NORTHWEST FISH-CULTURAL CONFERENCE
(formerly Fisheries Nutritional Conference)

REPORT FROM THE CHAIR

December 1954

To those of you who attended and participated in the 1954 Conference in Seattle, I would like to express my thanks. Your interest and cooperation did much to make this meeting the success that it was. The following abstracts of the talks delivered at the meeting are presented under the group headings: Nutrition, Disease, Effect of Temperature, and Miscellaneous.

Also of interest and importance to all of you is the following:

NAME CHANGE: By majority vote, it was agreed to change the Conference title to Northwest Fish-Cultural Conference.

CHAIRMAN - 1955: H. John Rayner, Chief of Fisheries Operations
Oregon Fish Commission
P. O. Box 4136, Portland 8, Oregon.

CONFERENCE DATES: The first Thursday and Friday of each December.

Sincerely,

Robert R Rucker
ROBERT R. RUCKER
Chairman, 1954

I N D E X

- continued -

Protein Requirement Studies with Salmonids

John E. Halver
Biochemist

The protein requirement studies of salmon and trout by the Salmon Nutrition Laboratory have been initiated and it is planned to develop the amino acid test diet this current research year. At first glance this may seem a minor contribution to the overall problems of the nutrition of fish, yet in a different sense this may well be one of the greatest strides fish nutrition studies have taken in the century. All other fields of animal husbandry have found that the studies of the amino acid and protein requirements of their animals have realized the greatest returns in more economical diets and increased quality of the product. Why should we then consider the effects in fish nutrition to be otherwise, especially since fish are more carnivorous and thus, perhaps more dependent on the intake of required amino acids than other specie studied?

If we can draw an analogy to other experimental animals whose metabolism schemes are well known, we find that the protein component of the diet determines the replacement of tissue and the growth of new flesh. Vitamins, minerals, fats, and an energy source are also required, but without the essential amino acids, no tissue can be replaced--no new tissue can be formed. The situation, at least in other experimental animals, is an "all or none" condition--either all the amino acids necessary to form one simple protein molecule must be present at one time or none of the amino acids can be utilized except as a source of energy. Amino acids are not stored in the liver and other organs, like the water soluble vitamins or kept available in the adipose tissue like the fat soluble vitamins and lipid components. Therefore, a balanced amino acid intake is essential before any tissue can be laid down or replaced. All extra amino acids which cannot be utilized for tissue synthesis because of lack of any one essential building block for the protein molecule are really lost as far as weight increase, growth, or body maintenance is concerned. When one considers the essential role of amino acids in building the protein antibodies for disease protection, it becomes readily apparent that an imbalance of the protein intake can lower the resistance to common disease.

Other fields of nutrition investigations have definitely shown that the maintenance of a proper amino acid balance results in the most efficient utilization of all the other ingredients in the diet. Unfortunately, they have also repeatedly found that obtaining the balanced protein diet requires the greatest portion of the diet cost. Therefore, we feel that soon we too will be in a position where high grade balanced protein components of the diet will become more and more expensive, forcing us to utilize more cereal grain proteins and more less desirable industrial byproducts. We can only utilize these economical sources of protein if we understand the amino acid requirements of the salmon and trout to be fed. Then perhaps we can supplement either with a high grade animal protein or synthetic amino acids themselves to balance the protein intake and thus utilize all the other ingredients fed.

So far we have found that we can keep fish alive for a considerable period of time with the protein component of the diet consisting of synthetic amino acids. Our experiments have indicated a hopeful future for raising chinook salmon through an entire experimental period with only l-amino acids for their protein. As soon as this step is accomplished, we will, of course, delete each one of the amino acids individually from the complete diet and thus determine the qualitative amino acid requirements. From there it is only a short step to feeding aliquots of the required amino acids and arriving at the quantitative amino acid requirements of the specie.

1954 Nutritional Studies at Sandy, Oregon

Wallace F. Hublou
Aquatic Biologist

Introduction

This report covers the first 24 weeks of the 1954 nutritional work at the Sandy Research Laboratory. The experiment started on June 8, 1954, and the present plans are to carry on the experiment until approximately March 1, 1955. This date corresponds to the usual liberation time of the yearling fish reared at the Sandy Hatchery.

The long-range objective of the nutritional work being done by the Oregon Fish Commission is to find suitable nutritious and economically available foods for young salmon. In many cases, this means trying substitutes for the present foods being used, as the rising cost and diminishing supply makes this substitution necessary. In cooperation with the Oregon Agricultural Experiment Station Seafoods Laboratory, several experiments have been run in which an attempt has been made to appraise and evaluate potential hatchery food components.

A basal control diet is used which is a modification of the Wisconsin diet, McLaren et al, 1947. This diet is now called the Oregon Purified Diet.

A maximum control diet is also used, which is composed of 1/3 Beef Liver, 1/3 Hog Liver, 1/3 Salmon Viscera. This diet has consistently produced fast growing fish in excellent health and with a low mortality.

In 1954, the main objective was to find protein substitutes for the casein portion of the basal control diet.

Up to the present experiment no attempt was made to produce diets that could be used on a hatchery-wide production scale. This year it was felt that enough information had been accumulated to try three diets on a production basis.

Procedure

The stock used for the experiment was 1953 brood silver salmon which had been fed the Oregon Purified Diet for two weeks prior to the beginning of the experiment on June 8. The size of the fish at this time was 1.45 grams per fish or 313 fish per pound.

Twelve six-foot circular firwood tanks were used to hold the fish. Each tank was stocked with 400 fish or 580 grams, randomly placed in the tanks in groups of 100 fish per group.

Each lot of fish was weighed biweekly. All lots were fed on a dry weight of food fed basis. All diet components were chemically analyzed and the diets compounded to give the same proximate chemical composition and caloric content.

Feeding Technique

Ever since the Oregon Fish Commission started nutritional studies in 1948, one of the biggest problems involved in presenting the various diets was to get a proper "bind". The has been a problem plaguing all diet work with fish. It has been felt that diets of unequal physical consistency sometimes affected growth responses more than the nutritional makeup of the diets. This year for the first time, it was felt that differences in our diets due to "bind" was held to an absolute minimum. This was a result of a change in feeding procedure. The diets with the synthetic components and where gelatin is added (after adding water and cooling) resemble a firm jell. Previously, this gelatinous mass was forced through a hand ricer and in so doing the jell was broken and the food leached considerably. The new method is to worm out the food while only partially cooled through a modified alemite gun with a perforated plate onto cookie sheets. The sheets of worms are then exposed to an infra-red lamp for about 30 seconds, just long enough to heat the worms so as to melt the gelatin and re-jell the material. No leaching occurs when this method is followed. Another method was used when the fish became large enough to consume small cubes of food about 3/16". The food (when mixed and water added) was poured while warm onto the cookie sheets. When cooled, a noodle cutter was run over the food making the small cubes. No re-heating is necessary by this method. A bind superior to the first method is accomplished with the noodle cutter as the original jell is never broken.

Mortality

The mortality due to the diet fed was quite low in all lots as of November 23. The total mortality, however, approached 10% in most of the lots. The biggest part of this mortality was due to an undetermined cause. The symptom of the trouble was a protrusion or hump at the nape of the neck. When first noticed an infected fish would be swimming with a slight list to one side. As the trouble progressed the hump became larger, the fish became weaker, and severe lordosis and scoliosis of the spine became visible. Upon dissection of the infected area, a hemorrhagic area was often noted along the spinal column. No causative agent was found, bacterial or otherwise. It is felt the trouble may have been caused by a virus. These infected fish were found in all lots and also in the regular hatchery fish.

DIETS AND OBSERVATIONAL RESULTS

	Diet	Observations
1. Maximum Control:	1/3 Beef Liver 1/3 Hog Liver 1/3 Salmon Viscera	Good growth. Very good external color. Very good gill color. Active fish. Mortality 37 fish.
2. Basal Control:	Oregon Purified Diet (OPD) 55% Vitamin Free Casein 18% Dextrin 1% Calcium Carbonate 4% Crab (Cancer magister) Meal 6% Supplemental Salts 16% Corn Oil Vitamins to equal #1 all meat diet. (10 parts gelatin to 100 parts of the above mixture).	Fair growth. Small fish but very active. Mortality 51 fish.
3. Whale Meal Modified OPD		Poor growth. Fish getting anemic. Sluggish. Always very hungry. Mortality 38 fish.

4. Dover Sole Meal Modified OPD	Very good growth. Slow eaters. Fish getting anemic, growth retarding. Fairly active. Mortality 35 fish.
5. Tuna Scrap Meal Modified OPD (drum dried at Seafoods Lab.)	Fair growth, same as Lot #2. Fish always hungry. Fairly active. Getting anemic. Mortality 25 fish.
6. Commercial Tuna Scrap Meal Modified OPD	Good growth. Gill color good. Slow eaters. Fairly active. Mortality 34 fish.
7. Skate Meal Modified OPD	Good growth. Fish very active. Good gill color. Slow eaters. Spooky most of the time. Mortality 27 fish.
8. Meat Meal Modified OPD	Poorest growth response. Good gill color Did not like the food. Deficiency symptoms included erratic behavior in feeding, inability to grasp the food. Not blind. Mortality 46 fish.
9. Herring Meal Modified OPD	Good growth. Good gill color. Very good eaters. Active fish. Mortality 33 fish.
10. Production Diet #1 40% Meal Mix 40% Fresh Frozen Turbot (Atheresthes stomias) 20% Yellowfin Tuna Liver	Best growth of all lots. Fair eaters. Very active. Very good gill color. Mortality 26 fish.
11. Production Diet #2 40% Meal Mix 40% Fresh Frozen Hake (Merluccius productus) 20% Yellowfin Tuna Liver	Growth one of the best. Fair eaters. Very active. Very good gill color. Same as #10, only slightly smaller. Mortality 33 fish.
12. Production Diet #3 90% Meal Mix (not the same as # 10 and #11.) 10% Fresh Frozen Beef Liver	Small fish. Good gill color. Very good eaters. Very active. Growth stimulus seems to be increasing in cold water while the other lots are slowing down. Mortality 18 fish.

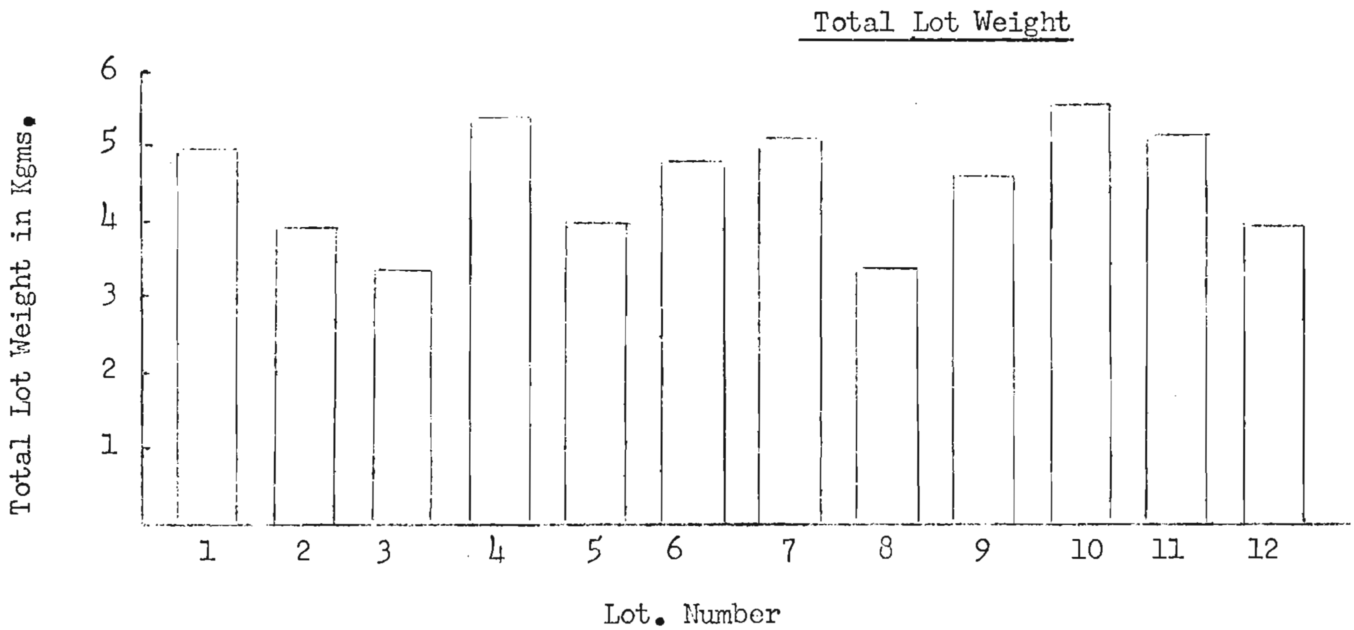
All three production diets were fed in a different manner than the first nine diets; that is, they were actually fed more food. The experiment was not set up with the intention of comparing the production diets with the modified Oregon

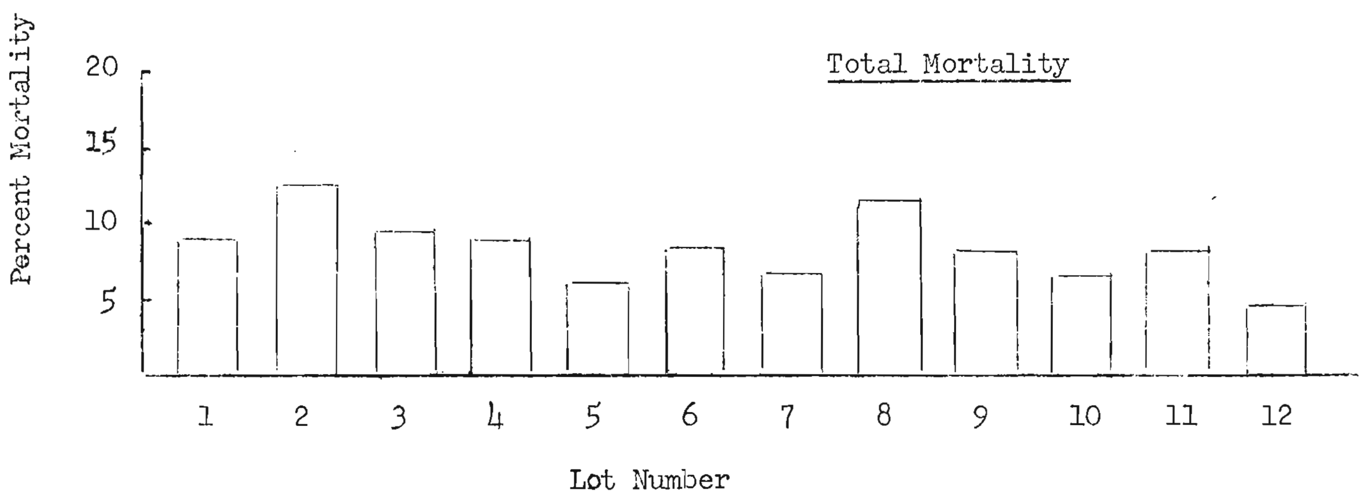
Purified Diets. More attention was paid to appetite in the production diets and as a result when the other diets were getting 3% food per day (dry weight) the production diets were at times getting $3\frac{1}{2}$%. They did not at all times get more than the other diets.

Summary

No summary is possible at this time; all observations and remarks are the picture as of November 23, 1954.

SANDY SILVERS - 1954





Water Temperatures;		
	High weekly average -	57° F.
	Low " " -	46°
	24-week period " -	52°

J. Wood
Aquatic Biologist

Introduction:

This report covers the 24-week diet experiment recently completed at the Oakridge Research Laboratory. The experiment started on May 7, 1954 and was terminated on October 20, 1954.

The nutritional work at the Oakridge Lab is integrated with the work at the Sandy Lab and is a part of the same general program, namely that of appraising and evaluating potential hatchery food components.

Eight diets were fed in this experiment. These consisted of: A maximum control diet (all meat), a basal control diet (the Oregon Purified Diet), two liver-supplemented basal diets, one vitamin B_{12}-supplemented basal diet, and three diets in which part of the synthetic ingredients in the basal diet were replaced with vegetable meal or dry skim milk.

Methods

The fish used in this experiment were Middle Willamette River spring chinook salmon of the 1953 brood year. At the start of the experiment these fish averaged 0.48 grams, or 940 fish per pound.

Eight circular wooden tanks six feet in diameter were used for holding the fish. Each tank was stocked with 700 fish. The initial weight of each lot was 338 grams.

All lots were fed on a dry weight basis (i.e., the dry weight of food fed each lot was a certain percentage of the weight of the fish in the lot). The percentage dry weight of food fed varied from 1% to 4% daily and was found to be dependent on the size of the fish and the weather conditions. No differential in the percentage dry weight of food fed to the various lots occurred. All lots were weighed bi-weekly and the amount of food fed to each lot was then adjusted to the new lot weight.

All diet components were analyzed by the Oregon Agricultural Experiment Station Seafoods Laboratory and all diets were compounded to give the same proximate analysis and caloric content

During the first part of the experiment the diets were fed with a hand ricer. Some of the diets were found to leach with this feeding method so it was discontinued in favor of the method adopted at the Sandy Lab where the diets were wormed out of a modified alemite gun, re-jelled, and cut into small pellets. During the latter part of the experiment the diets were, therefore, fed in a pelletized form except for the maximum control diet which, by necessity, was fed with either a hand ricer or by spoon. In a pelletized form the diets were thought to leach much less than when they were fed with the hand ricer.

Diets and Observations:

1. Maximum Control (1/3 beef liver, 1/3 hog liver, 1/3 salmon viscera, 2% salt). Final lot weight - 8,705 grams. Mortality - 0.9%. Exhibited good growth response throughout the feeding period. Good gill color.

2. Basal Control (Oregon Purified Diet - for the composition of this diet see the Sandy Lab report). Final lot weight - 4,185 grams. Mortality - 16.9%. Gill color fair to good.

2-1. Oregon Purified Diet with added vitamin B_{12} (vitamin B_{12} added to determine its role as an anti-anemic factor). Final lot weight - 4,275 grams. Mortality - 20.6%. No observable difference in gill color noted between these fish and those fed the basal control diet.

2-2. Oregon Purified Diet with 10% Rita-liver (Rita-liver is a dry commercial product consisting of whale liver and beef liver). Final lot weight - 5,345 grams. Mortality - 12.1%. Some increase in growth response over basal control diet. Gill color fair.

2-3. Oregon Purified Diet with 10% Fresh-frozen Albacore Tuna Liver (the albacore tuna liver was added on a dry weight basis). Final lot weight - 8,525 grams. Mortality - 1.2%. Good growth response. Good gill color.

13. Linseed Meal Modified O.P.D. This is the Oregon Purified Diet with part of the synthetic ingredients replaced by linseed meal. Final lot weight - 1,645 grams. Mortality - 33.4%. Very poor growth response. Gill color fair.

13A. Linseed Meal Modified O.P.D. Identical to Diet #13. Started on July 21, 1954 to a new lot of 700 fish weighing 900 grams. Final lot weight - 2,725 grams. Mortality - 11.6%. After the poor showing of Lot #13, this lot was started to see if larger fish would take more readily to the linseed meal modified diet and assimilate it more efficiently. The lot was fed on a 100% liver diet then changed to the Oregon Purified Diet for a few days before starting it on the linseed meal modified diet. The fish took quite readily to the change in diet, but the growth response was still very poor and numerous "pinheaded" fish appeared as the experiment progressed.

14. Dried Skim Milk Modified O. P. D. This is the Oregon Purified Diet with part of the synthetic ingredients replaced by dried skim milk. Final lot weight - 3,560 grams. Mortality - 20.7%. Poorer growth response than the basal control diet. Gill color fair to good.

15. Cottonseed Meal Modified O. P. D. This is the Oregon Purified Diet with part of the synthetic ingredients replaced by cottonseed meal. Final lot weight - 1,990 grams. Mortality - 22.6%. Very poor growth response. Gill color fair to good.

Mortalities

The majority of the mortalities occurring in this diet experiment were small emaciated fish commonly referred to as "pinheads". This type of mortality did not occur in Lot #1 (maximum control) or Lot #2-3 (O.P.D. with albacore tuna liver) which noticeably took more readily to their diets than the other lots. In all other lots "pinheaded" mortalities occurred to some extent throughout the diet experiment, reaching a peak between 4 and 8 weeks after the start of the experiment. It is interesting to note that during this period most of the mortalities in all lots were infected with Octomitus. To what extent the mortalities were caused by the intestinal protozoan is not known. Twice during this period carbarsone was included in the diets for four consecutive days as a therapeutic measure. As some of the small emaciated fish would refuse to eat, the protozoan persisted to be found in the mortalities throughout most of the feeding period.

Although the mortality rates in Lots 13 and 13A (the linseed meal modified diets) were high, no toxic effects of linseed meal were noted nor did a break in the mortality rate or growth rate occur.

Conclusions

1. The increased amount of vitamin B_{12} added to the Oregon Purified Diet did not noticeably increase the hemoglobin content of the blood as measured by the gill coloration.

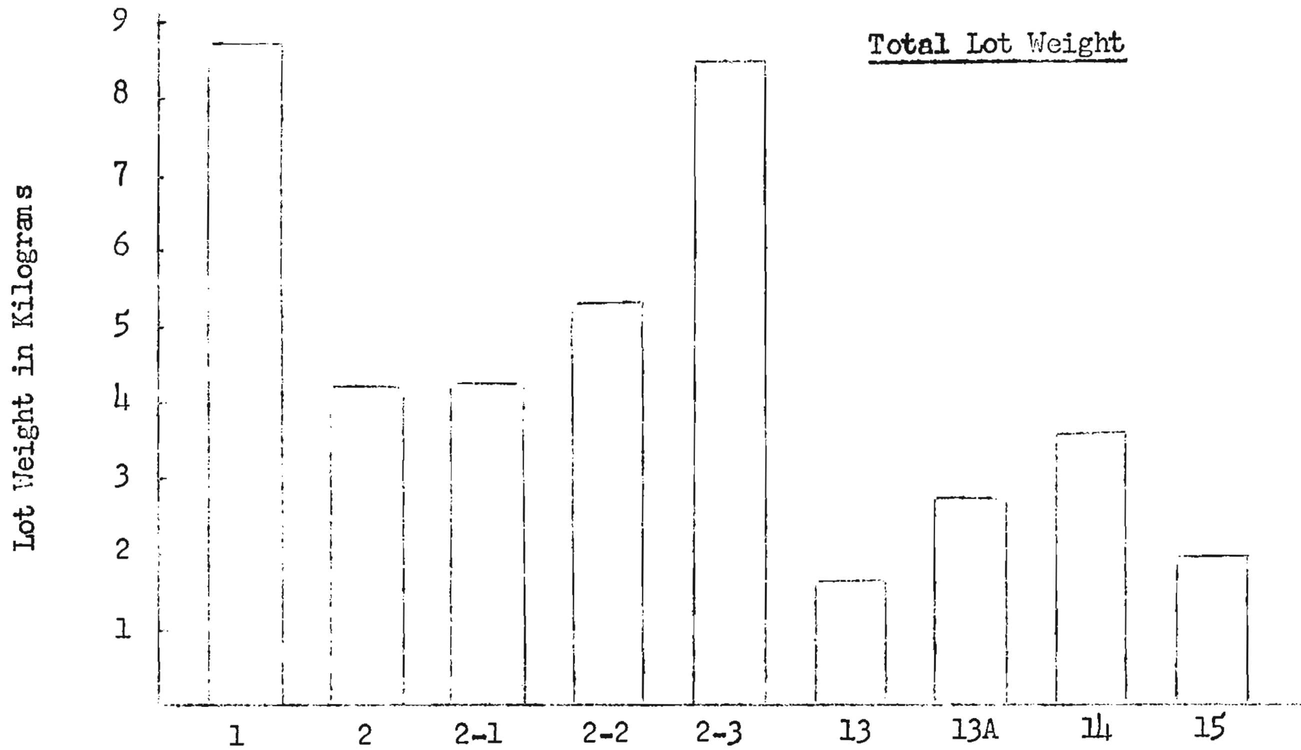
2. Rita-liver, a dry commercial product consisting of whale liver and beef liver, when added at a 10% dry weight level increased the growth response of the Oregon Purified Diet to some extent.

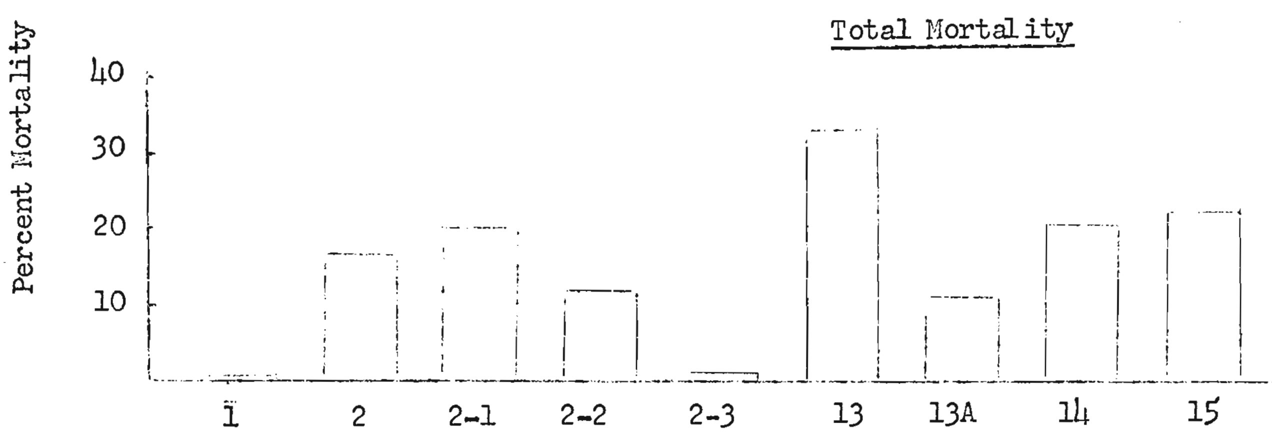
3. Fresh-frozen albacore liver when added to the Oregon Purified Diet at a 10% dry weight level greatly increased the growth response of the diet. The growth response of this diet was comparable to that of the maximum control diet.

4. The two vegetable meals, linseed and cottonseed, proved to be very poor substitutes for the synthetic products in the Oregon Purified Diet as indicated by growth response.

5. Dry skim milk when substituted in the Oregon Purified Diet rendered the modified diet inferior to the original diet.

OAKRIDGE SPRING CHINOOK - 1954





Water Temperatures :

High weekly average - 58° F.
Low weekly average - 49°
24 - week average - 53°

Remarks: (Nutrition studies at Oakridge and Sandy Laboratories)

R. O. Sinnhuber
Assoc. Biochemist

" I did mention that we had just completed a project on thiaminase (the vitamin B_1 destroying enzyme in several species of fish) and that a paper was in preparation. Results showed that shad and Columbia River chub, *Mylocheilus caurinus*, may be added to the list of thiaminase-containing fish. Care should be exercised in feeding those species to hatchery fish."

All-Meat Diets for Chinook Salmon

Harlan E. Johnson
Fishery Biologist

During the spring and summer of 1954 diet evaluations were conducted at the Little White Salmon Hatchery of the Fish and Wildlife Service using fingerling fall chinook salmon of the 1953 brood. The primary objective of the experiments was to select a good all meat diet for chinook salmon to be used only if it should become advisable to remove all fish products from the diet now in use. The evaluations were also designed to compare sheep liver and lungs with beef and hog products in all meat diets.

The experiments were conducted in standard deep troughs and each diet was fed to two troughs of fish. Water temperatures ranged from 45° to 52° F. with an average of about 48° F. during the tests.

Section A of the evaluations ran for 14 weeks and included 10 diets containing various combinations of beef liver, hog liver, sheep liver, beef spleen and beef lungs, with the Little White Salmon production diet as the control. This diet which consisted of 16.7% beef liver, 16.7% hog liver, 33.3% salmon eggs and 33.3% salmon flesh proved to be superior to any of the all-meat diets in growth, survival and food conversion. It is apparent that elimination of salmon products from the production diet will lower production and increase the costs. Of the all-meat diets tested, those composed of 100% liver produced the greatest growth and best food conversions. Sheep liver gave satisfactory results when fed in combination with other livers, but growth was slower when fed as the only liver in the diet. Inclusion of beef spleen and beef lungs at levels of 20 to 25 percent reduced the growth rate and increased the conversion. Mortalities in all diets were considered satisfactory with the greatest loss, during the 14-week test, of 2.63% in the 50-50 hog liver and beef lungs diet.

Section B, which ran for only 9 weeks, contained 4 diets designed to compare beef lungs and sheep lungs when used in all meat diets. The salmon fed the two diets containing sheep lungs at 25 or 50 percent levels made more growth with less mortality than those fed similar diets containing beef lungs.

A Comparison of several Salmon Viscera included in the diet fed to Sockeye Fingerlings at the Leavenworth, Washington Fish Cultural Station

Alfred C. Gastineau
District Supervisor

A program that was in operation this past rearing season (1954) to determine the source of a virus disease, included the possibility that one of the Pacific salmon viscera used in the diet fed to the fingerlings may be the cause. After this program was in operation for a time it was realized that interesting information concerning the effects of the various viscera diets on the growth of the fingerlings could also be obtained. This would be a collaboration of work done in the past, but on a much larger scale.

The program as set up for the virus experiment was not, of course, the same as one would set up a feeding experiment. At the outset of the program approximately 3,972,000 fish were used and about midseason this number was reduced due to lack of available space. Therefore, this report covers only those fish that were retained throughout the rearing season.

All of the viscera and other fish-product diets contained 25% beef or hog liver and 25% beef or hog spleen. The remainder of the diet components were as follows:

V-1	50%	chinook viscera
V-2	50%	Alaska sockeye viscera
V-3	50%	British Columbia sockeye viscera
V-4	50%	chum salmon viscera
V-5	50%	salmon eggs
V-6	12½%	wheat mids
	12½%	cotton seed meal
	12½%	distillers solubles
	12½%	fish meal
V-7	50%	humpback viscera
V-8	50%	humpback and silver viscera (Proportions of each not known)

Salt was added as needed to obtain a maximum bind.

The water temperatures were below average which retarded growth considerably.

Average water temperatures:

January	45 ° F.	June	44.5
February	43	July	48
March	43.5	August	52
April	44	September	52
May	44	October	42

After the preparation of each viscera diet all equipment was disassembled, cleaned and steam-sterilized. Separate ricers were used for each viscera diet, thus eliminating the intermingling of diets.

Due to the limited supply of some of the viscera, it was impossible to have the same number of fish on each diet. Two-hundred sixty-four hatchery troughs were used at the beginning; 134 troughs in the west end of the hatchery were confined to viscera or other fish product diets, and 134 troughs in the east end were fed meat only as controls.

At the beginning of the program last fall the eggs were taken from groups of twelve females. When it became time to initiate feeding, the resulting fish from each group were divided equally into two troughs, one trough to receive a viscera diet and the other the control diet. Sufficient numbers of groups were chosen to utilize all viscera and space available. These fish were kept in their original troughs until the first trough reached a weight between 30 and 40 pounds, at which time the weights were reduced by transferring four-fifths to ponds and dividing the remaining one-fifth into five troughs, except the chinook-viscera-diet fish and the Alaska-sockeye-diet fish which were confined to troughs throughout the season, but reduced the same as the others by spreading to more troughs.

The fish received their initial feeding about the middle of January, being fed a diet of 50% beef liver and 50% hog liver for about six weeks, then being changed to 50% beef or hog liver and 50% beef or hog spleen. This continued until March 12 at which time 50% of the fish were put on viscera diets; the remaining 50% continued on the meat diet as controls with the exception of those which were to receive diet No. V-8, initiated July 7, and those that were to receive a Cortland diet when the average water temperature reached 50° F. This was not until July 16.

At no time was disease considered a problem. It is the practice of the Leavenworth station to administer prophylactic treatments weekly to control gill disease in all feeding fish. However, this year the prophylactics were to be abandoned and therapeutic treatments given as needed, but as the season progressed troughs here and there throughout the entire hatchery were becoming infected with gill disease, and in order to keep the workload at a minimum it was decided to return to prophylactic treatments. These were continued until the close of the season except for diet No. V-5 where one-half was given prophylactic treatment and the other half none. No difference was noted in the condition of the fish and there was no difference in mortality.

Whenever it was necessary to treat a trough not being given the prophylactic treatments, its control was also given the same treatment whether or not disease was present.

Excessive losses were experienced in Lot V-1 (chinook viscera) and Lot V-5 (salmon egg). These losses began to increase the first of April, peaking about the middle of May, and back to normal the first of July. Clubbing of gills was in evidence in both of the lots, therefore, treatment was given for gill disease. It was first assumed that the excessive "smoking" of the diet was causing gill irritation and bringing on the disease. However, it was soon evident that treatments given were ineffective and thus were dropped and the usual prophylactics resumed. Nothing more was done with those of diet V-1, but in diet V-5, one-third was given sulfadiazine, one-third pantothenic acid, and one-third used as control. After one week of this, it also appeared to be ineffectual. In fact, the control had less mortality than those treated. Further treatments were withheld. The diet, however, was changed to one-third eggs, one-third liver, and one-third spleen; shortly, thereafter, the mortalities began to decline, resuming normality within a few weeks.

In both diets the high mortality and percent mortality was about the same both in duration and effect. Any change in diet appearing ineffective leads me to believe that composition was the cause of excessive mortalities, its being known that diets containing excessive amounts of egg produce a similar mortality pattern.

The groups receiving viscera and fish-product diets were fed this diet Monday through Friday. Saturday and Sunday they received the control diet in order to reduce heavy work loads over the week-end. It was apparent that the fish did not relish this change since the time for consuming the food was considerably longer than usual.

The amount to feed was controlled by pilot troughs which were weighed bi-weekly, the gain noted and food amounts increased accordingly.

"Smoking" of some of the diets did not seem to affect the general health. In fact, diet V-2 (Alaska sockeye viscera) was "smoked" more than any other diet except the chinook viscera and egg diets, yet least trouble was encountered in this group. Cannibalism was prevalent throughout most of the season and was greater in the meat diet than in the viscera. Size variation was also greater in the meat diet. The fish fed diets V-1 (chinook viscera), V-2 (Alaska sockeye viscera), and V-5 (salmon eggs) produced the most uniform fish.

Meat	No. Fish Start	Average weight Start	Percent Mortality	No. Fish End	Average weight End
M-1	15,528	.111	15.8	13,088	2.602
M-2	63,742	.112	15.3	53,989	2.523
M-3	256,080	.113	12.9	222,962	2.756
M-4	176,379	.114	17.4	145,629	2.401
M-5	226,108	.113	17.7	186,287	2,231
M-6	182,913	.113	14.8	154,869	2.266
M-7	256,217	.113	18.0	210,210	2.313
M-8	61,253	.113	22.6	47,413	2.719
Chinook					
V-1	15,527	.111	35.0	10,095	6.386
Sockeye Alaska					
V-2	63,743	.112	12.7	55,653	4.234
Sockeye B.C.					
V-3	259,829	.113	20.3	207,154	4.115
Chum					
V-4	176,379	.114	20.9	139,439	4.379
Eggs					
V-5	226,108	.113	34.7	147,688	6.963
Cortland					
V-6	185,074 (a)	.113	15.7	155,985	2.689
Hump.					
V-7	256,547	.113	17.3	212,132	3,510
Hump. Silvers					
V-8	61,046 (b)	.113	14.8	52,016	4.163

(a)....on meat diet until July 16
(b)....on humpy diet until July 7

Results of 1954 Feeding Trials

B. D. Combs
Fishery Research Biologist

The results of the 1954 feeding trials conducted on blueback and chinook salmon may be summarized as follows:

Blueback Salmon - The purpose of the blueback (sockeye) salmon experiments in 1954 was to develop diets which would be virus free. Two methods of approach were explored. Salmon viscera was sterilized by two methods of heat treatment and the growth rates compared with raw viscera. In the second method, other products were substituted for viscera and the nutritional response to these diets compared with those containing salmon viscera.

1. Tests of raw, pasteurized and canned salmon viscera fed in comparable mixed diets indicated that the growth potential of the viscera was reduced by either of the heat treatments. The canned viscera was more nearly comparable to the raw viscera than was the pasteurized product. Feeding consistency may be a factor also in these evaluations in that the pasteurized viscera was nearly liquid and, therefore, the feeding consistency of the diet was not comparable to that of the other two. Heat treatment also appeared to destroy the binding action of salmon milt. Regardless of cause, sterilization of the salmon viscera by either method resulted in an inferior diet.

2. In two diet combinations arrow-toothed halibut proved superior to squaw fish in its growth potential. The halibut when composing as much as 50 percent of the diet supplemented with hog liver and beef lung resulted in gains nearly comparable to a similar diet containing a like amount of salmon viscera. Arrow-toothed halibut may be considered an adequate substitute for salmon viscera in the diet of blueback salmon.

3. Dry meals in excess of 5 percent have not proved satisfactory in diets of blueback salmon at temperatures below 50° F. This finding is true of either salmon meal, distillers solubles or the Cortland No. 6 meal combination. Part of

the difficulty appeared to be the reluctance of the fish to consume meals at cold water temperatures.

4. Distillers solubles at the 5 percent level was an excellent vitamin supplement. Fish fed comparable diets which did not include distillers solubles showed an anemic tendency not present in the vitamin supplemented lots.

Chinook Salmon - The emphasis in this year's experiments was placed on high meal diets, 50 percent level, testing various meat and meal combinations with the Cortland combination and 10 percent meal diets as controls. As in the blueback experiments, the chinook were reluctant to consume the high meal combinations at temperatures below 50° F. Some fish in each group actually starved to death rather than eat the diet. A coccidia-like intestinal infection caused an increase in mortality during the first 12 weeks of the experiment, but was controlled by sulfa therapy. Despite these difficulties certain conclusions may be drawn from the experiment.

1. Meat-viscera-meal combinations were superior to 50 percent dry meal diets for chinook salmon. Gains in the raw product diets were about 200 percent greater.

2. Seal meal substituted for salmon offal meal in the Cortland No. 6 combination produced significantly greater growth than its counterpart.

3. Equal parts of hog liver and salmon viscera substituted for the 15 percent beef liver, 35 percent hog spleen mixture produced gains comparable to the Cortland meat combination.

4. Salmon viscera fed as the sole raw product in combination with 50 percent of the Cortland No. 6 meal mixture was inadequate during the cold water period. Clubbed gills in moribund fish indicated a pantothenic acid deficiency was the causative factor. Examination of fish at the conclusion of the experiment

indicated that a pantothenic acid deficiency had been present also in the hog liver-salmon viscera - Cortland No. 6 meal mixture.

5. The elimination of fish meal from Cortland No. 6 meal mixture and an increase in the amount of distillers solubles did not result in a reduction in the mortality or an increase in the growth rate.

Feeding Trials with Blueback Salmon - 1954 — Table 1

Initial number per trough: 1,225 fish
Initial weight per trough: 500 gr.
Initial average weight per fish: .41 gr.
Initial number per pound: 1,111 fish
Temperature: 1st 12 weeks average-- 45.97° F.
2nd 12 weeks average- 51.98°
24-week period average - 48.98°

Period: 4/14/54 to 9/29/54

Lot No.	Diet Components	Percentage Composition
1	Hog Liver S 1/	25.00
	Arrowtooth Halibut	25.00
	Salmon Viscera (raw)	50.00
	Salmon Offal Meal 2/	
2	Hog Liver S	25.00
	Arrowtooth Halibut	25.00
	50° C. Heat treated Salmon Viscera	50.00
	Salmon Offal Meal 2/	
3	Hog Liver S	25.00
	Arrowtooth Halibut	25.00
	100° C. Heat treated Salmon Viscera	50.00
	Salmon Offal Meal 2/	
4	Beef Liver S	100.00
5	Beef Liver S	25.00
	Hog Liver	25.00
	Beef Lung	25.00
	Squawfish	25.00
	Salmon Offal Meal 2/	
6.	Beef Liver S	25.00
	Hog Liver	25.00
	Beef Lung	25.00
	Arrowtooth Halibut	25.00
	Salmon Offal Meal 2/	
7.	Hog Liver S	25.00
	Beef Lung	25.00
	Squawfish	50.00
	Salmon Offal Meal 2/	
8.	Hog Liver S	25.00
	Beef Lung	25.00
	Arrowtooth Halibut	50.00
	Salmon Offal Meal 2/	
9.	Hog Liver S	23.75
	Beef Lung	23.75
	Arrowtooth Halibut	47.50
	Salmon Offal Meal 2/	

-continued-

Lot No.	Diet Components	Percentage Composition
10	Hog Liver S	23.75
	Beef Lung	23.75
	Arrowtooth Halibut	47.50
	Distillers Solubles	5.00
	Salmon Offal Meal 2/	
11	Hog Liver S	21.25
	Beef Lung	21.25
	Arrowtooth Halibut	42.50
	Distillers Solubles	15.00
	Salmon Offal Meal 2/	
12	Hog Liver S	25.00
	Beef Lung	25.00
	Distillers Solubles	25.00
	Wheat Middlings	12.50
	Cottonseed Meal	12.50

1/ Salt added at the rate of 2 grams per 100 grams of ration.
2/ At the end of the first 12-week period, 10% of flame-dried salmon offal meal was added to these diets with a corresponding proportional reduction in each of the original components.

Feeding Trials with Blueback Salmon - 1954 — Table 2

Initial number per trough: 538 fish
Initial weight per trough: 1,000 gr.
Initial average weight per fish: 1.86 gr.
Initial number per pound: 244 fish

Period: 4/7/54 to 9/22/54

Temperature: 1st 12 weeks average - - 45.72° F.
2nd 12 weeks average - - 51.61°
24-weeks period average - 48.67°

Lot No.	Diet Components	Percentage Composition
1-c	Beef Liver S 1/	20.00
	Hog Liver	20.00
	Hog Spleen	20.00
	Salmon Viscera	30.00
	Seal Meal	5.00
	Distillers Solubles	5.00
2-c	Hog Liver S	22.50
	Arrowtooth Halibut	22.50
	Salmon Viscera	45.00
	Seal Meal	5.00
	Distillers Solubles	5.00
3-c	Beef Liver S	15.00
	Hog Spleen	35.00
	Distillers Solubles	12.50
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
	Salmon Offal Meal	12.50
4-c	Salmon Viscera S	50.00
	Distillers Solubles	12.50
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
	Salmon Offal Meal	12.50
5-c	Hog Liver S	25.00
	Beef Lung	25.00
	Distillers Solubles	12.50
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
	Salmon Offal Meal	12.50
6-c	Hog Liver S	25.00
	Salmon Viscera	25.00
	Distillers Solubles	12.50
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
	Salmon Offal Meal	12.50

-continued-

Lot No.	Diet Components	Percentage Composition
7-c	Hog Liver S	25.00
	Salmon Viscera	25.00
	Distillers Solubles	12.50
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
	Seal Meal	12.50
8-c	Hog Liver S	25.00
	Salmon Viscera	25.00
	Distillers Solubles	25.00
	Wheat Middlings	12.50
	Cottonseed Meal	12.50
9-c	Hog Liver S	25.00
	Salmon Viscera	25.00
	Distillers Solubles	37.50
	Wheat Middlings	6.25
	Cottonseed Meal	6.25

1/ Salt added at the rate of 2 grams per 100 grams of ration.

2/ Fish lost weight first 12 weeks.

Feeding Trials -

TABLE I

Lot	Mean weight in grams 12 wks	24 wks	Percent Mortality 12 wks	24 wks	Conversion 12 wks	24 wks	Hemoglobin g/100 ml. blood- 24 wks	Deficiency Symptoms
1-	3,306	13,310	3.22	3.76	2.7	2.8	7.4	None
2-	3,000	7,618	2.73	4.00	2.9	4.0	6.9	None
3-	3,390	10,668	2.90	4.24	2.6	3.4	7.5	None
4-	2,740	7,305	2.53	4.37	3.1	4.0	7.2	None
5-	3.066	9,940	2.86	3.76	2.8	3.4	6.4	None
6-	3,238	10,350	2.49	3.51	2.5	3.4	6.7	None
7-	2,975	8,783	2.41	3.71	2.8	3.6	7.1	None
8-	3,269	11,007	2.20	3.31	2.6	3.3	5.8	Anemic tendency
9-	3,273	11.365	3.22	5.10	2.6	3.2	4.9	Anemic tendency
10-	3,107	10,659	3.27	4.16	2.7	3.3	7.6	None
11-	2,873	9,848	5.96	7.51	2.8	3.3	7.3	None
12-	2,176	5,589	5.88	7.91	3.4	4.5	6.7	None
	166	859	1.5%	2.4%	Least difference at the 5% confidence level			

TABLE 2

1-c	2,866	7,148	17.66	18.77	3.4	2.5	8.2	None
2-c	2,774	6,267	22.31	24.91	3.5	3.4	7.9	None
3-c	1,606		26.39		8.6	Diet discontinued 8/5/54		
4-c	870	1,946	59.48	84.01	2/	14.8	6.7	Clubbed and fused gills indicating previous pantothenic acid deficiency
5-c	1,131	2,208	39.96	61.06	37.2	8.6	6.6	None
6-c	1,587	3,995	32.62	45.45	8.9	4.3	6.9	Same as 4-c
7-c	1,948	5,227	26.95	33.46	5.7	3.5	7.6	None
8-c	1,593	3,818	27.14	36.43	8.4	4.8	7.6	None
9-c	1,522	3,132	24.54	34.11	9.6	6.2	6.4	None
	406	1,410	19.7 %	30.5 %	Least difference at 5% confidence level			

Feeding Experiments, 1954

John A. Coates
Biologist

The Washington State Department of Fisheries nutrition experiments for the 1954 feeding season were confined to the total and partial replacement of the salmon viscera portion of their production diet. The increasing demands for current viscera supplies and the possibility of viscera as a disease vector justified the need of this experiment.

The nutritional experiments were carried out at the Klickitat hatchery located on the Klickitat River in South Central Washington. The water supply is piped from a spring adjacent to the hatchery and the temperature is fairly constant through the year at 50° F.

1953 brood silver salmon (O. kisutch) were chosen as test animals because of their long rearing time (one year). One-thousand of these fish were started in six-foot diameter, circular wooden tanks; each tank was equipped with individual water supply. The fish were raised in accordance with normal fish cultural procedures of the Department, except in weighing procedures and in this case, the total population was weighed instead of a sample.

The diets and resulting data have been summarized in the table at the end of this report. Some trouble has been experienced in the past at the Klickitat hatchery with kidney disease. For this reason, sulfamethazine (Sulmet) was added to one of the paired diets at the rate of 2 grams per 100 pounds of fish weight.

The feeding trials were divided into two experiments. One, the partial replacement of salmon viscera with whale meat, salmon carcasses or cottonseed meal. Two, the total replacement of viscera by scrap fish -- hake (Merluccius productus), turbot (Atheresthes stomias) and English sole (Parophrys vetulus). The English sole were from lower Puget Sound, an area infested with a parasitic worm. In all instances, the viscera portion of the diets was the only portion changed. Diet No.'s 3 and 4 constitute the basic diet.

The results are presented in the Table. In the mortality table, the accountable mortality is the daily pickoff. The unaccountable mortality is the difference between the total number placed in the tanks, minus the loss and minus the number left at the end of the experiment. In the case of No.'s 8, 17, and 18, it was known that some fish were lost because of faulty screens. Some of this mortality may be due to errors incurred in counting, etc. The mortalities are calculated as accumulated mortalities.

Results: Partial Replacement of Salmon Viscera --

The addition of salmon carcass and whale meat to the basic diet improved the growth of the test fish. Diet 8 had the best growth at the end of 40 weeks on experiment. The increased growth of this diet group over its diet pair No. 7 may be explained in part by the decreased population in diet 8 tank due to a faulty screen on the outlet. Diets 5, 6 and 7 had very little difference in growth at the end of 40 weeks. All diets of this group were better than the basic diet of No.'s 3 and 4.

There was no difference in growth between the basic diet 3 and 4, and the diets 11 and 12 containing cottonseed meal.

Results: Total Replacement of Salmon Viscera --

Wormy Sole: This diet (13 and 14) produced growth second to the viscera control for the first sixteen weeks on diet. After that time, it was surpassed by all other diets and ended in last place in growth at the end of 40 weeks on diet.

There was a mortality difference between the pair in this diet. The diet without sulfa, diet 14, was fourth high with a total mortality of 9.5 percent for the 40 weeks. The diet pair containing sulfa, diet 13, was the same as the controls with a total of 4.5 percent in 40 weeks. Same as control, 11 and 12.

Turbot: This diet, 15 and 16, ranked third in growth behind the viscera, 11 and 12, and wormy sole, 13 and 14, until the end of the sixteenth week when this diet moved up into second place behind the viscera control. This diet held this position until the 37th week when it was replaced by a hake and turbot combination, diets 17 and 18.

The mortality of this diet group varied as to the sulfa content. Diet 15, which contains sulfa, had the highest mortality for the first 19 weeks. At this time diet 16, no sulfa, increased in mortality equal to diet 15. At the end of 40 weeks, both of these diets finished in fourth and fifth place with 7 percent for diet 16 and 8 percent for diet 15.

Turbot, 36.5% and Hake, 36.5% (diets 17 and 18) : This diet compared in growth to the turbot diet for the first eight weeks. After that time, diets 17 and 18 remained behind diets 15 and 16, turbot, until the last weigh period (40 weeks), when it had a phenomenal upsurge and finished second to the control diet of viscera.

The mortality curve of this group showed very little difference from the control until the 16th week, when both diets, 17 and 18, of the pair took an upswing. By the 20th week, diet 17 containing sulfa led the rest of the diets in mortalities ending the end of 40 weeks with the highest mortality of all diets with 20 percent. Diet 18, no sulfa, finished second high with 13 percent.

Hake, diets 9 and 10: This diet held last place in growth until the 21st week when this diet was replaced by wormy sole.

The diet pair without sulfa, diet 10, had the higher mortality; diet 10, no sulfa, was second high in mortalities for 16 weeks. After this time, it dropped to fourth place where it remained until the end of 36 weeks of the experiment when it, too, had an upsurge and ended third high with a total mortality of 12 percent . Diet 9, sulfa, compared with the viscera controls until after the 32nd week when an upswing in mortality placed this diet fifth high with 8 percent total mortality at the end of 40 weeks.

Discussion:

In general, when viscera is included in the diet to at least 67 percent, the fish on this diet experience greater growth and less mortality than those fish on diets containing complete replacements for this viscera.

There was no diet group that contained viscera that had an accountable mortality of 5 percent or more. For the forty weeks these diets ranged between 4.5 percent, 11 and 12, to 2.5%, 6 and 7.

The range in accountable mortality for the non-viscera group was between 20 percent, diet 17, and 4.5 percent, diet 13, with the average approximately 9 percent for the 40 weeks on diet.

TABLE I

S - Sulfa fed at 2 grams/100 lbs. fish level
N S - No sulfa in diet

Diet	Per Cent	No.	Sulfa	Starting 1/28/54 8% B.W. No. of Fish	Starting Total Wgt. in Pounds	Ending 10/30/54 40 weeks No. of Fish	Ending Total Wgt. in Pounds	Account. Mort.	Unacct. Mort.	Accumulative Mortality Total Mort.	% Acct. Mort.	% Total Mort.
Beef liver	15	3	S	1,000	0.63	914	9.23	40	46	86	4.0	8.6
Salmon viscera	83											
Salt	2	4	NS	1,000	0.63	931	9.46	34	35	69	3.4	6.9
Beef liver	15	5	S	1,000	0.62	912	11.10	35	53	88	3.5	8.8
Whale meat	16											
Viscera	67											
Salt	2	6	NS	1,000	0.63	915	10.86	25	60	85	2.5	8.5
Beef liver	15	7	S	1,000	0.63	914	10.68	28	58	86	2.8	8.6
Salmon carcass	16											
Salmon viscera	67											
Salt	2	8	NS	1,000	0.64	696	8.93	41	263	304	4.1	30.4
Beef liver	15	9	S	1,000	0.61	840	5.44	81	79	160	8.1	16.0
Hake	73											
Cottonseed meal	/10											
Salt	2	10	NS	1,000	0.61	742	5.08	112	146	258	11.2	25.8
Beef liver	15	11	S	1,000	0.63	945	8.90	44	11	55	4.4	5.5
Salmon viscera	73											
Cottonseed meal	/10											
Salt	2	12	NS	1,000	0.62	938	9.00	42	20	62	4.2	6.2
Beef liver	15	13	S	1,000	0.64	897	5.25	49	54	103	4.9	10.3
Wormy sole	73											
Cottonseed meal	/10											
Salt	2	14	NS	1,000	0.61	759	4.74	96	145	241	9.6	24.1
Beef liver	15	15	S	1,000	0.61	880	6.19	73	47	120	7.3	12.0
Turbot	73											
Cottonseed meal	/10											
Salt	2	16	NS	1,000	0.61	860	6.60	80	60	140	8.0	14.0

Beef liver	15	17	S	1,000	0.63	-599	4.94	202	199	401	20.2	40.1
Hake	36.5											
Turbot	36.5											
Cottonseed meal/10												
Salt	2	18	NS	1,000	0.61	671	5.71	129	200	329	12.9	32.9

<u>Minerals of Importance to Fish</u>

Lauren R. Donaldson
Professor, Fisheries, U/W;
Director, Applied Fisheries
for AEC

Although it has been assumed that there are unlimited supplies of minerals in the ocean, the experimental work with radioactive iodine in the Pacific Ocean showed that minerals may be a limiting factor in plant and animal populations.

(Note: Because of the nature of Dr. Donaldson's work for the Atomic Energy Commission, his report must necessarily be less detailed than the other reports. One of the interesting points brought out in Dr. Donaldson's talk at the Conference with reference to the summary given above was that the amount of absorption of minerals is dependent upon the deficiency.)

Feed as a Vector of the Sockeye Salmon Virus Disease

Raymond W. Guenther
Bacteriologist

Since 1950 a virus disease of the sockeye salmon has been a major problem at hatcheries rearing these fish. Total mortalities of over 90% within a period of ten days in some groups were not uncommon.

Since all attempted therapeutic measures failed, the federal hatcheries located at Winthrop and Leavenworth, Washington, were set up on an experimental basis during the 1954 rearing year to discover the point of entry of the etiological agent of this disease into the stations. All work was carefully planned and controlled in such a way that an outbreak of the disease would incriminate the fertilized egg, air- or water-borne insects, bacteria, or particles, or the raw salmon products used in the feed.

At the Winthrop hatchery, a diet containing assorted salmon viscera was fed to seven ponds of fingerlings and an all-meat diet (the control) was fed to an equal number of ponds. A diet containing viscera from known species was fed to 137 troughs and 20 ponds of fingerlings at the Leavenworth station, while an all-meat diet was fed to their control equivalent complements.

At Winthrop, three of the seven viscera-fed ponds contracted the virus disease. Two of these ponds contained fingerlings spawned at Lake Wenatchee and the third was stocked with fingerlings spawned at Winthrop. At Leavenworth the fish in two of the twenty-three troughs receiving a diet containing British Columbia sockeye viscera were lost to the disease. There were no other virus epidemics at these stations.

It is known that the returning adult sockeye salmon carry the etiological agent. The tests of 1954 of the spawning adults have, thus far, given the results which are shown on the following page:

Source	No. of adults tested	No. of carriers
Lake Wenatchee	24	2
Portage Bay (Seattle)	12	1
Issaquah Creek	12	0
Frazer River	10	7
Lake Whatcom (Kokanee)	10	3

Experimental work has shown that fingerlings become increasingly refractile to the virus as they become older, and there is evidence that the recovered fish, though almost completely immune to disease, carry enough of the infective particles to spread the virus to fingerlings held in the same trough immediately below the recovered fish. Therefore, it is highly probable that the plagues which have been causing the severe hatchery losses are due to the practice of feeding raw salmon products. Though at present it does not appear that species of fish other than sockeye salmon are acting as carriers of the agent, our present tests for the virus may not be sensitive enough to detect its presence.

From the disease viewpoint, the practice of feeding fingerlings raw fish products cannot be condoned, for bacteria as well as viruses can survive extended periods of freezing.

James W. Wood
Aquatic Biologist

Kidney disease was first recognized at our Oregon hatcheries by Mr. Tom McKee during the fall of 1948 among the spring chinook salmon fingerlings at the Trask River Hatchery. Since that time we have found the disease at nearly all of our hatcheries among both fall and spring chinook salmon, silver salmon, and steelhead trout. Silvers and steelhead seem to be more resistant to the disease than are the chinook. We have found the disease in chinook salmon as early as 60 days in their rearing period at one hatchery, while at another hatchery it has not shown up until after a 10 to 12-month rearing period.

The extent of the infection varies from hatchery to hatchery. In general, at hatcheries where the disease occurs during the warm water months fish suffer heavier losses than at hatcheries where the disease occurs during the cool water months. Mortalities as high as 20% weekly have occurred at the Sandy Hatchery among spring chinook salmon fingerlings during the month of July.

It has been postulated that the disease may be water-borne and that the fish contact the disease through the water supply, or else it is transmitted through the diet fed to the fish. Perhaps both factors contribute to the epidemics that occur among fingerling salmon.

We have done little to investigate the water-borne method of transmission, but we have been investigating our hatchery foods for the transmitting vector of the disease.

In 1953 Mr. Hanson, the superintendent of the Sandy River Hatchery, maintained one pond of silver salmon on a diet containing no salmon products; no salmon viscera, flesh or meal. The other eight ponds of silver salmon at the hatchery were fed the normal hatchery diet which contained a large percentage of salmon viscera. After a 9-month rearing period the mortality rate in the ponds being fed salmon viscera took a sharp jump while the mortality rate in the pond receiving no salmon products in the diet stayed at a low level. The high mortality rate was caused by kidney disease. The difference in mortality was so great that it indicated that the viscera was a possible vector responsible for the transmission of kidney disease.

To further investigate the role of salmon viscera as a transmitting vector of kidney disease, an experiment is being conducted at both the Sandy and Clackamas stations. This experiment commenced in the spring of 1954 and is still being carried on, (as of December 1954)

During the past two years I have examined a number of adult spring chinook in the middle Willamette River for kidney disease. In the past we have fed most of our spring chinook carcasses and it would seem that if these carcasses were infected they would offer a possible source of the disease in the hatchery. During August of this year I started to find adult spring chinook salmon whose internal organs, especially the liver and spleen and, to a lesser extent, the kidney, showed the white watery pustules found typical of kidney disease. Only a small percentage of the adults, probably one to two percent, showed these gross lesions. These pustules were filled with the characteristic diplo-bacilli of kidney disease. Specimens were sent to Dr. Erling Ordal, Microbiology Department of the University of Washington, and to Mr. Brian Earp of the Washington State Department of Fisheries for examination and they confirmed the findings of kidney disease. This disease has since been found in spring chinook adults in the Sandy River.

Unlike adults infected with the Mycobacterium characteristic of tuberculosis, adults infected with kidney disease have shown no sign of arrested sexual development. The disease has been found in spawned-out adults, both male and female as well as in fish that died previous to spawning. Whether the kidney disease is a factor in adult mortalities is not known.

As a result of our finding kidney disease in adult spring chinook salmon, we have discontinued feeding carcasses at both the Oakridge and Sandy hatcheries.

At the present time we are conducting an experiment at the Oakridge hatchery using 10 lots of spring chinook salmon fingerlings. Five lots are being fed a diet containing infected flesh and viscera gathered during the past spawning season and five lots, designated as control lots, are receiving no salmon products of any kind. We hope to find to what extent the feeding of infected adult carcasses is responsible for the kidney disease in the young fingerlings.

We suspect that the adult salmon became infected in fresh-water during the period between April and August. These were spring chinook salmon that reached the hatchery rack during the month of May. From what we know at the present time this four-month period is ample time for the adult fish to become infected. Future plans, however, call for the examination of spring chinook salmon taken in the commercial fishery at the mouth of the Columbia River.

Report on Low-level Sulfamethazine Prophylaxis for the Control of Kidney Disease

Brian Earp
Bacteriologist

As a result of experiments conducted at Klickitat hatchery during 1953, it was determined that the incidence of kidney disease could be greatly reduced by the continuous feeding of sulfamethazine in the diet at a low level.

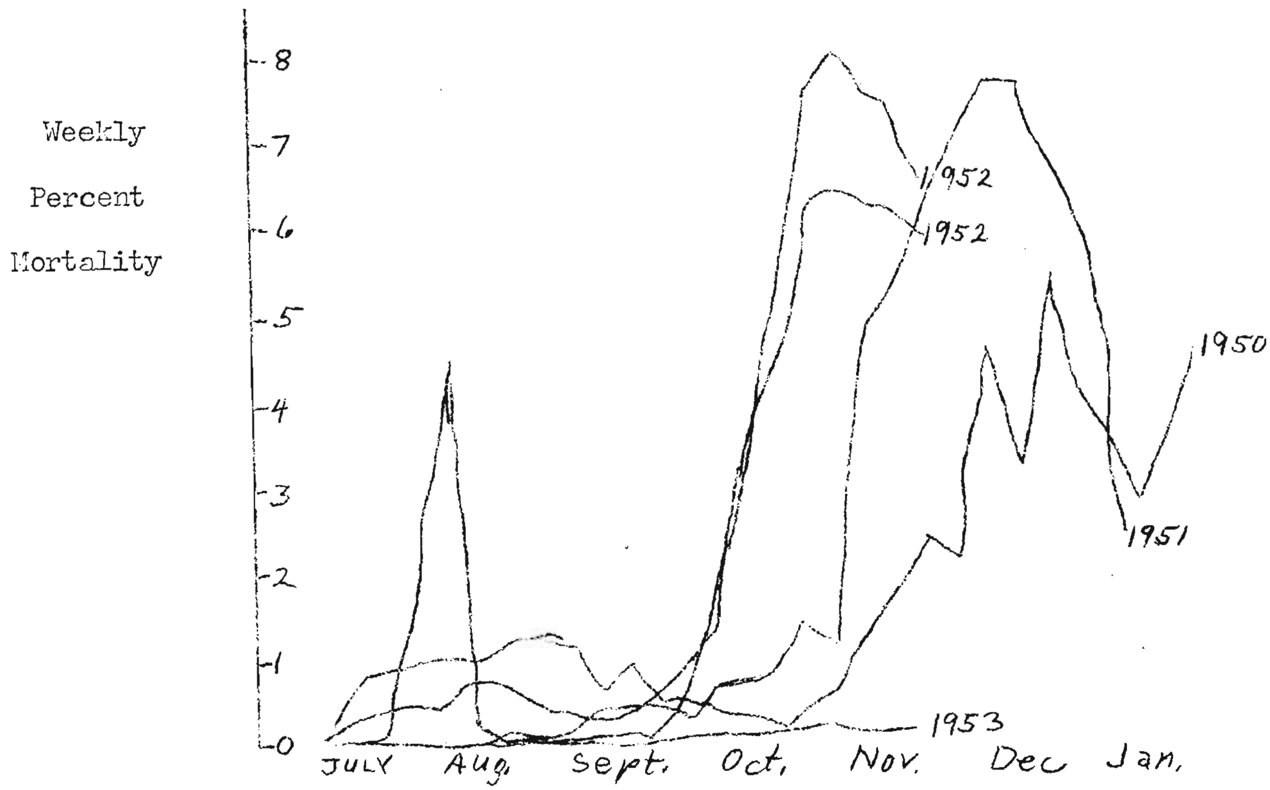
The entire stock of 1953 brood fish reared at Klickitat during the current year (1954) received sulfamethazine in the diet at the rate of 2 grams per 100 pounds of fish daily. These stocks included both silver salmon and spring chinook salmon. Prophylaxis was started March 16, 1954 in all ponds.

The graph following this report shows the weekly percent mortalities sustained in silver salmon at the Klickitat station for the brood years 1950 through and including 1953 for the period from July (when the mortalities from kidney disease usually appeared) to the following February. Two lines appear for the 1952 brood year. These represent two stocks of silver salmon, one from the Lewis River, the other from the local Klickitat salmon. Brood years 1950 through 1952 received no sulfamethazine at all, or received it intermittently. Brood year 1953 received continual prophylaxis as stated above.

No control ponds were kept. Heavy losses from kidney disease have always been sustained at this hatchery since it was put in operation.

The general appearance of the fish receiving sulfa prophylaxis is markedly improved over that noticed in previous years. Losses in the spring chinook are not shown graphically, but closely approximate those shown for the silvers. General appearance of this fish, also, is excellent for this year.

Silver Salmon Losses at Klickitat Hatchery - Brood years 1950 - 1953



Sulfonamide prophylaxis in 1953 only

Effect of High Constant Temperatures upon the Mortality and Growth of Chinook Salmon Eggs, Fry and Fingerlings

Allyn H. Seymour
Ass't Director, Applied Fisheries Laboratory

Egg mortality was nominal, averaged 5%, at temperatures from 40° to 57½° but increased to 29% at 60°, 81% at 62½° and 100% at higher temperatures. However, from hatching up to time of feeding total mortality for lots reared at 55° and 57½° F. increased to 65% and to practically 100% for lots that survived was nominal.

At the end of the experiment, 46 weeks after fertilization, there was no growth in the 40° F. lot. The number of fish per pound for the 45°, 50° and 55° F. lots was 138, 36, 25 respectively. For growth rate at temperatures above 55° F. an experiment was started during the 19th week using fish from a lot that previously had been reared at city water temperatures. At the end of the experiment there were no survivors in the lot at 74° F. and the number of fish per pound for the 60° and 67° F. lots was 41 and 61 respectively.

It is to be noted that the above remarks pertain to a Green River Chinook stock reared from fertilization for 46 weeks at constant temperatures.

Roger E. Burrows
Aquatic Biologist

Effect of Controlled Temperatures on Salmon Eggs

Results of experiments to determine the thresholds of normal development of chinook salmon eggs, fry, and fingerling indicate that the upper limit of normal development for green eggs is 57.5° F., for eyed eggs 55.0° F., and first-feeding fingerling below 55.0° F. These thresholds were determined from mortalities incurred at the different stages of development which were significantly higher than the controls. The lower limit of normal development for chinook salmon eggs subjected to constant temperatures throughout the incubation period was between 40.0° and 42.5° F.

It is assumed that changes in the temperature pattern to which the eggs are subjected would alter survival rates. Experiments now in progress indicate that eggs which have advanced to the eyed stage will tolerate colder temperatures than green eggs. It should be emphasized that the limits defined above are tolerance thresholds and that at temperatures slightly above or below these limits mortalities are significantly higher, but not necessarily complete.

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REMARKS:

Frank G. Lowman
Research Biologist

The high mortality of salmonoid eggs incubated at temperatures near the freezing point of water may be due, in part at least, to upsets in chromosome re-duplication in the early embryonic stages.

Eggs of rainbow trout held for 24 hours at 50° F., then for 48 hours at approximately 32° F. exhibited cytological abnormalities; mainly, in the form of chromosomal fragmentation. Loss of chromosome fragments in mitotic divisions would contribute to the death of a developing embryo.

Effect of Variation of Temperatures on Eggs

John R. Donaldson
Aquatic Chemist

Chinook salmon (Oncorhynchus tshawytscha, Walbaum) eggs were exposed to temperatures of 67°, 65°, and 63° F. for varying lengths of time and then were removed to more optimum temperature conditions (50° to 55° F.) where the after-effects, if any, were observed through to the fingerling stage.

It was found that the eggs and fry did not die at a constant rate, but that their tolerance to temperature exposure varies with the stage of development. The stages during which the greatest percent mortalities occurred were: the time until closure of the blastopore, the period just previous to and during hatching, and the period when the fry are adapting to feeding.

As the time of exposure to each of the three experimental temperatures increased, the occurrence of yolk erupting from the chorion just previous to hatching increased, the average length of the fingerling in each lot decreased and the frequency of commonly occurring anomalies increased. Also, when egg lots were exposed to the three experimental temperatures past the stage associated with the pigmentation of the eye (350 T. U.) the time necessary for the completion of the hatching period doubled.

In general, the results indicated that as the temperature increses from 63° to 67° F. the time necessary to kill a certain percentage of the eggs in any one lot decreases. Exposures to 67°, 65° and 63° F. for 2, 5, and 13 days respectively resulted in a 10 percent kill of the eggs by the end of the hatching period. It required exposures of 6.5, 14, and 22 days to the same respective temperatures to kill 50 percent of the eggs by the same time.

<u>Retention of Brood Stock in Blue Lake</u>

Cliff Millenbach
General Supt. of Hatcheries

For years cutthroat eggs for hatchery purposes have been somewhat difficult to obtain. The maintenance of broodstock of this species has not been without serious problems and sources of wild spawn have been limited. To alleviate this situation Blue Lake in Okanogan County was set aside for the production of cutthroat eggs.

In 1949 Blue Lake contained a heavy population of scrap fish, including carp, suckers, squawfish, shiners, and chubs. This lake had offered no trout fishing for several years and consequently, had no value from that standpoint. An inlet, Sinlahekin Creek was so situated that it could be completely controlled with all or any part of the flow available for diversion into or around the end of the lake.

Blue Lake was treated with rotenone in 1949 at which time it covered 169 acres and had a maximum depth of 69 feet. Observations since that time have proved that a complete kill was effected.

Cutthroat trout weighing 950 to 1600 per pound were planted in Blue Lake in October, 1949. That and subsequent plantings through 1952 total 225,702 fish, all small fingerling in size.

The cost of treating the lake with rotenone, building traps, and stocking with small fingerling has been figured to be approximately $8,670.00. First eggs were obtained in 1952, and subsequent egg takes in 1953, and 1954 provided a total of 7,825,000 eggs. A reasonable value for these eggs is $3.00 per thousand. This gives a value of $23,400.00 for an investment of $8,670.00.

An annual egg take of 5,000,000 eggs is predicted for 1955 and for many years to come. Blue Lake may be considered as an excellent example of good fisheries management.

Transportation of freshly spawned, Fertilized Pink Salmon Eggs by Air

Barney W. Johnson
Field Supervisor

Pink salmon differ from other Pacific Coast salmon in that they normally require only two years to complete their life cycle.

Both even and odd year runs are common to streams along the north Pacific Coast, while Puget Sound has only the odd year runs.

For several years the Washington State Department of Fisheries has been experimenting with the possibilities of transferring the "even year run" to Puget Sound streams.

Experimental lots of even year run pink salmon have been obtained from the Skeena River watershed, British Columbia, Canada. The results of these experiments have been encouraging and continuation of the program was planned in 1954.

In the past, the usual procedure has been to dispatch the necessary men and equipment to the Skeena River area to obtain the eggs. These eggs were held in a temporary hatchery of shallow troughs; the water supplied by a small spring. The eggs were held in baskets until they were eyed. Above normal losses were experienced under this procedure. High costs, water supply difficulties and high losses experienced in eyeing up the eggs and then transporting them to a Washington state salmon hatchery via truck and railroad gave reason to try moving the freshly spawned, fertilized eggs to better incubating and hatching facilities.

The advantages and disadvantages of using air transportation to move a large quantity of green eggs from Lakelse River to the Green River hatchery in Auburn, Washington, was carefully checked. Two problems were paramount. First, the losses on the eggs had to be minimum (speed in egg take and movement was vital in this phase); and second, the differences in the costs of one procedure over the other for collecting, shipping and incubating the eggs had to be considered and any additions justified. It was finally decided that sufficient facilities were available to make practical the air transportation of the green eggs.

Canadian fisheries agencies maintain very adequate upstream and downstream trapping facilities in the Lakelse River, a short distance below Lakelse Lake, a tributary to the main Skeena River. The ultimate success of this egg collecting project was due largely to the splendid cooperation and efforts of the personnel of these agencies. Without their help and equipment, the operation would have been much more costly and difficult.

The adult fish were collected at the trap in the Lakelse River. All the fish trapped were tested carefully and those which were ripe were placed in live boxes until enough females and males were on hand to furnish 450,000 to 500,000 fertilized eggs. Actual spawning of the selected fish began at 2:00 a.m. with a water temperature of 51° F. By 5:00 a.m., the eggs were taken, fertilized, washed and measured into the ten shipping containers. The containers were lightweight, plug cover cream cans of five-gallon capacity. Twelve quarts of near waterhardened eggs were placed in each can. Water was added to fill the cans level full and was maintained in that condition throughout the trip.

At 7:00 a.m., the eggs were carefully stirred by hand and ice was used to lower the water temperature. This was after they had been moved by boat across Lake Lakelse, stirred and transferred to a station wagon and hauled to Terrace. At 8:30 a.m. and about midway between Terrace and Prince Rupert, the eggs were stirred; water temperature was 46° F. and more ice was used. At 10:30 a.m., in Prince Rupert, the water was completely drained off the eggs and fresh water, cooled by ice to 42° F., was used to refill the containers. The shipment was loaded aboard a seaplane for the flight from Prince Rupert to Sandspit.

At 11:45 a.m. the containers were transferred to a land-based plane for the trip from Sandspit to Vancouver, B.C. All the eggs were carefully stirred at this point. The containers were opened and the eggs stirred twice during the flight from Sandspit to Vancouver. The first time at approximately 1:15 p.m. and again, at approximately 2:45 p.m. A fish transportation tank truck with a supply of freshly aerated water, cooled by ice to 42° F., was waiting at the Vancouver airport. Again, between 4:45 and 5:30 p.m., the water in all containers was completely replaced by water from the tank. The eggs were then loaded aboard the Department of Fisheries patrol plane and flown to Boeing Field in Seattle where they were picked up by truck and rushed to Green River hatchery at Auburn.

By 9:15 p.m., the eggs were all placed in baskets in the hatchery troughs without being tempered. Approximately 16 hours after the last eggs were taken, they had been transported 620 miles by truck and aircraft.

Summary of Egg Losses:

First pick off loss	14,137	
Pick off during eyeing period	17,117	
Pick off when shocked	9,750	
Total loss to eyed stage	41,004	
Eyed eggs on hand	470,400	
Total eggs taken	511,404	
Percent loss to eyed stage		.0801.

Returns from Plants of Large vs. Small Fish

Ernest O. Salo
Ass't Supvr.
Hatchery Research

The 1951 brood silver salmon were sized into two groups and marked Ad & RV (small fish) and Ad & LV (large fish) and released as yearlings. The small fish averaged 75 mm. in fork length (65 per pound) compared to 95 mm. (45 per pound) for the large fish.

Comparative fresh water survival rates were determined by the marked down-stream migrants from a sample plant of 4,500 each above the weir. The small fish had only a 52 percent fresh-water survival as compared to the 81 percent survival of the large fish for a combined average of 66.5 percent. An additional 108,077 marked small and 66,423 marked large fish were released below the weir. Theoretically, this would give a fresh-water survival of 63.6 percent, if all the reared silvers had been planted above the weir. This is lower than the expected 70-80 percent survival usually obtained for fish of this age.

There was a much greater overlap in size of the two groups counted through the traps than at the time of marking. Only the larger of the small size group migrated through the traps as yearlings.

The length-weight relationships of the hatchery fish before planting and after their recovery in the downstream traps were calculated. These before and after relationships were compared with those of the wild fish taken during the downstream migration. The equation derived for the small fish before planting was log weight= -4.86877 plus 2.98550 log length and after planting, the log of weight= -4.86940 plus 2.90548 log length. The equation derived for the large fish before planting was log of weight= -5.18643 plus 3.06227 log length. This shows that for a given length, the small fish were heavier than the larger fish both before and after planting. Before planting, the hatchery fish were heavier than the wild fish (log weight= -4.54150 plus 2.75770 log length), but when counted through the weir, they were much lighter than the wild fish. Also, the tendency for convergence of the log lines of the two groups is evident in the larger size groups and they approached the wild fish in their length-weight relationship.

The returns as adults were considerably fewer than the average of about 1%. This may have been due to the large plants in the restricted area below the weir. Summary of the escapement is given below along with comparisons to wildfish of the same brood year:

	Planted	Calculated F.W. Survival	No. Migrants Out	No. Returning	% Return	% of Plant
Small Fish Ad & RV	112,577	52.0%	58,540	149	0.25	0.132
Large Fish Ad & LV	70,923	81.0%	57,448	96	0.17	0.135
Wild Fish Dorsal	-	-	22,545	559	2.48	-

Fish Grader (and Movie)

John Rayner
Fishery Division
Operations Chief

(Note: Mr. Rayner's talk was primarily a movie demonstration of the fish grader. However, the following is a summarization of the grading paper by Newcomb - a copy of which was given out to each person at the meeting.)

The practice of grading in fish hatcheries was shown to be recommended in many fields of animal husbandry. The manner of utilizing a mechanically-adjustable, five-way grader, based upon a new principle, was presented through a discussion and motion picture.

As an example of the results of grading in a fish hatchery, a group of fish were followed through a season from October 1952 to August 28, 1953. A group of spring rainbow trout, numbering 125,571 and weighing 1,884 pounds, were graded into three lots. The fish averaged 66.6 per pound. Four months later, prior to regrading, the fish weighed 13,377 pounds and averaged 9.1 per pound. A 3.1 percent invisible loss was found to be within the range of probability for the method of enumeration used. Following regrading, each of nine groups was placed in a separate pond. Growth rates were manipulated by taking into consideration the spade factor in each pond and by feeding or withholding food as dictated by the demands of a liberation schedule. Between April 23rd and August 28th, 123,434 fish weighing 23,101 pounds were released from the hatchery. The slight "over-run" of 1,643 fish in excess of the 121,680 calculated to have been placed in the nine separate ponds following the second grading amounted to only 1.3 percent. The average size at time of liberation of all fish was 5.34 per pound. Substantial savings amounting to nearly $2,000 in food and handling costs were realized at the station as the result of grading and growth rate control.

It was concluded that good grading of the yearling stock resulted in a substantial saving in fish food, provided legal fish for stocking over a five-month period, and assured anglers that every fish stocked from the Wizard Falls Hatchery was a catchable fish.

Progress Report - Histological Comparison of Salmonids

Wm. T. Yasutake
Histopathological Tech.

Through the cooperation of the various conservation agencies in Oregon and Washington, the Histology Section of the Salmon Nutrition Laboratory made an extensive collection of both hatchery and wild salmonids necessary for the "Histological Comparison of Wild and Hatchery-reared Salmonids" project. In five trips through the two states, covering 5,000 miles, 72 wild and 84 hatchery collections, amounting to approximately 3,000 fish, were made. We are approximately at the half-way point in processing fish tissues before they can be examined under the microscope. Although it was anticipated earlier that the preliminary report on this project would be ready in about a year or two, it now appears that it may be ready within 6 to 10 months.

Note: The supplemental list giving the hatcheries and species collected is not included in this report since it was passed out to everyone at the meeting.

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