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WOLF LAKE FEEDING EXPERIMENTS--1937

PROGRESS REPORT, AUGUST 10, 1937

The third season of feeding experiments with trout at Wolf Lake began April 13, 1937, including at that time forty-four troughs containing about 277,000 fish. This program has been expanded somewhat so that now there are several experiments in progress involving all ninety-six troughs in the No. 1 building.

Experiment A. A total of eighty troughs are in use, testing ten different combinations of dry meals and fresh meats, shown in Table 1, as to their relative value as food for fingerling brook, brown and rainbow trout.

Experiment B. Six troughs of brook trout are being used to compare the effect of the location of the trough on the mortality and growth. These trout are fed diet 4: sheep liver 50%, fish meal 16.7%, cottonseed meal 16.7%, and skim milk powder 16.7%.

Experiment D. Four troughs of brook trout are being used to determine the carrying capacity of the standard troughs in use at this station. These trout are fed diet 4 (described in preceding paragraph).

Experiment F. Six troughs of brook trout were given mixtures of diet 6 (hog melts 75%, fish meal 8.3%, cottonseed meal 8.3%, skim milk powder 8.3%) diluted with various amounts of water in an attempt to determine the optimum consistency for feeding.

Experiment G. Six troughs of brook trout are receiving three different diets, some supplemented with tomato juice, in an attempt to determine whether or not it is effective in the prevention or cure of ulcer disease.

Experiment A

In experiment A, started April 13, twenty standard troughs of brook trout fingerlings from Cape Cod eggs, ten troughs of rainbow trout fingerlings, also from Cape Cod eggs, and ten troughs of brown trout fingerlings from eggs from the state hatchery at Paris, were used. The ten diets shown in Table 1 were given to the fish so that each diet was fed to two troughs of brooks, and one trough each of rainbows and browns. Three weeks later, on May 4th, additional trough space was available and the groups were then expanded into eighty troughs, half of the fish from each trough being placed into another. These fish were carried thus until June 29, at which time the brook trout on Experiment A were removed because of an epidemic of ulcer disease which threatened to wipe out the entire lot. It might have been highly instructive to have permitted the disease to run its course in order to determine the relation between any particular diet and the loss from disease of fish on that diet. But this could not be done without the danger of infecting all the trout receiving water from these troughs. The experiment with rainbows and browns was then expanded to include the space formerly occupied by the brooks, leaving from that time to the present forty troughs of rainbows and forty troughs of browns on this experiment. Except for a few troughs of browns which seem to have symptoms similar to ulcer disease, these trout are now in good condition.

Differences in the values of some of the diets have become apparent both in growth and mortality, so that after another six weeks' trial it should be safe to eliminate the poorest ones.

TABLE 1

COMPOSITION OF DIETS IN PARTS PER HUNDRED
WITH A SUMMARY OF THE RESULTS TO DATE OF EXPERIMENT A

INGREDIENTS	DIET NUMBER									
	2	4	6	17	18	19	20	21	22	23
Sheep liver	100	50.0	...	50.0	30.0	50.0	50.0	...	...	...
Hog melts (trimmed)	...	...	75.0	...	...	...	...	75.0	60.0	75.0
White fish meal	...	16.7	8.3	13.3	20.0	...	...	5.0	10.0	...
Cottonseed meal	...	16.7	8.3	13.3	20.0	...	13.3	5.0	10.0	...
Skim milk powder	...	16.7	8.3	13.3	20.0	20.0	13.3	5.0	10.0	...
Oatmeal	...	...	...	10.0	10.0	30.0	10.0	10.0	10.0	...
Grasshopper meal	...	...	...	...	...	...	13.3	...	...	...
Rowena Dog Diet #20	...	...	...	...	...	...	...	...	...	25.0
Water (shown as per cent by weight of rest of diet)	...	33.3	...	33.3	50.0	33.3	33.3	...	25.0	11.1
SUMMARY OF RESULTS OF EXPERIMENT A										
BROOK TROUT										
Rank	1	2	3	4	8	9	6	5	7	10
% increase in weight	1052	1028	944	875	706	634	834	863	745	621
Rank	5	7	9	4	1	6	2	10	3	8
Average % mortality	5.77	8.91	13.72	5.24	3.52	8.72	3.55	13.73	5.20	9.63
RAINBOW TROUT										
Rank	1	2	5	3	6	10	4	7	9	8
% increase in weight	2272	1759	1500	1738	1425	1112	1598	1234	1147	1194
Rank	1	4	9	2	6	3	5	8	7	10
Average % mortality	0.84	1.04	2.21	0.85	1.18	0.87	1.05	1.80	1.67	5.47
BROWN TROUT										
Rank	1	4	2	3	7	10	8	6	5	9
% increase in weight	1466	1375	1416	1387	1191	903	1162	1203	1208	1049
Rank	1	6	9	2	3	5	4	7	8	10
Average % mortality	0.82	3.28	7.16	2.16	2.41	3.13	3.04	6.00	6.11	17.04

The figures for brook trout cover a period of eleven weeks from April 13, 1937, to June 29, 1937; the figures for rainbow and brown trout cover a period of seventeen weeks from April 13, 1937, to August 10, 1937.

Referring to Table 1, in all three species of trout the best growth has resulted from a diet of fresh sheep liver. Diet 4, in which 50% of the sheep liver is replaced by a mixture of equal parts fish meal, cottonseed meal, and skim milk powder, ranks second best in producing growth with the brook and rainbow trout, and fourth best with browns. Diet 17, the same as diet 4 except that it contains 10% oatmeal replacing an equal part of the dry meal mixture, ranks third with rainbows and browns and fourth with brooks. Diet 6, consisting of 75% pork melts and the other 25% made up of equal parts of fish meal, cottonseed meal, and skim milk powder, ranks second in producing growth in brown trout, third in brooks, and fifth in rainbows.

The poorest growth was obtained from diet 19. This consists of sheep liver 50%, skim milk powder 20%, and oatmeal 30%. The diet containing 75% pork melts and 25% of Rowena Dog Diet #20 resulted in the next poorest growth. Both of these mixtures are quite easily handled and the fish feed ravenously upon them.

These growth results may in some cases have been distorted because of the disease conditions encountered this season. Also the results given for brook trout cover a period of eleven weeks after April 13, whereas those for rainbows and browns include a period of seventeen weeks. Growth curves will be prepared for the final report for this season's experiments so that growth at corresponding dates may be compared. No food conversion factors have been computed as yet so that it is impossible to state how much food is being used by these trout in increasing their weight; and without food conversion factors it is not possible to determine the food cost to rear a pound of trout.

The mortality record presents a somewhat different picture than the growth record. The mortality is shown as an average of the per cent of loss for each two-week period. (Due to the necessity of reducing the number of fish per trough and the fact that additional space was made available at

the time, period No. 2 continued for only one week.) The daily loss from each trough is recorded and the number of fish at the start of each period is used as a basis for determining the per cent lost. The mean of these percentages is called the average per cent mortality, and is used in Table 1 to compare the loss of fish on each of the ten diets in use.

This report shows only an average figure for all lots of fish of a particular species receiving the same diet, and therefore may be slightly distorted in some cases, especially among the brook trout, due to the disease condition encountered. Usually this disease affected all the troughs receiving a particular diet, but this was not always true.

Except among the brook trout the lowest per cent mortality resulted from a pure sheep liver diet. In the rainbows, however, the average per cent mortalities of diets ranking second and third were so nearly the same as that of the liver that there is no significant difference. The greatest mortality has resulted from diet 23 containing 75% pork melts and 25% Rowena Dog Diet #20. The average per cent mortality, 5.47%, among rainbows receiving this diet is about two and one-half times as great as the one ranking ninth. The same is true for the brown trout. Diet 23 ranked eighth with brook trout from the standpoint of mortality, and though not the worst, the fish on this diet were among the first to show an increasing mortality rate.

The most outstanding feature of the mortality record is the position in rank of the diets containing pork melts as compared with those containing sheep liver. With all three species the diets containing pork melts rank last (seventh to tenth, inclusive) except with the brook trout receiving diet 22, composed of 60% pork melts and 10% each of fish meal, cottonseed meal, skim milk powder and oatmeal. This particular lot of fish ranked third.

From the standpoint of the mortality record in this experiment to date, pork melts seem rather an undesirable ingredient in the diets. Also it is more difficult to remove debris and fecal material from the troughs of fish receiving diets containing pork melts, thereby increasing the amount of labor necessary to keep the troughs clean. In general, too, the diets containing melts are more difficult to prepare than those containing liver. Recently the price of pork melts increased about sixty per cent, so that melts will likely be even less desirable when cost is taken into consideration.

A number of visitors to the hatchery have noted the slightly darker color of the fish receiving diet 20, containing 13.3% grasshopper meal. This diet can be compared with diet 17,which is the same as diet 20 except that instead of the grasshopper meal it contains fish meal in the same proportion. Except in the average per cent mortality of the brook trout, diet 17 ranks better than diet 20. However, if the grasshopper meal may be obtained at a very low cost, the disadvantages of slower growth may be offset by lower cost.

Although the growth produced by the pure sheep liver diet has been better than that from any other of the diets, judging from previous experience, it is likely that the food cost for rearing trout will be less on several of the diets containing dry meals. Also it is hoped that these diets may be altered so that better growth and lower mortality will result.

Experiment B

In previous seasons there seemed to be an appreciable difference in the mortality and growth between fish reared in troughs next to the windows at the northeast end of the #1 hatchery room and the fish reared in troughs next to the wall at the other end of the room. Diet 4, 50% sheep liver and 50% of a mixture of equal parts of fish meal, cottonseed meal, and skim milk

powder, was fed to brook trout in two troughs next to the windows, two troughs next to the wall, and two troughs located about halfway between. The following table shows the per cent increase in weight and average per cent mortality for both six and nine periods.

Brook Trout

Trough	Location	Per Cent Gain in Weight Six Periods	Per Cent Gain in Weight Nine Periods	Average Per Cent Mortality Six Periods	Average Per Cent Mortality Nine Periods
1	next to	1085.8	1637.0	3.97	5.88
2	windows	1082.6	1559.7	4.75	3.85
7	middle of	864.2	*	7.51**	*
17	room	1037.6	*	5.28	*
47	next to	1036.0	1403.6	6.44	7.03
48	wall	1007.2	1271.4	4.88	10.55

* Discontinued at the end of the sixth period because of the epidemic of ulcer disease.

** This percentage shows effects of loss due to ulcer disease during the sixth period.

Experiment D

At the beginning of period three, 2041 grams of brook trout were put into two troughs, and one-third as many, 680 grams, were put into two others in an attempt to determine approximately the optimum carrying capacity of our standard rearing troughs. Two troughs having 1361 grams of brook trout, just halfway between the other two weights, were selected, but can not be considered of any value in this experiment since at the start their weight per thousand was not the same as that of the fish in the other four troughs. As the fish increase in weight it is necessary to remove some in order to maintain a ratio of 3:1 by weight.

Starting May 4 and continuing for fourteen weeks until August 10, the per cent increases in weight for those started at 2041 grams have

been 1395.3% and 1117.7% (during the last two periods both troughs of fish have been troubled with ulcer disease and consequently are showing a heavy loss). The fish that started at 680 grams per trough have increased in weight by 1751.3% and 1795.3% during the same period of time. No evidence of ulcer disease has been noted among these latter lots. At present these fish average 18.313 grams each; many individuals, of course, are quite a lot larger, one having attained a length of 160 mm. and a weight of 60 grams.

The average per cent mortality figures of the two lots carried at 2041 grams are 10.81% and 11.81%; those for the lots carried at 680 grams are 4.55% and 5.88%. At the end of four periods these percentages were nearly equal. However, at the end of the fourth period of this experiment the troughs carrying the heavier lots of fish began showing heavy losses due to ulcer disease, thereby bringing the average per cent mortality to a higher figure, and at the same time reducing the number and weight of fish in the troughs to such a point that a ratio of 3:1 by weight can not be maintained. If the weight of fish in the troughs holding the fewer grams of fish were reduced to suit this ratio, there would be too few fish to be conducive to good feeding.

Experiment F

In this experiment an attempt was made to find whether or not the mixtures of fresh meat and dry meals (in this case diet 6, consisting of 75% pork melts, the other 25% made up of equal parts of fish meal, cotton-seed meal and skim milk powder) could, by the addition of various quantities of water, be more easily prepared, more easily handled in feeding, and more easily ingested by the fish. Usually the consistency of the mixture is that of a stiff dough of which small pieces are scattered the length of the trough. Most fish culturists contend that unless the food is evenly distributed in the water in very small particles, the fish will not be uniform in size.

Two troughs, 97 and 98, were fed diet 6 with no water added; troughs 95 and 96 were fed the same diet to which water was added equal to one-third the weight of the meat-meal mixture; troughs 93 and 94 received diet 6 to which an equal quantity of water was added. At the end of six weeks troughs 93 and 94 were in such poor condition that they were removed from the experiment. The fish in the other troughs were still feeding quite well and were continued on their respective mixtures for another two weeks, during which time trough 97 endured a heavy loss (cause undetermined). At this time, June 29, most of the brook trout were removed from the building, and so this experiment was terminated.

Apparently this particular feed mixture can be prepared and fed satisfactorily with no water added, or with water added up to as much as one-third by weight of the meat-meal mixture. Regardless of the consistency of the food, no difference in the uniformity of the trout could be noticed. The only advantage seems to be that with the added water the mixture is more easily prepared.

Experiment G

This experiment, using tomato juice as the source of vitamin C in a limited study of its relationship to ulcer disease, was terminated August 10. No summary of the data is ready at present, but it is evident that tomato juice as used in this experiment is probably not effective in prevention or cure of ulcer disease.

Some Difficulties Encountered in Experimental Work at Wolf Lake Hatchery

The experimental work is conducted in the No. 1 hatchery building receiving fresh spring water, whose temperature and dissolved gas content seem both from experience and recent tests to be suitable for hatching and rearing trout. However, this spring pond contains numerous adult brook trout, which according to authorities should not be the case with a hatchery

water supply, especially so if fry and fingerlings make use of the water. Frequent infestations of Gyrodactylus sp. occur among the trout in the No. 1 building, which at times sericusly interfere with normal hatchery production and which are especially disturbing during the conduct of nutrition experiments. In some cases it is desirable to test the value of a diet in the presence of disease factors, but for the basic work it would be much better if any conditions possibly contributing disease factors could be eliminated.

Nowhere in the literature examined is there any reference to the occurrence of Gyrodactylus other than on fish. Possibly they may be present elsewhere; but the removal of all fish life from the spring pond would likely result in a decrease of the incidence of occurrence of Gyrodactylus, and perhaps eliminate it entirely. A few of the brook trout from this pond have been examined, but usually not for Gyrodactylus, and no records were kept. It is planned to make examinations of a number of specimens from here and see whether or not any "Gyros" are present on these fish.

Mr. J. G. Marks, whose long fish cultural experience and advice have materially assisted in the conduct of these experiments, has for some time realized the undesirability of this condition, but practical difficulties have rendered it difficult to properly clean the spring pond which is the source of supply. It is understood that plans have been made to do this during the coming fall.

With reference to the ulcer disease, the Wolf Lake station is a production unit and therefore the arrangement of hatchery, ponds and raceways using the water repeatedly, demands that all diseased fish be immediately removed from the premises to avoid any possibility of spreading the disease to the regular hatchery stock. If it were possible to have the water supply for the experimental work used only for that purpose and passed out into a waste area where it could do no harm to the rest of the

hatchery, then diseased stock could be carried and studied in an attempt to discover the cause, or methods of prevention or cure. As it is at present, it is necessary to discontinue diseased stock not only to avoid contamination of the regular hatchery fish, but also to prevent reducing the production of the station.

There is no doubt but that experimental work conducted in a production station interferes somewhat with the regular program. Sometime during each season it is necessary to dry out the buildings and paint the troughs in preparation for the hatching and rearing program starting late in the fall. The time preferred for this painting is during the hot, dry weather of the summer months. This means that either the painting must be delayed until later in the fall, or that the fish must be moved from the original troughs to another suitable place or that the experiment must be discontinued. Due to refrigeration problems, other suitable space is not now available at this station.

When used for experimental purposes, standard rearing troughs necessitate the use of large numbers of fish. Up to the present this arrangement has been quite satisfactory since the experiments involved only fingerling trout, and it was desirable to handle them in as nearly the same way as at production hatcheries. For more detailed nutrition or disease studies, however, troughs of perhaps different shape as well as dimensions would be more satisfactory.

Thus far the experiments have all been conducted indoors, even after the fish were so large that many were lost by leaping over the sides of the troughs. This situation calls for covers, sideboards, specially constructed tanks, or removal to out-of-door raceways. At Wolf Lake no such raceways are available and so in past seasons it has been necessary to resort to covers which greatly impede cleaning and feeding and which are

likely to have some effect upon the trout. Since it is customary during May to move many of the young trout to rearing stations, it would seem advisable another year to conduct some experiments in raceways under out-of-door conditions. And since the feeding of larger fish in the rearing stations is responsible for a large part of the cost of fish food in the state, results obtained with fish studied under raceway conditions would permit of direct application of methods and diets found to be suitable.

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