A REPORT OF

THE FISHERIES NUTRITIONAL CONFERENCE
AT SEATTLE, WASHINGTON

DEC. 4 & 5, 1952

PREFACE

The attached document represents a recording of the subject matter as covered in the "Fisheries Nutritional Conference", held at the University of Washington, Fisheries Center, on December 4 and 5, 1952. Reports of the individual speakers have been prepared by the speakers and are included without editing, excepting for very minor changes to provide for continuity.

Members of the Washington State Department of Fisheries took notes on the discussion as it took place throughout the meeting, but such recordings were far from being, nor were they intended to be a complete transcript of all discussion.

C. H. Ellis
Chairman

FISH NUTRITIONAL CONFERENCE HELD AT THE UNIVERSITY OF WASHINGTON FISHERIES CENTER ON DECEMBER 4 AND 5, 1952

Meeting was called to order by Chairman Ellis at 9:30 A.M. on December 4. Introduction of personnel was made and a roster of those in attendance was compiled and is herewith incorporated.

Dr. L. R. Donaldson made the introductory talk, a brief of which follows:

Progress and Problems in Feeding Fish in the Western States

by

Lauren R. Donaldson

The need for an inventory of our fish food problems is a constant and ever pressing one. To those of us assembled here, it thus seems unnecessary to emphasize again the acuteness of our problem and to point out that there is slight hope it will be quickly solved.

Even though the danger of being classified among the "oldsters" is involved by my referring to the days when liver was available by the carload and fish nutritionists were as yet an unborn professional group, let me call attention to the fact that the problems of fish nutrition have pushed to the fore with great suddenness.

Within the span of my limited experience in fish culture, the entire concept has changed from hatching millions of eggs from wild stock for fry plants to a program of rearing brood fish, fingerlings, to migration or catchable size - commercial rearing of trout at the rate of millions of pounds. Not only have the amounts of food required increased by leaps and bounds but new concepts of processing and blending foods in the diets have evolved.

In short, the present idea of integrated management has developed in the matter of a few years.

As late as 1921 O'Malley wrote:

"When the salmon have reached the proper age for distribution, they should be released on or near the natural spawning grounds, in the most protected spot that can be found. It is unwise to liberate young salmon before they have absorbed the yolk sac, and when the necessary facilities exist it is advisable to feed them until they have attained a length of at least 2½ inches, as fish of that size are much more likely than fry to elude their enemies."

Thus formerly, feeding of salmon was evidently a rather casual practice with little concern about size at time of release, about optimum release dates for the various species and races of fish, quality of fish, survival expectancy, or about many of the problems that occupy the attention of present day nutritionists.

For feeding the young salmon it is "convenient" to rear, O'Malley (1920) suggests that a very good food can be prepared from cooked Columbia River smelts, which he recommends be prepared in the following manner:

"The method which has given most satisfactory results is to place smelt in 50 or 100 pound lots in a farm kettle and cook them until the bones become softened. After this a quantity of the cooked mass convenient for handling is placed in gunny sacks and permitted to drain thoroughly. The mass in the sack is then transferred to a press of convenient size, operated by an ordinary house jack, and is pressed into cakes 12 inches square and varying from 3½ to 4 inches in thickness. The burlap forming the sack is pulled away and is serviceable for further use. Quantities of this food can be prepared at one time, and if kept in a cool, dry place, will remain in a wholesome condition for several days. When needed for food it is grated by means of a homemade power grater and screen, the degree of fineness depending upon the age of the fish to be fed."

There seemed to be little concern for the water soluble fractions of the smelt processed by the cook-and-press operation described by O'Malley.

In preparation of finely ground beef liver for feeding trout, Leach (1923) seems to have equal disregard for water soluble food values, for he writes:

"The introduction of beef liver into the troughs causes a milky discoloration of the water. This may be overcome, however, by washing the prepared material before giving it to the fish. The washing process is accomplished by introducing a stream of water into the vessel containing themeat, which is screened to prevent loss of the food, and allowing the milky substances to escape with the overflow. This treatment does not in any way lessen the nutritive value of the food."

The interval of 30 years since Leach's statement hasn't been entirely wasted, I am sure, for diets made up of a variety of foods blended and bound together are giving us better fish at a lower cost.

The amounts of food needed to make up, in part, for the loss of the natural feeding pasture of our salmonoids with the advance of civilization have constantly increased. Fiedler and Samson 1935, in a report based on the information from an estimated 85 per cent of all state, federal and commercial hatcheries in the country, state that the fish food fed in 1934 was 11,600,000 pounds, valued at $608,000. In a summary of the fish foods used by only the state fisheries of California, Idaho, Oregon, and Washington for 1947 (Donaldson 1948), it was found that these four western states had fed 8,480,629 pounds of food costing $506,409.

With further expansion of the pond-rearing facilities in these four western states in an effort to meet the needs for more hatchery reared fish, the total food fed in 1952 had increased to 11,299,282 pounds and the cost to $902,558.59.

California, Idaho, Oregon and Washington, in the short interval of eighteen years, have expanded rearing-feeding programs to one and one-half times that of the entire country for 1934. With additional hatcheries and rearing ponds being built <u>more</u> food will be needed and <u>better</u> combinations of foods are required to produce more and better fish.

This meeting to be successful must contribute to that objective.

References

1. Donaldson, Lauren R. - "Fish Foods as Used in the States of California, Idaho, Oregon and Washington during 1947" - 1947 Annual Bull., State of Wash. Dept. of Fish.-Bull. No. 47, p. 59. 1948.

2. Fiedler, R. H. and Samson, V. J. - "Survey of Fish Hatchery Foods and Feeding Practices" - Trans. Am. Fish. Soc. 65:376. 1935.

3. Leach, Glen C. - "Artificial Propagation of Brook Trout and Rainbow Trout, with Notes on Three Other Species" - Dept. of Com. Bur of Fish. Doc 955 - p. 29. 1923.

4. O'Malley, Henry - "Artificial Propagation of the Salmons of the Pacific Coast" Dept. of Com. Bur of Fish. Doc. No. 879, p. 30. 1920.

SPEAKER: WALLY HUBLOU OF THE MARION FORKS HATCHERY, OREGON FISH COMMISSION

Notes on the Experimental Feeding Programs,
at the Marion Forks Laboratory during 1952

THIRD NUTRITIONAL EXPERIMENT: December 20, 1951 to April 10, 1952.

At the present time, there is much controversy regarding the soundness of results obtained in feeding experiments where single diets, and not paired diets, are used. It is the contention of some investigators that experimentation using single lots, or diets, is not feasible statistically. Other investigators contend that a single lot, or diet, may be used if the period of feeding is sufficiently long, and that the results will be statistically sound. With the foregoing points in mind, an experiment was set up at the Marion Forks Laboratory to test the variance between lots when all the conditions of water inflow, temperature, food, type of food, frequency of feeding, time of feeding, and other variables normally encountered were held constant.

Methods & Procedures:

Ponds: Five circular concrete rearing ponds, 25 feet in diameter, were used for the experiment. These ponds afford a maximum feeding depth of approximately 36 inches. A feeding depth of 24 inches was used to prevent any fish from jumping out of the ponds.

Stock: Fingerling steelhead trout were used. The average weight per fish was .864 gram. A total of 17,282 grams of fish were stocked in each of the five ponds, making a total of 20,000 fish per pond.

Food: The diet fed to all five ponds was composed of 32.7% Beef Liver, 32.7% Hog Liver, and 32.6% Salmon Viscera, plus 2% Salt. The food was fed at the 1.5% level, using the dry weight basis. The food was mixed and fed six days a week, with no food being fed on Sunday.

Weights: The fish were weighed every two weeks to keep a check on the growth of each lot. The total lots were not weighed but, rather, random samples were taken of each lot, using crowder screens of the live box type to confine the fish in a small area. By passing a dip-net through the live box from one end to the other, and from the top to the bottom, a netfull of fish was obtained. The fish were then weighed in a pre-balanced bucket of water. The fish in the sample were then counted; two such samples were taken from each lot.

Miscellaneous: Daily mortality checks were made and recorded. All fish killed in weighing procedures, etc., were kept separate from the natural mortality. The water temperature, maximum and minimum, were recorded every day. A constant check was made for the incidence of any disease, but none was found. The water inflow was adjusted to approximately 35 gallons per minute in each pond.

Results:

Due to the high mortality in each lot, which varied from 19.7% to 26.1%, plus the slow individual rate of growth, the lot weights showed an increase in only one lot while the other four had a loss in weight. The average individual weight gain, which varied from 23.3% to 26.7%, had only a variation of .03 gram per fish in all of the lots.

Conclusions:

The high rate of mortality and slow rate of growth made the results of this experiment much more inconclusive than they would have been had the experiment been conducted during a period of rapid growth.

The fish in each lot appeared to be the same size and condition as the fish in the other lots at the end of the experiment. The small variation of .03 gram per fish could only be determined by accurately weighing the fish in each lot.

The high mortality was not due to any disease but rather was due to the rigors of the cold water period encountered at this hatchery.

FOURTH NUTRITIONAL EXPERIMENT: July 9, 1952 to October 9, 1952.

This nutritional feeding program was the fourth, and last, in a series of experiments which have been conducted at this laboratory.

Ten 6-foot circular wooden tanks, 30 inches deep, were assembled and used for the experiment. Many of the techniques used in the previous work at Marion Forks were either changed or modified as the use of the small tanks made it possible to weigh the complete lots of fish every weigh day. The method of presenting the diet was also changed from spoon to ricer.

Each of the ten tanks were stocked with 1,000 grams of spring chinook fingerlings, of the 1951 Brood. These fish had been fed the control diet for approximately 6 weeks prior to the start of the experiment.

The following is a list of the components and percentages used in the make-up of the ten diets:

Lot #1 (Control Diet): 1/3 Beef Liver, 1/3 Hog Liver, 1/3 Salmon Viscera, 2% Salt.

Lot #2: Kraylets (A prepared dry diet made up mostly of dry milk solids, sold by the Kraft Foods Company).

Lot #3: 50% Meal Mix* 50% Turbot (Arrow toothed Halibut) in the round.

Lot #4: 50% Meal Mix 50% Hake in the round.

Lot #5: 50% Meal Mix 50% Shad in the round.

Lot #6: 50% Meal Mix 50% Salmon Carcass.

Lot #7: 50% Meal Mix 50% Horse Meat.

Lot #8: 50% Meal Mix 50% Dover Sole Fillet Scrap.

Lot #9: 90% Synthetic Meal Mix** 10% Sheep Liver

Lot #10: 90% Synthetic Meal Mix 10% Horse Liver

* Meal Mix consists of:

10% Wheat Germ
40% Soy beam meal
10% Skim milk
10% Condensed fish solubles (5% H_2O)
10% Salmon Meal
10% Casein
10% Brewers yeast
5% Dextrin

** Synthetic Mix consists of:

55% Vitamin free Casein
18% Dextrin
1% $CaCo_3$
4% Crab Meal
6% Mixed Salts
16% Mazola or Corn oil
10 parts Gelatin added to 100 parts above Vitamins added (A.D.C. para amino benzoic acid, choline, B_{12}, folic acid, & vitamin K).

A vitamin mix was also prepared for use in all of the diets: B_1, B_2, Niacin, Biotin, Panothenic acid, B_6, Folic acid and Vitamin K. The vitamins were added to each diet to bring the level up to the vitamin content of the control.

PROCEDURES:

Once every two weeks the total lots were weighed and the lot loss or gain was recorded.

The fish were fed several times a day, six days a week, with no food being fed on Sunday. The food was fed on the dry weight basis. At the start of the experiment, 3% of the body weight of the fish was fed per day. On August 14, the amount fed was increased to 4% because of the increase in water temperature. This amount was continued until the end of the experiment.

As soon as the fish were large enough to handle easily, the gills of 25 fish per lot were inspected every weigh day to keep a current check on the blood condition of the fish. A red or light red gill was considered quite normal and given a rating of #1 or #2, respectively. A pink gill was considered anemic and given a rating of #3. A pale pink or white gill was called a #4 gill, and was considered very anemic. As the fish increased in age and size, the relative color of the gills darkened as the gill area increased but by checking the control lot first, which was known to produce healthy looking gills, it was not too difficult to determine the difference in the color of the gills in the other lots.

RESULTS:

Lot #1 (Control): 1/3 Beef Liver, 1/3 Hog Liver, 1/3 salmon Viscera, 2% Salt.

This diet, as in the past, experienced good growth with a total lot weight of 4,740 grams. The total mortality was 4.8%, which was third lowest of the diets. The gill color was good throughout the experiment. There was an unexplainable high initial mortality and the fish were rather uneven in size.

Lot #2: Kraylets.

Every effort was made to make the fish eat this diet, but they refused to have anything to do with it. After six weeks, the lot weight was reduced to 565 grams, due somewhat to the high mortality and also to the loss in average fish weight. The lot was then considered broken and was put back on the control diet. The total mortality for the first six weeks was 52.7%.

Lot #3: 50% Meal Mix 50% Turbot.

This lot experienced very good growth, the final lot weight was 4,975 grams. Towards the end of the experiment, however, the fish were becoming very anemic and the mortality was starting to increase. If the experiment had been continued it was felt that these fish would have continued to die at a very high rate. The total mortality was 17.3%. For the first 12 weeks the lot looked great; then the fish started to become very sluggish as they became anemic.

Lot #4: 50% Meal Mix 50% Hake.

This lot experienced very poor growth; the final lot weight was 2,829 grams. The fish became very anemic and the mortality became very high at the end of the experiment; a total mortality of 21.6%. This diet leached to a very high degree, even though every attempt was made to bind the material to prevent leaching. It is felt that the fish did not receive much of the diet, due to this leaching, and perhaps the mechanics of feeding the diet resulted in the poor growth rather than the diet itself.

Lot #5: 50% Meal Mix 50% Shad.

As in past experiments, the use of shad in the diet was not very successful. The lot had very poor growth; total lot weight 2,172 grams. The mortality was very high; 36.3%. The fish started to become anemic but, with the addition of extra vitamins, the condition was improved considerably. The fish in this lot were very uneven in size.

Lot #6: 50% Meal Mix 50% Salmon Carcass.

This lot had good growth over most of the experimental period, but the fish became extremely anemic about the 12th week. The mortality became very high as a result of the anemia; 46.2%. An analysis of the food at the time of feeding showed that the diet was extremely low in B_1, although in the make-up of the diet the vitamin content was adequate. The fish turned dark in color, became pop-eyed, bloated, and had no appetite at all. The total lot weight was 2,173 at the end, but had been as high as 3,120 grams at the end of the tenth week.

Lot #7: 50% Meal Mix 50% Horse Meat.

These fish had no growth at all to speak of for the first eight weeks of the experiment. At this time, another analysis of the diet was made and it was found that the fat content was very low because the horse meat being used was very lean. With the addition of the extra calories in the diet, the fish began to grow at a rapid rate and the mortality rate decreased; total mortality of 33.1%. The gill color remained fair and the appetite of the fish was excellent. The total lot weight was 2,580 grams.

Lot #8: 50% Meal Mix 50% Dover Sole Fillet Scrap.

This lot also had very poor growth for the first eight weeks, at which time an analysis of the fat content showed that the diet was very low in calories. With the addition of the proper amount of fat, the fish began growing at a much faster rate. The mortality was very high during the first eight weeks, but towards the end of the experiment the mortality decreased very rapidly. The gill color was fair throughout the experiment. Total lot weight of 2,439 grams; total mortality 31.3%.

Lot #9: Synthetic Meal Mix 90% Sheep Liver 10%.

This lot had the second best growth; total lot weight of 5,952. The mortality was very low; 3.8%. The gill color was the best of all the lots. The fish were very even in size, had a good appetite and appeared very healthy.

Lot #10: Synthetic Meal Mix 90% Horse Liver 10%.

This diet was the best of all ten, from every standpoint. The lot growth was the best, 6,279 grams. The mortality was the lowest; 1.4%. The fish were very even in size. Gill color excellent, appetite quite good, and fish color excellent.

CONCLUSIONS:

Although the vitamin content of each diet was made to equal, or better, the vitamin content of the control diet some of the vitamins were apparently not available to the fish. There is some question whether or not the fish can get to, or use, the vitamins present in the vegetable meals in the Meal Mix.

The two diets using the Synthetic Meal Mix, plus Sheep Liver and Horse Liver, proved to be very successful. They both had excellent growth, very low mortality, and the fish appeared to be in very good health.

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Question: Ellis -- Why did you use steelhead for the experiment?

Answer: The most available species at the hatchery.

Question: Johnson -- Did you weigh entire lot in experiments?

Answer: Yes.

Question: Garlick -- How did your experimental mortality compare with those on production diets?

Answer: The mortalities compared to fish of same age at station. This was, however, the first time steelhead had been reared at the station and a great deal of trouble was encountered.

Question: Brittain - How was food presented to the fish?

Answer: Food presented to fish by means of spoon, mixed fresh every morning.

Question: Burrows -- Just what did you propose to determine by this experiment?

Answer: Significant differences (variabilities) in mortality were shown in the five lots which had been fed the same diet. All variabilities were held as constant as possible. However, these significant differences were encountered.

Question: Ellis -- Was there any evidence of kidney disease?

Answer: No.

Discussion followed regarding the variability between experiments that mortality had not followed growth in variability. Comments by Dr. Donaldson indicated that variability of a stock were comparable. In fish, that malformations approximated 23 per cent of the stock and in humans malformations also approximated 23 per cent of the total stock.

Comment: Sinnhuber -- Analysis of sheep and horse liver showed them to be 4 and 5 times greater in vitamin B_1 than beef liver.

Question: What was object of adding fat content to salmon diet to bring it up to turbot?

Answer: The chemical content of all diets were kept as close to the same as possible -- a control measure.

SPEAKER: ERNIE JEFFRIES OF THE OREGON FISH COMMISSION

"Work Done by the Oregon Fish Commission
at the Sandy Laboratory During 1952"

Twelve diets were fed spring chinook fingerling singly at the Sandy lab. Work was continued on the results of the findings from the previous three years work at Bonneville. The synthetic diet as described by McLaren, et al, and modified according to our specifications, was used in eleven diets. Substitutions and deletions were tried. The only meat diet was one of the Leavenworth diets composed of 1/3 beef liver, 1/3 hog liver, 1/3 salmon viscera, with 2 per cent salt and which we use as our control diet. Each lot was started with 1,362 grams of fish, the numbers of fish per tank varied somewhat. The experiment was started on June 3 and is still continuing as of this meeting.

On October 7 after 18 weeks all lots that were above 3,500 grams in total weight were cut back to that figure. In the following discussion the increase mentioned will be the increase before the lots were cut back.

There were several factors which will influence the results we obtained.

(1) About one week after starting 29 fish were found dead in the control tank one morning. There had been no loss previous and there was no loss immediately following this catastrophe.

(2) Temperatures were high in the summer months. An average of about 70° was recorded for three weeks straight. On several occasions the water was 75° in the tanks.

(3) Temperatures were cold in the early winter cold spells. For a couple weeks the temperature remained in the 32 to 34° range.

(4) During the warm water period we experienced an outbreak of columnaris in one of our diets, the control diet.

(5) About the middle of the summer we noticed while dissecting our mortalities, an increasing number of encysted cercaria of Troglotrema in the kidneys of the fish. The lower 1/2 of the kidney would be almost completely filled with these

encysted forms. This organism is the one which causes Salmon Poisoning in dogs, etc. The life history is somewhat complicated. The snail Goniobasis plicifera is the early host in which the redia and then the cercaria develop. The cercaria leave the snail and are carried by the water current into areas with fish. The cercaria enter the fish and we have found them encysted mostly in the lower portion of the kidney, some in the heart, liver, pyloric caeca, gills, and in the optic nerve.

To complete the life cycle the fish with the encysted cercaria must be eaten by a dog, raccoon, etc.

We believe the great numbers of encysted cercaria contributed to the mortality we observed.

(6) When the fall rains finally came the water became very muddy and has not cleared up as of this report.

(7) And finally, towards the end nearly every lot had the so-called kidney disease.

Diet No. 1 - Control - beef liver 1/3, hog liver 1/3, salmon viscera 1/3, and salt 2 per cent. This diet, over 22 weeks the previous year at Bonneville, suffered 11 fish as mortalities. In a corresponding time period we lost 143 fish at Sandy, caused by Columnaris and other factors. Before the lots were cut back to 3,500 grams the weight had increased to 6,029 grams. Growth was not spectacular but was fairly constant, the total lot growth increasing even with the high mortality.

Diet No. 2 - Oregon Synthetic - This is the Wisconsin diet modified which we found capable of rearing spring chinook. The fish grew slowly , with 59 mortality in 18 weeks to 4,061 grams.

Diet No. 9 - Oregon Synthetic minus APF and B-12 - These fish, with a similar diet to lot No. 2 except for the deletion of B-12 and APF, appeared to be in much better shape. The loss was only slightly less, 44 fish for 18 weeks; however, the lot weight was 1,100 grams greater. This bunch of fish were more active and were a better lot of fish all around.

Diet No. 10 - Oregon Synthetic minus West coast crab meal - This lot had the complete diet except the crab meal was taken out. Apparently something the fish needed for good growth was present in the crab meal. The fish weight increased only slightly from each two weekly weigh day. They had not reached the 3,500 gram mark after 18 weeks, the weight being some 3,147 grams. Mortality was high with 128 dead fish.

Diet No. 11 - Oregon Synthetic minus crab meal, APF, B-12 and all the other Vitamin supplements - After six weeks these fish were so poor they were considered broken and the diet was changed in that the APF, B-12, and vitamins were restored to the diet, making the diet similar to that of lot No. 10. The fish again started to grow slowly. The growth pattern similar to that of No. 10.

Diet No. 3 - Oregon Synthetic minus most of the vitamin-test casein plus drum-dried turbot meal - The fish started out in good shape, however, there was more loss than we would expect, some 51 fish in the 18 weeks. The weight gain was comparable to that of No. 4, being 6,089 grams at the end of the period.

Diet No. 4 - Oregon Synthetic minus most of the vitamin-test casein plus drum dried turbot meal plus 10 per cent beef liver on dry weight basis - This is one of the diets which did so well at Bonneville last year -- increasing from 2,000 to 20,437 grams in the 22 weeks and the total loss was six fish. However, at Sandy we suffered 137 dead fish and the weight increase was somewhat less than that of Bonneville, being up to 5,637 grams. However, this was one of the better diets at Sandy this year.

Diet No. 5 - Oregon synthetic plus 10 per cent wet weight of beef liver - At Bonneville last year we had a similar diet only with 10 per cent dry weight of liver which is about 1/3 as much as 10 per cent wet weight of beef liver, due to beef liver being around 70 per cent moisture. We thought perhaps three times the beef liver would give a greater growth response than did the last years diet. However, the growth was only a little better than diet No. 2 without any beef liver at all. The loss was 60 fish which is high.

Diet No. 6 - Oregon synthetic plus 10 per cent wet weight of tuna liver - The analysis of tuna liver rates it comparable to beef liver in many respects. In other feeding tests we have never found it to be too good. This also was the result of this try. The loss was 77 fish and the weight increase was a few grams more than that of lot 2.

Diet No. 7 - Oregon synthetic minus vitamin-free casein plus drum dried rockfish meal plus 10 per cent beef liver dry weight - Another diet utilizing scrap fish products to replace the vitamin-free casein looking towards a production diet. The loss in this was high 69 fish, and the growth was mediocre, some 4,582 grams.

Diet No. 8 - Oregon synthetic minus vitamin test casein plus drum dried Dover sole scrap plus 10 per cent beef liver dry weight - This diet was similar to numbers 4 and 7 but the loss was higher with 99 dead fish and the total lot weight was lower being 3,981 grams only.

Diet No. 12 - Oregon synthetic minus vitamin-free casein plus commercially prepared rockfish scrap meal plus 10 per cent beef liver dry weight - This was another diet set up to be comparable with 4, 7, and 8. The loss as in all other lots was high at 57 fish and the growth was just a little greater than lot number 5 at 4,932 grams.

About the time the lots were cut back to 3,500 grams many had started down hill. Especially lots 2, 3, 4, 5, 6, 7, 8, 10, 11 and 12. Lot 1, the control and number 9 held up fairly well. The losses increased with a corresponding decrease in total weight. The kidney disease mortalities increased and several lots experienced severe anemia. Due to the many uncontrollable factors the results of this series of diets are very unreliable.

Question: What was criteria of a vitamin B deficiency in certain groups?

Answer: Fish became darkened, pop-eyed, exhibited unusual swimming motions, gyrations, spinning, etc. They exhibited all symptoms of vitamin B deficiency.

Comment -- Sinnhuber: There is the possibility of sterilizing intestinal tract of fish by the use of anti-biotics and thus leave the tract open to other infections.

Comment - Burrows: We experienced reductions in growth by the introduction of crab meal.

Comment - Sinnhuber: West coast crab meal much higher in ash than eastern crab meal.

SPEAKER: ERNIE SALO -- MINTER CREEK BIOLOGICAL STATION, WASHINGTON DEPARTMENT OF FISHERIES

First, I must say that I am not a nutritionist and that the following thoughts and observations are only indirectly related to applied nutrition, although population dynamics can affect and be affected by the study of nutrition. Furthermore, the studies of which I shall have mentioned here are, for the present at least, limited to Minter Creek observations.

Optimum seeding studies at Minter Creek demonstrate that there is a ceiling of approximately 35,000 yearlings in the natural production of silver salmon. That is, we get approximately the same number of yearlings whether we have a 500 female or a 1,000 female escapement. The progeny of a one hundred female excapement appear to suffer much less from over crowding and enjoy a comparatively higher percentage survival rate with a production of about 20,000 yearlings. So, generally speaking, the greater the escapement the less the PERCENTAGE fresh water survival of the potential egg deposition.

The salt water survival of these yearling differ markedly. Ability of these yearling to survive to adulthood corresponds directly with the degree of competition they were exposed to in their fresh water existence. Thus, the smaller the PERCENTAGE fresh water survival, the greater the PERCENTAGE salt water survival.

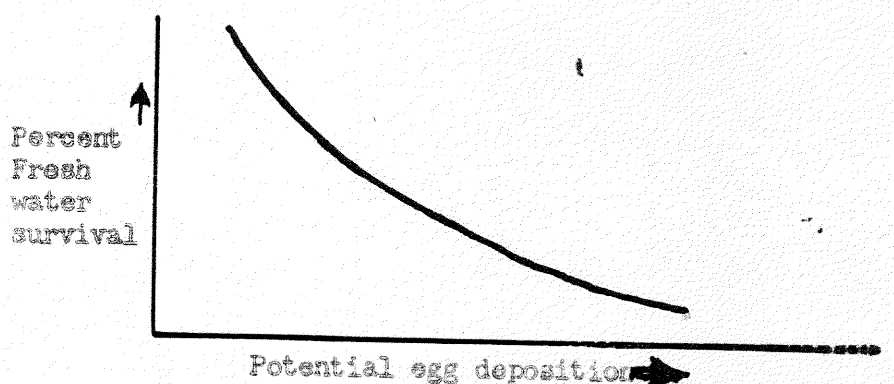

Figure 1: Fresh water Survival Trend of Natural Spawned Silver Salmon

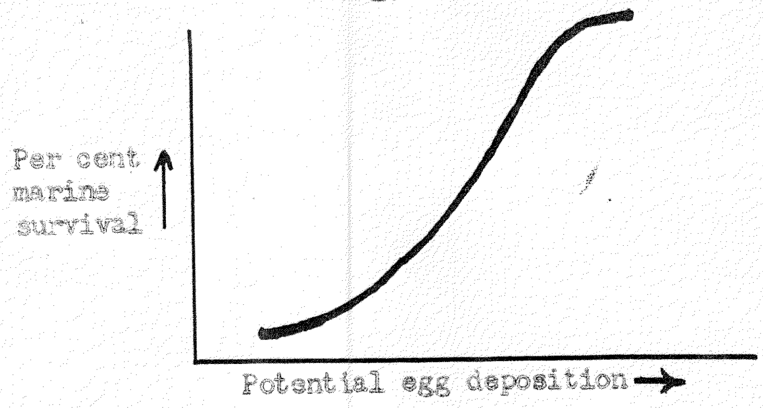

Figure 2: Saltwater Survival Trend of Natural Spawned Silver Salmon.

In addition, some selective forces, whether natural or artificial, appear to affect the ultimate survival of our hatchery reared silver salmon. The two types of survival curves shown in the natural production are demonstrated in the survival of hatchery reared fish. This time, the sigmoid type or relationship is evident in the fresh water survival of fish reared to various ages. For example, small plants of 3-months reared fish show a fresh water survival of about 10 per cent, while plants of yearlings show a fresh water survival of an average of 70 per cent. The saltwater survival of these two groups have a mortality curve reminiscent of the fresh water survival curve of naturally propagated fish.

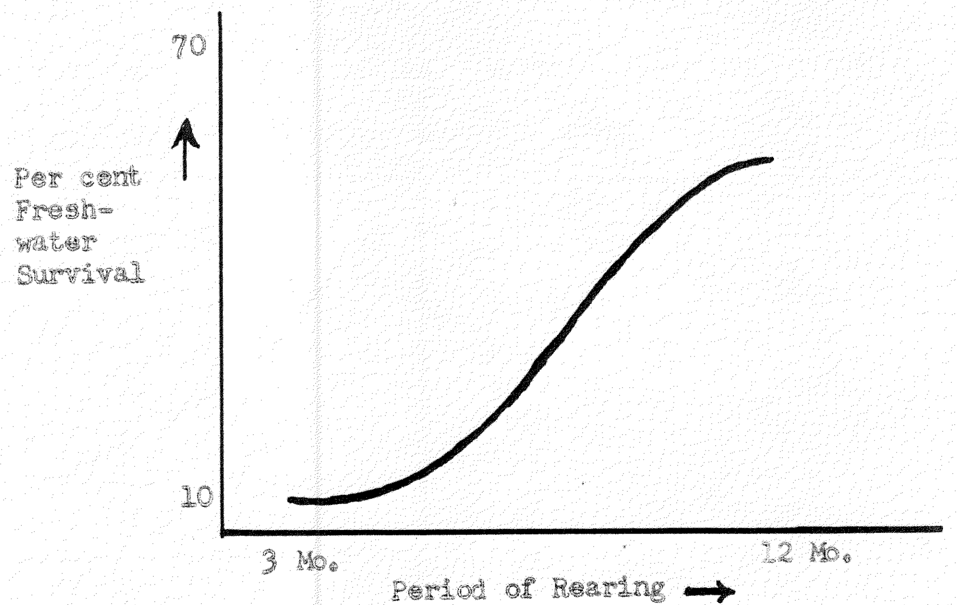

Figure 3: Fresh water Survival Trend of Hatchery Reared Silver Salmon

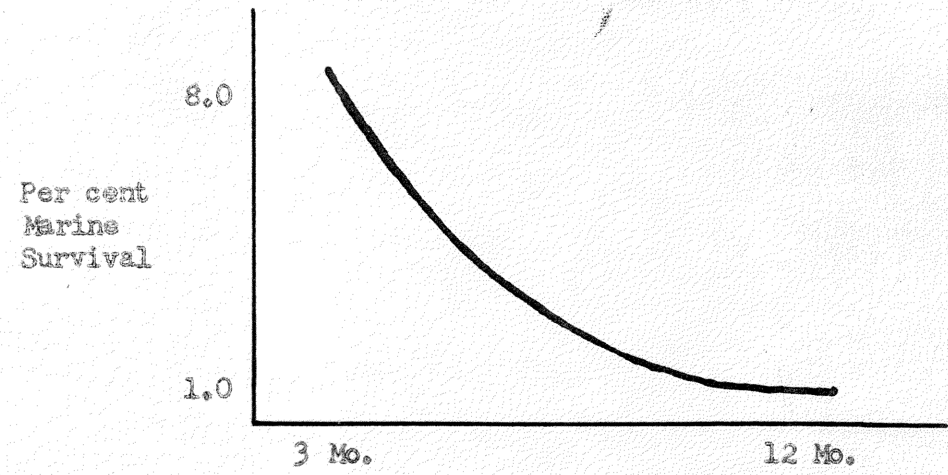

Figure 4:

Saltwater Survival Trend of Hatchery Reared Silver Salmon.

Further investigation and refinement of these relationships are needed to convert specific values to the problems of optimum seeding and optimum periods of rearing.

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Question: Burrows -- You assume 1 to 4 are caught in the fisheries; suppose none were caught?

Answer: Salo -- Then 500 escapement would be the optimum.

Question: Garlick -- From your total survivals it appears that it would pay to be rough to the very young?

Answer: Salo -- Apparently so that is, with what we see now.

SPEAKER: C. H. ELLIS -- WASHINGTON DEPARTMENT OF FISHERIES

1952 Feeding Experiments at Klickitat Hatchery
With 1951 Brood Stock

Five experimental diets were utilized at the Klickitat Hatchery during 1952. These diets were designed to compare the relative value of modified Leavenworth diets, Diets 4 and 5; modified Washington production diet, Diets 2 and 3; and a control diet, Diet No. 1.

Two races of chinook salmon were utilized for the experiment; one, fall chinook salmon, parent stock from Underwood station of U. S. Fish and Wildlife Service; the other, native Klickitat River spring chinook salmon obtained at the Klickitat station from the Klickitat River.

All diets were carried out in duplicate, for each race of chinook for each diet, making a total of 20 tanks used in the experimental feedings. The tanks, as used, were the 6-foot circular wood tanks as described and used in previous feeding experiments by this Department.

Listed below are the results of the diet feedings for an 18 and 20 week period for the fall chinook and spring chinook, respectively.

For the spring chinook, tanks were repopulated in June, and an additional 15 weeks of experimental feeding was carried out. In the second phase, however, disease played such a great part in mortalities that consideration of mortalities in respect to diet was irrelevant. A discussion of the progress of the disease in the spring chinook for the June to October period may be found on pgs. 49-52 in publication entitled, "Kidney Disease in Young Salmon", as published by the Washington Department of Fisheries.

Results of the experiment indicate that for fall chinook salmon, the modified Washington production diet, Diet No. 2, compared very favorably with either of the modified Leavenworth diets, and its cost and availability make it a very useful one for consideration in the production of fall chinook salmon. In spring chinook salmon, however, Diet No. 2 fell considerably behind Diet No. 4, although it was ahead of Diet No. 5. Diet No. 2 could not be considered a particularly desirable diet to use for spring chinook salmon, as indicated from the results obtained.

1951 BROOD FALL CHINOOK SALMON (UNDERWOOD STOCK)

Fish started feeding on 1/25/52 and received a diet of 68% salmon viscera, 14% salmon carcasses, 15% beef liver, 2% yeast and 1% salt for 21 days, until Feb. 15, when all tanks were evenly populated and placed on diets as listed.

DIET	Tank Nos.	Starting 2/15/52 No.Fish	Starting 2/15/52 Tot.Wt. LBS.	18 Weeks Ending 6/19/52 No. Fish Survival	18 Weeks Ending 6/19/52 Per cent Survival	18 Weeks Ending 6/19/52 Total Wt. LBS.	Hemoglobin Content on 5/20/52
No. 1 96% Beef Liver 2% Yeast 2% Salt	19&20	6,000	7.8	5,037	83.9	44.03	76%
No. 2 81% Salmon Viscera 15% Beef Liver 2% Yeast 2% Salt	17&18	6,000	7.78	5,775	96.3	61.22	78%
No. 3 81% Salmon Carcasses 15% Beef Liver 2% Yeast 2% Salt	11&12	6,000	7.79	5,609	93.5	66.22	56%
No. 4 32% Beef Liver 32% Hog Liver 32% Salmon Viscera 2% Yeast 2% Salt	15&16	6,000	7.81	5,715	95.3	60.82	81%
No. 5 22% Hog Liver 22% Beef Lungs 52% Salmon Viscera 2% Yeast 2% Salt	13&14	6,000	7.85	5,694	94.9	53.91	65%

1951 BROOD SPRING CHINOOK SALMON (KLICKITAT RIVER STOCK)

Fish started feeding over period December 8, 1951 to January 5, 1952. All were fed Diet No. 1 until February 2, 1952, when all tanks were evenly populated and placed on diets as listed.

DIET	Tank Nos.	Starting 2/2/52 No. Fish	Starting 2/2/52 Tot. Wt. LBS.	20 Weeks Ending 6/19/52 No. Fish Survival	20 Weeks Ending 6/19/52 Per cent Survival	20 Weeks Ending 6/19/52 Total Wt. LBS.	Hemoglobin content on 5/20/52
No. 1 96% Beef Liver 2% Yeast 2% Salt	1&2	5,801	8.09	4,771	82.3	32.13	66%
No. 2 81% Salmon Viscera 15% Beef Liv. 2% Yeast 2% Salt	3&4	5,804	7.95	5,096	87.8	47.08	70%
No. 3 81% Salmon Carcass 15% Beef Liver 2% Yeast 2% Salt	9&10	5,806	8.18	2,910	50.1	23.44	45%
	* Diet #3 discontinued on 5/3/52 and fish fed on Diet #4 from 5/3, on.						
No. 4 32% Beef Liver 32% Hog Liver 32% Salmon Viscera 2% Yeast 2% Salt	5&6	5,800	8.03	5,272	90.9	49.04	75%
No. 5 22% Hog Liver 22% Beef Lungs 52% Salmon Viscera 2% Yeast 2% Salt	7&8	5,800	8.06	5,064	87.3	42.59	63%

		Starting 6/26/52		15 Additional Weeks Ending 10/8/52		
No. 1	1&2	1,678	16.0 Lbs.	314	18.7%	11.73 Lbs.
No. 2	3&4	1,516	16.0 "	179	11.8%	3.74 "
* No. 4	9&10	1,485	16.0 "	313	21.1%	11.73 "
No. 4	5&6	1,786	16.0 "	132	7.4%	4.84 "
No. 5	7&8	1,895	16.0 "	149	7.9%	3.43 "

SPEAKER: BRIAN EARP -- WASHINGTON DEPARTMENT OF FISHERIES

Fish Disease Investigation, State of Washington Department of Fisheries

An extensive survey of our work on kidney disease has been completed and is currently in press. The paper deals with studies on kidney disease, starting with the first recognized outbreak at Kalama in 1946 and extending up to recent outbreaks at Klickitat in 1952 and 1953. Findings are summarized as follows:

1. Kidney disease in salmon is a generalized bacterial infection usually accompanied by definite lesions in various organs. A very small Gram-positive diplo-bacillus is always found in large numbers. The disease is called kidney disease because of the affinity of this bacterium for the kidney, and the frequency with which characteristic macroscopic lesions occur in this organ.

2. Kidney disease has been found in fall and spring chinook salmon, blueback and silver salmon. In most instances the disease has been less severe in silver salmon. The disease has persisted in stocks of fall chinook salmon tempered into sea water.

3. The disease occurs over a wide range of water temperatures. At low temperatures, the disease occurs in chronic form with mortalities slowly, but inevitably, increasing. At higher temperatures mortalities may reach explosive proportions.

4. Mortalities in stocks of fall and spring chinook salmon and blueback salmon suffering from kidney disease have been reduced to relatively low levels by use of antibacterial agents. Unsatisfactory results have been obtained from experiments on therapy in silver salmon.

5. Kidney disease has been transmitted by injection of cultures of the etiological agent and by injection of materials from infected fish. The disease has been transmitted to chinook, blueback and silver salmon and to rainbow trout.

6. The disease has been transmitted to chinook and blueback salmon by feeding of tissues from infected fish. It is considered that this is the normal method of transmission of the disease once it is established in a population of fish.

7. The agent, or agents, responsible for introduction of kidney disease into a hatchery has not yet been established. The possibility of a relationship between the diplo-bacillus of kidney disease and the etiological agent of salmon disease in dogs and foxes is suggested.

8. As a by-product of this investigation, tuberculosis was found in adult chinook salmon migrating from the sea.

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Question: Garlick -- Could disease be transmitted by amphibious animals?

Answer: Earp -- Good possibility that disease is transmitted by amphibious animals -- also possible from copepods.

Question: Is there any immunity developed in kidney disease?

Answer: As near as known, there is no immunity developed in fishes to the disease.

Question: Is there an optimum temperature for development of disease in fish?

Answer: The disease appears to develop more readily in cold temperatures.

Question: Will aureomycin work as a therapeutic agent?

Answer: It has never been used, but has possibilities.

Question: What is the youngest fish that you have ever established the disease to be present?

Answer: Ninety days.

Question: Is salmon viscera considered to be the most logical source of infection?

Answer: It is highly likely that if it is transmitted through the feed that the source is through fish products because of the temperature requirements of the bacteria.

Question: Sinnhuber -- Why can't you feed penicillin?

Answer: The P.H. of the stomach destroys the products.

Question: Sinnhuber -- Sometimes kidney disease kills with only small ruptures on a kidney; at other times the fish does not die until the kidney is practically all destroyed; why is this?

Answer: Earp -- Kidney disease is technically a misnomer; actually it is a septicemia.

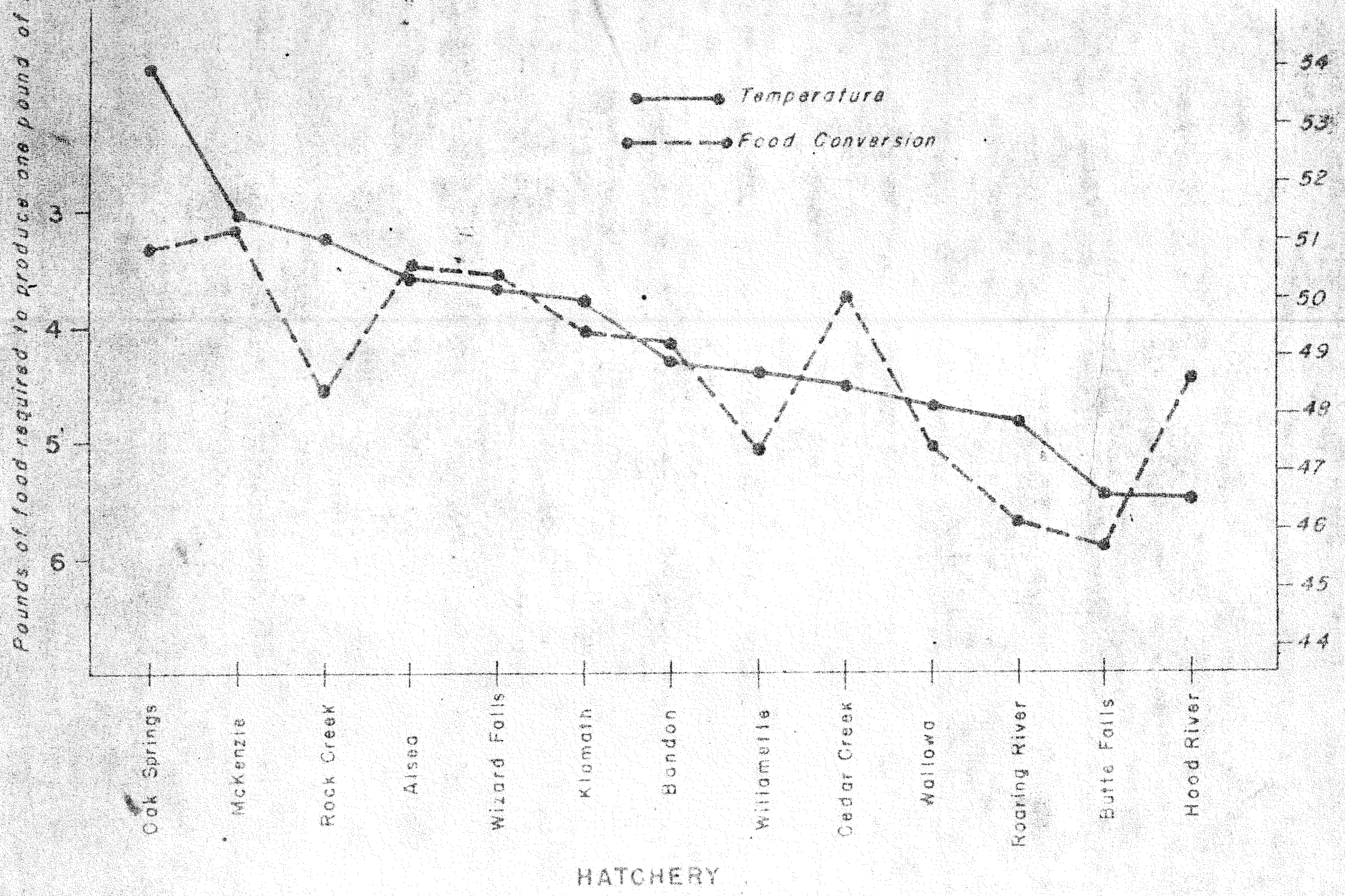
Friday, December 5, 1952
SPEAKER: JOHN RAYNER -- OREGON GAME COMMISSION

FOOD CONVERSION AT HATCHERIES

The accompanying chart pictures the performance of hatcheries of the Game Commission in terms of food conversion. All values are for rainbow trout and generally for a period of sixteen months of rearing from the time of first feeding to final release of the fish from the hatchery.

The relationship of the variance of conversion to water temperatures is apparent. The hatcheries whose conversions do not follow the temperature trend may not do so because of a relationship to efficiency or to the presence of large amounts of roiled water with resultant food waste.

FOOD CONVERSION, RAINBOW TROUT, OREGON HATCHERIES
1951-1952



SPEAKER: ROBERT RUCKER -- U. S. FISH AND WILDLIFE SERVICE

Summarizing contents of a paper titled, "A Contagious Disease of Salmon Possibly of Virus Origin", by -- R. R. Rucker, W. J. Whipple, J. R. Parvin and C. A. Evens. This paper published in Fishery Bulletin 76, Fish and Wildlife Service.

SUMMARY

1. An investigation was made of a disease affecting blueback salmon and kokanee fingerlings at the Leavenworth and Winthrop stations in 1951. The disease did not infect fingerlings of the chinook salmon, silver salmon, or cutthroat trout.

2. The disease was characterized at the beginning of an outbreak by a great increase in its infectious nature, and a resulting increase in the mortality of the fish.

3. The total mortality in a population of 800,000 to 1,400,000 salmon ranged from 11 to 40 per cent. A decrease in the epizootic appeared to follow sterilization of cleaning equipment. The incidence of the disease decreased during summer months, and it was suspected that the higher water temperatures were a favorable factor.

4. The disease was produced by material that passed through bacteria-proof filters. The infection that was produced in healthy salmon by injection of suspensions made from moribund fish resembled the disease as it occurred naturally during the epizootic. Some injected fish developed scoliosis or lordosis. Results of the injection of salmon with heated material were negative.

5. The larger fish in a group were attacked first, becoming infected when they were 1 to 1.5 inches in length and about 3 months old.

6. Diseased fish were lethargic and often exhibited hemorrhagic areas at the base of the fins and in the isthmus. The stomach was distended with a milky fluid; and the intestine appeared reddened and contained a watery straw-colored fluid often tinged with blood. The bile appeared normal, but in greater quantity than usual. Hyperemic areas frequently were present on the air bladder, peritoneum, or fat.

7. Spinal deformities developed in later stages among some of the fish that survived the early acute stage of the epizootic.

8. Experimental infection was accomplished by placing healthy fish in one end of a trough that contained sick fish in the upper compartment.

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Question: What agent was used for sterilization of equipment at station?

Answer: Roccal 1 - 2,000.

Question: Are there any survivals and, if so, are they planted?

Answer: The policy is to destroy all lots infected with a high degree infection of this virus.

Question: You don't think that the fish exhibiting the curvatures are carriers?

Answer: We don't think so.

Question: Do any other species other than blueback and kokanee contract this disease?

Answer: No.

SPEAKER: JOHN HALVER -- U. S. FISH AND WILDLIFE SERVICE

THE QUALITATIVE WATER-SOLUBLE VITAMIN REQUIREMENT OF CHINOOK SALMON

Early attempts to investigate the vitamin requirements of fish were hampered by the lack of a vitamin-test diet in which the factor or factors in question could be adequately controlled. McLaren et al(1) reported in 1947 that a diet consisting of casein, starch, fish liver oils, crab meal, minerals and vitamins would maintain Rainbow Trout for a period of twenty weeks and further described the use of the diet in establishing the vitamin requirements of trout. Trials with salmon and continued feeding periods with trout failed to support these claims (2,3,4). Wolf(5) published a diet which could be used for vitamin work with pantothenic acid, inositol, and folic acid but which failed with niacin, biotin, ascorbic acid, B_{12}, K and E.

Introductory work outlined the possibility of eliminating the anti-anemic factor or factors in previous test diets by supplementing the test diet with folic acid and Vitamin B_{12}. Improving the ingredients in the test diet published by Wolf a complete vitamin-test diet for Chinook Salmon (Oncorhynchus tschawytscha) was successfully tested for two years on two different strains of Chinook Salmon in carefully controlled water. The growth, mortality, food conversion, and examination for any vitamin-deficiency syndrome was compared with production diets, and a liver control diet. Growth lagged behind production and liver diets by about 10% but no deficiency syndromes appeared within the test period. Rainbow trout were continued on the diet to date without the appearance of any recognizable vitamin deficiency syndrome, after 73 weeks on the complete test diet.

The water soluble vitamins were individually removed from the test diet and groups of young Chinook Salmon fry were fed the various vitamin deficient diets with the results summarized on the following sheets. The technique used was to continue the deficient diet until 20% of the population had died, split the remaining population in half, feed one half the complete test diet, and allow the other half to continue on the deficient diet until death of that population

1. McLaren, Barbara A., et al, Arch. of Biochem., 15: 169 (1947).

2. Rucker, Robert R., et al, Prog. Fish. Cult., 14: 10 (1952).

3. Phillips, A. M., Jr., et al, Fish. Res. Bull. 14: 5 (1950).

4. McKernan, Donald, et al, Annual Reports Oregon Fish Commission 1949-1951.

5. Wolf, Louis E., Prog. Fish. Culturist, 13: 17 (1951).

VITAMIN DEFICIENCY SYNDROMES

Described in literature, Observed, (Additional observations)

VITAMIN	DEFICIENCY SYNDROMES
Thiamine assay 0.1mcgm/gm.	Poor appetite, impaired CHO metabolism, pyruvic acid accumulation in tissues, ascending symmetrical bilateral peripheral neuritis, muscle atrophy, degeneration of peripheral nerve fibers, brain lesions, convulsions, generalized edema, instability and loss of equilibrium, (convulsions only in most acute stage just prior to death.)
Riboflavin assay 0.2mcgm/gm.	Corneal vascularization, cloudy lens, ulceration of eye, cataracts, photophobia, dimness of vision, scleral congestion, abnormal pigmentation of iris, cheilosis and angular stomatitis, incoordination, impaired erythrocyte formation, (styrated constriction abdominal wall, dark discoloration, loss of appetite.)
Pyridoxine assay 0.10mcgm/gm.	Symmetrical dermatosis, dermal lesions, cheilosis, hypo chromic anemia, extensive deposition of iron pigment in liver, rise in serum iron content, epiliptiform fits, hyperirritability, ataxia, (loss of appetite, edema of peritoneal cavity, serus fluid colorless, spastic confulsions with jerky swimming, rapid and gasping breathing, have tendency to swim in circles or change direction rapidly, after death rigor mortic occurs very rapidly,

in acute stages prior to death fish turn typical blue-green color along back, lay motionless in water and violently flex opercles and shake heads.)

Niacin — Anorexia, buccal lesions, diarrhea, smooth red tongue, neurological lesions, skin erruptions, loss of appetite, extensive dilation of blood vessels, lesions in colon, fatty infiltration of liver, numbness, pain, weakness, jerky or difficult motion, (stomach and colon filled with colorless fluid, fish lethargic but have muscle spasms while apparently resting).

assay 0.5-0.7mcgm/gm

Pantothenic acid — Spectacle alopecia, generalized scaling and dermatitis, diarrhea, diffuse hyperemia of intestine, disturbed gait, prostration, myelin degeneration of peripheral nerves, cellular atrophy, necrosis and scarring, (typical clubbed gill filaments, flared opercles "mumpy appearance", gills covered with exudate, no appetite, sluggish, lethargic).

assay 0.24mcgm/gm.

Inositol — Alopecia in mice, circumocular alopecia in rats, low growth, nutritional encephalomalacia, increased gastric emptying time, (dark coloration, no appetite, largest fish die, stomach bloated and filled with undigested food).

assay 17mcgm/gm.

Biotin — Seborrheic skin disease, generalized erythema and alopecia circumocular alopecia, scaly dermatitis, abnormal humped posture and spastic gait, muscle atrophy, necrosis of fibers and increase in sarcolemma, loss of appetite, no growth, (dark coloration, swim on sides and in circles, some spastic convulsions just prior to death, largest fish most affected, low Hb and TBC with some fragmentation).

assay 0.0053mcgm/gm.

Folic Acid assay $1.2 mcgm/gm.$	Megaloblastic erythropoiesis, nutritional cytopenia, paralysis, hydrocephalas, infarction of spleen, weight loss, lethargy, interposed with convulsions just prior to death, (fragility of caudal fin, dark coloration, low Hb and TBC but not as low as in generalized acute anemia).
Vitamin B_{12} assay $0.005 mcgm/gm.$	Pernicious anemia, macrocytic anemia, sprue, low or poor growth in children and microorganisms, (poor appetite, erratic Hb and TBC generally low near death, dark coloration, some fragmentation of erythrocytes).
p-Amino benzoic acid assay $0.10 mcgm/gm.$	Alopecia in rats and poor growth for chick. No growth for some microorganisms. (No abnormal indications in growth, appetite, mortality, blood, or post mortem examinations).
Choline	Fatty infiltration of liver, necrosis and scarring, long prothrombin time, elevated serum phosphatase, hemorrhage of peripheral cortical vessels and necrosis of renal tubular epithelium, mottled reddish kidney, hemorrhages in eyes, poor growth, poor food conversion, (no hemorrhage found, some indications of fatty livers, very poor growth, mortalities indicate necessary for growth but not for survival).
Ascorbic acid assay $1.0 mcgm/gm.$	Scurvy, capillary fragility, delayed healing of wounds, immature fibroblastic proliferation, failure of osteo blasts to form osteoid, (No abnormal indications in growth, appetite, mortality, blood, or post mortem examinations).

SUMMARY OF QUALITATIVE REQUIREMENTS OF CHINOOK SALMON

REQUIRED	PROBABLY REQUIRED	NOT REQUIRED
Thiamin	Folic acid	p-Amino benzoic acid
Riboflavin	Vitamin B_{12}	Ascorbic acid
Pyridoxine		
Pantothenic acid		
Biotin		
Choline		
Niacin		
Inositol		

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Question: Burrows -- After severe clubbing of the gills in pantothenic acid deficiency, will the fish recover?

Answer: Halver -- No., not if proceeded too far.

Question: Cleaver -- Are these all water soluble vitamins?

Answer: Yes.

Question: Is niacin deficiency a swollen gill?

Answer: No. We didn't find any such evidence such as we did in pantothenic acid deficiency.

Comment: Halver -- Choline deficiency showed up in a very low growth rate. However, not much chance for such deficiency to occur in most diets.

Question: The fish having deficiencies exhibit a greater growth rate when the deficiency is removed than the normal control fish?

Answer: This is not an abnormal situation -- when restoration of the vitamin is made the animal takes off rapidly in growth rate. This occurs in most all vitamin deficiencies.

Question: Is choline water soluble?

Answer: Yes, all these vitamins are water soluble.

Question: Isn't the fact that ascorbic acid is not required, contrary to McLaren's work?

Answer: Yes, but she was working with trout and that might have some importance in the matter.

SPEAKER: H. WILLIAM NEWMAN

SUMMARY OF FEEDING TRIALS - 1952

U.S. Fish and Wildlife Service

Salmon-Cultural Laboratory

Entiat, Washington

The 1952 feeding trials at the Entiat Salmon-Cultural Laboratory consisted of two - 24-week experiments, one using fingerling blueback salmon, the other using fingerling chinook salmon. The methods were those of previous years.

FIRST EXPERIMENT

The results of the first experiment are consolidated in Table 1. This experiment consisted of two parts, meal tests and practical diet tests. In the meal tests, an attempt was made to determine the cause of high mortalities encountered when feeding dry meal during cold-water phases. In addition, four meals, all commercially available, were compared with the vacuum-dried salmon viscera meal used in this laboratory.

A series of substitutions in the standard diet and a series utilizing half viscera and half meat comprised the practical diet tests. The commonly accepted 100 per cent beef liver control (Diet 1) was included; it was exceeded in growth by all of the test diets.

Meal Toxicity Tests:

The meal toxicity tests represented an attempt to determine the cause of the mortality when meals were added during the cold-water phase. It had been assumed that the vitamins in the meal might not be available to, or utilized by, the fish in cold water. This assumption was tested by feeding vacuum-dried salmon viscera meal at the 10 per cent level, fortified with the major vitamins (Diet 4). For comparison, Diet 3 contained 10 per cent meal without fortification, while Diet 5 had unfortified meal at 5 per cent. All were prepared from the same

FEEDING TRIALS WITH BLUEBACK SALMON - 1952 -- Table 1

Initial Number per Trough: 1,361 Fish
Initial Weight per Trough: 500 Gr.

Initial Average Weight per Fish: .37 Gr.
Initial Number Per Pound: 1,236 Fish
Period: 4/8/52 to 9/23/52

Temperature: Average for 1st 12 Wks., 44.96° F.
Average for Second 12 Weeks, 50.4° F.
Average for 24 Weeks, 47.68° F.

Lot	Diet Components	Percentage Composition	Mean Wt. in Grams 12 Wks.	Mean Wt. in Grams 24 Wks.	Per Cent Mortality 12 Wks.	Per Cent Mortality 24 Wks.	Conversion 12 Wks.	Conversion 24 Wks.	Hemoglobin g/100 ml. Blood 12 Wks.	Hemoglobin g/100 ml. Blood 24 Wks.	Deficiency Symptoms
1	Beef liver	100.0%	1,831	6,530	6.02	7.24	3.6	4.4	11.9	12.8	None
2	Beef liver S 1/	22.2%									
	Hog liver	22.2%									
	Hog Spleen	22.2%									
	Salmon viscera	33.4%									
	Salmon meal 2/		3,077	16,955	5.40	6.02	2.5	2.3	12.2	12.7	None
3	Beef liver S	20.0%									
	Hog liver	20.0%									
	Hog spleen	20.0%									
	Salmon viscera	30.0%									
	Salmon meal	10.0%	3,503		9.29		2.3		11.9		None
4	Beef liver S	20.0%									
	Hog liver	20.0%									
	Hog spleen	20.0%									
	Salmon viscera	30.0%									
	Salmon meal (Vit. Supp.)	10.0%	3,440		6.72		2.3		12.5		None
5	Beef liver S	21.1%									
	Hog liver	21.1%									
	Hog spleen	21.1%									
	Salmon viscera	31.7%									
	Salmon meal	5.0%	3,218	16,568	7.42	8.16	2.4	2.4	12.4	13.0	None
6	Beef liver S	22.2%									
	Hog liver	22.2%									
	Hog spleen	22.2%									
	Salmon viscera	33.4%									
	Comm. whale meal 2/		3,138	14,685	4.56	4.74	2.5	2.8	12.4	13.5	None
	Least difference at the 5% confidence level:		217 Grs.	922 Grs.	3.1%	3.0%					

Table 1 -- Continued

Lot	Diet Components	Percentage Composition	Mean Wt. in Grams 12. Wks.	Mean Wt. in Grams 24 Wks.	Per Cent Mortality 12 Wks.	Per Cent Mortality 24 Wks.	Conversion 12 Wks.	Conversion 24 Wks.	Hemoglobin g/100 ml. Blood 12 Wks.	Hemoglobin g/100 ml. Blood 24 Wks.	Deficiency Symptoms
7	Beef liver S	22.2%									
	Hog liver	22.2%									
	Hog spleen	22.2%									
	Salmon viscera	33.4%									
	Wheat middlings 2/		3,092	13,538	6.32	7.46	2.5	3.0	13.3	12.5	None
8	Beef liver S	22.2%									
	Hog liver	22.2%									
	Hog spleen	22.2%									
	Salmon viscera	33.4%									
	Seal meal 2/		3,172	16,173	5.22	5.80	2.4	2.4	13.6	13.9	None
9	Beef liver S	22.2%									
	Hog liver	22.2%									
	Hog spleen	22.2%									
	Salmon viscera	33.4%									
	Distillers Sol. 2/		3,085	16,094	4.48	5.36	2.6	2.6	13.1	13.6	None
10	Beef liver S	22.2%									
	Hog liver	22.2%									
	Beef lung	22.2%									
	Salmon viscera	33.4%									
	Salmon meal 2/		2,951	14,361	3.82	4.44	2.8	2.8	13.5	12.8	None
11	Herring S	22.2%									Dark in color; weak & listless; some exhibiting loss of equilibrium; some suffering violent nervous convulsions when startled; intestinal fat heavy
	Hog liver	22.2%	Diet discontinued at end of 14 weeks								
	Beef lung	22.2%									
	Salmon viscera	33.4%									
	Salmon meal 2/		3,031	2,514	7.42	7.64	2.5	12.13	13.5		
Least difference at the 5% confidence level:			217 Grs.	922 Grs.	3.1%	3.0%					

Table 1 - Continued

Lot	Diet Components	Percentage Composition	Mean Wt. in Grams 12 Wks.	Mean Wt. in Grams 24 Wks.	Per Cent Mortality 12 Wks.	Per Cent Mortality 24 Wks.	Conversion 12 Wks.	Conversion 24 Wks.	Hemoglobin g/100 ml. Blood 12 Wks.	Hemoglobin g/100 ml. Blood 24 Wks.	Deficiency Symptoms
12	A.T. Halibut S	22.2%									
	Hog liver	22.2%									
	Beef lung	22.2%									
	Salmon viscera	33.4%									
	Salmon meal 2/		3,026	14,889	5.11	5.99	2.6	2.7	12.8	12.7	None
13	Hog liver S	25.0%									
	Beef lung	25.0%									
	Salmon viscera	50.0%									
	Salmon meal 2/		3,008	14,748	5.88	6.91	2.5	2.7	13.5	12.5	None
14	Herring S	25.0%	Diet discontinued at end of 12 weeks								Dark in color; weak and listless; some exhibiting loss of equilibrium; some suffering violent nervous convulsions when startled; intestinal fat heavy
	Beef lung	25.0%									
	Salmon viscera	50.0%	3,036.5			7.94		2.5		13.3	
15	A.T. Halibut S	25.0%									
	Beef lung	25.0%									
	Salmon viscera	50.0%									
	Salmon meal 2/		3,084	15,210	8.89	10.32	2.5	2.5	13.3	12.8	None
Least difference at the 5% confidence level:			217 Grs.	922 Grs.	3.1%	3.0%					

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 meal was added to these diets with a corresponding proportional reduction in each of the original components.

meat-viscera base as the standard blueback control diet (Diet 2), composed of 22.2 per cent each of beef liver, hog liver and hog spleen and 33.4 per cent of salmon viscera.

Mortalities were significantly different between the non-meal (Diet 2) and the 10 per cent meal diet (Diet 3). There were no differences in mortalities among diets that included vitamin supplemented meal (Diet 4), 5 per cent meal (Diet 5) and no meal (Diet 2). The result was a range of mortalities that did not differ from each other except at the extremes of the range, Diets 2 and 3.

The mean weights of the two 10 per cent meal diets were not different from each other; both exceeded the 5 per cent meal and the non-meal diets by a significant figure. An advantage over the non-meal diet was derived from the vitamin-supplemented meal: a significantly greater growth with no greater mortality. The vitamin supplement (the B-complex) used in the 1951 trials produced more growth and greater mortality than the non-meal diet. The vitamin supplement (B complex, C and all of the fat soluble vitamins) used in the 1952 trials produced more growth without an increase in mortality. Apparently the additional vitamins used in 1952 contained a factor which prevented an increase in mortality.

Diets 3 and 4 were discontinued at the end of the cold-water phase. Diet 5 was continued at the 5 per cent level while Diet 2 received 10 per cent meal during the warm-water phase. A comparison was thus obtained between a diet including 5 per cent meal for 24 weeks and a diet containing no meal for 12 weeks (cold temperatures) followed by 10 per cent meal for 12 weeks (warm temperatures). Mortalities were not significantly different at the end of either the 12-week or 24-week period. Although Diet 5 had a somewhat higher mean weight at the end of 12 weeks, the relative positions were reversed in 24 weeks with no significant difference. No advantage was determined for feeding 5 per cent meal at all temperatures.

Meal Evaluations:

The meal used in warm-water feeding at this laboratory exceeds all other salmon meals tested for growth potential, but it is not available on the market. Four other meals were tested in the search for commercial meal of a comparable growth potential. These were whale meal, wheat middlings, seal meal and distiller's solubles. They were included in Diets 6, 7, 8 and 9, respectively, during the warm-water phase. Compared with vacuum-dried salmon viscera meal (Diet 2), whale meal (Diet 6) and wheat middlings (Diet 7) were inferior. On the other hand, seal meal (Diet 8) and distiller's solubles (Diet 9) were, on the overall, as good as salmon viscera meal and are to be recommended.

Practical Hatchery Diets:

Diet 2, the standard production control, served as the control for both series of practical diets, and all diets had 10 per cent of vacuum-dried salmon viscera meal included during the warm-water phase.

The first series consisted of substitutions in the standard diet to eliminate the more expensive products. Diet 10, with hog spleen replaced by beef lung, was a success in 1951 and served here as a base for further substitutions. The beef liver was replaced in Diets 11 and 12 by herring and arrow-toothed halibut.

At 24 weeks the mean weight of Diet 10 was less than that of Diet 2, although Diet 10 produced good growth and conversion. This may in part be attributed to the use of spleen not trimmed of fat, causing Diet 2 to have proportionately greater mean weights than previously.

At 12 weeks Diets 11 and 12 were similar in weight to Diets 2 and 10. Diet 11, however, exceeded Diet 10 in mortality. At the end of 14 weeks, the mortality became excessive and Diet 11 (with herring) was discontinued. At 24 weeks the mean weight of Diet 12 was significantly lower than Diet 2 but similar to Diet 10.

The second series of practical diets was based on another combination developed in 1951: hog liver and beef lung 25 per cent each, salmon viscera 50 per cent (Diet 13). Diets 14 and 15 were variations in which herring and arrow-toothed halibut replaced hog liver. The herring diet was discontinued after 12 weeks due to a heavy mortality.

At 24 weeks a difference existed between Diets 13 and 15 and between 15 and 2. Although Diet 15, with halibut, produced less growth than the production control (Diet 2), the diet contained no liver or spleen and still outgrew the series control, Diet 13.

Since first tested as a single component in 1951, arrow-toothed halibut has consistently produced good growth without anemia in each combination tested. As a result of the 1952 trials, two diets (12 and 13) containing arrow-toothed halibut can be recommended.

Two diets contained herring, one at 22.5 per cent and the other at 25 per cent. Neither diet contained beef liver; the second contained no liver. In the 1951 trials, herring fed alone produced excellent growth but at the end of 12 weeks symptoms of thiamine deficiency were present. When fed in combination with 40 per cent liver as a substitute for spleen in the standard diet, no deficiency appeared. In the 1952 trials, herring (22.2 per cent) was combined with hog liver (22.2 per cent) beef lung (22.2 per cent) and salmon viscera (33.4 per cent) and the deficiency symptoms appeared. These symptoms also appeared in Diet 14 (herring 25 per cent, beef lung 25 per cent and salmon viscera 50 per cent) and the diet was discontinued 2 weeks earlier than Diet 11. The 1951 diet contained 40 per cent liver (beef and hog), Diet 11 contained 22.2 per cent hog liver and 22.2 per cent beef lung, Diet 14 contained no liver although it had 25 per cent beef lung which had adequately replaced liver in other diets. The appearance of thiamine deficiency symptoms were correlated with the reduced amounts of liver and 40 per cent liver seems to have been adequate coverage to overcome the thiamine deficiency of the herring.

CHINOOK FINGERLING DIETS

In 1951, chinook salmon fingerlings were used as test animals for the first time at the Salmon-Cultural Laboratory. In these trials, the standard blueback diet was found adequate for chinooks, although experience in the various Grand Coulee Stations had not indicated this.

For the 1952 trials, the blueback diet (1-C) was again fed as well as the standard chinook ration of one-third each of beef liver, hog liver, salmon viscera (Diet 4-C). Using some of the substitutions in the blueback diet that proved of value in the 1951 blueback tests, Diet 2-C had spleen replaced by lung, while Diet 3-C had spleen replaced by herring.

The results were similar to the 1951 trials in that no anemia developed in chinook fed the blueback ration, (Diet 1-C) and they compared in weight with fish fed the chinook ration (Diet 4-C). Lung substituted for spleen (Diet 2-C) and herring substituted for spleen (Diet 3-C) were as good as Diet 4-C. When compared with Diet 1-C, Diet 2-C produced a significantly lower growth. Diet 3-C (herring for spleen) was as good as 1-C. Confirming the 1951 experiment with blueback salmon, no thiamine deficiency developed in the ration which included herring (Diet 3-C).

Two more diets that gave good growth in the 1951 tests with bluebacks were tested on the chinooks. These were Diets 5-C (hog liver 50 per cent, salmon viscera 50 per cent) and 6-C (hog liver 25 per cent, beef lung 25 per cent and salmon viscera 50 per cent), both comparable to Diet 4-C. There was a significant difference between 1-C and 5-C, and 1-C and 6-C. This is in accord with the results of the blueback diet tests this year where Diet 13 (same as 6-C) was not as good as the production control.

FEEDING TRIALS WITH CHINOOK SALMON - 1952 — Table 2

Initial number per trough: 603 fish Initial average weight per fish: 1.66 Gr. Temperature: Average 1st 12 Wks., 44.96° F.;
Initial weight per trough; 1,000 Gr. Initial number per pound: 274 fish Average for Second 12 weeks, 50.4° F.;
Period: 4/8/52 to 9/23/52 Average for 24 weeks, 47.68° F.

Lot	Diet Components	Percentage Composition	Mean Wt. in Grams 12 Wks.	Mean Wt. in Grams 24 Wks.	Per Cent Mortality 12 Wks.	Per Cent Mortality 24 Wks.	Conversion 12 Wks.	Conversion 24 Wks.	Hemoglobin g/100 ml. Blood 12 Wks.	Hemoglobin g/100 ml. Blood 24 Wks.	Deficiency Symptoms
1-C2/	Beef liver S1/	22.2%									
	Hog liver	22.2%									
	Hog spleen	22.2%									
	Salmon viscera	33.4%	3,737	9,215	1.58	1.99	2.7	3.3	13.1	13.8	None
2-C2/	Beef liver S	22.2%									
	Hog liver	22.2%									
	Beef lung	22.2%									
	Salmon viscera	33.4%	3,376	7,315	2.74	3.73	3.0	3.9	13.3	13.3	None
3-C2/	Beef liver S	22.2%									
	Hog liver	22.2%									
	Herring	22.2%									
	Salmon viscera	33.4%	3,616	8,472	3.40	4.14	2.9	3.4	13.6	13.4	None
4-C2/	Beef liver S	33.3%									
	Hog liver	33.3%									
	Salmon viscera	33.4%	3,438	8,196	1.74	1.99	2.9	3.4	13.9	13.0	None
5-C2/	Hog liver S	50.0%									
	Salmon viscera	50.0%	3,584	7,586	2.90	4.06	2.8	3.7	13.0	12.2	None
6-C2/	Hog liver S	25.0%									
	Beef lung	25.0%									
	Salmon viscera	50.0%	3,554	7,839	4.31	4.98	2.9	3.6	13.5	11.6	None
Least difference at the 5% confidence level:			288.8	1,234	1.5%	1.2%					

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 vacuum-dried salmon viscera meal was added to these diets with a corresponding proportional reduction in each of the original components.

Question: Cleaver -- Were these paired experiments and, if so, what was the variation in the pairs?

Answer: Analyses of variances was made.

Question: Red Johnson -- Do these experiments re-confirm your previous contention that you can't feed meals at low temperatures?

Answer: Generally speaking, yes.

Question: Halver -- Is 10% meal the most efficient level?

Answer: Burrows -- We tried 20% but that increased losses and tended to cause anemia. We might try graduated amounts between 10% and 20%.

Question: Garlick -- Are hog and beef livers interchangeable?

Answer: Burrows -- No.

SPEAKER: HARLAN E. JOHNSON -- U.S. FISH AND WILDLIFE SERVICE

Results of Experiments at the Dorena Dam Experimental Laboratory

The Dorena Dam Experimental Laboratory was operated by the U. S. Fish and Wildlife Service from September, 1950, to November, 1952. The primary objective of the laboratory was to determine if it were possible to incubate, hatch and rear eggs and fingerlings of spring and fall chinook salmon, silver salmon, cutthroat trout, and rainbow trout in the impounded water from Dorena Reservoir. The hatchery water for these experiments was obtained from intakes located at three levels in the reservoir.

The following are the tentative conclusions drawn from the water analysis data and the results of the hatchery experiments:

1. Dorena Reservoir water contains no toxic substance in high enough concentration to be harmful to salmon or trout.

2. Water from the lower levels of the reservoir was deficient in dissolved oxygen during part of the summer and fall and aeration was necessary to make it suitable for hatchery use.

3. Aerated water from the lower hatchery intake was suitable for rearing fingerlings of all species included in the experiments. This water was also satisfactory for the incubation of eggs of silver salmon, cutthroat trout, and rainbow trout.

4. All water supplies available were too warm for satisfactory incubation of spring and fall chinook salmon eggs. This water was suitable for such use when cooled to below 55° F.

5. Columnaris caused high mortalities of fingerling salmon and trout reared in water with temperatures over 65° F. for extended periods. The disease was partially controlled by treatments with sulfamerazine.

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Question: Rucker -- Did you establish a critical temperature for columnaris?

Answer: Johnson -- Not exactly, but you can get it at 60° F.; water doesn't have to be 65° F.

SPEAKER: CLIFF MILLENBACH -- WASHINGTON STATE GAME DEPARTMENT

I have no prepared material and express only some general remarks regarding our program noting that our over-all feeding program, approximately 25% to 30% of the diet, consisted of meat products and the balance fish products. The consumption of beef liver has been reduced to 7% as compared to better than 20% not too many years ago.

In regard to the use of pellets, my impression has been that the commercial pellet provided by the Head Tide Fish Feed Company of Maine appeared to have considerable merit. The Game Department has used these pellets at two hatcheries and the rearing program at these stations has been comparable to fish reared on our wet diet.

Wet pellets, as developed at the Vancouver Station using 55% fish meal and the balance some raw fish such as salmon carcasses, is still being used with success. Expansion of the wet pellet program is being held back because of the lack of suitable grinding equipment to make the pellet.

During the year no experimental work was carried on in the way of controlled diets.

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Question: Donaldson -- Is the Vancouver station the only one using the soft pellets?

Answer: Millenbach -- Yes.

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A short business discussion was conducted and it was decided that the next meeting of the nutritional conference would be held in the Oregon State Game Commission conference room in Portland, Oregon. Fred Cleaver, of the Oregon Fish Commission, was selected as chairman for the 1953 meeting.

MEETING ADJOURNED

ROSTER OF THOSE IN ATTENDANCE AT THE FISH NUTRITION
CONFERENCE HELD IN THE U. OF W. FISHERIES CENTER, ON DEC. 4 & 5, 1952

NAME	ORGANIZATION REPRESENTED	INDIVIDUAL'S LOCATION
F. Cleaver	Oregon Fish Commission	Portland, Oregon
Ernie Jeffries	" " "	Clackamas, Oregon
Irving French	" " "	Portland, Oregon
Jim Wood	" " "	Oakridge, Oregon
Wallace F. Hublou	" " "	Portland, Oregon
Russ Sinnhuber	Seafoods Lab., O.S.C.	Astoria, Oregon
John Rayner	Oregon Game Commission	Portland, Oregon
Don D. Hansler	U. of W., School of Fisheries	University of Washington
Paul R. Olson	Applied Fisheries Lab., U. of W.	Seattle 5, Washington
Lauren R. Donaldson	" " " "	" "
John R. Donaldson	University of Washington	Fisheries Center, Seattle
Bruce B. Cannady	U. S. Fish & Wildlife Service	Carson, Washington
L. R. Garlick	" " " "	Portland, Oregon
H. E. Johnson	" " " "	Cottage Grove, Oregon
R. E. Burrows	" " " "	Entiat, Washington
H. W. Newman	" " " "	Entiat, Washington
David D. Palmer	" " " "	Entiat, Washington
Clinton E. Atkinson	" " " "	Seattle, Washington
John Coates	" " " "	Fisheries Center, Seattle
R. R. Rucker	" " " "	Fisheries Center, Seattle
S. W. Watson	" " " "	Fisheries Center, Seattle
Ted Perry	" " " "	Portland, Oregon
Cliff Burner	" " " "	Seattle, Washington
John E. Halver	" " " "	Seattle, Washington
Allen Demorest	Wash. Department of Fisheries	Marblemount, Washington
Don Johnson, Seattle	" " " "	Seattle, Washington

NAME	ORGANIZATION REPRESENTED	INDIVIDUAL'S LOCATION
C. H. Ellis	Wash. Department of Fisheries	Seattle, Washington
Gil Holland	" " " "	Bowman's Bay, Anacortes, Wn.
Ernie Salo	" " " "	Minter Creek, Gig Harbor
Brian J. Earp	" " " "	Fisheries Center, Seattle
A. G. Ewing	" " " "	Skykomish Hatchery, Startup, Washington
Rudy Schwab	" " " "	Minter Creek, Gig Harbor
Donald Wienk	" " " "	Toutle Hatchery, Toutle, Wn
S. B. Fallert	" " " "	Rt. 1, Box 740, Auburn, Wn.
C. F. Brittain	" " " "	Seattle, Washington
E. G. Fisher	" " " "	Skagit Hatchery, Marblemount
B. D. Staeger	" " " "	Issaquah, Washington
Barney Johnson	" " " "	Seattle, Washington
Stanley Gwinnett	" " " "	Simpson Hatchery, Elma, Wn.
Wilbur Ashcraft	" " " "	" " " "
Harry Fallert	" " " "	Kalama Hatchery, Kalama, Wn.
H. O. Hoggatt	" " " "	Lewis River Hatchery, Woodland, Washington
L. H. Hyden	" " " "	Klickitat Hatchery, Glenwood, Washington
Al Lasater	" " " "	Bowman's Bay, Anacortes, Wn.
Ernest M. Brannon	" " " "	Sequim, Washington
Leland Esary	" " " "	Bowman's Bay, Anacortes, Wn.
C. T. Wilson	" " " "	Puyallup Hatchery, Orting, [illegible]
Cliff Millenbach	Wash. Department of Game	Seattle, Washington