water were of monofilament material, rigged vertically in four sections, each of which was 50 feet long and 25 feet deep. Each net section contained one panel each of 2-1/2, 1-1/2, 1 and 3/4 inch stretched mesh material. Thus a curtain 50 feet wide and 100 feet in depth was formed.

To set the net, "bridle" ropes were tied to each end of the lead line before the net was played out. The loose ends of the "bridle" rope were passed thru the eyes of two anchors and temporarily tied to the boat. By a third line an

^{1/} Dingell-Johnson project No. F-71-R-1 was activated July 1, 1964 to continue research initiated by the Research Division, OGC, in 1962.

anchor was lowered. A styrofoam marker was attached to the anchor line. As the boat drifted with the wind, the slack in the "bridle" rope was taken up and the net was lowered by two men playing out the side lines. The "bridle" rope was then attached to a lighted buoy at the float line (Figure 1).

From a second boat, the second anchor was lowered with the "bridle" line running freely through the eye. The anchor "rides" the "bridle" line to the bottom. With the boat, the free end of the "bridle" line was pulled tight and tied to the second lighted buoy. Remaining slack in the anchor lines was thus taken up and the net was set as in Figure 1.

A midwater trawl was used in the manner described by Fortune (1964) for taking kokanee fry. The net is 9 feet square at the opening, 27 feet long and tapered to a 24-inch circular throat leading into a cod-end trap. The trawl was attached to a 3/16-inch towing cable snapped to a nylon harness on each upright pipe, forming the edge of the square opening (see Figure 2). The cable was wound on the drum of a gasoline driven winch (Easy-Go) which was mounted on a 4" x 4" wood superstructure amidships in the 14-foot aluminum work barges, or scows. Uniform engine speed of each of the 40 h.p. Evinrude engines as measured with a tachometer, a predetermined length of cable, and lead weights, established the depth of the trawl (Fortune, 1964).

A brief attempt was made to determine the movement of fish away from the midwater trawl in daylight hours at the 50 and 80-foot levels. A boat containing a DE 721A "Raytheon" Depth Sounder was put in position directly above the trawl, and slightly ahead of it (see Figure 3). With the trawl in motion, the cables leading to the trawl were easily identified on the depth recorder. There was evidence that individual large fish or perhaps small schools of kokanee moved downward to escape the trawl. Inasmuch as no kokanee over 145 mm in length have been captured in the tow net, it is likely that the echo sounder was recording the escapement of fish.

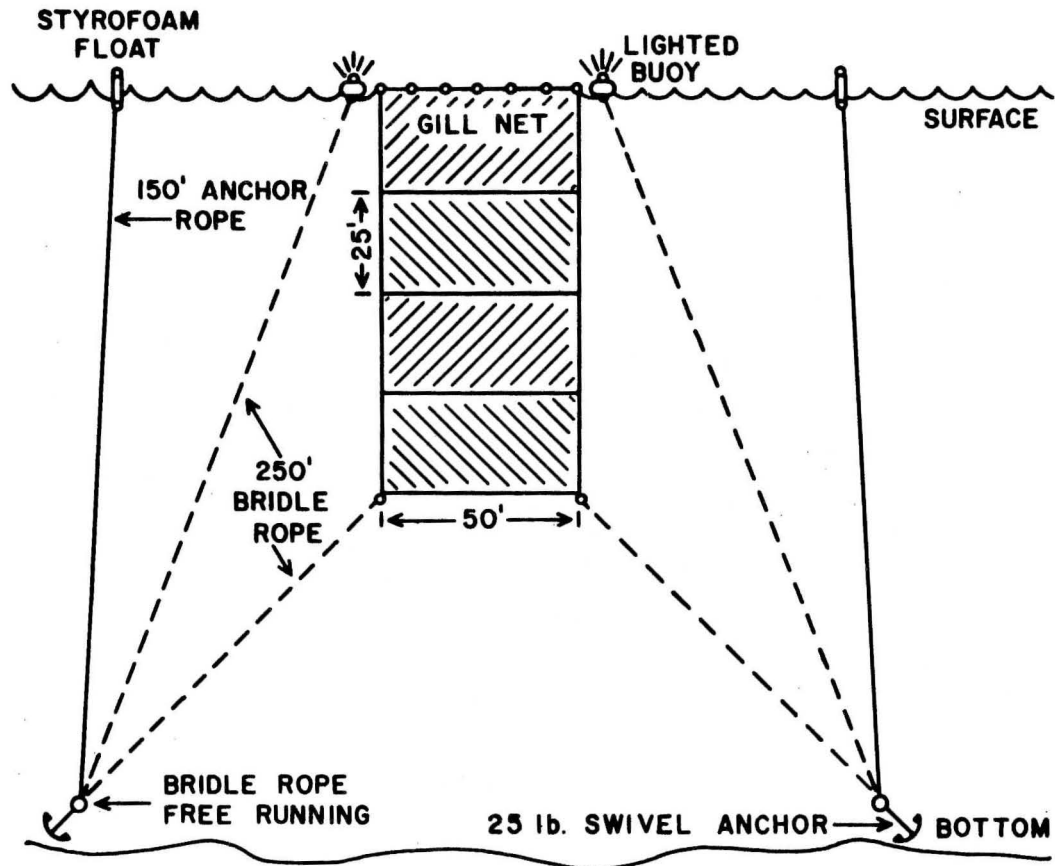


FIG. 1.--DIAGRAM OF MONOFILAMENT CURTAIN GILL NET SET



Figure 2. Tow net in position before release to proper trawling depth.



Figure 3. Trawling position of two aluminum scows, Odell Lake. Echo sounder, in foreground, will come into position between the towing scows.

To determine temperature conditions at the time of midwater trawl sampling and gill net sampling at Odell Lake, the thermal stratification of the lake was recorded. From August 11 to October 16, eight temperature profiles were constructed with the use of a thermistor and 100 foot probe. Temperature (in degrees F) was recorded at each 5 foot level from surface to 100 feet to locate the thermocline (Appendix A).

Generally, the thermocline was located between the 45 and 60 foot level, progressing downward with the season. Surface water rose to 64°F in mid-August and began a downward trend on August 31 to 59.5°F which was maintained into October. Fortune (1964) found that the distribution of plankton in relation to the thermocline had a direct bearing on the location of kokanee.

Results

A. The 1964 kokanee fishery at Odell Lake

Sampling procedures were developed to provide an estimate of the total catch of kokanee. In order to obtain a measure of effort in boat hours, counts of boats from a bluff overlooking the lake were made on a random day basis throughout the season at 10 A.M. and 6 P.M. The two time periods were selected after separate hourly boat counts were made to plot curves of activity for week days and weekend days. The area under such a curve is a measure of effort in boat hours.

Sampling was designed on the basis of three strata; (1) for week days, (2) for weekend days and (3) for the Labor Day weekend. Within the three strata, sampling was divided into two time periods, A.M. and P.M. Actual contact with anglers was made on predetermined days at five locations around the lake where the majority of anglers must, of necessity, launch and beach their boats. Almost without exception, the kokanee fishery is prosecuted by boat anglers who troll at depths of 20 to 60 feet dependent on the location of kokanee.

The occupants of each boat were questioned upon their arrival at shore concerning the length of time they had fished, the number, size and origin of kokanee taken and whether or not they had intended to fish for kokanee exclusively. The procedure provided a random sample of completed boat trips, yielding statistics suitable for estimating total catch in each stratum.

Total effort in terms of boat hours per day in each stratum was derived from the number of boats counted on the various sampling days at 10 A.M. and 6 P.M. multiplied by an index number:

$$\sum_{i=1}^n \frac{\text{boat count}_i}{n} (I)$$

and represents the estimate of the average boat hours spent when boat counts were made at 10 A.M. and 6 P.M. The index number (I) is the ratio of total boat hours spent on the lake to the number of boats on the lake at 10 A.M. and 6 P.M. on the same day. The ratio is assumed to be fairly constant, while boats are not. An index number was computed for weekend days and week days and found to coincide closely. The 10 A.M. and 6 P.M. boat counts made throughout the season could be adjusted to total boat hours by use of the index number for any particular day in the three strata.

Boat counts and random catch sampling through July, August and 20 days of September provided the basis for estimating total catch. The equation for determining total catch was as follows:

$$\text{Total catch} = \frac{(F)}{(AH)} \frac{(AH)}{(BH)} \sum_{i=1}^n \frac{BC_i}{n} (I) \quad NP$$

Where:

F/AH = fish per angler hour

AH/BH = angler hours per boat hour

A/B = anglers per boat

BC_i = 10 A.M. and 6 P.M. boat count on ith day

- I = index number
 n = number of days that peak time boat counts were made
 N = total possible number of sampling days in stratum
 p = percentage of boats fishing for kokanee

Estimates made by the method revealed that approximately 30,200 kokanee were taken from the lake in a 107 day period as a result of approximately 16,000 angler trips. Of the total catch, 27 percent (or about ^{8,170} 8,000 kokanee) were of hatchery origin of the 1962 and 1963 release. Almost 90 percent of the marked fish were from the 1963 release (see Table 1).

B. The growth and survival of kokanee

1. Trawl sampling results

Midwater trawling was confined to the southwestern one-half of the lake (see Appendix B). The midwater trawl (or tow net) was operated on a 10-minute fishing time basis from the first hour of darkness until approximately 1 A.M. the following morning. Midwater trawling was not done on a systematic chronological basis, but when weather permitted and manpower was available.

A total of 33 ten-minute hauls was made in the period from August 23 to October 23, 1964 with a total catch of 2,166 fry. The average number of fry taken per 10-minute haul under all light conditions was 65 and the range was from 0 to 900 fish per 10-minute trawling period. Among the catch were several chub (Siphateles bicolor) 4 to 7 inches in length. Eight kokanee over 10 centimeters in length were taken with the trawl within the sampling period.

A sample of fork lengths was taken from kokanee fry recovered from the three operating levels (surface, 20 feet, and 50 feet). An effort was made to measure from 10 to 15 fry from each sample taken. In some instances such a number was not available.

Table 1
Kokanee catch totals,

Odell Lake, 1964 July 1- Sept 20

	Stratum 1		Stratum 2		Stratum 3		Totals for season
	Weekdays		Weekend days		Labor Day weekend		
	AM	PM	AM	PM	AM	PM	
Total boat count	313	228	730	388	190	66	1,915
No. of days	20	19	13	13	2	2	
Total possible days	75	75	30	30	2	2	107
Boat contacts	162	130	198	187	106	27	810
Percent who fish for kokanee	78	78	89	93	100	100	87%
Fish/boat trip	4.23	3.97	3.72	4.03	7.69	6.48	4.63
Total anglers interviewed	274	224	418	435	250	67	1,668
Total hours effort	813	694	1,430	1,599	945	275	5,756
Total kokanee	538	401	660	707	816	175	3,297
Fish/angler-hour	0.66	0.58	0.46	0.44	0.86	0.63	0.57
Fish/angler	1.9	1.8	1.5	1.6	3.2	2.6	1.97
Percent hatchery origin	25%	30%	28%	28%	25%	17%	27%
*Estimated catch	3,709	2,786	5,561	3,398	1,461	427	17,342
*Estimated boats	877	702	1,495	837	190	66	4,167
**Total catch	7,306	5,211	9,580	5,292	2,265	607	30,261

*Simple expansion

**Estimate by effort index

Kokanee fry taken by surface trawling averaged 36.2 millimeters in fork length on August 20, and 58.8 millimeters on October 16, approximately 60 days later. When mean lengths and ranges of samples are plotted (Figure 4) an unusual indication of a length differential occurs with depth. The surface-caught kokanee were larger on the average than those taken at greater depths. Insufficient data in the early part of the season and in October preclude further inference concerning this apparent phenomenon.

A wide difference in catch of fry with the trawl occurred in relation to moonlight. Fortune (1964) related the position of the kokanee to that of the plankton which formed their food supply. In the summer of 1964, eight times more kokanee fry were taken in the surface trawls on bright moonlight nights than on dark ones. The average number of fry per 10-minute trawl was 172 on bright nights and only 20 on dark ones. Averages were derived from nine separate samples on moonlight nights and nine on dark nights.

Twice as many kokanee fry were taken at the 20-foot level on bright moonlight nights than on dark ones. At the 20-foot level four samples were taken on bright moonlight nights while 6 samples were made in the dark.

At the 50-foot level, five times more fry were taken on dark nights than in bright moonlight. Three samples were available on dark nights at the 50-foot level but only two samples were available on dark nights. Because of the small sample size, the effect of light at the 50-foot level could not be measured adequately.

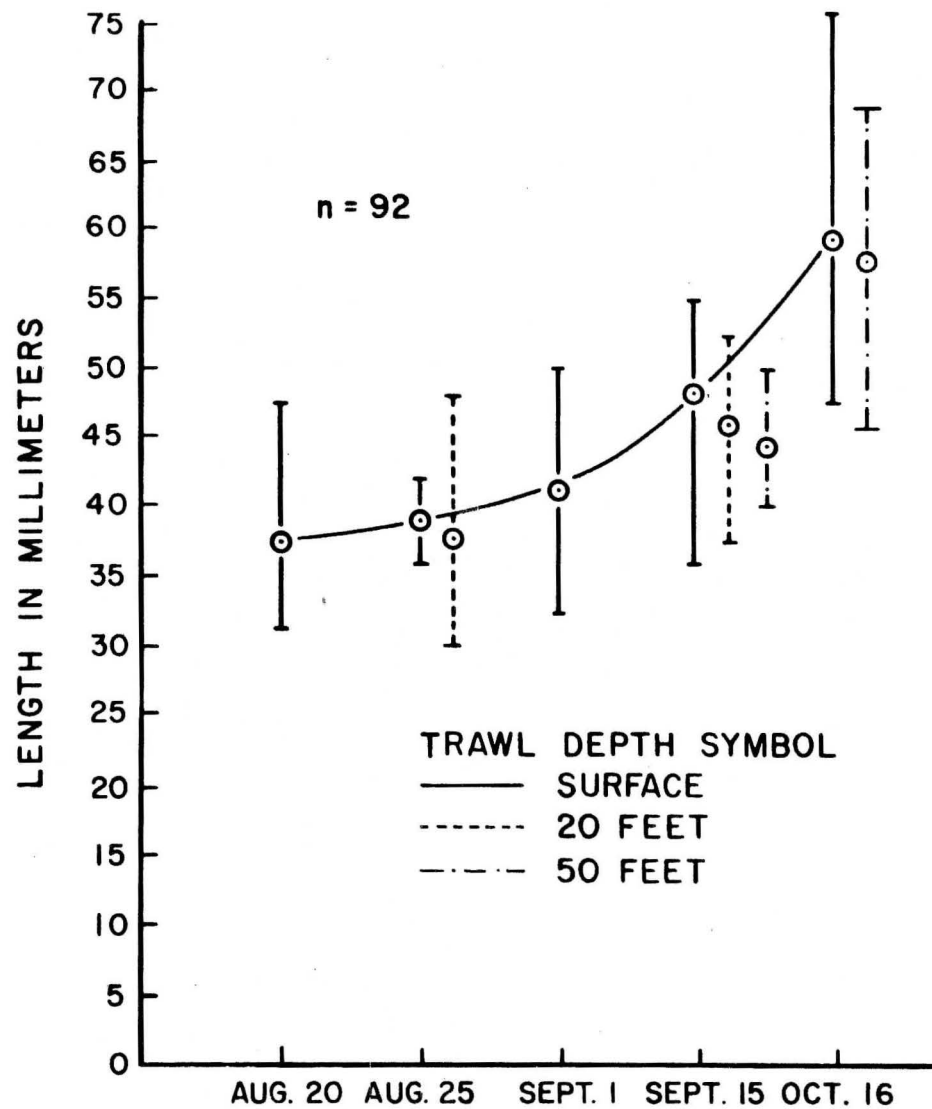


Figure 4

Mean length and range of kokanee fry taken
with the midwater trawl at three depths
Odell Lake, 1964

The efficiency of the midwater trawl is not completely understood. The procedure of closing the net after each 10-minute haul is open to question. There is a possibility that greater engine power and other methods of closing the trap at the end of the time period could increase trawling efficiency.

2. Gill net sampling results

A total of 12 consecutive sets were made with the 50 x 100 foot monofilament curtain gill net beginning July 27 and ending September 16, 1964. Larger kokanee (20 to 36 centimeters) exceeded the smaller 10 to 20 centimeter length group in total number only at the 50 to 75-foot level. At the other three 25-foot levels of the curtain net the catch of the 10 to 20-centimeter fish was twice that of the 20 to 30 plus centimeter group. The distribution of larger kokanee in the 50 to 75-foot level suggests a seeking of the thermocline, while the smaller kokanee apparently distribute themselves more widely. Since there are more kokanee in the smaller size group available to be caught, the congregation of the larger kokanee at the 50 to 75-foot level is even more striking.

The largest number of 10 to 20-centimeter kokanee was taken in the curtain gill net at the 25 to 50-foot level.

In four consecutive time periods of three sets each, nearly identical numbers of kokanee in both size groups were taken in the third and fourth time periods (see Table 2).

The largest number of 10 to 20-centimeter kokanee was taken in the second time period (August 5 to 12 when all depths are included) while the largest number of 20 to 30+centimeter kokanee was taken in the fourth time period (September 2 to 17).

Of the 641 kokanee taken in the 12 gill net sets, only one fish in the range of over 17 centimeters in length and under 23 centimeters in length appeared in the catch. Length frequency figures of the catch are illustrated in Figure 5. The fact that larger kokanee are entering the gill net in the last time period might suggest recruitment as the season progresses, or the possibility of the larger fish moving into Area I as maturation proceeds. The catch of kokanee throughout the season at 4 depths is recorded in Table 2.

Growth and survival of hatchery-reared kokanee

There were 188 marked kokanee of the 1963 release weighed and measured as they appeared in the gill net or angler catch. Wide differences appeared between the two marked groups (LV or RV) in length and weight (see Table 3). More surprising than size differences is the marked contrast in the apparent survival of the two groups.

We would expect the ratio of RV to LV in the gill net and sport catch to be the same (1:1) since their numbers (30,000), source, and treatment were identical. The fact that only 23 and 25 percent of the total marked fish recovered by the two methods are LV fish (May release) we might conclude that the lower survival is probably a direct reflection of size at the time of stocking.

The effect of environmental conditions to which each of the two lots was exposed at different times (May 15 and June 17) is obscure, and a relationship to survival might exist.

The contribution of hatchery-reared kokanee to the creel, the experimental gill nets and to the spawning population is seen in Table 4.

C. Kokanee spawning activity

An attempt was made to determine the number of spawners in main areas of reproduction in Odell Lake and its tributaries. Surveys of the tributaries

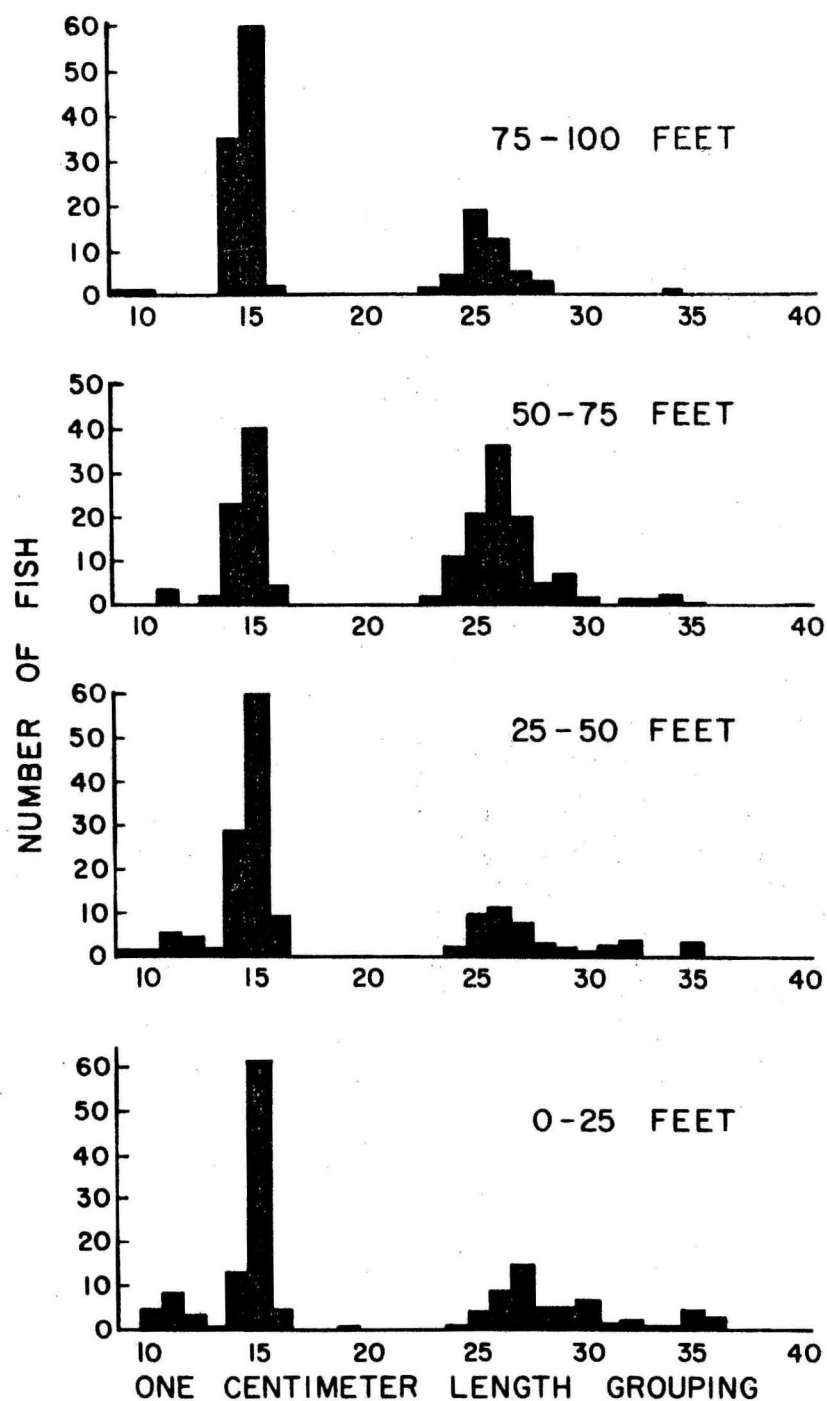


Figure 5

Length frequency of kokanee taken in
the curtain gill net at four depths
July 20 to September 20, 1964
(n = 641)

Table 2

Gill net catch of two length groups of kokanee at four depths
in relation to four time periods

Depth	Fork length 10 to 20 cm group					Fork length 20 to 30+ cm group					Season catch by net depth
	Time period ^{1/}				Total	Time period ^{1/}				Total	
	1	2	3	4		1	2	3	4		
0-25	17	18	15	47	97	1	5	18	33	57	154
25-50	27	32	13	40	112	11	10	6	18	45	157
50-75	11	33	11	19	74	20	28	25	39	112	186
75-100	15	68	6	12	101	7	13	5	18	43	144
	70	151	45	118	384	39	56	54	108	257	641

^{1/}Time periods: (1) July 27-August 3; (2) August 5-12; (3) August 18-31;
(4) September 2-16.

Table 3

Differential growth and survival of marked kokanee from the same
strain, lot, and hatchery stocked at two sizes in Odell Lake

Stocking record 1963				Recovery data August, September 1964			
Date stocked	No/lb	Mean length (cm)	Range	Mean weight (gr)	Range	No. in gill net	No. in angler catch
LV May 15, 1963	241	22.7	15.4 - 27.0	167	36-244	8	36
RV June 17, 1963	114	26.9	23.3 - 30.2	233	159-334	24	120

Table 4

Summary of total contribution of hatchery-reared kokanee, Odell Lake, 1964

	No. of fish examined				Total calculated number of hatchery origin	Percent contribution
		LV	RV	BV		
Catch	3,297	36	120	10	880	27
Gill nets	647	8	24	0	160	24
Spawners	282	4	7	12	175	61

and of the lake shore began October 1 and continued at intervals of a few days until October 23. Table 5 summarizes spawning activity data collected in the period.

Spawning activity occurred in Trapper Creek^{1/} from October 1 to the end of October. Spawning on Crystal Creek occurred from the lake to a point at least 1/4 mile above the lake. In Odell Creek, spawning occurred for at least one mile below Odell Lake. Spawning was not observed in any of the other tributaries.

Lake spawning was confined to an area near the Post Office. No evidence of spawning activity could be seen elsewhere.

The utilization of yellow (dart-type) spaghetti tags on spawning adults entering Trapper Creek was tested to determine if information concerning the length of time spawners remain in the stream could be obtained and if spawning populations can be estimated more accurately by sample tagging. With a seine, 42 mature kokanee were taken from the lower portion of Trapper Creek, tagged on the left side, if females, and on the right side, if males. The tagged fish were released at the point of capture to redistribute themselves among the spawning population. Seining was difficult in the stream because of the shape of the pools, logs, brush, swift current and cold water (39°F). Of the 42 fish tagged, 25 were males and 18 females, a ratio of 1 to 1.3. Of the 42 fish seined from the spawning population, six were marked, 5 with a BV clip and 1 LV (Table 5).

Of the 240 dead spawners and 42 captured spawners examined in the three streams, 12 bore the both ventral mark indicating that approximately 120 (42 percent) of the fish were of the 1962 hatchery release^{2/}. In addition, 4 fish had the left ventral mark while 7 were seen with the right ventral mark indicating

^{1/} See map, Appendix B

^{2/} Only 10 percent of the release were marked

Table 5

Kokanee spawning activity, Odell Lake 1964

Crystal Creek (mouth to 400 yds upstream)

Date	Alive	Dead	No. of dead examined	Marks
October 1	331	5	0	
October 9	335	75	60	3 RV, 3 BV
October 20	120	150	155	4 RV, 3 LV, 4 BV

Trapper Creek (mouth to RR)

Date	Alive	Dead	Tags seen	Comments
October 1	900	0	0	Lake temp. 54°F, Stream 44°F Schools off mouth very active, bright color
October 9	965	2	0	Schools off mouth active
October 14	800	15	0	Several 8-9" mat. ♂
October 20*	655	Many	14 (5♂ & 9♀)	(Temp. 39°F)
October 23	510	Many	9 (3♂ & 6♀)	

Odell Creek (Lake to Hwy #58)

Date	Alive	Dead	No. of dead examined	Marks
October 10	575	100	25	0

*Tagging on October 16-25♂ and 18♀, yellow spaghetti tags. Of the 42, 1 LV ♀
and 5 BV (4♂ & 1♀)

that 19 percent of the total number of spawners examined must have come from the 1963 release of kokanee. If we can accept the validity of marked proportions being equally represented in the spawning population then 61 percent were of hatchery origin while 39 percent were wild (Table 4). Estimating the length of time which kokanee remain on the spawning beds is not possible.

Summary

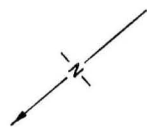
1. Kokanee populations in Odell Lake were inspected in the summer of 1964 through the use of gill nets, a midwater tow net and systematic creel sampling to determine the survival, growth and size at maturity of wild and hatchery-reared kokanee of a known strain.
2. Midwater trawling from August 20 to October 23, 1964 produced 2,166 fry. Eight times more kokanee fry were taken in the surface tows on bright moonlight nights than on dark ones. Twice as many kokanee fry were taken at the 20-foot level on bright moonlit nights as on dark nights. At the 50-foot level more fry were taken on dark nights than on bright moonlit ones.
3. The mean fork length of kokanee fry rose steadily from 36.2 mm in mid-August to 58.9 mm in mid-October. There is evidence that kokanee fry distribute themselves vertically in relation to size, the largest being nearer the surface.
4. An experimental monofilament gill net was designed and used as a sectional curtain, 50 feet wide, suspended from the surface, and hanging 100 feet into the water. Each of the four sections was 25-feet deep and contained four mesh sizes. In 12 separate sets 641 kokanee were taken of 9 to 36 centimeters in length. Larger kokanee were taken in greatest numbers at the 50 to 75-foot level, the area of the thermocline.

5. Catch estimates based on boat hours per day were made for the period of June 15 thru September. Approximately 30,000 kokanee were taken from the lake in a 107-day period. Of the total catch, 27 percent were of hatchery origin. Most of the marked fish were from the 1963 release.
6. Wide allometric differences appeared between two marked groups released one month apart in 1963. The later release of larger fry comprised nearly 70 percent of the total number of marked fish examined in the gill net and angler catch in 1964. Size at release appears to be the factor determining survival and growth.
7. Spawning populations were sampled in October to determine the presence of marked hatchery fish. Of 282 spent kokanee examined, 61 percent were believed to be of hatchery origin.

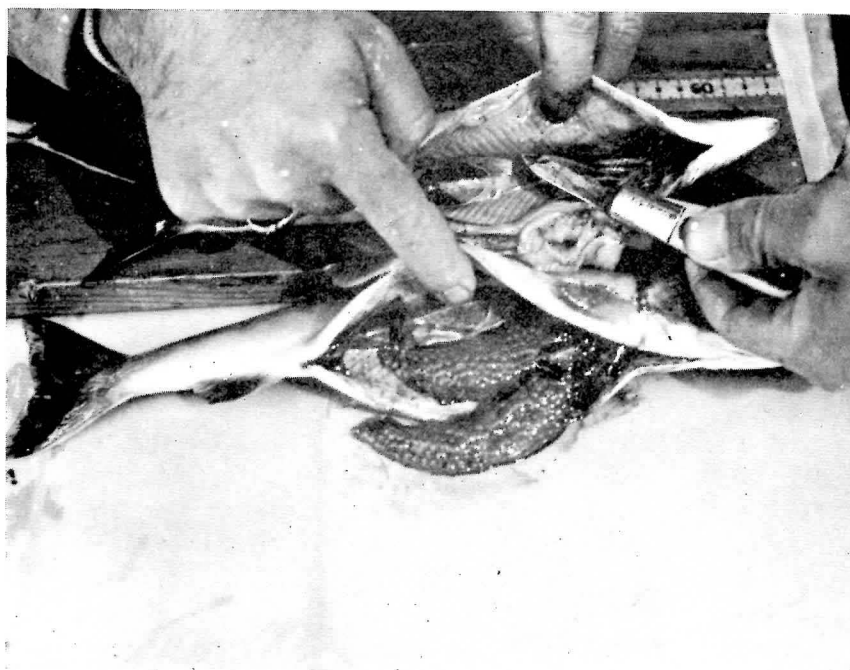
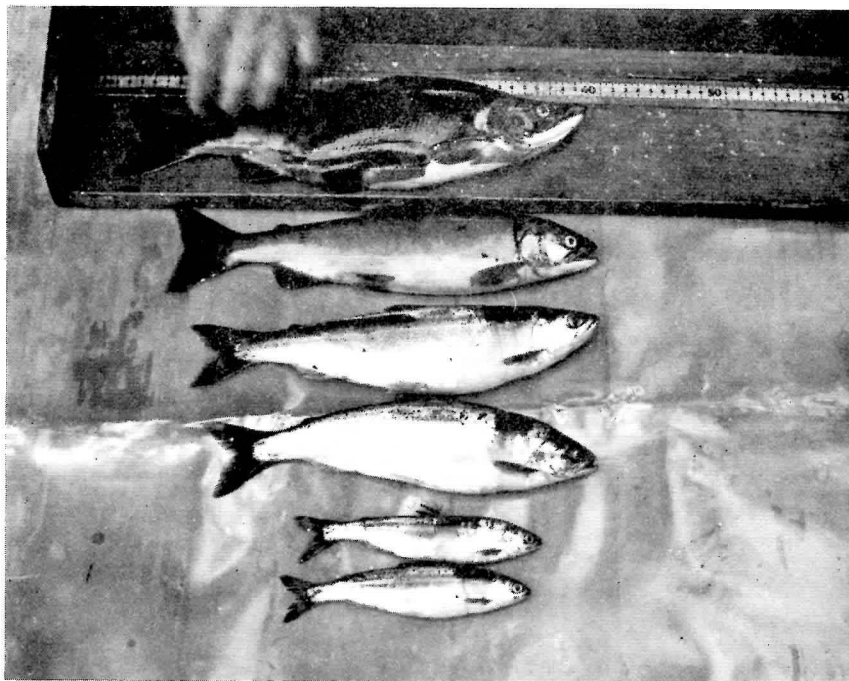
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APPENDIX



OREGON STATE GAME COMMISSION	
PORTLAND, OREGON	
ODELL LAKE	
DATE	12/14
BY	KSL
SCALE	1" = 115'
SHEET NO. 1	
TOTAL SHEETS 1	
PROJECT NO. 1	
DRAWN BY KSL	
CHECKED BY	
APPROVED BY	



Appendix C. Kokanee from the curtain gill net illustrating length grouping and length at maturity of females.