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 more food will be needed and better 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.

Miscell-
aneous: 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.