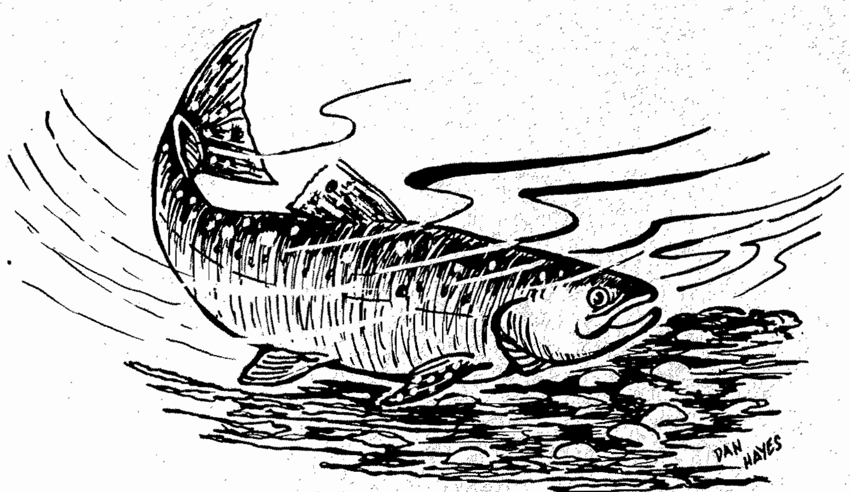
NORTHWEST FISH CULTURE CONFERENCE



PORTLAND, OREGON
DECEMBER 1-2, 1965

1965

Sixteenth Annual

Northwest Fish Cultural Conference

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A sincere thank you is extended to all those who participated in this fish cultural conference held in Portland, Oregon, December 1 1-2, 1966. The spirit of active discussion was stimulating and commendable as the various aspects of current problems and recent research accomplishments were explored. I also wish to thank those on the staff at the Western Fish Nutrition Laboratory and in the Regional Office, Bureau of Sport Fisheries and Wildlife, who arranged and completed many details which enabled this conference to proceed smoothly on schedule with minimum problems and maximim comfort while we were assembled there. Hopefully, these informal presentations, research and management reports together with vigorous discussion which ensued, served to stimulate much active interest in, and advance our understanding of, modern fish culture.

Mr. Wally Hublow of the Oregon Fish Commission was selected as chairman for the 1966 Conference.

John E. Halver, Chairman, 1965

SIXTEENTH ANNUAL NORTHWEST FISH CULTURE CONFERENCE

AUDITORIUM
INTERIOR BUILDING
PORTLAND, OREGON

DECEMBER 1 AND 2, 1965

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3:10 - 3:25	Break	
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9:20 - 9:35	"Characterization of Five Fish Cell Lines" B. McCain, Oregon State University	50
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10:40-10:55	"Effect of Spawning Density of Sockeye Salmon on the Number of Resulting Fry" D. A. Hurley, Int. Pac. Sal. Fish Comm.	59
11:00-11:15	"Marking of Pacific Salmon with Tetracycline Antibiotics" D. Weber, Bureau of Commercial Fisheries	61
11:20-11:35	"Tetracycline Marking and Thermal Brand Studies" I. Jones, Oregon Fish Commission	65
11:40-11:55	"The Atlantic Salmon in Oregon" J. Rayner, Oregon Game Commission	67
12:00-1:00	Lunch and individual conferences	

Fatty Acid Variation with Diet in Coho Salmon

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The fatty acids of river Coho Salmon *Oncorhynchus kisutch* (Walbaum) on two different diets were compared with fatty acids of salmon taken directly from the river and with fatty acids of river salmon retained in the labratory without food for 21 days. The salmon were fed exclusively *ad libitum* on diets of tubified worms or enchytraeid worms for 21 days. The salmon were homogenized and the lipids extracted with methanol-chloroform. Identification of fatty acid methyl esters was accomplished by gas-liquid chromatography.

The total lipid content of salmon, taken directly from the river, averaged 2.80% , of salmon starved for 21 days, 1.38%; salmon fed tubificid worms, 3.42%; and salmon fed enchytraeid worms, 6.03%. The lipid percentage was based on the wet weight of the fish.

The percentage of saturated fatty acids in the total fatty acids of salmon taken from the river was 25.4%, salmon retained in the labratory and fed nothing, 28.3%; salmon fed tubificid worms, 25.8%; and salmon fed enchytraeid worms, 40.8%. In salmon fed enchytraeid worms, the percentage of the unsaturated fatty acids differed markedly from the percentage of unsaturated fatty acids in the salmon taken from the river, of the salmon retained in the laboratory and fed nothing, and of the salmon fed of tubificid worms.

The table gives a comparison of some of the fatty acid percentages among the total fatty acids as affected by diet.

Fatty Acids	Per Cent of Individual Fatty Acids			
	Fish taken from river	Starvation for 21 days	Tubificids for 21 days	Enchytraeids for 21 days
14:0	2.07	1.52	3.91	22.65
16:1	7.96	4.45	8.23	12.99
18:1	23.30	20.23	18.06	11.90
18:2	14.36	7.38	11.52	13.10
20:4	2.25	4.73	5.83	3.47
20:5	3.98	5.38	4.57	0.70
22:6	8.30	18.27	7.04	1.87
Total lipid percent of body weight	2.80	1.38	3.42	6.03

Salmon fed on enchytraeid worms showed a significantly high lipid content associated with a high percentage of saturated fatty acids and a low percentage of polyunsaturated fatty acids. The fatty acids associated with these changes were primarily 14:0 and 22:6. Salmon fed on tubificid worms showed a slight increase in lipid content, close similarity in saturated fatty acid percentage, and an increase in polyunsaturated fatty acid percentage as compared with salmon taken from the river. In comparison with salmon from the river, salmon that were not fed showed a decrease in total lipid content, an increase in saturated fatty acid percentage, and an increase in the percent of some of the unsaturated fatty acids including 22:6.

PROGRESS REPORT ON THE EVALUATION OF HERRING, SALMON, AND HAKE AS WET INGREDIENTS FOR OREGON PELLETS

Dwain Mills

Oregon Fish Commission

Clackamas, Oregon

The wet fish products which comprise 40% of the Oregon pellet are occasionally difficult to obtain, and it would be desirable to have a wider selection.

An experiment was started at the Clackamas Labratory on August 11 and will terminate on December 8. Pasteurized herring, pasteurized salmon carcasses, and pasteurized and raw hake are being tested as the complete wet portion (40%) of the production pellet formula. Results to date (November 3) indicate that pasteurized herring is the only wet ingredient tested that is satisfactory for use in the pellet.

Results are summarized on table 1.

Table I. Summary of Results, Oregon Pellet Wet Ingredient Tests, Clackamas, November 3, 1965

Ingredient	Ave. Wt. Gain (gms)	Conversion (wet)	Mortality (%)	Hemoglobin (gms %)	Hematocrit (%)
Tuna Viscera-Turbot (Production pellet)	8.04	1.57	0.50	7.0	40.1
Tuna Viscera	7.18	1.64	0.88	6.5	38.8
Pasteurized Herring	6.13	1.58	0.38	6.6	38.3
Pasteurized Salmon	5.57	1.72	0.13	6.5	40.5
Raw Hake	4.74	1.90	1.12	6.7	43.9
Pasteurized Hake	5.08	1.82	0.38	6.2	37.5
$LSD_{.05}$	1.32	0.24	1.18	1.2	6.2

OREGON PELLET STARTER DIETS

John Westgate

Oregon Fish Commission

Clackamas, Oregon

Manufacturing and handling problems are encountered when the moist Oregon pellet is used for starting salmon fry. A dry Oregon pellet formulation would appear to be more practical as a starter diet.

An experiment to evaluate the relatively high moisture level in the Oregon pellet and two methods of producing a dry diet from the Oregon pellet formula was conducted for 8 weeks at the Clackamas Labratory, using replicate lots of 750 fall chinook salmon.

Test diets were prepared by three methods: (1) regular moist Oregon pellets (control); (2) oven-drying moist Oregon pellets; and (3) drying the wet fish components, then pelletizing all ingredients in a dry pellet mill. Each method was used for a diet of high moisture and a diet of low moisture. The low moisture control diet was prepared by freeze-drying the moist Oregon pellets, whereas the high moisture oven-dried and pellet mill diets were obtained by rehydrating the dry pellets.

Results are summarized in Table 1. The regular Oregon pellet control diets were superior to the oven-dried diets, while the pellet mill diets were inferior to the others. The oven-drying and pèllet mill methods appeared to destroy some factor present in the moist Oregon pellets, but a need for relatively high moisture in the Oregon pellet was not demonstrated.

Table 1. Summary of Results, Oregon Pellet Starter Diet Experiment, 1965

Method	Moisture	Average Wt. Gain (grams)	Mortality (%)	Conversion (dry)	Hematocrit (%)
Control	High	1.45	0.93	1.10	40.8
	Low	1.35	1.33	1.15	43.5
Oven-dried	High	1.01	4.06	1.50	38.2
	Low	1.00	2.00	1.45	42.9
Pellet Mill	High	0.60	2.66	2.20	40.9
	Low	0.80	2.46	1.70	40.3
$LSD_{.05}$		0.16	4.09	0.41	7.6

EVALUATION OF DRY FEEDS FOR IDAHO CUTTHROAT PROGRAM

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College of Fisheries

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The Idaho Fish and Game Department began the use of open formula dry fish feed during 1963. Continued development of the program made necessary the evaluation of formulas to be used in feeding of cutthroat and other species raised in cold water hatcheries. The Warm River Hatchery (a 50°F soft water spring source), operated during the summer months, and managed by H. Misseldine, was chosen as the site for the experimental program.

The cutthroat trout for the experiments were obtained as eyed eggs from the wild spawning stock at Henry's Lake. Each test group was duplicated and consisted of 20,000 swimup fry. The number of pounds per cubic foot of tank space was was not closely maintained because of the design of the tanks. Both inside and outside facilities were used. The outside facilities consisted of long raceways, and the inside facilities consisted of deep hatchery tanks. Throughout the experiment, less than 0.5 pounds of fish were present per cubic foot of water volume, well below the crowded level.

For the first year of study (1964), five formulas were chosen for study (Table 1). In these, fish meal was the principal ingredient. A number of ingredients were substituted in this basic formula to evaluate their desirability for inclusion in cutthroat feeds. The control formula for these tests was a commercial Chinook mash found in the past to be reasonably satisfactory as a starter feed for cutthroat. This formula was proprietary and could not be used as a proper control nor as a guide for the calculation of the basic formulas. The vitamin premix was the Idaho production formula without choline or ascorbic acid. The formulas, including the commercial ration, were calculated to provide 57-63% protein. Fat (17%) was added in part as a source for energy, but principally to control the texture and wetting behavior of the mixture.

A second series of experiments, based upon the results of the preliminary experiments in 1964 was undertaken during the summer of 1965. The formulas were similar (Table 2). In that fish meal was the major ingredient. The variables tested included soybean flour meal, corn gluten meal, oat flour, and Durabond (a ligninsulfonate). Durabond was included in this test series to provide data on its acceptability, since it is used as a pelleting aid by feed manufacturers. The formulation was not pelleted and was not suitable for pelleting, due to the high level of added fat.

The results for 1964 (Table 5) indicated certain basic changes in the formulas were required, and these were incorporated in the 1965 tests. First, it was necessary to eliminate kelp meal because it increased five-fold in volume and irritated the anus of the trout. This swelling characteristic could not be changed through normal milling procedures, since the dry meal is already ground quite finely.

The second major change was the elimination of meat scrap meal. Meat scrap meal has been found acceptable in rainbow production tests but, here again, the presence of bone chip residues was deemed undesirable in cutthroat trout feeding.

Since there was a suggestion that corn gluten meal used in the 1964 tests was not entirely satisfactory, both soybean flour meal and oat flour were tested as replacements for this ingredient. Another substitution imposed by the market situation was that of blood meal for liver meal, as the latter was no longer available through commercial channels.

The results from the 1965 test series are shown in Table 3. Since there was no consistent difference between indoor and outdoor experimental groups, the results were pooled.

Disease treatments were used at an early stage of the experiment, but only in the treatment of fish located inside the hatchery. Nonetheless, mortality was not significantly different between the inside and outside groups and, thus, disease treatment was not considered to be a major variable. The production group was treated with Malachite Green. The 65 Ct B group, which had the highest mortality, was treated with permanganate, and group 65 Ct E was treated with Roccal and Malachite Green. A further treatment for 65 Ct B and 65 Ct E was to vary the water level and flow rate.

In the overall result, all but one formula proved more satisfactory than the 1964 formulas. Formula 65 Ct G contained both light and heavy particles which distributed more uniformly throughout the water. Most of the other formulas tended to remain floating for a short period before they sank, leaving a slight oil slick upon the surface. Variation in the sinking rate encouraged more uniform distribution of the fish during the feeding period and may be a desirable feature for dry feeds.

With the exception of 65 Ct B and 65 Ct D, the growth and conversion was similar for all formulas. During 1964, the trace mineral salt seemed to improve the mechanical consistency of the diet and behavior. However, in a somewhat similar test in 1965, 65 Ct B (corn gluten meal and trace mineral salt) failed to give a satisfactory result. The formula for the trace mineral salt mix had been changed since 1964 and possibly the new mix was not as satisfactory as was found in 1964.

No unusual effects could be observed for those diets containing Durabond, and it can be concluded that this ingredient has little or no effect on cutthroat trout.

65 Ct F, which had the highest level of herring meal, gave the best overall results. Substitution of blood meal and soybean oil meal for the herring meal, i.e. 65 Ct G, gave very acceptable results, from the standpoint of growth, mortality, food conversion, and protein conversion. Thus, it can be concluded that blood meal is acceptable in cutthroat trout feed, and that a combination of blood meal and soybean flour meal can be substituted for fish meal.

The reduced food allowance could have been a major factor in achieving the better conversions found during the 1965 series. Much more attention must be given to the adaption and the evaluation of food allowance tables for feeding of the more concentrated type of protein foods.

The overall conclusion from the 1964-1965 studies would be that dry feeds of the types tested are reasonably acceptable for the feeding of cutthroat trout and possibly other salmonids. The food conversions achieved by cutthroat trout in 50°F water are reasonably similar to those expected for rainbow trout in warmer water stations, in that 0.6-0.8 g. of protein is required for a live weight gain of 1 g. These levels of protein conversion are the same as those reported by Phillips et al., (1964, 1965) for diets 5, 6, and 7.

Literature Cited

Phillips, Arthur M., Jr., Henry A. Podoliak, Hugh A. Poston, and Donald L. Livingston. 1964. Dry Concentrates as Complete Fish Foods. Fisheries Research Bulletin No. 27, The Nutrition of Trout, Cortland Hatchery Report No. 32 for the Year 1963, p. 47.

Phillips, Arthur M., Jr., and Glen L. Hammer. 1965. Modified Pelleted Dry Mixtures as Complete Foods for Brown Trout. Fisheries Research Bulletin, No. 28, The Nutrition of Trout, Cortland Hatchery Report No. 33 for the Year 1964, p. 23.

Table 1

Composition of Formulas, Cutthroat Tests, 1964

Ingredient	64 C1	64 C2	64 C3	64 C4	64 C5
Fish Meal (B.C. herring)	63	63	63	63	70
Corn Gluten Meal	3	6	3	5.5	10
Oat Flour					
Soybean Flour Meal					
Blood Meal					
Liver Meal	5	5	5	5	5
Meat Scrap Meal	10	10	10	10	
Brewer's Yeast	2	2	2	2	
Condensed Fish Solubles	1	1	1	1	1
Dried Skim Milk					
Durabond					
Vitamin Premix[1]	0.5	0.5	0.5	0.5	1.0
2250A-300D Feeding Oil	3	3	3	3	3
Herring Oil	2	2	2	2	2
Lecithin	5	5	5	5	5
Trace Mineral Salt			2.5		
Kelp Meal	3		3	3	3
Salt	2.5	2.5	2.5	2.5	
Protein (minimum)	57	57	57	57	63
Fat (maximum)	17	17	17	17	16

[1] No choline or ascorbic acid

Table 2

Composition of Formulas, Cutthroat Tests, 1965

Ingredient	Production Fry Feed	65Ct B	65Ct C	65Ct D	65Ct E	65Ct F	65Ct G
Fish Meal (B.C. herring, whole meal)	67	69	69	69	69	69	47
Corn Gluten Meal		5	5	6			
Oat Flour						4	4
Soybean Flour Meal	9				6		8
Blood Meal	5	5	5	5	5	5	24
Brewer's Yeast		5	5	5	5	5	2
Condensed Fish Solubles	1	1	1	1	1	1	1
Dried Skim Milk	4						
Durabond		2	2			2	
Vitamin Premix	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2250A-300D Feeding Oil	3	3	3	3	3	3	3
Herring Oil (Stabilized, 2 less than 0.01% free acid)	2	2	2	2	2	2	2
Lecithin	5	5	5	5	5	5	5
Trace Mineral Salt (Key Minerals type MF)		0.25					
Salt (iodized , 0.01% KI)	3.5	2.25	2.5	3.5	3.5	3.5	3.5
Protein (Minimum)	58	56	56	57	59	57	59
Fat (Maximum)	17	16	16	16	16	16	14

Table 3

Idaho Cutthroat Feeding Trials (1964-1965)
Warm River State Fish Hatchery
Water Temperature 50°

Formula	Mortality percent	Average daily food allowance	Weight gain percent	Food Conversion food/gain	Food Conversion protein/gain
1964 Series					
64 C1	8.5	10	626	2.78	1.58
64 C2	7.6	10	576	2.32	1.32
64 C3	15.1	10	708	2.60	1.48
64 C4	8.8	10	592	2.48	1.41
64 C5	11.8	10	871	2.06	1.30
Commercial (Chinook mash)	5.5	10	454	5.00	
1965 Series					
Production Fry Feed	10.7	4.2	753	1.36	0.81
65Ct B	42.2	5.0	430	2.33	1.32
65Ct C	11.2	3.8	615	1.10	0.62
65Ct D	22.8	4.3	516	1.52	0.87
65Ct E	11.2	3.9	606	1.30	0.77
65Ct F	12.3	3.9	722	1.08	0.61
65Ct G	7.2	4.0	625	1.26	0.77

Idaho Production Diet Test, 1965

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Introduction

Fish feed purchased for use in Idaho State trout hatcheries is an open formula diet. The feed specifications, the conditions of manufacture and delivery are advertised for competitive bidding by interested feed manufacturers.

In order to improve the diet and keep abreast of changing supplies of fish feed ingredients, it has been necessary to carry on continuing diet tests.

The diets tested were formulated in cooperation with Dr. A. M. Dollar, University of Washington, College of Fisheries.

Diet tests were conducted at production stations by the regularly assigned hatchery personnel.

Each test commenced with approximately 15,000 rainbow trout swim-up fry. These fish were fed a fry diet, described in Table I, until they were large enough to accept the number 2 size fry diet. At this time, they began feeding on the test diet.

A density of one pound of fish per cubic foot of water was maintained with the exception of Mackay Fish Hatchery where the density was .5 pounds per cubic foot of water. Fish were reduced in number randomly when this density was exceeded, and the number of pounds of fish on each test at a given hatchery was equalized.

Test Diets

The diets tested were the production diet, used at all State fish hatcheries during 1965, which is listed as Diet B in Table II. The other diets tested were variations of the production diet. Diet C was a substitution of whey for dried skim milk and the addition of two percent Durabond as a pelleting agent. Diet D was a substitution of herring meal for blood meal. This diet also contained two percent Durabond as a pelleting agent.

Vitamin Concentrate

All diets had the same vitamin concentrate added at the rate of ten pounds per ton of finished feed. The vitamin concentrate is presented in Table III.

Diet Cost

The B diet was purchased for $8 cwt for the first six months of 1965, and $8.78 cwt during the last six months of 1965. The increase of 78 cents per cwt was caused by increasing herring meal prices. Experimental diets were all priced at $15 per cwt due to the special mixing and handling problems. No comparative cost analysis was made.

Length of Tests

Feeding tests were carried on for a period of eight months with the exception of those at Hagerman, which were for a five-month period.

Results

The results of the feeding tests are tabulated in Table IV.

The addition of two percent Durabond in the C diet had no effect on the test fish as compared to fish fed Diet B. It also did not appear to improve the pelleting quality of the feed.

The substitution of five percent fish meal for blood meal did not show any appreciable change in growth response.

Acknowledgement

Special thanks are extended to those who carried on the experiments: Hatchery superintendents - B. D. Ainsworth, E. O. Bailey, Walt Bethke, Calvin Coziah, Norman Floyd, L. W. Gaver, and Hark Misseldine and their respective hatchery personnel.

TABLE I

Idaho Fry Feed (Size 1 only)

Herring meal	Blood meal	Skim milk	Soybean flour meal	Lecithin	A&D oil	Herring oil	Iodized salt	Fish solubles	Vitamin concentrate
67	5	4	9	5	3	2	3.5	1	.5

TABLE II

Diet Ingredients, Idaho Production Diet Tests, 1965

Diet	Herring meal	Meat scrap meal	Blood meal	Soybean flour meal	Delactosed whey	Dried skim milk	Wheat mids	Brewer's yeast	Condensed fish solubles	A&D Feeding oil	Vitamin Concentrate	Iodized salt	Kelp meal	Durabond
B	31	10	5	10	5	4	20	5	1.0	2	0.5	3.5	3	
C	31	10	5	10	9		18	5	1.0	2	0.5	3.5	3	2
D	36	10		10	9		18	5	1.0	2	0.5	3.5	3	2

1. All fish were started on Idaho fry diet which is presented in Table I.

TABLE III

Idaho Vitamin Concentrate Per Ton of Finished Feed

Vitamin E	not less than	60,000 IU
Riboflavin	not less than	90,000 milligrams
D-Calcium Pantothenate	not less than	50,000 milligrams
Niacin	not less than	100,000 milligrams
Ascorbic Acid	not less than	200,000 milligrams
Vitamin B_{12}	not less than	20 milligrams
D-Biotin	not less than	600 milligrams
Thiamine Hydrochloride	not less than	90,000 milligrams
Pyridoxine Hydrochloride	not less than	20,000 milligrams
Folic Acid (without zinc folate)	not less than	3,000 milligrams
Choline Chloride	not less than	250,000 milligrams

TABLE IV

Results of eight-month[1] feeding tests at
Idaho Fish and Game Department Hatcheries, 1965

Station	Diet	Pounds of feed/pound of fish	Mortality percent	Hematocrit readings
Ashton	B	1.77	33.6	37.4
	C	1.83	42.5	32.6
Grace	B	1.47	6.2	36.1
	C	1.21	5.1	33.6
Hagerman	B	1.42	1.6	38.1
	C	1.46	1.1	37.3
Mackay	B	1.47	2.5	37.0
	C	1.52	2.4	38.6
American Falls	B	1.58	1.8	41.2
	D	1.46	1.8	34.1
Hagerman	B	1.42	1.6	38.1
	D	1.40	.9	35.2
Hayspur	B	1.22	3.0	36.7
	D	1.24	3.0	36.1
Mackay	B	1.47	2.5	37.0
	D	1.46	1.3	38.4
Twin Falls	B	1.70	.8	36.4
	D	1.99	4.4	36.2

[1] Except Hagerman Fish Hatchery where tests were for five months.

Digestion and Metabolism Studies In Closed Systems

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This report is an introduction to the digestion and metabolism studies currently being conducted and describes equipment and methods used in these studies. We are attempting to evaluate complete diet and also diet ingredients on the basis of the protein and energy content available to fish. Metabolism chambers described in Progressive Fish Culturist, April 1965 are being used with the addition of a recirculation and cooling system. This equipment permits separate and quantitative collection of feces, urine and gill excretions. Energy and nitrogen determinations are made on feed fed, on excretions, and from these data digestable energy, metabolisable energy, digestable protein and the Apparent Biological Value of the protein can be calculated.

Physical limitations make it necessary to use fish weighing 250 to 500 grams. Fish are usually not reared to this size under normal hatchery conditions except as brood stock. Feeding trials are planned to determine if values obtained with large fish can be used for small fish and if values obtained with one species can be applied to similar species of the same or of different size. This system appears to be a valuable tool in the rapid evaluation of diets and diet ingredients for energy and protein components.

The Reclamation and Reuse of Water

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Hatchery production is often limited by the quantity or quality of the water supply. Recirculating water reclamation and reuse systems would have the effect of increasing the water supply and would allow control of the environment. Experiments conducted at the Salmon-Cultural Laboratory in 1964 indicated that water reclamation and reuse was practical for both rearing fingerlings and holding adult salmon. The 1965 tests were directed toward increasing the efficiency of the water reconditioning facilities.

The water reconditioning facilities of the original model reuse system included a settling tank and an oyster shell filter. Tests proved that most of the nitrifying bacterial culture was contained in the oyster shell filter and was lost each time the filter was cleaned. In order to provide additional area for bacterial growth a more efficient filter, in terms of nitrification, was developed which contained a layer of crushed rock on the bottom with a layer of oyster shell on top of the rock. During cleaning only the oyster shell was agitated to remove the accumulated debris; the rock was not disturbed.

Experiments disclosed that a more efficient operation could be achieved by substituting filter area for the settling tank. A second model system was constructed without a settling tank but with 7 filters which equalled the combined area employed for settling and filtration in the prototype model. At a fish loading of approximately 6 pounds per gpm of recirculating water, the new system functioned efficiently with 4 of the 7 filters operating.

A new method of filter cleaning was developed which introduced compressed air into the bottom of the filter tank to agitate the oyster shell. The method practically eliminated hand labor and reduced the backflush water requirement by 75 percent.

A large-scale, 2-rearing pond reuse system with supplemental well water at 53° F. was utilized successfully for fingerling rearing. Filter area was increased 50 percent over that used in 1964 by the addition of a third filter tank. All filters contained crushed rock and oyster shell. Each of the 2 ponds was stocked with 117 pounds of fall chinook fingerlings averaging 485 per pound on January 20. On May 12, each pond contained 1,025 pounds of fingerlings averaging 55 per pound. Production fish of the same age reared in comparable ponds on creek and well water averaged 94 per pound. Difference in size was due primarily to more favorable water temperature in the reuse system. Stamina tunnel performance of the reuse fish was comparable to that of the production fish. Approximately one-half the fish were liberated in May and the remainder reared until August 2. Growth was excellent and mortality was comparable to that of production fish reared in ponds with single water use. Performance of the reuse fish at the August release was somewhat less than the production fish due primarily to furunculosis in the reuse ponds. It was believed that furunculosis was introduced into the ponds when the filters were backflushed with creek water. The disease was controlled but not eliminated by treatment with TM-50.

Adult fall chinook and silver salmon were held to full maturity ina recirculating water reuse system. Eggs were collected from both species and were normal.

Criteria have been established for the design of water reclamation and reuse systems based on the results of experiments conducted during the past 2 years. These criteria are as follows:

1. Carrying Capacity of Reconditioned Water:

   90 per pound fingerlings: 5 lbs./gpm at 60° F.

   5 per pound fingerlings: 8 lbs./gpm at 60° F.

2. Requirements for Reconditioning Systems:

   Filters require 1 sq. ft. of area per gpm of recirculated water.

   Filter backflush requires 5 gpm per sq. ft. of filter or 1 gpm per sq. ft. if supplemental air is introduced.

   Aspirators have capacity of 125 gpm at 10 psi and require 4 sq. ft. of area each.

   Jets should drive into 5 ft. of water and bottom of jet should be 6 inches above water surface.

   Aspirators are 90 to 95 percent efficient.

3. Supplemental Water Requirements:

   10 percent supplemental water required to be added to recirculated water to attain one theoretical interchange in system every 12 hours.

4. Temperature Control:

   For every 4° F. rise in ambient temperature, 1° F. rise in reused water temperature above that of supplemental water supply.

Complete design drawings are available for the proposed water reconditioning system of the Salmon-Cultural Laboratory. In this system 5,000 gpm will be recirculated with a supplemental water requirement of 500 gpm to be derived from 53° F. well water. The recirculation system will supply all outside ponds and the experimental area and be capable of producing 2,250,000, 90-per-pound fall chinook fingerlings with all facilities operating.

The Use of Drugs in Fish Culture

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The use of drugs in fish culture has been questioned by the Federal Food and Drug Administration (FDA). We in fish-cultural work often think the FDA is too severe on us, but we must remember that the FDA has the job of protecting the consumer against harmful products. In 1906, Congress passed the Wiley Pure Food Law. After the Elixir Sulfanilamide incident, this was supplemented by a Federal Food, Drug and Cosmetic Act in 1938, which stated that the safety of new drugs must be established before being marketed. Thus, the approach shifted from one originally designed to deal with "after-the-fact" violations to a "preclearance" or a "preventive" approach which places upon the regulated industries the burden of establishing the safety, effectiveness and usefulness of their products prior to marketing. This act was modified by the Food Additive Amendment of 1958 and again amended in 1962. It is with this section of the law that our rules and regulations concerning drug additives and food additives took on a new emphasis. Food additives include substances used in manufacturing, packaging, transporting, or holding if such substances become a part of the food. A drug added to a feed, whether for growth enhancement, disease prevention or disease treatment is a food additive. Also a drug added to drinking water for whatever purpose is a food additive. If there is residue of a drug in animal tissues consumed by man, the drug is a food additive. No animal used for investigational testing, or their products, shall be used for food purposes unless authorization has been granted by the Commissioner. The FDA's responsibility covers all food including that for man, the common domestic animals, wild animals, birds, reptiles, amphibians, fish and even invertebrates.

We in fish-cultural work must abide by the laws of our country and obtain clearance from the FDA to legally use anesthetics, sulfonamides, antibiotics, furans, carbarsone, mercurials, etc. in the treatment of fish. Under the law, the responsibility for gathering the necessary safety and effectiveness data rests with those who want to market or use the drugs or medicated feed. Because the drug manufacturers do not have the facilities or interest to obtain clearance for the products we use, it is our responsibility to do this tedious, time-consuming chore. The information required for clearance of a drug seems all inclusive and encompasses:

1. Specific clearance for each drug for each species of fish.
2. Toxicity, efficacy, and residue data on:
    a. three sizes of each species (fingerling, legal, adult)
    b. at least three water temperatures
    c. in water of different degrees of hardness
    d. in water at different pH levels
    e. residues at various withdrawal times (raw and cooked fish)
3. Long range effects on exposed fish and their offspring.
4. Gross and histopathological autopsy report on excess use.
5. Stability of the drug in food.
6. Mammalian toxicity (2-year feeding study with dogs and rats when indicated).
7. _In vitro_ information on etiologic agents is also required.

In order to obtain clearance on a drug, the foregoing information must be accumulated and submitted formally to the FDA. If it is determined that all criteria are satisfied, clearance will be given for that drug to be used only under the conditions tested and with the species of fish used. FDA has agreed to have a "Master File" in Washington on fishery drugs so that industry, patent-holders, or such could submit applications for clearance on the basis of data in the Master File.

Dr. Snieszko, Director of the Eastern Fish Disease Laboratory, submitted voluminous material to the Master File on sulfamerazine for the control of furunculosis. He has drawn up a petition for clearance using literature citations and his own work to give an extensive backgroud in fish culture, a list of fish diseases for which chemotherapy may be recommended, and methods for treating diseased fish. He mentioned other sulfonamides and showed that sulfamerazine is effective against the etiologic agent and is not toxic to trout. He gave tremendous detail in all phases of the work but to date FDA has not replied. Clearance was given for sulfamerazine before 1950 by FDA but with a stipulated nine-month withdrawal time.

The Fish Control Laboratory at LaCrosse, Wisconsin, has agreed to obtain the necessary data for FDA clearance for the anesthetics MS-222, Quinaldine, methyl pentynol, and McNeil-7405. As data are collected they will be submitted to the FDA Master File in Washington.

The Western Fish Disease Laboratory is accumulating data on the use of mercurials for the treatment of fish diseases. The FDA will be petitioned for clearance on these compounds after sufficient information has been gathered.

Dr. George Post, formerly with the State of Utah Department of Fish and Game, has done considerable work on the use of furan drugs for the control of bacterial infections in fish. So far his attempts to obtain FDA clearance have not been successful.

The Fish Farming Experimental Station at Stuttgart, Arkansas, is carrying on research for the control of the copepod, *Lernaea cyprinacea*, on the golden shiner with organophosphate insecticides in the food.

We all in fish-cultural work look forward to the day when we will have FDA clearance for the drugs and chemotherapeutic agents we so urgently need.

The Use of Mercurials in the Hatchery

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Mercurials in private, state and federal fish hatcheries have been used extensively for control of various external fish pathogens with little knowledge of the absorption, retention, and elimination of mercurials by fish. Since mercurials are highly toxic and have the ability to concentrate in animal tissues, they might be considered a public health problem. The Western Fish Disease Laboratory is now cooperating with the Food and Drug Administration (FDA) in trying to determine the limitations of these drugs.

To date all of our studies have been with ethyl mercuric phosphate (Lignasan, Timsan). In juvenile sockeye salmon treated weekly for one hour with Lignasan at 1.1 to 1.5 ppm for about four months, the maximum mercury concentration in whole fish homogenates was 4.8 ppm. The mercury concentration had decreased only 38% in twelve weeks following the last treatment.

The tissues were analyzed for mercury from the same group of fish. It was found that the kidney contained the highest concentration of mercury (36 ppm), followed by the liver (20 ppm), gill (11 ppm), muscle (4.5 ppm) and head (4.2 ppm). The fish had been frozen; therefore, no blood samples were available. After twelve weeks the decrease in mercury concentration in all tissues, except the kidney, averaged 62%. In the kidney the decrease was about 17%, and there was no difference in concentration between the anterior and posterior kidney. It was concluded that the kidney is the primary organ where mercury is concentrated and retained.

A single exposure of Timsan for sixty minutes at 5 ppm (1 LC_{50}) was given to yearling rainbow trout. In this case the gill contained the highest concentration at 19.9 ppm, followed by the red blood cells (2.0 ppm), Kidney (1.6 ppm), liver (0.9 ppm), and skin (0.5 ppm). The blood serum contained no mercury.

An actual incident of mercury poisoning of humans (Minamata Disease) from fish contaminated with mercury has been reported. Mercurial poisoning will be discussed, and the results from the data presented will be compared to the Minamata incident.

"Whirling" Silvers

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"Whirling" juvenile silvers have been observed on occasion for the past several years in many Northwest hatcheries. Clinical symptoms are characterized by whirling along the long axis of the body or in a corkscrew fashion similar to that associated with several other diseases such as IPN and Hexamita infection. In the more severe cases the fish have any or all of the following symptoms: scoliosis, lordosis, lordoscoliosis, distended abdomen and dorsal swelling just posterior to the head.

This disease has not been considered much of a problem since it has never reached epizootic proportions and the mortality rate is rarely above normal. However, it occurs annually at some hatcheries and histological findings indicate that it may become a serious problem.

In 1963 definite histopathological changes which were associated with this disease, strongly suggested neoplasia of the central nervous system, particularly in the posterior portion of the brain. These changes have been microscopically confirmed only in coho salmon from three National Fish Hatcheries in Washington. Preliminary studies indicate that it is not of viral or bacterial origin.

Detailed morphology, etiology and pathology are yet to be described. Actually we have an ulterior motive in presenting this brief report: we need help, particularly from the hatchery men and biologists in the field. In order to obtain more information we would appreciate being notified when "whirling" silvers are seen. Detailed case histories regarding egg source, diet, % mortality, % of affected fish, etc. would be appreciated.

Basic Hematology for the Fish Culturist

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Hematology is defined as the branch of medicine that has to do with the blood in all its relations -- anatomy, physiology, pathology, and therapeutics. Blood is a tissue which circulates in a virtually closed system of blood vessels. It consists of solid elements - the red and white cells and thrombocytes - suspended in a fluid medium - the plasma. The more important functions of blood are:

1) Respiration
2) Nutrition
3) Excretion
4) Maintenance of acid-base balance (pH)
5) Defense against infectious agents

Hematopoiesis is the term used to describe the formation of blood. In the salmonid the main site for blood cell production - both red and white - is the anterior kidney. The middle kidney, spleen, and posterior kidney follow in decreasing order of activity. There is very little cellular hematopoietic activity in the liver. The production of the main plasma proteins - fibrinogen, prothrombin, and albumin - occurs in the liver. The globulins - the plasma proteins usually associated with defense mechanisma - are produced in the reticuloendothelial system - the kidney and spleen.

Some of the more important tests that reflect the relative state of health of the host are:

1) Hematocrit - the packed cell volume in percent of cells in a given unit of blood. It reflects the numbers of red blood cells more accurately in most cases than does the red cell count proper. It is also an indirect index of circulating hemoglobin in some cases. The color of the plasma layer is an index to the amount of circulating bilirubin, a pigment derived from red blood cell destruction.

2) Hemoglobin - the expression as grams per 100 ml. whole blood indicates the relative oxygen carrying capacity of blood. In fisheries, it indirectly could be considered an index of stamina.

3) Red cell count - the numbers of red blood cell per ml. of blood. It is a highly inaccurate test in terms of degree of error. Most workers consider an error of less than 15% quite satisfactory. However, this test is a necessary part of the circulation of the red blood cell indices (the MCV, MCH, and MCHC which follow).

4) MCV - the mean corpuscular volume. That is, the volume of the average red blood cell expressed in cubic microns. It is calculated by the hematocrit multiplied by 10 being divided by the red cell count expressed as so many million per mm^3. For example, the hematocrit is 37 and the red cell count is 2.3 million per mm^3.

$$\frac{37 \times 10}{2.3} = 160.8 \text{ cubic microns}$$

Normal MCV - normocyctic

Increased MCV - macrocytic

Decreased MCV - microcytic

5) MCH - the mean corpuscular hemoglobin. That is how much hemoglobin by weight there is in the average red cell. It is expressed in micromicrograms. It is calculated by the hemoglobin in grams percent times 10, divided by the red cell count in millions per mm^3. For example, the hemoglobin is 11.0 grams percent and the red cell count is 2.3 million per mm^3.

$$\frac{11.0 \times 10}{2.3} = 47.8 \text{ micromicrograms } (\mu\mu g)$$

6) MCHC - the mean corpuscular hemoglobin concentration. It is the ratio of the weight of the hemoglobin to the size of the cell in which it is contained and is expressed as percent. It is calculated by the hemoglobin in grams percent times 100, divided by the hematocrit. For example, the hemoglobin is 11.0 grams percent and the hematocrit is 37.

$$\frac{11.0 \times 100}{37} = 29.7\%$$

Normal MCHC - normochromic

Decreased MCHC - hypochromic

Increased MCHC - there are no conditions in which this occurs

Now the next step is to use the foregoing tests effectively. The main purpose of these tests is to aid in classifying the different types of anemias as to their probable cause.

Anemia is defined as a decrease below normal in numbers of circulating red blood cells, hemoglobin, and hematocrit. With what knowledge we have as of now, we can make the following interpretations regarding the probable cause(s) of some of the anemias:

Normocytic normochromic:

1) Acute and subacute hemorrhage
2) Certain infections - both bacterial and viral
3) Metabolic diseases resulting in excessive red blood cell destruction.

Microcytic hypochromic:

1) Chronic hemorrhage
2) Iron deficiency through inadequate amounts of iron in the diet or faulty absorption of iron from the diet.
3) Deficiency of some of the hematopoietic factors - pyridoxine and riboflavin.

Macrocytic hypochromic:

1) Increased hematopoetic activity in the kidney and spleen.

There are other hematologic tests that can be used as diagnostic aids but, in general, they are time consuming and are generally done in the laboratory situation. The changes in white blood cell count and the differential white cell count have been studied in our laboratory and we so far have concluded that in the clinical phase of an infection they often are not significant from a diagnostic standpoint.

A Myxobacterium and a Myxosporidian Found in Juvenile Salmonids in Oregon Fish Commission Hatcheries in 1965

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A Myxobacterium

"Cold Water Disease" occurs yearly in juvenile coho salmon at most Oregon Fish Commission hatcheries. Incidence varies between hatcheries and sulfamethazine prophylaxis during temperatures below 50°F. usually prevents high mortality.

Deformed fish are also present, in varying numbers, each year in our coho stocks. Crippled fish are usually first noticed as water temperatures exceed 50°F., and cold water disease symtoms disappear. They become more numerous and evident as the season progresses, due to more pronounced spinal aberration.

Prior to the 1965 rearing season, we were unable to associate any pathogen with spinal aberrant fish. This year, in early May, small inflamed closed blebs usually located posterior to the dorsal fin were noted on deformed coho at the Alsea and Sandy hatcheries. Later in the season, blebs were also observed on Coho at Bonneville and Cascade hatcheries. Tissues underlying the blebs were hemorrhagic and soft. As the season progressed, the blebs became somewhat hard and underlying tissues were necrotic. Now, small hard lumps are often noted on caudal peduncles, and dissection usually reveals fused vertebrae without hemorrhage or necrosis of surrounding tissues.

A gram negative bacterium seemingly indentical in morphology and colony type to the etiological agent of cold water disease was isolated from blebs and kidneys of deformed fish early in the season. We were unable to culture the bacterium from blebs after they became hard and non-necrotic, but it can still be isolated from kidneys of some deformed fish.

Normal Appearing coho from Oxbow, marked by adipose fin excision and unmarked spinal aberrant coho from Sandy have been maintained in a small circular tank at the Clackamas Laboratory since May 21, 1965. On September 29, 1965, two of the marked fish had crooked spines. A myxobacterium, apparently the same as the one cultured earlier, was isolated from the kidney of one marked deformed fish. Kidney inocula from the other fish did not produce growth. Oxbow Hatchery coho were selected for the transmission study because very few deformed fish have been noted there, and cold water disease has usually been nonexistent or not a problem. However, none of the other marked fish have shown spinal aberration, and it is quite possible that the bacterium isolated from the one deformed marked fish resulted from a prior infection.

We do not infer that this bacterium is the etiological agent responsible for spinal aberrant fish. However, this year the bacterium has been repeatedly isolated from the kidneys of deformed fish, and the incidence of such fish has been greatest at hatcheries where the largest numbers of fish were lost from cold water disease, which indicates that the cold water disease organism may be implicated.

A Myxosporidian

Ceratomyxa was found this year in 1964-brood spring chinook and 1965-brood steelhead at Pelton Hatchery, and in 1964-brood coho at Bonneville Hatchery. It was also found by Oregon State University personnel in residual spring chinook believed to be 1963-brood at the adult holding ponds below Dexter Dam on the Willamette River. These appear to be the first reports of *Ceratomyxa* in juvenile salmonids in Oregon. Diagnosis in all cases were made by microscopic observation of wet mounts usually prepared from intestinal mucosa.

Symptoms of the infection varied widely between fish species. At Pelton, an experimental hatchery in its first year of operation, *Ceratomyxa* was found only in scrapings from the hind gut in only two emaciated spring chinook. Emaciated fish were never abundant, only one or two spores were found per fish, mortality was negligible, and not all emaciated fish harbored the parasite. Very few spores were found in residual spring chinook at the Dexter holding ponds and mortality there was nonassessable.

Symptoms in the Pelton steelhead were very conspicuous. Caudal peduncles were often dark. Addomens were always distended and hemorrhagic areas, extending from the vent past the pelvic fins, were usually present. Stomachs were filled with fluid and lined with caseous material. Coagulated or caseous material was often dispersed among the pyloric ceca, intestinal contents were mucoid, and the posterior portion of the intestines were swollen and usually hemorrhagic. Spores were found in liver tissues, gall bladders, kidneys, and caseous material dispersed among the pyloric ceca, but the greatest concentrations of the parasite, both mature spores and trophozoites, were found in the hind gut. Mortality attributed to *Ceratomyxa* reached a high of about 7% per week in July, decreased to about 2% weekly in August, and increased to approximately 10% per week in September. Mortality declined throughout October, and is now about 2% per week. By November 6, 1965, approximately 58% of the fish had died. However, some of this loss occurred early in the season before *Ceratomyxa* was detected.

The appearance of lethargic nondeformed fish among spinal aberrant ones near the outlet screens was the first indication of *Ceratomyxa* in

Bonneville coho. These fish had slightly raised ridges over the rectal contour on each side of the body. Vents were enlarged (sometimes excessively) and often oozed mucous, but were seldom inflamed. Stomachs were empty and the fish appeared emaciated although all contained considerable fat. The posterior portion of the intestine was distended and did not contain feces. Spores were found in liver tissues, gall gladders, and kidneys, but as in the steelhead, greatest concentrations, both mature spores and trophozoites, were always found in the hind gut. Mortality did not exceed .7% per week and much of this loss was comprised of spinal aberrant fish not infected by Ceratomyxa as determined by wet mount examination. However, change in water supply immediately after the organism was detected may have prevented higher losses.

It is interesting to note that all three sites of infection are below impoundments. Pelton Hatchery is located on the Deschutes River below the Pelton reregulatory reservoir. Water is delivered to the hatchery via the Pelton fish ladder or is pumped from the river below the dam. Dexter holding ponds are just below the Dexter reregulatory dam on the Willamette River. Water is conveyed to the ponds by pipe from approximately 49 feet below the surface of the reservoir forebay. Bonneville Hatchery, located on the Columbia River below Bonneville Dam, is normally supplied with water from Tanner Creek. This year, from July 1 until Ceratomyxa was detected, (September 2, 1965) a mixture of approximately 1/3 Columbia River water and 2/3 Tanner Creek was used. Soon after Columbia River water was eliminated, the incidence of infected fish decreased. This was possibly due to elimination of infection by water borne spores in the hatchery supply, and reduction of water temperature which probably curtailed spread of the infection within pond populations.

The Pelton site afforded the best opportunity for detection of *Ceratomyxa* in wild fish. Consequently, various salmonids and trash fish species collected in the ladder and at the trap below Pelton regulatory dam were sent to Oregon State University for examination. *Ceratomyxa* was not found in any of the fish.

The Detection of Infectious Pancreatic Necrosis

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The control of the spread of infectious pancreatic necrosis is, in part, dependent upon the ability to detect the disease in virus-carrying, asymptomatic trout; especially adults which produce infected eggs. Outbreaks of IPN often occur among young fish at locations remote to the parent brood stock and the disease has been shown to be spread with the eggs from these infected populations. Techniques of sampling fish for virus and the methods of testing the resultant samples in RTG-2 tissue cultures were discussed and a film illustrating these procedures was shown.

Recent research has indicated that the testing of the feces of fish for IPN virus is a sensitive and probably superior sampling technique. These methods are an important first step toward the isolation and control of IPN and possibly other diseases, but the future development of control measures is dependent upon the completion of vital epizootiological studies.

Characterization of the Oregon Sockeye Salmon Virus [1/]

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The development of a reliable method of preparation and cultivation of fish cells *in vitro*, by Fryer, Yusha and Pilcher (1965) has opened the way for determining some of the biochemical, physical and biological properties of the Oregon sockeye virus.

It has been found that this virus will infect tissue cultures of sockeye embryonic cells, causing a well defined sequence of cytopathic events. The cytopathic changes include thickening of the nuclear membrane, alteration of the nucleoli and occasionally division of the nucleus into several segments.

In vivo experiments carried out to determine the host range of the Oregon sockeye virus have indicated that it will infect only sockeye (kokanee) salmon. Chinook, and coho salmon and rainbow trout were also exposed to the virus but gave no indication of being susceptible to it. The results of these experiments are similar to those reported by Watson, Guenther and Rucker (1954).

Other properties of the virus which have been described are as follows:

1. The virus was completely inactivated after exposure to a buffered aqueous mixture containing approximately 20% ether by volume for 23 hours at 4°C. This indicates that the virus contains essential lipids.

1/ This work supported by funds received from the Oregon Fish Commission.

2. The particle size of the virus as determined by filtration is between 110 and 165 mμ.

3. The virus showed no hemmaglutinating action when tested on red cells from several different animal species.

4. Studies using 5 Bromo deoxyuridine have suggested that the viral nucleic acid may be RNA.

5. The virus produced easily discernible plaques on tissue culture monolayers of sockeye embryonic cells. This provides a new method of titrating the virus.

6. Temperature studies in tissue culture have shown that the virus multiplies most rapidly at 13 and 18°C, much more slowly at 4°C, and not at all at 23°C.

Presently attempts are being made to purify the virus. After this has been accomplished, electron microscopy will be employed to determine the size and structure of the virus.

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Characterization of Five Fish Cell Lines[1/]

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Cell lines derived from several species of salmonids have been established in this labratory. The species represented are chinook, coho, and sockeye salmon; and steelhead and rainbow trout. All of these cultures have been growing for over two years, and are considered to be autonomous, i.e., capable of unlimited growth.

Many of the characteristics of these lines have been described by Fryer, Yusha, and Pilcher (1965). This investigation further describes these cell systems by analyzing their chromosomes. Preparation of cells for chromosome analysis was carried out by the method of Pacha and Kingsbury (1962) with slight modifications. From stained preparations of each culture, 100 cells were randomly selected and examined for the number and general morphology of the chromosomes.

As shown in Table I. the modal number of chromosomes was found to be different in four of the cell lines from that characteristic of the species. The range and distribution of chromosome numbers per cell were far greater for all the lines than that found in cells from normal tissue. Four of the lines have become definately aneuploid.

1/ This work supported by funds received from the Oregon Fish Commission.

Table 1 Results of Chromosome Analyses

Origin of Cell Line Culture	Normal Diploid Number 2/	Modal Number (s)	Range of Chromosome Numbers	Ploidy
Chinook Embryo	68	71	18-190	Aneuploid3/
Coho Embryo	60	71	57-173	Aneuploid
Steelhead Embryo	60	62	58-126	Aneuploid
Rainbow Hepatoma	60	54,60	18-144	Aneuploid
Sockeye Embryo	56	56	51-101	Euploid

2/ Reported by Simon (1963) and Simon and Dollar (1963).

3/ Aneuploidy in a cell culture is defined as a significant shift in modal values from the euploid condition found in normal tissues.

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Automatic Fish Dispatcher

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During the past few years our salmon spawning operations have undergone considerable change with the introduction of new methods and techniques. One of the more recent innovations at Little White Salmon National Fish Hatchery is a machine called a Fish Dispatcher. The main function of the device is to kill and bleed adult salmon immediately after sorting our ripe spawners. The machine performs both of these steps in one motion. It eliminates the traditional method of killing salmon with a hand club and at the same time eliminates the necessity of cutting tails manually for the bleeding process.

Some time ago, I became interested in the possibility of replacing the hand club with an air motor particularly since we had a compressed air source at our spawning site. I submitted my design to Mr. Stanley in our Engineering Department. Together we made minor modifications and Mr. Stanley then drew up construction plans.

We set the machine up at Little White toward the end of our chinook season this year. Unfortunately the machine was not operational during the chinook run but the mechanical problems were eliminated by the early part of our silver season. We were able to utilize the device through the major part of our silver season. It proved to be a very efficient and effective tool both for killing and bleeding silvers.

The Fish Dispatcher is an automated device consisting basically of an electrically controlled high speed air motor and piston rod assembly which utilizes air pressure at the spawning site. Attached to the end of the piston is a 2 pound wedge and a knife blade. The fish to be killed is positioned on its side between two vertically tilted guide plates, one of which pivots under spring tension. The latter plate adjusts for different-sized fish and at the same time holds the fish firmly in place under the impact blow of the piston. The operator, working at waist height, activates the piston by depressing a conveniently located knee button. The anterior portion of the piston assembly consisting of a knife edge advances through an opening in the guide plate and severs the spinal cord of the fish. The killing and bleeding processes are theregy accomplished in 1 step.

The piston stroke is approximately ten times faster than that of a standard air motor. The explosive piston velocity is due to a built-in air accumulator and a quick release valve in the front cylinder chamber which opens to the atmosphere.

The unit operates on a 12 volt electrical system. 110 volt line current is reduced to 12 volts by a transformer located in a sheltered area apart from the main operation.

Incoming air from our compressor is fed through a lubri-air control unit which assures a supply of clean, dry air at controlled pressure. The pressure may be adjusted by turning a dial on the regulator while watching the pressure guage.

My observations as well as those of the hatchery staff point to a number of advantages in using the dispatcher. It eliminates the hand-club for killing adult salmon and at the same time eliminates manual tail cutting as a prerequisite for the bleeding process. It reduces the amount of work necessary to kill fish and enables the job to be done faster. One blow with the knife blade is usually sufficient to kill a fish whereas the club may require 2 or 3 blows. We have not done any time studies but feel that with the killing and bleeding processes both considered, approximately 1 man may be eliminated from the spawning operation.

Another important advantage is that of safety. The danger of hitting oneself or someone else is eliminated, and the safety guards on the machine prevent access to the knife blade.

Another advantage is that of public relations. It is felt that the public would be more receptive to the fish dispatcher than to the hand club. In my opinion, as far as the public is concerned the automated system reduces the time to kill fish. The use of the hand club is probably one of the more impressionable aspects of the spawning operation. These factors will no doubt become more important as time goes on and we have increasing numbers of visitors at our hatcheries.

Anesthetics for Adult Salmon

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For the past several years, National Fish Hatcheries on the lower Columbia River have used anesthetic solutions to inactivate adult salmon so they could be easily checked for sexual maturity. The hatchery managers and their staffs have developed various methods and devices for this purpose.

Tricaine methanesulfonate (MS 222), methyl pentynol and quinaldine have been tested and used on a production scale. Tricaine methanesulfonate is the best of the three drugs as it produces a deep anesthesia much faster than the others, but it is considerably more expensive. Some of the fish are given to Indians after spawning and there has been objection to the odor of methyl pentynol on these carcasses.

Three to five minutes immersion in the solution are required to anesthetize the fish sufficiently for easy handling. All anesthetic solutions are changed completely at least twice daily and additional amounts are added several times to make up for dilution. The amount and total cost of the anesthetic vary somewhat with the number of adults handled. We believe it is essential that the adult salmon be well rinsed or washed before spawning to prevent anesthetic draining from the fish into the egg bucket. All fish must be killed by a blow on the head before spawning as anesthetia is not complete enough to prevent all reaction from the fish during the spawntaking procedure.

Almost all of the adult fall chinook salmon spawned at Spring Creek NFH in 1964 and 1965 were anesthetized in equipment designed by

Manager H. B. Cox. The methods used at Spring Creek are less elaborate, and much cheaper, than those to be described later. A hand crowder operated by two men is used to force the adult salmon over a grid which drains off most of the water, and the fish then slide into one of two tanks containing anesthetic solution. As soon as the fish turn on their sides, a man standing in the tank lifts each fish in turn onto a table where an experienced hatcheryman checks the females for ripeness. These are killed with a club for spawning and the green fish are returned along a chute to another pond. Males are handled in the same manner as the females. While the fish in one tank are being checked, the second tank is loaded with fish which become anesthetized by the time the first tank is emptied.

Quinaldine at a concentration of about 16 ppm is the anesthetic used with this equipment. Although the fish become inactive in the anesthetic solution in a few minutes they will still react vigorously to some stimuli. The man removing the fish from the tank does not release his hold until the checker has a firm grip on the fish. If the fish are merely laid on the table they will usually flop as though they were not anesthetized. The cost of the quinaldine for a full day of spawntaking is about $2.00.

In 1963 Manager Donald Cairns designed a mechanized fish anesthetizing unit which has been used at Eagle Creek NFH with good success. This is a portable device constructed to fit inside a standard 8' X 80' raceway. The adult salmon or steelhead trout are crowded into a brail, a gate is lowered to confine the fish and the brail, which has a slanting bottom of tubing, is raised by a winch and small motor. The water drains as the brail is raised and the fish slide into a tank containing anesthetic. When anesthetized, the adult salmon are removed by hand and checked for sexual maturity as previously described. Methyl pentynol is the anesthetic usually used with this equipment at a concentration of about 3030 ppm. Costs for the anesthetic are about $12.00 per day.

In 1964, an enlarged and modified version of Mr. Cairns' device was constructed in the adult holding pond at Little White Salmon NFH. Manager A. C. Gastineay and his staff have made several changes in the design to make the equipment more efficient. The adult salmon are placed in the anesthetic by a mechanically operated lifting device that also assists in draining excess water from the fish. The salmon slide from the lift over a grid of tubing and into the tank of anesthetic. The tank contains a basket or brail which, after the fish are anesthetized, is raised and the fish slide off the brail onto a table where they are checked for sexual maturity.

Tricaine methanesulfonate is the only satisfactory anesthetic that has been used with this system. With either quinaldine or methyl pentynol the adult salmon react quite violently when they slide on to the the table making it very difficult for the men to handle and check the fish.

Tricaine methanesulfonate is used at a concentration of about 83 ppm. We have recently been able to purchase this anesthetic for 13.5¢ per gram. Daily costs for anesthetic are about $27.00.

Effect of Spawning Density of Sockeye Salmon

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Different numbers of adult sockeye salmon of Cultus Lake stock, were placed in each of four separate sections of an artificial spawning ground and allowed to spawn. In one of the sections two populations of adults were allowed to spawn consecutively to determine the effects of duplicate spawning.

The spawning efficiency, i.e. the number of eggs deposited as a ratio of the number of eggs available, varied from 99.3 per cent to 64.3 per cent. The low values were primarily the result of poorer quality of fish taken from the end of the run. The most frequent efficiency recorded was about 80 per cent.

The number of fry produced over the number of eggs deposited, the incubation efficiency, was determined for each section. At 0.51 females per square yard the efficiency was 54.5 per cent; at 0.60 females per square yard it was 46.2 per cent and at 1.02 females per square yard it was 39.0 per cent.

In the section in which duplicate spawning occurred, it was found that the second population of adults did not attempt to avoid earlier nests and in some instances, fish spawned directly over nests which had been made by the first population of spawners. The incubation efficiency in this section did not show any reduction as a result of duplicate spawning. It is thought that sufficient time had elapsed between the peak spawning in the two populations to allow the eggs of the first group to develop beyond the blastopore closure and thus have some immunity to mechanical movement.

From the shape of the curve showing relationship between density of egg deposition and density of fry on a square yard basis, it appears that the maximum allowable egg density may be in the region of 4200 eggs per female, this would mean about 1.05 females per square yard if spawning was 100 per cent efficient.

Samples of migrating fry were measured to determine their weights and lengths at intervals during the migration out of the spawning channel. The fry increased in length and weight up to the time of the peak migration. Following peak migration both length and weight of the fry sampled fell slightly. Samples of wild fry from Cultus Lake were obtained and the size of these fry was comparable to those from the artificial spawning ground. Fry from the artificial spawning ground showed reactions to light and movement comparable to those of wild fry.

Marking of Pacific Salmon with Tetracycline Antibiotics

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Studies on marking of salmonid fishes with tetracycline antibiotics were initiated in mid-1961 at the Seattle Biological Laboratory. By the end of the year, we felt that laboratory experiments had demonstrated that tetracycline marking was a potentially useful marking tool. However, to adequately demonstrate this potential, it was necessary to gain information on two questions: (1) Are tetracycline-induced marks permanent? (2) Is there any effect of tetracycline administration on survival? These questions were answered through two pilot studies initiated in the spring of 1962.

The first question was resolved from a pilot study conducted on silver salmon at the Klaskanine hatchery in 1962 and 1963. We found that tetracycline is deposited permanently, and is detectable not only throughout the life of the fish but also after death and until the bones are decomposed. The details of this study were presented at the 14th Annual Nortwest Fish Culture Conference.

The remainder of this report concerns a pilot study designed to answer the second question--affect of tetracycline administration on survival. In this study we used 1961 brood sockeye slamon reared at the Leavenworth National Fish Hatchery.

Prior to our administration of tetracycline at Leavenworth, one-third of the sockeye from each holding pond were removed, and Ad-LM clip combination applied, and the fish returned to their respective ponds. About one month later, in August 1962, the fingerling sockeye in 10 of the 30 holding ponds were fed a pelleted tetracycline diet. This diet was fed for 4 consecutive days, resulting in a total dose of two grams per kilogram body weight of oxytetracycline (OTC). A sample from these 10 ponds indicated that 100 percent of the sockeye fed were tetracycline marked.

In October the hatchery production of sockeye (1,778,000) were randomly sampled with a 10-place sampler and then released into Lake Wenatchee. The estimated percentage of fish in each category at time of release was as follows:

Fin clip only	20.8%
Fin clip plus OTC	11.3%
OTC only	24.0%
Unmarked	43.9%

Our estimate of the affect of tetracycline administration on survival is based on the percentage of fin clip plus OTC within the total fin-clipped group. This estimate is not influenced by the affect fin clipping itself may have. Of the total fin-chipped group, 35.3 per cent at release were double marked (OTC plus Ad-LM). Upon subsequent sampling, if the percent double marked of the total fin clips was significantly less than 35 percent, we would assume differential survival beca because of tetracycline administration.

There is one other comparison of proportions which will be referred to; the relation between total fin clip and total OTC marks. The total number of fin clips released equaled 32.1 percent of the hatchery production, and the total number of OTC marks equaled 35.3 percent. Generally speaking, the percent fin clipped equals the number with tetracycline marks, and any deviation from this approximate 50:50 ratio would be indicative of differential survival between these two groups.

In the spring of 1963 the sockeye smolts migrated out of Lake Wenatchee. Samples of these outmigrants were obtained over a month period with fyke nets set at the mouth of the lake. Of 2,020 fish examined, 748 had an Ad-LM clip; and of these, 34.4 percent bore a tetracycline mark. This percentage is not significantly different from the 35.3 percent expected, and indicates that during their stay in Lake Wenatchee the deposited tetracycline did not affect their survival.

We were rather distressed though, in the relation between the total fin clipped and the total tetracycline marked. There were significantly fewer tetracycline-marked fish at time of outmigration than expected. However, in view of the results on the percent fin clip plus OTC within the fin-clipped fish at outmigration is the length-weight relationship (condition factor). In the following equations, based on samples collected at outmigration, it is noticeable that the values of the exponents and constants are decidedly lower for fin-clipped fish as compared to OTC only marked and unmarked fish. (W = weight in grams, and L = length in millimeters for fish 75 to 120 mm. fork length.)

Category	Sample Size	Length-weight equation
Fin clip only	269	$W = 4.44 \times 10^{-4} L^{2.76}$
Fin clip plus OTC	144	$W = 4.27 \times 10^{-4} L^{2.76}$
OTC only	242	$W = 5.70 \times 10^{-4} L^{2.83}$
Unmarked	710	$W = 5.95 \times 10^{-4} L^{2.83}$

Some of the OTC only marked fish, being generally larger, may have migrated out of Lake Wenatchee at an earlier time and were not available for sampling in the spring of 1963.

The 1961 brood sockeye were not sampled again until their return as adults in the fall of 1965. Sockeye salmon taken by the Indian dipnet fishery at Cascade Locks, Oregon, and the gill-net fishery near Lyle, Washington, were checked for fin clips. Of 2,382 sockeye examined, 1.3 percent bore an Ad-LM clip. From these same samples, a vertebrae was removed from 2,049 fish and 2.7 percent were found to be tetracycline marked. The difference between the total fin clipped and the total tetracycline marked clearly exceeds the expected 50:50 ration.

Further sampling of these sockeye was made on the spawning grounds in the Wenatchee drainage. Of 3,787 fish recovered in the streams leading into Lake Wenatchee (Little Wenatchee and White Rivers), 2.1 percent had Ad-LM clips. Vertebral samples from 2,936 of these same fish showed that 3.3 percent were tetracycline marked. The relation between total fin clip to total OTC mark, though lower on the spawning grounds than in the fishery, still exceeds the expected 50:50 ration.

Additional samples of fin-clipped fish were recovered from Icicle Creek where Leavenworth hatchery is located. These Ad-LM clips, combined with those collected on the Little Wenatchee and White Rivers, give a total of 152 Ad-LM sockeye recovered. Of these, 41.1 percent bore a tetracycline mark. This is not significantly different from the 35.3 percent expected.

In summary, we have demonstrated that administration of tetracycline meets the requirements of an acceptable marking tool. A tetracycline-induced mark is permanent, readily detectable, and does not adversely or beneficially affect growth or survival.

Tetracycline Marking and Thermal Brand Studies

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An application to the F.D.A. for clearance of oxytetracycline (OTC) for marking Pacific salmon was prepared and submitted jointly by the Oregon Fish Commission and Bureau of Commercial Fisheries.

Because the cost of marking a group of fish with tetracycline is related directly to fish weight, we need to know the sizes at which fingerlings can be marked successfully, and the quality of the marks in adult salmon. Toward this end, we marked 1963-brood coho salmon with four 1 gram per kilogram doses of tetracycline hydrochloride in low calcium Oregon pellets. Fish were marked at sizes of 290 per pound, 100 per pound, 50, and 25 per pound. Jack coho returning this fall to Oxbow Hatchery showed 28% marked from the feeding at 290 per pound, 97% from feeding at 100 per pound and 100% of marks put on at sizes of 50 and 25 per pound.

To help identify tetracycline-marked Oxbow coho and to test a thermal branding technique, we marked 15,000 with a right ventral fin clip and another 15,000 were marked with a left ventral clip and thermal branded with the letters "FC". Marked jack returns this fall to Oxbow Hatchery were: 171 (1.1%) left ventral mark, all with visible brands; and 150 (1.0%) right ventral mark.

At Siletz Hatchery on the Oregon Coast, 610,000 1963 brood coho were treated with 2 doses of OTC at a level of 1/4 gram per kiolgram of fish weight. Within this group, 62,000 were marked with a third dose of 1/4 gram/kilo. To date a sample of 40 randomly taken jacks has been examined for tetracycline marks and 39 of them showed fair to good marks. All of the OTC marked fish showed at least 2 marks and 15% showed 3 marks (about 10% were triple-marked before release).

In tests with controlled-temperature water at 45°, 55°, and 65° F., coho fingerlings which had been fed doses of OTC ranging from 0.40 to 0.75 g/kilo showed marks in increasing intensity as water temperatures increased. Cleithrum bones showed no mark at 45° F., fair marks at 55° F., and strong marks at 65° F. The results for the 45° group are regarded as anomalous since other antibiotics have marked well at 45° F. with spring water.

A tool was developed for sampling entoptergoid bones from the roof of the mouth of living salmon. The tool is a pair of large pliers with one blade modified into a spatula-shaped cutter blade with a skirt-shaped cutter on the opposing side which effectively cuts off the portion of the bone separated by the blade.

The Atlantic Salmon in Oregon

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Why should Atlantic salmon be introduced to the Pacific Coast? We already have a comparable fish, the steelhead. All of the endemic diseases and parasites such as furunculosis and the salmon-poisoning fluke could be highly detrimental to the species. In addition, many unsuccessful introductions of the salmon have been made already.

As far as we know, the salmon has been placed in western rivers in the past but not in lakes. When the possible environments are narrowed down to lake systems, survival possibilities become enhanced, especially if the species is not associated with other fishes. Lake stocking of the sea-run Atlantics has been tried with success by the New York Conservation Department and an extensive sport fishery is thus supported.

Mud Lake in the Cascades near Bend was successfully treated to destroy carp and successive plants of 2 to 8-inch salmon were stocked in the period between 1958 and 1964. The fishery has been for salmon to six pound in weight.

Hatchery-propagation provides fish for the lake since natural spawning does not occur or is insignificant. Brood stock are held at Wizard Falls in 50° water. Eggs are taken in the last three weeks in October. Females average 3,600 ova and weigh 4 to 15 pounds at maturity. The best eggs are taken from five-year-old maiden fish. Most of the salmon mature at five, some at four, six to eight, and a few at three years of age. As an example, in 1965 there were 22 mature three-year-olds out of 712.

The sac is much larger than with trout and is pointed posteriorly.

The fry are golden brown with a slight greenish cast. The fins are larger than those of trout.

In water cooler than 55°, fry tend to stay on the bottom. The lower limit of good feeding temperature is about 48°. In warmer temperatures they swim up in three to ten days. Feeding the salmon in cold water is a tedious and almost continuous process. Care must be taken at this time to avoid pollution. Small amounts of food should be offered over a long period.

Fry perfer food in motion. They feed well before the sac is absorbed.

Bacterial gill disease and KD have occurred with the salmon early in its history at the station but of late the hatchery disease problem appears to have been solved except for some current white spot in eggs. In Mud Lake, what appears to be a carcinomatous thyroid is sometimes in evidence. In 1955, two of 132 sampled were so inflicted.

The egg source for the Oregon Atlantic salmon was Gaspe Harbor, Quebec, from fish destined for the Dartmouth, York, and St. John rivers. They were the largest fish from the early part of the season. The first shipment was received March 7, 1951, the second in April, 1958, each of 10,000 eggs at 121 per ounce.

The adults could easily be confused with brown trout but have a weak or absent vomer. If present it is in a single row. The adipose is gray to olive. In contrast, the brown has orange or red spots or blotchers on the adipose and the vomerine teeth are strong in a double zig-zag row.

Fishing for the species has been excellent. They must be caught with flies and returned to the lake unharmed.

Creel samples were as follows:

1961

Size	Number	Percentage
14-16	10	2
16-18	42	10
18-20	119	28
20-22	134	31
22 plus	128	29
	433	

1962

Size	Number	Percentage
8-10	3	
12-14	3	
14-16	39	
16-18	29	1.25 fish/hr.
18-20	2	
20 plus	4	
	80	

1963

Size	Number	Percentage
10-12	7	
12-14	62	
14-16	162	
16-18	30	1.53 fish/hr.
18-20	1	
20 plus	23	
	287	

1964

Size	Number	Percentage
12-14	2	
14-16	14	
16-18	54	0.68 fish/hr.
18-20	67	
20 plus	44	
	181	

1965

Size	Number	Percentages
14-16	1	
16-18	1	
18-20	48	1.20 fish/hr.
20 plus	87	

An Analysis of Return of Chinook Salmon to the
Green River Hatchery ... 1965

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The Fisheries Research Institute of the University of Washington is conducting a study of some of the parameters involved in the estuarine ecology of Elliott Bay and the lower Duwamish estuary. One of the objectives of the study is the development of a mathematical stimulation model describing the response of salmon and some of the bottom fish to changes in the environment.

In August and September of 1965, 1,330 adult chimook salmon were captured and tagged in the general area of the turning basin above the Spokane Street bridge. Recoveries of the tags during successive seining operations were used to estimate the number of adult salmon in the Duwamish estuary. Using the thirty recoveries obtained in a single day's sampling of 1,200-1,500 chinook, population estimates of 40,000 to 60,000 were obtained.

The recovery of 411 tags in the total of 10,500 adults returning to the hatchery at Soos Creek gave an estimate of some 39,000 in the lower Duwamish. On the basis of these estimates the return to the hatch ery was considerably below the anticipated number. Returns to the College of Fisheries and to the hatchery at Issaquah accounted for some of the "missing fish", but the numbers were not nearly enough to make up the difference.

The schooling and migration pattern of this group of fish was somewhat unexpected in that some members that were in the influence of the Duwamish re-entered Elliott Bay and then returned to the

College and Issaquah. The fish which returned to the College were marked (maxillary) thus indicating that certainly was their point of origin.

The discrepancy between the actual numbers returning to the Green River and that obtained in the population estimate is not accounted for but probably was due to sampling error.

Indexes In Evaluating a Trout Hatchery System

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Because of the many variables it is more difficult to assign indexes or indicators of the performance of an individual trout hatchery or hatchery system than it would be to a manufacturing concern. Yet it is just as important that we have measures of performance as other production facilities. Some of the variables so familar to fish culturists follow: the sizes of the hatcheries which may be in direct relation to the available water supply, water quality and temperatures vary, programs differ as to size of fish raised and species. Some stations have brood stock. There are hatcheries that raise trout by the million which are released as fry and other stations that liberate only larger fish. Because of these variables and many more, it is helpful to use a number of indicators or indexes to evaluate first individual hatcheries and then the entire system under one administration. The four we use are not new, having been used in fish cultural work for many years.

The first index is the number of pounds of fish raised at a hatchery. This figure should be fish produced rather than fish planted. A station providing small fish for rearing at another station should receive credit for the poundage raised. Conversely, a station receiving fish for rearing should have this poundage deducted from their production poundage.

The second index is the cost per pound of fish raised. We include salaries, operations and maintenance of the facilities but not capital outlay. We delete capital outlay costs because the wide fluctations from one year to the next make comparative values difficult.

The third index is the number of <u>pounds of food required to produce one pound of fish</u> or conversion factor. Related to this is the cost of the food to raise one pound of fish.

The fourth index is the number of <u>pounds of fish produced per man</u> per year. Only those people who are working at fish rearing stations are included in this evaluation.

The use of indices in analyzing our fish cultural performance is based first on what is within our power or jurisdiction to change. An unproductive hatchery is very difficult to shut down. Those of the public that criticize the loudest of the insufficiencies of an obsolete hatchery, support any action to abandon the facility. However, sometimes it is possible to shut down a station. The second point is that at the time new installations are considered, one might look at all the fish rearing facilities and analyze the operations. Using the four indexes is most helpful. The pounds of fish produced per man might indicate where more than necessary help is employed. There have been so many improvements in the past ten years. The elimination of grinding and mixing of the various fish foods at the hatchery, the development of fish foods that perform well, the use of automatic feeders, the selection of broodstock which produce eggs with a very low percentage loss and consequently less labor in egg picking are just a few of them. The use of anesthetics in trout spawning operations has made it possible to use all our help in spawning rather than a few experts. The use of heavy duty maintenance equipment, such as grass cutters is also helpful in reducing time required for this activity. In our operations it is evident that the type of natural rearing ponds for production of migrant steelhead might be extended. The number of pounds produced by the one man necessary at such an installation is much higher than the average hatchery installation.

We have been able to man most of our new installations by transferring employees from stations; which because of updating procedures and the many improvements in fish culture, had more help than necessary. The improvement of our operations is indicated by the cost per pound and the pounds of fish produced per man per year. Another use shown very clearly by the use of these indexes is the stride in progress that has been made in fish culture the past ten years. Not only are these indexes indicating better performance but also the most important of all the quality of the fish raised has improved so much that the product we now plant has a much better chance of surviving to reach the fisherman's basket. Some evaluations of our total fish cultural activities follow:

Year	Pounds of Fish Produced	Cost per pound	Employees	Pounds of Fish Produced per man
1953-1954	683,066	.78	70	11,551
1963-1964	1,465,227	.63	78	18,861
1964-1965	1,350,472	.72	78.5	17,200

It is evident that there was a very considerable improvement in our productivity from 1953 to 1963 regarding costs. The costs are going up again 1964-1965, we will do our best to reduce these by analyzing our individual stations with the help of the indicators or indexes.

Progress Report on Klaskanine River Coho Production

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It is assumed that we are not approaching a surplus of good quality coho salmon to the sports and commercial fisheries. There must be an under-harvest of some specific groups of fish. Coho are returning in such large numbers at some of our stations that our present facilities are inadequate to handle them; consequently, we often do not know how many are returning.

The Klaskanine River Salmon Hatchery is situated so that a commercial fishery could be started in Youngs Bay and could be restricted almost entirely to this hatchery stock. The attached table lists the liberations, jack returns, and adult returns by brood year to this fishery and to the hatchery. The 1961 brood adults returning in 1964 were 19,971 fish. The adult returns of the 1962 brood as of November 30, 1965 are 29,136. The jacks returning from the 1962 brood were 28,165 and of the 1963 brood were 24,165.

An attempt has been made to reduce the number of jacks that are returning by using feeding techniques which produce a more uniform size fish. The smolts have been more uniform in size but the reduction in numbers of jacks has not been accomplished as well as expected. Hatcheries rearing coho in large ponds or lakes consistently have more variation in the size of smolts liberated and in the large number of jacks that return. A jack study is now being conducted which is expected to provide sufficient new information that would help to reduce the number of jacks returning.

A 2.3 commercial catch to 1.0 escapement has been used by our department to evaluate hatchery operations for coho. By applying this ratio to the 28,942 fish that returned to the Youngs Bay fishery and to the hatchery, the commercial catch would have been 66,569. If these fish averaged eight pounds each and were worth 35¢ per pound, the value would be $186,900. Also, the value of the adults caught in Youngs Bay would be $58,000. This ratio of 2.3 to 1 was established before the Youngs Bay fishery was started and when the sports catch was much lower than the present catch of over 247,000 fish at the mouth of the Columbia River. Starting with the 1964 brood, a coho marking program is planned for the Klaskanine Hatchery to obtain new data for a hatchery evaluation and management study.

Mechanical Oregon Pellet Feeder

Personnel at the Klaskanine Hatchery have developed a mechanical feeder powered with a 6 horsepower, 41 pound aluminum block gasoline motor, equipped with a squirrel cage furnace blower. Pellets drop into the air current from the hopper and are airborne thus having a minimum of contact with any part of the feeder. A whirlwind-type fan was tested whereby pellets clung to the blades and sides of the fan.

In addition to the more even distribution of the feed and the savings of considerable time, two unexpected advantages of this mechanical pellet feeder were propulsion of the load and attraction of the fish to or near the surface of the water by the sound of the motor. The latter is a distinct advantage when the water is discolored.

This same type feeder has been built with a spout at either side of the feeder to be used from the center walk of the 20' by 80' ponds. It has been quite satisfactory. Another feeder was adapted to feed from a truck driven along the side of a pond 40 feet in width.

Klaskanine Hatchery Coho Production
and Youngs Bay Commercial Catch

Brood Year	Yearlings Liberated	Returns to Hatchery Jacks	Returns to Hatchery Adults	Youngs Bay Catch Jacks	Youngs Bay Catch Adults
1955	288,000	205	306		
1956	203,000	1,312	966		
1957	356,000	631	969		
1958	410,000	2,616	3,323		459
1959	788,000	6,813	4,086	131	2,056
1960	1,124,000	15,234	5,602	663	4,074
1961	1,079,000	6,796	8,865	2,166	11,114
1962	1, 83,000	20,179	8,431 1/	7,986	20,705
1963	1,718,000	18,169 1/		5,996	
1964	1,464,000 (on hand)				

1/ As of November 30, 1965.

Preliminary Results of Hybridizing Coastal and Puget Sound Stocks of Fall Chinook

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The Washington Department of Fisheries operates and maintains three salmon hatcheries along the coast of Washington. In past years it has been extremely difficult to obtain sufficient fall chinook eggs to adequately stock the hatchery streams. Excessive flood conditions during the fall season usually accentuated the problem of obtaining sufficient eggs for a full rearing program.

With the abundance of female chinook returning to the Puget Sound hatcheries it was natural to attempt a direct import of this stock. To measure the degree of success, marked lots of Puget Sound stock fall chinook were liberated into hatchery streams on the Coast. Virtually no returns resulted from this direct transfer of stocks.

A continual program of searching for an outside stock of fall chinook that would survive in streams along the coast was maintained.

Because the number of males arriving to the coastal stations was adequate for hatchery operations a hybridization study was undertaken at the Nemah Hatchery.

Procedures:

During the fall of 1961, 224,600 eggs were taken from Deschutes River females and crossed with Nemah males. These were incubated and reared at the Nemah Hatchery until the day of release. This "hybrid" lot was compared with a control lot or one typical of hatchery operations and origination from the Nemah River stock.

Both groups were fin-clipped prior to release. When the adults returned to the hatchery rack as 2, 3, and 4-year-old fish, each was examined for marks. The number of marked fish spawning below the rack was not estimated.

The returns to the Nemah Hatchery of "hybrids" as two-year-old, three-year-old and 4-year-old fish was slightly greater than the control or local stock. The size of the fish was almost identical to the local stock.

Tables 1-2 and 3 give a summary of the rearing period, the return of adults, and the size of the adults upon return,

Inherent within such a program of moving stocks of salmon from one region to another are advantages and disadvantages.

Immediately the question of potentially harmful effects arises:

A partial list of these disadvantages might include transmittal of diseases, changing the survival of local stocks, and changing the racial characteristics of the local fish.

Other than the transmittal of diseases into new areas the other factors may be either advantages or disadvantages. All of these factors were taken into consideration prior to the introduction of this project.

It was concluded that when the stocks were nearly to the point of extinction the probability of benefiting the resource was greater than the potential harm.

Table 1. Data on the period of hatchery rearing of 1961 brood fall chinook

	Nemah Hatchery	
	Local stock	"Hybrid Nemah- Male Deschutes- Female
Per cent egg loss	13.0%	9.0%
per cent fry loss	1.0%	2.0%
Rearing loss	7.0%	9.0%
Conversion	7.8 :1	7.5 :1
Number of fish released	175,305	181,000
Size fish released	185/#	200/#
Mark used	LV RP	LV RP

Table 2. Return of marked 1061 brood fall chinook to the Nemah hatchery rack

Age of Rt.	Local stock	Nemah - Male Deschutes cross	% Rt Control	% Rt cross
2	37	28	0.021	0.015
3	251	250	0.142	0.138
4	118	169	0.067	0.094
5	not available until fall 1966			
Total	406	447	0.230	0.247

Table 3. Mean fork length of marked fall

Age of Rt.	Local stock	Nemah - Male Deschutes - cross
2	40 cm (16")	42
3	62 cm (24")	63 cm
4	79.5 (31)	78.5

Mechanical Feeder, Fish Crowder, Fish Loader
and Distribution Unit

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The mechanical feeder is almost completed; a version of the feeder reported on at previous meetings. Production model covers a bank of fifteen ponds.

The gasoline motor powered crowder was used for crowding adult salmon in 40' by 250' spawning ponds. It runs on rails laid on top of pond walls. Rate of travel is about 20 feet a minute. Wight of crowder is 6,000 pounds.

Combination fish loader and distribution unit consists of air tight fish tank, two way water valve at outlet of fish tank pump, a vacuum pump and a float valve installed in tank to keep water out of vacuum pump. In loading operation the fish tank acts as enlarged screened portion of suction line. It stores the fish until amount needed is reached. The vacuum pump bleeds off excess air that may enter the system, thus maintaining a constant water level.

The Affects to Ovum from Extreme Rough Handling of Adult Coho

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When four live mature adult females were dropped upon a hard surface four times from a 6-foot elevation, the eggs experienced a mortality averaging 72%, while four anethesized females handled in a like manner had egg mortality averaging 96%. The eggs from four semi-green females dropped from a 5-foot elevation twice experienced a mortality averaging 35%.

Unusually high embryo mortalities have occasionally been experienced during hatchery incubation. Abuse to the female during transportation, rough handling during spawning, and self-imposed damage by leaping against upstream obstacles are examples of suspected causes. This phase of the study was designed to determine if embryo mortalities were induced under the most severe cases of rough handling. If no unusual mortalities were encountered, there would be no need to experiment further.

Three study groups of 4 females each were rough handled. All fish from study group No. 1 were removed alive from the Simpson Hatchery trap and dropped a distance of 6 feet onto a concrete slab, 4 times. Each fish was then spawned as in the routine hatchery procedure. The eggs from each female were incubated in four seperate hatchery trays. Group No. 2 received the same treatment as No. 1 with the exception, each female was anesthetized before being dropped 4 times each. A control group of 4 females was spawned with the eggs also being incubated in 4 individual trays.

The third study group was one of 4 females which were semi-green. These were dropped twice each onto a concrete slab for an average distance of 5 feet, then spawned 7 days later.

It was decided that dropping each fish a distance of 6 feet 4 times each as in group No. 1 and No. 2 may be too injurious for surviving the 7 days of subsequent holding. Quinaldine was the anesthetic used in tranqualizing the females. Another group of 4 females was used as a control. These were spawned in a manner typical of hatchery procedures. Eggs from each female in the third group and its control were incubated separately as in study groups No. 1 and 2.

The following tables summarizes the result of the experiment.

Summary chart of rough handled Satsop River coho

	Group #1 Group #1 *rough handled	Group #2 Group #2 anesthetized	Group #1, #2 control	Group #3 rough handled held one week then spawned	Group #3 control
No. females spawned	4	4	4	4	4
Total No. Eggs Taken	12,855	12,449	13,606	11,156	11,727
Number Eggs to Eying	3,593	461	12,823	7,196	10,070
Per cent Survival to Eying	28%	3.7%	94%	64.5%	86%
Total No. Broken Eggs	649	388	0	473	24
Per cent of Broken Eggs	5.05%	3.12%	0	4.24%	0.205%

* All females dropped 6 feet onto concrete slabs 4 times then spawned.

** All semi-green females dropped an average of 5 feet onto concrete slabs 2 times, and held seven days before spawning.

Results of Rough Handled Females Spawned
Immediately Group No. 1

Female	Total No. Eggs	No. Eggs Eyed	No. Eggs Eggs
Number 1	2,932	1,458	83
Number 2	3,027	1,808	166
Number 3	3,576	4	230
Number 4	3,320	324	170
Totals	12,855	3,594	649

Results of Anethesized Rough Handled

Females spawned Immediately Group No. II

Number 1	2,401	143	120
Number 2	3,888	42	91
Number 3	2,848	39	70
Number 4	3,312	237	107
Totals	12,449	461	388

Control for Rough Handled

Females Spawned Immediately

Number 1	3,709	3,466	0
Number 2	3,521	3,453	0
Number 3	3,092	2,700	0
Number 4	3,284	3,204	0
Totals	13,606	12,823	0

Results of Semi-Green Females Held Seven

Days After Rough Handling Group No. III

Female	Total No. Eggs	No. Eggs Eyed	No. Eggs Broken Eggs
Number 1	Eggs from this fish disintegrated after 50 days so a count was impossible. It will not be included in totals.		
Number 2	3,306	1,720	55
Number 3.	2,472	1,423	60
Number 4	3,314	2,439	346
Number 5	2,064	1,614	12
Totals	11,156	7,196	473

Control for Semi-Green Females Held

Seven Days After Rough Handling

Number 1	3,571	3,293	6
Number 2	2,612	2,243	15
Number 3	2,255	1,517	0
Number 4	3,289	3,017	3
Totals	11,727	10,070	24

The Contribution of the Alsea Hatchery to the Steelhead Fishery of the Alsea River

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The Alsea Hatchery started production in 1936. It is located on the North Fork of the Alsea River 43 miles up stream from the Pacific Ocean at Waldport.

The Alsea River basin drains 450 square miles of the coast range. The entire system comprises approximately 914 lineal stream miles. In general the North Fork has poor spawning gravel. There is an impassable fallsapproximately five miles above the hatchery on the North Fork proper. One small tributary located about four and one half miles above the hatchery has good spawning gravel, but until recent years has been blocked by an impassable log jam.

Chart #1 gives a comparrison of adult females released above the North Fork weir and the resulting return of the progeny four years later. Releases of one to two hundred females seems to be the optimum number for this section of stream. Since 1962 we have been hauling surplus adults from our weir to other streams without a native run or to areas above impassable barriers. The 1965-66 migratory season should give us our first return from these plants.

Table 1 gives production records of Steelhead reared at the Alsea Hatchery and released in the Alsea River. Steelhead were raised at the Alsea Hatchery prior to 1948, but records are not complete enough to give any indication as to the effect the hatchery program might have had on the total run of fish.

The Alsea river has been the primary source of Steelhead eggs for all North coast streams in the past fifteen years. We have reared fish at Alsea for release in other streams as well as supplying eyed eggs for the Cedar Creek and Gnat Creek hatcheries.

A marking program was started in 1952 and since that time all Steelhead released in the Alsea river have been marked. Research programs have been conducted to determine the best size of fish, and time of release, for the greatest return. Fish of 8 or 10 to the pound, with liberation occuring about mid April, has given us out best returns.

Chart #2 gives the percent of marked fish returning both to the North Fork weir and to the fishery. Time of release and size of fish at release have been the main factors in return to the weir, but total fish population is the stream has probably had the freatest influence on the return to the fishery. As indicated in Table 2 angling effort increased sharply as the population in the stream increased. This seems to indicate that although we probably have a surplus with respect to spawning escapement, this may in reality be a population at a minimal level to insure reasonable fishing success.

Table 1

Brood Year	Weir Count	% Mark	% Mark Plant at Weir	No.	Ripe No.	No. Above Weir	Fish As Year	Fish Per Pound
1948	1176			471	88.0	59	256396	100.0
1949	545			309	97.1	8	157215	60.0
1950	1840			8	1.5	520	13612	11.4
1951	1699			22	5.3	389	6972	10.5
1952	1175			17	3.1	535	19303	12.0
1953	1848			12	1.1	1024	11700	1300.0
							9460	10.0
1954	1955			61	9.7	567	411 13447	4.0 8.6
1955	255	18.8	.25	46	35.6	83	29678	10.5
1956	508	22.4	.70	126	52.0	117	10000 10000 20000	16.5 12.0 9.8
1957	624	23.5	.64	114	41.0	165	3000 16000 15000	26.0 13.0 7.7
1958	823	68.3	1.8	103	24.0	326	10000 33776	25.0 8.9
1959	617	69.2	1.1	77	24.0	239	12129 53125	20.0 9.8
1960	1101	78.1	2.4	186	38.0	315	101745	8.9
1961	687	86.1	1.3	155	39.4	238	147821	8.8
1962	2101	85.5	2.7	111	10.6	928	149660	8.0
1963	2046	95.7	1.9	364	42.5	384	152109	7.5
1964	2883	94.4	1.7	442	32.9	437	96217	7.7
1965	3017	87.7	1.8	740	58.8	526		

Table 2

Brood Year	Marked Fish Planted	Fish Per. Pound	Percent of Marked Fish Returning To Weir	To Fishery	Total
1952	19303	12.0	.25		
1953	21160	10.0	.70		
1954	22858	8.6	.64		
1955	29678	10.5	1.8		
1956	39999	11.6	1.1	..47	1.5
1957	34279	10.3	2.4	1.8	4.2
1958	43776	8.9	1.3	.74	2.04
1959	65354	10.0	2.7	2.1	4.8
1960	101754	8.0	1.9	2.2	4.1
1961	157821	8.8	1.7	3.4	4.8
1962	149660	8.0	1.8	2.5	4.3
1963	152109	7.5			
1964	96217	7.7			

The Abernathy Incubation Channel

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Preliminary experiments with chum salmon in the Abernathy Incubation Channel in 1963-64 indicated that much heavier stocking than utilized in spawning channels can be used without reducing fry survivals. Spawning channels are commonly stocked with 1 female per 10 square feet of channel or a maximum of 140 eggs per square foot of gravel. Six million fall chinook eyed eggs were planted in the channel at a rate of 435 eggs per square foot of gravel. The capacity of the channel at this stocking rate would be about 7-1/2 million eggs. The capacity if used as a spawning channel would be only 910,000 eggs. Survivals from the eyed eggs were 4,600,000 fry or 78.5%. Green egg mortality in the incubators reduced the overall survival to 75.0%. Reported survivals for chinook spawning channels vary from 5% to about 42%. Adult survivals will be compared with marked hatchery fish. Natural spawning in Abernathy Creek was sampled with a Fyke net and estimated to be 75,000 fry or a 2.6% survival. Assuming equal survival for the channel and natural spawning fry, those from the creek will make up only 1.6% of the returning unmarked adults.

Between 70% and 100% of the fry had been feeding on plankton in the gravel before migration. All fish had traces of yolk sac remaining. Comparisons with hatchery fry showed that no gain in weight resulted from this food and swimming ability had actually decreased.

In the 1965-66 experiment, about 840,000 unwaterhardened green eggs from fall chinook were planted in the channel at the same stocking as the 1964-65 eyed-egg plant. The numbers of eggs were below desired levels because of the reduced fall chinook run this fall and exotic eggs could not be used. This difference in egg number will prevent a comparison of adult survival between the two types of egg plantings and only fry survival figures will be compared. Survivals are expected to be low because of abnormally low water and high water temperatures during and immediately after egg planting.

Chum salmon are presently being spawned and their unwater-hardened green eggs are being planted at the rate of about 400 eggs per square foot of gravel. Survivals from these eggs will be compared with the 1963-64 chum salmon eyed egg experiment. The chum salmon run is expected to be small and only about 53,000 eggs have been taken so far.

The purpose of tests at different stocking rates and stages of egg development is to determine the most efficient and economical procedures to use for maximum fry survivals and production.

Contributions by Hatchery Reared Umpqua Spring Chinook

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The Umpqua River is one of three snow-fed Oregon rivers that flow directly to the sea. The North Umpqua River heads in the Cascades at Diamond Lake and Maidu Lake approximately 217 miles from the Pacific Ocean. The Rock Creek Hatchery is located at the mouth of Rock Creek, tributary to the North Umpqua, a distance of 148 miles from the ocean.

Historical records indicate that at one time the spring chinook run in the North Umpqua exceeded 20,000 fish. In 1946 the total run was less than 3,000 fish and immediate restrictive measures were necessary. In 1947, the river was closed to commercial fishing and the sport fishery greatly curtailed. The run built back to a point where we were able to somewhat lift the restrictions on the sport fishery. By 1964, we were back to the statewide limit of two fish over 20 inches and five fish 12 to 20 inches. Table 1 shows the average run since the counting station on Winchester Dam was built in 1945.

Table 1

Average Spring Chinook Run at Winchester Dam, 1946-65

Period	Average Run
1946-50	2,745
1951-55	5,908
1956-60	5,355
1961-65	8,671

An artificial production program was initiated in 1949, although results at this time with springchinook were not too optimistic.

The first release was made in 1952 with egg stocks from Umpqua, Rogue, and Imnaha rivers. The next three years saw the program continue with fish reared eighteen months and releases below Winchester Dam in March. In 1953, the program was altered to rearing the fish for twelve months and releasing in the fall. The returns from the March plants averaged less than two per cent, the program returned to March. In 1953, the program was altered to rearing the fish for twelve months and releasing in the fall. The returns from the March plants averaged just under five per cent of the number stocked. Because returns from the fall plants averaged less than two per cent, the program returned to March releases in 1959. The next change in the program was in 1960 with increased plants. Prior to 1960, the plants averaged 48,000 fish, while since then, they have averaged just under 80,000 fish. Table 2 shows the historical record of plants made in the North Umpqua.

Table 2

Spring Chinook Stocking in the North Umpqua, 1951-65

Brood Year	Number Stocked	Date Stocked	Size at Stocking	Area Stocked
1949	52,000	Mar. '51	6.8/lb.	Winchester
1950	31.500	Mar. '52	5.8/lb.	Winchester
1951	39,000	Mar. '53	5.8/lb.	Winchester
1952	51,000	Oct. '53	9.7/lb.	Winchester
1953	62,000	Nov. '54	9.5/lb.	Winchester
1954	62,000	Nov. '55	14.1/lb.	Winchester
1955	75,000	Dec. '56	20.6/lb.	Winchester
1956	10,000	Nov. '57	16.3/lb.	Winchester
1957	51,000	Mar. '59	9.4/lb.	Winchester
1958	46,000	Mar. '60	7.5/lb.	Winchester
1959	67,000	Mar. '61	8.2/lb.	Winchester
	43,000	Mar. '61	17.3/lb.	Winchester
1960	25,000	Mar. '62	4.3/lb.	Rock Creek
	55,000	Mar. '62	5.5/lb	Rock Creek
1961	43,900	Mar. '63	5.3/lb.	Rock Creek
1962	54,700	Feb. '64	7.2/lb.	Rock Creek
	24,800	Feb. '64	11.2/lb.	Rock Creek
1963	82,400	Dec. '64	6.7/lb.	Rock Creek

Fish from the 1960 and 1961 broods have returned at an excellent rate Slightly under 80,000 fish from the 1960 brood were released between 4.3 and 5.5 fish per pound. Todate, 3,750 fish, or 4.6 per cent, have been recovered. The 44,000 fish from the 1961 brood released at 5.3 fish per pound are exhibiting an even better return. With one year to go, 2,667 fish, or 6.1 per cent, have been recovered. Starting with the 1960 brood, the fish have been released directly into Rock Creek from the ponds rather than trucking them to Winchester. The recovered adults are not only contributing to the spawning runs past Wincheseter Dam but are being harvested in the sports fisheries in the Umpqua River, and off both the Oregon and Washington coast. Adults are also being taken in good numbers in the commercial troll fisheries off Oregon, California, Washington and British Columbia.

The fish returning to the river show much the same story as other people have shown in hatchery produced salmon. The larger fish at release, the stronger possibility that it will return earlier, while if too small at release there is a good possibility that you will get no returns. Table 3 gives a comparison of the average size at return to the size at release.

Table 3

A comparison of size at return to size at release

Life History Pattern	Average length at release	Average length at return
f - s	7.4"	12.7"
f - s - S	7.2"	21.1"
f - s - s - S	7.0"	27.3"
f - s - s - s - S	6.8"	30.7"

It is interesting to observe the pattern of return. Table 4 shows that almost 43 per cent of the 1960 brood returned to Winchester Dam at four years of age. Almost 60 per cent of the wild stock returns at five years of age.

Table 4

Pattern of Return to Winchester Dam for 1960 Brood

Year stocked	Year Returned	Number Returned	Per cent Returned
1962	1962	30	1.1
1962	1963	812	29.1
1962	1964	1194	42.9
1962	1965	749	26.9

25,700 stocked 4.3/lb.
55,200 stocked 5.5/lb.

Conclusions:

1. Although hatcheries may not replace mother nature, that hatchery production aided considerably in bringing the spring chinook run back to where it is today on the Umpqua River.

2. The returns from Umpqua hatchery reared spring chinook are contributing not only to the spawning run and river fishery, but to the sports and commercial fisheries from California to British Columbia.

3. Returns in excess of 6.1 per cent of the number stocked have been recovered.

HISTORICAL RECORD OF NORTHWEST FISH CULTURE CONFERENCE

Date	Where Held	Host Agency	Chairman
1950	Portland, Oregon	Fish and Wildlife Service	Perry
1951	Wenatchee, Washington	Fish and Wildlife Service	Burrows
1952	Seattle, Washington	Wash. Dept. of Fisheries	Ellis
1953	Portland, Oregon	Oregon Fish Commission	Cleaver
1954	Seattle, Washington	Fish and Wildlife Service	Rucker
1955	Portland, Oregon	Oregon Game Commission	Rayner
1956	Seattle, Washington	Washington Game Dept.	Millenbach
1957	Portland, Oregon	Fish and Wildlife Service	Johnson
1958	Seattle, Washington	Wash. Dept. of Fisheries	Ellis
1959	Portland, Oregon	Oregon Fish Commission	Jefferies
1960	Olympia, Washington	Wash. Dept. of Game	Johansen
1961	Portland, Oregon	Oregon Game Department	Jensen
1962	Longview, Washington	U.S. Fish and Wildlife	Burrows
1963	Olympia, Washington	Wash. Dept. of Fisheries	Ellis
1964	Corvallis, Oregon	Oregon State University	Fryer
1965	Portland, Oregon	U.S. Fish and Wildlife	Halver
1966		Oregon Fish Commission	Hublou